Page changes for Main Report

INTERIM FEASIBILITY REPORT

FOR

SALEM RIVER, NEW JERSEY

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
JULY 1990

REVISED MARCH 1991

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106-2991

REPLY TO
ATTENTION OF

DELAWARE RIVER, COMPREHENSIVE NAVIGATION STUDY

INTERIM FEASIBILITY REPORT

FOR

SALEM RIVER, NEW JERSEY

Revised

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
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Dredged materials would be placed at the existing Federal disposal site at Killcohook, ~~on a reimbursement with costs reimbursed by the local sponsor.~~

SYLLABUS

This interim feasibility study is in response to a resolution adopted by the House Committee on Public Works authorizing the Delaware River Comprehensive Navigation Study (2 December 1970) and a resolution by the Senate Committee on Public Works (20 September 1974) regarding disposal of dredged material. Additionally, the study is in response to Section 859 of the Water Resources Development Act of 1986 (P.L. 99-662). The existing 12' project was adopted in 1925 and provides for an entrance channel from the Delaware River to the fixed Route 45 highway bridge in Salem, a distance of about five miles. The dimensions are 150' wide from the Delaware River through Salem Cove narrowing to 100' at the cutoff at Sinnicksons Landing. The existing authorized dimensions do not provide adequate depths to permit efficient transit of vessels, necessitating costly shipping practices of lightloading, tidal delays and use of smaller ships than those which the terminal can accommodate.

Channel depths of 14' MLW to 24' MLW and corresponding widths ranging from 160' to 280' are examined in this feasibility report. Based on the findings of the study, the recommended plan of improvement includes deepening the channel to 18' MLW, widening to 180' and providing a turning basin.

The total cost ~~of the~~ project is $9,974,000 of which $8,128,000 is Federal and $1,846,000 non-Federal. The figures are based on 90% Federal and 10% non-Federal cost sharing for the general navigation features ($9,031,000 - channel and turning basin) and additional provision of lands, easements rights-of-way, relocations, and dredged material disposal areas (LERRD=$943,000 (which includes costs for advance replacement of the Federal disposal area)) by the non-Federal sponsor. The sponsor is also responsible for associated project costs of $266,000, which brings the total costs for the non-Federal sponsor to $2,112,000 and the total first cost to $10,240,000. An additional 10 percent of the cost of general navigation features less credit for LERRD may be repaid by the non-Federal sponsor over a period of 30 years. However, since the LERRD exceeds 10 percent of the general navigation features, no additional payments are necessary. Based on the total average annual investment costs of $1,342,000 and cumulative average annual benefits of $2,053,000 the benefit cost ratio is 1.5 to 1. All operation and maintenance costs, exclusive of the berthing area costs would be borne by the Federal government.

SALEM RIVER
INTERIM FEASIBILITY STUDY

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DELAWARE RIVER COMPREHENSIVE
NAVIGATION STUDY

SALEM RIVER
FEASIBILITY STUDY

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INTRODUCTION

1. The Delaware River Comprehensive Navigation Study was established to address the problems of Federal interest in the waterways within the Delaware River system. This Interim Feasibility Report prepared under the Comprehensive Navigation Study authority addresses the adequacy of authorized channel dimensions of the Salem River in Salem County, New Jersey. Because the current and projected commerce on the Salem River are not dependent on the other waterways of the Delaware River, the problems at this waterway and the potential solutions to these problems have been considered separately.

STUDY AUTHORITY

2. This interim feasibility study was initiated in September 1984 and was conducted in response to a resolution authorizing the Delaware River Comprehensive Navigation Study. This resolution, passed by House Committee on Public Works in 1970 reads as follows:

> Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports on the Delaware River from Trenton, New Jersey, to the sea, contained in House Document Number 358, 83rd Congress and other reports with a view of promoting and encouraging the efficient, economic and logical development of the Delaware River Ports. The scope of such review shall encompass investigation of current shipping problems, adequacy of facilities, delays in intermodal transfers, channel dimensions, storage locations, and capacities, and other physical aspects of affecting waterborne commerce, including the conduct of such model studies as may be necessary to establish an efficient layout of the port complex and the design of navigation facilities. Such investigation shall also include, but not be limited to, the impact of waterborne commerce in the Delaware River region on the local, national and international economies, and its relation thereto: research into current and future markets for the import and export commerce of the region; evaluation of regional integrated approaches toward the opportunities and problems engendered thereby; an inventory of regional shipping facilities, capacity, and operating entities and evaluation thereof; a study of industrial and trade trends owing to new and improved technological advances, methods, improved vessel design, cargo handling facilities, extension of automation, and other cargo, vessels, and operating concepts; relationship of waterborne shipping to other modes of transportation with particular reference to intermodal transfer and facilitation of through shipments; comparison of the status and future of Delaware river ports and terminals with other national and

> international harbor complexes; recommendations for types, sizes, and locations of future facilities, and improvements and expansions of existing facilities, including deep-draft navigation channels; recommendations for improvements in port and industrial operations and development through improved coordination and programming, and long-term planning; determination of the adequacy of the region's shipping capacity in terms of its role and function of the port complex in Delaware River Basin development; presentation of guidelines for regional development to the extent required by navigational uses and potentials; determination of bulk movement projections, including estimated raw material requirements of the regional and national economy possible of shipment through the Delaware River ports, with particular reference to economies afforded by use of supersized bulk transport vessels and tankers; effects of the regional and national economy of new and expanded heavy industry and ancillary industries dependent thereon as a result of improved navigation and more efficient port operations; and desirability and extent of Federal participation in securing adequate bases for expansions and improvements of shipping facilities and further integration of regional planning for waterborne commerce. In carrying out this study the Secretary of the Army and the Chief of Engineers shall cooperate with and coordinate their efforts with all affected Federal departments, agencies and instrumentalities and all other interested parties, public and private.

3. This study also responds in part to a resolution regarding dredged material disposal adopted by the U.S. Senate Committee on Public Works on September 20, 1974 which reads as follows:

> Resolved by the Committee on Public Works of the United States Senate that the Board of Engineers for Rivers and Harbors, created under the provisions of Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Delaware River between Philadelphia, Pennsylvania and Trenton, New Jersey, and Philadelphia to the Sea, printed as House Document 358, 83rd Congress, 2nd Session, and other reports with a view to the developing a regional dredging spoil disposal plan for the tidal Delaware River, its tidal tributaries, and Delaware Bay.

4. Additionally, this study is in response to Section 859 of the Water Resources Development Act of 1986 (P.L. 99-662), which states:

> Subject to section 903(b) of this Act, the project for navigation, Salem River, New Jersey, is modified to provide that the depth of such project shall be 20 feet.

STUDY AREA

5. The Salem River Study addresses a study area surrounding the Salem River in the Salem County, New Jersey, a tidal stream entering the Delaware River at mile 60, about 45 miles south of Philadelphia, Pennsylvania (see Figure 1). Since the Port of Salem services Gloucester, Atlantic, and Cumberland Counties in addition to Salem County, this four county area and the five mile river segment comprise the New Jersey portion of the Salem River study area (see Figure 2). Because the border of New Castle County, Delaware extends across this segment of the Delaware River to the New Jersey shoreline, this county is also included in the Salem River study area. The study area reflects the role of the Port in the economic life of southern New Jersey and a market niche which includes locally produced agricultural products and manufactured goods.

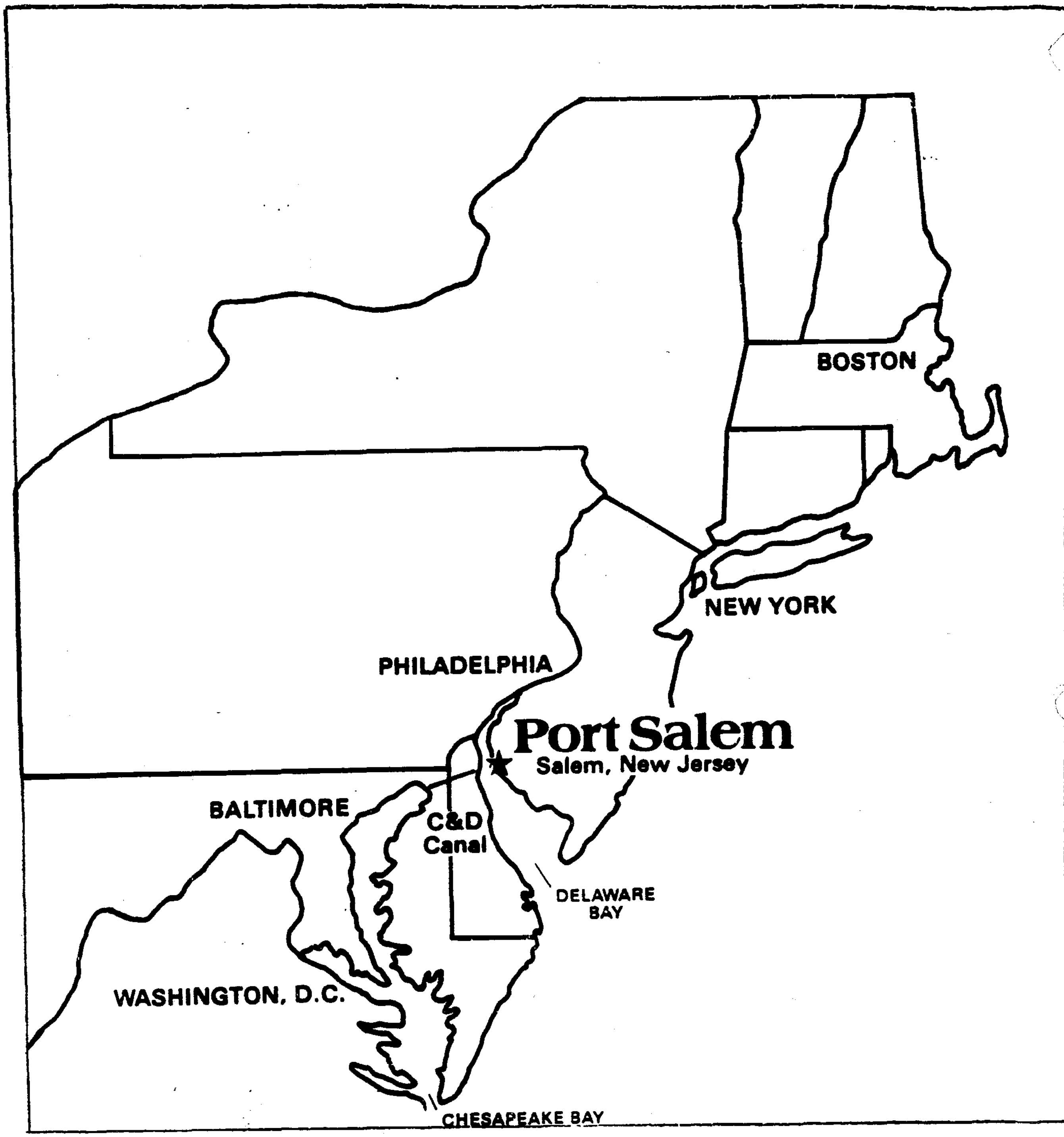
STUDY OBJECTIVE

6. The objective of this interim feasibility study is to investigate the adequacy of the authorized channel dimensions of the Salem River waterway in Salem County, New Jersey.

PRIOR REPORTS AND STUDIES

7. SALEM RIVER - PREVIOUS STUDIES. The River and Harbor Act of July 11, 1870 provided for the first Federal survey of the Salem River. Subsequently a nine foot MLW channel was adopted in 1907. The authorized width was 100 feet. The existing 12 foot project, adopted as HD 68-110 in 1925, is five miles long and provides for an entrance channel from the Delaware River to the Route 49 highway bridge in Salem, south of the Little Salem River. The improved draft from nine to 12 feet was recommended to accommodate vessels utilizing the Chesapeake and Delaware Canal which was under reconstruction at the time. The Salem River dimensions are 150 feet wide from the Delaware River through Salem Cove and 100 feet wide along the cutoff from the "Horseshoe Bend" near Sinnicksons Landing to the port. This cutoff, constructed as part of the 1925 authorization, saves vessels one mile travelling from Salem to deep water in the Delaware River.

8. SALEM RIVER PORT REDEVELOPMENT PLAN. The Salem River Housing Authority and Community Development Agency completed a plan in 1982 for redeveloping the Port of Salem prior to the formation of the Salem Port Authority. This plan examined existing zoning statutes, land use patterns, cultural/historic areas, and transportation and utility networks and made a series of recommendations for port redevelopment, many of which were subsequently accomplished. The recommendations were intended to provide a framework for industrial land use associated with the proposed port.

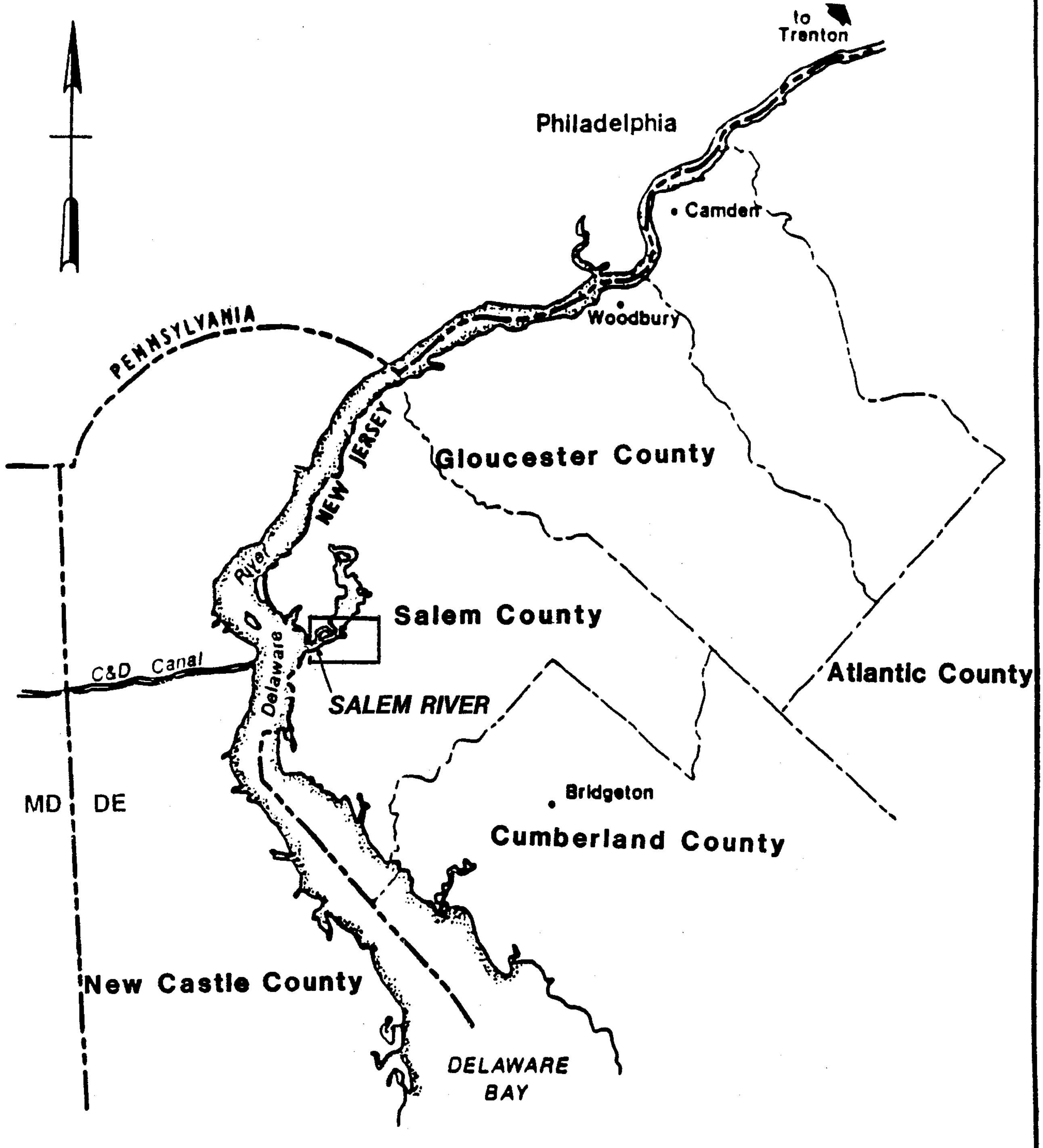


SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

GEOGRAPHIC STUDY AREA

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 1



SALEM RIVER, NEW JERSEY
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COUNTY POLITICAL BOUNDARIES

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 2

9. SALEM RIVER MAINTENANCE DREDGING ENVIRONMENTAL ASSESSMENT. The U.S. Army Corps of Engineers conducted an environmental assessment of the dredging and open water disposal of dredged material prior to the 1984 maintenance dredging of 350,000 cubic yards of material from the lower Salem River. That environmental assessment determined that the maintenance project was in full compliance with all environmental protection statutes and environmental review requirements.

EXISTING PROJECTS

10. The existing project provides for an entrance from the Delaware River at Elsinboro Point to the State Route 45 highway bridge in the City of Salem with dimensions and limits as shown in Figure 3. The 12 foot authorized depth of the Salem River was authorized in 1925 and constructed in 1928 from the mouth to Penns Neck Bridge (Route 49). However, the channel was not maintained between 1961 and 1984 due to an absence of commercial navigation. The redevelopment at the Port of Salem led to the 1984 reinstitution of maintenance dredging to authorized dimensions. The Little Salem River (also known as Fenwick Creek) portion, has never been constructed to a twelve foot depth. The Little Salem River was deauthorized in December 1989 under the provisions of Title X of the Water Resources Development Act of 1986. Under the provisions of the Act the Little Salem River authorization reverts to the nine foot depth constructed in 1907.

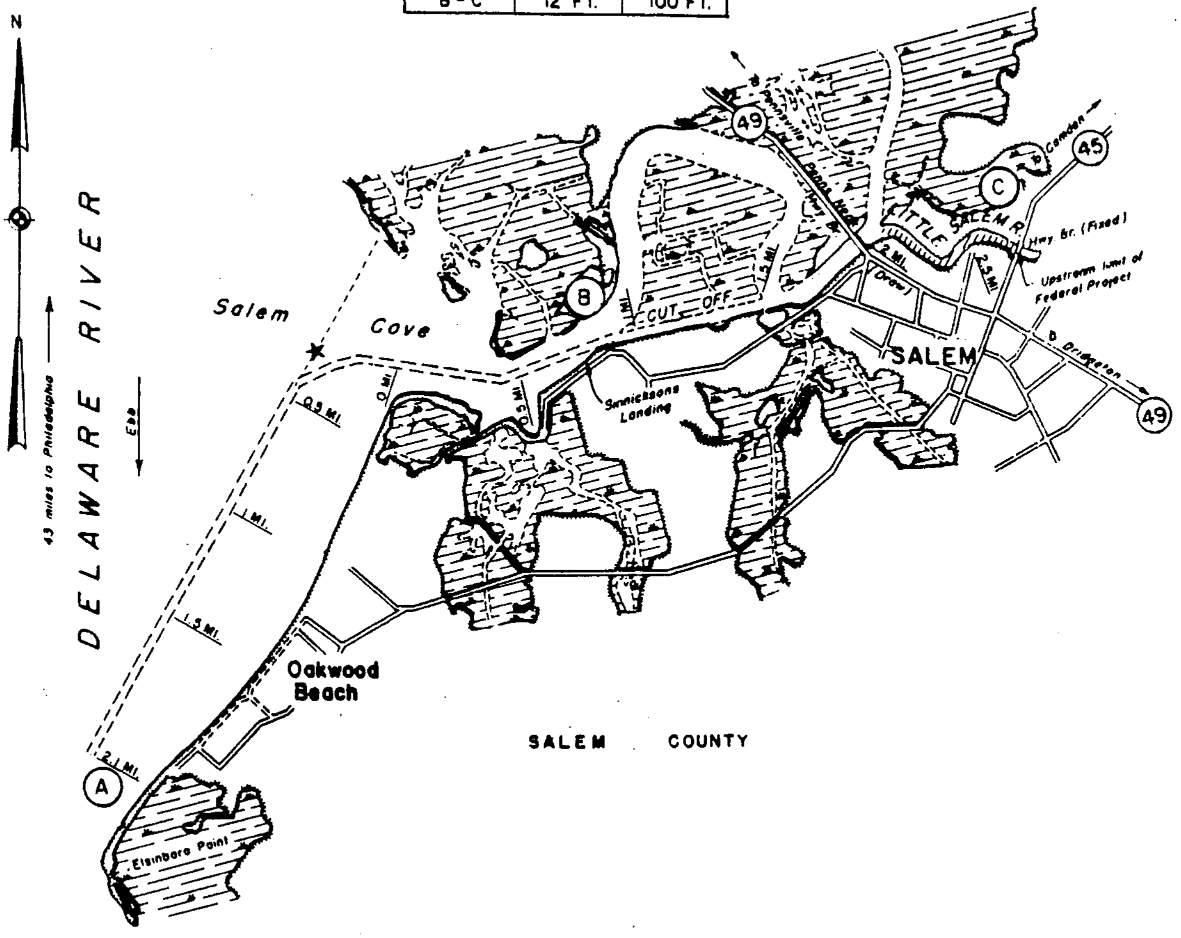
11. The Salem River is accessed via the Delaware River, Philadelphia to the Sea waterway. This project, shown in Figures 4 and 5, provides for a 40 foot deep-draft waterway extending the 100 mile distance between Philadelphia Harbor and the Atlantic Ocean. One anchorage adjacent to the Philadelphia to the Sea channel, Reedy Point Anchorage, has been used for mid-stream transfer of grain from barges loaded at the Port of Salem to deep-draft dry bulk vessels and for occasional topping off of vessels too large to transit Salem River. Vessels waiting for appropriate tides to enter Salem River anchor at Reedy Point Anchorage.

12. The Delaware River terminus of the Chesapeake and Delaware Canal (C&D) is directly across the Delaware River from the mouth of the Salem River. The C&D Canal system provides a continuous sea level channel connecting the Port of Baltimore and Ports to its south to the northern ports of Wilmington, Philadelphia, New York and the northern trade routes. This canal connects the Delaware River and the Chesapeake Bay and is currently authorized at 35 feet and under study for improvement. Due to the disparities in depths, any modifications to the Chesapeake and Delaware Canal would not impact the Salem River project, although the C&D Canal has historically been an influence on the Salem River as manifested by the 1925 House Document cited previously. As the Port expands, shippers could take advantage of the river's proximity to the C&D Canal link to Baltimore, Norfolk and the southern trade routes.

CORPS OF ENGINEERS U.S. ARMY

N32

CHANNEL DIMENSIONS		
LOCATION	DEPTH	WIDTH
A - B	12 FT.	150 FT.
B - C	12 FT.	100 FT.



AREA WHERE NEW WORK REMAINS TO BE DONE, SHOWN THUS: //////////

THIS AREA HAS BEEN DREDGED TO A DEPTH OF 9 FEET.

SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

EXISTING PROJECT

SCALE OF FEET
1000 0 1 2 3 4 5 6 7 8000

U.S. ARMY ENGINEER DISTRICT, PHILA.

FIGURE 3

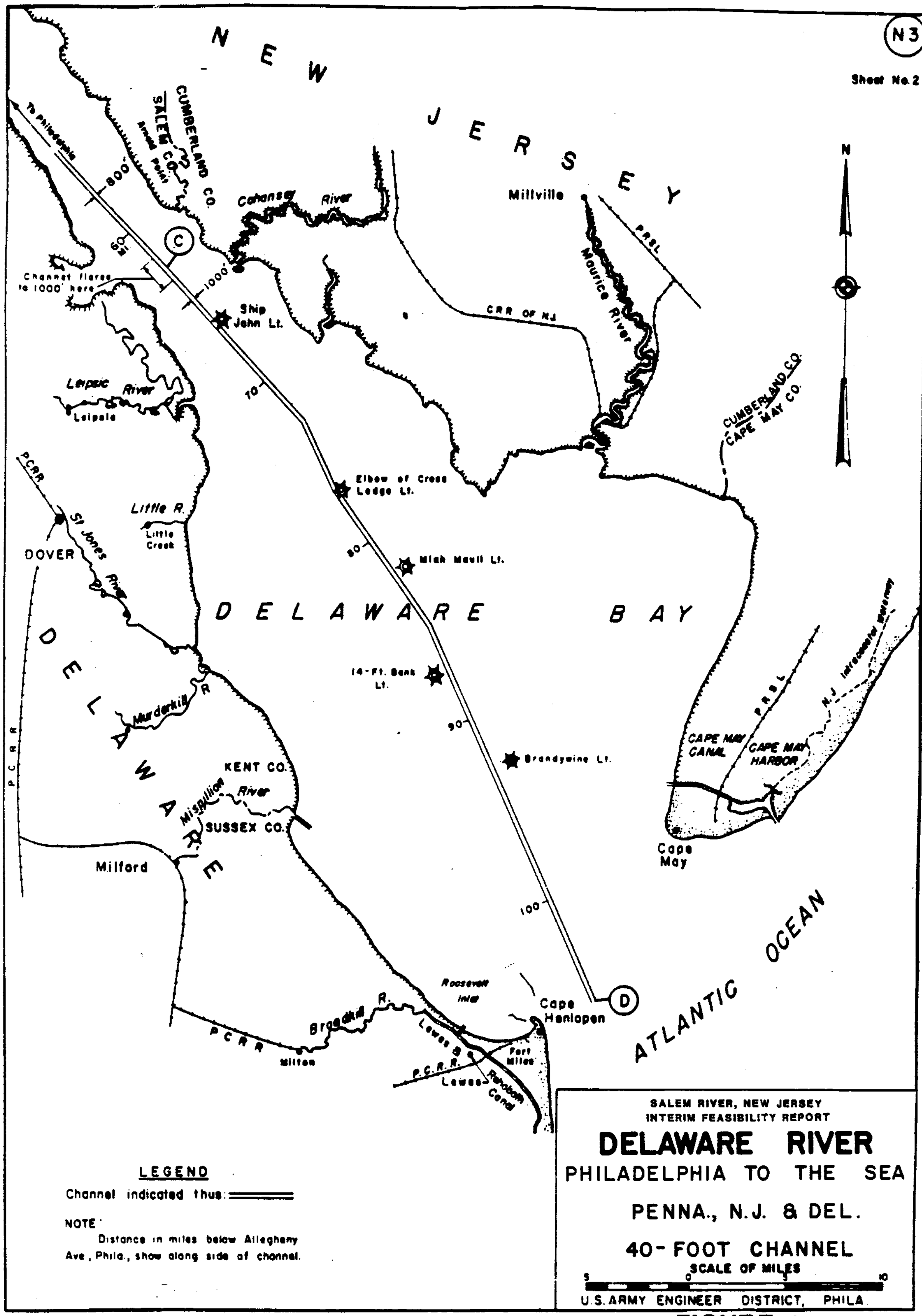
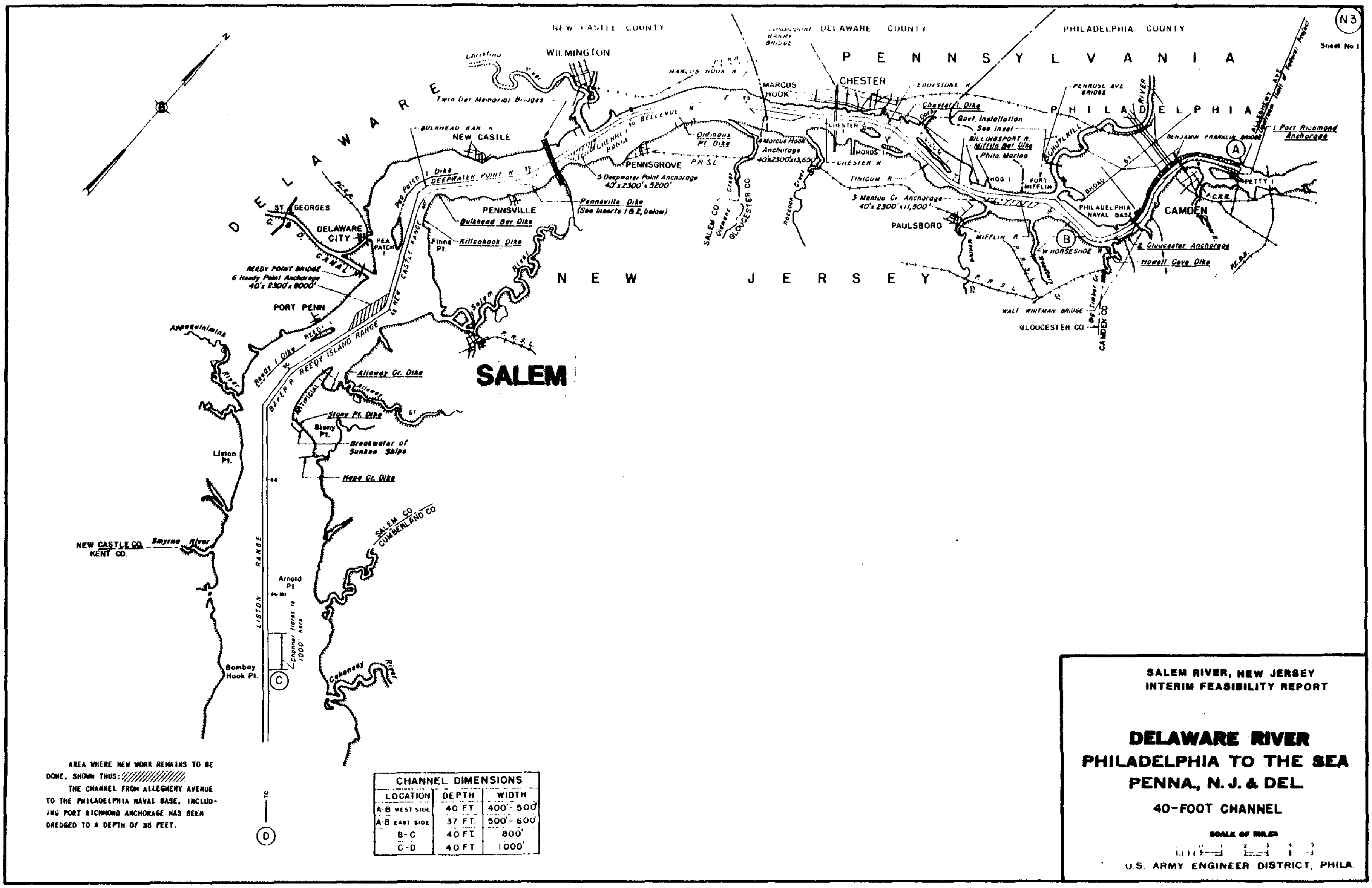

N3
Sheet No. 2
NEW JERSEY
CUMBERLAND CO.
SALEM CO.
To Philadelphia
800'
Cohansey River
Millville
PRSL
Maurice River
Channel flares to 1000' here
1000'
Ship John Lt.
CRR OF NJ
Leipsic River
Leipsic
70
Elbow of Cross Ledge Lt.
CUMBERLAND CO.
CAPE MAY CO.
PCRR
Little R.
Little Creek
DOVER
St Jones River
80
Miah Maull Lt.
DELAWARE BAY
DELAWARE
14-Ft. Bank Lt.
Murderkill R.
90
Brandywine Lt.
CAPE MAY CANAL
CAPE MAY HARBOR
KENT CO.
Mispillion River
SUSSEX CO.
Milford
Cape May
100
ATLANTIC OCEAN
Roosevelt Inlet
Cape Henlopen
Broadkill R.
PCRR
Milton
Lewes
Fort Miles
Lewes & Rehoboth Canal
LEGEND
Channel indicated thus:
NOTE
Distance in miles below Allegheny Ave., Phila., show along side of channel.
SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT
DELAWARE RIVER
PHILADELPHIA TO THE SEA
PENNA., N.J. & DEL.
40-FOOT CHANNEL
SCALE OF MILES
5 0 5 10
U.S. ARMY ENGINEER DISTRICT, PHILA.

FIGURE 4



CHANNEL DIMENSIONS

LOCATION	DEPTH	WIDTH
A-B WEST SIDE	40 FT	400'-500'
A-B EAST SIDE	37 FT	500'-600'
B-C	40 FT	800'
C-D	40 FT	1000'

FIGURE 5

EXISTING CONDITIONS

HUMAN RESOURCES

13. POPULATION. The five county study area has a population of approximately one million based on 1985 Bureau of the Census estimates. The population estimate of the five county area was 1,014,300 reflecting a 10.5% increase within the fifteen year time period (1970-1985). Table 1 shows a breakdown of population by county.

TABLE 1

POPULATION OF STUDY AREA

County	Population 1970	Population 1980	Population Estimates 1985	Percentage Changes 1970-1980	Percentage Changes 1980-1985
DELAWARE					
New Castle	385,856	398,115	402,100	3.4	1.0
NEW JERSEY					
Atlantic	175,043	194,119	205,000	10.9	5.6
Cumberland	121,374	132,866	134,900	9.5	1.5
Gloucester	172,681	199,917	207,100	15.8	3.6
Salem	60,346	64,676	65,200	7.2	.8
TOTAL	915,300	989,693	1,014,300		

14. EMPLOYMENT AND INCOME. The counties in the study area have a labor force which rose from 350,766 in 1970 to 427,986 in 1980, an increase of 18% (see Table 2).

TABLE 2
EMPLOYMENT AND INCOME

County	Total Employment 1970	Total Employment 1980	Total Unemployment 1970	%	Total Unemployment 1980	%	Per Capita Income 1970	Per Capita Income 1980	Median Family Income 1970	Median Family Income 1980
DELAWARE										
New Castle	151,125	182,132	6,097	3.9	11,525	6.0	3,577	8,067	10,985	22,704
NEW JERSEY										
Atlantic	65,462	82,915	3,978	5.7	7,659	8.5	3,083	7,194	8,775	19,216
Cumberland	46,942	52,866	2,931	5.7	5,522	9.5	2,882	6,032	9,522	17,557
Gloucester	64,034	84,758	2,661	4.0	6,935	7.6	3,032	6,939	10,620	21,882
Salem	23,203	25,315	901	3.7	2,515	9.0	3,102	6,714	10,221	20,498
Total	350,766	427,986	16,568	4.6	34,156	8.1				

15. Unemployment also rose from 16,468 to 38,156 during the ten year time period reflecting an unemployment rate in the area of 4.6% in 1970 and 8.1% in 1980. Income doubled in the five county region from 1970 to 1980 (see Table 2). The employment trends in the Salem River study area show a decrease in manufacturing positions consistent with the regional trend and an increase in service related jobs (See Table 3).

16. The Port of Salem employs a leased labor workforce of about 75 men who are on call for use by the Salem Marine Terminal Corporation. The past two years (1988-1989) were less labor intensive due to shifts in cargo to more containerized commodities, as shown:

	1986	1987	1988	1989
Total Hours	15,234	28,822	6,087	10,056
Total Wages	$168,140	$328,670	$70,000	$95,000

17. The educational levels of the workforce on an average county-wide basis have increased from 11.46 median years to 12.34 median years from 1970 to 1980 (see Table 4). Training programs have been instituted in cooperation with the local vocational school to provide a more experienced work force and benefit the economy of the local community.

ENVIRONMENTAL SETTING AND NATURAL RESOURCES

18. TERRAIN. Salem County is part of the Atlantic Coastal Plain physiographic province. The terrain is characterized by gently rolling hills and sandy soils with no rock outcrops or steep slopes. The Atlantic Coastal Plain is generally composed of a wedge-shaped series of unconsolidated layers of sands, clays and marls on gently southeastward dipping bedrock 1300 to 6000 feet below the surface extending seaward to the submerged Continental Shelf.

19. LAND USE. Salem County is predominantly rural in character; agricultural or open space comprises the majority of the land use.

20. In the immediate vicinity of the project, land use generally consists of wetlands and undeveloped areas adjacent to the Salem River channel and areas of residential and commercial development, including the Salem Redevelopment Area. Undeveloped upland areas around the City of Salem are generally woodlands or prime farmlands. The shorefront of Elsinboro Township includes Oakwood Beach bordering Salem Cove and Sinnicksons Landing along the "new cut" of the Salem River constructed in 1928 by the Corps of Engineers. These areas are exclusively residential communities, with large tracts of low marshlands.

TABLE 3

EMPLOYMENT BY INDUSTRY (Percentages)

	Agriculture & Mining 1970	Agriculture & Mining 1980	Construction 1970	Construction 1980	Comm. Transp. & Utilities 1970	Comm. Transp. & Utilities 1980	Wholesale & Retail Trade 1970	Wholesale & Retail Trade 1980	Service 1970	Service 1980	Public Admin. 1970	Public Admin. 1980	Finance Admin & R.E. 1970	Finance Admin & R.E. 1980	Manufacturing 1970	Manufacturing 1980
DELAWARE																
New Castle	1.0	1.0	7.1	5.8	6.0	6.9	19.4	21.7	27.6	29.8	3.5	4.3	5.0	5.8	30.5	24.7
NEW JERSEY																
Atlantic	1.9	1.3	8.2	7.5	7.4	6.8	24.9	21.0	28.1	38.0	7.8	8.0	5.2	5.9	16.5	11.5
Cumberland	4.6	3.4	5.3	4.5	5.5	6.2	16.1	16.8	18.9	26.5	3.7	4.6	4.4	4.7	41.5	33.2
Gloucester	2.5	1.7	7.2	6.7	7.6	8.1	18.9	21.1	21.4	27.1	3.8	4.6	5.0	5.4	33.6	25.4
Salem	4.3	3.8	5.9	6.3	5.9	8.1	15.3	16.1	18.1	24.8	2.5	3.2	3.2	3.4	44.8	34.2

TABLE 4

EDUCATION LEVEL OF WORK FORCE

County	Median School Years Completed 1970	Median School Years Completed 1980
DELAWARE		
New Castle	12.2	12.6
NEW JERSEY		
Atlantic	11.2	12.3
Cumberland	10.7	12.1
Gloucester	11.9	12.4
Salem	11.3	12.3
Average	11.46	12.34

21. Oakwood Beach borders the Salem Cove and is comprised of single-family dwellings on narrow, deep land parcels most of which have bulkheads and/or small beaches. The beach area has eroded substantially over the last several decades and in recent years there has been significant local concern. The Salem River channel and associated dredging do not contribute to any of this erosion.

22. Sinnicksons Landing is built on land which has been filled from its natural lowland and/or marshy state. The homes are single-family dwellings on larger land parcels than in Oakwood Beach. Many have small boat landings on the Salem River new cut.

23. The Port of Salem Redevelopment Area is located on the south bank of the Salem River about 200 yards west of the State Route 49 bridge. The predominantly industrially developed land is interspersed with a few commercial enterprises. It is zoned for light and general manufacturing. Industrial buildings in the redevelopment area are mainly older one and two-story warehouses and manufacturing structures. The largest facility, occupied by a trucking firm, is located in the former H.J. Heinz plant in the northernmost portion of the redevelopment area. The former Foster Glass Company structure, located in the center of the redevelopment area, was converted into a mineral reprocessing plant by Alu-Chem, Inc. The Salem City Landfill, a few commercial enterprises (i.e., a sandwich shop, a liquor store, a gas station, a bank), the North Bend Firehouse, and a Conrail branch line spur also are within the borders of the redevelopment area. A portion of the landfill is occupied by Mid-Atlantic Shipping and Stevedoring, Inc. in conjunction with their establishment at Barber's Basin. Mid-Atlantic leased an additional land parcel called the Fire Grounds in January 1989 for container storage. The other portion of the landfill is slated to become part of active Port property. Salem Marine Terminal leased a 60,000 square foot dry storage warehouse and two older warehouses (originally the Wheaton warehouse and the Alu-Chem warehouse). Salem Marine and Mid-Atlantic both own their office buildings within the redevelopment district.

24. Establishments adjacent to the redevelopment area include portions of Mid-Atlantic Shipping and Stevedoring Inc., and a boat repair facility located at Barber's Basin, the Salem City sewage treatment plant, a light manufacturing plant, and an oil storage facility belonging to the TriCounty Oil Company. Two marinas are located downstream along the natural alignment of Salem River in the vicinity of the cutoff. The light manufacturing plant was most recently occupied by South Jersey Technology, a subsidiary of Radiation Technology, Inc., and is located downstream from the Port and Barber's Basin on Tilbury Road. Negotiations have been ongoing for lease of the property by the Port to a company which treats packaged medical products prior to disposal. The site of the former Blue Claw Restaurant adjacent to Barber's Basin was purchased in 1986 by Mid-Atlantic Shipping and Stevedoring Inc. Mid-Atlantic obtained Department of the Army and New Jersey

Department of Environmental Protection permits to construct and operate a terminal at the site. The company has been shipping varied commodities since early 1989 and has expanded the original six and one half acres to eight acres by leasing a portion of the Fire Grounds.

25. CLIMATE. The study area is situated in the mid-Atlantic temperate zone. In general, the climate is mild with a few brief hot, humid periods in summer and cold, windy winter periods of similar duration and frequency. The yearly mean temperature is about 54 degrees and the normal annual precipitation is about 44 inches. The rainfall is well distributed throughout the year with generally more than three inches per month. Temporary droughts or periods of subnormal rainfall are not uncommon for the area.

26. HYDROLOGY. The Salem River project study area is located in the Delaware River estuary between river miles 58 and 61. The Delaware River at this point drains over 11,000 square miles of New York, Pennsylvania, New Jersey, and Delaware.

27. The Salem River is about 22 miles long and discharges into an embayment, Salem Cove. The river drains roughly 117 square miles all within Salem County, New Jersey. The Salem River begins as a moderately fast-moving stream and becomes a tidal river.

28. TIDAL HYDRAULICS. The authorized navigation project occupies approximately two miles at the downstream end of the Salem River, and extends approximately two miles across Salem Cove to deep water in the Delaware River. Flows in the navigation project section of the Salem River are primarily tidal, driven by the semi-diurnal tide of the Delaware River and Bay. The mean tide range in the Salem River study area is 5.6 feet with a 6.1 foot spring tide range. At the Salem Cove entrance to the Salem River, the average maximum flood tide speed is 1.5 knots (2.5 ft/sec.) with an average maximum ebb tide speed of 1.6 knots (2.7 ft/sec.). River currents upstream of the cove can attain 10 to 12 ft/sec. or 6 to 7 knots, according to the river pilots.

29. The Salem River navigation channel has no detectable effects on the Delaware River shoreline between Oakwood Beach and Elsinboro Point. The shoreline has been studied for beach erosion control and hurricane protection in previous studies but sufficient justification for protection could not be established. Hydraulic model studies of the Delaware River have been conducted previously in the vicinity of Salem River. Although these model studies were not specifically directed at evaluating the impacts of the Salem River channel, the data and observations indicate that the navigation project in the Salem River is not related to the Elsinboro erosion problems. The existing authorized channel follows a southwest alignment across Salem Cove, to naturally deep water adjoining the navigation channel of the Delaware River, Philadelphia to the Sea project. This channel alignment is essentially parallel to the Oakwood Beach-Elsinboro shoreline.

Deepening the channel would following the existing channel alignment and should induce no changes in the overall flow pattern capable of causing or increasing erosion of the adjacent shoreline.

30. A survey study of shoreline protection entitled Delaware Bay Coastline, Delaware and New Jersey, was initiated in June 1990. This reconnaissance study will cover the 60 miles from Cape May Point to the Salem River in New Jersey and Cape Henlopen to the Chesapeake and Delaware Canal in Delaware.

31. SALINITY. The salinity of the Salem River project area is controlled by the combined effects of the ambient salinity in the Delaware River and rainfall over the Salem River drainage area. The Delaware River salinity has been monitored by the U.S. Geological Survey since 1963 at the Reedy Island dike approximately three miles southwest of the confluence of the Salem River and Delaware River navigation channels. The salinity is measured as specific conductance of the river water, and daily minimum, maximum and mean values are recorded. Although the long-term mean salinity at the Reedy Island dike gage site is approximately 5 to 6 ppt (dissolved solids in parts per thousand by weight), variations in salinity occur due to semi-diurnal tidal effects in the Delaware River and Bay, as well as seasonal and flood/drought effects. The maximum salinity observed at the gage over the period of record was approximately 23 ppt on 15 November 1978 with a minimum salinity of less than 0.1 ppt. occurring on a number of occasions in 1969 and 1970.

32. The existing Salem River navigation project extends about two miles upstream of Salem Cove in a zone dominated by tidal effects of the Delaware River. Consequently, salinity in the navigation project area reflects the ambient salinity in the adjacent Delaware River. Above the upstream limit of the navigation project is the Mannington Meadow estuary. Detailed salinity studies were conducted of that area in 1972 and 1973 by Rutgers University investigators. The salinity measurements reflect the dilution of ambient Delaware River water by freshwater inflow from the adjacent drainage area. Salinities in the Mannington Meadow area generally are in the range of 20 to 80 percent of the corresponding two day mean salinities at Reedy Island.

33. GEOLOGY. The Salem River Study area is underlain by roughly 1,400 feet of unconsolidated Quaternary, Tertiary, and Cretaceous sediment deposits. These sediments overlie bedrock which consists of metamorphic and igneous rocks of the upper Precambrian age. The unconsolidated formations dip to the southeast and generally thicken oceanward. The older formations are at or near the surface in the vicinity of the Delaware River and are progressively deeper toward the Atlantic Ocean. The unconsolidated sediments consist of pervious and impervious layers which form a series of aquifers and aquicludes.

34. The primary aquifer units within the vicinity of Salem River belong to the Wenonah formation and Mount Laurel Sand of Cretaceous age, the Vincentown formation of Tertiary age, and the Cape May formation of Pleistocene age. The Wenonah formation and Mount Laurel Sand and the Vincentown formation outcrop in narrow bands trending southwest to northeast while the Cape May deposits blanket areas of the older formations. In many locations in or adjacent to the Salem River, these aquifer units are mantled by recent alluvial deposits.

35. The Wenonah formation and overlaying Mount Laurel sand function as a single hydrologic unit. They comprise a highly used aquifer and an important source of water for future development. The Wenonah formation overlies the Cretaceous Marshalltown formation, a leaky aquiclude composed of sandy clay. The Woodbury Clay, also of Cretaceous age, underlies the Marshalltown formation and constitutes a widespread major aquiclude.

36. The Mount Laurel Sand is overlain by the Navesink formation of Cretaceous age, which is in turn overlain by the scarcely distinguishable Hornerstown Sand of Tertiary age. These deposits are composed of sand with varying amounts of silt and clay, and function together as a leaky confining unit for the underlying Mount Laurel aquifer. The Vincentown Sand overlies the Hornerstown Sand and is an important local source of water supply.

37. The Cape May formation is predominantly composed of sands and gravels. In areas where the Cape May deposits are not thick enough to function as an aquifer, their chief hydrologic function is to absorb precipitation and transmit it to underlying formations. If these formations are pervious, a hydraulic connection exists between the shallow water table aquifers in the Cape May formation and the underlying materials.

38. Test borings were taken throughout the proposed project area in order to determine the nature of the material to be dredged. The majority of the borings revealed the material to be a low plasticity clay mixed with some sand, silt and gravel. The only appreciable granular material exists between stations 8+000 and 13+000 and consists of a mixture of sand, gravel, silts and clays.

39. GROUNDWATER QUALITY. Groundwater in the vicinity of Salem Cove generally has natural total dissolved solids concentrations of less than 500 mg/l; this corresponds with New Jersey Department of Environmental Protection (NJDEP) Groundwater Class GW2. Designated uses and quality criteria for this class are:

> Suitable for potable, industrial, or agricultural water supply, after conventional water treatment (for hardness, pH, Fe, Mn, and chlorination) where necessary, or for the continual replenishment of surface waters to maintain the quantity and quality of the surface waters of the state and other reasonable uses (NJDEP 1978).

40. Groundwater beneath the study area in the Cape May Formation, Mount Laurel Sand and Wenonah Formation, and Raritan Formation is influenced by the major recharge areas of the respective aquifers. The Cape May Formation receives induced recharge from the Delaware River between Wilmington and Trenton and is also recharged by rainwater infiltration. The formation's hydraulic gradient in the study area is generally toward the Delaware River. Tidal action and supply well pumpage can locally control or reverse groundwater gradients. The relatively impermeable Holocene alluvium acts as a partial barrier to saltwater intrusion from the Delaware River; however, chloride concentrations preclude the use of this formation for water supply in the study area.

41. The groundwater recharge area of the Mount Laurel Sand and Wenonah Formation is approximately parallel to and midway between the Delaware River and the Atlantic Ocean. The major source of recharge is rainwater infiltration and leakage from the overlying Cape May Formation. The hydraulic gradient is generally toward the southwest; however, local reversals occur due to the effect of pumping wells for water supply and tidal action. Leakage from the Cape May Formation also has introduced salt water into this aquifer. In addition, iron concentrations are extremely high in the formation.

42. Because of the overlying aquiclude, groundwater in the Raritan Formation aquifer is recharged mainly in outcrops in urbanized areas immediately west of the Delaware River, including the City of Philadelphia, and by the Delaware River reach extending from Wilmington to Trenton. The aquifer historically has provided good quality water. However, in recent years groundwater quality has been degraded in portions of the aquifer upgradient of the study area. Changes have occurred in concentration of dissolved solids, chlorides, alkalinity, iron, and manganese; concentrations of iron and manganese greatly exceed the New Jersey groundwater standards. The changes in groundwater quality can be attributed in part to conditions characteristic of an urban recharge area and can be expected to eventually affect groundwater quality in the study area.

43. WATER AND RIVER SEDIMENT QUALITY. The Salem Cove channel lies in New Jersey Department of Environmental Protection (NJDEP) designated Zone 5 of the Delaware River, which includes river miles 78.8 to 48.2. Desirable uses for the study area portion of this zone are as follows:

> Industrial water supply after reasonable treatment; wildlife; propagation of resident fish and other aquatic life, passage of anadromous fish; primary contact recreation; and navigation (NJDEP 1978)

44. The NJDEP stream standards do not address specific heavy metals or toxic substances, but reference the Environmental

Protection Agency (EPA) standards (Quality Criteria for Water, 1976) and similar information for toxicity level guidelines.

45. Water quality in Salem River is considered to be generally fair (United States Geological Survey Water-Data Report NJ-83-2). The river is affected by both point (industrial and municipal discharges) and nonpoint source (agricultural and livestock) wastes. A single composite water quality sample taken on July 26, 1983 was analyzed for the Salem River Maintenance Dredging Environmental Assessment in conjunction with elutriate testing of sediment from the Salem Cove channel. The results show all organic parameters at concentrations below detection limits, with the exception of phenols, and only five metals at detectable concentrations. All measurable concentrations meet water quality criteria. Temperature, dissolved oxygen, and pH data taken during sampling also indicate acceptable water quality conditions. Upstream water quality is discussed in the Environmental Assessment for this report and was also addressed in the earlier report, "Salem River Maintenance Dredging Environmental Assessment, January 1984" (See Figure 6).

46. Salem River channel sediment samples were collected on July 26, 1983, for purposes related to the proposed maintenance dredging. A gravity sediment coring device was driven (where possible) to the proposed dredging depth. The extraction test utilized various chemistry methods, depending on the nature of the parameter being investigated. Extraction test results showed low concentrations of heavy metals and generally nondetectable concentrations of EPA priority pollutants.

47. SHOALING/MAINTENANCE DREDGING CHARACTERISTICS OF EXISTING PROJECT. The channel bottom sediments along the navigation project consist primarily of fine sand and silt, with minor gravel and clay-sized components. The earliest reported improvement to the Salem River in the interest of navigation was dredging across the bar in the Salem Cove area in 1878. Subsequent to that effort, the Salem River navigation project was enlarged in both width and depth. In 1928 the present authorized dimensions and new cut were established. In 1934, 1937 and again in 1945, maintenance dredging was required in the uppermost portion of the authorized project known as the Little Salem River, located between the Penns Neck (Route 49) bridge and the Route 45 bridge. Shoaling in this area was primarily silt and clay contributed from both upstream riverine and downstream estuarine sources.

48. Due to the absence of commercial navigation in the upper portion of the river since the 1945 dredging, maintenance efforts have involved primarily the section of river downstream of the Penns Neck (Route 49) bridge. Maintenance dredging of this section has been performed in 1946, 1960, 1984 and 1988. The total quantity of sediment removed in this period is approximately

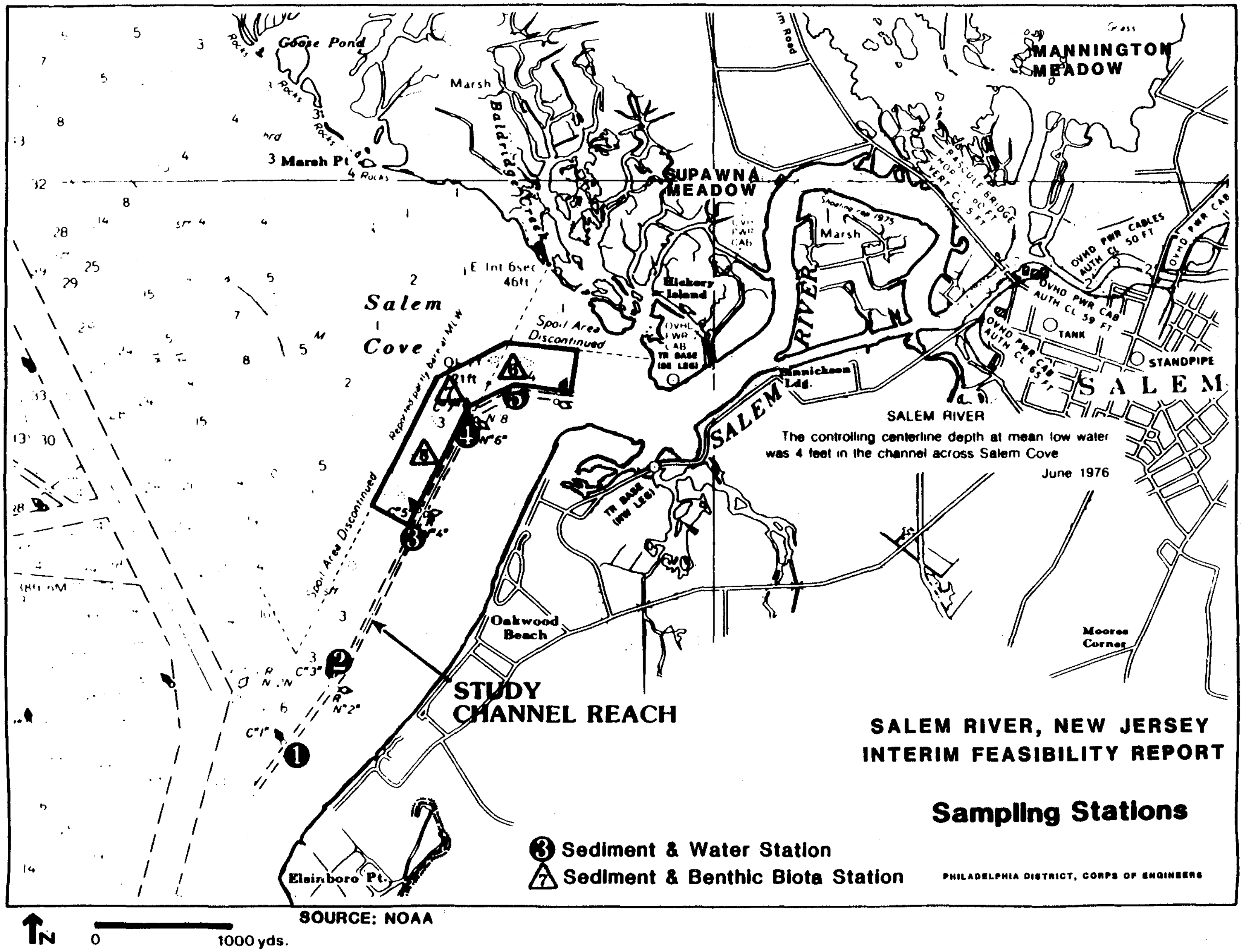

SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT
Sampling Stations
3 Sediment & Water Station
7 Sediment & Benthic Biota Station
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
STUDY CHANNEL REACH
SALEM RIVER
The controlling centerline depth at mean low water was 4 feet in the channel across Salem Cove
June 1976
Salem Cove
Goose Pond
Marsh Pt
Baldridge Creek
SUPAWNA MEADOW
MANNINGTON MEADOW
Hickory Island
Oakwood Beach
Elsinboro Pt.
Moores Corner
SALEM
Spoil Area Discontinued
TANK
STANDPIPE
SOURCE: NOAA
0
1000 yds.
N

FIGURE 6

one million cubic yards, of which only 18,000 cubic yards was removed from the Little Salem River. The remainder of the dredged volume from 1946 to 1988 was removed from a zone about 12,000 feet long where the channel transits Salem Cove. Upstream of the transition from Salem Cove to the Salem River proper, no maintenance dredging has been required since 1946, as depths in this portion of the project upstream to the Penns Neck (Route 49) bridge, have naturally exceeded the authorized depth of 12 feet and exhibit no trend towards shoaling. The average annual maintenance dredging quantity necessary for the 12 foot project has been estimated to be 22,500 cubic yards per year, with a maintenance interval of four years.

49. ECOLOGY. The Salem River study area is mostly open water and includes estuarine subtidal open water, intertidal mudflats, and intertidal emergent wetland habitats.

50. ESTUARINE HABITATS. The waters within the study area support many organisms, although these organisms are somewhat stressed. Several substrate types exist, ranging from poor habitat consisting of silt and clay (in the area used for disposal in the cove) to good habitat consisting of a mixture of sand, silt and clay. The project area is about 13 miles upriver of commercial oystering areas; the cove is used for commercial crab potting and recreational crabbing. The lower portion of the Salem River also is used for recreational crabbing.

51. Fish surveys of the Salem Cove area show a good diversity of fish species, including resident, estuarine-dependent, and marine visitor species. Many species, including Atlantic sturgeon, striped bass, and white perch utilize the cove shallows for spawning and nursery areas. Available icthyoplankton data confirm this.

52. The project area is located on the northeast migratory flyway and "thousands" of migratory waterfowl utilize the cove, river, and adjacent wetlands (described in the following section) during spring and fall migration periods (USFWS 1981). The most common species are mallard (Anas platyrhynchos), black duck (Anas rubripes), and Canada goose (Branta canadensis). Several hundred waterfowl over-winter in the area each year.

53. INTERTIDAL/WETLAND HABITAT. The project study area contains some high-quality wetland and intertidal habitats. Almost all of the intertidal habitat is emergent wetland categorized as "Estuarine Intertidal Emergent Persistent" according to the U.S. Fish and Wildlife Service approved "Classification of Wetlands and Deepwater Habitats of the United States". The most significant wetland area is the Supawna Meadows National Wildlife Refuge (see Figure 6).

54. The southern extreme of the Supawna Meadows National Wildlife Refuge extends to the north bank of the Salem River opposite

Sinnicksons Landing. Dominant vegetation includes saltmarsh cordgrass (Spartina alterniflora) (high vigor), common reed (Phragmites australis), arrow arum (Peltandra virginica), and marsh mallow (Hibiscus palustris). Saltmarsh cordgrass and common reed are the dominant species in the other study area wetlands, with the exception of a small pocket of sea myrtle (Baccharis halimifolia located near the Salem Country Club golf course.

55. TERRESTRIAL HABITAT. The project area includes significant agricultural, industrial, and residential terrestrial habitats. The inventory of existing ecological conditions in these areas is limited to species tolerant of human activity. The setting becomes more rural toward Elsinboro Point. The Salem Country Club golf course provides some large relatively undeveloped upland areas.

56. THREATENED OR ENDANGERED SPECIES. There are no state and Federally listed endangered or threatened species known to occur within the study area. Species may be present on a transient basis.

57. CULTURAL RESOURCES. The major cultural/chronological periods identified for the Northeast and North America are the: Paleoindian (c. 12,000 to 8,500 years Before Present, or B.P.), Archaic (c. 8,500 to 5,100 B.P.), Woodland (5,100 to 400 B.P.) and Historic (400 B.P. to present). The evolution of the Delaware River from a flowing freshwater river to a drained estuary would have submerged, and perhaps destroyed, most sites from the earliest two periods within the project area. However, evidence from later prehistoric and historic cultures has been found along the banks of the Salem River. A 1979 cultural resources study categorized portions of the Delaware River and Bay shoreline as high, medium, and low sensitivity zones. The Salem River study area is categorized as low to medium sensitivity for cultural resources. A 1986 reconnaissance level assessment of cultural resources in the new cut area demonstrated a high sensitivity for prehistoric sites in the western end of the north bank where high ground is located. From its earliest settlement, Salem has been a major shipping point for South Jersey. Historical records refer to several wrecks in the vicinity of the rocks and bars at the mouth of the Salem River. A remote sensing investigation identified one target area to examine further to determine the significance of possible submerged cultural resources.

58. Europeans first settled along the Salem River in the mid-seventeenth century and Salem was one of the first European settlements in the state. The Market Street Historic District is the only designated National Register of Historic Places property in the city. The district, located adjacent to the wharf redevelopment area in Salem, is composed predominantly of two-and-a-half and three-story brick houses built in a variety of architectural styles.

59. The precise location of seventeenth-century Swedish Fort Elfsborg is the principal unresolved historical issue at Salem. Over the past 300 years the shoreline has receded 500 to 1,000 feet to the east. The most likely location for the fort is offshore from the present Elsinboro Point between the high water mark and the main channel of the Delaware River (See Figure 7). The site is not within an impact area of any project modification.

DEVELOPMENT AND ECONOMY

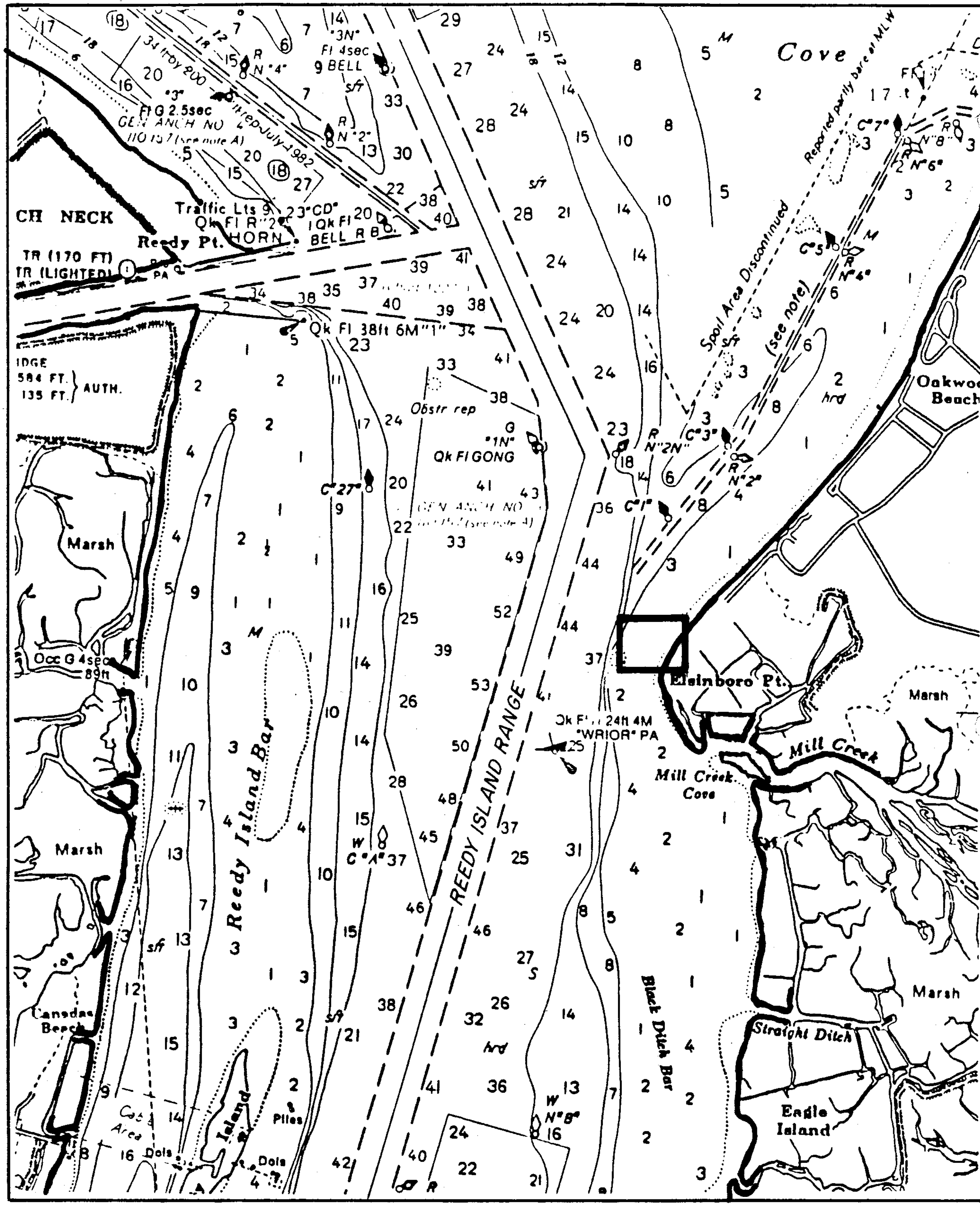
60. The redevelopment of the Port of Salem was formally proposed after a resurgence of interest at a public meeting in March, 1982. In May of that year a trial run of soybeans was shipped out of the port to Norfolk, Virginia through the Chesapeake and Delaware Canal. As a result of this successful test shipment, the Salem City Council in July, 1982 created the municipal port authority.

61. Development of port facilities followed as potential trade relationships were cultivated and a few shipments were made. The 1984 dredging of the lower Salem River to authorized dimensions allowed the revitalization of a general cargo port operation serving the coastwise and Caribbean international markets.

62. Additionally in August 1987, the Port Authority was authorized as a general purpose Foreign-Trade Zone (FTZ) within the Philadelphia Consolidated Customs port of entry. This expanded the economic potential of the Port by increasing trade advantages. In early 1988 the Port Authority sponsored an FTZ sub-zone application for a Mount Holly, Burlington County automobile parts assembly firm. In April 1988 a boundary modification request for the FTZ was submitted to the Department of Commerce to include the area leased by the Salem Marine Terminal Corporation. This request was approved in August 1988. Salem Marine's initial shipment in the late summer of 1988 consisted of 1200 tons of relief cargo to Central America and the company has continued to do Caribbean trade.

63. WATERBORNE COMMERCE TRADE ROUTES. The Port of Salem is linked to an economic study area by internal, coastwise, and ocean-going transport of commodities as listed in Table 5.

64. COMMODITY MOVEMENTS. The first modern day shipment through the Port of Salem occurred in May 1982, when 1500 short tons of soybeans traveled by barge down the Salem River channel en route to Norfolk, Virginia, by way of the Chesapeake and Delaware Canal. Four additional barge shipments occurred that year, two for soybeans and two for chemicals. A summary of historical general cargo/container and bulk commodity movement categories from 1982-1989 is given in Table 6.



POSSIBLE FORT LOCATION

ONE MILE

SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

FORT ELFSBORG: NOAA CHART 12311

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 7

TABLE 5

WATERBORNE TRADE ROUTES

General Cargo/Containers
- (1) Salem - Bermuda
- (2) Salem - Jamaica
- (3) Salem - Trinidad
- (4) Salem - Barbados

Grain (originating from southern New Jersey agricultural region)
- (1) Salem to Jamaica
- (2) Salem to Nova Scotia

Fertilizer (destined for use in Southern New Jersey agricultural region)
- (1) South Carolina to Salem
- (2) Nova Scotia to Salem

Perishables (originating from Southern New Jersey agricultural region; processed in the local irradiation facility; shipped to foreign destinations)
- (1) Salem to Trinidad
- (2) Salem to East Germany
- (3) Salem to United Kingdom

Scrap Iron/Steel (used locally in the manufacture of finished steel products)
- (1) Nova Scotia to Salem

Lumber (used in local construction industry)
- (1) Brazil to Salem

Fish Meal (used locally)
- (1) Maryland to Salem

Other Miscellaneous Bulk Commodities
- (1) Salem from Trinidad
- (2) Salem from Brazil
- (3) Salem from Mexico

65. Grain shipments comprised the majority of tonnage between 1982 and 1984. In 1985, the leading commodity, in terms of tonnage, was scrap iron and steel imported from Nova Scotia. The second largest commodity movement was wastepaper. General cargo amounted to 4,400 short tons and comprised the third largest commodity volume. Also, in 1986, general cargo/containers and lumber comprised the two largest commodity groups. Frozen food was the third largest commodity. Scrap iron and steel imports were fourth in significance. The years 1987 and 1988 were represented entirely be general cargo/container movements. The year 1989 showed approximately 50% of total movements as general cargo/container movements to Bermuda, with the other half consisting of bulk movements of stone, paper, and cement.

66. VESSEL USAGE. Existing vessel usage at the Salem River includes barges and small ships. A summary of historical vessel movements is shown in Table 7. Existing traffic includes a variety of commodities, general cargo, and containerized vessels, including refrigerated cargo vessels.

TABLE 6

HISTORIC PORT OF SALEM TONNAGE
1982-1989

COMMODITY	1982	1983	1984	1985	1986	1987	1988	1989
GENERAL CARGO/CONTAINERS	0	0	0	4,400	5,200	32,600	22,600	21,600
BULK	7,700	6,000	22,300	25,100	11,100	0	0	24,800
TOTAL	7,700	6,000	22,300	29,500	16,300	32,600	22,600	46,400

SOURCES: PORT OF SALEM, PORTS OF PHILADELPHIA MARITIME EXCHANGE, MID-ATLANTIC, PIERS, WCSC

TABLE 7

HISTORIC PORT OF SALEM VESSEL TRIPS
1982-1989

VESSEL TYPE AND COMMODITY	1982	1983	1984	1985	1986	1987	1988	1989	TOTAL
SHIPS									
GENERAL CARGO/CONTAINER	0	0	0	24	21	26	18	88	177
BULK COMMODITIES	0	0	1	2	0	0	0	10	13
SUBTOTAL	0	0	1	26	21	26	18	98	190
BARGES									
GRAIN	3	0	11	0	0	0	0	0	14
FERTILIZER	0	4	2	0	1	0	0	0	7
CHEMICALS	2	0	0	0	0	0	0	0	2
SCRAP IRON & STEEL	0	0	0	1	0	0	0	0	1
SUBTOTAL	5	4	13	1	1	0	0	0	24
TOTAL	5	4	14	27	22	26	18	98	214

SOURCES: PORT OF SALEM, PORTS OF PHILADELPHIA MARITIME EXCHANGE

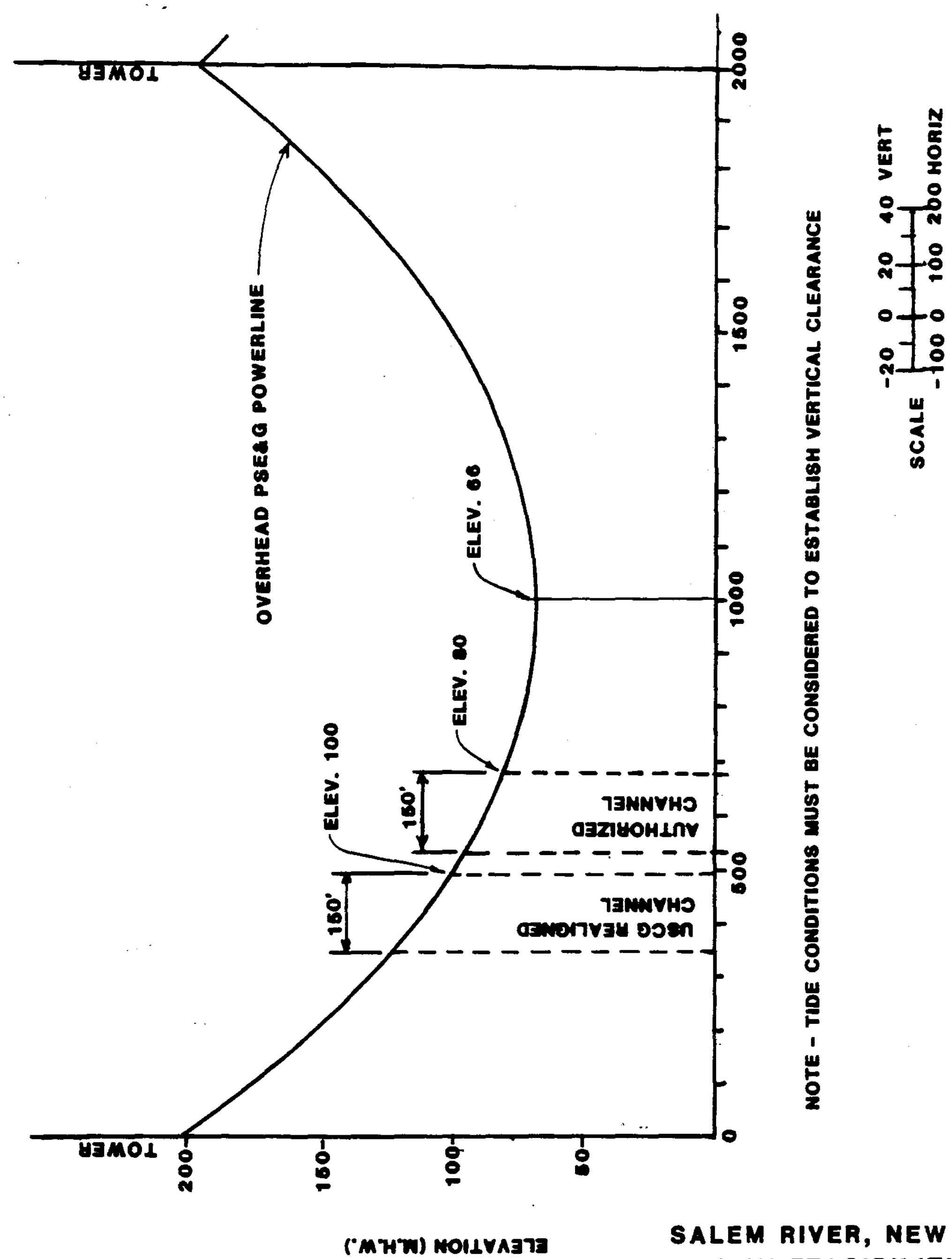
67. Since the 1984 maintenance dredging to authorized dimensions, barges which have used the Salem River are typically 40' x 195' with 11' draft and a 1500 ton capacity. The most common sized ship using the river is a 44' x 268' general cargo vessel with a 14.5' draft and 3000 DWT. The longest ship taken up the river was 347' with a beam of 60'. The widest vessel to use the port was 65' x 310'. The recommended draft restriction was adjusted by the pilots to 15.5' when maintenance dredging was completed in July 1988. Prior to the 1988 maintenance dredging the pilots recommended that vessels not exceed 65' x 350' or a draft of 14.5' and a maximum air clearance of 80 feet due to the Public Service Electric and Gas Company (PSE&G) power line crossing at Sinnicksons Landing. Air clearance over the Salem River varies considerably depending on local temperature, and minimum clearance is published by the U.S. Coast and Geodetic Survey based on mean high water and maximum sag (summer) conditions. As shown on Figure 8, the minimum clearances are 66 feet over the Salem River and about 100 feet over the existing channel as realigned by the U.S. Coast Guard. This is an increase of 20 feet from the authorized channel location. The PSE&G has stated that the minimum clearance from any part of a vessel to the conductors should be 18 feet. This is based on the National Electric Safety Code (ANSI C2-1990 Section 23). Correspondence on this matter is contained in Appendix A.

68. NAVIGATION PRACTICES. Traffic is one-way and all vessels arriving or departing from the Port must be tug assisted and consider tidal conditions.

69. According to the pilots, vessels currently transiting the river use the tidal cycles for efficient operation. Based on vessel draft versus channel depth, some ships transit the Salem River navigation channel during periods of high tide. The mean tidal fluctuation at Salem is 5 to 5.6 feet, meaning that ships using the channel at high tide have approximately 17 feet of depth with which to work. The average length of the tidal cycle (from one low tide to the next) is approximately 12.4 hours.

70. Figure 9 indicates the tidal "window" that is currently available for ships using the Salem channel whose required draft (vessel draft plus 2 feet of keel clearance) exceeds the 12 MLW channel depth. A ship requiring a 17 foot channel depth has approximately 2.2 hours during which the channel is at least that deep. If the vessel misses its window it has to wait 10.1 hours for the next tidal cycle. Similarly, a vessel requiring a 16 foot channel has a window of 4.2 hours during which it could use the channel. Transits were restricted to daytime hours until nighttime aids were installed in November 1989.

71. Since normal transit time is about 45 minutes for Salem River, the window for the vessels requiring a 17 foot channel permits two vessels to move through the channel during this

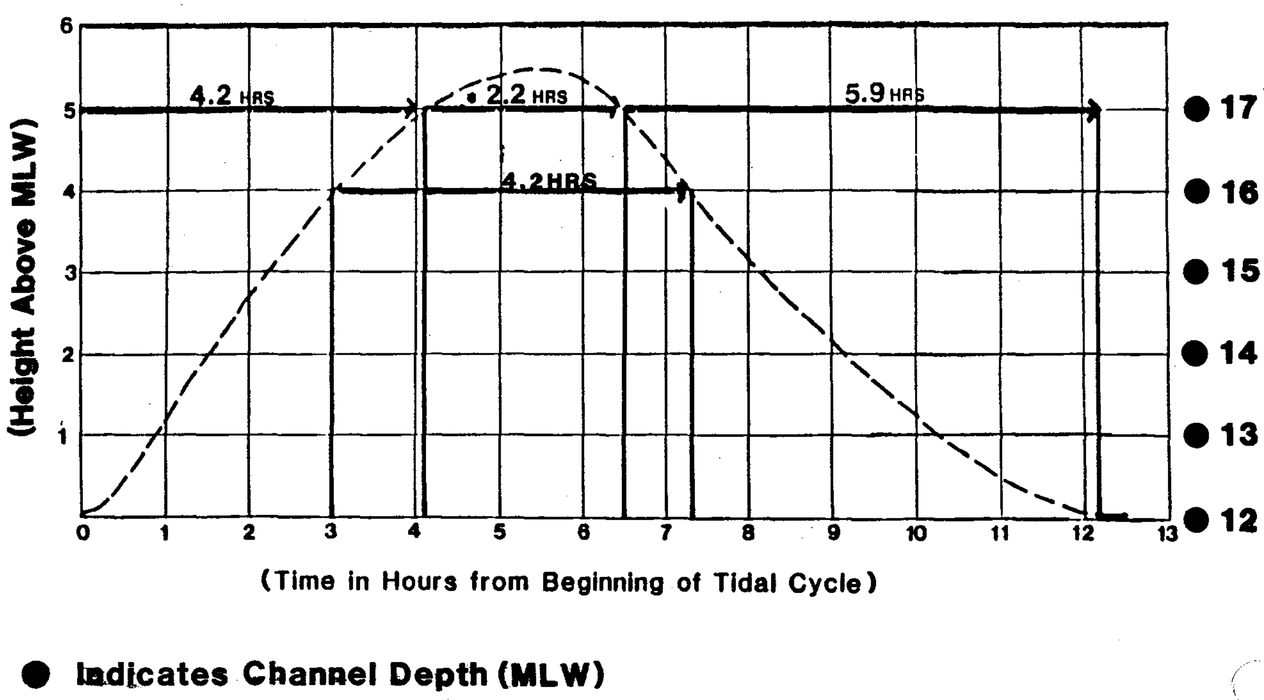


SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

POWER LINE CROSSING - SINNICKSONS LANDING

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 8



SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

Tidal Rise and Depth of the Salem River Navigation Channel

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 9

period. Two vessels can either "piggyback" each other in the same direction, or two vessels can travel in opposite directions with a minimal delay incurred by the second vessel. Queuing is not a problem.

72. General cargo and bulk vessels are navigated by Delaware River pilots to the Reedy Point Anchorage to await docking by the contracted Salem River pilot. Vessels normally encounter a six to seven knot current and are subject to wind forces which necessitate tug assistance. Wilmington Tug and Launch Inc. has been providing these services. Tug operations in the Salem River are presently conducted with a 525 HP tug with an operating draft of six feet and beam and length of 10 and 46 feet, respectively. Vessels over 330' in length or vessels under adverse weather conditions sometimes require use of two tugs or one larger tug (1100 horsepower, 65' x 25' with a 10.5' draft) unless the vessel has thrusters to enhance maneuverability.

73. Vessel transits on the Salem River are made on the flood tide depending on the draft requirements of the vessel to allow for turning and maneuvering during favorable current conditions. Transits are made with a tug to provide assistance in the critical areas at the bend in Salem Cove, the crossing under the overhead power cable at Sinnicksons Landing, and the turning area just downstream of the Port of Salem. The assisting tug precedes the ship up the channel and ties on to the starboard side about one mile south of the Port where the channel narrows from 150 feet to 100 feet. At the turning basin, the tug is positioned perpendicular to the keel to rotate the ship to the left 180 degrees until it is facing downstream. The ship is then pushed in place next to the working barge at Major's Wharf for berthing. Barges that transit the river are pushed up backwards to avoid the turning movement. Two tugs were used to bring in a relatively large 60' x 300' barge with a draft of 10.6'; otherwise, the recent transits have been limited to single tug assistance. When leaving the Port, vessels are tied to the tug with a line to maximize control. The pilots have indicated that safe underkeel clearance is considered to be two feet.

74. The U.S. Coast Guard provided ice breaking services in 1984 using Red Oak, a buoy tender. Other current practices expected to continue are:

a. Use of the prevailing tidal flows.
b. Pivot movements downstream of Major's Wharf.
c. Berth depths greater than vessel draft.
d. Sufficient clearance under the power line.

75. The U.S. Coast Guard maintains and improves the navigation aids on the Salem River. The entrance is marked by a flashing red buoy and a directional light installed in 1990. Two range lights are located on the north side of the channel. One is 200 yards outside of the channel and the other is on rip-rap landside. The

Coast Guard installed 12 lighted navigation aids in 1989. These were upgraded from one pile to four pile structures in 1990 to provide greater resistance to ice damage.

76. FACILITIES/CAPACITIES. From the March 1982 proposal to the October 1984 initiation of full-scale operations with the dedication of the grain elevator, the facilities and the 155 acres occupied by the Port of Salem have been planned to handle general cargo, grain, lumber, scrap iron and other commodities. The goal has been to create a market niche for 3000-5000 DWT vessels by maximizing the opportunities which often accompany a relatively small operation through efficiency, flexible equipment and practicing an economy of scale.

77. There are presently two berthing areas associated with the Port (see Figure 10). The first, Major's Wharf at the western end of the Port, is approximately 120 feet long and 100 feet wide and is currently dredged to 16 feet MLW. The second berthing area is a 35' x 240' work barge at the grain elevator immediately eastward (upstream) of Major's Wharf.

78. The Port has essentially operated on a single berth since 1984 because the second berth has been constrained by the presence of the grain elevator and the location of the grain arm. The Port has been working on plans to construct a 400 foot wharf extension downstream of Major's Wharf which will be in place by the base year. Permanent facilities for three berths are planned by the Port prior to the base year. The planned new upstream berth adjacent to the dry storage warehouse will be dredged to 16 feet and have dimensions of 350' x 80'. The new berth at the grain elevator will also be 350' X 80'. The proposed downstream berth would be adjacent to open storage area and would handle bulk commodities.

79. The single-berth private marine terminal at Barber's Basin downstream of the Port is owned by Mid-Atlantic Shipping and Stevedoring Inc. Mid-Atlantic owns two and one-half acres along the river on Tilbury Road and in 1989 leased the area known as the Fire Grounds from the Port to be used for container storage. Mid-Atlantic's facilities include a 270' long 50' wide pile supported dock. An associated 12,000 square foot warehouse is used to hold commodities and any frozen food prior to trucking. Frozen foods are brought to facilities in Bridgeton, New Jersey for distribution.

80. The Port currently does not have permanent equipment for transferring commodities between the berths and the West Jersey Railroad since some of the tracks at the port are not operational. The existing siding can accommodate 10 rail cars, although space is available for an additional 100 cars. Vacuum hoses and portable

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Coast Guard installed 12 lighted navigation aids in 1989. These were upgraded from one pile to four pile structures in 1990 to provide greater resistance to ice damage.

76. FACILITIES/CAPACITIES. From the March 1982 proposal to the October 1984 initiation of full-scale operations with the dedication of the grain elevator, the facilities and the 155 acres occupied by the Port of Salem have been planned to handle general cargo, grain, lumber, scrap iron and other commodities. The goal has been to create a market niche for 3000-5000 DWT vessels by maximizing the opportunities which often accompany a relatively small operation through efficiency, flexible equipment and practicing an economy of scale.

77. There are presently two berthing areas associated with the Port (see Figure 10). The first, Major's Wharf at the western end of the Port, is approximately 120 feet long and 100 feet wide and is currently dredged to 16 feet MLW. The second berthing area is a 35' x 240' work barge at the grain elevator immediately eastward (upstream) of Major's Wharf. The Port is currently proposing to dredge the berth at Major's Wharf and the grain elevator to a 16 foot depth.

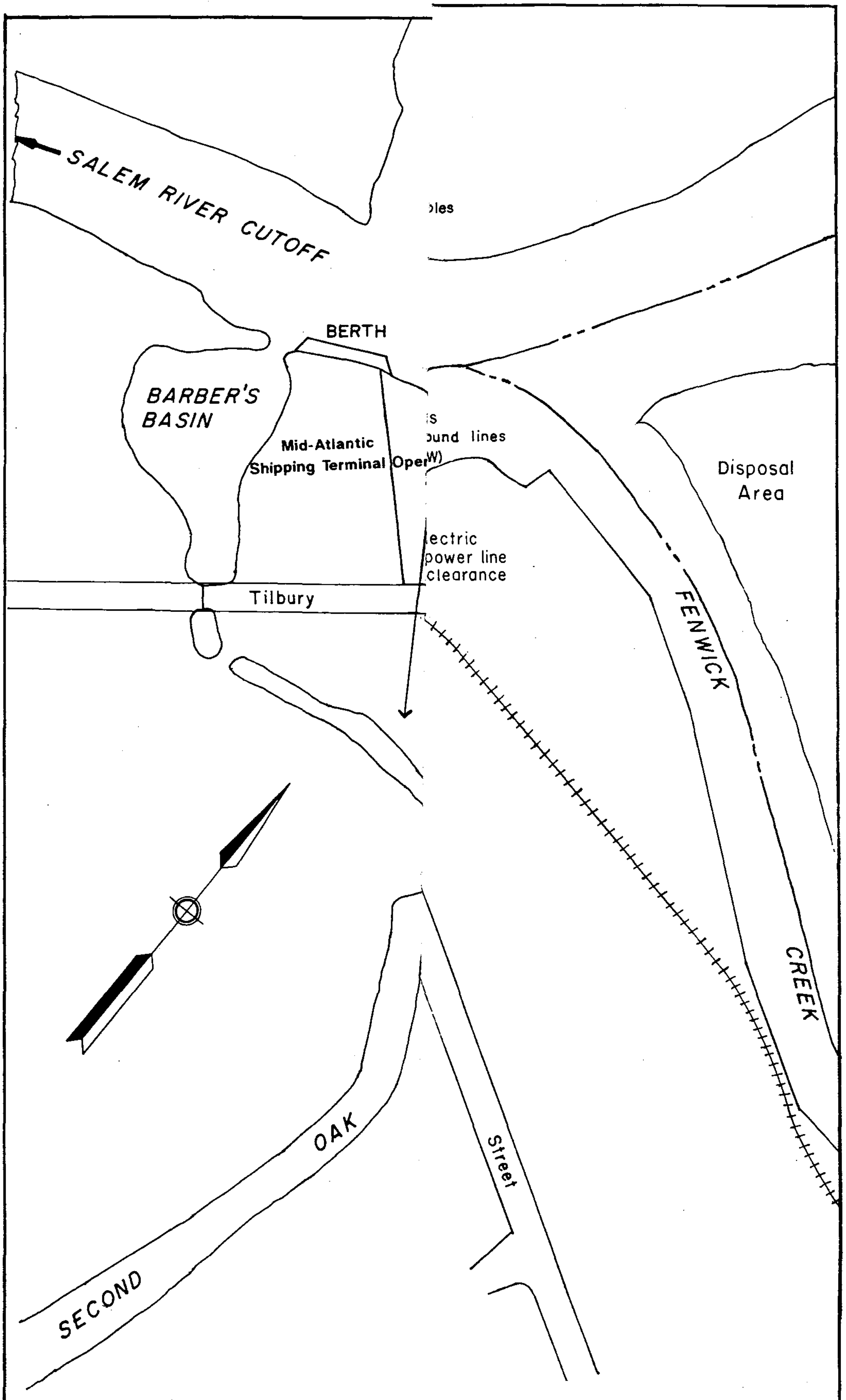
deleted

conflicted

78. The Port has essentially operated on a single berth since 1984 because the second berth has been constrained by the presence of the grain elevator and the location of the grain arm. The Port has been working on plans to construct a 400 foot wharf extension downstream of Major's Wharf which will be in place by the base year. Permanent facilities for three berths are planned by the Port prior to construction of an improved channel. The planned new upstream berth adjacent to the dry storage warehouse will be dredged to 16 feet and have dimensions of 350' x 80'. The new berth at the grain elevator will also be 350' X 80'. The proposed downstream berth would be adjacent to open storage area and would handle bulk commodities.

79. The single-berth private marine terminal at Barber's Basin downstream of the Port is owned by Mid-Atlantic Shipping and Stevedoring Inc. Mid-Atlantic owns two and one-half acres along the river on Tilbury Road and in 1989 leased the area known as the Fire Grounds from the Port to be used for container storage. Mid-Atlantic's facilities include a 270' long 50' wide pile supported dock. An associated 12,000 square foot warehouse is used to hold commodities and any frozen food prior to trucking. Frozen foods are brought to facilities in Bridgeton, New Jersey for distribution.

80. The Port currently does not have permanent equipment for transferring commodities between the berths and the West Jersey Railroad since some of the tracks at the port are not operational. The existing siding can accommodate 10 rail cars, although space is available for an additional 100 cars. Vacuum hoses and portable



SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

PORT FACILITIES

DEPARTMENT OF THE ARMY
ADELPHIA DISTRICT, CORPS OF ENGINEERS

These repairs will be accomplished by 1993.

conveyors have been used to load cars. Grants to the rail operators from the New Jersey Department of Community Affairs and the Department of Transportation for maintenance and repair of facilities have improved operations. Additional grants are under development to link Port operations with the railroad. Improvement of the rail facility became a part of the New Jersey state plan for capital improvements in July 1990. A Federal grant was used for improved security and lighting.

81. To accompany docking facilities, the Port of Salem has developed handling and storage facilities for a variety of commodities in bulk, unitized and containerized form. The waterfront grain elevator is currently in need of repairs estimated to cost $125,000. Equipped with truck tilt and a conveyer system, this elevator can, when operational, store 85,000 bushels in four silos and offload 10,000 bushels per hour onto vessels berthed at the floating dock. Grain stack and reclaim capacity at the Port of Salem is 200 long tons per hour. A grain dryer capable of processing 30 long tons per hour of wet grain sits alongside the grain storage tanks.

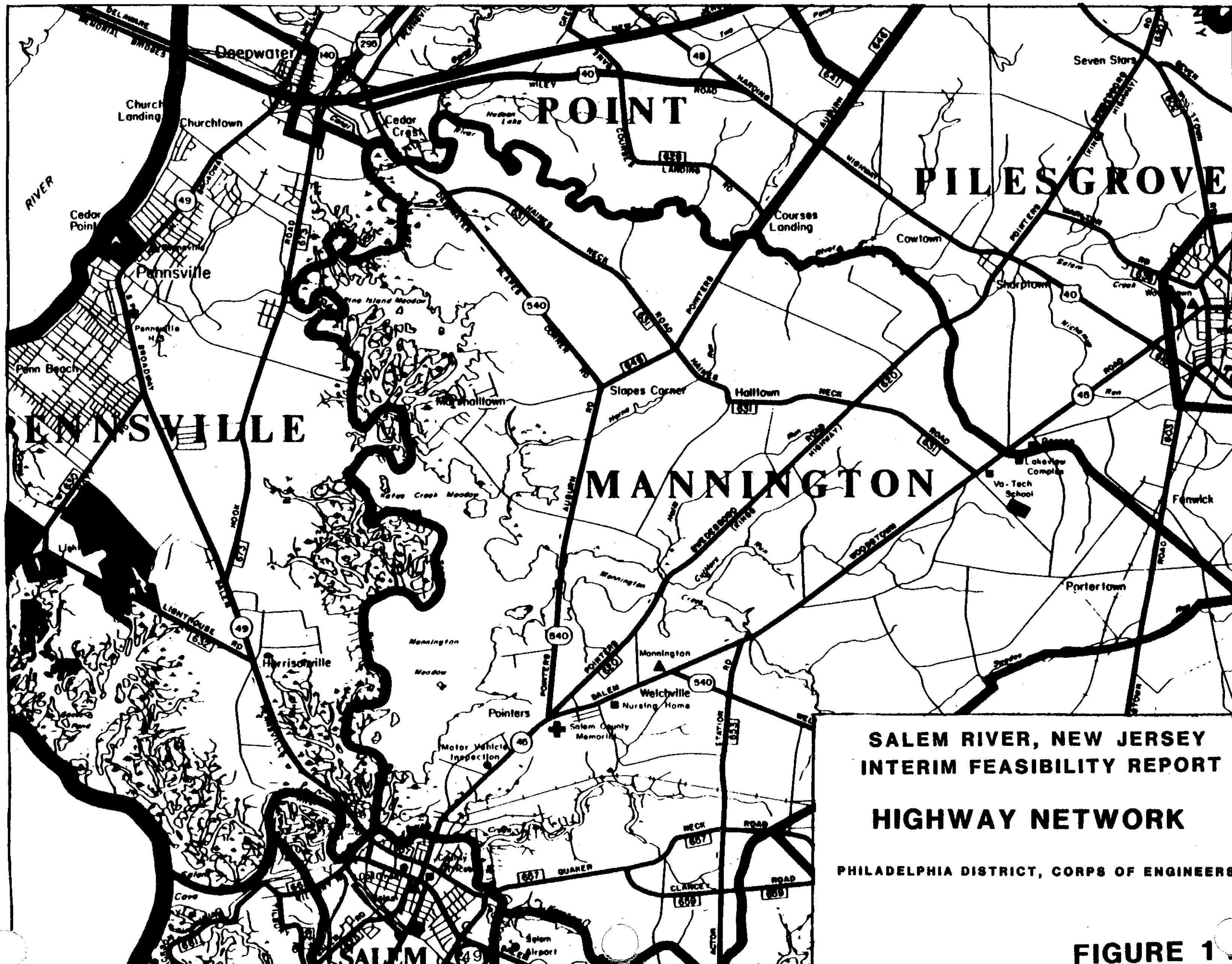
82. Storage facilities include 60,000 square feet of covered storage located in the shed immediately east of the elevator. This facility is leased to Salem Marine Terminal and is equipped with truck loading/unloading dock and forklift compatibility. Salem Marine Terminal handles varied commodities including break bulk and containers. The Port of Salem has access on a lease basis to additional crane capacity adequate to handle commodities. The configuration includes a single crane capable of making six 30 ton lifts per hour. The crane is also equipped with a three cubic yard bucket which can be lifted 10 to 12 times per hour.

LAND TRANSPORTATION SYSTEMS

83. An integral part of the study is an analysis of the transportation systems servicing the project area and the associated hinterlands.

84. HIGHWAY NETWORK. In establishing the existing network servicing the Port areas, coordination was conducted with various regulatory and user agencies. These agencies primarily consisted of the New Jersey Department of Transportation, professional motor transportation associations, and selected freight carriers, where deemed necessary, to clarify pertinent information. The major (primary) access routes which service the City of Salem are presented on Figure 11.

85. The principal roadway serving the City of Salem is the two lane State Route 49. This road extends towards the southeast and connects to numerous secondary routes leading to various South



SALEM RIVER, NEW JERSEY
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HIGHWAY NETWORK

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 1

Jersey shore points such as Cape May and Sea Isle City. Route 49 also connects Salem to such major highways as the New Jersey Turnpike, Interstate 295 and the Delaware Memorial Bridge at Deepwater, New Jersey with inherent access to points north, west, and southwest. The Route 49 bridge at Penn's Neck is scheduled for replacement. Alternatives to the current bridge are under study by the New Jersey Department of Transportation.

86. The primary New Jersey highway serving the north-south corridor is the New Jersey Turnpike, a 118 mile toll road which runs from its southern terminus at the Delaware Memorial Bridge to points northeast, including northern New Jersey, New York and the Northeast Region. The Turnpike is a four lane highway in southern New Jersey and widens in northern New Jersey. The Turnpike has spurs which connect with the Holland Tunnel (New York City) and the Pennsylvania Turnpike (I-276).

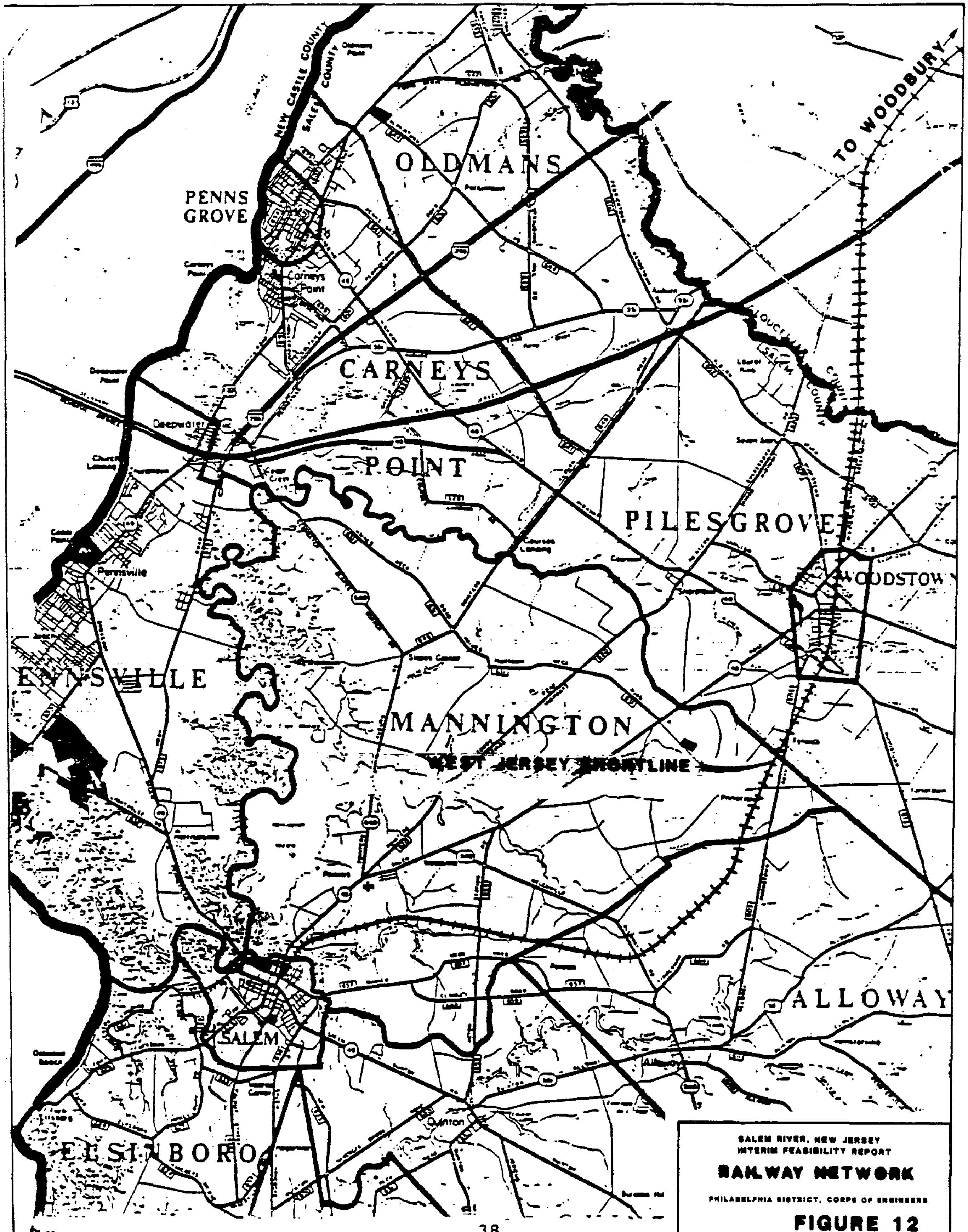
87. Interstate Route 295 parallels the New Jersey Turnpike between the Delaware Memorial Bridge and its temporary terminus at U.S. 130 in Bordentown. Interstate I-295 is a six lane facility south of Camden and intersects with NJ 42, the major east-west highway which leads to the Atlantic City Expressway. I-295 provides service, via numerous interchanges, to New Jersey communities between Bordentown and Deepwater.

88. U.S. 130, which is the predecessor to these two major highways, currently provides local service to the Camden, Salem and Gloucester County regions. In addition, State Route 45 is an important local service road connecting Salem to Gloucester and Camden Counties. Salem is connected via Route 49 and the Delaware Memorial Bridge to I-95 and Routes 40, 13, and 301 in Delaware, the major routes to the southwest.

89. RAILROAD NETWORK. The Salem River study area is serviced by the Consolidated Rail Corporation (Conrail). Figure 12 shows the railway network in the study area. The Salem Branch of Conrail extends to Woodbury where main line connections can then be made to the Philadelphia and New York City areas. Salem County bought the 18-mile rail spur (Salem Branch) from Conrail in 1985 for $267,000 and leased it to a private group (the West Jersey Short Line Company), which moved scrap iron in conjunction with Mid-Atlantic Shipping & Stevedoring Inc. The Pioneer Railroad Co. Inc. of Peoria, Illinois assumed the lease and assets of the railroad in October 1988 and continues to operate the line as the West Jersey Railroad.

EXISTING INSTITUTIONS

90. A number of government agencies both affect and are directly affected by Federal navigation activities in the study area. Some of these agencies are regulatory in nature and directly affect the conduct of dredging. Others are advisory and play a role in the



SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

RAILWAY NETWORK

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 12

formulation and development of project plans. Those that are affected by Federal project activities are consulted for input as plans are developed. A list of these agencies and a brief description of roles or missions as relating to Federal dredging activities is provided below. It is not an all-inclusive list of agencies with which project plans are coordinated but rather a list which emphasizes key agencies in the institutional framework relative to Federal navigation projects.

91. FEDERAL GOVERNMENT. The Environmental Protection Agency (EPA) is generally responsible for the enforcement of Federal laws regarding air and water quality, solid waste, and hazardous materials. Relative to Federal navigational activities, the EPA and the Corps have established the guidelines for the evaluation of the water quality impacts associated with the disposal of dredged material as required by Section 404(b)(1) of the Clean Water Act (CWA). EPA also maintains a veto authority over decisions made by the Corps regarding specifications of disposal sites under Section 404(c) of the CWA. In the Clean Air Act (Section 309), EPA has been given the authority to review and comment on actions subject to the National Environmental Policy Act (NEPA) and to refer those actions to the Council on Environmental Quality (CEQ) if the agency finds the action to be unacceptable from an overall environmental standpoint.

92. Under the Fish and Wildlife Coordination Act the U.S. Fish and Wildlife Service (FWS) provides evaluations of Project impacts to fish and wildlife resources and recommendations concerning the conservation of those resources and mitigation of impacts. Those recommendations must be considered in project planning consistent with the Act. Enforcement and coordination under the Endangered Species Act is primarily the responsibility of the FWS.

93. The National Marine Fisheries Service (NMFS) is similarly responsible for evaluation of project impacts on marine life and enforcement coordination under the Endangered Species Act for endangered species in the marine environment.

94. The National Park Service, Office of Archeological Services (OAS) is charged primarily with overseeing the historic preservation program established as a result of the Archaeological and Historic Preservation Act of 1974. A primary function is the review of historic preservation reports prepared by various Federal agencies.

95. Federal agencies are required to afford the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on any Federally-funded or licensed activities that may have an effect on any District, building, site, structure, or object that is listed in or is eligible for inclusion in the National Register of Historic Places.

96. U.S. Coast Guard authority includes maritime law enforcement, placement and maintenance of aids to navigation, supervision over the anchorage and movement of vessels, the handling of explosives and other dangerous vessel cargoes, and safeguarding of life and property on the high seas. It also enforces laws relating to oil pollution, immigration, quarantine and numerous statutes under the jurisdiction of other Federal agencies that require marine personnel and facilities.

97. The responsibilities of the Federal Maritime Commission (FMC) embrace two broad areas of commercial navigation: regulating shipping practices and ensuring financial responsibility for water pollution cleanup. The FMC licenses ocean freight forwarders and maintains surveillance over services, practices, and agreements to assure equitable treatment to all segments of the maritime industry and the general public. The FMC also administers a provision of the Water Pollution Control Act of 1970 (PL 92-500) requiring the owner or operator of every vessel over three hundred gross tons to establish and maintain evidence of financial responsibility for assuming the cost of removing oil discharged into navigable waters.

98. The Maritime Administration (MARAD) administers Federal laws designed to promote and maintain a U.S. merchant marine capable of meeting the Nation's shipping needs for both domestic and foreign commerce and national security. To carry out its mandate, MARAD assists the maritime community in the areas of ship design and construction, development of advanced transportation systems and equipment, and promotion of the use of U.S. flag vessels. Among other activities, MARAD helps industry generate increased business for U.S. ships and conducts programs to develop ports, facilities and intermodal transport to promote domestic shipping.

99. REGIONAL AGENCIES AND ORGANIZATIONS. The Delaware River Port Authority's (DRPA) jurisdiction includes two counties in Pennsylvania and eight in New Jersey. Eight commissioners from each state are appointed by each state's Governor. The Delaware River Port Authority operates and maintains four bridges between Pennsylvania and New Jersey and promotes the area's ports through the World Trade Division. That division promotes the ports to domestic and overseas shippers and encourages increased investment in the ports.

100. Developed as a mechanism for planning and cooperation between two States, the Delaware River and Bay Authority (DRBA) is responsible for transportation crossings between New Jersey and Delaware and has potential responsibilities with respect to port development. Each Governor appoints five commissioners to DRBA. The DRBA operates and maintains the Delaware Memorial Bridge and the Cape May-Lewes Ferry. Because bridge and ferry crossings have been determined to be adequate for the present, the DRBA is moving toward other responsibilities, including port or marine facility development.

101. STATE AND LOCAL AGENCIES. Two state agencies in the study area are involved with regulatory matters, the Delaware Department of Natural Resources and Environmental Control (DNREC) and the New Jersey Department of Environmental Protection (DEP). These state agencies are tasked with the responsibility to conserve and maintain natural, scenic and aesthetic values of the environment, to assure its residents clean air and clean water, and to manage the states' land and water management program and all aspects of environmental control. The departments are the authority for environmental permits, monitoring and surveillance, enforcement, certification and training, planning and financial assistance and the Coastal Zone Management Program. Both departments issue Water Quality Certificates for disposal of dredged or fill material under Section 401 of the Clean Water Act.

102. The South Jersey Port Corporation (SJPC) was created in 1968 as an agency of the New Jersey Department of Commerce and Economic Development. The South Jersey Port Corporation has jurisdiction over port facilities between Trenton and Cape May.

103. The South Jersey Economic Development District is a regional agency for coordination of financial assistance projects for economic development projects in Salem, Cumberland, Atlantic and Cape May counties.

104. The Salem Port Authority is a municipal, city-managed entity whose purpose is to oversee all vessel and barge traffic on the Salem River. The Salem Port Authority's goal is to provide services to the communities of South Jersey and to promote the existing intermodal service in the area. The City of Salem Port Authority has indicated its willingness to act as local sponsor for a project resulting from this study.

PROBLEM IDENTIFICATION

MEANS BY WHICH PROBLEMS WERE IDENTIFIED

105. Coordination meetings and discussions were held with various groups and individuals during the data collection and problem identification phases of this study. These sessions included: the U.S. Fish and Wildlife Service; the National Marine Fisheries Service; the United States Coast Guard; the New Jersey Department of Environmental Protection; the New Jersey State Historic Preservation Office; the Delaware Department of Natural Resources and Environmental Control; the Delaware State Historic Preservation Office; Salem River pilots, and Salem Port and City officials. Interviews were conducted with shippers regarding commodities handled, transportation modes, problems and needs. In addition, prior reports were reviewed to identify problems which had been addressed and the availability of data. These reports included previous Corps' reports on waterway maintenance, studies at the national level regarding commodity trends, and other planning and technical documents.

CONDITION IF NO FEDERAL ACTION IS TAKEN (WITHOUT PROJECT CONDITION PROFILE)

106. WITHOUT PROJECT CONDITION ANALYSIS. The without project condition is the most likely condition expected to exist over the planning period in the absence of a plan. It provides the starting point for problem identification and impact evaluations for alternative with-project conditions. Non-structural measures which are currently used to increase efficiency, would continue including favorable tides, lightering, lightloading and tug assistance.

107. The environmental characteristics in the study area are expected to remain the same throughout the study period. The without project condition at the Salem River would avoid the potential for environmental disturbances generally associated with increased levels of dredging and disposal of material.

108. The ongoing redevelopment of the Port of Salem followed conpletion of the redevelopment plan in 1982. A history of commodity and vessel movements was developed. This information was used as a point of departure for estimating the without project conditions. By analyzing data or existing fleet composition, historic trends in world ship characteristics and distributions, and other factors such as maximum channel dimensions which could influence vessel size, a typical without-project vessel distribution over the period of analysis was forecast.

109. <u>Commodity Projections</u>. Estimates of future commodity movements through the Port of Salem were based on the historical data base of vessel movements and tonnage, interviews with the local users and port authority, economic growth projections from a consulting firm service and U.S. Department of Commerce OBERS projections.

110. <u>General Cargo/Container Exports to Bermuda</u>. The DRI/TBS World Sea Trade Service has been used as the source for the projections of export tonnage form the U.S. North Atlantic Coast to Bermuda through the year 2000. Table 8 presents the projections for the total market in the left-hand columns. Growth has been extrapolated from the year 2000 to the year 2014 to anticipate continued growth for the first 20 years of the project life. Tonnage has then been held constant in the economic analysis for the remaining 30 years of the study period. Specific projections for Salem, shown in the right-hand columns, used the DRI/TBS projections of the total market as the baseline. Projections of specific market share for Salem were obtained from the shipping agent for Bermuda International Shipping Ltd. (BISL), Voigt Maritime. BISL moves tonnage through Mid-Atlantic's facilities. DRI/TBS anticipated that Salem would maintain only a 20% share of the total U.S. North Atlantic market. However, Salem's market share was greater than 20% in 1990. Also, in late 1990 (postdating DRI/TBS's projections), Lloyd Bermuda, one of the two North Atlantic competitors to the Mid-Atlantic/BISL/Voigt operation, ceased operations. As a result, by 1995, Mid-Atlantic is expected to split the market share vacated by Lloyd Bermuda with its one competitor, Bermuda Container Lines (which operates out of the port of New York) and reach a 40% market share. Tonnage is derived by multiplying projected TEU 's for Salem by the historic average of 8 tons per TEU for port operations. Average annual tonnage for this commodity and trade route is equal to 113,000 tons.

111. <u>Bulk Movements</u>. Bulk tonnage through the port of Salem was equal to 24,800 tons in 1989. Growth in tonnage, applying OBERS will be at 2% per annum. Average annual bulk tonnage is equal to 31,000 tons.

112. The port plans for additional berths to be available by the base year will significantly increase the port's annual throughput capacity and assure that the growth in tonnage can be handled by the port users.

113. In order to independently assess the level of potential future commodity movements, two ports located on the east coast of the U.S. with 24-foot channel depths were contacted (Port Royal, SC, and Richmond, VA). Discussions with representatives from both ports indicated that they are more heavily oriented towards bulk cargo than Salem is anticipated to be. However, the annual tonnage of these ports did provide excellent assurance on the potential for

TABLE 8

GENERAL CARGO/CONTAINER COMMODITY PROJECTIONS
U.S. NORTH ATLANTIC EXPORTS OF GENERAL CARGO/CONTAINERS TO BERMUDA
GROWTH FOR FIRST 20 YEARS OF PROJECT LIFE (TO YEAR 2014)

TOTAL MARKET: U.S. NORTH ATLANTIC

YEAR	DRI/TBS CONTAINER S.T.	DRI/TBS CONTAINER TEUS	DRI/TBS TONS PER TEU		CONTAINER TONS	CONTAINER TEUS	TONS PER TEU
1989	96,973 *	9,733 *	9.96		19,400 *1]	2,058 2]	9.43
1990	105,902 *	10,850 *	9.76		21,200 *1]	2,489 2]	8.52
1991	113,507 *	11,727 *	9.68		30,432	3,804 2]	8.00
1992	123,856 *	12,763 *	9.70		32,200	4,025 2]	8.00
1993	137,429 *	14,117 *	9.74		34,688	4,336 2]	8.00
1994	149,710 *	15,370 *	9.74		38,080	4,760 2]	8.00
1995	160,859 *	16,575 *	9.70		41,904	5,238 2]	8.00
1996	173,515 *	17,943 *	9.67		53,040	6,630	8.00
1997	186,608 *	19,361 *	9.64		57,418	7,177	8.00
1998	199,758 *	20,810 *	9.60		61,955	7,744	8.00
1999	213,047 *	22,315 *	9.55		66,592	8,324	8.00
2000	225,654 *	23,822 *	9.47		71,408	8,926	8.00
2001	243,706	25,847	9.43		76,230	9,529	8.00
2002	263,203	28,044	9.39		82,710	10,339	8.00
2003	284,259	30,428	9.34		89,740	11,218	8.00
2004	307,000	33,014	9.30		97,368	12,171	8.00
2005	331,560	35,820	9.26		105,645	13,206	8.00
2006	358,085	38,865	9.21		114,624	14,328	8.00
2007	386,731	42,168	9.17		124,367	15,546	8.00
2008	417,670	45,753	9.13		134,939	16,867	8.00
2009	451,083	49,642	9.09		146,408	18,301	8.00
2010	487,170	53,861	9.04		158,853	19,857	8.00
2011	526,144	58,439	9.00		172,356	21,544	8.00
2012	568,235	63,407	8.96		187,006	23,376	8.00
2013	613,694	68,796	8.92		202,901	25,363	8.00
2014	662,790	74,644	8.88		220,148	27,519	8.00
				AVG ANN TONS	113,000		

*: DATA PROVIDED BY DRI/TBS, OTHER YEARS CALCULATED FROM PROVIDED YEARS

1] FOR 1989-1990, BASED ON DRI/TBS PROJECTION OF 20% MARKET SHARE FOR SALEM; ACTUAL TONNAGE SLIGHTLY HIGHER (1989=21,600; 1990=22,900)

2] SOURCE: VOIGT MARITIME

future tonnage that is projected to pass through the Port of Salem. For example, Port Royal, in operation for only a couple of years, has already handled in excess of 170,000 tons. Also, average annual tonnage through the port of Richmond was 2.1 million tons. By comparison, the average annual tonnage through the Port of Salem is projected to be 137,800 tons.

114. The analysis of commodity projections for Salem was based only on existing commodities (with relevant trade routes) that have moved through the port historically. No new commodities or diversions are included in the analysis, although a list of potential additional commodities were identified in the economic investigation.

115. Least-Cost Port Analysis. Dr. Russell Harrison, a professor at the Rutgers University-Camden campus, in a 1989 study, Identifying Key Target Opportunities For The Port of Salem, tabulated data to help identify the countries, commodities, and types of vessels that define key market niches for terminal operations at the Port of Salem. Dr. Harrison stated in the study that, "Any specific terminal operation in the North Atlantic port region, in general, or in South Jersey, in particular, can succeed. It can do so to the extent that it positions itself to capture certain targets of opportunity, which may be a niche defined by target countries and target products, bolstered by a willingness to provide competitive service at competitive prices". The data collected by Dr. Harrison for comparative shipping costs for the ports in the competitive market area extending from Boston, Massachusetts to Norfolk, Virginia were of particular use in conducting a least-cost analysis in this study for "niche" tonnage being moved through Salem. As an example, a port by port transportation cost analysis for the movement of general cargo/container tonnage by the potentially competing ports (Salem, Philadelphia, Boston, New York, Baltimore, and Norfolk) to the Bermuda trade route was developed. The results verify that vessel movements for this "niche" market are accomplished more efficiently by the port of Salem than through the potentially competing larger North Atlantic ports.

116. Current plans for the Salem River indicate a total of four berths. The economic projections were based on the most likely future, the presence of three berths at the Port and one berth at the Mid-Atlantic facility at Barber's Basin. The without project improvement assumptions included improved berth depths of 16 feet at the Port as currently planned with bulkheading adequate for improved berth depths and the 16 foot berth at Barber's Basin. Vessels would continue to make transits using the tidal cycles. Additionally, by the base year, the grain facilities would be repaired.

PROBLEMS, NEEDS AND OPPORTUNITIES

117. ADEQUACY OF WATERWAYS WITH RESPECT TO VESSEL USAGE. The authorized and maintained dimensions of the Salem River project are a 12 foot depth and width of 150 feet from Elsinboro Point to Sinnicksons Landing and a 100 foot width upriver to the Route 49 bridge.

118. Channel dimensions, both width and depth, present problems at Salem River. The primary problem area for maneuvering is the bend in Salem Cove where the channel turns southward toward the Delaware Bay. This area is of particular concern because of the length of vessels and barges. No widening at bends was included in the existing project and groundings occur in this area. The combined beam of a vessel/tug pair is slightly below the available 100 foot channel width in the upper section, therefore minimum required bank clearance is not available. This results in frequent minor groundings and hazardous hydraulic conditions due to squat. However, no damages have been reported as a result of groundings. The 100 foot wide channel is also less than the 130 foot minimum recommended width for a one-way commercial navigation channel for vessels and barges according to Corps of Engineers shallow draft channel criteria (EM 1110-2-1611, dated 31 December 1980).

119. Although the existing project does not include a designated turning basin, the relatively deep and wide area just upstream of the cut-off provides vessels with an area about 450 feet in diameter for turning.

120. The planned expansion of port facilities will encroach into the existing turning area. Accommodations for an improved turning basin will require some use of the natural channel across from the port facility.

121. Overhead transmission cables from the Salem Nuclear Generating Plant cross the Salem River upstream of Salem Cove. The location of the authorized channel and the limited vertical clearance under the utility line was a problem with some vessels operating on the Salem River until November of 1989. While the minimum vertical clearance at MHW for the river is only 66 feet, the pilots follow naturally deep water outside of and to the north of the authorized channel to increase vertical clearance for vessels. In November 1989 the Coast Guard installed the new lighted navigation aids outside the authorized channel, consistent with the pilot practices to follow deep water and increase vertical clearance. The pilots prohibit vessels with air drafts over 85 feet from transiting the river. The marked channel allows eighty-five feet of air draft under the power lines and approximately 20 feet of clearance (see Appendix A). This restriction meets the standards for aerial clearance set by the industry. The opportunity exists to increase vertical clearance under the utility cable and reduce dredging requirements by realigning the channel at Sinnicksons Landing to

follow natural deep water in accordance with the Coast Guard modifications. The power lines have not constrained the use of the river for commercial navigation.

122. During ice conditions, navigation aids presented problems at Salem River. Buoys were displaced. The first set of fixed aids did not withstand the severe ice conditions of the winter of 1989. The reinforced navigation aids installed in 1990 are expected to sustain ice effects. The Coast Guard has in the past assisted with ice-breaking.

123. ADEQUACY OF PORT FACILITIES. The capacity of a port is limited by maximum available berth occupancy, the throughput rates of the berth, the conveyance between berth and storage areas, availability of storage space and the access between the storage areas and landside transport. A comparison of projected tonnage to throughput capacity determined that there will not be a constraint to the Port in handling the tonnage over the project life.

124. As noted, the grain elevator is in need of repairs. The Port has explored various options to retrofit the facility to accommodate the grain trade.

125. CAPACITY OF TRANSPORTATION NETWORK. The overall adequacy of the transportation systems was examined with respect to the level of current usage and future requirements (with and without waterway improvements). The analysis is based on coordination with appropriate Federal, state and regional transportation agencies, as well as representative user agencies, and supplemented with studies regarding conditions and operations.

126. The current and potential highway traffic volumes associated with the Salem River project are judged insignificant relative to the volumes and capacities of the major highways in the Salem River study area. The most relevant issue regarding highway capacity with regard to the Salem River is local access. Because of the shift from trucks to waterborne transport and the relatively low level of project related traffic, the capacity of the local and regional highway networks is not considered to be a constraint to throughput or have a significant negative impact. The capacity of the study area railroad network is also not an important consideration relative to the Salem River project because of the small levels of anticipated project related rail traffic and anticipated improvements.

SUMMARY OF PROBLEM IDENTIFICATION

127. The current authorized channel dimensions at the Salem River present constraints to efficient vessel movement. Unless plans are developed to provide adequate access for current and future ship movements, increased costs will be incurred due to the required shipping practices (i.e., light-loading, long tidal delays due to the draft constraints of the authorized twelve foot channel, and use of ships smaller than those that can be accommodated at the terminal).

PLAN FORMULATION

128. The purposes of this section are to provide the background on the criteria used in the formulation process and to present the procedures for the identification of the selected plan. The formulation process involved establishment of plan formulation rationale, identification and screening of management measures, and the assessment and evaluation of detailed plans which are responsive to the identified problems and needs.

PLANNING OBJECTIVES

129. The following planning objectives were established in response to the problems, needs and opportunities identified in projecting the without-project condition over the 1994-2044 period of analysis.

- Provide adequate and safe navigation channels.
- Identify and examine alternatives available for increasing the efficiency of waterborne commerce movement throughout the project.
- Identify and evaluate acceptable disposal sites and techniques for disposal of material dredged within the study area.
- Minimize degradation of the natural environment in any areas impacted by initial construction or maintenance dredging and disposal activities.
- Provide an appropriate level of public participation for the study.

PLANNING CONSTRAINTS

130. The formulation and evaluation of alternative plans is guided by technical and economic criteria. Factors considered in formulation are environmental awareness policies, institutional requirements, and the application of the criteria associated with National Economic Development (NED) plan. The objective of water resource project planning is to contribute to the nation's economic development consistent with environmental and other planning requirements.

131. TECHNICAL CONSTRAINTS. These constraints include physical or operational factors which limit alternatives. Such constraints include the following considerations:

- Projected vessel usage and channel depth requirements should not exceed limitations to vessel size presented by waterway dimensions both along the trade route and at the port of the trading partner.

- Project features will be designed in accordance with criteria contained in Corps of Engineers' regulations for deep-draft and shallow-draft navigation channels, with consideration to the views of pilots and the U.S. Coast Guard regarding safety of design. In addition, project features will incorporate the views of the sponsor, where available.

132. ECONOMIC CONSTRAINTS. Economic constraints limit the range of alternatives considered based on principles of project optimization. The following items constitute the economic constraints foreseen to impact formulation of alternatives to be considered.

- Shippers are assumed to use the least cost mode of transportation if there are not overriding non-economic factors influencing modal preference including shipment size and vessel availability.

- Analyses of project benefits and costs are to be conducted in accordance with Corps of Engineers' regulations and must assure that any plan is complete, efficient, safe, and economically feasible in terms of current prices.

- Economic evaluations of project improvements and features assume that authorized dimensions are maintained. Improvements and construction alternatives are evaluated through incremental justification.

133. ENVIRONMENTAL CONSTRAINTS. Appropriate measures must be taken to ensure that any resulting projects are consistent with local, regional, and state plans, and that the necessary permits and approvals are likely to be issued by the regulatory agencies. Identification of a viable National Economic Development (NED) plan necessitates likely approval of required permits and certificates, and a favorable environmental impact statement or environmental assessment. Selection of a mitigation plan must be accomplished using incremental analysis procedures.

PLAN FORMULATION RATIONALE

134. The formulation process used to develop and evaluate alternative plans was based on the consideration of all possible alternatives with the potential for addressing the planning objectives and meeting the technical, economic and socio-environmental criteria. This process was accomplished in

three different formulation iterations, known as cycles. The first step, Cycle 1, included the preliminary screening of all possible structural and non-structural alternatives and their associated features. Based on this screening and primarily due to technical and economic reasons, non-structural measures were eliminated from further consideration.It was determined that all possible non-structural measures were already being utilized to their greatest extent and therefore could not achieve the planning objective. Structural measures were subsequently evaluated in the formulation process in Cycle 2. Cycle 2 consisted of preliminary channel analyses and disposal area formulation. Cycle 3 consisted of optimization and identification of the National Economic Development (NED) Plan.

FORMULATION AND EVALUATION CRITERIA

135. All plans were formulated and evaluated on the basis of technical, economic, and socio-environmental criteria. These criteria, along with less tangible considerations, permitted the development and tentative selection of plans which best responded to the planning objectives. The specific technical, economic, and socio-environ- mental criteria are as follows.

136. TECHNICAL CRITERIA. The following technical criteria are used to develop and analyze alternative plans:

- Each alternative is designed as a complete project that does not obligate the Federal government to future work, except for maintenance as provided by law.

- Channel and turning basin designs are in accordance with design criteria contained in EM 1110-2-1613, title "Engineering and Design- Hydraulic Design of Deep Draft Navigation Projects" dated 8 April 1983.

- Safe air draft under aerial utility lines are established through coordination with the appropriate pilots and vessel operators and industry standards.

- For quantity computations, two (2) feet below the channel design depth (overdepth) is allowed as a tolerance in the dredging operation and industry standards.

- Designs and layout of alternatives will be coordinated with the appropriate pilots and vessel operators and the U.S. Coast Guard to assure safe design. Layout of suitable navigation aids is accomplished by the U.S. Coast Guard.

137. ECONOMIC CRITERIA. The following economic criteria were applied during plan formulation and evaluation.

- Tangible benefits should exceed project economic costs. Measurement is based on the NED benefit-cost ratio greater than 1.0 to 1, and maximized net benefits.

- The benefits and costs of any alternative are expressed on comparable economic terms. Costs for the selected plan are based on the April 1990 price level.

- ER 1105-2-45, <u>Deep Draft Navigation Analysis and Design Underkeel Clearance Standards</u>

- For the analyses, annual benefits and costs are based on a 50-year amortization period and an interest rate of 8 3/4 percent. Annual costs also include maintenance and operations and associated costs.

- ER 1105-2-100, Chapter 6, Section VII NED Benefit Evaluation Procedures: Transportation Deep Draft Navigation.

138. SOCIO-ENVIRONMENTAL CRITERIA. The following socio-environmental criteria and intangible effects were considered in the plan formulation and evaluation:

- Protect public health, safety and well-being.

- Avoid, where possible, detrimental environmental impacts and include features to prevent unavoidable adverse effects.

- Formulate a plan that would contain inputs by the general public, interested Federal and non-Federal agencies, special interest groups and individuals.

139. EVALUATION OF ALTERNATIVE MEASURES. The following discussion describes the formulation and screening of alternative measures in the preliminary planning stage of this study. Non-structural measures are addressed in Cycle 1 with consideration of structural measures on a conceptual basis. Cycle 2 and Cycle 3 further address specific structural measures necessary to meet the project needs.

CYCLE 1 - MANAGEMENT MEASURES

140. The purpose of this portion of plan formulation is to screen alternative solutions to navigation problems of Federal interest. Measures and combinations of measures which address the study planning objectives are considered.

There are many measures which address the efficiency of waterborne commerce. These measures pertain to disposal of dredged material, waterway improvements, and provision of adequate landside facilities and transportation. A variety of structural and non-structural measures are enumerated and discussed for these various aspects of the waterborne transportation system. Many of the non-structural waterway measures are currently in practice at the Salem River. These 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 non-Federal governments, port authorities, corporations, and shippers.

141. NAVIGATIONAL IMPROVEMENTS. The waterway-related measures which could improve the safety and efficiency of waterborne commerce include:

Structural	Non-Structural
. Channel modification (widening, deepening, realignment, extension, advance maintenance)	. Transshipment (lightering, topping off, or modal shifts)
. Anchorage, turning basins	. Use of high tides for vessel movements, loading, unloading
. Aids to navigation	. Lightloading
	. Modification to pilot regulations and management
	. Tug assistance
	. Scheduling of arrivals departures/traffic management

STRUCTURAL MEASURES. The formulation and screening of structural measures considered in Cycle 1 are discussed below.

142. Channel Modifications. Channel modifications benefit existing or potential users by allowing use of larger vessels, reducing or eliminating more costly non-structural measures, preventing accidents and vessel damages, allowing a shift to waterborne movement from a more costly mode, or by lowering total transportation costs for commodities moving through other ports or to other origins and destinations. Deepening and/or widening the Salem River channel could expand the transportation options for commodities by creating economic benefits. A feasible plan for the river should incorporate channel designs and project vessel usage compatible with the vertical and horizontal clearances provided by existing bridge or utility crossings. Bend widening is an additional feature which is needed to maximize use of the navigation channel.

143. Anchorage Structures, and Turning Basins. Anchorages for general use are designated by the U.S. Coast Guard for short-term anchoring (48 hours maximum without special permission). Ships may anchor while waiting for favorable tidal conditions, safe weather conditions for operation, repairs or for the availability of berth space. Lightering and topping off are conducted at some general anchorages. These include Reedy Island which has been used in

conjunction with grain topping off operations at the Port of Salem and waiting for favorable tides. Turning basins are channel areas widened to allow for reversing the direction of vessels prior to or after docking. Turning areas are particularly common in channels such as Salem River where a relatively long channel permits one-way traffic for larger vessels and the only other option for movement would be backing a vessel in or out. Deep draft vessel turning movements are generally accomplished with the assistance of tugs at the turning area near the Port. The current turning area will require modification to be compatible with the design vessels.

144. <u>Navigation Aids.</u> Navigation aids include range lights, buoys, lightships, beacons, maritime radio beacons, loran, 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 for pilots to determine vessel position. As noted, the Coast Guard significantly improved the aids at the Salem River in November 1989. Twelve lighted navigation aids were installed to enable nighttime navigation. No further efficiencies are anticipated through navigation aids.

145. NON-STRUCTURAL MEASURES. Shippers are expected to make maximum use of nonstructural practices such as waiting for the tide or lightloading in order to minimize transportation costs. The following non-structural measures were considered during Cycle 1 planning.

146. <u>Transshipment.</u> Transshipment means the transfer of cargo from one type of transport to another. Lightering and topping off generally refer to intramodal transfer of cargo between a large deep-draft vessel and a smaller vessel or barge in order to maximize the cargo tonnage carried over a long voyage. However, transshipment can also apply to intermodal shifts such as transfer of cargo from a vessel to rail car, truck, or pipeline enroute to its final destination. Lightering and topping-off are practiced where vessel design drafts exceed available channel depths and commodities can be transferred to another vessel with a suitable draft. Topping off was accomplished with grain shipments out of the Port of Salem during initial operations. The Port is exploring ways to improve intermodel capabilities by improvement of the rail system adjacent to the facilities. Joint municipal ventures are being investigated for such commodities as newsprint.

147. <u>Use of High Tides.</u> Movement of vessels at high tide in channels of restrictive depth is a means of increasing efficiency of commodity movements and is commonly employed at the Salem River. Figure 9 illustrates the tidal window. Costs for tidal delays are generally small in comparison to transportation savings over a long voyage. When channel depths are shallower than the potential vessel operating draft, transits at the time of peak tides maximize the tonnage or cargo carried by those vessels.

148. Lightloading. Lightloading can reduce overall transportation cost per ton of cargo where channel depths are restrictive. A lightloaded larger vessel sometimes can carry greater tonnage than a fully loaded smaller vessel of equal draft. Therefore, more tonnage can be carried per vessel trip and a cost savings achieved due to lower operating costs per ton. Lightloading is also used where channels are so restrictive that fully loaded vessels exceed the available depth and smaller vessels are not available. Lightloading is currently practiced when economical on the Salem River; no further efficiencies would be gained through this measure by itself. With channel modifications this will continue at the discretion of shippers.

149. Pilot Regulations. The pilot regulations for safe movement of vessels for the Delaware River are published in the Code of Federal Regulations, Title 33, Subchapter D. The regulations 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. No further efficiencies are expected through modifications to these regulations. The pilot rates were lowered for Salem River transits early in 1990 to reflect the smaller size of vessels using the facilities. Pilot fees are set by the states; New Jersey and Pennsylvania lowered the unit rate to factor in the smaller vessels and establish an economy of scale.

150. Tug Assistance. Using tugs for turning, docking, and navigating in restrictive waterways is a common way of minimizing the need for larger channel and maneuvering areas. A tug accompanies vessels transiting Salem River and assists in turning movements because of the extremely restrictive channel dimensions and potential hazards (such as aerial utility crossings and upstream bridge crossings) if a vessel were to lose power. Future use of this measure will continue even with channel modifications.

151. Scheduling/Traffic Management. Where problems include traffic congestion or backlog, scheduling of arrivals and departures can minimize demurrage costs while vessels wait for berth space. Traffic management can be used to minimize accidents and maximize the efficiency of vessel movements such as avoiding vessel delays for through traffic due to vessels turning or docking. Due to the limited berth space, efficient scheduling of arrivals and departures is currently practiced at Salem and should continue as the volume of cargo and number of vessel transits increase.

152. DREDGED MATERIAL DISPOSAL. Generally, disposal area options include management measures to: prolong the useful life of

existing disposal areas; reduce shoaling; identify new sites, and otherwise provide added disposal area capacity. The following measures were considered during the study. Each of these measures considered was screened to identify those with the greatest potential to satisfy the disposal needs for a channel deepening project.

153. Raising Dikes. Containment dikes are periodically raised to increase the useful capacity of a site. The maximum height of a containment dike is based on engineering considerations such as slope stability and existing subsurface conditions. The dike heights are periodically increased by stepping in or encroaching into the disposal area with successive lifts designed for one or more periods of filling. The actual height increase depends upon the characteristics and volume of material to be placed and an allowance for freeboard (usually 2 feet). The final dike elevation in Federally owned sites considers safety, lease agreements, effects on adjacent properties, and future land use in addition to the technical limitations. Conversely, final dike elevation in privately owned sites is usually controlled by easement, local ordinances and owner's future plans for the site. This measure is an economical way to minimize the need for additional site acquisition. However, there are no existing diked disposal sites for the Salem River project. Dike raising is being practiced at Federal disposal areas for the Delaware River navigation project which are near Salem River.

154. Dewatering of Dredged Material. Dewatering dredged material is a common practice that is employed to increase the useful life of any upland disposal area. Field tests which were conducted as part of the Dredged Material Research Program (DMRP) have proven that even some of the more difficult types of dredged material can be efficiently dewatered. Interior surface trenching and perimeter trenching by dragline and backhoe are effective ways to achieve a greater degree of dewatering than can be done through natural drainage. These methods have been utilized at Federal disposal areas for the Delaware River near Salem River. Both methods appear to be cost effective and are used to the maximum extent practical. Other more complex methods exist, such as those involving under-drainage systems and vacuum pumping. However, these methods are extremely costly with variable results. Dewatering practices will be included in the operations of any upland sites considered for Salem River.

155. Reusing Dredged Material. The sale of dredged material was initiated by the Philadelphia District in 1972 as a means of extending the useful life of existing disposal sites as well as providing a means of more efficiently utilizing the dredged material. The material is sold in quantity as excess government property directly from the disposal area. It has many productive uses, such as for landfill or construction activities. The future volume of material that can be reused in this manner depends on such factors as demand, type and quality of material, and distance

between the disposal site and reuse site. Some of the varied uses of dredged material are as follows:

- Highway Fill. Although it is likely that there will always be a market for this purpose, suitable material is necessary. The Salem River material is not considered viable.

- Shoreline Protection. Shoreline protection involves the deposition of dredged material onto eroding shorelines either as direct beach placement or offshore berms. The added transportation and placement costs, might result in increased costs in comparison to other alternatives for disposal, however such measures can be recommended in accordance with applicable cost sharing requirements, if local sponsors agree to finance the cost differential. The lower Salem River channel is adjacent to the eroding shoreline at Oakwood Beach in Elsinboro Township. Consideration of using dredged material from Salem River along that shoreline is warranted.

- Land Reclamation. This concept involves the placement of dewatered dredged material in areas such as abandoned pits and quarries, strip mines, sanitary landfills, agricultural soil enrichment, and resource recovery. There are no known locations near Salem where these techniques warrant consideration.

156. Site Management. Under this alternative, consideration was given to management practices (other than dewatering) that would extend the useful life of existing dredged material disposal areas. This measure would assure that the need for new dredged disposal areas were kept to a minimum. Management practices include baffle dikes, outflow facilities and use of optimal lift thickness to assure maximum drainage of dredged material. The current practice at the large Federal disposal areas in the vicinity of Salem River has been to construct as many interior baffle dikes and sluice gates as are needed in each disposal area so that the sediment particles are retained within the disposal site and, at the same time, the drying process is accelerated. Along with these measures, the District has normally used thin lift thicknesses to minimize the cost of dewatering. These management practices have been used in the past with good results and will continue to be used in the past with good results and will continue to be used in the future at the large Federal sites used for the Delaware River navigation system. For any new sites considered for the Salem River, site management practices will be assumed which are efficient for the size of the site.

157. Aquatic Disposal. Disposal of dredged material in aquatic areas can be accomplished by confined or unconfined disposal using hopper, bucket, or hydraulic dredges. Unconfined disposal can include techniques to bottom dump, thin layer, and fill holes. Filling of deep holes can be a practical disposal technique to avoid impacts on more valuable shallow water aquatic habitat. In addition, thin layering of disposed material can be accomplished to

limit impacts on the benthic organisms and minimize habitat destruction.

- Confined/Unconfined Disposal. Unconfined disposal of dredged material has been practiced for maintenance dredging operations of the channel through Salem Cove. Confined and unconfined disposal methods warrant consideration at aquatic sites studied as part of a channel modification project.

- Filling Holes. Filling deep holes to create shallows or to create a more uniform bathymetry may have limited potential for material disposal at Salem River. Any further consideration of this option should consider the potential effects of sediment migration on operation and maintenance dredging which might result and may require evaluation of dikes to properly confine the material.

- Thin Layering. Thin layering of dredged materials is a relatively new technique for disposal in aquatic environments which is designed to minimize the disturbance to benthic organisms by limiting material placement to a one foot layer or less. Primary considerations for this technique are compatibility of dredged and native material, proximity to the channel, and availability of equipment. Two techniques are employed; use of a barge mounted discharge pipe with a swivelling baffle to allow barge oscillation during disposal operations and secondly, spray techniques. Barge operations would be limited to areas with a depth sufficient for barge draft, but this technique might be suitable for various material types. Spray techniques can be employed in shallower areas and have been tried in wetlands areas to gradually raise their level. That technique is not well suited to materials with high organic content or gravels and rocks. Both techniques require a reasonable offset from the channel so that material suspended by the surface discharge operations does not immediately return to the channel. The Mobile District has used an offset of about 2500 feet from its deep draft channels and 1000 feet from smaller projects, however considerations at other locations include the currents, material type, and the slope of the bottom. Most importantly, consideration must be given to the turbidity and resuspension of fine materials as it affects the environment and the cost of maintenance dredging operations. Thin layering warrants further study.

158. Marsh/Shallow/Upland Creation. Dredged material disposal in aquatic environments can also be used to create marsh, shallows, or uplands. This may involve construction of dikes to contain material and protect it from erosive waves and currents. These techniques generally involve filling water depths of 30 feet or less and involve loss of medium and shallow water depth habitat, although they may present the opportunity to dispose of significant quantities of dredged material. Aquatic disposal operations during

maintenance of the existing Salem River channel have created a few small sand mounds in Salem Cove. These mounds provide some habitat diversity in the cove, however wetlands have not developed. Further consideration is warranted of creating shallows and uplands through disposal operations. Aquatic habitat should also be considered under Section 150 of the Water Resources Development Act of 1976 and ER 1165-2-27 for any viable aquatic sites.

159. RESULTS OF CYCLE 1 SCREENING. The preliminary screening in Cycle 1 concluded that there were no non-structural navigation plans not already utilized which would adequately address the planning objectives to increase the safe and efficient movement of commerce through the Salem River. Therefore, only channel modifications with a turning basin warrant further consideration. Non-structural measures will continue to be practiced at the discretion of pilots and shippers to achieve efficient operations.

160. The disposal analysis in Cycle 1 defined further efforts for Cycle 2. There are no active non-Federal upland disposal sites for the Salem River project. Previous maintenance dredging of the lower section used the overboard disposal area in the Salem Cove. The review of management measures determined that several disposal measures were not appropriate for the Salem project. Improved site management, dewatering, reuse of material, and raising of dike heights may have limited applicability in connection with new sites, but would not satisfy disposal needs for a channel deepening project by themselves. Other measures were determined to warrant further analysis. These include: acquisition of new upland sites; use of existing Federal sites; use of aquatic sites; thin layering, and creation of aquatic habitat (shallows) through disposal operations.

CYCLE 2 - ALTERNATIVE WATERWAY IMPROVEMENTS

161. The purpose of Cycle 2 formulation was to assess and evaluate structural plans and conduct an analysis of disposal options as a basis for detailed formulation. The "do nothing" plan was considered in this section as a means to assess impacts of the with project conditions. The initial work effort for Cycle 2 of plan formulation consisted of scoping the project to identify options and needs for navigation improvements and alternatives. The second step involved disposal analysis to determine which alternative warranted detailed studies.

162. SCOPING OF PROJECT. Based on the projected movements of vessels and commodities, alternative waterway modifications were evaluated.

163. <u>Entrance Channel</u>. Two entrance channel alignments were initially considered, one along the existing channel alignment, and another modified alignment through Salem Cove. The modified alignment, which was suggested by a Salem resident, proceeded straight out to the Delaware River from the channel bend toward the entrance of the C&D Canal. Evaluations of the latter alignment indicated

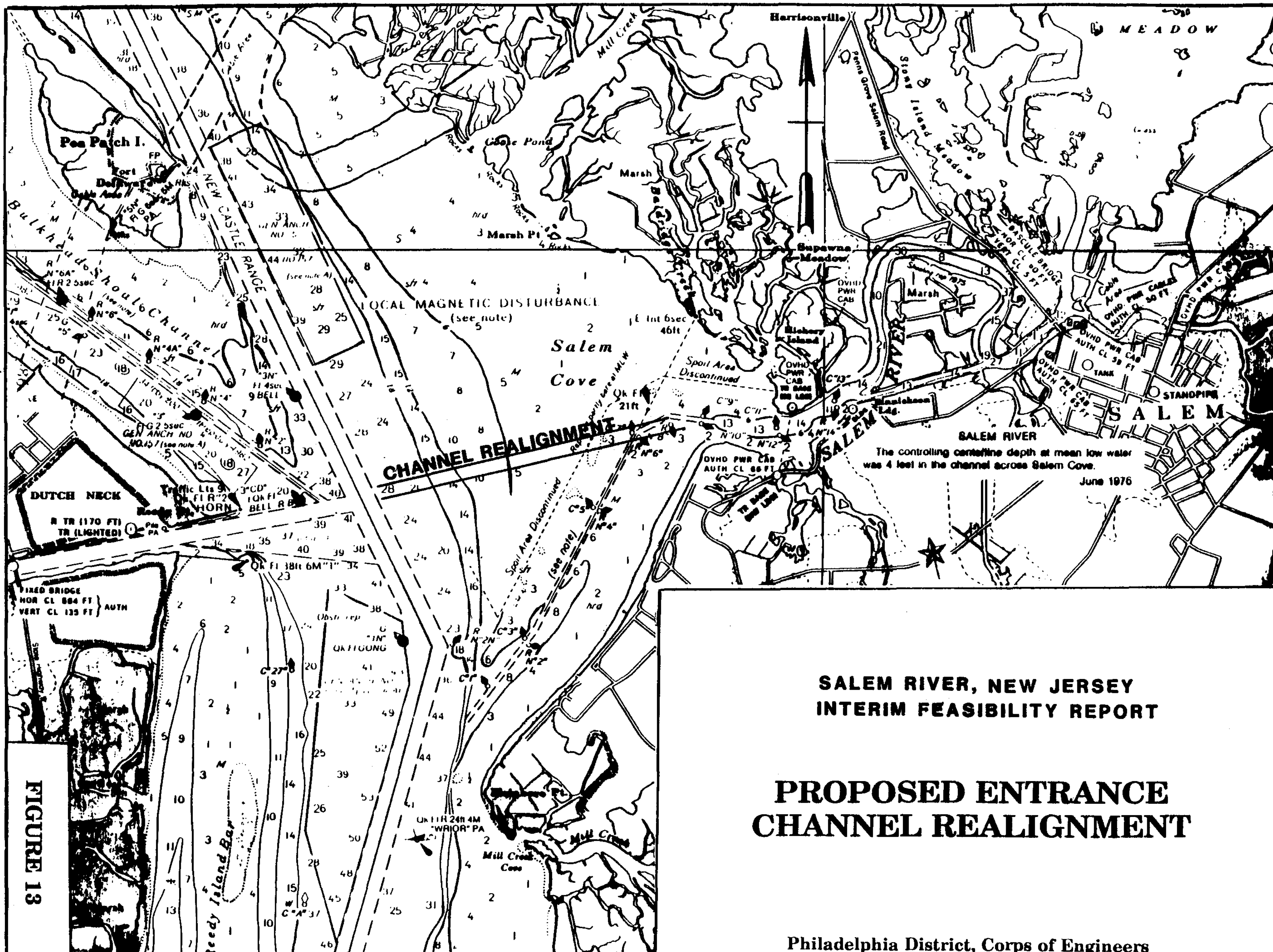
that it would require higher initial dredging quantities and costs since it crossed a much shallower, although shorter, bottom area than the existing channel. The alignment also would be subject to very difficult cross currents at its entrance from the Delaware River. There would be loss of benefits from this alignment for most shippers since nearly all traffic proceeds to or from the south for which the existing alignment provides the most direct route. Therefore, only the existing alignment of the entrance channel was considered appropriate for detailed study (see Figure 13).

164. Channel Depth and Alignment. A range of channel depths from the existing project depth of 12 feet MLW to 24 feet was considered reasonable based on the characteristics of vessels and barges anticipated to call at the Port of Salem and input from Port officials. Since no need for waterway improvements was evident above the upstream berth of the port facility, the upper project limit was established at the Route 49 bridge. Channel realignment under the overhead transmission cable in Salem Cove was considered necessary to more safely accommodate vessels and adapt to navigation practices and the more recent Coast Guard realignment. The realignment implemented in November 1989 is consistent with NED objectives since the water is naturally deep and would require less dredging than the existing project channel thereby providing a less expensive modification.

165. The geographic proximity of the Chesapeake and Delaware Canal was determined to have no impact on formulation. The operations of the Canal would remain unaffected at the existing 35 foot depth. The chief beneficiaries of the Canal are 37,000 DWT container vessels, very different from the vessels which utilize Salem.

166. Channel Width. Channel width is determined by the beam of the design vessel for each particular depth. The scoping of the channel width was complicated by the restrictive dimensions of the existing channel, particularly in the upper reach. Initial consideration was given to providing two different improved widths for the upper and lower channel sections, similar to the existing design (100' and 150'). Coordination with the U.S. Coast Guard, tug operators, and pilots indicated that the 100 foot width is inadequate. However, the pilots indicated that there was not a need to have a wider channel in the Cove compared to the upper reach. A uniform width channel would be adequate to safely meet the navigation needs. Because of the very narrow width of the upper channel through the cutoff, widening the channel to beyond 100 feet requires some bank disturbance due to the three to one sideslope dredging.

167. Turning Basin. Since operation of vessels on the Salem River requires turning at the port facility, provision of a Federal turning basin is an integral feature of any new project. Two alternate locations and layouts downstream of the port were considered. The first was a more traditional layout which would



SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

PROPOSED ENTRANCE CHANNEL REALIGNMENT

Philadelphia District, Corps of Engineers

FIGURE 13

provide a basin with sufficient diameter to pivot vessels as currently practiced. This scheme required some excavation of banks and marsh area across from the port, depending on the size of the turning basin. A second non-traditional layout developed would have allowed a vessel to execute a three-point turn with its bow in the natural Salem River channel, while its stern was rotated to the opposite direction. Such a scheme would still have required excavation of the natural channel and the adjacent banks, and would have required a more difficult turn due to fast-moving channel currents acting broadside to the vessel for a longer period. The more traditional layout was carried forward for detailed design since the latter plan was deemed too impractical.

168. DISPOSAL SCREENING. The first step in the initial screening of dredged material disposal areas was to identify potential sites through interviews with port officials, review previous reports and correspondence, and review past dredging contracts and public notices. A total of 26 candidate sites were identified and considered for disposal. Of these, three sites had been used for dredged material disposal in the past (Killcohook, 25-15, and 24-6), while the remaining areas were newly identified sites in the vicinity of the Salem River (see Figure 14). Killcohook is used for disposal related to the Delaware River navigation project. Disposal areas 25-15 and 24-6 have been used for the Salem River dredging in past years.

169. Site 25-15 is a small site previously used for the Salem project construction which has reverted to wetlands in the intervening decades, although some dikes still exist. Site 24-6 is an aquatic site in Salem Cove which was used for overboard disposal during maintenance dredging of the lower Salem River channel in 1961, 1984, and 1988.

170. Candidate sites included four overboard or aquatic areas and 22 areas consisting of uplands or uplands interspersed with wetlands. The aquatic areas included site 24-6; site 24-16, which is essentially expansion of site 24-6 into other portions of Salem Cove; a naturally deep hole behind Pea Patch Island; and placement of material on Oakwood Beach (site 24-17). Sites 24-16 and 24-17 were proposed by a Salem resident as possible solutions to offset a long-term erosion problem along the Oakwood Beach shoreline. It was determined that expansion of the existing aquatic site 24-6 into the larger cove area would be necessary as 24-6 is nearing capacity and would be filled by the base year, 1994.

171. Other candidate sites were upland areas, including an existing Federal site, Killcohook. Killcohook is the nearest Federally owned dredged material disposal site in New Jersey, used for maintenance of the Delaware River Philadelphia to the Sea project. Several other potential new upland sites were identified specifically for the Salem River project. In addition, five large sites in the general vicinity of Salem were considered which had been identified during the Delaware River Dredging Disposal Study as potential

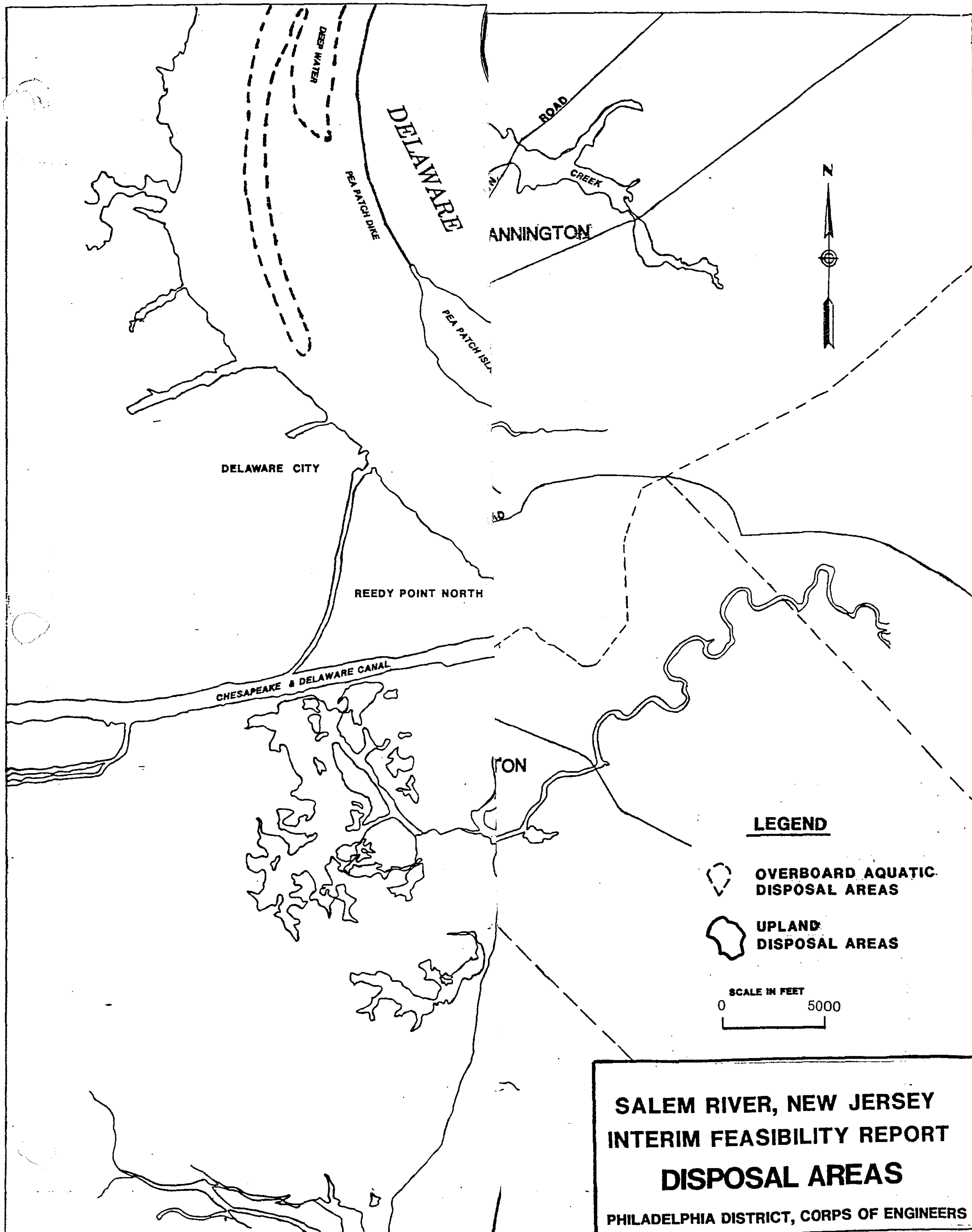

DEEP WATER
DELAWARE
PEA PATCH DIKE
PEA PATCH ISL
ROAD
CREEK
ANNINGTON
N
DELAWARE CITY
REEDY POINT NORTH
CHESAPEAKE & DELAWARE CANAL
TON
LEGEND
OVERBOARD AQUATIC DISPOSAL AREAS
UPLAND DISPOSAL AREAS
SCALE IN FEET
0
5000
SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT
DISPOSAL AREAS
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 14

sites for Delaware River dredging. These upland sites consisted of vacant parcels of land, agricultural fields and woodlands, and are zoned for a variety of uses including industrial, residential, agricultural and conservation. An additional Federal site, Reedy Point North, is located in Delaware, north of the C&D Canal entrance. Although it is nearly the same distance from the project as Killcohook, this site was considered a backup Federal site since it is in a different state and would require submerged lines crossing the Delaware River channel.

172. As a basis for initial screening, inventories were developed for each site to determine site characteristics considering engineering, environmental, economic, and institutional factors. The objective was to limit the number of alternatives to those which would result in an implementable NED plan during further studies. Engineering considerations included site capacity, proximity, an adequate foundation to support stable dikes, accessibility to trucks and pipelines, suitability for drainage of effluent, and the need for costly blankets or liners due to underlying soils and potential groundwater impacts. Aerial photographs were reviewed to determine existing development or land use. The disposal area distance from dredging locations is also an important factor. Dredging costs increase as distance from the dredging site increases. Consideration was also given to the efficiency of site size and capacity since small sites require significantly more dike construction for the volume of material contained. Additionally, small sites require multiple weir construction costs if additional sites are required, create problems during dike raising as site size becomes smaller, and provide less opportunity for dewatering and effective site operation and management as discussed under Cycle 1.

173. As part of the engineering screening, sites of less than 25 acres were eliminated from consideration. The results of this engineering screening are reflected in Table 9 under expected capacity and overall acceptability. The easement costs were not a significant consideration in that they reflect overall site size and not relative value per acre between sites. Residential and agricultural land was generally valued at $2,000 to $2,400 per acre whereas industrially zoned land was about $14,000 and subaqueous areas are valued at $200 to $250 per acre.

174. In addition, ecological and cultural investigations were conducted for these sites to determine their environmental suitability for disposal activities. The presence of wetlands and cultural resources in particular was evaluated and results used to screen sites for acceptability. Environmental concerns included adverse impacts to quality ecological habitats and potential disturbance of cultural resources. One site (25-5) is a former

TABLE 9

INITIAL SCREENING DISPOSAL AREAS
Salem River, Screening Criteria

Disposal Site No.	Description	Fish and Wildlife Impacts 1/	Institutional Acceptability 2/	Easement Cost	Expected Capacity	Overall Acceptability	Comments
25-1	Agricultural	SM	-	Low	Insufficient	No	Cultural Resource Impacts
25-2	Agricultural/Wetlands	SM	-	Medium	Medium	No	Cultural Resource Impacts
25-3	Agricultural	SM	0	Medium	Insufficient	No	Cultural Resource Impacts
25-4	Woodland	US	-	Low	Insufficient	No	Cultural Resource Impacts
25-5	Landfill	SM	+	Low	Insufficient	No	Problems of capacity and groundwater contamination
25-7	Agricultural	SM	0	Medium	Medium	Yes	Good location, size
25-8	Agricultural/Wetlands	SM	0	High	High	Yes	Good location, size
25-9	Agricultural/Wetlands	SM	0	High	High	No	Cultural Resource Impacts
25-10	Agricultural/Wetlands	SM	0	Medium	Insufficient	No	Cultural Resource Impacts
25-11	Agricultural	SM	0	Low	Insufficient	No	Cultural Resource Impacts
25-12	Agricultural	SM	0	High	High	No	Cultural Resource Impacts
25-15	Wetlands	SM	0	Medium	Low	No	Previous Disposal Area, reverted to wetlands
24-6	Subaqueous	SM	+	Low	Insufficient	No	Existing Overboard Site
24-13	Agricultural/Wetlands	SM	0	High	Low	No	Cultural Resources Impacts

1/ S = Satisfactory, SM - Satisfactory with Possible Mitigation, US = Unsatisfactory

2/ Includes zoning, real estate cost, past and present use, and location evaluations

TABLE 9 (CONT'D)

Disposal Site No.	Description	Fish and Wildlife Impacts 1/	Institutional Acceptability 2/	Easement Cost	Expected Capacity	Overall Acceptability	Comments
24-14	Agricultural	SM	0	High	High	No	Cultural Impacts
24-CC	Agricultural/Wetlands	SM	0	High	High	No	Excessive distance, wet-lands
24-U	Agricultural	SM	0	High	High	No	Excessive distance, wet-lands
24-T	Agricultural	SM	0	High	High	Yes	Upland portion attractive
24-N	Wetlands	US	0	High	High	No	Excessive distance, wet-lands
25-I	Agricultural	SM	0	High	High	No	Difficult access
25-H	Agricultural	SM	0	High	High	No	Difficult access
25-G	Agricultural	SM	0	High	High	No	
24-16	Subaqueous	US	+	Low	High	Yes	
24-17	Subaqueous	SM	+	Low	High	Yes	Disposal within part of this area suggested by residents for Elsinboro Point erosion control
-	Killcohook	S	+	None	High	Yes	Reimbursement Costs for accelerated use
-	Pea Patch Island	S	0	Low	High	Yes	

municipal landfill. This site was discounted because of groundwater contamination concerns and limited capacity. Table 9 displays potential acceptability based on fish and wildlife impacts and the need for mitigation. Nearly all of the agricultural sites were located on prime farmland, however, the significance of this decreased due to changed regulations and it was not a key factor in the screening.

175. The institutional screening was conducted using a numerical rating system to assess attractiveness, similar to the spatial analysis model conducted for the Delaware River. Consideration was given to parameters for zoning, ownership, location, cost, existing and future planned use. Coordination was undertaken with the project sponsor to determine the institutional acceptability of proposed sites and to determine if additional sites needed to be considered. All sites were screened using this data to determine overall acceptability. The results of this screening are summarized in Table 9. Those sites which appeared to provide overall acceptability were considered further.

176. Table 9 summarizes the findings. All but three of the candidate non-Federal upland sites were excluded from the analysis after this initial screening due to fundamental engineering, economic and institutional factors. These factors included limited disposal capacity at smaller sites, excessive pumping distances at outlying sites, inaccessibility from an engineering perspective, and institutional problems due to zoning, cost, location, and past and present use. There was also environmental concerns with a number of these sites due to the extent of wetlands and the potential for cultural resource impacts.

177. As a result of this screening, four upland areas and three aquatic areas were considered viable. The upland areas included three newly identified sites (24T, 25-7 and 25-8), and the existing Federally owned Killcohook dredged material disposal site. Killcohook is located adjacent to the Delaware River, approximately 3.25 miles from the mouth of the Salem River. This site is approximately 1,200 acres in size and has sufficient capacity to accommodate the estimated quantities of material for initial construction and maintenance of the proposed Salem River project, without significantly impacting the Delaware River maintenance program. The three new candidate sites are predominantly agricultural fields with small pockets of non-tidal wetlands. These sites would be suitable for disposal activities from an environmental perspective, with minor amounts of mitigation. The aquatic sites included the hole behind Pea Patch Island; 24-16, which is an expansion of 24-6, the previously used overboard disposal site in Salem Cove; and 24-17 which incorporates Oakwood Beach. These latter sites were closest and parallel to the lower Salem River channel.

178. Following scoping of the project and initial disposal area screening, project formulation continued with a view toward identification of the least cost disposal scenario as well as the

optimum channel depth in order to identify the NED plan. Since the level of navigation benefits due to transportation savings are not dependent on the disposal scenario selected, it was decided to identify the least cost disposal scenario (NED) prior to conducting detailed channel depth optimization studies. An initial evaluation was made to determine the channel depth for which a least cost disposal analysis should be conducted, since it was not practical to evaluate every disposal option for each channel depth. For this test analysis it was assumed that the nearest disposal areas could be used, without regard to details of design such as mitigation requirements and effects on shoaling conditions or maintenance requirements. This initial evaluation identified 18 feet MLW as the appropriate depth for the disposal analysis. An incremental analysis of disposal scenarios was then conducted as a basis for channel optimization using the least cost disposal option.

179. A total of 12 dredged material disposal scenarios were developed from the eight candidate sites. These scenarios included all aquatic and upland disposal. These 12 scenarios were evaluated through detailed cost analyses in order to identify the National Economic Development (NED), or preferred plan for dredged material disposal. The NED plan is defined as the alternative that reasonably maximizes net economic benefits, and is consistent with protecting the Nation's environment. Environmental concerns were incorporated into the cost analyses by factoring in the cost of mitigation required for each scenario. The 12 disposal scenarios and costs associated with each scenario are provided in Table 10.

180. INCREMENTAL ANALYSIS. The analysis was conducted according to a Corps memorandum dated 18 May 1989, subject: Management of Materials Dredged from Navigation Channels. This memorandum reiterates the following requirements from principles and guidelines:

- formulation of alternative plans in a systematic manner to ensure that all reasonable alternatives are considered.

- recommendation of the alternative plan that reasonably maximizes net national economic development benefits consistent with protecting the Nation's environment unless an exception is granted by the Assistant Secretary of the Army (Civil Works).

181. The disposal area formulation was expanded with particular attention to the aquatic sites near Salem River. Table 10 includes April 1990 cost estimate data for the 12 disposal alternatives considered including costs for fish and wildlife mitigation due to aquatic impacts.

ITEM	1. All overboard to undiked Salem Cove (24-16)	2 :s :ch	10.Diked behind Pea Patch Island	11.Thin Layering behind Pea Patch Island	12. Killcohook with maint. over board to undiked Salem Cc
Acreage	500 acres		88 acres	1300 acres	310 acres
Initial Cost	$5,329		$26,890	$23,530	$ 9,031
Associated Costs	$ 183		$ 267	$ 269	$ 266
Federal Site	0		0	0	$ 288
Replacement costs *					
Environment concerns/criteria	.Nursery, spawning and foraging habitat for: striped bass weak fish Spot Blue crab .Turbidity		.Shallow water habitat .Nursery, spawning & foraging habitat for striped bass weakfish spot	.Shallow water habitat .Turbidity Nursery and foraging for striped spot	Nursery, spawning and foraging habitat for: striped bass weak fish Spot Blue crab Turbidity
Disposal Area Mitigation	.Create 500 acres of shallows .Seasonal restrictions		Seasonal restrictions for rookery .Create 88 acres of shallows	.Seasonal restrictions	.Create 360 acres of shallows .seasonal restrictior
Disposal Area Mitigation Costs	Dike $5,000 Place material $ 6,000		Dike $ 1,000 Place material $ 1,056	0	Dike $ 4,000 Place material $ 4,300
Total Initial Costs	$16,512		$29,213	$23,799	$17,885
Amortized First Costs	$ 1,467		$ 2,595	$ 2,114	$ 1,589
Annual O&M Require.**	94,050 c.y.		62,700 c.y.	62,700 c.y.	94,050 c.y.
Maintenance Costs					
Dredging Cycle	3		3	3	3
Project Cost	$ 1,687		$ 2,768	$ 4,430	$ 1,636
Associated Cost	112		115	184	$ 112
Total Cycle Cost	$ 1,799		$ 2,883	$ 4,614	$ 1,748
Average Annual Maint. Cost	$ 550		$ 882	$ 1,411	$ 535
Total Avg. Annual Cost	$ 2,017		$ 3,477	$ 3,525	$ 2,124
Exist. Maint.	$ 239		$ 383	$ 612	$ 232
Total Incremental Cost	$ 1,778		$ 3,094	$ 2,913	$ 1,892

Note: * The replacement cost is the rei
** The annual O&M requirement redr
from unconfined overboard dispo
*** Use of Oakwood Beach for initia

182. Several aquatic approaches were considered with regard to dredged material disposal within Salem Cove, along Oakwood Beach, and adjacent to Pea Patch Island. Thin layering, unconfined disposal, beachfill, and disposal with dike construction to create shallows or uplands were analyzed with attention to impacts on shallow waters and the resources of the Salem River.

183. The high ecological value placed on shallow water habitats is primarily attributed to biological productivity. A major factor contributing to this productivity is the maintenance of high concentrations of dissolved oxygen throughout the water column. Suitable oxygen levels are essential for the support of aquatic organisms, and are often lacking in deep water areas. Another important factor is the production of green plants either in or adjacent to shallow zones. The availability of live and dead plant materials attracts detritivores and herbivores, which in turn attract secondary and tertiary consumers. As such, plants are an important link in the maintenance of the aquatic food web. Largely due to the availability of favorable food and oxygen conditions, the eggs, larvae, juveniles and adults of hundreds of species of zooplankton, invertebrates, fish, birds and mammals have been found within the shallow water zones of the Delaware River and Salem Cove.

184. The Salem Cove provides an extensive stretch of shallow water habitat. The Cove is positioned in the brackish portion of the Delaware River, between freshwater further up-river, and marine conditions in Delaware Bay. This section of the river provides valuable nursery, spawning and foraging habitat for a variety of estuarine resident and migratory species of fish. Commercially and/or recreationally important species in the Delaware River Basin are known to utilize the area as nursery habitat include Atlantic menhaden, bluefish, weakfish, spot, and white perch. The white perch has been fished both commercially and recreationally within the basin, however, it is considered to be a species of lesser value.

185. Two species that may utilize Salem Cove for spawning as well as nursery habitat are the bay anchovy and striped bass, as listed on Table 10. While not of direct commercial or recreational value, the bay anchovy is considered one of the most important species of fish in the Delaware River. This species is heavily used as forage by many of the larger predacious species including striped bass, bluefish, weakfish and summer flounder. Without healthy stocks of forage species, the populations of these larger commercial and sport fishes would noticeable decline. As such, the bay anchovy does play an important role in the economy of Delaware River fisheries.

186. The striped bass has been a species of great concern in recent years. Once plentiful in the Delaware River basin, this commercially and recreationally valued species steadily declined as

development within the basin increased. The apparent reason for the decline is the lack of suitable spawning habitat. Today, the only portions of the basin believed to be suitable for striped bass spawning are the Chesapeake and Delaware Canal and the Delaware River between Salem Cove and Wilmington, Delaware, thus making Salem Cove valuable for this purpose.

187. In addition to finfish, Salem Cove also supports a valued blue crab fishery. Blue crabs are found within shallows during the spring and summer mating period, while they tend to migrate to deeper water during the winter. Salem Cove is a productive area for commercial crabbers during the midsummer season. The lower portion of the Salem River and the Cove are also used for recreational crabbing.

188. It was also appropriate to review the possible costs of mitigation for aquatic impacts. Due to the high ecological value attributed to shallows, and significance of the Salem Cove shallows, utilization of this area and other shallows would require in-kind habitat replacement on a one-to-one basis. One option for mitigation would entail acquisition of an upland area immediately adjacent to the Delaware River, and excavation of that area to provide a bottom elevation at least 2 to 3 feet below the elevation of mean low water in the adjacent portion of the river. However, preliminary consideration of this option concluded that it would be prohibitively expensive; in the range of $100,000 per acre. Creating shallows by filling deeper aquatic areas was considered to be a more efficient approach and an area adjacent to Pea Patch Island in the Delaware River was identified as the nearest suitable site. The analyses focused on three approaches in taking these factors into consideration.

189. The first disposal area and method considered was disposal of dredged material without construction of containment dikes (Alternative #1 on Table 10). The height of fill for this alternative could range from a very thin layering, so as not to lose the shallow water habitat that currently exists, to a maximum of six feet, which is the most that could be achieved considering the nature of the material and the physical characteristics of the cove. With a fill height of six feet, approximately 500 acres of Salem cove would be required to accommodate all of the material generated from construction and maintenance of the project. In addition, six feet of fill would result in the loss of shallows, as the cove predominantly ranges between one and five feet deep at mean low water. The estimated cost of creating 500 acres of shallows at Pea Patch Island as mitigation is 11 million dollars. This alternative was found to be the least cost aquatic option.

190. Aside from the loss of shallow water habitat, unconfined dredged material disposal in the cove raises other serious environmental and engineering concerns. The Cove is adjacent to the Supawna Meadows National Wildlife Refuge. A disposal operation

of this magnitude could significantly alter the circulation patterns of this wetland system.

191. In addition, a change in flow patterns could seriously degrade the quality of existing habitat. Unconfined disposal operations would generate a significant amount of turbidity in the river. This movement of unconfined dredged material will impact the Delaware River channel and the Salem River approach channel by increasing the rate of siltation. An increased rate of siltation in the Delaware River and Salem River navigation channels would also increase the need for maintenance dredging of those channels due to unconfined disposal. Additional costs for this increased Salem River operations and maintenance dredging are reflected in Table 10 for unconfined alternatives. The Salem River is adjacent to the New Castle Range of the Delaware River which is one of the highest shoaling areas of the river, requiring over a million cubic yards of dredging annually and accounting for nearly one fourth of the total maintenance requirement for the entire main channel. As concluded by a Tidal Hydraulics Committee study of the Delaware River, dredging requirements were reduced significantly for the Delaware River, after fiscal year 1955 when tight control over dredging procedures was instituted and upland disposal was used to positively remove dredged material from the waters of the estuary. A significant amount of the Salem material would likely have to be redredged if placed unconfined in the Salem Cove between the Delaware and Salem River channels.

192. The second technique evaluated was the creation of a diked island (#2), to minimize the area required to accommodate all of the material generated from initial construction and 50 years of maintenance. It was estimated that 120 acres would be required, with a dike height of approximately 25 feet. While this is technically feasible, the cost associated with dike construction was conservatively estimated at 15 to 20 million depending on dike requirements and layout. This assumes geotextile would be required similar to the Wilmington Harbor South site. Converted to an annual basis, the diked island alternative costs $892,000 more than the undiked overboard disposal alternative (#1) and $1.4 million more than the Killcohook alternative (#7). The increased average annual cost of diked disposal includes costs of mitigating the loss of 120 acres of shallow water habitat which is approximately $4 million.

193. The third disposal method considered was thin layering (#3). A thin layering approach in Salem Cove would require over the life of the project, a much larger area than available in the Cove. Thin layer disposal would be more practical using a hopper dredge and disposing into deep water using a spreader. For the Salem project trying to mimic this technique in Salem Cove with a hydraulic pipeline dredge would be more expensive. Use of a barge mounted discharge pipe would be impossible to implement due to the shallow water (1'-5') in the cove; therefore a spray technique

would be necessary. In addition to the acreage requirement, unconfined disposal of dredged material in Salem Cove would generate a significant amount of turbidity due to the large percentage of fine material. Aside from the adverse aesthetic impact, excessive turbidity would place stress on aquatic organisms and increase the rate of siltation in nearby navigation channels. Elevated levels of suspended sediment stresses aquatic organisms by lowering dissolved oxygen concentrations, reducing water clarity and clogging gill filaments. This would be detrimental to anadromous species that must pass this area during migratory periods. These species include the American Shad, which makes spawning runs in the Delaware River, and the alewife, which makes spawning runs in the Salem River. There would also be concerns with regard to turbidity impacts on spawning striped bass, blue crabs and oysters. Overall this disposal option was not found to be practical.

194. Further consideration was also given to unconfined disposal at Oakwood Beach (#4). It was concluded that only material between stations 8+000 and 13+000 could be used since material dredged from other portions of the project is unsuitable for placement on the beach. However, due to the high percentage of fine-grained material between stations 8+000 to 13+000 approximately half of the material (150,000 cubic yards) dredged during construction of an 18-foot channel would be susceptible to rapid dispersal. Additional fine-grained material would be lost after disposal operations as a result of tidal currents and wave action. Much of the material would probably have to be redredged as increased maintenance quantities either from the Salem River channel or the Delaware River channel, and this disposal option would not result in the least cost plan.

195. The up-river end of Pea Patch Island, Delaware (#9,#10,#11) was also considered for shallows creation, upland creation, and thin layering. This site is approximately four miles from the mouth of the Salem River and is flanked by a submerged training dike that could partially serve to keep material in place. Additional diking would be required because the existing currents maintain the deep water in this area through scouring.

196. From a cost perspective, the use of the Pea Patch Island site would be more expensive than disposal at Killcohook. It would be slightly more expensive to transport material to the Pea Patch Island site as it is farther from the mouth of the Salem River than Killcohook. In addition, a submerged pipeline would be required to cross the Delaware River navigation channel. However, the major expense would be underwater dike construction to keep material in place. The need to "contain" this material in the designated disposal area is necessary since the sediments could otherwise adversely impact 1) the Delaware River navigation channel, 2) the entrance channel to the Texaco Oil Refinery pier located immediately down-river, 3) adjacent wetlands on Pea Patch Island

and the Delaware shoreline of the Delaware River, and 4) shellfish and other important benthic populations in the vicinity. The cost of this underwater diking would be in the range of $15 to $25 million. These options would be much more costly than disposal at the existing Killcohook site.

197. Table 10 shows that Alternative #7, the use of Killcohook for disposal of all project quantities, is the least-cost option based on an average annual cost comparison of all alternatives. The distance factor is offset by the greater acquisition and diking cost at the other upland sites 25-7, 25-8 and 24T (Alternative #5,#6#,8). The replacement cost item displayed is the amount the project sponsor would contribute to compensate the Federal government for the accelerated use and replacement of its existing Federal disposal areas, thereby fulfilling the local cooperation requirement to provide a suitable disposal area for the Salem project. If Killcohook is used for disposal of materials from the Salem River, capacity would be reached earlier than projected under the Philadelphia to the Sea Project. The use of subsequent Delaware River sites would also be advanced. Alternative #12 combines initial disposal at Killcohook with maintenance to Salem Cove. Based on the results of the incremental disposal analysis use of Killcohook for initial and maintenance dredging was carried forward as the least cost option.

CYCLE 3 - ASSESSMENT OF DETAILED PLANS

198. Cycle 3 involved optimization of the channel depths to determine the NED plan. The costs were assessed for a range of depths, 14'-24' based on the design vessel for each depth, channel dimensions and dredged disposal quantities with placement of material into the NED disposal site (Killcohook).

199. Design Vessels. The economic benefits used for plan formulation were based on projections of existing commodities for 1994-2044 at depths of 14 feet to 24 feet. The vessel fleet over the economic life of the project was projected and the design vessel identified. In order to minimize dredging costs, channel widths were established for each channel depth based on the design vessel, the largest common vessel. Channel dimensions were established based on vessel trips, vessel characteristics and Corps design criteria shown in Table 11.

TABLE 11

CHANNEL/VESSEL DIMENSIONS

Channel Depth	Channel Width	Tug(s) Beam	Design Vessel Beam/Length	Design Vessel Draft
14′	160′	10′	42′/250′	18′
16′	170′	10′	45′/315′	19′
18′	180′	10′	50′/330′	21.5′
20′	250′	20′	64′/440′	27′
22′	280′	20′	72′/450′	29′
24′	280′	20′	72′/450′	29′

200. The channel widths listed in Table 11 incorporate use of a 10' x 46' accompanying tug for vessels up to the 18 foot channel depth under design conditions. Design conditions as defined by Corps criteria allow for safe passage for the project design vessel under most weather conditions with an experienced pilot or captain. Vessels are lightloaded and operate under tidal conditions permitting design vessels to transit the respective channel depths. Two tugs with beams of ten feet or one larger tug (25'x 65') would be used at the discretion of the pilot under adverse hydraulic or weather conditions or depending upon maneuverability if the vessel size exceeded 50' x 330'. The shift to use of two smaller tugs or the single larger tug under design conditions occurs with a 20 foot channel depth. The costs of using two smaller tugs compared to using the larger tug are approximately the same, according to the Salem River operators.

201. <u>Dredged Quantities</u>. Table 12 illustrates the quantities for the improvement scenarios. These initial dredging quantities assume maintenance dredging to the authorized 12 foot depth is accomplished by the time of construction. Average annual maintenance quantities are cumulative as shown, including 22,500 cubic yards annually for the existing 12' project. An over-depth of two feet is included in the quantities as presented.

TABLE 12

CYCLE 3

DREDGING QUANTITIES SUMMARY 14' - 24' CHANNEL DEPTHS

1. Initial Dredging Quantity (rounded) - cubic yards

Depth	Federal Project	Berths	Total
14'	394,000	14,000	408,000
16'	776,000	21,000	797,000
18'	1,254,000	28,000	1,282,000
20'	2,576,000	35,000	2,611,000
22'	3,637,000	51,000	3,668,000
24'	4,287,000	59,000	4,346,000

2. Average Annual Maintenance Dredging Quantity

Depth	Federal Project	Berths	Total
14'	36,900	1,700	38,600
16'	49,400	2,100	51,500
18'	60,200	2,500	62,700
20'	90,700	2,800	93,500
22'	114,100	3,000	117,100
24'	129,000	3,500	132,500

202. The years which Killcohook and the replacement site for the Delaware River project (20I, to the north of Killcohook), reach capacity under the Philadelphia to the Sea project calculated in Cycle 2 were refined in Cycle 3. Both analyses demonstrated that no problem would be created for the Philadelphia to the Sea project by adding Salem disposal quantities to Federal sites. The quantities from the Salem River 18 foot project would have a minimal impact on the overall use of the disposal areas for the Delaware River main channel at depths of 40 to 45 feet. Therefore, use of Killcohook represents the optimal disposal plan for the Salem River.

203. Fleet Distribution. A fleet distribution is influenced by many factors. The criteria for selecting ship sizes include the volume of trade, distance of transport, controlling depths at both the loading and discharge ports, and cargo handling and storage facilities. Generally, the most efficient vessel size for any trade route tends to be one of the largest, if not the largest, ship that can be accommodated on that route. So, as

the Salem River is deepened, a gradual shift to a larger weighted fleet size is projected in order to take advantage of cost efficiencies provided by the deeper navigational channel.

204. The fleet distribution were based on operating costs as a criteria and assumed a normal distribution using the optimal vessel as the mean. Any vessel which had an operating cost greater than one standard deviation was dropped from the distribution for the considered channel depth.

205. The maximum vessel class that will use the Salem River channel is projected to be 5000 DWT for general cargo.

206. A referral to world and regional fleet statistics developed by the IWR MARDATA Ship Library verified that there are sufficient vessels of pertinent size to handle the tonnage projected to be moved through Salem over the project life.

207. As the channel becomes deeper a larger proportion of commodities would move by larger vessel classes. This assumption for the channel deepening is based on traditional navigational vessel operating decisions. As stated in Step 5 of ER 1105-2-100, Chapter 6, Section 7, "Transportation costs with a plan should reflect any efficiencies that can be reasonably expected such as use of larger vessels, increased load reductions in transit time and delays, etc."

208. The primary sources for vessel information included the two companies operating facilities on the Salem River, the Corps' Institute for Water Resources, Port of Salem officials, the pilots association, and the local tug and launch company. Additional sources of information included shipping companies and ship brokers using the port of Salem. These sources were asked to identify the most likely and maximum vessel dimensions for both ships and barges for each of the channel depths.

209. Table 13 presents the fleet distribution for general cargo/container vessels for each level of current actual operating practice defined by data from the pilots logs (i.e., unconstrained, 1.5 feet constrained, and 2.5 feet constrained), and for each channel depth The largest vessel size anticipated is 5000 DWT. The fleet distributions will not shift over the project life.

TRANSPORTATION COST AND SAVINGS ESTIMATION

210. <u>General Cargo/Container Benefits: Exports to Bermuda</u>. A transportation cost model was developed to analyze the actual operating practices of outbound general cargo/container vessels to Bermuda (determined from the sailing drafts listed by the Salem River pilot logs). Vessel movements on this trade route are port to port. 11.8% of vessels have operated unconstrained,

TABLE 13

FLEET DISTRIBUTION BY CHANNEL DEPTH FOR GENERAL CARGO/CONTAINER VESSELS
ACTUAL OPERATING PRACTICE: DESIGN DRAFT AND CARRYING CAPACITY ADJUSTMENT
FLEET DISTRIBUTIONS BY CHANNEL DEPTH ESTIMATED BASED ON NORMAL DISTRIBUTION
FOR VESSEL CLASSES <1 STANDARD DEVIATION FROM MEAN

VESSEL CLASS	A]	B]	C]
12 FT CHANNEL			
1000 DWT			
1500 DWT	10.0%	2.9%	0.5%
2000 DWT		11.4%	20.4%
3000 DWT	60.0%	45.7%	40.8%
4000 DWT	30.0%	40.0%	38.3%
5000 DWT			
14 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	8.1%	1.4%	14.4%
3000 DWT	46.3%	37.5%	28.8%
4000 DWT	45.6%	38.9%	29.5%
5000 DWT		22.2%	27.3%
16 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.1%	1.1%	16.9%
3000 DWT	32.6%	30.4%	26.5%
4000 DWT	35.8%	33.7%	27.7%
5000 DWT	30.5%	34.8%	28.9%
18 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.2%	0.4%	4.3%
3000 DWT	27.9%	31.3%	30.0%
4000 DWT	34.9%	33.6%	31.4%
5000 DWT	36.0%	34.7%	34.3%

FOOTNOTES:
A] VESSELS OPERATING >15 FT SAILING DRAFT CURRENTLY (UNCONSTRAINED)

B] VESSELS OPERATING WITH 14 FT SAILING DRAFT CURRENTLY (1.5 FT CONSTRAINT)

C] VESSELS OPERATING WITH 13 FT SAILING DRAFT CURRENTLY (2.5 FT CONSTRAINT)

VESSEL CLASS	A]	B]	C]
20 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.2%	0.4%	4.3%
3000 DWT	27.9%	31.3%	30.0%
4000 DWT	34.9%	33.6%	31.4%
5000 DWT	36.0%	34.7%	34.3%
22 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.2%	0.4%	4.3%
3000 DWT	27.9%	31.3%	30.0%
4000 DWT	34.9%	33.6%	31.4%
5000 DWT	36.0%	34.7%	34.3%
24 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.2%	0.4%	4.3%
3000 DWT	27.9%	31.3%	30.0%
4000 DWT	34.9%	33.6%	31.4%
5000 DWT	36.0%	34.7%	34.3%

FOOTNOTES:

A] VESSELS OPERATING >15 FT SAILING DRAFT CURRENTLY (UNCONSTRAINED)

B] VESSELS OPERATING WITH 14 FT SAILING DRAFT CURRENTLY (1.5 FT CONSTRAINT)

C] VESSELS OPERATING WITH 13 FT SAILING DRAFT CURRENTLY (2.5 FT CONSTRAINT)

TABLE 13

FLEET DISTRIBUTION BY COMMODITY AND CHANNEL DEPTH FOR GENERAL CARGO/CONTAINER VESSELS
ACTUAL OPERATING PRACTICE: DESIGN DRAFT AND CARRYING CAPACITY ADJUSTMENT
FLEET DISTRIBUTIONS BY CHANNEL DEPTH ESTIMATED BASED ON NORMAL DISTRIBUTION
FOR VESSEL CLASSES <1 STANDARD DEVIATION FROM MEAN

VESSEL CLASS	A]	B]	C]
12 FT CHANNEL			
1000 DWT			
1500 DWT	10.0%	2.9%	0.5%
2000 DWT		11.4%	20.4%
3000 DWT	60.0%	45.7%	40.8%
4000 DWT	30.0%	40.0%	38.3%
5000 DWT			
14 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	8.1%	1.4%	14.4%
3000 DWT	46.3%	37.5%	28.8%
4000 DWT	45.6%	38.9%	29.5%
5000 DWT		22.2%	27.3%
16 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.1%	1.1%	16.9%
3000 DWT	32.6%	30.4%	26.5%
4000 DWT	35.8%	33.7%	27.7%
5000 DWT	30.5%	34.8%	28.9%
18 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.2%	0.4%	4.3%
3000 DWT	27.9%	31.3%	30.0%
4000 DWT	34.9%	33.6%	31.4%
5000 DWT	36.0%	34.7%	34.3%

FOOTNOTES:

A] VESSELS OPERATING >15 FT SAILING DRAFT CURRENTLY (UNCONSTRAINED)

B] VESSELS OPERATING WITH 14 FT SAILING DRAFT CURRENTLY (1.5 FT CONSTRAINT)

C] VESSELS OPERATING WITH 13 FT SAILING DRAFT CURRENTLY (2.5 FT CONSTRAINT)

VESSEL CLASS	A]	B]	C]
20 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.2%	0.4%	4.3%
3000 DWT	27.9%	31.3%	30.0%
4000 DWT	34.9%	33.6%	31.4%
5000 DWT	36.0%	34.7%	34.3%
22 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.2%	0.4%	4.3%
3000 DWT	27.9%	31.3%	30.0%
4000 DWT	34.9%	33.6%	31.4%
5000 DWT	36.0%	34.7%	34.3%
24 FT CHANNEL			
1000 DWT			
1500 DWT			
2000 DWT	1.2%	0.4%	4.3%
3000 DWT	27.9%	31.3%	30.0%
4000 DWT	34.9%	33.6%	31.4%
5000 DWT	36.0%	34.7%	34.3%

FOOTNOTES:

A] VESSELS OPERATING >15 FT SAILING DRAFT CURRENTLY (UNCONSTRAINED)

B] VESSELS OPERATING WITH 14 FT SAILING DRAFT CURRENTLY (1.5 FT CONSTRAINT)

C] VESSELS OPERATING WITH 13 FT SAILING DRAFT CURRENTLY (2.5 FT CONSTRAINT)

44.1% have operated with a 1.5 foot constraint, and 41.2% have operated with a 2.5 foot constraint. 2.9% of the fleet have operated with a greater than 2.5 foot constraint and are not included in the benefit analysis.

211. Table 14 presents the transportation cost model for the unconstrained vessels in the fleet. Vessels will use 76% of design deadweight tonnage carrying capacity (including TEU box weight). Vessel classes range from 1000 to 5000 DWT. The immersion factors were developed by applying an equation provided by IWR. The tidal allowance is 5.5 feet with required underkeel clearance of 2 feet. Shut-out tonnage is determined by netting out constrained tonnage (based on the immersion factor) from the available channel depth in comparison to the maximum vessel carrying capacity of 76%. Cargo tonnage carried nets out from the calculation the weight of the TEU boxes that hold the commerce. Cruising speeds used were checked and are reasonable compared to data provided by IWR. Loading, dockage, wharfage, and tug costs are based on coordination with representatives of the Salem River facility. Operating costs at sea and in port were reasonable compared to a regression model that used FY 1990 IWR Foreign Flag Container vessel data. Tidal delays are defined based on the channel depth, vessel characteristics, range of tide, and underkeel clearance. Pilotage costs are based on coordination with the pilots. Total transportation costs are a summation of the total costs for a round-trip movement. Backhauling is a very insignificant part of the operations for this trade route. Transportation costs per ton are determined by dividing total transportation costs by the amount of tons carried for each channel depth and vessel class.

212. The transportation savings model for unconstrained vessels, incorporated the cost per ton data from Table 14, the fleet distributions by channel depth from Table 13, and the commodity projections from Table 8.

213. Comparable transportation cost models were developed to incorporate the impact of 1.5 and 2.5 foot constraints on actual operating practice. The greater the constraint, the less tonnage that is carried per channel depth. Average annual cumulative transportation savings, by channel depth, are displayed in Table 15.

TABLE 14

TRANSPORTATION COST MODEL

SALEM RIVER
VESSEL CLASSES ADJUSTED BASED ON 76% CARRYING CAPACITY FOR BERMUDA ISLANDER

	General Cargo and Container Vessels:					
VESSEL/CHANNEL CHARACTERISTICS						
Design Deadweight Tonnage (tonnes)	1000	1500	2000	3000	4000	5000
Vessel Carried Tonnage Capacity (S.T.)	838	1257	1675	2513	3351	4189
Design Draft	12.8	14.6	17.7	18	19	22
Immersion Factor (M.T.)	18.0	19.0	20.0	21.0	36.0	39.0
Tidal Allowance	5.5	5.5	5.5	5.5	5.5	5.5
Required Keel Clearance	2	2	2	2	2	2
Required Channel Depth	14.8	16.6	19.7	20	21	24
Shut Out Tonnage to Port (By Depth)						
12	0	0	582	694	1668	3352
14	0	0	53	139	715	2321
16	0	0	0	0	0	1289
18	0	0	0	0	0	258
20	0	0	0	0	0	0
22	0	0	0	0	0	0
24	0	0	0	0	0	0
	0	0	0	0	0	0
Cargo Tonnage (S.T.)-Net Box Wgt						
12	609	914	796	1323	1224	608
14	609	914	1180	1727	1917	1359
16	609	914	1219	1828	2437	2109
18	609	914	1219	1828	2437	2859
20	609	914	1219	1828	2437	3046
22	609	914	1219	1828	2437	3046
24	609	914	1219	1828	2437	3046
OCEAN VOYAGE PARAMETERS						
Cruising Speed (Statute MPH)	16	16	16	17	17	18
Cruising Speed (Nautical MPH)	13.9	13.9	13.9	14.8	14.8	15.7
Hourly Operating Cost at Sea	$338	$344	$356	$374	$397	$421
CARGO TRANSFER COSTS						
In-Port						
In-Port Waiting Hours	9	9	9	9	9	9
In-Port Transfer Hours (180 TPH)	3	5	7	10	14	16
Hourly In-Port Operating Cost	$262	$264	$272	$282	$296	$309
In-Port Cargo Transfer Cost	$887	$1,340	$1,839	$2,864	$4,001	$4,900
In-Port Waiting Time Cost	$2,358	$2,376	$2,445	$2,538	$2,660	$2,777
Dockage						
Vessel Length	187	254	257	268	332	353
24 Hour Dockage Fee	$374	$508	$514	$536	$664	$706
Days in Port	1	1	1	1	1	1
Dockage Costs	$374	$508	$514	$536	$664	$706
Wharfage Fee per Net Ton	$1.25	$1.25	$1.25	$1.25	$1.25	$1.25
Wharfage Costs						
12	$762	$1,142	$994	$1,654	$1,530	$761
14	$762	$1,142	$1,475	$2,159	$2,397	$1,698
16	$762	$1,142	$1,523	$2,285	$3,046	$2,636
18	$762	$1,142	$1,523	$2,285	$3,046	$3,574

20	$762	$1,142	$1,523	$2,285	$3,046	$3,808
22	$762	$1,142	$1,523	$2,285	$3,046	$3,808
24	$762	$1,142	$1,523	$2,285	$3,046	$3,808
Total In-Port Costs						
12	$4,380	$5,367	$5,792	$7,592	$8,855	$9,143
14	$4,380	$5,367	$6,273	$8,096	$9,721	$10,080
16	$4,380	$5,367	$6,321	$8,222	$10,371	$11,018
18	$4,380	$5,367	$6,321	$8,222	$10,371	$11,956
20	$4,380	$5,367	$6,321	$8,222	$10,371	$12,190
22	$4,380	$5,367	$6,321	$8,222	$10,371	$12,190
24	$4,380	$5,367	$6,321	$8,222	$10,371	$12,190
In-Port Travel Costs						
Tidal Delays						
Avg. Hrs. of Maximum Tidal Delay	6	6	6	6	6	6
Avg. Feet of Tidal Delay Per Depth						
12	2.8	4.6	5.5	5.5	5.5	5.5
14	0.8	2.6	5.5	5.5	5.5	5.5
16	0.0	0.6	3.7	4.0	5.0	5.5
18	0.0	0.0	1.7	2.0	3.0	5.5
20	0.0	0.0	0.0	0.0	1.0	4.0
22	0.0	0.0	0.0	0.0	0.0	2.0
24	0.0	0.0	0.0	0.0	0.0	0.0
Avg. Hrs. of Tidal Delay Per Depth						
12	3.13	4.25	6.00	6.00	6.00	6.00
14	1.50	2.75	6.00	6.00	6.00	6.00
16	0.00	0.75	3.50	3.90	4.90	6.00
18	0.00	0.00	1.75	2.25	3.13	6.00
20	0.00	0.00	0.00	0.00	1.50	3.90
22	0.00	0.00	0.00	0.00	0.00	2.25
24	0.00	0.00	0.00	0.00	0.00	0.00
Delay for Tide:						
Operating Cost at Sea	$338	$344	$356	$374	$397	$421
Operating Cost at Port	$262	$254	$272	$282	$296	$309
Tidal Delay Costs						
12	$819	$1,080	$1,632	$1,692	$1,776	$1,854
14	$393	$699	$1,632	$1,692	$1,776	$1,854
16	$0	$191	$952	$1,100	$1,450	$1,854
18	$0	$0	$476	$635	$925	$1,854
20	$0	$0	$0	$0	$444	$1,205
22	$0	$0	$0	$0	$0	$695
24	$0	$0	$0	$0	$0	$0
Pilotage						
Vessel Length	187	254	257	268	332	353
Vessel Beam	36	39.7	43	44	59	60
Vessel Draft	12.8	14.6	17.7	18	19	22
Pilotage Units	67.32	100.838	110.51	117.92	195.88	211.8
C&D Use Flag						
Delaware River Pilot Fee	$1,320	$1,331	$1,459	$1,557	$2,586	$2,796
C&D Canal Fee (if applicable)	$500	$500	$500	$500	$500	$500
Tug Costs						
Number of Tugs Used	1	1	1	1	1	1
Tug Rate	$650	$650	$650	$650	$650	$650

	Tug Costs	$650	$650	$650	$650	$650	$650
In-Port & Cargo Transfer Costs							
	12	$7,169	$8,427	$9,533	$11,490	$13,866	$14,442
	14	$6,743	$8,046	$10,014	$11,995	$14,733	$15,380
	16	$6,350	$7,538	$9,382	$11,529	$15,057	$16,318
	18	$6,350	$7,348	$8,906	$11,063	$14,531	$17,255
	20	$6,350	$7,348	$8,430	$10,429	$14,050	$16,841
	22	$6,350	$7,348	$8,430	$10,429	$13,606	$16,331
	24	$6,350	$7,348	$8,430	$10,429	$13,606	$15,636

TOTAL COST AND COST PER NET CARGO TON BY TRADE ROUTE:

Bermuda

Total Cost:	12' Channel Depth	$48,641	$51,766	$55,195	$58,704	$65,653	$66,864
	14' Channel Depth	$47,790	$51,004	$56,157	$59,713	$67,386	$68,739
	16' Channel Depth	$47,004	$49,988	$54,893	$58,781	$68,034	$70,615
	18' Channel Depth	$47,004	$49,607	$53,941	$57,850	$66,983	$72,490
	20' Channel Depth	$47,004	$49,607	$52,989	$56,581	$66,021	$71,661
	22' Channel Depth	$47,004	$49,607	$52,989	$56,581	$65,133	$70,641
	24' Channel Depth	$47,004	$49,607	$52,989	$56,581	$65,133	$69,251
Cost Per Ton:	12' Channel Depth	$79.83	$56.64	$69.38	$44.36	$53.63	$109.90
	14' Channel Depth	$78.44	$55.81	$47.59	$34.58	$35.15	$50.60
	16' Channel Depth	$77.15	$54.70	$45.05	$32.16	$27.92	$33.49
	18' Channel Depth	$77.15	$54.28	$44.27	$31.65	$27.48	$25.36
	20' Channel Depth	$77.15	$54.28	$43.49	$30.96	$27.09	$23.52
	22' Channel Depth	$77.15	$54.28	$43.49	$30.96	$26.73	$23.19
	24' Channel Depth	$77.15	$54.28	$43.49	$30.96	$26.73	$22.73

Distances to Ports-Nautical Miles

Bermuda	706

TABLE 15
AVERAGE ANNUAL CUMULATIVE TRANSPORTATION SAVINGS

	UNCONSTRAINED	1.5 FT CONSTRAINED	2.5 FT CONSTRAINED
12 TO 14 FT	$1,399,101	$1,305,098	$ 571,949
12 TO 16 FT	$1,926,678	$1,825,479	$1,071,455
12 TO 18 FT	$2,275,219	$2,082,178	$1,615,568
12 TO 20 FT	$2,387,411	$2,127,220	$1,645,047
12 TO 22 FT	$2,414,825	$2,146,289	$1,665,050
12 TO 24 FT	$2,433,397	$2,153,683	$1,665,050

PCT. OF GENERAL CARGO/CONTAINER OUTBOUND FLEET SAILING DRAFTS (SOURCE: PILOT LOG):

UNCONSTRAINED	11.8%
1.5 FT CONSTRAINED	44.1%
2.5 FT CONSTRAINED	41.2%
>2.5 FT CONSTRAINED	2.9%
TOTAL	100.0%

214. Bulk Benefits. This benefit estimation has been finalized by applying, as a base, tonnage at the 1989 level (with 2% per annum growth) and prorating the benefits developed in the interim feasibility report. The average annual benefits are as follows:

12 to 14 feet:	$148,100
12 to 16 feet:	$183,300
12 to 18 feet:	$201,100
12 to 20 feet:	$213,400
12 to 22 feet:	$225,000
12 to 24 feet:	$241,000

215. Table 16 presents the annualization of costs. Table 17 presents the economic optimization conducted for the study. The optimal depth is 18 feet, with a benefit-cost ratio of 1.5 and net benefits of $711,000. For general cargo/container traffic only, the project remains at 18 feet, has a BCR of 1.4, and net benefits of $570,000.

TRADE OFF ANALYSIS

216. Table 17 illustrates that the 18-foot plan has the highest net benefits and a satisfactory benefit/cost ratio. These costs include mitigation for the estimated acres of wetlands impacted at the cut off and turning basin by excavation. The per acre cost figure of $28,950 is based on site preparation, vegetation necessary to create new wetlands and engineering and design, construction management, and a contingency factor through the construction phase. It is anticipated that new wetlands would be constructed adjacent to existing wetlands which may already connect to the aquifer. No significant additional salt water intrusion would be expected and no provisions for additional site preparation costs to counteract salt water intrusion into aquifers is included. A final analysis (also shown in Table 17) was conducted on 17 and 19 foot alternatives to determine if the two foot increment was sufficiently responsive to benefits and costs for proper optimization. The analysis confirmed the optimization of the 18 foot plan.

RATIONALE FOR SELECTED PLAN

217. The process used for the selection of the most desirable plan considered the degree of study objective fulfillment, economic justification, and environmental considerations. The main planning objectives were to provide adequate and safe navigation channels to accommodate vessels travelling along the Salem River while satisfying the national objective of maximizing net benefits. Based on the comparison of alternative depths presented in Table 17 the 18 foot depth channel was selected. This alternative fulfills the planning objectives, is economically justified, maximizes net benefits and qualifies as the National Economic Development (NED) plan.

RISK AND UNCERTAINTY ANALYSIS

218. A number of parameters were identified as having risk and uncertainty associated with the outcome of the benefit analysis. A sensitivity analysis in accordance with ER 1105-2-100 was conducted to vary the key parameter of general cargo/container tonnage growth to determine what impact, if any, this would have on project justification and optimization.

TABLE 16

SALEM RIVER COST ANNUALIZATION 1)

DISCOUNT RATE= 8.750%

PRICE LEVEL= APRIL 1990

	12 FT	14 FT	16 FT	17 FT	18 FT	19 FT	20 FT	22 FT	24 FT
FIRST COST:									
PROJECT	$0	$4,330,000	$7,071,000	$8,914,000	$9,974,000	$14,493,000	$17,747,000	$23,431,000	$26,736,000
ASSOC. COSTS	$0	$164,000	$222,000	$239,000	$266,000	$276,000	$299,000	$398,000	$452,000
SUBTOTAL	$0	$4,494,000	$7,293,000	$9,153,000	$10,240,000	$14,769,000	$18,046,000	$23,829,000	$27,188,000
INT DURING CONSTR 2)	$0	$160,605	$260,634	$327,106	$365,952	$527,808	$644,920	$851,590	$971,632
TOTAL	$0	$4,654,605	$7,553,634	$9,480,106	$10,605,952	$15,296,808	$18,690,920	$24,680,590	$28,159,632
CRF	0.08884	0.08884	0.08884	0.08884	0.08884	0.08884	0.08884	0.08884	0.08884
AVG ANN FIRST COSTS	$0	$413,515	$671,065	$842,213	$942,233	$1,358,968	$1,660,501	$2,192,624	$2,501,702
MAINTENANCE COSTS:									
DREDGING CYCLE-YEARS	4	4	3	3	3	3	3	3	3
PROJECT	$1,394,000	$1,905,000	$1,909,000	$2,060,000	$2,215,000	$2,557,000	$2,865,000	$3,438,000	$3,794,000
ASSOC COSTS	$0	$88,000	$81,000	$86,000	$92,000	$91,000	$89,000	$90,000	$103,000
TOTAL	$1,394,000	$1,993,000	$1,990,000	$2,146,000	$2,307,000	$2,648,000	$2,954,000	$3,528,000	$3,897,000
SFF	0.219477	0.219477	0.305796	0.305796	0.305796	0.305796	0.305796	0.305796	0.305796
AVG ANN MAINT COSTS	$305,951	$437,418	$608,534	$656,238	$705,471	$809,748	$903,321	$1,078,848	$1,191,687
AVG ANN COSTS (12 FT)	$306,000								
CUMULATIVE AVG ANN COSTS		$851,000	$1,280,000	$1,498,000	$1,648,000	$2,169,000	$2,564,000	$3,271,000	$3,693,000
CUMULATIVE AVG ANN COSTS (NETTING OUT 12 FT AVG ANN COSTS)		$545,000	$974,000	$1,192,000	$1,342,000	$1,863,000	$2,258,000	$2,965,000	$3,387,000

1)INCLUDES MITIGATION, REPLACEMENT

2)NINE MONTH CONSTRUCTION PERIOD;FIRST COST APPORTIONED UNIFORMLY

TABLE 17

SALEM RIVER ECONOMIC OPTIMIZATION

HIGHEST NET BENEFIT DEPTH NOTED BY ASTERISK

APPLYING TRANSPORTATION COST MODEL WITH IMPACT OF ACTUAL OPERATING PRACTICES

CONTAINER: MID-ATLANTIC SHIPPING, INC. BERMUDA TRADE USING HISTORIC TONNAGE AND DRI/MID-ATL/VOIGT PROJECTIONS

BULK: 1989 TONNAGE WITH 2% GROWTH

TRANS COST MODEL BASED ON 76% CARRYING CAPACITY FOR ALL VESSEL CLASSES INCLUDING BOX WEIGHT

FLEET DEFINED BY NORMAL DISTRIBUTION FOR VESSEL CLASSES <1 STANDARD DEVIATION FROM MEAN

DISCOUNT RATE= 8.750%

PRICE LEVEL= APRIL 1990

CHANNEL IMPROVEMENT	CUMULATIVE AVG ANN BENEFITS	CUMULATIVE AVG ANN COSTS	BENEFIT-COST RATIO	NET BENEFITS	GENERAL CARGO/ CONTAINER BENEFITS	BULK BENEFITS
12 TO 14 FT	$1,124,000	$545,000	2.1	$579,000	$976,300	$148,100
12 TO 16 FT	$1,657,000	$974,000	1.7	$683,000	$1,473,800	$183,300
12 TO 17 FT	$1,855,000	$1,192,000	1.6	$663,000	$1,663,050	$192,200
12 TO 18 FT	$2,053,000	$1,342,000	1.5	$711,000 *	$1,852,300	$201,100
12 TO 19 FT	$2,082,000	$1,863,000	1.1	$219,000	$1,874,950	$207,200
12 TO 20 FT	$2,111,000	$2,258,000	0.9	($147,000)	$1,897,600	$213,400
12 TO 22 FT	$2,143,000	$2,965,000	0.7	($822,000)	$1,917,500	$225,000
12 TO 24 FT	$2,164,000	$3,387,000	0.6	($1,223,000)	$1,922,900	$241,100

PESSIMISTIC SCENARIO: BULK BENEFITS DELETED, SALEM STRICTLY A GENERAL CARGO/CONTAINER PORT:

CHANNEL IMPROVEMENT	CUMULATIVE AVG ANN BENEFITS	CUMULATIVE AVG ANN COSTS	BENEFIT-COST RATIO	NET BENEFITS	GENERAL CARGO/ CONTAINER BENEFITS
12 TO 14 FT	$976,000	$545,000	1.8	$431,000	$976,300
12 TO 16 FT	$1,474,000	$974,000	1.5	$500,000	$1,473,800
12 TO 17 FT	$1,663,000	$1,192,000	1.4	$471,000	$1,663,050
12 TO 18 FT	$1,852,000	$1,342,000	1.4	$510,000 *	$1,852,300
12 TO 19 FT	$1,875,000	$1,863,000	1.0	$12,000	$1,874,950
12 TO 20 FT	$1,898,000	$2,258,000	0.8	($360,000)	$1,897,600
12 TO 22 FT	$1,918,000	$2,965,000	0.6	($1,047,000)	$1,917,500
12 TO 24 FT	$1,923,000	$3,387,000	0.6	($1,464,000)	$1,922,900

A. NO GROWTH IN GENERAL CARGO/CONTAINER TONNAGE OVER PROJECT LIFE

219. Transportation savings have been quantified with general cargo/container tonnage held constant at the level for year one of the project, 1994. The results are as follows:

Channel Depth Increment	CUMULATIVE Transp Savings
12-14 feet	$ 561,000
12-16 feet	$ 806,000
12-18 feet	$ 984,000
12-20 feet	$1,015,000
12-22 feet	$1,035,000
12-24 feet	$1,054,000

With no growth in general cargo/container tonnage over the project life, the project would optimize at 14 feet.

B. NO GROWTH IN GENERAL CARGO/CONTAINER TONNAGE BEYOND THE EXISTING YEAR

220. Transportation savings have been quantified with no growth in general cargo/container tonnage beyond the level of the existing year, 1989. The results are as follows:

Channel Depth Increment	Cumulative Trans Savings
12-14 feet	$358,000
12-16 feet	$500,000
12-18 feet	$599,000
12-20 feet	$621,000
12-22 feet	$637,000
12-24 feet	$655,000

With no growth in tonnage beyond the existing year level, the project would not be justified.

221. In addition, thirteen new commodities were identified that will potentially move through the Port of Salem. Benefits could be higher than the benefits as quantified for the most likely scenario. With this increase in benefits, the optimal depth could possibly be deeper than 18 feet. However, due to the speculative nature of these new commodities at this time, it was not considered appropriate to include them in the benefit analysis.

AGENCY COORDINATION

222. Coordination has been conducted with various Federal, state, and local agencies from initiation through formulation. More intense coordination was conducted with the various port interests including the port authority, shippers, pilots, the U.S. Coast Guard. Information collected from the Salem River tug and docking pilots was utilized regarding design of the horizontal alignment of the plan, widening at bends, turning basin layout, and practicality of the proposed plan as it relates to existing procedures and anticipated needs.

223. The U.S. Fish and Wildlife Service was consulted repeatedly in the planning process in keeping with the requirements of the Fish and Wildlife Coordination Act. The Service has prepared two Planning Aid Reports, September 1986 and August 1987, which were used in the preparation of the Environmental Assessment. A Fish and Wildlife Service 2(b) coordination report dated March 1989 was prepared following review of the Draft Environmental Assessment and Feasibility Report. The Draft Environmental Assessment/Feasibility Report was circulated for comment to various Federal, state, and local agencies and the interested public. Additional information regarding coordination of environmental issues is contained in the Environmental Assessment and in correspondence in Appendix A. Responses to all comments received are contained in Appendix A.

SELECTED PLAN

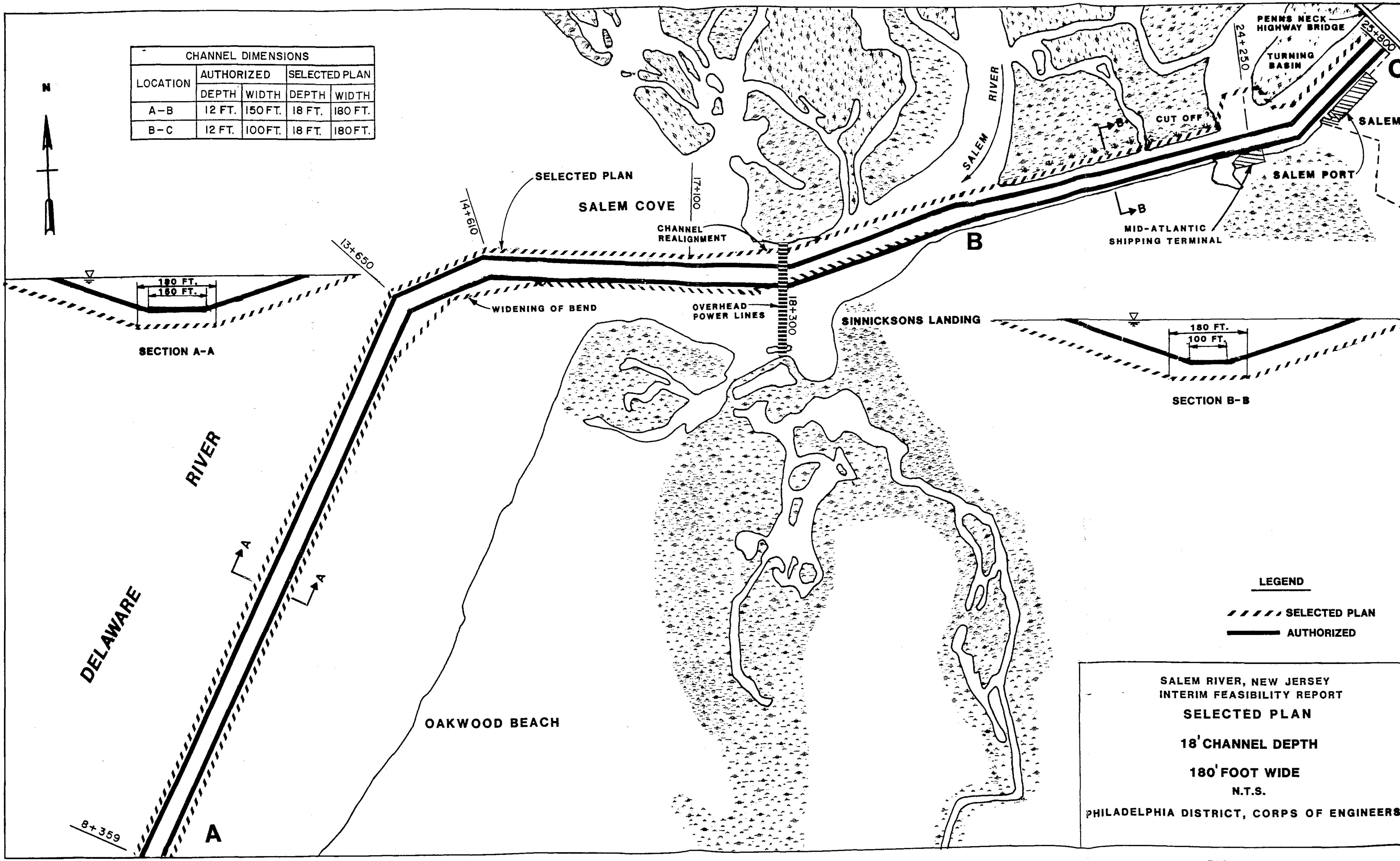
224. The preceding section identified the plan to resolve the navigation problems of the study area. The following paragraphs present a description of that plan, including its accomplishments, effects, significant design, construction, and operation and maintenance aspects.

PROJECT DESCRIPTION

225. The selected plan as shown on Figure 15 consists of a five mile long navigation project extending about three miles up from the Delaware River main channel to the Salem Cove and then upstream to the Penns Neck highway bridge at Route 49, a distance of about two miles. The selected plan provides for a 180 foot wide one-way channel with an 18 foot MLW depth and an allowable dredging overdepth of two feet. Channel dimensions are based on a design vessel of 50' X 330' with a 21.5 foot draft, single screw propulsion thrusters and an accompanying tug with a 10 foot beam. The proposed maneuvering lane is 180% of the 60 foot combined tug and vessel beam with 60% of the combined beam for bank clearance on each side.

226. The turning basin dimensions are based on a length of 495' in order to accommodate the design vessel and the largest anticipated vessel, with a 350 foot length. To widen the channel and construct the basin, it will be necessary to excavate seven acres of wetland in the new cut area opposite the Port. A seven acre wetland mitigation site would be constructed at the Supawna Wildlife Refuge located adjacent to Salem Cove. The resulting dimensions satisfy Corps criteria of 150% of the design vessel length for transit under design conditions. Since the pilots recommended 30 feet of clearance at bow and stern the largest vessel anticipated with an 18 foot project would be accommodated under favorable conditions.

227. The selected plan incorporates a berth at Barber's Basin (Berth 1) and three berths at the municipal Port as shown with the access areas on Figure 16. To provide for the expected larger fleet and larger vessels, the berth at Major's Wharf (Berth 2) is planned at a depth of 22 feet. The tidal operation will continue to maximize economic benefits. Berth dimensions are shown on Table 18.



CHANNEL DIMENSIONS				
LOCATION	AUTHORIZED		SELECTED PLAN	
	DEPTH	WIDTH	DEPTH	WIDTH
A–B	12 FT.	150 FT.	18 FT.	180 FT.
B–C	12 FT.	100 FT.	18 FT.	180 FT.

SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT
SELECTED PLAN
18' CHANNEL DEPTH
180' FOOT WIDE
N.T.S.
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 15

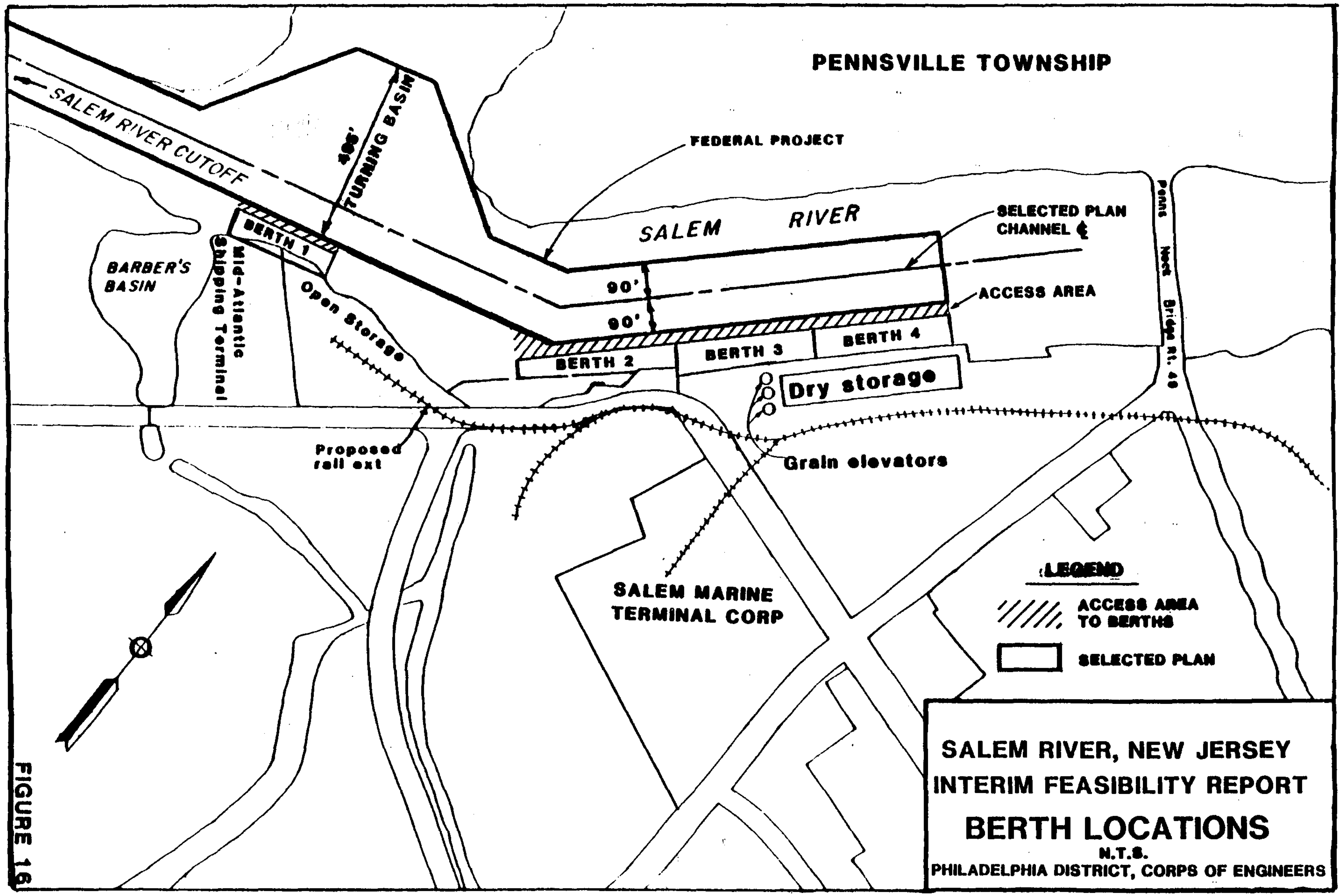

PENNSVILLE TOWNSHIP
SALEM RIVER CUTOFF
495' TURNING BASIN
FEDERAL PROJECT
SALEM RIVER
SELECTED PLAN CHANNEL ℄
ACCESS AREA
90'
90'
BERTH 1
BERTH 2
BERTH 3
BERTH 4
Dry storage
Grain elevators
BARBER'S BASIN
Mid-Atlantic Shipping Terminal
Open Storage
Proposed rail ext
Penns Neck Bridge Rt. 49
SALEM MARINE TERMINAL CORP
LEGEND
ACCESS AREA TO BERTHS
SELECTED PLAN
SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT
BERTH LOCATIONS
N.T.S.
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 16

TABLE 18

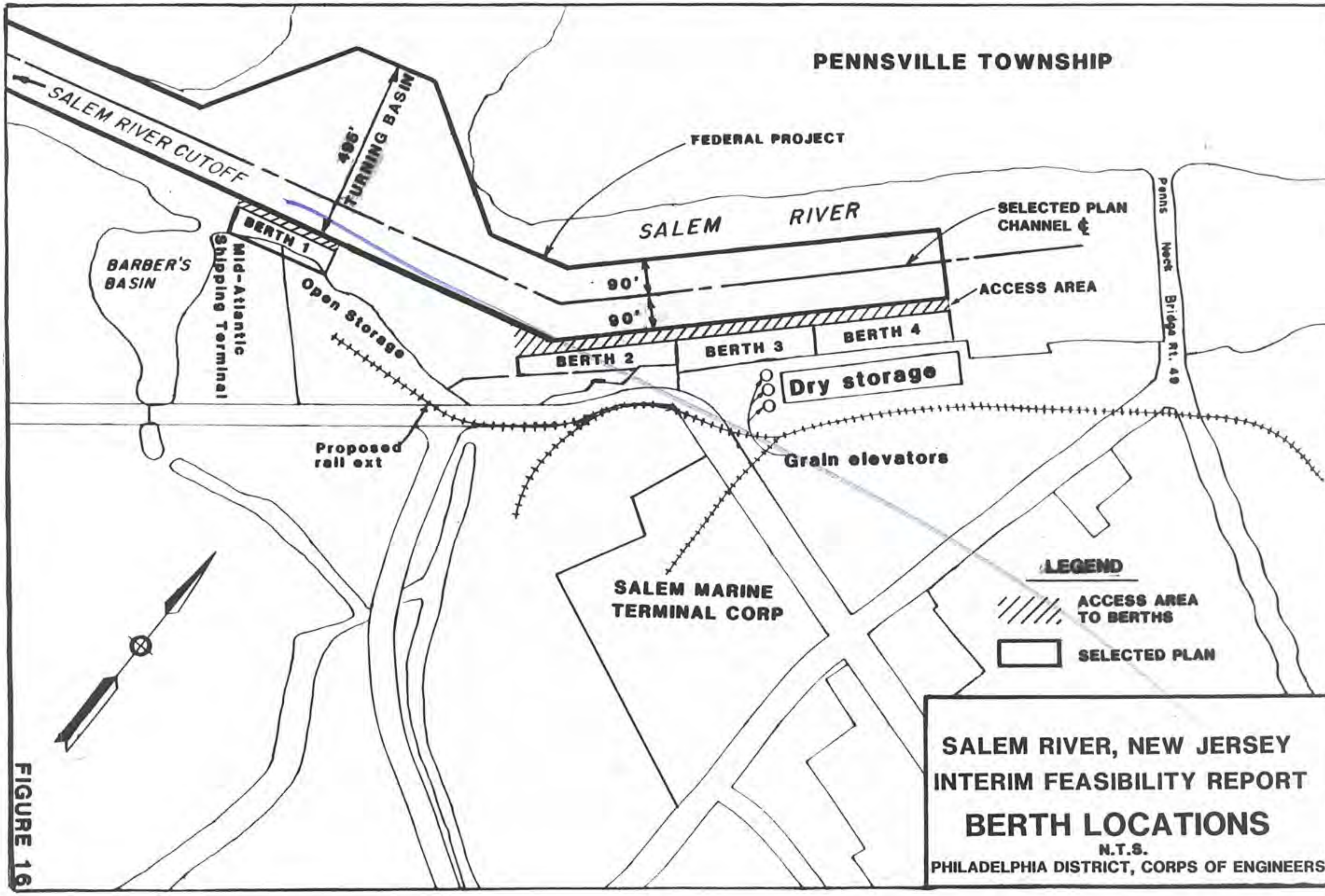
Selected Plan Berth Dimensions

	Berth	Depth	Length	Width
1.	Barber's Basin	22'	270'	70'
2.	Major's Wharf	22'	400'	80'
3.	Grain Elevator	22'	350'	80'
4.	Dry Storage Shed	22'	350'	80'

228. Under improved conditions to an 18 foot channel depth, each of the berths would be deepened to 22 feet. The berths benefit from tidal operations and the facilities at the Port will accommodate the anticipated traffic.

229. To allow for increased vertical clearance, the channel would be realigned under the PSE&G lines at Sinnicksons Landing (see Figure 17). The new configuration for the authorized channel follows current navigation practices and takes advantage of the naturally deeper waters north of the channel and the upswing of the power line. Moving the channel as close to the bank as possible yields about 100 feet of vertical clearance in the new navigation channel as opposed to the 66 foot minimum elevation at the point of maximum sag over the river. This realignment will accommodate the projected vessels for the 18 foot channel. The vessels will be tug assisted, which provides for improved maneuverability in the Salem River where the currents are strong. As indicated by the Coast Guard and the Port, the groundings which have occurred were the result of human error and shoaling.

230. DREDGED MATERIAL DISPOSAL PLAN. The initial dredging quantity necessary to increase channel depths from the currently authorized 12 foot channel has two components, initial and associated. The Federal project quantity refers to the materials from the channel and turning basin; the non-Federal or associated quantity refers to material from the berth areas. Quantities are listed in Table 19. The average annual maintenance quantity for the project channel is cumulative as shown, including 22,500 cubic yards annually for the existing 12' project. The total quantity of project and associated dredging over the fifty year project life is about 3.2 million cubic yards.


PENNSVILLE TOWNSHIP
SALEM RIVER CUTOFF
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ACCESS AREA
Penns Neck Bridge Rt. 49
BARBER'S BASIN
Mid-Atlantic Shipping Terminal
BERTH 1
Open Storage
90'
90'
BERTH 2
BERTH 3
BERTH 4
Dry storage
Proposed rail ext
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SALEM RIVER, NEW JERSEY
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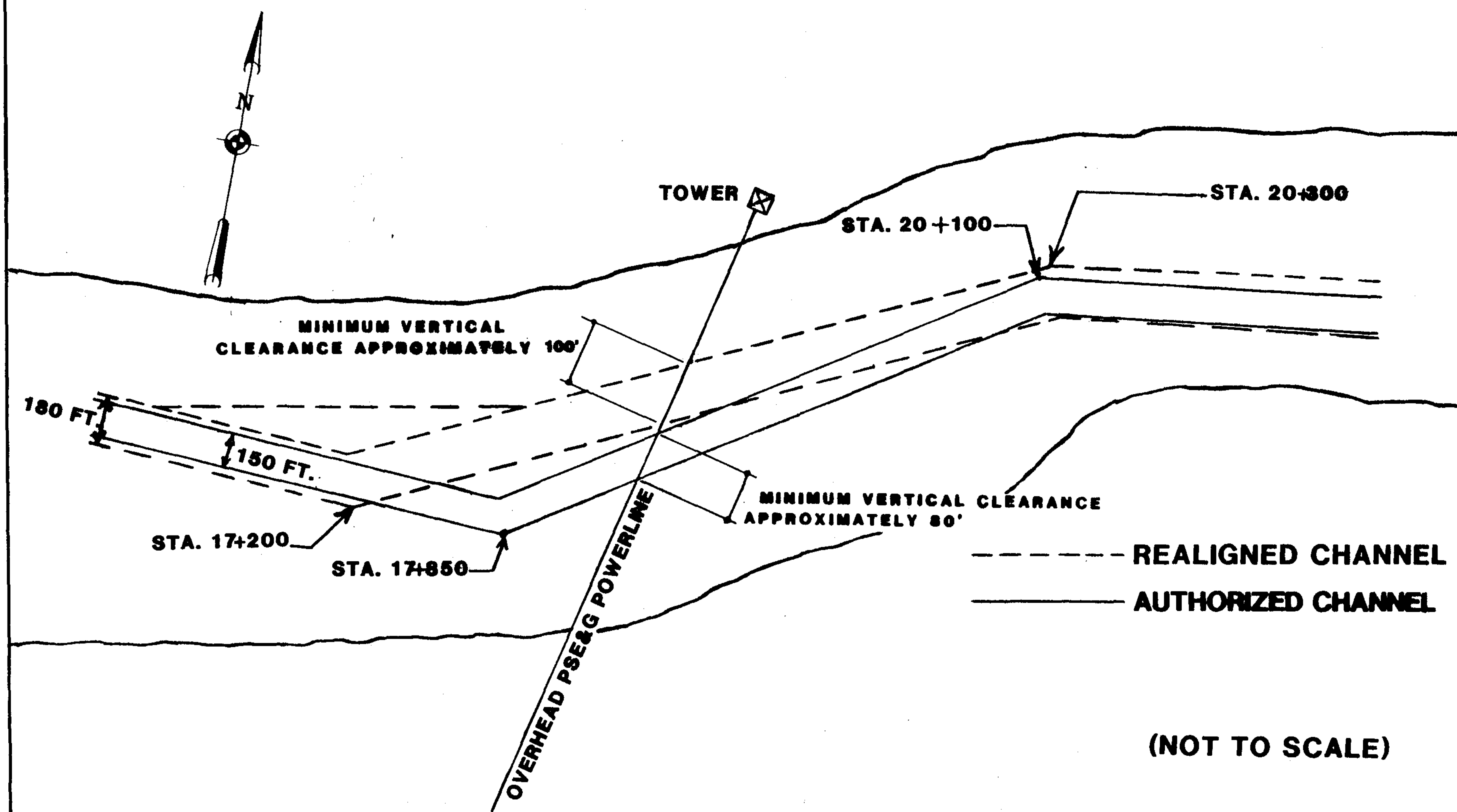
3.	Grain Elevator	22'	350'	80'
4.	Dry Storage Shed	22'	350'	80'

228. The berth adjacent to the grain elevator (Berth 3) dedicated to agricultural products could accommodate carriers other than grain, subject to a 30 foot air draft restriction due to the location of the grain elevator arm. The upstream berth adjacent to the dry storage facility (Berth 4) will have a depth of 18 feet, adequate for the anticipated commodities. Mid-Atlantic anticipates using larger vessels to handle commodities with an 18 foot channel and would accordingly increase the depth at Berth 1 an additional four feet from the existing 16 feet. Both berths 1 and 4 benefit from tidal operations. This mix of facilities at the Port will accommodate the anticipated traffic.

229. To allow for increased vertical clearance, the channel would be realigned under the PSE&G lines at Sinnicksons Landing (see Figure 17). The new configuration for the authorized channel follows current navigation practices and takes advantage of the naturally deeper waters north of the channel and the upswing of the power line. Moving the channel as close to the bank as possible yields about 100 feet of vertical clearance in the new navigation channel as opposed to the 66 foot minimum elevation at the point of maximum sag over the river. This realignment will accommodate the projected vessels for the 18 foot channel. The vessels will be tug assisted, which provides for improved maneuverability in the Salem River where the currents are strong. As indicated by the Coast Guard and the Port, the groundings which have occurred were the result of human error and shoaling.

230. DREDGED MATERIAL DISPOSAL PLAN. The initial dredging quantity necessary to increase channel depths from the currently authorized 12 foot channel has two components, initial and associated. The Federal project quantity refers to the materials from the channel and turning basin; the non-Federal or associated quantity refers to material from the berth areas. Quantities are listed in Table 19. The average annual maintenance quantity for the project channel is cumulative as shown, including 22,500 cubic yards annually for the existing 12' project. The total quantity of project and associated dredging over the fifty year project life is about 3.2 million cubic yards.



SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT

REALIGNMENT OF SALEM RIVER CHANNEL

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

FIGURE 17

TABLE 19

DISPOSAL QUANTITIES
18 Foot Plan

a. Initial Dredging - cubic yards

Project Channel	Associated Berth Area
1,254,000	28,000

b. Average Annual Maintenance Dredging - cubic yards

60,200	2,500

231. Based on the disposal area formulation analyses, the disposal plan selected uses the existing Killcohook upland site for initial and maintenance quantities.

232. MITIGATION PLAN. Supawna Meadows is the selected mitigation site for the loss of seven acres at the turning basin area. The location is upstream of the Port and adjacent to a shallow water impoundment, which is managed by the Fish and Wildlife Service for waterfowl feeding. The site grades down from upland fields, to a transitional upland area dominated by common reed, to the impoundment. Construction of seven acres of brackish emergent wetlands along the fringe of this impoundment would increase the habitat value of this area for waterfowl. Brackish wetland vegetation would be planted in the site to provide food and cover for waterfowl. Vegetation species would include narrow-leaved cattail (Typha angustifolia), saltmarsh bulrush (scirpus robustus), switch grass (Panicum virgatum), sedges (Carex spp.) and rushes Juncus spp.). Water levels within the impoundment can be manipulated to provide some inundation to the site. It would be necessary to keep the water level within the impoundment somewhat shallow for waterfowl feeding. While implementation of the proposed mitigation plan would not replace tidal wetlands impacted along the cut-off, it would create wetland habitat of greater value (i.e. dominant vegetation along the cut-off is common reed). The proposed mitigation plan would benefit waterfowl that utilize the Salem River focus area. As such, the plan is consistent with the goals and objectives of the North American Waterfowl Management plan. Construction aspects of the mitigation plan include excavation and grading to achieve desired elevations throughout the site. It is anticipated that one to three feet of material would be removed over most of the area. The site would be graded, so that areas immediately adjacent to the impoundment. Portions of the site to provide a backwater area to increase habitat diversity. Prior to construction, a site survey will be required to determine accurate elevations for both the existing topography and the limit of excavation. Excavation of the wetland area to the required elevations should not present significant slope stability problems

because of the relatively shallow nature of the cut. Temporary dewatering of the excavation can be accomplished by drawing down the water level of the impoundment. This plan is in accordance with the Fish and Wildlife mitigation policy for this habitat with no net loss of habitat value and as near to the impacted site as possible.

PROJECT COSTS

233. INITIAL CONSTRUCTION COST. Estimates were prepared for initial dredging of the Federal and Non-Federal associated portions of the recommended plan (see Tables 20 and 21). Dredging of the Federal and Non-Federal associated portions of the project will be done simultaneously by the same dredging contractor. The estimates assume that the dredging of the Federal and Non-Federal associated portion of the recommended project will be done using a hydraulic dredge. Material will be pumped to the Killcohook disposal area. Cost estimates were also prepared for disposal area replacement. The disposal area work consists of site clearing, dike raisings and construction of sluices. All disposal area work will be done prior to initial dredging. Costs also include mitigation for wetlands. Initial dredging costs reflect April 1990 price levels.

234. MAINTENANCE COSTS. Estimates were prepared for maintenance dredging of the recommended plan. Dredging of the Federal project, including the existing 12' channel, and non-Federal berth areas will be done simultaneously by the same dredging contractor. In order to develop incremental project costs, a separate estimate was also prepared for the existing project maintenance, and this was annualized and deducted from the cumulative annual maintenance costs. Maintenance costs are based on dredging on a four year cycle for the 12 foot project and a three year cycle for the selected plan. All maintenance dredging will be done using a hydraulic dredge pumping all dredged material into Killcohook disposal area. Maintenance dredging costs reflect April 1990 price levels. Estimates for maintenance dredging of the recommended plan (cumulative), non-Federal berths, and the existing project are shown on Tables 22, 23, and 24. The total maintenance costs per cycle are estimated at $2,215,000 ($677,000 annually) for the Federal project and $92,000 ($28,000 annually) for the non-Federal berth areas. The cost per cycle for the existing project is $1,394,000 ($306,000 annually).

235. DISPOSAL. All initial and maintenance dredging material will be disposed at Killcohook disposal area throughout the 50 year project life.

236. CONTINGENCIES. The estimated cost for each major subdivision or feature of the recommended plan includes an item for "contingencies". The item for "contingencies" is an allowance against some adverse or unanticipated condition not susceptible to exact evaluation from the data at hand but which must be expressed

or represented in the cost estimate. The contingency allowances used in the development of the cost estimates for the recommended project were estimated as a lump sum amount. The contingency allowances used in the following major features of the cost estimates reflect the following uncertainties and concerns exposed during the feasibility study:

a. Mobilization, Demobilization and Preparatory Work: Contingencies in this line item reflect concerns about availability of dredges and probability of having to mobilize the dredge and attendant plant from a distance of more than 200 miles from the dredging site.

b. Pipeline Dredging: Contingencies for the line item reflect concerns about encountering boulders, timber piles and any other miscellaneous objects as previously encountered during the maintenance dredging operations of the existing project. In addition contingencies reflect concerns about the fluctuation of fuel prices, surveys, labor costs and size of digging banks.

237. PLANNING, ENGINEERING, and DESIGN. Planning, Engineering and Design (P,E&D) related costs for the Federal portion of the recommended plan during the initial dredging stage were estimated as a lump sum item based on similar Corps of Engineers projects. The related costs consisted of P,E&D in the amount of $450,000, mitigation costs, and E&D during construction in the amount of $75,000 for a total P,E&D lump sum cost of $525,000. Planning, Engineering and Design (P,E&D) for the non-Federal associated portion of the recommended plan during the initial dredging stage were estimated at 15 percent of the direct construction cost. Planning, Engineering and Design (P,E&D) during the maintenance dredging stages for both the Federal and non-Federal associated portions of the recommended project were estimated at 15 percent of the direct construction cost.

238. CONSTRUCTION MANAGEMENT. Construction Management (S&A) related costs for the Federal portion of the recommended plan during the initial dredging stage were estimated as a lump sum in the amount of $400,000. Non-Federal associated portions of the work during the initial dredging stage were estimated at 10 percent. During the maintenance dredging stages, Construction Management (S&A) related costs for the Federal and non-Federal associated portions of the recommended plan were estimated at 10 percent of the direct construction cost.

239. REAL ESTATE. The values of lands and damages are based on real estate gross appraisals prepared by the Appraisal Branch of the Baltimore District Real Estate Division. The lands were inspected in the field and a determination of value was estimated by comparing similar properties located within the geographical area of the project. Adjustments were made for use requirements, size, and physical features to establish the fair market value of

parcels being evaluated. These included potential disposal areas, wetlands required for excavation of the channel and turning basin, and uplands required for mitigation work.

240. Administration Costs. Administration costs for the local sponsor and the Government are based on estimated values determined to be relevant to the work required. The local sponsor's administrative cost was computed from a previous navigation project and increased by means of an economy factor to the current price level. The Government's computed value is based on past experience in performing required project tasks.

241. Contingencies. The contingency for lands is 25% based on EM 1110-2-1301, Appendix C, EC 1110-2-263, EC 1110-2-538 and the allowance for appraised values to have an additional contingency factor to offset the effects of counteroffers and uneconomic remnants incurred during the acquisition process for the project. A contingency of 15% is used for administrative and contract costs as determined by the above mentioned regulations.

TABLE 20

SALEM RIVER

INITIAL PROJECT COSTS

DEPTH: 18 FEET D/A: KILLCOHOOK ESTIMATOR: JOSE ALVAREZ
PRICE LEVEL: APRIL 1990 DATE: 22 JAN 1991

ACCOUNT CODE	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL PROJECT COST
06.-.-.-	FISH AND WILDLIFE FACILITIES						
06.2.R.B	MITIGATION COSTS	7	AC	$18,525.00	$129,675	$32,419	$162,094
	TOTAL, FISH AND WILDLIFE FACILITIES				$129,675	$32,419	$162,094
12.-.-.-	DREDGING						
12.0.A.-	MOBILIZATION, DEMOBILIZATION AND PREPARATORY WORK	---------	JOB	L.S.	$246,490	$61,622	$308,112
12.0.2.-	PIPELINE DREDGING						
12.0.2.B	SITE WORK						
	EXCAVATION AND DISPOSAL	1254387	C.Y.	$4.87	$6,108,865	$1,527,216	$7,636,081
	TOTAL, DREDGING COST				$6,355,355	$1,588,838	$7,944,193
	TOTAL CONSTRUCTION COSTS				$6,485,030	$1,621,257	$8,106,287
30.-.-.-	PLANNING, ENGINEERING AND DESIGN				$525,000	$0	$525,000
31.-.-.-	CONSTRUCTION MANAGEMENT				$400,000	$0	$400,000
	SUBTOTAL				$7,410,030	$1,621,257	$9,031,287
01.-.-.-	LANDS AND DAMAGES						
01.D.M.-	DISPOSAL AREA REPLACEMENT	---------	JOB	L.S.	$739,874	$157,271	$897,145
01.D.P.-	WETLANDS, MITIGATION	---------	JOB	L.S.	$38,510	$7,649	$46,159
	TOTAL, LANDS AND DAMAGES				$778,384	$164,920	$943,304
	TOTAL PROJECT COSTS				$8,188,414	$1,786,177	$9,974,591
	(ROUNDED)				$8,188,000	$1,786,000	$9,974,000

TABLE 21

SALEM RIVER

INITIAL ASSOCIATED COSTS

DEPTH: 18 FEET | D/A: KILLCOHOOK | ESTIMATOR: JOSE ALVAREZ
PRICE LEVEL: APRIL 1990 | DATE: 22 JAN 1991

ACCOUNT CODE	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL PROJECT COST
12.-.-.-	DREDGING						
12.0.A.-	MOBILIZATION, DEMOBILIZATION AND PREPARATORY WORK	---------	JOB	L.S.	$5,510	$1,378	$6,888
12.0.2.-	PIPELINE DREDGING						
12.0.2.B	SITE WORK						
	EXCAVATION AND DISPOSAL	28051	C.Y.	$4.87	$136,608	$34,152	$170,760
	SUBTOTAL, DREDGING COST				$142,118	$35,530	$177,648
12.0.-.-	TOTAL CONSTRUCTION COSTS				$142,118	$35,530	$177,648
30.-.-.-	PLANNING, ENGINEERING AND DESIGN				$21,318	$5,330	$26,648
31.-.-.-	CONSTRUCTION MANAGEMENT				$14,212	$3,553	$17,765
	SUBTOTAL				$177,648	$44,413	$222,061
01.-.-.-	LANDS AND DAMAGES						
01.D.M.-	DISPOSAL AREA REPLACEMENT	---------	JOB	L.S.	$35,920	$7,637	$43,557
	TOTAL, LANDS AND DAMAGES				$35,920	$7,637	$43,557
	TOTAL PROJECT COSTS				$213,568	$52,050	$265,618
	(ROUNDED)				$214,000	$52,000	$266,000

TABLE 22

SALEM RIVER

MAINTENANCE PROJECT COSTS

DEPTH: 18 FEET   D/A: KILLCOHOOK   ESTIMATOR: JOSE ALVAREZ
PRICE LEVEL: APRIL 1990   CYCLE: 3 YEARS   DATE: 22 JAN 1991

ACCOUNT CODE	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL PROJECT COST
12.-.-.-	DREDGING						
12.0.A.-	MOBILIZATION, DEMOBILIZATION AND PREPARATORY WORK	---------	JOB	L.S.	$241,950	$60,488	$302,438
12.0.2.-	PIPELINE DREDGING						
12.0.2.B	SITE WORK						
	EXCAVATION AND DISPOSAL	180600	C.Y.	$6.51	$1,175,706	$293,926	$1,469,632
	SUBTOTAL, DREDGING COST				$1,417,656	$354,414	$1,772,070
12.0.-.-	TOTAL CONSTRUCTION COSTS				$1,417,656	$354,414	$1,772,070
30.-.-.-	PLANNING, ENGINEERING AND DESIGN				$212,648	$53,162	$265,810
31.-.-.-	CONSTRUCTION MANAGEMENT				$141,766	$35,442	$177,208
	TOTAL PROJECT COSTS				$1,772,070	$443,018	$2,215,088
	(ROUNDED)				$1,772,000	$443,000	$2,215,000

TABLE 23

SALEM RIVER

MAINTENANCE ASSOCIATED COSTS

DEPTH: 18 FEET   D/A: KILLCOHOOK   ESTIMATOR: JOSE ALVAREZ
PRICE LEVEL: APRIL 1990   CYCLE: 3 YEARS   DATE: 22 JAN 1991

ACCOUNT CODE	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL PROJECT COST
12.-.-.-	DREDGING						
12.0.A.-	MOBILIZATION, DEMOBILIZATION AND PREPARATORY WORK	---------	JOB	L.S.	$10,050	$2,512	$12,562
12.0.2.-	PIPELINE DREDGING						
12.0.2.B	SITE WORK						
	EXCAVATION AND DISPOSAL	7500	C.Y.	$6.51	$48,825	$12,206	$61,031
	SUBTOTAL, DREDGING COST				$58,875	$14,718	$73,593
12.0.-.-	TOTAL CONSTRUCTION COSTS				$58,875	$14,718	$73,593
30.-.-.-	PLANNING, ENGINEERING AND DESIGN				$8,831	$2,208	$11,039
31.-.-.-	CONSTRUCTION MANAGEMENT				$5,888	$1,472	$7,360
	TOTAL PROJECT COSTS				$73,594	$18,398	$91,992
	(ROUNDED)				$74,000	$18,000	$92,000

TABLE 24

SALEM RIVER

MAINTENANCE PROJECT COSTS

DEPTH: 12 FEET D/A: KILLCOHOOK ESTIMATOR: JOSE ALVAREZ
PRICE LEVEL: APRIL 1990 CYCLE: 4 YEARS DATE: 22 JAN 1991

ACCOUNT CODE	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT	CONTINGENCY	TOTAL PROJECT COST
12.-.-.-	DREDGING						
12.0.A.-	MOBILIZATION, DEMOBILIZATION AND PREPARATORY WORK	---------	JOB	L.S.	$252,000	$63,000	$315,000
12.0.2.-	PIPELINE DREDGING						
12.0.2.B	SITE WORK						
12.0.2.B	EXCAVATION AND DISPOSAL	90000	C.Y.	$7.11	$639,900	$159,975	$799,875
	SUBTOTAL, DREDGING COST				$891,900	$222,975	$1,114,875
12.0.-.-	TOTAL CONSTRUCTION COSTS				$891,900	$222,975	$1,114,875
30.-.-.-	PLANNING, ENGINEERING AND DESIGN				$133,785	$33,446	$167,231
31.-.-.-	CONSTRUCTION MANAGEMENT				$89,190	$22,298	$111,488
	TOTAL PROJECT COSTS				$1,114,875	$278,719	$1,393,594
	(ROUNDED)				$1,115,000	$279,000	$1,394,000

242. <u>Disposal Area Replacement</u>. As mentioned previously, the cost to the project sponsor for use of Killcohook was based on Corps policy whereby project sponsors can reimburse the Federal Government for use of Federal disposal sites. The replacement costs are due to the extra costs which would be incurred during future Delaware River operations. Table 10 shows that this approach minimizes project costs as opposed to alternatives where the project sponsor would supply new upland sites for Salem River dredging.

243. There are four components to the replacement costs which are incorporated in the cost data for the 18 foot Salem project:

a. Accelerated site acquisition costs of site 20I (replacement for Killcohook).

b. Differences between disposal area annual maintenance costs.

c. Differences between the transportation costs per cubic yard.

d. Differences between the disposal area diking costs. Each component will be considered separately.

244. The reimbursement cost calculated incorporates the impact on Killcohook's use from the placement of material from the berthing areas.

245. One new site (20I) would have to be acquired earlier for the Philadelphia to the Sea project if Killcohook were to serve as the disposal site for the 18 foot Salem project. This acceleration in years is determined by dividing the Salem initial and maintenance dredging volume by the annual maintenance quantity for the appropriate ranges of the 40 foot Philadelphia to the Sea project.

$$\frac{3,252,300}{2,081,000} = 1.56 \text{ years accelerated use, rounded to 2 years.}$$

246. This projection is based on a disposal capacity at Killcohook given a 50 foot dike elevation, use of 20I for 10 years and subsequent use of Artificial Island, the existing Federal disposal site located by the Salem Nuclear Power Plant.

247. The method of establishing the cost differences for acquisition of 20I uses the Single Payment Present Worth Factor (SPPWF) for the accelerated year of acquisition in the project life (2022) minus the SPPWF for the scheduled year of acquisition (2024) multiplied by the acquisition cost of the new site. Through these calculations it is possible to convert the cost of acquisition in the different years to present dollars for comparison. The cost of

20I would be about $3,838,000 including contingencies and administration costs. The cost of accelerated acquisition is $52,900 in present worth dollars for the Federal project and $2,600 for the non-Federal portion.

248. The differences in annual maintenance costs of Killcohook versus 20I and Artificial Island are a result of the two accelerated years. The difference in maintenance of the disposal sites is multiplied by the Uniform Series Present Worth Factor (USPWF for two years) and the appropriate SPPWF.

Annual Maintenance Cost based on Dredged-Material Disposal Management Model (D2M2)

Site	
Killcohook	$12,502
20I	$ 2,746
Artificial Island	$12,484

249. For this factor, use of Killcohook for the Salem Federal project saves the government $1,300 rather than incurring any extra costs. The non-Federal portion of the project saves $100.

250. According to the D2M2 model, a hopper dredge is the least expensive mode of transportation for Delaware River material to Killcohook. The differences in costs between Killcohook, 20I, and Artificial Island are established by calculating a weighted cost per cubic yard for each Delaware River range and multiplying by the appropriate yardage and the SPPWF to determine the transportation cost difference in present worth value. The cost to the Federal government would be $434,000. The non-Federal costs for accelerated transportation costs due to berth dredging would be $21,100. The cost differences of diking can be determined from D2M2 input and are expressed in dollars per cubic yard. These figures, when used with the SPPWF for the year of acquisition, indicate the present worth of the replacement cost of diking. The differences per cubic yard when computed amount to net cost of $411,500 for accelerated diking and use of Killcohook for the Federal project. The non-Federal cost would be $20,000.

251. The replacement cost for use of Killcohook included in alternative #4 in Table 10 and Tables 20 and 21 is the sum of the four components as follows:

ITEMS	COSTS FEDERAL	COSTS NON-FEDERAL
a. Accelerated acquisition	$ 52,900	$ 2,600
b. Disposal area annual maintenance	$ -1,300	$ -100
c. Transportation	$434,000	$21,100
d. Diking	$411,500	$20,000
Sub-Total	$897,100	$43,600

242. Disposal Area Replacement. As mentioned previously, the cost to the project sponsor for use of Killcohook was based on Corps policy whereby project sponsors can reimburse the Federal Government for use of Federal disposal sites. The replacement costs are due to the extra costs which would be incurred during future Delaware River operations. Table 10 shows that this approach minimizes project costs as opposed to alternatives where the project sponsor would supply new upland sites for Salem River dredging.

243. There are four components to the replacement costs which are incorporated in the cost data for the 18 foot Salem project:

a. Accelerated site acquisition costs of the 20I (replacement for Killcohook).

b. Differences between disposal area annual maintenance costs.

c. Differences between the transportation costs per cubic yard.

d. Differences between the disposal area diking costs. Each component will be considered separately.

244. The reimbursement cost calculated incorporates the impact on Killcohook's use from the placement of material from the berthing areas.

245. One new site (20I) would have to be acquired earlier for the Philadelphia to the Sea project if Killcohook were to serve as the disposal site for the 18 foot Salem project. This acceleration in years is determined by dividing the Salem initial and maintenance dredging volume by the annual maintenance quantity for the appropriate ranges of the 40 foot Philadelphia to the Sea project.

$$\frac{3,252,300}{2,081,000} = 1.56 \text{ years accelerated use, rounded to 2 years.}$$

246. This projection is based on a disposal capacity at Killcohook given a 50 foot dike elevation, use of 20I for 10 years and subsequent use of Artificial Island, the existing Federal disposal site located by the Salem Nuclear Power Plant.

247. The method of establishing the cost differences for acquisition of 20I uses the Single Payment Present Worth Factor (SPPWF) for the accelerated year of acquisition in the project life (2022) minus the SPPWF for the scheduled year of acquisition (2024) multiplied by the acquisition cost of the new site. Through these calculations it is possible to convert the cost of acquisition in the different years to present dollars for comparison. The cost of

20I would be about ~~$3,883,000~~ [3,838,000] including contingencies and administration costs. The cost of accelerated acquisition is $52,900 in present worth dollars for the Federal project and $2,600 for the non-Federal portion.

248. The differences in annual maintenance costs of Killcohook versus 20I and Artificial Island are a result of the two accelerated years. The difference in maintenance of the disposal sites is multiplied by the Uniform Series Present Worth Factor (USPWF for two years) and the appropriate SPPWF.

Annual Maintenance Cost based on Dredged-Material Disposal Management Model (D2M2)

Site	
Killcohook	$12,502
20I	$ 2,746
Artificial Island	$12,484

249. For this factor, use of Killcohook for the Salem Federal project saves the government $1,300 rather than incurring any extra costs. The non-Federal portion of the project saves $100.

250. According to the D2M2 model, a hopper dredge is the least expensive mode of transportation for Delaware River material to Killcohook. The differences in costs between Killcohook, 20I, and Artificial Island are established by calculating a weighted cost per cubic yard for each Delaware River range and multiplying by the appropriate yardage and the SPPWF to determine the transportation cost difference in present worth value. The cost to the Federal government would be $434,000. The non-Federal costs for accelerated transportation costs due to berth dredging would be $21,100. The cost differences of diking can be determined from D2M2 input and are expressed in dollars per cubic yard. These figures, when used with the SPPWF for the year of acquisition, indicate the present worth of the replacement cost of diking. The differences per cubic yard when computed amount to net cost of $411,500 for accelerated diking and use of Killcohook for the Federal project. The non-Federal cost would be $20,000.

251. The replacement cost for use of Killcohook included in alternative #4 in Table 10 and Tables 20 and 21 is the sum of the four components as follows:

	ITEMS	COSTS	
		FEDERAL	NON-FEDERAL
a.	Accelerated acquisition	$ 52,900	$ 2,600
b.	Disposal area annual maintenance	$ -1,300	$ -100
c.	Transportation	$434,000	$21,100
d.	Diking	$411,500	$20,000
	Sub-Total	$897,100	$43,600

252. Assuming disposal of berth quantities at Killcohook, the total is $940,700. The rounded total of $941,000 is therefore the accelerated cost to the Federal government for use of Killcohook by the Salem River project, due to the impacts on alternative disposal sites.

PROJECT OPERATION

253. The Port management would continue under the auspices of the Salem Port Authority. Formal assurances of local cooperation will be furnished by the Port prior to construction of improved project.

254. The Port will have three berths in-place by the base year. Maintenance of the channel, turning basin and navigation aids would be a Federal responsibility. The channel and basin maintenance would be performed on a three year cycle. Berth maintenance and facility upkeep would be a local responsibility with the Barber's Basin downstream berth at 22' MLW (Berth 1), the municipal berth at Major's Wharf at 22' MLW (Berth 2), the grain elevator berth at 22' MLW (Berth 3) and the berth at the dry storage shed at 22' MLW (Berth 4). The Federal government will maintain the navigation channel should a project be implemented.

255. PLAN ACCOMPLISHMENTS. The selected plan would provide annual net benefits of $711,000 to national economic development. The degree to which the selected plan fulfilled planning objectives was evaluated by comparing the impacts of the alternative depths. Those items evaluated include the following:

256. Provide Adequate and Safe Navigation Channels. Although there have been no reported damages related to the existing Federal project, the deeper and wider channel provided by this plan will enhance the safety of vessels.

257. Increase the Efficiency of Movement of Waterborne Commerce. The measures provided by these plans would improve the efficiency of vessel movements by permitting the use of larger vessel and reducing tidal delays and the need for lightloading.

258. Identify and Evaluate Acceptable Disposal Sites and Techniques. The disposal scheme selected for the plan of improvement represents the most cost effective method of disposal.

259. Minimize and/or Mitigate Any Adverse Environmental Impacts. Wetland areas destroyed during dredging operations would be replaced with wetlands of equal or greater habitat value.

260. Protection of Finfish and Wildlife Resources. By observing the seasonal restraints for dredging operations and implementation of appropriate mitigation, impacts to finfish and wildlife resources will be minimized.

261. Provide Appropriate Level of Participation. Throughout the conduct of this study, coordination has been effected with various port interests and responsible Federal, State and local officials. Two public meetings were held at the conclusion of the draft report early in 1989 to solicit the views of residents of the area.

PROJECT EFFECTS

262. The construction of an improved channel and turning basin will impact seven acres of wetlands which will be replaced. Some downstream shallows will also be impacted although the habitat value is not established and may be minimal due to the strong currents.

263. Hydraulic dredging will be used for the entire project area during construction. Disposal at the existing Federal site will not have any significant impact on cultural or social resources and no change will be noticed in the general character of the area. Social well-being should be enhanced as a result of the increased commercial navigation capability produced by the improved channel. The Environmental Assessment further addresses impacts of the proposed project.

RELATED PROJECTS

264. Based on the steepness of the river bank in this portion of the Salem River, it is estimated that less than one acre of intertidal habitat would be impacted through bulkheading and construction of the berths. The habitat to be lost is within and immediately adjacent to existing Port facilities. Based on the steepness of the bank, which has led to erosion, and the proximity to the Port, this habitat is not considered to be of high value. Regulatory requirements for berth construction include a Section 10 and 404 permit from the Corps, Section 401 State Water Quality Certification from the State of New Jersey, and a State Waterfront Development permit. These approvals were recently obtained for construction of a similar berth at Barber's Basin. Cumulative impacts of berth construction are not expected to be significant because of the degraded nature of the project area. Mitigation requirements are low, and not expected to be a detriment to obtaining the necessary approvals.

ECONOMIC EVALUATION

265. All costs for the construction and operation and maintenance of the selected plan are based on the April 1990 price level and 8 3/4 percent discount rate. Operations and maintenance dredging costs were calculated per cubic yard using a project life of 50 years and 16 maintenance cycles. Benefits were based on projections of existing commodities.

Project Implementation Costs	$ 9,974,000
Associated Costs	$ 266,000
Total First Costs	$10,240,000
Interest During Construction (nine month construction period)	$ 366,000
Total Investment Costs	$10,606,000
Annual Investment Costs	$ 942,000
Annual Operations and Maintenance (Cumulative)	$ 705,000
Less Annual Operations and Maintenance (12')	$ -306,000
Total Average Annual Costs	$ 1,342,000
Total Average Annual Benefits	$ 2,053,000
Net Benefits	$ 711,000
Benefit Cost Ratio	1.5

COST APPORTIONMENT

266. Public Law 99-662 (Water Resources Development Act of 1986) has established the basis for the Federal and non-Federal sharing of responsibilities in the construction, operation and maintenance of Federal water resources projects. Under the terms of Public Law 99-662, the non-Federal interests would pay at the outset of construction, 10 percent of the total costs of construction of General Navigation Features (GNF) which comprise the main channel and turning basin. In addition, the non-Federal interests are to provide any lands, easements, and rights-of-way including dredged material disposal areas. The non-Federal sponsor is responsible for the associated costs of the project. An additional 10 percent of the cost of GNF can be repaid over time. The costs of lands, easements and rights-of-way including dredged material disposal areas (LERRD) can be credited towards this additional ten percent. The remaining amount can be repaid with interest over a period not to exceed 30 years. However, since the LERRD exceeds 10 percent of the General Navigation Features, no additional payment is necessary. The Federal government would pay the remaining cost of General Navigation Features. Operation and maintenance costs for the channel and turning basin are a Federal responsibility. Maintenance for associated features is a non-Federal responsibility. In the case of the Salem River, capacity replacement costs on an in-place volumetric basis are the avenue of compensation for use of the Federal property and constitute the provision of LERRD. Cost sharing arrangements for the selected plan are displayed on Table 25.

267. The non-Federal sponsor is responsible for 10% of the costs for general navigation features during construction ($9,031,000) and the costs of lands, easements, rights-of-way, relocations and dredged material disposal areas ($943,000). The ultimate non-Federal project cost is $1,846,000. In addition the sponsor is responsible for the associated project costs of $266,000, resulting in a total non-Federal cost of $2,112,000. The ultimate Federal project cost is $8,128,000. The maintenance of the channel and

TABLE 25

COST SHARING FOR THE NED PLAN
(18 ft. channel, turning basin)

FEDERAL CHANNEL COSTS

General Navigation Features (Federal Channel, Mitigation)	$ 9,031,000
LERRD (Replacement Costs)	$ 943,000
TOTAL FEDERAL CHANNEL COSTS	$ 9,974,000

WATER RESOURCES DEVELOPMENT ACT OF 1986 COST SHARING

FIRST COSTS

	FEDERAL	NON-FEDERAL	TOTAL
General Navigation Features, Initial	$ 8,128,000 (90% x $9,031,000)	$903,000 (10% x $9,031,000)	$ 9,031,000
Repayment	-$903,000 (10% x $9,031,000)	+ $903,000 (10% x 9,031,000)	--
Disposal Area Cost	N/A	+ $ 943,000	$ 943,000
LERRD Credit	+ $903,000	- $ 903,000	--
ULTIMATE COSTS	$ 8,128,000	$ 1,846,000	$ 9,974,000

Note: April 1990 Price Levels; Discount Rate = 8 3/4%.

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turning basin are a Federal responsibility which will cost approximately $371,000 annually.

LOCAL COOPERATION

268. Federal participation in the proposed project is contingent upon provisions that the project sponsor furnish assurances that they will comply with Section 221 of the River and Flood Control Act (Public Law 91-611) and, prior to construction, enter into a Local Cooperation Agreement as per the Water Resources Act of 1986 (PL 99-662). Items of Local Cooperation to be satisfied by the time of construction include the following:

- Provisions and maintenance at local expense of adequate public terminal and transfer facilities open to all on equal terms and such depths from the Federal channel line to and between the wharves at the terminal (berthing areas) as may be required for the accommodation of vessels at the terminal, consistent with the Federal project;

- Provision without cost to the United States of all lands, easements, rights-of-way, and relocation necessary for the construction, and subsequent operation and maintenance of the project including suitable areas, determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material and necessary retaining dikes, bulkheads, and embankments therefore, or the costs of such retaining works.

- Holding and saving the United States free from damages due to the construction works, except for damages due to the fault or negligence of the United States or its contractors.

- Provision during the period of construction 10 percent of the cost of construction associated with general navigation features and an additional 10 percent of the cost of the general navigation features of the project in cash over a period not to exceed 30 years, at an interest rate determined pursuant to Section 106 of Public Law 99-662. The value of lands, easements, rights-of-way, relocations, and dredged material disposal areas provided shall be credited toward the additional 10 percent payment.

- Accomplishment without cost to the United States of alterations and relocations as required in sewer, water supply, drainage, and other utility facilities.

- Compliance with applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1978 (P.L. 91-646) and implementing regulations.

- Compliance with Section 601 of the Civil Rights Act of 1964 (P.L. 83-352).

- Establishment of regulations prohibiting discharge of untreated sewage, garbage, industrial waste, and other pollutants into the water of the port by users thereof, which regulations shall be in accordance with applicable laws or regulations of Federal, State, and local authorities responsible for pollution prevention and control.

- Assume financial responsibility for cleanup of hazardous materials located on project lands and covered under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

269. The City of Salem Port Authority is the agency empowered by law to provide the non-Federal cooperation required for the project. The Port enabling resolution created pursuant to the New Jersey State law 40:68A-29 et. seq., was passed by the Mayor and Common Council of the City in 1982. The enabling legislation empowers the Port to arrange for financing for said port by issuance of bonds. The sponsor is aware of the local cooperation requirements and a sample model of the Local Cooperation Agreement was provided to the Port of Salem for their review. Correspondence related to this coordination is contained in Appendix A.

270. FINANCIAL ANALYSIS. The Port acquired a 1.7 million dollar loan interest-free in December 1986 from the State of New Jersey to be repaid over 17 years. In 1990 the State Treasury Department released the remaining funds of the trust fund established by the State Legislature. This erased the Port debt. Additionally, the city allotted a $300,000 bond to resolve Port credit issues. This loan is being paid off within three to five years using lease payments from Port properties. The Port of Salem anticipates financing the construction project using State aid. A high level of state interest and legislative support has been demonstrated throughout the resurgence of the Port due in part to the critical importance of economic revitalization in southern New Jersey. No other source of Federal funds, such as Economic Development Administration (EDA), is

being contemplated for use toward the non-Federal share of the project.

271. Letters from the State of New Jersey and the Port of Salem are included in Appendix A, which attest to the financial capability and intent to sponsor the project.

PLAN IMPLEMENTATION

272. The steps necessary to complete the channel improvement plan are as follows:

The Division Engineer issues a public notice announcing study recommendations and the report is sent to the Board of Engineers for Rivers and Harbors. The Board reviews the report and comments in response to the notice and sends its recommendations to the Chief of Engineers who solicits review and comment by the Governor and interested Federal and state agencies. The report is then sent to the Assistant Secretary of the Army (Civil Works) for approval of the plan in accordance with the Water Resources Development Act of 1986 (section 903(b)). Section 903(b) provides for Congressional authorization of certain projects, subject to approval of a favorable report by the Secretary of the Army. Detailed engineering and design will begin when the Division Engineer issues the Public Notice.

273. Funding for construction will be allocated from the general budget. At that time, the project sponsor will be called upon to satisfy the requirements of local cooperation, including execution of a contract stating the local cooperation requirements and their legal and financial capability to provide them. After all necessary financial requirements and local cooperation items have been met, a construction contract will be awarded and carried to completion.

ENVIRONMENTAL ASSESSMENT

274. The following section contains the Environmental Assessment.

SUMMARY OF COORDINATION
PUBLIC VIEWS AND COMMENTS

275. Appendix A (Correspondence/Public Meetings) incorporates the comments received during the coordination phase of the study from Federal and state agencies and individuals. Many questions pertained to the environmental impacts of the project and the selection of the 18 foot alternative. The 18 foot alternative constitutes the National Economic Development plan since it has the highest net benefits with appropriate mitigation for impacts to wetlands.

276. In the initial phases of the study, coordination and information meetings were conducted with maritime and Port interests in addition to coordination with Federal, state and local agencies. These agencies are described in the Existing Conditions of the report. A meeting was held with environmental agencies in the later plan formulation stages of the draft report. As a result of that meeting, the agencies and the Philadelphia District concurred that mitigation for shallows would be incorporated into plan formulation. The related correspondence from this meeting is included in Appendix A.

277. The Public Notice was issued on the Draft Interim Feasibility Report on November 29, 1988. The report and technical notebook were sent to the appropriate Federal and state agencies as well as Salem County, the City of Salem, Port interests, and the surrounding municipalities. The comments received in response to the report are contained in Appendix A.

278. A public meeting was held in Salem, New Jersey, on January 12, 1989. The Public Notice and memorandum from that discussion are included in Appendix A also. Residents of Oakwood Beach expressed many concerns with the erosion along the shoreline and advocated placement of disposal materials on the beach. As a result of the high degree of concern, the Corps conducted further review of the impacts of disposal on the beach and held another public meeting with Oakwood Beach residents. The summary from that meeting is part of Appendix A.

279. Additional letters included in Appendix A are the letter of intent from the Port of Salem to support a project, a letter on financing from the State of New Jersey, correspondence from PSE&G officials regarding safety criteria for the power line, and the Salem River Pilots confirmation of their transit restrictions.

shift to pg. 119

ENVIRONMENTAL ASSESSMENT

FINDING OF NO SIGNIFICANT IMPACT
DELAWARE RIVER COMPREHENSIVE NAVIGATION STUDY
INTERIM FEASIBILITY REPORT
SALEM RIVER, SALEM COUNTY, NEW JERSEY

The Corps of Engineers proposes to widen and deepen the existing authorized channel, which is currently 150 feet wide by 12 feet deep at Salem Cove, narrowing to 100 feet wide at Sinnicksons Landing. The present project is approximately 5 miles long and stretches downstream from New Jersey Route 49 bridge at the City of Salem to Elsinboro Point at the southwest corner of Salem Cove in the Delaware River. The proposed project will extend the Delaware River segment an additional 200 feet, from the 12-foot depth to the 18-foot depth contour. About 1,282,000 cubic yards of dredged material, including 46,200 cubic yards from the 3.5 acre turning area at Salem, will be removed by hydraulic pipeline dredge. Approximately 7 acres of wetlands will be impacted, for which full mitigation will be provided. The dredged material will be deposited in the active Federal upland diked disposal area at Killcohook, which is used for the dredging of the main Delaware River navigation channel.

The environmental assessment for the project has been coordinated with the U.S. Environmental Protection Agency, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the New Jersey Department of Environmental Protection (NJDEP), the National Park Service, the Delaware Department of Natural Resources and Environmental Control, the Delaware Division of Historical and Cultural Affairs and all other known interested parties. Local coordination included participation in disposal site selection and other facets of project development, including environmental research.

The environmental assessment has determined that the proposed activity is not likely to jeopardize the continued existence of any species or the critical habitat of any fish, wildlife, or plant which is designated as endangered or threatened pursuant to the Endangered Species Act of 1973 as amended by P.L.96-159.

A Section 401 Water Quality Certificate was obtained from the NJDEP on September 19, 1989.

There are no known properties listed on, or eligible for listing on, the National Register of Historic Places that would be affected by the proposed activity. The proposed project is restricted to areas with limited resource sensitivity. Thus, the loss or destruction of unknown cultural data will be minimized.

Because the environmental assessment concludes that the proposed project is not a major Federal action significantly affecting the human environment, I have determined that an Environmental Impact Statement is not required.

Date

Kenneth H. Clow
Lieutenant Colonel, Corps of Engineers
District Engineer

FINDING OF NO SIGNIFICANT IMPACT
DELAWARE RIVER COMPREHENSIVE NAVIGATION STUDY
INTERIM FEASIBILITY STUDY
SALEM RIVER, SALEM COUNTY, NEW JERSEY

The Corps of Engineers proposes to widen and deepen the existing [illegible] channel, which is currently 100 feet wide by 12 feet deep at Salem Cove, narrowing to 100 feet wide at [illegible] Landing. The present project is approximately 3 miles long and stretches downstream from New Jersey State Route [illegible] in the City of Salem to [illegible] Point at the southwest corner of Salem Cove in the Delaware River. The proposed project will extend the Salem River segment an additional 700 feet, from the 12-foot depth to the 16-foot depth contour. About 1,283,000 cubic yards of dredged material, including 43,200 cubic yards from the 2.5 acre turning area at Salem, will be removed by hydraulic pipeline dredge. Approximately 7 acres of wetlands will be impacted, for which full mitigation will be provided. The dredged material will be deposited in the active Federal upland diked disposal area at Killcohook, which is used for the disposal of the main Delaware River navigation channel.

The environmental assessment for the project has been coordinated with the U.S. Environmental Protection Agency, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the New Jersey Department of Environmental Protection, the National Park Service, the Delaware Department of Natural Resources and Environmental Control, the Delaware Division of Historical and Cultural Affairs and all other known interested parties. Local coordination included [illegible] in disposal site selection and other facets of project development, including environmental reviews.

The environmental assessment has determined that the proposed activity is not likely to jeopardize the continued existence of any species or the critical habitat of any fish, wildlife, or plant, which is designated as endangered or threatened pursuant to the Endangered Species Act of 1973 as amended by [illegible].

A Section 401 Water Quality Certificate was obtained from the NJDEP on November 7, 1989.

The project does not directly affect any listed on, or eligible for listing on, the National Register of Historic Places. [illegible] to be affected by the proposed activity. The proposed project is not expected to affect high historic resource sensitivity. Thus, the loss or destruction of unknown cultural data will be minimized.

Because the environmental assessment indicates that the proposed project is not a major Federal action significantly affecting the human environment, I have determined that an environmental impact statement is not required.

Date

[illegible]
Lieutenant Colonel, Corps of Engineers
District Engineer

FINAL

ENVIRONMENTAL ASSESSMENT

SALEM RIVER, NEW JERSEY

INTERIM FEASIBILITY REPORT FOR

SALEM RIVER, NEW JERSEY

SALEM RIVER, NEW JERSEY
ENVIRONMENTAL ASSESSMENT
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I. PROJECT DESCRIPTION AND SITE HISTORY

A. GENERAL

This Environmental Assessment (EA) discusses potential impacts associated with proposed dredging of the Salem River Federal Navigation Project. The Philadelphia District of the U.S. Army Corps of Engineers has investigated the adequacy of the existing authorized channel dimensions, as well as a number of alternative channel designs for maximizing efficient movement of waterborne commerce through the project area. Alternative channel designs included channel depths of 14 to 24 feet below mean low water (MLW) and channel widths of 160 to 280 feet. A variety of dredged material disposal options were also considered, including both upland and overboard sites. Refer to the Plan Formulation section of the Main Report for a detailed description of the study process.

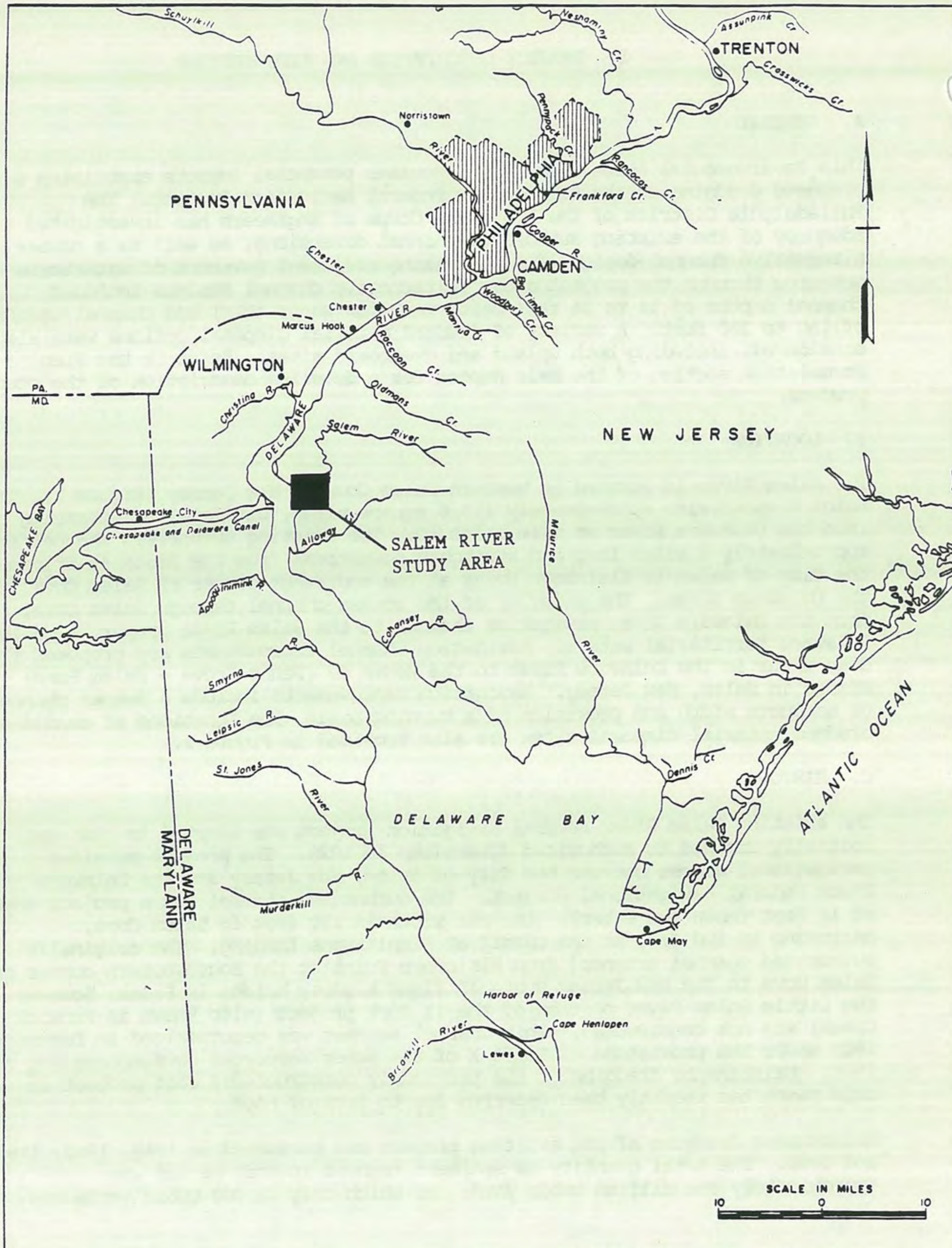
B. LOCATION

The Salem River is located in western Salem County, New Jersey (Figure 1). The Salem River drains approximately 113.6 square miles, ultimately discharging into the Delaware River at mile point 60. The existing authorized channel is approximately 5 miles long and stretches downstream from the Route 49 Bridge in the City of Salem to Elsinboro Point at the southwest corner of Salem Cove in the Delaware River. The majority of the access channel through Salem Cove, from the Delaware River navigation channel to the Salem River proper, lies in Delaware territorial waters. Navigation channel improvements are proposed from deep water in the Delaware River to the Route 49 (Penns Grove - Salem Road) Bridge in Salem, New Jersey. Navigation improvements include a deeper channel of adequate width and provision of a turning basin. The locations of candidate dredged material disposal sites are also provided in Figure 2.

C. HISTORY

The existing Salem River Federal Navigation Project was adopted in 1925 and initially dredged to authorized dimensions in 1928. The project provides navigational access between the City of Salem, New Jersey and the Delaware River Federal Navigational Project. The authorized channel has a project depth of 12 feet (mean low water). Channel width is 150 feet in Salem Cove, narrowing to 100 feet at the cutoff at Sinnicksons Landing. The originally authorized channel extended from Elsinboro Point at the southwestern corner of Salem Cove to the New Jersey Route 45 fixed highway bridge in Salem; however the Little Salem River portion of the 12 foot project (also known as Fenwick Creek) was not constructed. This channel segment was deauthorized in December 1989 under the provisions of Title X of the Water Resources Development Act of 1986. Maintenance dredging of the previously constructed 9 foot project in this reach has recently been deferred due to lack of need.

Maintenance dredging of the existing project was performed in 1946, 1960, 1984 and 1988. The total quantity of sediment removed in this period was approximately one million cubic yards, of which only 18,000 cubic yards was



EA-2

Figure 1. Project Location
Salem River, New Jersey
Delaware River Comprehensive
Navigation Study.

FIGURE 1

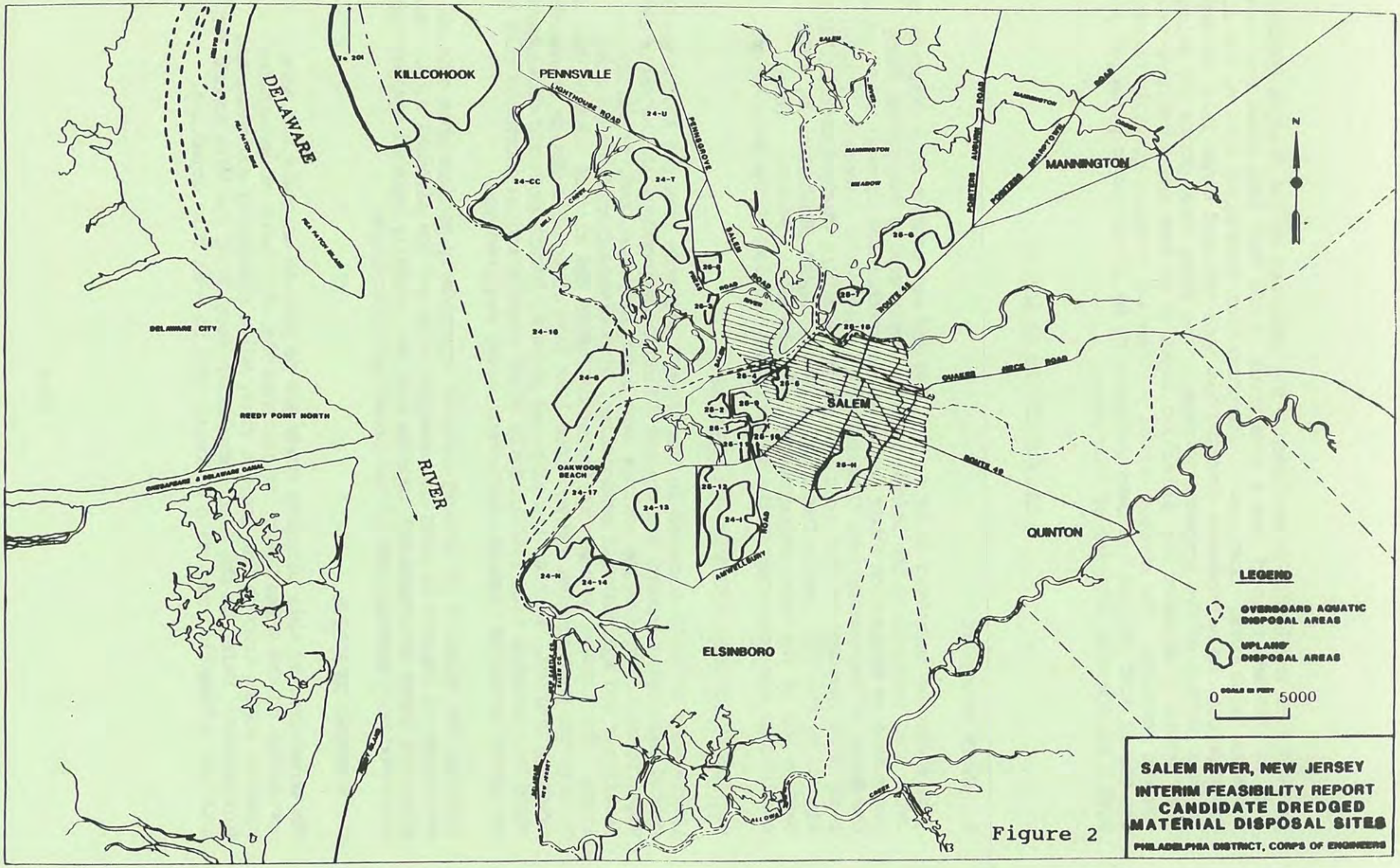


Figure 2

SALEM RIVER, NEW JERSEY
INTERIM FEASIBILITY REPORT
CANDIDATE DREDGED MATERIAL DISPOSAL SITES
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

removed from the Little Salem River. The remainder of the dredged volume from 1946 to 1988 was removed from a zone about 12,000 feet long where the channel transits Salem Cove. Upstream of the transition from Salem Cove to the Salem River proper, no maintenance dredging has been required since 1946, as depths in this portion of the project upstream to the Penns Neck (Route 49) bridge, have naturally exceeded the authorized depth of 12 feet and exhibit no trend towards shoaling. The average annual maintenance dredging quantity necessary for the 12 foot project has been estimated to be 22,500 cubic yards per year, with a maintenance interval of four years.

II. OBJECTIVES OF ACTION

A. STUDY AUTHORITY

This study was initiated in September 1984 and was conducted in response to a resolution authorizing the Delaware River Comprehensive Navigation Study. The Comprehensive Navigation Study was primarily authorized through a resolution by the House of Representatives Committee on Public Works (December 2, 1970). The study also responds in part to a resolution regarding dredged material disposal adopted by the U.S. Senate Committee on Public Works (September 20, 1974), and Section 859 of the Water Resources Act of 1986 (P.L. 99-662). These resolutions are contained in the Introduction section of the Main Report.

B. PUBLIC CONCERNS AND NEED FOR PROPOSAL

Little port activity occurred in the Salem River area from the 1940's until recent port redevelopment and channel maintenance projects in the early 1980's. Significant transportation savings have since been realized, primarily in fertilizer and agricultural commodities, with diversification into other areas. The current channel configuration limits the size of vessels that may utilize the port complex and provides less than acceptable design standards for existing traffic. Without the proposed project, future economic development would be conducted with inefficiently sized vessels and an increased risk of accidents generated through additional vessel requirements.

Dredging and disposal of dredged material unavoidably produce some adverse environmental impacts at both the dredging site and the disposal site. The extent of these environmental impacts must be carefully weighed against the socio-economic consequences of the no-action alternative.

C. PLANNING OBJECTIVE

The objectives of this planning study are to provide adequate and safe navigation on the Salem River, to increase the efficiency of waterborne commerce moving through the project area, while minimizing environmental degradation. Refer to the Plan Formulation section of the Main Report for detailed information regarding criteria used to meet this objective.

III. ALTERNATIVES

A. NO ACTION ALTERNATIVE

Under the no action alternative, no channel improvements would be undertaken. Periodic maintenance dredging would continue to maintain the project downstream of the Route 49 bridge at currently authorized depths. This alternative would hinder planned port expansion and is considered unacceptable because of its adverse impact on the economic growth potential of the region.

B. NAVIGATION IMPROVEMENTS

An array of alternative navigational improvements were considered to meet the planning objective. Non-structural alternatives include transshipment (lightering, topping off, or modal shifts), use of high tides, lightloading, modification to pilot regulations, tug assistance, and traffic management. Structural alternatives include a variety of channel depths (14 to 24 feet MLW) and channel widths (160 to 280 feet), with alternative turning basin schemes and navigational aids. These alternatives were evaluated against a variety of factors including construction costs, projected vessel sizes, navigational conditions, and environmental impacts. The major considerations in channel design options are discussed in the Plan Formulation section of the Main Report.

C. DISPOSAL AREAS

A total of 26 alternative sites were identified and considered for disposal of material dredged in conjunction with modification of the Salem River navigation channel. These sites included a variety of upland and aquatic areas. The location and pertinent information concerning these sites are provided in Figure 2 of this environmental assessment and Table 9 of the Main Report, respectively.

Candidate sites included four aquatic areas and 22 areas consisting of upland or uplands interspersed with wetlands. The aquatic sites included two shallow water areas in Salem Cove (sites 24-6 and 24-16), Oakwood Beach (site 24-17), and a deep water site in the Delaware River, located in the vicinity of Pea Patch Island. Upland areas included the existing, Federally owned Killcohook dredged material disposal site and new areas identified in the vicinity. The new areas primarily consist of vacant parcels of land, agricultural fields and woodlands, and are zoned for a variety of uses including industrial, residential, agricultural and conservation.

All sites were initially screened for engineering, economic, environmental and institutional acceptability. The purpose of this screening was to reduce the number of candidates to those that were realistic possibilities for dredged material disposal. All but three of the candidate non-Federal upland sites were eliminated from the analysis through this screening. Sites were eliminated because of limited capacity, excessive pumping distances, inaccessibility from an engineering perspective, and institutional problems due to zoning, cost, location and past and present use. There were also environmental concerns with a number of these sites due to the extent of wetlands and the potential for cultural resource impacts. Three aquatic candidate sites were retained in the analysis for further consideration. The existing overboard site 24-6 was found to reach its capacity near the base year and therefore was not carried forward.

As a result of the initial screening effort, four upland and three aquatic areas were considered viable disposal alternatives for material dredged from the Salem River navigation channel. The upland areas included the existing Killcohook dredged material disposal site and sites 24T, 25-7, and 25-8. Killcohook is located adjacent to the Delaware River and approximately 3.25 miles from the mouth of the Salem River. The site is approximately 1,200 acres in size, and has sufficient capacity to accommodate material dredged from the Salem River channel, without significantly impacting the Delaware River maintenance program. The three new sites are predominantly agricultural fields with small pockets of non-tidal wetlands. These sites would be suitable for disposal activities, with minor amounts of mitigation. These sites are much smaller than the Killcohook site, but are located closer to the dredging area.

The aquatic sites included site 24-16, which encompasses a larger portion of Salem Cove than the existing overboard site 24-6, Oakwood Beach, and the deepwater site adjacent to Pea Patch Island. Site 24-16 is located in shallow water habitat. The value of Salem Cove shallows is discussed in section IV.A.2. of this environmental assessment. Based on the importance of Salem cove shallows, it was determined that loss of this habitat type would require in-kind replacement of habitat on a one for one basis, as mitigation.

Three alternatives were evaluated with regard to the disposal of dredged material in Salem Cove. The first was creation of a diked island to contain the dredged material, and minimize the area of impact. It was estimated that approximately 120 acres, with a dike height of 25 feet, would be required to accommodate all material dredged for initial construction and maintenance of a 50-year project. While this Salem Cove alternative would minimize the loss of shallows, it would be very costly to construct, maintain and operate a dredged material disposal island. The second alternative was unconfined disposal of dredged material in Salem Cove. This alternative would increase the area of impact. With a maximum fill height of six feet, approximately 500 acres of shallows would be required to accommodate all material dredged for the project-life. Confined and unconfined disposal in Salem Cove would require the construction of 120 acres and 500 acres of shallows, respectively, to mitigate the loss of existing shallows. The third alternative was to spread the dredged material in a thin layer, so that the disposal operation would not result in the loss of shallows. It was estimated that over 3,000 acres of shallows would be required over the life of the project. Due to the shallow nature of the cove (one to five feet deep) it was determined that implementation of thin layering would be very expensive, if not impossible to accomplish.

The third aquatic disposal alternative was placement of material on Oakwood Beach (site 24-17). Subsurface testing conducted in the Salem River channel indicated that portions of the channel contain sand intermixed with finer grained materials to a depth of 18 feet. These stations are located at the upstream end of the entrance channel and near Sinnicksons Landing. Material in these areas has some potential for limited beach disposal. Material below 18 feet as well as in other sections of the channel is nearly all fine grained and therefore not suitable for beach disposal.

The final candidate aquatic site was a deepwater area located in the Delaware River, at the up-river end of Pea Patch Island. This site was selected for consideration as it was the closest deep water area to the Salem River navigation channel. A deep water site was included in the analysis because the disposal of dredged material in deep water could result in the creation of shallows, which is considered to be a more productive habitat type. Army Corps of Engineers regulation ER 1165-2-27 promotes the establishment of productive aquatic habitat in connection with dredging required for authorized water resources development projects. The Pea Patch Island site was also considered for thin layering. This site is approximately four miles from the mouth of the Salem River and is flanked by a submerged training dike that could partially serve to keep material in place. Additional diking would be required because the existing currents maintain the deep water in this area through scouring.

A total of 12 dredged material disposal scenarios were developed from the eight candidate sites. These scenarios included all aquatic disposal options, all upland disposal options and combinations of aquatic and upland disposal. These 12 scenarios were evaluated through detailed cost analyses in order to identify the National Economic Development (NED), or preferred plan for dredged material disposal. The NED plan is defined as the alternative that reasonably maximizes net economic benefits, and is consistent with protecting the Nation's environment. Environmental concerns were incorporated into the cost analyses by factoring in the cost of mitigation required for each scenario. The 12 disposal scenarios and costs associated with each scenario are provided in Table 10 of the Main Report. Additional information pertaining to the disposal scenarios is provided in the plan formulation section of the Main Report.

D. THE SELECTED PROJECT

Plan components are discussed in the Selected Plan section of the Main Report. Briefly, the elements of the project consist of a channel depth of -18 feet MLW and a width of 180 feet, with widening at bends and an expanded turning basin 495 feet wide opposite the berthing area. The authorized channel would also be realigned under the utility line at Sinnicksons Landing to improve air draft. This realignment also maximizes use of deep water and is in accord with the pilot practice. Approximately 1,282,000 cubic yards of material would be removed from the project area during initial construction. Annual maintenance dredging requirements are estimated at 62,700 cubic yards. Maintenance dredging would be necessary approximately every three years. This selected plan for channel improvements and turning basin causes environmental concerns regarding impacts to potential cultural resources in the cut-off area and near the river mouth, and concerns regarding habitat losses. These concerns are discussed in the impacts section of this EA (Section V).

Port of Salem plans include four berthing areas; three at the Port and one at Barber's Basin. These berthing areas are considered as "without project conditions" for this planning study. The Port berths would be 80 feet wide and have an associated access area. The Port berths would be located at Major's Wharf, adjacent to the grain elevator, and adjacent to the dry storage area, and would be 22 feet deep MLW (refer to Figure 9 in the Main Report). The berth at Major's Wharf would be 400 feet long, and the other two would each be 350 feet long. Approximately 1,000 feet of bulkhead would be required for construction of these berthing areas. Based on the steepness of the river bank in this portion of the Salem River, it is estimated that less than one acre of intertidal habitat would be impacted through bulkheading and construction of the berths. The fourth berth at Barber's Basin has been constructed and is currently 16 feet deep at MLW. This berth would be deepened to 22 feet at MLW, to take advantage of an 18-foot Salem River channel.

Detailed cost analyses of the 12 dredged material disposal scenarios identified the existing, Federally owned Killcohook site as the NED plan for dredged material disposal. Under this scenario all material dredged during initial construction as well as a 50-year maintenance program would be placed in the Killcohook site. This alternative is both the least costly and least environmentally damaging of the 12 scenarios evaluated (refer to Table 10 of the main report). Since Killcohook is an active dredged material disposal site, no previously unused upland or aquatic habitats would be disturbed. No mitigation is required for implementation of this disposal plan.

IV. EXISTING ENVIRONMENTAL SETTING

A. AQUATIC RESOURCES

1. Surface Water

1.1 Hydrology

The Salem River study area includes the lower Salem River and the Delaware estuary between river miles 58 and 61. At this point the Delaware River drains over 11,000 sq. mi. of New York, Pennsylvania, New Jersey, and Delaware. The study area is near the middle of the tidal zone of the Delaware River.

The Salem River initially flows west draining much of central Salem County until reaching Deepwater where it turns and flows south-southwest to Salem. From Salem, the flow is westerly to the confluence with the Delaware River at Salem Cove. The Salem River basin includes 113.6 square miles and contains 6 major lakes. The head of tide is at Deepwater, upstream of the project vicinity (NJDEP, 1979). Based on interpretations of data obtained from the most downstream USGS monitoring station, discharge for the entire Salem River drainage basin averages 131 cubic feet per second (cfs). The drainage basin is largely undeveloped, but contains two major population centers - Salem and

Woodstown (BCM, 1984). Table D-1 (Appendix D) presents tidal range and current velocity information for the Salem River entrance (mouth) and the Delaware River at Reedy Point. Refer to the Existing Conditions section of the Main Report for further discussion.

1.2 Surface Water Quality Standards

The Salem River in the study area is classified by the New Jersey Department of Environmental Protection (NJDEP) as saline estuarine water category SE1 (N.J.A.C. 7:9-4.12). Designated uses for the SE1 category include the following:

1. Shellfish harvesting in accordance with N.J.A.C. 7:9-12;
2. Maintenance, migration and propagation of the natural and established biota;
3. Primary and secondary recreation; and
4. any other reasonable uses.

In the vicinity of the project area, the New Jersey portion of the Delaware River, Salem Cove and the Salem River are condemned for shellfish harvesting. This is due to violations of coliform bacteria standards established by the National Sanitation program of the federal Food and Drug Administration (FDA).

The mouth of the Salem River discharges to the Delaware River. The majority of the Salem River approach channel is located in Delaware territorial waters. The Delaware River Basin Commission assigns designated uses and water quality standards for Delaware River Basin waters, for which Delaware and New Jersey standards must be at least as stringent. The protected uses for Zones 5 and 6 (Refer to tables D-4 and D-5) of the Delaware River are:

1. a. industrial supplies after reasonable treatment;

2. a. maintenance of resident fish and other aquatic life;
   b. propagation of resident fish from R.M. 70.0 to R.M. 48.2;
   c. passage of anadromous fish;
   d. wildlife;

3. a. recreation - secondary contact from R.M. 78.8 to R.M. 48.2;
   b. recreation from R.M. 59.5 to R.M. 48.2; and

4. a. navigation.

In some instances, Delaware DNREC water quality standards and designated uses are more stringent, or more precisely defined than DRBC standards. Drainage and anadromous fish are protected uses for stream basins. No upper limit is assigned to alkalinity, although substituted by an acidity and alkalinity difference criteria. Wording is different for taste, odor and color causing substances, specific criteria are identified for total coliforms and total residual chlorine in shellfish waters, frequency to permit valid interpretation is defined for fecal coliforms, and a 30 day maximum excedance criteria is specified for fecal coliforms below river mile 59.5. Toxic substances limits are specified for some substances.

Delaware surface water standards reference Quality Criteria for Water (USEPA, 1976) for toxicity level guidelines regarding heavy metals and toxic substances. The USEPA published updated water quality criteria for toxic pollutants for the protection of saltwater aquatic life in the Federal Register of November 29, 1980 (45 FR 79318) and February, 1984 (49 FR 4551). Water quality standards are presented in Appendix D.

1.3 Water Quality

Salem River water quality was rated "generally poor" in the 1977 New Jersey Water Quality Inventory (NJDEP, 1976). The river is affected by both point source (industrial and municipal discharges) and non-point source (agricultural and livestock) pollution. The Salem River drainage basin is largely agricultural. With population centers at Salem, Woodstown, and Sharptown, the majority of the population utilizes on-site wastewater disposal systems. There are four municipal/institutional and three industrial permitted point source discharges within the Salem River drainage basin (Table D-3). Of these discharges, the Woodstown and Salem wastewater treatment plants probably have the greatest effect on water quality.

The NJDEP lower Delaware Area Draft Water Quality (208) Management Plan (NJDEP, 1979) summarized violations of state water quality standards for historical and 208 water quality data. Table D-2 presents selected results of these findings for the Salem River, upstream of the proposed dredging area. Figure 3 shows the location of the sampling stations, point source discharges, and non-point source problem areas.

Frequent violations of dissolved oxygen and fecal coliform levels indicate that the Salem River fails to meet the National goal of swimmable and fishable waters. The Salem River is classified as Water Quality Limited due to a low base flow and assimilative capacity, poor water quality as evidenced by dissolved oxygen water quality violations, and the probability that the application of effluent limited technology and non-point source management practices in urban industrial areas would be insufficient to meet water quality standards (NJDEP, 1979).

A single composite water quality sample taken on July 28, 1983 was analyzed in conjunction with the elutriate testing of sediment from the Salem Cove channel. The results, presented in Table D-10, show all organic parameters at concentrations below detection limits, with the exception of phenols, and only five metals at detectable concentrations. All measurable concentrations meet water quality criteria. Temperature, dissolved oxygen, and pH data taken during sampling also indicate acceptable water quality conditions (BCM, 1984).

Water quality in the Delaware River undergoes a recovery as it passes the Salem River study area. Wastes from the Trenton-Philadelphia-Camden-Wilmington industrial areas create a zone of high BOD and generally poor water quality that causes depression of dissolved oxygen levels in the river water above Wilmington, especially during the summer months. Below Wilmington, waste inflow decreases, the water begins to recover, and dissolved oxygen levels rise. By the time the wastes reach the study area, acceptable biological conditions prevail, and water quality continues to improve downriver (BEE 1975;

Figure 3.

POINT SOURCES, NONPOINT SOURCES, AND SURFACE WATER SAMPLING STATIONS IN THE SALEM RIVER WATERSHED

SALEM RIVER,N.J. AND

DELAWARE RIVER
COMPREHENSIVE NAVIGATION STUDY
ENVIRONMENTAL ASSESSMENT
U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

SOURCE: NJDEP, 1979

NJDEP 1978). The U.S. Fish and Wildlife Service (USFWS) reviewed temperature, dissolved oxygen, and pH data collected by the USGS in 1981 at Reedy Island, Delaware, which is located approximately 2 miles downriver from Salem Cove. The data, although limited, indicate conditions "not considered limiting to fish population" (USFWS 1981, BCM 1984).

The Delaware DNREC performs water quality monitoring for the DRBC in the Delaware Estuary and Bay in the vicinity of the Salem River project. Sampling stations for zones 5 and 6 are presented in Figure 4. Summary water quality data for 1982 and 1983 in the project vicinity are presented in Tables D-4 and D-5 (see Appendix D). Dissolved oxygen standards at mile 61 met the water quality standard of 4.5 most of the time, although this standard does not provide for fishable quality water. State pH standards were met most of the time, except for a pulse which was believed to emanate from a point source near Philadelphia. The fecal coliform standards met primary contact recreation standards, which are more stringent than those standards from river mile 59 to 79. Phenol violations were believed to be due to chloride interference or oceanic background.

2. Aquatic Ecology

2.1 Fisheries

The U.S. Fish and Wildlife Service has prepared two Planning Aid Reports characterizing existing conditions in the study area. These reports are provided in Appendix A of the Main Report. In addition, various studies have addressed fisheries in the vicinity of the Salem River study area. Walton et al. (1973) examined aquatic communities of the Delaware River estuarine marshes. A relative measure of abundance was assigned by field personnel ranging from abundant to rare. White Perch (Morone americana) were found to be common in the Salem River. American Eel (Anguilla rostrata), Alewife (Alosa sp.), Atlantic Menhaden (Brevortia tyrannus, and Brown Bullhead (Ictalurus neoluosus) were rare.

Zich, et al. (1977) performed an inventory of anadromous fish for the NJDEP Division of Fish, Game and Shellfisheries. This study collected existing information and performed field investigations on anadromous clupeid spawning runs. Alewife (Alosa pseudoharengus) spawning runs have been confirmed in the Salem River, but shad spawning runs have become extinct. Anadromous fish migrate from March to May and September to November (BCM, 1984).

In May and June, 1987, the Fish and Wildlife Service and the New Jersey Department of Environmental Protection conducted sampling activities in Salem River and Cove. Following is a resume of that report. The full report is included in Appendix A. A total of 1,130 fish were collected and identified, representing 20 different species. Ninety percent were represented by bay anchovy (69%), striped killifish (8%), Atlantic silverside (7.7%) and white perch (6%). The remaining species include carp, bluefish, pumpkinseed, mummichog, white catfish, Atlantic menhaden, gizzard shad, alewife, American shad, blueback herring, channel catfish, white crappie, American eel, sundial, golden shiner and brown bullhead. In addition were grass shrimp and various species of crabs.

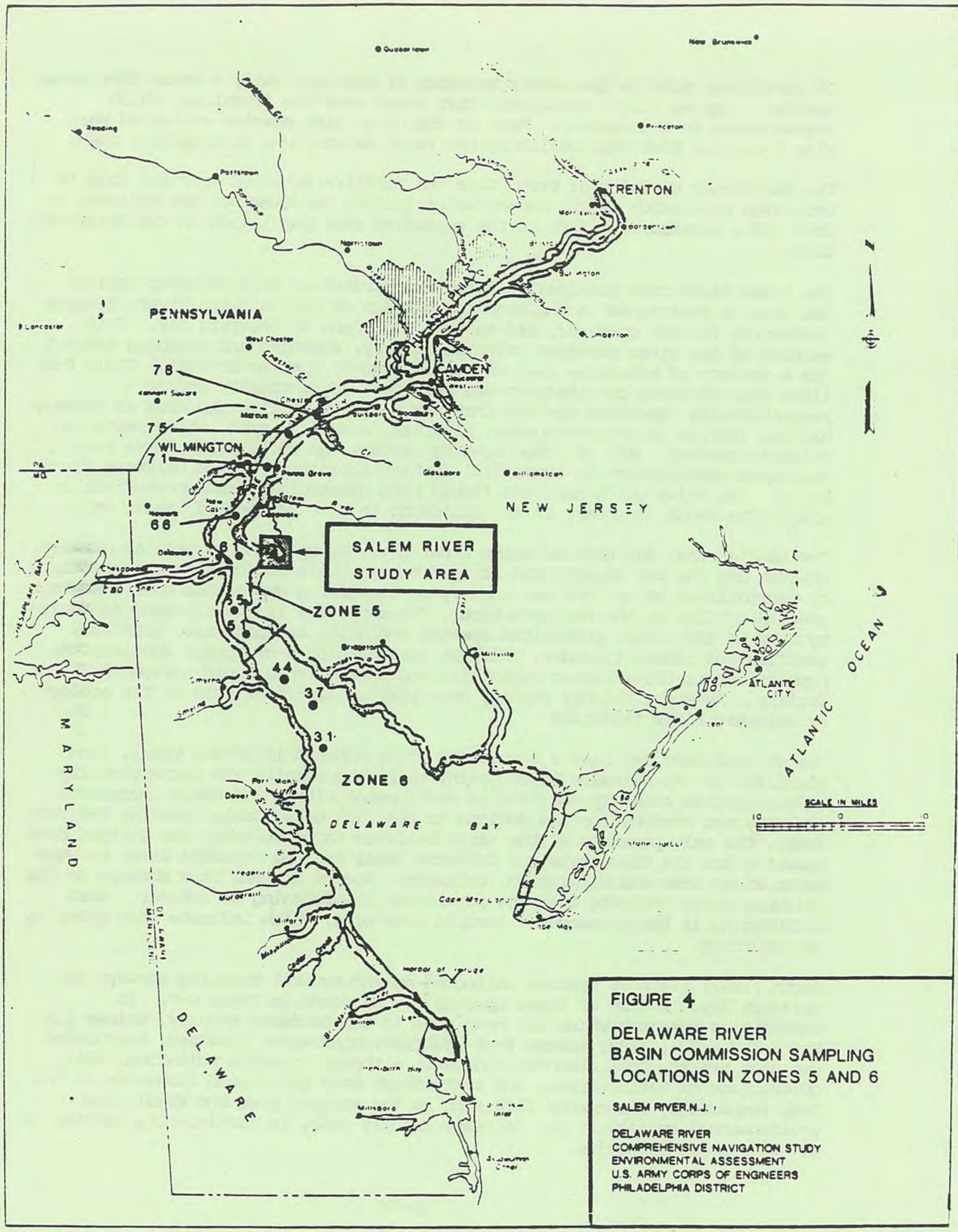


FIGURE 4
DELAWARE RIVER
BASIN COMMISSION SAMPLING
LOCATIONS IN ZONES 5 AND 6

SALEM RIVER, N.J.

DELAWARE RIVER
COMPREHENSIVE NAVIGATION STUDY
ENVIRONMENTAL ASSESSMENT
U.S. ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

Of particular note is the sample presence of American shad, a State threatened species. Lupine (1987) determined that these shad are juveniles, which overwintered in the estuary. Most of the other fish species collected were also juveniles that were utilizing the lower Salem River as a nursery area.

The New Jersey Division of Fish, Game and Wildlife monitors American shad to determine population size. Recent water quality improvements are believed to have had a beneficial effect on the expanding shad population in the Delaware River.

The Salem River cove provides an extensive stretch of shallow water habitat. The cove is positioned in the brackish portion of the Delaware River, between freshwater further up-river, and marine conditions in Delaware Bay. This section of the river provides valuable nursery, spawning and foraging habitat for a variety of estuarine resident and migratory species of fish. Table D-6 lists species known or likely to use the cove. Commercially and/or recreationally important species that are known to utilize the area as nursery habitat include Atlantic menhaden, bluefish, weakfish, spot, white perch and Atlantic croaker. All of these species, except the white perch, have been important contributors to commercial fishing activities in the Delaware River basin. The white perch has been fished both commercially and recreationally within the basin, however, it is considered to be a species of lesser value.

Two species that may utilize Salem River cove for spawning as well as nursery habitat are the bay anchovy and striped bass. While not of direct commercial or recreational value, the bay anchovy is considered one of the most important species of fish in the Delaware River. This species is heavily used as forage by many of the larger predacious species including striped bass, bluefish, weakfish and summer flounder. Without healthy stocks of forage species, the populations of these larger commercial and sport fishes would noticeably decline. As such, the bay anchovy does play an important role in the ecology of Delaware River fisheries.

The striped bass has been a species of great concern in recent years. Once plentiful in the Delaware River basin, this commercially and recreationally valued species steadily declined as development within the basin increased. The apparent reasons for the decline is the lack of suitable spawning habitat. Today, the only portions of the basin believed to be suitable for striped bass spawning are the Chesapeake and Delaware Canal and the Delaware River between Salem River cove and Wilmington, Delaware. Recent striped bass surveys in the Delaware River indicate that the population is beginning to recover. Most encouraging is the presence of striped bass eggs, which indicate that spawning is occurring.

Smith (1982) lists 76 species collected during several trawling surveys in Delaware Bay. A list of these species may be found in Table D-7. In summarizing research which has been done in the Delaware estuary, Grimes (in Sharp J.H., Ed., 1983) states that weakfish, windowpane flounder, hogchokers and spot are the most abundant species. Although riverine pollution, fill, obstruction of watercourses, and overfishing have threatened fisheries in the past (especially anadromous fish such as the striped bass and shad), the environmental quality of the Delaware Estuary today is sufficiently healthy to maintain major fisheries.

2.2 Benthic Habitat and Resources

As part of this Environmental Assessment, benthic invertebrate sampling was conducted at four stations on April 14 and 15, 1985. Sampling locations are provided on Figure 5 (PAS-1 through PAS-4). The Salem River benthic community was dominated by the tube-dwelling amphipod Corphium. The predominant species identified was Corphium lacustre, an estuarine amphipod that is dominant in the Chesapeake Bay estuaries (Bousfield, 1973). The amphipod comprised an average of approximately 75% of the samples examined. The remaining benthos consisted primarily of amphipods, isopods, oligochaetes, and the polychaete Polydora (Table D-8). These amphipods and isopods are generally epifaunal in nature and are detritus and deposit feeders. Their occurrence is most likely due to the high levels of detritus present in the sediment.

Densities and total numbers of organisms were highest in the most upstream station and generally decreased in the stations nearer to the Delaware River. Among the means by which community structure can be quantitatively assessed is the application of Indices of Community Structure. Communities which display high diversity and evenness tend to be balanced, complex, stable systems. Communities which display low diversity and evenness, in contrast, tend to be unstable.

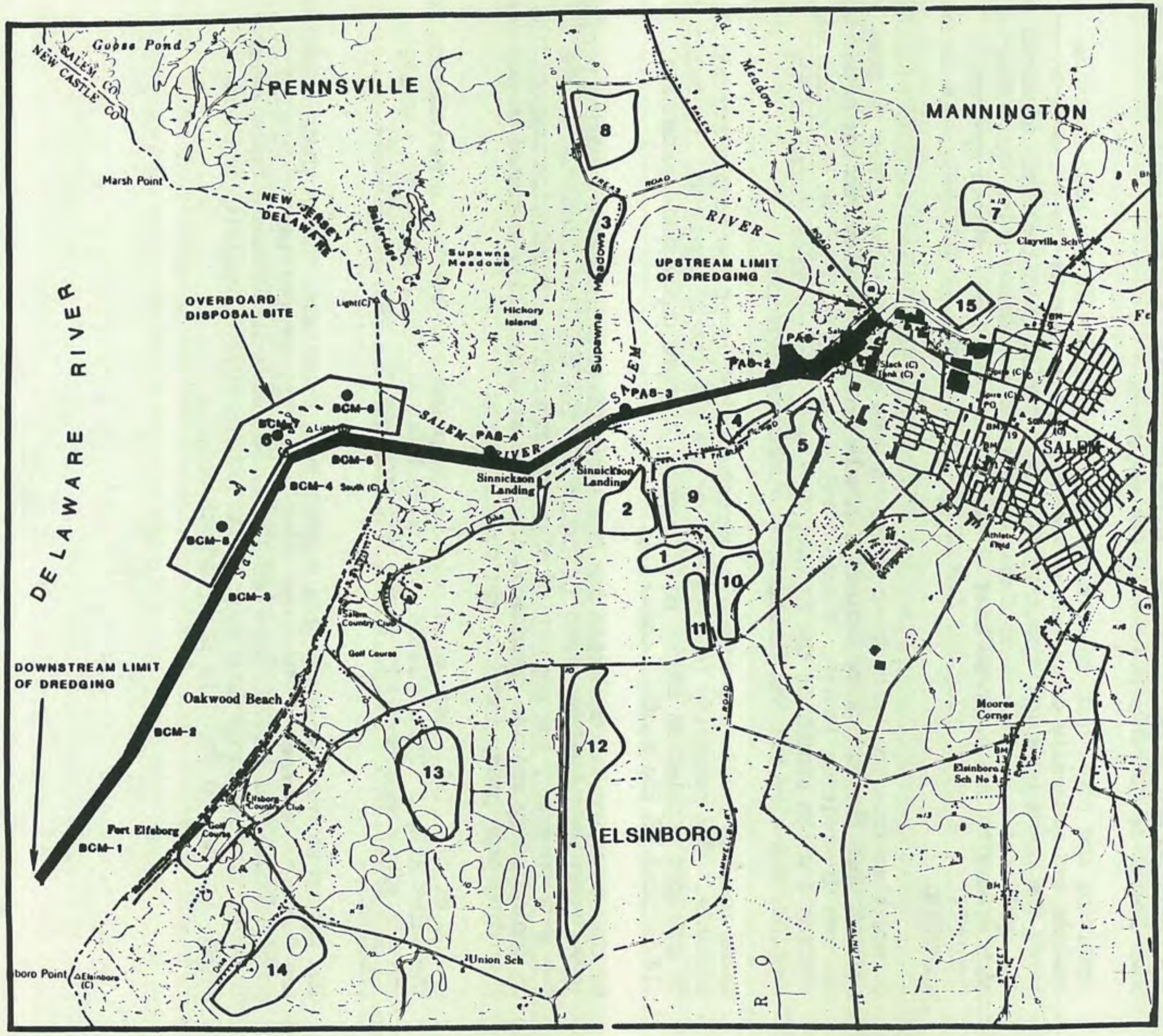
Diversities from the Salem River stations were generally low. This is more evident when the diversity indices H (Table D-8) are compared to the potential maximum diversities (Hmax). Evenness values were also low. An exception was station 4 which exhibited the highest diversity and evenness values of the samples, but also had the lowest total number of organisms.

These results indicate a community structure that is of low complexity and thus unstable. The community is dominated by one species of amphipod. Fluctuations in amphipod population and/or environmental changes could cause extensive alterations in the benthic community.

Benthic sampling was conducted for the Salem River maintenance dredging project (BCM, 1984) at locations shown in Figure 5. The results, presented in Table D-9 show generally low population size and diversity. Population composition is dominated by species considered tolerant of organically enriched conditions, including amphipods, isopods, and aquatic worms.

Walton et al. (1973) estimated relative abundances of benthic invertebrates in the Salem River. Oligochaetes, Chironomid larvae, Rhithropanapeus harrissi. and Uca minax were commonly found, and Gammarus sp. were encountered frequently.

The waters within the study area support many organisms, though these organisms are "somewhat stressed" (Tyrawski 1979). Benthic communities in Salem Cove are poorly documented (USFWS 1981; COE 1981), but several substrate types exist. These substrates range from poor habitat where organic material and some vegetation may be found in silty substrates.



LEGEND

—— PROPOSED DISPOSAL AREA BOUNDARY

N

0 FEET 5000

Figure 5.

BENTHIC INVERTEBRATE AND SEDIMENT SAMPLING LOCATIONS IN THE SALEM RIVER STUDY AREA

SALEM RIVER FEDERAL NAVIGATION CHANNEL

COMPREHENSIVE NAVIGATION STUDY
ENVIRONMENTAL ASSESSMENT
STUDY AREA

U.S. ARMY CORPS OF ENGINEERS DISTRICT
PHILADELPHIA, DISTRICT

Adult crabs are just emerging from deep water overwintering during the spring months. Young of the year crabs, mostly spawned in areas further downbay, migrate to the vicinity of Salem Cove in the early fall. The blue crab Callinectes sapidus) is a major commercially harvested shellfish in the Salem Cove and the Delaware Bay (USCOE, December 1982). The lower portion of the Salem River is used for recreational crabbing as are the cove and bay (BCM, 1984).

Oysters are an important commercial resource in the Delaware Bay region. Substantial preserved natural seed beds of the American oyster (Crassostrea virginica) are located in the Delaware River, 13 miles downstream of Salem Cove. These beds are harvested for seed during May and June (when permitted) by the oyster industry for planting in leased areas. Oysters are relatively sensitive organisms. A decline in oyster harvest during the late 1950's to the late 1960's was due to a combination of over-harvesting, disease, predation, fouling organisms, and poor water quality (USFWS, 1970). The oyster population is beginning to recover and stabilize but does not approach the earlier harvest levels.

2.3 Endangered and Threatened Species

The shortnose sturgeon (Acipenser brevirostrum) is a Federally endangered species, which has been recorded in the Maurice River and Delaware Bay. This species migrates up the Delaware River estuary in early spring to reach freshwater spawning grounds upriver of Trenton, New Jersey. Adult individuals migrate downstream in the fall to overwinter in higher salinity waters in Delaware Bay and the Atlantic Ocean. Adults have been observed overwintering in freshwater, immediately downstream of Trenton. Shortnose sturgeon may be expected to occur in the Salem River, although it has not been documented (John McClain, NJDEP Bureau of Marine Fisheries, personal communication, April 5, 1984 and March 1, 1985). The Atlantic (sea) sturgeon (Acipenser oxyrhynchus) is an anadromous New Jersey State threatened species which, like the shortnose sturgeon, may be found incidentally in the Delaware Bay and Salem River. The Atlantic ridley, leatherback and hawksbill sea turtles are federally endangered species, while the green sea turtle and the loggerhead are both threatened species. Blue, finback, humpback, right, sei and sperm whales are also federally endangered species. Some of the whales and turtles are occasionally transient in the bay area. None are reported in the Salem River. The Atlantic tomcod (Microgadus tomcod) and the American shad (Alosa sapidissima) are New Jersey State threatened species which have been recorded in the Delaware River (USACOE, April 1984).

3. Sediments

3.1 Sediment Composition

As part of this Environmental Assessment, sediment samples were collected at four stations within the Salem River (Figure 5). The substrate at stations 1, 3, and 4 was impenetrable. As such, the sampling locations for these stations were moved closer to the shore. Station 1 sediments were comprised of a brown/black firm, clayed clay with detrital peat. Station 2 sediments consisted primarily of brown clay and fibrous peat. Sediments at stations 3 and 4 primarily consisted or coarse sand with plant detritus.

The EP Toxicity Procedure was used to obtain leachate samples from the Salem River sediments. These leachate samples were analyzed to identify potential contaminants in channel sediments. Results of this testing and comparison to applicable standards are provided in Table D-10. The sediment chemical leachate analysis indicated low levels of toxic substance contamination, well below EP toxicity criteria.

BCM (1984) performed sediment sampling at 8 locations in Salem Cove (Figure 5). Five samples taken in the access channel of the proposed Salem River project were analyzed for purgeable halocarbons and aromatics, pesticides, PCB's, metals, and some miscellaneous parameters on a bulk and elutriate basis. The results of this testing are provided in section V.A.2. of this Environmental Assessment.

The samples taken at the 5 access channel sites were physically and visually described and subject to particle size analysis. Channel stations BCM-1, BCM-2, and BCM-3 were comprised primarily of silty-clay. Channel stations BCM-4 and BCM-5 were composed mainly of sand, with some gravel and cobble at the upstream station.

3.2 Sediment Transport Phenomena

In the Salem River project area, shoaling is greatest in Salem Cove. The lower Salem River remains well scoured as evidenced by the relatively swift currents and hard bottom condition encountered mid-channel during recent sampling. Maintenance dredging is rarely needed in this area except for spot dredging.

The Coriolis effect in the Delaware estuary is such that the strongest current velocity occurs during flood tide on the New Jersey side. Sediment movement would tend to be in the northern direction. Sediment disposed in the existing overboard disposal area would have a tendency to move north away for the channel (USACOE, April 1984).

4. <u>Channel Dependent Shipping of the Area</u>

The Salem River channel is used for one-way commercial vessel traffic and two-way recreational navigation. The Port of Salem was relatively inactive until interest was renewed in 1982. Refer to the Existing Conditions section of the Main Report for expanded commercial vessel discussions.

5. <u>Navigation Channel</u>

The present authorized dimensions are 12 feet deep by 150 feet wide for the portion of the channel from deep water to the cutoff and 12 feet deep by 100 feet wide for the remainder of the project (USACOE, 1983). Maintenance dredging of the existing project was performed in 1946, 1960, 1984 and 1988. The total quantity of sediment removed in this period was approximately one million cubic yards. Prior to the 1984 maintenance dredging, shoaling at the Salem River mouth allowed only 3 to 4 feet of draft during low tide.

6. Climate

The study area lies within one broad climatic zone, which is considered subtropical, with hot summers, mild winters, and regular rainfall. Summer weather patterns are influenced by maritime tropical air masses, where high pressure systems dominate and remain stable for several days at a time. Weather systems in the winter are generally more intense because of rapidly moving fronts and continental polar air masses. Refer to the Climate discussion in the Existing Conditions section of the Main Report.

7. Air Quality and Odor

The study area is located in the Philadelphia Air Quality Control Region (AQCR), an air quality monitoring network. Criteria pollutants include sulfur dioxide (SO_2), total suspended particulates (TSP), nitrogen dioxide (NO_2), carbon monoxide (CO), lead (Pb), -and ozone (O_3). In general, sulfur dioxide levels in the project area are reflected in the levels of particulates (TSP).

Materials deposited in a diked disposal area may produce gases, released by the agitation of organic and other chemical constituents within the dredged material. Odor problems usually occur with dredged material taken from intertidal or brackish areas. These sediments often contain various sulfur compounds. Decomposition of organic material usually produces methane, an odorless gas. However, when saline water contains sulfur, the decomposition produces hydrogen sulfide instead. This is released, and produces nuisance conditions during periods of high concentration, usually during the summer.

Generally speaking, sediments in the Salem River are not anticipated to be sufficiently organic to develop these conditions. Highly organic sediments are the most likely to be malodorous if insufficient oxygen is present to satisfy the biochemical oxygen demand (BOD).

8. Noise

Existing noise in the vicinity of the Port is dominated by industrial process machinery and transport ship on- and off loading operations. Construction noise generated by the project is expected to be minor, short-term and not considered a significant environmental factor.

9. Aesthetics

The project area is typically rural in nature. Disposal areas are a common occurrence in the vicinity of coastal waters where dredging occurs. They are typically vegetated with common reed (Phragmites) which is also found in the less developed portions of the river and bay complex. The visual appearance of a reed-covered disposal area is similar to reed-covered natural marsh-lands, except for the elevation factor.

10. Mosquito Control

Tidal wetlands in the project area are known to breed mosquitoes. Control of potential mosquito breeding areas is performed by the Salem County Mosquito Commission. Due to uneven settling and ponding of water during heavy rains, mosquitoes may use dredged material disposal areas for breeding grounds. Isolated ponds such as those within the disposal areas are often difficult to find. Some areas are mechanically drained to decrease ponding.

Disposal areas are left to be free draining to avoid mosquito breeding habitats. Inspectors ensure detection in case a problem area develops. In this case, corrective action would be taken by the Corps of Engineers in conjunction with the Salem County Mosquito Commission.

11. Cultural Resources

Cultural resources concerns within the Salem River itself are limited to (a) the potential for prehistoric sites and historic sites along the river banks in areas where the channel is to be widened, (b) the potential for shipwrecks within the channel deepening and channel widening areas, and (c) the potential for prehistoric sites or shipwrecks in any possible overboard disposal area. Humans have lived along the banks of the Delaware River and its tributaries for at least ten thousand years. Europeans first settled along the Salem River in the mid-seventeenth century. Both prehistoric and historic sites have been found along portions of the banks of the Salem River. There remains a possibility that such sites may exist within the project impact area. With regard to shipwrecks, from its earliest settlement Salem has been a major shipping point for South Jersey. Historical records refer to several wrecks in the vicinity of the rocks and bars at the mouth of the Salem River.

Sea level rise over the last several thousand years has inundated land that would have been dry during much of th prehistoric period. The current shallow depths in the Salem Cove area would have been a hazard to ships trying to reach Salem River. As a result, the Salem Cove vicinity has the potential to contain prehistoric sites and/or shipwrecks that could be affected by overboard disposal.

In 1987, an underwater cultural resources investigation was conducted in the Salem Cove and Salem River project area for Philadelphia District (COX 1988). The documentary research included in this study revealed the Salem has been a site of significant maritime activity since the last quarter of the seventeenth century.

B. UPLAND AND WETLAND HABITATS

1. Groundwater Resources

1.1 Geological Characteristics

Quaternary formations surficially underlie the Salem River study area. These formations include Holocene Alluvium and Pleistocene Cape May deposits. Holocene Alluvium deposits consisting of undifferentiated silt, clay organic material, sand and gravel are found in the vicinity of stream corridors. The Pleistocene Cape May Formation consists of floodplain deposits in low terraces and plains consisting of organically rich gravel and sand with some clay.

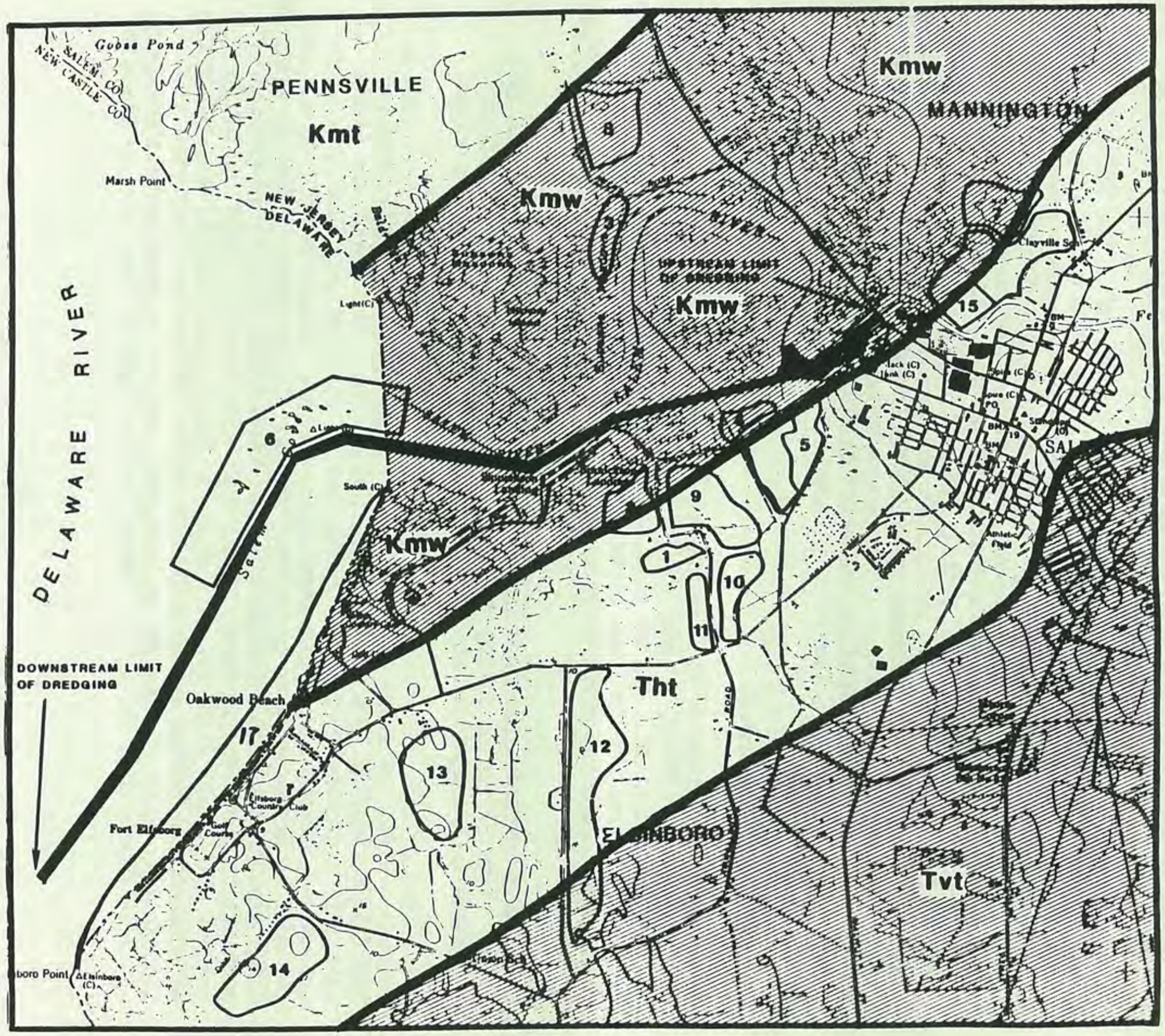
Figure 6 shows the outcrop areas of geologic formations in the Salem River study area. These unconsolidated geological formations comprising the coastal plain of New Jersey dip to the southeast, with outcrop areas oriented along a southwest to northeast axis. The Vincentown Formation (Tertiary System, Paleocene Series) is a major aquifer consisting of medium grained slightly clayey sand. Hornerstown sand (Tertiary, Paleocene) and the Navesink Formation (Cretaceous, Upper Cretaceous) from a leaky aquiclude consisting of glauconitic sand, silt and clay, light to dark green and weathered brown in color. This aquiclude underlies and outcrops north of the Vincentown formation. The Mount Laurel Sand, Wenonah Formation (Cretaceous, Upper Cretaceous), is another major aquifer that entirely underlies the Lower Salem River study area. This aquifer consists of glauconitic, lignitic, micaceous, and fossiliferous fine-to-coarse grained quartz sand.

1.2 Geohydrology

The primary direction of flow in the Wenonah Formation and Mount Laurel Sand is toward the Salem River, Alloway Creek, and their tributaries, in the direction of the Delaware River. In the past, a piezometric depression in western Salem City has occurred due to large withdrawals of water from municipal wells in that area. Along the outcrop areas in the Lower Salem River, some discharges to streams may occur.

Salt water intrusion has been indicated in various wells in the vicinity of Salem. Tidal flooding during drought periods can occur, causing salinity increases in the aquifer until several years of adequate flushing occur.

Salem uses surface water runoff from Laurel Lake and Elkington Mill Pond in Quinton. Wells are still available on a backup basis. The piezometric depression reported by Rosenau et al (1969) in the vicinity of the Salem wellfield has probably risen in recent years, reducing potential salt water intrusion problems. Specific capacity of 39 wells range from 0.7 to 9.4 gpm per foot of drawdown, with an average of 3.8. Public supply wells in Salem and Elmer yielded 0.81 mgd. The Wenonah and Mount Laurel aquifer is the second most utilized aquifer in Salem County with more than 100 wells (as of 1964), most of them small diameter. Tests in the Salem public supply well vicinity determined the average transmissibility to be 9000 gpd per foot; the permeability to be 100 gpd per square foot; and the storage coefficient to be .35 X 10 (Rosenau et at. 1969). Wells in the Tillbury Road area in Elsinboro



LEGEND

OUTCROP AREAS OF SIGNIFICANT AQUIFERS IN STUDY AREA

Kmt - MARSHALLTOWN FORMATION

Kmw - MOUNT LAUREL AND WENONAH SAND (UNDIFFERENTIATED)

Tht - HORNERSTOWN SAND

Tvt - VINCENTOWN SAND

N

0 FEET 5000

FIGURE 6

GEOLOGICAL OUTCROP AREAS OF SIGNIFICANT AQUIFERS IN THE SALEM RIVER STUDY AREA

SALEM RIVER FEDERAL NAVIGATION CHANNEL

COMPREHENSIVE NAVIGATION STUDY ENVIRONMENTAL ASSESSMENT STUDY AREA

U.S. ARMY CORPS OF ENGINEERS DISTRICT PHILADELPHIA, DISTRICT along the Salem River have experienced salt water intrusion problems. Potable water lines from the City of Salem have been extended along Tillbury Road to the Salem City border, with the intention that the residences in Elsinboro near the Salem River could be served (Ken Morran, City of Salem Water and Sewer Superintendent, personal communication, March 10, 1985).

The Navesink Formation and overlying Hornerstown Sand function as a leaky aquiclude above the Wenonah and Mount Laurel aquifer. The vertical permeability of the Navesink Hornerstown aquiclude is 0.42 gpd/sq. ft. No domestic wells exist in this aquiclude in Salem County. The Marshalltown formation underlies the Wenonah Mount Laurel aquifer and acts as a confining leaky aquiclude. The few small wells which tap this formation are found to have permeability of 0.01 to 0.001 gpd per square foot, and specific capacities between 2 to 3 gpm per foot of drawdown.

The New Jersey Coastal Plain aquifer system, which underlies Salem County, has been designated as a sole source aquifer by the EPA (48 FR 22619) under section 1424 (e) of the Safe Drinking Water Act (P.L. 93523). Federal financial assistance would be withheld for projects which have a potential for contaminating the aquifer creating a significant public health hazard (personal communication, Damien Duda, EPA Region 2, February 1, 1985).

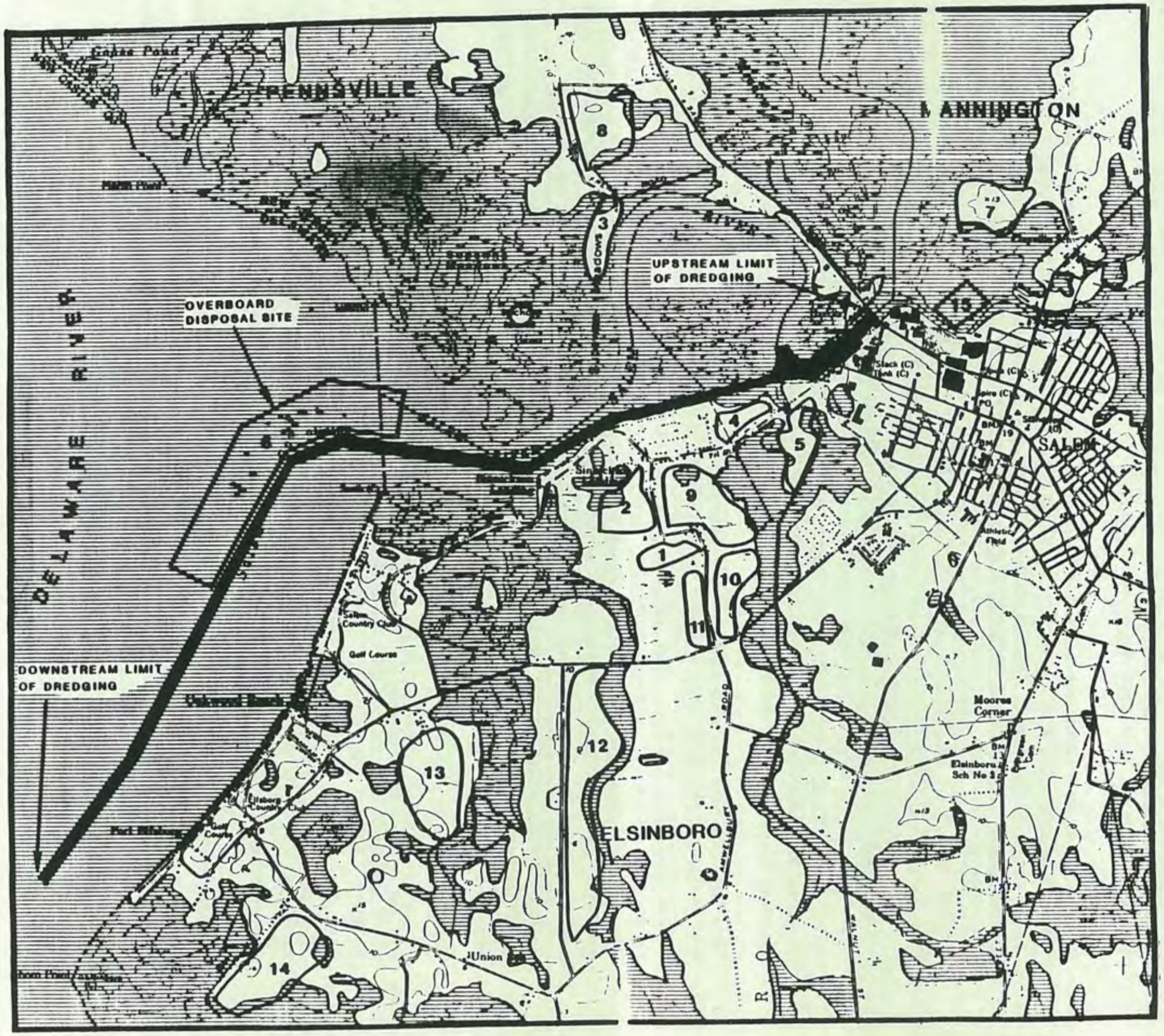
2. Intertidal and Wetland Habitats

The U.S. Fish and Wildlife Service (USFWS) has mapped wetlands in the study area including both tidal and nontidal wetland communities (USFWS, 1981). Figure 7 shows wetlands mapped as part of the National Wetland Inventory (NWI) in the Salem River study area.

The New Jersey Department of Environmental Protection regulates development in tidal wetlands and has mapped regulated wetlands associated with the Salem River (NJDEP, 1972). Wetland segments found on NJDEP maps on or adjacent to proposed disposal sites, but not mapped on the NWI maps, are also included in Figure 7. The project study area contains some high-quality wetland and intertidal habitats. Almost all of the intertidal habitat is emergent wetland categorized as "Estuarine Intertidal Emergent Persistent". The most significant wetland is the Supawna Meadows National Wildlife Refuge. The southern extreme of this refuge extends to the north bank of the Salem River opposite Sinnickson Landing (BCM 1984).

In the Salem River study are, dominant vegetation includes saltmarsh cordgrass (Spartina alterniflora high vigor), common reed (Phragmites communis), arrow arum (Peltandra virginica), and marsh mallow (Hibiscus palustris) (USFWS, 1981; NJDEP, 1972). Saltmarsh cordgrass and common reed are the dominant species in the study area wetlands, with the exception of a small pocket of sea myrtle (Baccharis halimifolia) located near the Salem Country Club golf course.

The project area is located on the northeast migratory flyway and thousands of migratory waterfowl utilize the cove, river, and adjacent wetlands during spring and fall migration periods (USFWS 1981). The most common species are mallard (Anas platyrhynchos), black duck (Anas rubripes) and Canada goose (Branta canadensis). Several hundred fowl over-winter in the area each year (BMC, 1984).



LEGEND

PROPOSED DISPOSAL AREA BOUNDARY

Wetland/Aquatic Habitats

N

0 FEET 6000

Figure 7. Salem River Study Area Wetland/ Aquatic Habitats

SALEM RIVER FEDERAL NAVIGATION CHANNEL

COMPREHENSIVE NAVIGATION STUDY
ENVIRONMENTAL ASSESSMENT
STUDY AREA

U.S. ARMY CORPS OF ENGINEERS DISTRICT
PHILADELPHIA, DISTRICT

SOURCE:
U.S.G.S., 1970; COE, 1985; BCM, 1984
USFWS, 1981; NJDEP, 1972.

Ferren (1982) identified critical tidal wetlands of New Jersey river systems that drain the Outer Coastal Plain. Criteria used to establish critical wetland areas included floristic uniqueness and vulnerability to pressures of land use and resource development. Ferren identified as a critical wetland a 0.5 km2 segment at the intersection of Raritan-Suburn Road and Mannington Creek, upstream from Salem. The entire Mannington meadow is characterized as an important brackish wetland. Two narrowly restricted species of special concern, <u>Sagittaria calycina</u> and <u>Scirpus cylindricus</u>, are found in this wetland. Mannington Meadow is a tidal wetland found just upstream of the Salem River navigation project.

The Salem River and adjoining wetlands provide valuable habitat for thousands of migratory waterfowl annually. The river is censused each year in early January to monitor populations. The 1985 aerial census, from Fort Elfsborg Road Canal, disclosed 8,255 Canada geese, 600 black duck, 400 mallard, 100 American widgeon, 100 scaup, 500 bufflehead and 50 tundra swan (U.S. Fish and Wildlife Service, 1985).

Supawna Meadows National Wildlife Refuge provides excellent interspersion of aquatic and wetland habitat north of Sinnicksons Landing. This refuge is particularly valuable as a stopover location during waterfowl migration for resting and feeding when specific occurrence and population are at optimum levels.

The wetlands on the oxbow island, adjacent to the "new cut" as well as the tidal tributaries which flow through the island, provide feeding and resting habitat for various waterfowl and waterbirds. Waterfowl and waterbirds, however, do not nest in wetlands bordering the "new cut". The wetland banks are also being utilized as dens by muskrats. McCauley (1987) reports that the oxbow island yielded 600-700 muskrats for 2 part-time trappers during the trapping season between November 15 to March 15. McCauley also believes the island can sustain a 1,000 - 1,200 yearly harvest of this species.

3. <u>Endangered and Threatened Species</u>

The New Jersey DEP and the Delaware DNREC were contacted to determine the existence of threatened and endangered species within the study areas. The NJDEP Division of Fish, Game and Wildlife, Endangered and Non game Species Project's (1980) publication entitled "Endangered and Threatened Species of New Jersey" was consulted to make this determination. The project area is in the breeding range of the Short Billed Marsh Wren (state threatened); in the unconfirmed wintering range of the Cooper's hawk (state endangered); in the range of traditional nesting sites for Henslow's Sparrow (state threatened); may be partially within the breeding ranges of the Savannah and Grasshopper Sparrows (state threatened); may be partially within the range of the Eastern Tiger Salamander (state threatened); and is within the range of the Bog Turtle (state endangered).

Short billed Marsh wrens occupy the drier portions of brackish marshes and wet inland meadows with grasses and sedges. Henslow's sparrows occupy dry grassy fields with small bushes or damp brush marsh edges with sedges. Cooper's hawks require woodland edges or open woodlands and build nests 20 to 60 feet from the ground. Savannah sparrows require extensive short grass fields or dry short grass salt marsh. Grasshopper sparrows require grassy farm fields. Eastern tiger salamanders inhabit temporary ponds in early sucession, surrounded by oak woodlands. Bog turtles inhabit bogs, swamps, and meadows with clear slow moving streams and muddy bottoms.

Consultation with the U.S. Fish and Wildlife Service indicates that except for occasional transient species (bald eagle, peregrine falcon), no Federally listed or proposed threatened or endangered species are known to occur within the project area. The project area is within the historic range of the federally-designated endangered bald eagle and peregrine falcon. The only confirmed pair of nesting bald eagles in New Jersey is in Cumberland County. Nesting activity has also been observed in Mannington Meadows and in Alloways Creek (Clark, 1987). Although these nesting attempts have not been successful they provide evidence to the excellent habitat for the eagle that the area provides. Additionally, a pair of eagles overwintered during 1986 to 1987 in Mannington Meadows (Clark, 1987).

Peregrine falcons nest on the Delaware Memorial Bridge. Reynolds (1987) reports nesting activity on this bridge during the 1984-1987 period, but nesting success is unknown. Clark also reported 9 successful nests in 1987 on Artificial Island for the State threatened osprey.

4. Land Use and Terrestrial Habitat

Alternative dredged material disposal sites in the Salem River study area were identified in four municipalities: the City of Salem and the Township(s) of Elsinboro, Pennsville and Mannington. These sites are identified on Figure 2. Referenced sites in this section correspond to the second site number in Figure 2 (eg. site 5 in this section is site 25-5 on Figure 2).

Site 5 and the majority of Site 4 are located in the City of Salem. Site 5 is zoned for general manufacturing (M-2) in the northern half and light manufacturing (M-1) along the southern portion of the site (City of Salem, 1976). A major segment of Site 5 is located on the former municipal landfill. This landfill is no longer in operation. Wetlands surround the site and encroach on the northeast site boundary. The main portion of Site 4, which lies in Salem, is zoned for light industry. This upland site was formed by fill material from a 1927 dredging of the Salem River navigation channel and is presently woodland (Heite and Heite, 1985).

A portion of Site 4 and all of Sites 1, 2, and 9 through 14 lie in the township of Elsinboro. Sites 1, 11, and 12 are zoned entirely Rural Residential Agricultural (RR-A). Portions of all other Elsinboro sites are also zoned as RR-A. Portions of Sites 9, 10, 13, and possibly Site 14 are zoned Conservation (CONS) district. Portions of Sites 2, 4 and 9 are zoned for Medium Density Residential (MR). A portion of Site 14 may be mapped as Low Density Residential (LR). Land use at Sites 1, 10, 11, and 12 consist of one or two large contiguous fields. Site 14 consists of a few medium size fields. Sites 2, 9 and 13 consist of scattered small fields and forests. Residential housing not related to agriculture may be found along road frontage of fields along sites 1, 2, 9 and 13.

Sites 7 and 15 lie in Mannington Township. Site 7 is zoned High Density Residential (HR), with possibly some overlap of the surrounding Conservation (CONS) district. The new area, site 15, is zoned as Conservation district. The majority of site 7 is cultivated at present. Wetlands encroach on the site boundary, especially to the southeast. Remains of a former Heinz canning sewage treatment plant can be found to the west. Site 15 is a previously used, diked disposal site, which is partially filled and partially underwater.

Sites 3 and 8 are located in Pennsville. Site 3 is zoned for Development (D) with possibly some portions in the Heavy Industrial (HI) district. Site 8 is zoned for low density Residential (R3), with possibly some portions in the Development of Heavy Industrial districts. Site 3 is comprised mostly of fields with trees towards the Salem River to the east and wetlands on the eastern portion of the site and a farmhouse on Freas Road.

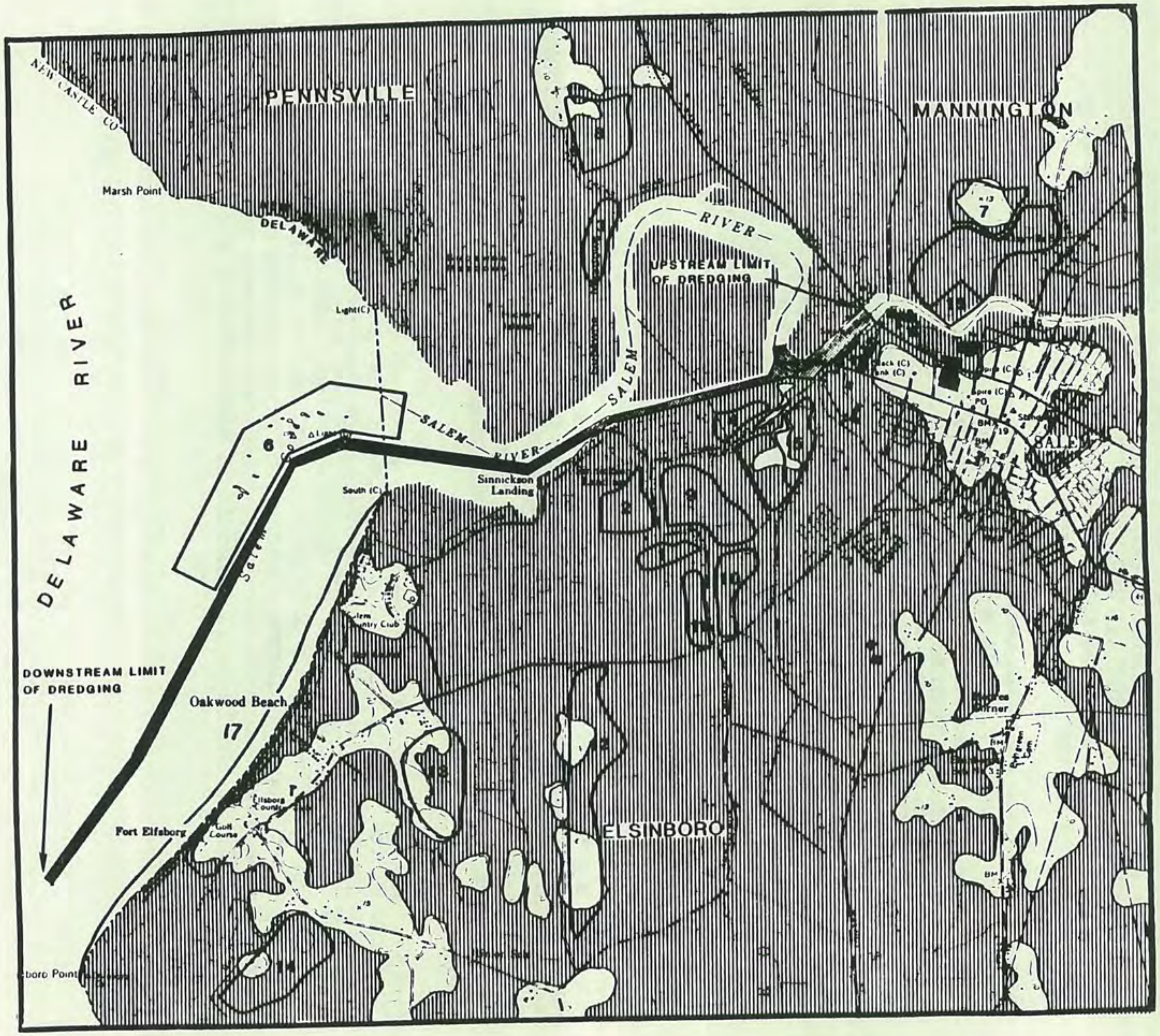
Sites 12, 10, and 3 contain nearly exclusively soils characteristic of Prime Farmlands. Sites 1, 7, 8, 11 and 14 contain soil where the majority are characteristic of Prime Farmlands. Sites 8 and 13 contain mostly Soils of Statewide Importance, with minor amounts or no Prime Farmland soils. Sites 4 and 5 contain minor amounts of Soils of Statewide Importance. Site 15 contains no Prime Farmland or Statewide Important soils (U.S.D.A., SCS, May 1974, September 11, 1978).

Sites within the 100 year floodplain are shown in Figure 8. Sites 5, 7, 8, 12, 13, and 14 are only partially located in the floodplains; all other sites are totally located in the 100-year floodplain. Sites 7, 12, and 13 have significant areas outside the floodplain. Sites 8 and 14 are almost entirely located in the floodplain. Areas of site 5 located above the floodplain contour are a part of the municipal landfill.

5. Cultural Resources

In 1985, a preliminary cultural resources documentary search and field investigation was undertaken for Philadelphia District (Heite and Heite 1985) to identify prehistoric and historic resources at the proposed dredged material upland disposal sites. The project area is one of the first European settlements in the state, and is characterized as being rich in prehistoric resources.

Figure 9 presents sites in the study areas listed on the National Register of Historic Places, in the files of the offices of the New Jersey state Historic Preservation Officer and the State Archaeologist, and/or historical sites (near proposed disposal areas) listed in the Salem county Planning Board Cultural Resource Survey (1984). This information, supplemented by field investigation, indicates that candidate disposal areas 4, 5, 8, and 11 have at best only a low potential for intact cultural resources. Candidate disposal areas 1, 2, 3, 7, 9, 10, 12, 13, 14, and 15 have a moderate to high potential for intact cultural resources.



LEGEND

100 YEAR FLOODPLAIN

N

0 FEET 5000

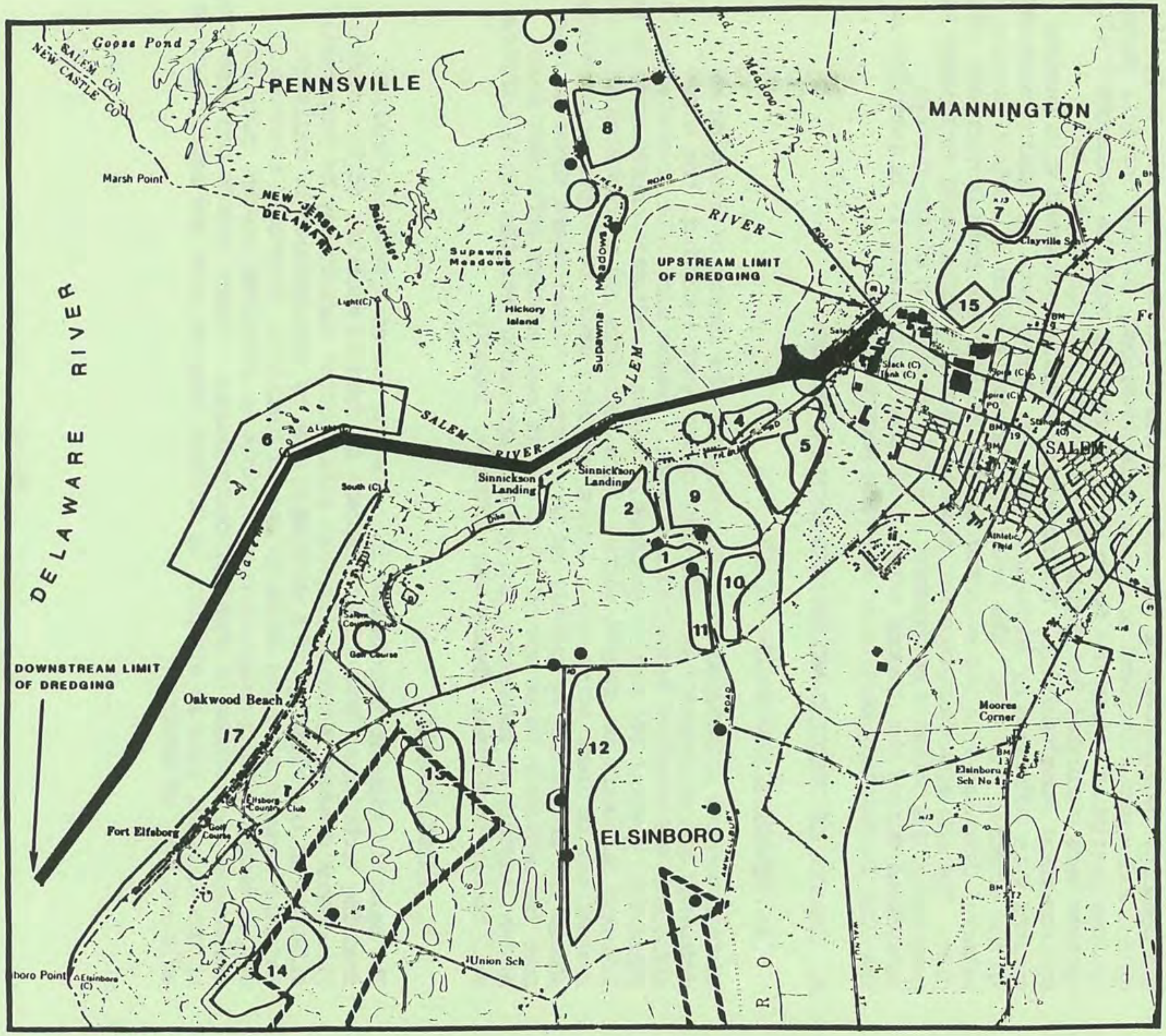
FIGURE 8
SALEM RIVER STUDY AREA
100 YEAR FLOODPLAIN

SALEM RIVER FEDERAL NAVIGATION CHANNEL

COMPREHENSIVE NAVIGATION STUDY
ENVIRONMENTAL ASSESSMENT
STUDY AREA

U.S. ARMY CORPS OF ENGINEERS DISTRICT
PHILADELPHIA, DISTRICT

SOURCE
U.S.G.S., 1970; COE, 1985; BCM, 1984
USGS, 1973



LEGEND

NATIONAL REGISTER BOUNDARIES

1984 COUNTY INVENTORY

SITES IN THE STATE INVENTORY

N

0 FEET 5000

FIGURE 9

SALEM RIVER STUDY AREA

CULTURAL RESOURCES

SALEM RIVER FEDERAL NAVIGATION CHANNEL

COMPREHENSIVE NAVIGATION STUDY
ENVIRONMENTAL ASSESSMENT
STUDY AREA

U.S. ARMY CORPS OF ENGINEERS DISTRICT
PHILADELPHIA, DISTRICT

SOURCE:
U.S.G.S., 1970; COE, 1985; BCM, 1984
HEITE AND HEITE, 1986.

V. ENVIRONMENTAL IMPACTS

Project formulation and alternative screening, discussed in the Plan Formulation section of the Main Report, resulted in the selection of a plan that approached both economic and navigational feasibility. The selected plan requires dredging of the existing project to provide a channel that is 180 feet wide and 18 feet deep at mean low water. The plan also provides a turning basin 495 feet wide.

A number of candidate dredged material disposal sites were evaluated to meet the capacity requirements of the selected channel alternative. An array of upland and aquatic disposal scenarios were developed, so that the full range of options available within the Salem River study area could be evaluated. All options were evaluated for engineering, economic, institutional and environmental acceptability. Environmental impacts associated with various options were addressed by including costs for appropriate mitigation measures in the economic analyses. The existing, Federally owned Killcohook dredged material disposal site was selected as the National Economic Development (NED) plan. The NED plan maximizes net economic benefits while being consistent with protecting the Nation's environment. A full discussion of the factors considered during the dredged material disposal site analysis is provided in the Plan Formulation section of the Main Report.

A. IMPACTS OF DREDGING AND DREDGED MATERIAL DISPOSAL

1. Hydrology and Sedimentation

Certain general principles apply to analyzing the impact of dredging on hydrology and sedimentation. The more constricted a channel, the more efficient the scour of deposited sediments. Deeper and wider channels tend to accumulate greater volumes of sediment. However, sediment accumulation is not linearly dependent on channel width. More sediments may be captured in a wider channel due to lower scour and a larger settling area, but depth of sediments should not accumulate as rapidly as in a narrow channel where there is less area for sediments to be spread over. It is assumed that efficient scour, minimal capture of sediments, and maximum spreading over the channel bottom will result in minimal adverse environmental impacts.

2. Water Quality

The selected plan of improvement includes the use of hydraulic pipeline dredging techniques, and upland disposal of dredged material at the existing Killcohook dredged material disposal site. Water quality may be temporarily affected in the vicinity of a working dredge by resuspension of sediment. Sediment resuspension can cause increased turbidity, increased biochemical oxygen demand with corresponding reductions in dissolved oxygen, nutrient enrichment and release of chemical contaminants. These impacts can also occur at the disposal site as effluent is drained from the site and returned to an adjacent body of water.

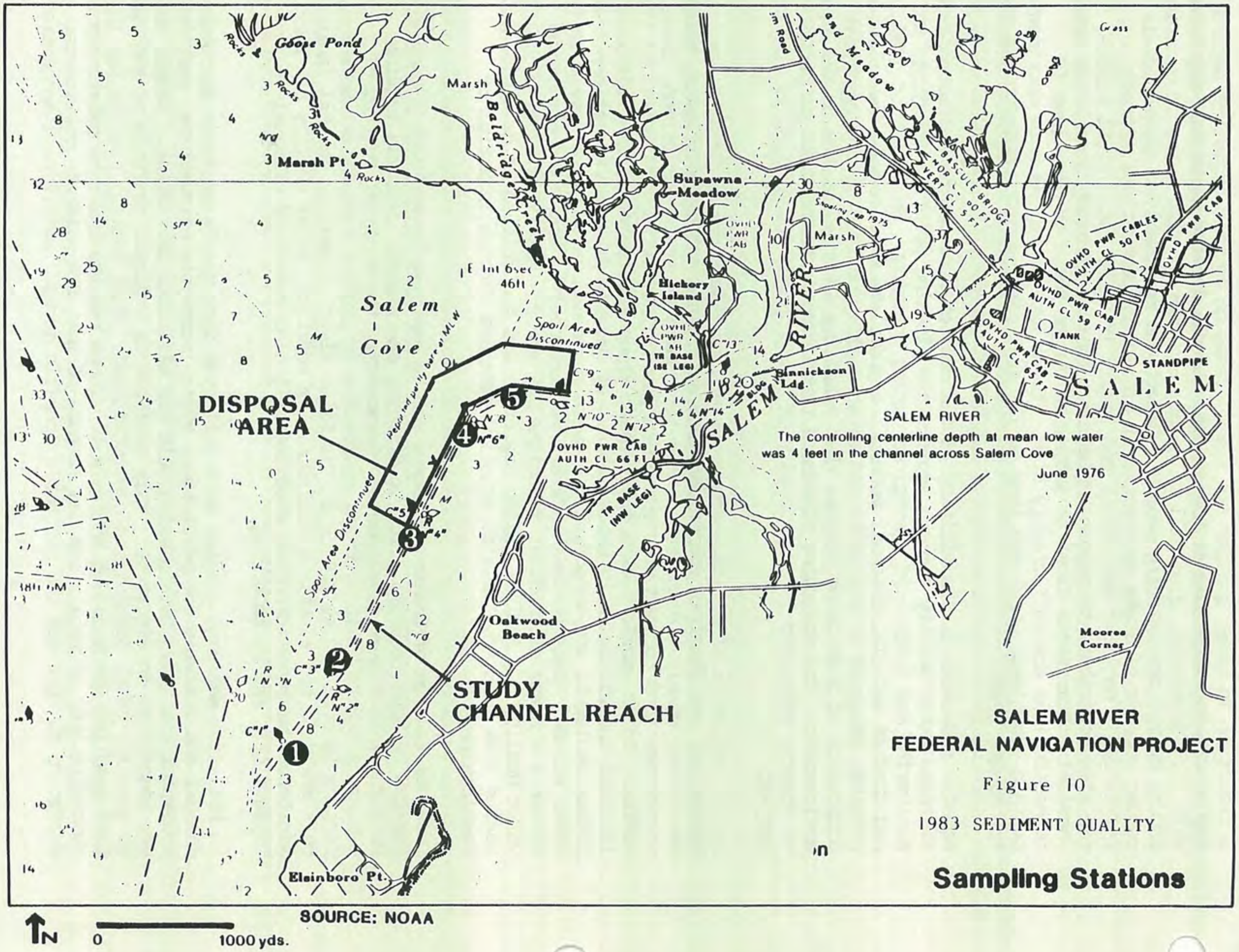
A reduction in water quality can place stress on aquatic organisms depending on the nature and magnitude of the impact. Dredge induced turbidity may interfere with fish movements, clog gill filaments and smother fish eggs, if dredging occurs during the spawning season. Reductions in dissolved oxygen levels can render aquatic habitats unsuitable if minimum concentrations are not maintained. Nutrient enrichment can result in undesirable algal blooms, which can also contribute to oxygen depletion. Release of heavy metals and organic chemical contaminants from the sediments can be toxic to organisms if concentrations are sufficiently high. These impacts may be more detrimental to benthic organisms, which are less mobile than fish, and can not readily escape the impact area.

Aquatic resources in the vicinity of the project area can be protected from degraded water quality through appropriate planning prior to dredging, and monitoring and control of operations during dredging. Selection of dredging and dredged material disposal methods, appropriate time-of-year restrictions, chemical analysis of sediments and water quality monitoring are important components of a dredging program that minimizes adverse impacts to the aquatic environment. The following discusses these components relative to protection of aquatic resources in the vicinity of the proposed Salem River navigation project.

Bottom sediments of aquatic ecosystems are considered to be "sinks" for biological and chemical substances such as organic matter, nutrients, heavy metals and chemical compounds. When introduced to the water column, these substances tend to bind with suspended particulate matter and settle to the bottom. In an anoxic bottom environment these substances remain relatively immobile and biologically unavailable. By nature, dredging operations disturb bottom sediments and temporarily elevate suspended particulate levels in the water column. Once contaminants are reintroduced to the oxygenated water column a variety of chemical reactions may occur. Resulting adverse impacts to water quality may include oxygen depletion and the release of contaminants, making them more available to aquatic organisms through ingestion or respiration.

Chemical testing of bottom sediments can be employed to evaluate potential impacts to aquatic biota prior to dredging operations. Various testing procedures have been developed to characterize the chemical content of sediments and to mimic dredging operations to predict contaminant movement. Testing to evaluate sediments in the Salem River navigation channel include bulk analysis and elutriate analysis. In addition, water quality has been monitored during maintenance dredging utilizing overboard disposal to identify impacts that may be occurring.

In 1983 five sediment samples were collected from the Salem River approach channel and analyzed for pesticides, PCB's, purgeable halocarbons, purgeable aromatics and heavy metals using bulk and elutriate procedures. Sample sites are identified on Figure 10. Bulk analysis is a direct analysis of sediments to quantify total contaminant concentrations. Bulk testing results for the 1983 sampling are provided in Table 1. These results indicate relatively low concentrations of metals and the absence of most EPA priority pollutants. One exception to this was the purgeable aromatic group. Significant concentrations



SALEM RIVER
FEDERAL NAVIGATION PROJECT

Figure 10

1983 SEDIMENT QUALITY

Sampling Stations

TABLE 1

SALEM COVE CHANNEL WATER AND SEDIMENT TESTING RESULTS
TOTAL CHEMISTRY (DRY)
JULY 26, 1983

Parameters and Units	Sampling Stations				
	1	2	3	4	5
PESTICIDES AND PCB (mg/kg)					
PCB A-1016	<60	<60	<60	<60	<60
PCB A-1221	<520	<520	<520	<520	<520
PCB A-1232	<110	<110	<110	<110	<110
PCB A-1242	<62	<62	<62	<62	<62
PCB A-1248	<45	<45	<45	<45	<45
PCB A-1254	<240	<240	<240	<240	<240
PCB A-1260	<31	<31	<31	<31	<31
Aldrin	<4	<4	<4	<4	<4
a-BHC	<4	<4	<4	<4	<4
b-BHC	<11	<11	<11	<11	<11
d-BHC	<5	<5	<5	<5	<5
g-BHC	<4	<4	<4	<4	<4
Chlordane	<8	<8	<8	<8	<8
4,4'-DDD	<4	<4	<4	<4	<4
4,4'-DDE	<4	<4	<4	<4	<4
4,4'-DDT	<5	<5	<5	<5	<5
Dieldrin	<4	<4	<4	<4	<4
Endosulfan I	<13	<13	<13	<13	<13
Endosulfan II	<13	<13	<13	<13	<13
Endosulfan sulfate	<14	<14	<14	<14	<14
Endrin	<5	<5	<5	<5	<5
Endrin aldehyde	<5	<5	<5	<5	<5
Heptachlor	<4	<4	<4	<4	<4
Heptachlor epoxide	<4	<4	<4	<4	<4
Toxaphene	<10	<10	<10	<10	<10

TABLE 1 (Continued)

Parameters and Units	Sampling Stations 1	2	3	4	5
PURGEABLE HALOCARBONS (mg/kg)					
Chloromethane	<0.1	<0.1	<0.1	<0.1	<0.1
Bromomethane	<0.1	<0.1	<0.1	<0.1	<0.1
Vinyl chloride	<0.1	<0.1	<0.1	<0.1	<0.1
Chloroethane	<0.1	<0.1	<0.1	<0.1	<0.1
Methylene chloride	<0.1	<0.1	<0.1	<0.1	<0.1
Trichlorofluoromethane	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-Dichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-Dichloroethane	<0.1	<0.1	<0.1	<0.1	<0.1
Trans-1,2-Dichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1
Chloroform	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloroethane	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,1-Trichloroethane	<0.1	<0.1	<0.1	<0.1	<0.1
Carbon tetrachloride	<0.1	<0.1	<0.1	<0.1	<0.1
Bromodichloromethane	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloropropane	<0.1	<0.1	<0.1	<0.1	<0.1
Trans-1,3-Dichloropropene	<0.1	<0.1	<0.1	<0.1	<0.1
Trichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1
Dibromochloromethane and/or 1,1,2-Trichloroethane and/or cis-1,3-Dichloropropene	<0.1	<0.1	<0.1	<0.1	<0.1
Bromoform	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane and/or Tetrachloroethene	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0
PURGEABLE AROMATICS (mg/kg)					
Benzene	<10	22	<10	<10	<10
Toluene	<10	304	<10	29	13
Chlorobenzene	<10	747	<10	204	75
Ethyl benzene	<10	716	<10	167	115
1,3-Dichlorobenzene	<10	3,780	10	1,320	507
1,4-Dichlorobenzene	<10	3,990	<10	1,410	616
1,2-Dichlorobenzene	<10	2,560	<10	833	434

TABLE I (Continued)

Parameters and Units	Sampling Stations 1	2	3	4	5
METALS AND MISCELLANEOUS (mg/kg)					
Di-2-Ethy-hexylphthalate	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic (GF)	6.5	6.5	2.9	0.71	1.7
Barium	<10	<10	<10	<10	20
Cadmium	<0.30	<0.30	<0.30	<0.30	<0.30
Cyanide	<0.121	<0.121	<0.121	<0.121	<0.121
Chromium as Cr	38	19	12	2.4	<1.2
Copper	43	24	14	5.7	3.4
Mercury	0.034	0.019	<0.010	<0.010	<0.010
Nickel	12	7.3	8.0	<9.5	16.6
Oil & grease (Sox) %	0.092	<0.089	0.064	0.035	0.030
Lead	56	34	16	<6.0	<6.0
Phenols, as Phenol	0.26	7.01	1.43	0.90	8.60
Selenium (GF)	0.27	0.17	0.13	0.055	0.026
Zinc	277	210	82	77	75

Source: BCM Eastern, Inc.

of these contaminants, particularly dichlorobenzenes, were found at three of the five sample sites. Concentrations of dichlorobenzenes in these samples ranged between 400 and 4,000 mg/kg.

While bulk testing quantifies the magnitude of contaminants in sediments, it does not provide information about the movement of contaminants as a result of sediment disturbance. For this purpose, sediments are analyzed via the elutriate test, which was developed by the Corps and the U.S. Environmental Protection Agency to predict the soluble release of contaminants from bottom sediments during the dredging process. The movement of sediments from an anoxic environment on the bottom to an oxygenated environment in the water column may result in the release of chemical contaminants previously bound to sediment particles. The elutriate test mimics the dredging process by oxygenating sediments through agitation, to promote release of contaminants from sediment particles. The liquid fraction of the sample is then analyzed to determine contaminant concentrations. As such, this analysis predicts short-term increases of contaminants in the water column during dredging. The validity of the elutriate test as a predictor of dissolved contaminant release from sediment particles has been demonstrated through extensive laboratory and field studies conducted by the U.S. Army Engineer Waterways Experiment Station.

Elutriate testing results for the five sediment samples collected in 1983 are provided in Table 2. As with bulk testing, these results show an absence of EPA priority pollutants. This is also true for the purgeable aromatics, which were detected in sediments with bulk testing. Concentrations of heavy metals were significantly lower than the bulk testing results. Metals from the sediment elutriates were either not detected, or present at concentrations below the U.S. Environmental Protection Agency's marine acute and chronic criteria. Exceptions to this were lead and zinc, which met the marine acute criteria, but violated chronic criteria. The USEPA marine chronic criterion for lead is 0.0056 mg/l. Lead concentrations in sediment elutriates ranged between 0.012 and 0.018 mg/l. The USEPA marine chronic criterion for zinc is 0.058 mg/l. Zinc concentrations in sediment elutriates ranged between not detected and 0.13 mg/l.

In 1988, water quality monitoring was conducted in association with maintenance dredging of the existing Salem River navigation channel. A variety of parameters were tested before, during and after dredging to characterize the impact of dredging on water quality. Dredged material disposal for this maintenance cycle was at an open water site located in Salem Cove. Seven sample sites were selected in the vicinity of the disposal area for the sample period that occurred during dredging, because this was viewed as the area of greatest impact (Figure 11). Open water disposal places all of the dredged material in the water column, and provides the maximum opportunity for increased contaminant concentrations in the water column. Upland disposal of dredged material via hydraulic dredging techniques removes the majority of bottom sediments from the aquatic environment without exposing them to the water column.

TABLE 2

SALEM COVE CHANNEL WATER AND SEDIMENT TESTING RESULTS
EPA ELUTRIATE
JULY 26, 1983

Parameters and Units	Water Column Composite	Sampling Stations 1	2	3	4	5
PESTICIDES & PCB (mg/l)						
PCB A-1016	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PCB A-1221	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
PCB A-1232	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
PCB A-1242	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PCB A-1248	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB A-1254	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
PCB A-1260	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
a-BHC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
b-BHC	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
d-BHC	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
g-BHC	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chlordane	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
4,4'-DDD	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4,4'-DDE	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4,4'-DDT	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Endosulfan II	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Endosulfan sulfate	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Endrin	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Endrin aldehyde	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heptachlor epoxide	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Toxaphene	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003

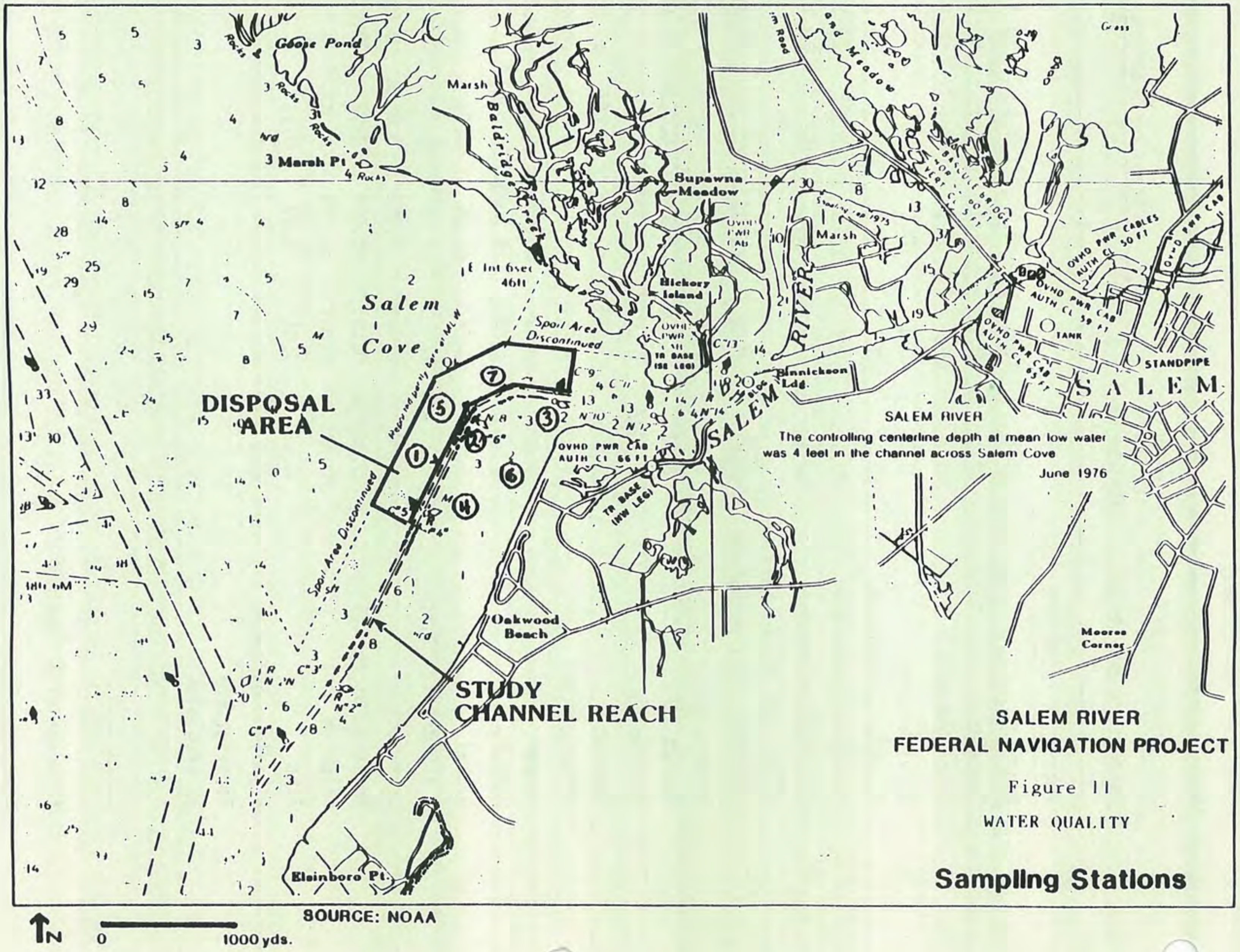
TABLE 2 (Continued)

Parameters and Units	Water Column Composite	Sampling Stations				
		1	2	3	4	5
PURGEABLE HALOCARBONS (mg/l)						
Chloromethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bromomethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Vinyl chloride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloroethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methylene chloride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichlorofluoromethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-Dichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1-Dichloroethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-1,2-Dichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloroform	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloroethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,1,1-Trichloroethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carbon tetrachloride	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bromodichloromethane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloropropane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trans-1,3-Dichloropropene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Trichloroethene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibromochloromethane and/or 1,1,2-Trichloroethane and/or cis-1,3-Dichloropropene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bromoform	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
1,1,2,2-Tetrachloroethane and/or Tetrachloroethene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorobenzene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

TABLE 2 (Continued)

Parameters and Units	Water Column Composite	Sampling Stations 1	2	3	4	5
PURGEABLE AROMATICS (mg/l)						
Benzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethyl benzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,3-Dichlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,4-Dichlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichlorobenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
METALS AND MISCELLANEOUS (mg/l)						
Di-2-Ethy-hexylphthalate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic (GF)	0.006	0.008	0.011	0.006	0.004	0.005
Barium (GF)	0.013	0.202	0.188	0.318	0.176	0.150
Cadmium (GF)	<0.0005	0.0009	0.0005	0.0005	0.0007	0.0008
Cyanide	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (GF)	0.005	<0.002	<0.002	<0.002	<0.002	<0.002
Copper	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Mercury	0.0007	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Oil & grease (Sox)	2	2	<1	<1	<1	2
Lead (GF)	<0.002	0.014	0.012	0.013	0.015	0.018
Phenols, as Phenol	0.062	0.183	<0.002	0.02	0.032	0.032
Selenium (GF)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	0.05	<0.01	0.03	0.13	0.10	0.09
Dissolved oxygen*	6.6	--	--	--	--	
Temperature*	27.0	--	--	--	--	
pH (field)*	7.4	--	--	--	--	

*Average of 5 readings



SALEM RIVER
FEDERAL NAVIGATION PROJECT

Figure 11

WATER QUALITY

Sampling Stations

Water quality monitoring results from the 1988 maintenance dredging are provided in Table 3. Concentrations of organic nutrients appear to have increased slightly during dredging, but dropped subsequent to completion of operations. The Delaware River Basin Commission monitors set stations in the Delaware River on a regular basis for a variety of parameters, including ammonia, nitrate and phosphorus. Stations are located immediately above and below the confluence with the Salem River. For the years 1988 and 1989 the average concentrations of ammonia, nitrate and total phosphorus in the Delaware River above the Salem River were 0.37, 1.85 and 0.15 mg/l, respectively. Concentrations of ammonia, nitrate and phosphorus in the Delaware River below the Salem River were 0.28, 1.81 and 0.18 mg/l, respectively. Comparing these values to those obtained during the dredging period suggests that ammonia and nitrate concentrations were not significantly elevated above the average concentrations observed in this part of the Delaware River. Concentrations of total phosphorus did increase above the average concentrations observed by the Delaware River Basin Commission, however, values fell back into the average range subsequent to dredging.

Concentrations of heavy metals were low, and with the exception of zinc, were below USEPA marine acute and chronic criteria. Concentrations of zinc were below the marine acute criterion, but slightly above the chronic criterion of 0.058 mg/l. Concentrations of zinc observed during dredging were 0.06 and 0.09 mg/l.

The Delaware River Basin Commission and the New Jersey Department of Environmental Protection have the same surface water quality standards for pH and dissolved oxygen for the Delaware River in the vicinity of the Salem River. The 24-hour average concentration of dissolved oxygen shall not be less than 6.0 mg/l. pH values shall remain between 6.5 and 8.5. Dissolved oxygen concentrations did appear to drop slightly in the disposal area during dredging, but were comfortably above the 6.0 mg/l minimum. Dissolved oxygen concentrations were higher during the post-dredge sampling, which suggests that the impact was short-term. pH values remained in the vicinity of neutral for all three sampling periods.

The use of hydraulic pipeline dredging techniques and upland disposal of dredged material for the proposed deepening project will minimize water quality impacts during dredging operations. Hydraulic pipeline dredging has been demonstrated to induce the lowest near- and far-field suspended material concentrations of the conventional dredging techniques. Background suspended sediment concentrations are usually obtained within 500 to 1,000m downstream from the source and 20 to 40m perpendicular to the axis of the plane. Additionally, studies indicate that optimum productivity of the hydraulic dredge also corresponds to minimum resuspension of bottom sediments. Correctly designed and conducted hydraulic dredging operations generally result in only temporary, localized impacts due to increased turbidity, and do not pose a significant long-term threat to the integrity of the aquatic environment.

Upland disposal of dredged material minimizes impacts to the aquatic environment by permanently removing sediments from the aquatic system. During disposal operations, effluent flowing through the discharge weir can increase suspended sediment loads within the receiving body of water. The concentration

Table 3. Water Quality Monitoring Associated with 1988 Maintenance Dredging of the Existing Salem River Navigation Channel.

Parameter[a]	5-26-88 Pre-dredge Background	6-13-88 During-dredge									7-6-88 Post-dredge	
		Background	Site 1	Site 2	Site 2 Dup	Site 3	Site 4	Site 5	Site 6	Site 7	Upcurrent	Downcurrent
TKN	0.62	1.2	2.4	1.2	1.2	1.2	ND	ND	ND	ND	0.62	1.2
Ammonia as N	0.15	<0.1	0.21	0.24	0.16	<0.1	ND	ND	ND	ND	<0.2	<0.2
Nitrate as N	1.9	1.9	2.2	2	2	1.9	ND	ND	ND	ND	1.6	1.5
Total P	<0.4	0.2	0.61	0.34	0.38	0.36	ND	ND	ND	ND	0.2	0.15
TOC	6.5	6.7	7.9	7.8	6.8	6	ND	ND	ND	ND	5.27	4.76
Zinc	0.02	0.03	0.09	0.06	0.06	0.06	ND	ND	ND	ND	0.03	0.03
Lead	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	ND	ND	ND	ND	<0.05	<0.05
Cadmium	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	ND	ND	ND	ND	0.01	0.01
Chromium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	ND	ND	ND	ND	<0.05	<0.05
Copper	<0.05	<0.02	0.02	<0.02	<0.02	<0.02	ND	ND	ND	ND	ND	ND
Nickel	<0.02	0.03	0.03	0.04	0.04	0.02	ND	ND	ND	ND	0.04	0.04
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	ND	ND	ND	ND	<0.001	<0.001
Arsenic	<0.004	<0.04	<0.04	<0.04	<0.04	<0.04	ND	ND	ND	ND	ND	ND
Total Susp Solids	67	73	400	170	160	160	71	150	64	66	63	28
Turbidity (NTU)	24	29	125	73	71	64	32	65	31	29	22	12
Temperature (C)	19.1	22.2	21.8	22.2	ND	22.4	23.1	22.1	22.3	22.6	25.6	25.7
pH (S.U.)	6.94	7.14	7.22	7.14	ND	7.12	7.22	7.31	7.25	7.31	7.34	7.32
Chloride	110	1340	1260	1270	1290	1120	1060	1380	1110	1270	2250	2280
Dissolved Oxygen	8.8	7.4	7.1	7.2	ND	7	7.2	7.1	6.95	7.3	7.65	7.9

[a] All parameters expressed as mg/l unless noted.
ND - No data collected.

of this suspended sediment is controlled through proper operation of the weir structure. The elevation of the weir can be raised to increase the time water remains in the site before being discharged. As water remains in the site suspended sediments settle out of the water column. Through monitoring of the effluent leaving the site, the weir can be appropriately adjusted to achieve the desired degree of settling. The effluent discharged from existing dredged material disposal sites along the Delaware River is currently monitored and controlled to insure that it contains no more than eight grams per liter of suspended sediment above the background level of the receiving water. While this is the current standard, it is possible to achieve much lower concentrations. The observed range of suspended sediment concentrations in effluent draining from Cohansey River, New Jersey, dredged material disposal sites during 1990 maintenance dredging was 0.7 to 2.6 grams per liter. The Cohansey River is a tributary to the Delaware River located approximately 20 miles downstream of the Salem River.

Another consideration in developing an environmentally responsible dredging program is appropriate seasonal restrictions on dredging to protect fishery resources. Excessive turbidity and low dissolved oxygen levels can adversely affect critical fishery activities such as anadromous fish runs in the spring and fall, and spawning. The Delaware Basin Fish and Wildlife Management Cooperative is in the process of revising seasonal restrictions for the Delaware River Basin. The Cooperative has divided the Basin into six areas, and has developed, seasonal restrictions for each. The first area, mouth of bay to Delaware Memorial Bridge, includes the Salem River project area. For this reach the cooperative suggests a restriction on bucket dredging, overboard disposal and blasting from March 1 through June 30. No restrictions are placed on the remainder of the year, and no restrictions are placed on hydraulic dredging and upland disposal. Based on the Cooperative's recommendations and the selected method of dredging and disposal, no time-of-year restrictions are proposed for the Salem River project.

Based on the above information, it has been demonstrated that appropriate planning and precautions have and will be taken to insure that deepening of the Salem River navigation channel would not result in unacceptable water quality degradation. Hydraulic dredging techniques and upland disposal of dredged material are considered to be the least disruptive to water quality, of the conventional dredging methods. These methods are not seasonably restricted within the Salem River project area. Sediment testing and water quality monitoring conducted in association with maintenance of the existing Salem River project throughout the life of the proposed project to insure that problems do not arise. Proper monitoring and control of effluent discharged from the dredged material disposal site will minimize suspended sediment loads to the Delaware River as a result of disposal operations. The Philadelphia District has had good results with controlling effluent at similar projects. Through careful management of dredging and disposal operations, and monitoring of critical water quality parameters, a dredging cycle can be completed with minimal impact to water quality. The operation can be temporarily shut down if impacts are identified, to allow time for conditions to improve. Tidal action, wind and freshwater inflow are considered adequate to provide sufficient mixing, dispersal and dilution to abate problems in a relatively short period of time. As such, it has been determined that aquatic resources in the vicinity of the Salem River project area would be protected with implementation of the proposed plan of improvement.

3. Aquifer Protection

There are two aquifers of concern within the Salem River project area. The first is the Raritan Magothy aquifer, which has been designated a sole source aquifer for southern New Jersey. The second is the Wenonah and Mount Laurel aquifer, which is not of regional importance, but is utilized within Salem County. The following assesses potential impacts to these aquifers as a result of implementing the proposed plan of improvement.

The Salem River portion of the project area lies within the outcrop area for the Wenonah and Mount Laurel aquifer. Within this outcrop some recharge naturally occurs, as well as discharge to local streams draining the area. Because the Wenonah and Mount Laurel aquifer outcrops within the Salem River, the existing navigation channel is incised into the aquifer. This may increase the potential for aquifer discharge to the Salem River, which would lower aquifer storage, or the potential for surface water intrusion to the aquifer during periods of drought or heavy pumping of water from the aquifer. Because of the location of the Salem River within the Delaware River estuary, the lower portion of the Salem River is brackish. Aquifer recharge from this portion of the river could result in saltwater intrusion to the aquifer.

Within the Wenonah and Mount Laurel aquifer outcrop area some surface water recharge to the aquifer occurs naturally. The amount of recharge can be increased through overpumping of large municipal or industrial wells. These large wells can create cones of depression, which can promote aquifer recharge from a surface water source, provided the source is located close enough to the area of impact. The location of large municipal and industrial wells, and high municipal water demands created by increased urbanization are considered the primary causes of above normal aquifer recharge from a surface water source. Individual residential wells do not pose this problem because they do not pump sufficient quantities of water to create a cone of depression. The majority of wells tapping the Wenonah and Mount Laurel aquifer are located northwest of the project area in the Townships of Mannington, Alloway and Pilesgrove. These wells are too far from the project area to influence aquifer recharge.

The proposed deepening of the Salem River channel may have a minimal impact on the aquifer. Deepening the channel would remove localized Holecene alluvial deposits. Where present these deposits consist of silt and clay, and offer varied aquifer protection against saltwater intrusion. Because the existing channel currently lies within the Wenonah and Mount Laurel aquifer, deepening the channel would increase the surface area of the aquifer directly in contact with Salem River water. This increased exposure is considered relatively small in comparison to the area of the entire outcrop.

The Magothy Raritan Formation has been designated a sole source aquifer for southern New Jersey. This aquifer contributes significantly to potable water supplies. Because of its importance, saltwater intrusion is also a concern with respect to the Magothy Raritan aquifer. Within the Salem River project area, the Magothy Raritan aquifer is overlain by the Merchantville Formation, the Woodbury Clay, the Marshalltown Formation and the Wenonah and Mount Laurel Formation. The Woodbury Clay and the underlying Merchantville Formation serve as the confining layer for the Magothy Raritan Formation. Drillers commonly report the Woodbury Clay in Salem County as a black, blue or olive-gray clay and occasionally indicate the presence of coarse-grained sand, yellow pebbles, mica and hard dark clay or hardpan. The presence of this aquiclude between the Wenonah and Mount Laurel aquifer and the Raritan Magothy aquifer is sufficient to prevent exchange of water between the aquifers.

Impacts to groundwater quality can also result from the disposal of dredged material in confined upland disposal sites. Brackish water or contaminants can leach into the underlying aquifer and degrade water quality. This is more of a concern in new disposal sites as the placement of fine grained dredged material acts as a groundwater protection blanket, effectively sealing the site as it consolidates. As successive lifts of material are placed into a site and dewatered, the ability of water to percolate through the material and into the underlying aquifer is reduced. The Killcohook dredged material disposal site has been in use for many years. To date, more than 30 feet of dredged material has been placed in the site, on average. As such, the continued disposal of dredged material at this site is not expected to have any adverse impacts on the quality of groundwater. As with the Salem River channel, the Woodbury Clay and Merchantville Formations are situated between the Killcohook dredged material disposal site and the Raritan Magothy Formation. The presence of these layers also provide adequate protection against saltwater infiltration to the Raritan Magothy.

4. Aquatic Ecology

Dredging will impact existing nearshore shallows and emergent wetlands in the vicinity of the cut-off and turning basin. This 3,300-foot reach is in the narrowest part of the existing navigation channel. Widening the channel will result in the loss of approximately seven acres of estuarine emergent wetlands, located on the north side of the channel. In addition to this wetland impact, estuarine intertidal and estuarine subtidal habitat will be relocated through channel modification. These habitat types are defined as shallow water areas located between +3 feet and -10 feet at mean low water. Construction of a larger channel will remove existing bottom surface within this range. Sessile benthic organisms, such as worms, would not be able to leave the dredging area. These organisms would be removed with the sediments and would not be expected to survive. Based on available data, the slope of the new channel side is projected to approximate the slope of the existing channel side. This would result in the creation of an equivalent amount of bottom surface as currently exists. Typically, benthic organisms from adjacent areas begin to recolonize disturbed areas soon after completion of dredging operations. Because sediment type and depth would be similar before and after channel modification, the recreated shallow water habitat is expected to be similar to the existing shallows.

As previously stated, approximately seven acres of estuarine emergent wetlands will be lost by widening the navigation channel through the cut-off area. On page eight of their March 1989 Fish and Wildlife Coordination Act Section 2(b) report (see Correspondence Appendix of the Main Report), the U.S. Fish and Wildlife Service indicated that these wetlands are not utilized by waterfowl and other waterbirds for nesting. The Service indicated that the river bank is steep in this area, and bordered by dense stands of common reed. The Service identified the remaining wetlands on the oxbow island as feeding and resting habitat for waterfowl and waterbirds. In addition, the island provides habitat for muskrat and river otter. The New Jersey Department of Environmental Protection, Division of Fish, Game and Wildlife indicated that loss of seven acres of marsh would decrease the carrying capacity of the area for these species without appropriate mitigation (see Appendix B of the Service's Section 2(b) report.

Based an evaluations conducted by the U.S. Fish and Wildlife Service (see pages eight and nine of their March 1989 Section 2(b) report), the Service classified the seven acres of wetlands as category III habitat in accordance with the Fish and Wildlife Service Mitigation Policy (Federal Register Vol. 46, No. 15, January 23, 1981). Category III habitat is defined as habitat of high to medium value for fish or wildlife species that is relatively abundant on a National or State basis. According to the Service's mitigation policy, category III habitat losses must be replaced either in-kind or out-of-kind with no net loss of habitat value and as near to the impacted site as possible.

One of the most important attributes of wetland habitats within the study area is their value to migratory waterfowl. Thousands of individuals use this area for resting and feeding during their annual migrations. Species of importance include Canada geese, black duck, mallard, pintail, teal, American widgeon, scaup, bufflehead and tundra swan. The North American Waterfowl Management Plan, adopted by the United States and Canada in 1986, identified the Atlantic coast as a priority area for waterfowl habitat protection. Within the Atlantic Coast Joint Venture area, focus areas have been established. Focus areas are defined as the highest priority wintering, migration or production habitats for black ducks and other waterfowl. The objective of the North American Waterfowl Management Plan is to protect and enhance these priority habitats for the production of waterfowl. The freshwater and brackish wetlands in the vicinity of the Salem River have been identified as a focus area.

Coordination with the U.S. Fish and Wildlife Service and the New Jersey Department of Environmental Protection, Division of Coastal Resources led to the identification of a suitable wetland mitigation site within the Supawna Meadows National Wildlife Refuge (Figure 12). This site is adjacent to a shallow water impoundment, which is managed by the Service for waterfowl feeding. The site grades down from upland fields, to a transitional upland area dominated by common reed, to the impoundment. Construction of seven acres of brackish emergent wetlands along the fringe of this impoundment would increase the habitat value of this area for waterfowl. Brackish wetland vegetation would be planted in the site to provide food and cover for waterfowl. Vegetative species would include narrow-leaved cattail (<u>Typha angustifolia</u>), saltmarsh bulrush (<u>Scirpus robustus</u>), switch grass (<u>Panicum virgatum</u>), sedges (<u>Carex</u> spp.) and rushes (<u>Juncus</u> spp.). Water levels within the impoundment can be manipulated to provide some inundation to the site. It is necessary to keep the water level within the impoundment somewhat shallow for waterfowl feeding. While implementation of the proposed mitigation plan would not replace tidal wetlands impacted along the cut-off, it would create wetland habitat of greater value (i.e. dominant vegetation along the cut-off is common reed). The proposed mitigation plan would benefit waterfowl that

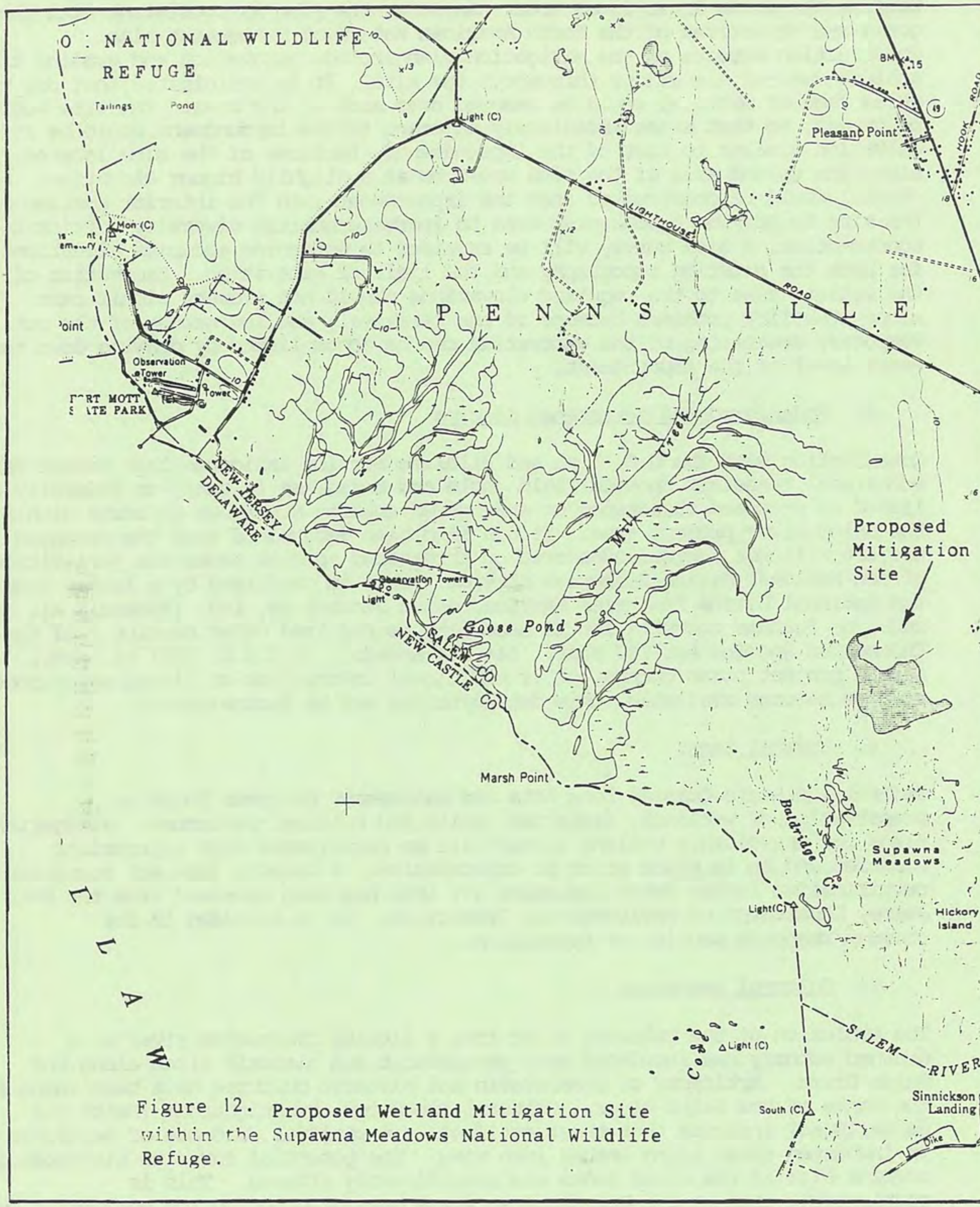


Figure 12. Proposed Wetland Mitigation Site within the Supawna Meadows National Wildlife Refuge.

utilize the Salem River focus area. As such, the plan is consistent with the goals and objectives of the North American Waterfowl Management plan. Construction aspects of the mitigation plan include excavation and grading to achieve desired elevations throughout the site. It is anticipated that one to three feet of material would be removed over most of the area. The site would be graded, so that areas immediately adjacent to the impoundment would be at an elevation similar to that of the impoundment. Portions of the site located along the upland side of the site would be at a slightly higher elevation. A channel would be constructed from the impoundment into the interior portion of the site to provide a backwater area to increase habitat diversity. Prior to construction, a site survey will be required to determine accurate elevations for both the existing topography and the limit of excavation. Excavation of the wetland area to the required elevations should not present significant slope stability problems because of the relatively shallow nature of the cut. Temporary dewatering of the excavation can be accomplished by drawing down the water level of the impoundment.

5. Endangered and Threatened Species

Consultation with the U.S. Fish and Wildlife Service indicates that except for occasional transient species (bald eagle and peregrine falcon), no Federally listed or proposed threatened or endangered species are known to occur within the Salem River project area. It has also been determined that the proposed project will not impact endangered or threatened species under the jurisdiction of the National Marine Fisheries Service. This is confirmed by a letter from the National Marine Fisheries Service, dated January 16, 1991 (Appendix A). As such, no further consultation is necessary as required under Section 7 of the Endangered Species Act (87 Stat. 844, as amended; 16 U.S.C. 1531 et. seq.). Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

6. Coastal Zone.

Federal and State Coastal Zone Acts and management programs focus on preservation of wetlands, fisheries, soils and cultural resources. Mitigation plans for unavoidable wetland losses will be coordinated with appropriate agencies and be in place prior to construction. A Coastal Zone Act consistency certification letter dated September 19, 1989 has been received from the New Jersey Department of Environmental Protection. It is included in the comment/response section of Appendix A.

7. Cultural Resources

The evolution of the Delaware River from a flowing freshwater river to a drowned estuary has inundated many prehistoric and historic sites along the Salem River. Artifacts of prehistoric and historic cultures have been found on the banks of the Salem River. Cultural resources investigations (Heite and Heite 1986c) indicate that these artifacts are residual evidence of destroyed or inundated sites being washed into view. The potential for site disturbance remains high if the river banks are significantly altered. This is particularly true at the New Cut area where careful construction monitoring by a professional archaeologist will be required. Additional cultural resource investigations would be necessary to mitigate potential damage if sites are discovered during construction.

Of particular concern is the now-inundated seventeenth-century Fort Elfsborg. A study of historical accounts and navigation charts from that era to the present (Heite and Heite 1986a) show that a dry land point existed out into the bay from the present Elsinboro Point, about 2 1/2 miles south of the mouth of the Salem River. A three-sided earthwork fort on that site would place a cannon battery within reasonable range of bay shipping, while such a battery on the highland above would not. From about 1850 to the present, unsupported observations of a log fort and cannonball finds related to the point make it the best candidate for the fort site. That site is a point adjacent to the present channel, within 1200 feet of the westernmost point of the meadowbank. Less likely fort sites could be in offshore shallows northeast for about 1/2 mile from the point. Since the proposed project widening will occur on the north west side of the present channel in the vicinity of Elsinboro Point, it is unlikely to encroach on submerged remains or ancillary structures, and no further studies will be required.

With regard to shipwrecks, ships have been sailing the Salem River for more than three centuries. Historical maps (Heite and Heite 1986a) indicate that in the last several centuries water depths were so shallow in what is now the Salem River Channel that any shipwrecks that may once have been there would probably have been removed when the channel was originally dredged. However, it is possible that shipwreck remains may be found either in the shallow waters adjacent to the present channel or buried in the channel itself. A remote sensing survey of the Salem River area was undertaken for the Corps (Cox 1988) to determine whether or not there may be shipwrecks that might be impacted by the proposed project. That study, utilizing both magnetometer and side scan sonar, identified two targets suggestive of possibly significant submerged cultural resources. One target, located in Salem Cove, will not be impacted since overboard disposal within the cove has not been selected. The other target, located in the Salem River channel just to the east of navigational buoy "N-10", will be impacted by the proposed channel dredging. This target yielded no sonar return, indicating that the material is buried in the bottom sediment. The magnetometer results for this target created a magnetic signature consistent with that derived from documented historically significant submerged sites. Further investigations, including diving and probing beneath the surface, will be necessary to determine whether this target represents a resource eligible for nomination to the National Register of Historic Places.

The results of the remote-sensing survey, and the need for any additional cultural resources work in the channel, has been coordinated with the Offices of the Delaware and New Jersey State Historic Preservation Officers. The reports of the cultural resource investigations described above will be on file and available for review at the Philadelphia District of the Army Corps of Engineers. A comment letter dated January 12, 1989 has been received from the Delaware SHPO office. A comment letter dated March 12, 1991 has been received from the New Jersey SHPO office. Both letters are provided in the comment/response section of the main report.

Killcohook is an existing dredged material disposed area that has been used in the past and is therefore disturbed. Use of this disposal site for the proposed Salem River project should have no impact on significant cultural resources.

8. Odor, Noise and Mosquito Control.

Odor, mosquitoes and construction noise are sometimes associated with dredging and dredged material disposal activities. Odors and mosquitoes result from decay of organic matter in dredged material and from trapped water pools which do not properly drain. Properly constructed and operated disposal areas are designed to be self draining. Area management can eliminate trapped pockets of water and hasten area drying. Periodic inspection ensures detection of a mosquito breeding problem, should it develop. In this case, corrective action would be taken by the Corps of Engineers in conjunction with the Salem County Mosquito Commission. The average to low organic content of dredged sediments in the study area is not anticipated to produce significant odor. The Philadelphia District Office of the Corps of Engineers has not received complaints from nearby residents or environmental groups about the odor of material being deposited or mosquito breeding in these areas. Virtually no odor or mosquito problems have been noticed during inspection. As such, these potential problems do not appear to be significant.

The use of construction equipment to build and maintain dikes at the disposal area, and the actual dredging of the Salem River navigation channel will generate some amount of noise. This noise will only occur for limited periods of time and is not considered significant.

At the Killcohook dredged material disposal site, construction equipment will be required to prepare the area for disposal operations. Construction equipment does elevate noise levels in the vicinity, and can be a nuisance if residential areas are located in close proximity. The Killcohook site is located in a remote area. There are no residences close enough to the construction area to be impacted by noise.

The use of hydraulic dredging equipment to deepen and maintain the Salem River navigation channel is not expected to significantly elevate local noise levels. Hydraulic pipeline dredging is not considered a noisy operation. The approach channel to the Salem River accounts for approximately 2.6 miles of the 4 mile channel. This portion of the project area is located approximately 2,000 feet off of the Delaware River shoreline. Residences located along the shoreline would not be disrupted by a dredge working this far away. The remaining 1.4 miles of the channel is located within the Salem River proper. There are residences located along the shoreline between Sinnickson Landing and approximately half way through the cutoff area, which is a distance of about 3,500 feet. Above this area, residences are located further from the shoreline, and much of the area is dedicated to port activities.

Homes located between Sinnickson Landing and the cutoff would be impacted the most by dredging activities. The working dredge would be located closest to homes through this area. The impact would be greatest during nighttime hours when people are normally asleep. It is anticipated that dredging activities within this area would last a few weeks.

Section IV of the Public Health Nuisance Code of New Jersey (1953) states the following relative to the prohibition of certain noises or sounds:

> "It shall be unlawful for any person to make, cause or suffer or permit to be made or caused upon any premises owned, occupied or controlled by him or it, or upon any public street, alley or thoroughfare in this municipality, any unnecessary noises or sounds by means of the human voice, or by any other means or methods which are physically annoying to persons, or which are so harsh, or so prolonged or unnatural, or unusual in their use, time and place as to occasion physical discomfort, or which are injurious to the lives, health, peace and comfort of the inhabitants of this municipality or any number thereof."

The Salem County Department of Health provided maximum permissible sound levels within residential areas. These levels are 65 dBA from a commercial or industrial source between 7AM and 10PM, and 50 dBA from a commercial or industrial source between 10PM and 7AM.

Sound levels for construction equipment such as pumps, generators and engines from construction vehicles range from approximately 70 dBA to 95 dBA, at 50 feet from the sound source (Canter, 1977). Based on this range, a conservative estimate for the sound level associated with hydraulic dredging equipment was determined to be 85 dBA. This sound level is attenuated on a dredge due to the location of the equipment within the vessel. On a dredge, pumps and engines are enclosed within the vessel, which dampen sound levels. In addition, the equipment is isolated to the vessel and the vessel is isolated in the water, which also reduces sound propagation. Sound attenuation attributed to vessel enclosures and the isolators are estimated to reduce sound levels by 30 dBA. As such, at 50 feet from the working dredge, the estimated sound level is 55 dBA. This sound level is within the maximum permissible level for residential areas between 7AM and 10PM, but 5 dBA higher than permissible between 10PM and 7AM. The intensity of sound waves diminish as the waves travel away from the sound source. According to the inverse square law, for every doubling of distance from the sound source, the sound level decreases by 6 dBA (Canter, 1977). As such, if the sound level at 50 feet from the dredge is 55 dBA, it would decrease to 49 dBA at 100 feet and 43 dBA at 200 feet. Thus, the sound level at 100 feet from the working dredge would be within the maximum permissible level between 10PM and 7AM. Within the cutoff area, residences are located greater than 100 feet from the Salem River channel. Thus, the temporary increase in noise associated with dredging this portion of the project area is considered to be within acceptable limits.

9. Hazardous and Toxic Assessment

An assessment of the potential for Hazardous and Toxic Wastes (HTW) contamination on project lands was made in accordance with 30 July 1990 draft guidance on HTW for civil works projects and studies, from CECW-PO. The assessment was made subsequent to completion of the Final Salem River, New Jersey Interim Feasibility Report and Environmental Assessment, which is also dated July 1990. Based on the timing of the final report and the draft guidance, the project is considered in "transition" with respect to HTW. As such, it would be acceptable to conduct studies to determine the extent of HTW as part of PED, if considered necessary. The assessment conducted as part of this effort has led to the conclusion that the potential for HTW contamination on project lands is low, and that additional studies are not warranted.

The HTW assessment considered the potential for contamination on project lands, including structures and submerged lands. Project lands include the existing Salem River navigation channel, the approach channel within the Delaware River, and the Federally owned Killcohook dredged material disposal site. The Salem River channel and the approach channel are both existing, currently maintained channels that would be deepened as part of the proposed project. Chemical testing of channel sediments, conducted as part of the maintenance dredging program, has not identified any HTW contamination concerns (refer to water quality discussion). Deepening of the existing channels and continued commercial navigation is not expected to increase the potential for HTW contamination problems in the future.

The Federally owned, Killcohook dredged material disposal site is an upland area that is currently used for the disposal of dredged material. A review of Corps records indicates that the site was acquired by the Philadelphia District in 1925. Prior to disposal activities, approximately half the site was part of the Delaware River and the other half was predominantly wetlands. To date, more than 30 feet of dredged material has been placed in the site, on average. There are no known facilities such as buildings, underground/above ground storage tanks, or remnants of past operations on-site. The site is regularly visited as it is currently used for the disposal of material dredged from the Delaware River, Philadelphia to the Sea Federal Navigation channel. Features that could suggest HTW problems such as the presence of containers, discolored soil, seeping liquids, unusual odors, or stressed/dead vegetation or animal life have not been observed. Continued use of this Federally operated site for the disposal of dredged material is not expected to increase the potential for HTW contamination in the future.

Based on the above, it has been concluded that additional studies to evaluate the potential for HTW contamination on Salem River project lands are not required. Concerns related to groundwater impacts, as a result of dredging and dredged material disposal within the project area, are addressed in the aquifer protection section. This section concludes that the proposed plan of improvement would not have a detrimental affect on groundwater quality.

B. SUMMARY AND CONCLUSIONS

Potential impacts of dredging and disposal proposals are anticipated to be low to moderate. That evaluation is based on the satisfactory conclusion of cultural resource investigations, the capability to mitigate aquatic habitat losses and the anticipation that benthic recolonization would occur rapidly. Water quality impacts during dredging would be short-term and minor. Sediments are essentially pollutant free and recirculation in the water column would not be detrimental with hydraulic dredging techniques. There is limited risk to the local aquifer from dredging. The increase in channel size relative to the entire river-bay hydraulic regimen is minuscule, if even measurable, and is not expected to change riverine salinity concentrations at any point.

The Killcohook Dredged Material Disposal Area near Pennsville, New Jersey, is an active Federally operated upland disposal site adjacent to the Delaware River. That site is diked, close to the project area and has sufficient available capacity to accommodate project needs. The environmental impact of using this site for dredged material disposal is not significantly adverse.

VI. INCREMENTAL ANALYSIS OF FISH AND WILDLIFE MITIGATION

The proposed plan of improvement for the Salem River Federal navigation project consists of widening and deepening the existing channel through hydraulic dredging operations (refer to section III.D. of this Environmental Assessment.). All material dredged for initial construction and a 50-year maintenance program would be placed in the existing Killcohook dredged material disposal site. Widening the channel through the "cut-off" area (refer to Figure 2) would result in the loss of seven acres of estuarine intertidal emergent wetlands. The dominant species of vegetation within this wetland is common reed (Phragmites communis).

Wetland and aquatic habitats in the vicinity of the Salem River have been designated as a focus area for waterfowl habitat protection under the 1986 North American Waterfowl Management Plan. The Salem River is located on the Atlantic Flyway and provides a valuable stopover location for thousands of migratory waterfowl annually. The area is censused each year in early January to monitor waterfowl populations. Major species utilizing the area include Canada geese, black duck, mallard, American widgeon, scaup, bufflehead and tundra swan. The North American Waterfowl Management Plan targets 11,500 acres of wetland habitats in the vicinity of the Salem River for protection. The plan states: "A diversified complex of high-quality freshwater and brackish wetlands composed of wild rice, arrow arrum, and salt marsh cordgrass makes the area a high-priority ecosystem for black ducks, mallards, teal, widgeon, pintail, and Canada geese. Important wetlands in need of protection along the Salem River include: Mannington, Pine Island, Kate Creek, Stoney Island, Supawna, Mill Creek, Elsinboro, Money Island, Abbott's and Fenwick Marshes."

Investigations of the seven acre wetland site to be impacted along the cut-off have led to the determination that the site is not used by waterfowl for nesting purposes. The wetland banks along the river are steep, and the area is vegetated with dense stands of common reed. The site does however provide valuable cover habitat for resting and feeding waterfowl during migrations. The U.S. Fish and Wildlife Service used black duck and snowy egret as indicator species to evaluate the habitat value of the wetland site. Based on these evaluations, the Service classified the wetland site as resource category III habitat, relative to their 1981 mitigation policy. Category III habitat is defined as habitat of high to medium value for fish and wildlife resources, which is relatively abundant on a National or State basis. The Service recommends that loss of category III habitat be mitigated by replacement either inkind or out-of-kind with no net loss of habitat value.

The seven acre wetland site is part of a larger wetland island located along the cut-off. The banks of this island are utilized as dens by muskrats. The Service reports that during the 1986/1987 trapping season the island yielded 600-700 muskrats. The Service has indicated that the island can sustain a yearly harvest of 1,000-1,200 muskrats.

As previously stated, implementation of the proposed plan of improvement for the Salem River navigation channel would result in the loss of seven acres of estuarine intertidal emergent wetlands. These wetlands would be lost through excavation due to the need to widen the channel through the cut-off area. The primary attribute of wetlands within the project area is the resting and feeding habitat provided for migratory waterfowl. Based on the value placed on wetlands within the Salem River area under the North American Waterfowl Management Plan, it is important to maintain wetland acreage in order to maintain waterfowl carrying capacity. As such, the selected unit of measurement for this analysis is the acre.

The primary mitigation objective associated with the proposed Salem River project is to replace seven acres of wetlands and their waterfowl habitat values.

Wetland replacement can be accomplished by constructing wetlands through excavation of uplands or filling in aquatic habitat. Aquatic habitats in the vicinity of the project area have been documented as valuable spawning, nursery and foraging habitat for a number of fishery species of commercial and/or recreational importance. As such, it was determined that filling aquatic habitat to create wetlands in the vicinity of the project area was not a desirable alternative because of the additional impacts that would be incurred. Refer to the Plan Formulation section of the Main Report for additional information pertaining to the placement of material in aquatic areas.

Construction of wetlands from uplands would entail excavation and grading to achieve site elevations sufficient to support wetland vegetation. Aspects of the plan would include land acquisition, excavation and grading, and planting. Activities necessary for achieving the desired surface elevations and planting vegetation are viewed as dependent features of a single mitigative action. Both steps are required to construct an ecologically functional system.

The type of wetland constructed (i.e. intertidal, non-tidal, estuarine, freshwater) is dependent on site selection. The seven acre wetland area that would be lost through channel modification is an estuarine intertidal emergent wetland. For the purposes of this analysis, achieving the mitigation objective was approached in two ways. The first was in-kind replacement of habitat, or construction of seven acres of estuarine intertidal emergent wetlands. The second was out-of-kind replacement of habitat, or construction of seven acres of non-tidal estuarine emergent wetlands. Both habitat types would provide suitable cover, resting and feeding habitat for migratory waterfowl. Thus, both habitat types would meet the mitigation objective. A third alternative considered for mitigation was upgrading existing wetlands in the area. This alternative was rejected because it would not replace the lost wetland acreage, and would not meet the stated objective.

Coordination with the U.S. Fish and Wildlife Service and the New Jersey Department of Environmental Protection, Division of Coastal Resources led to the identification of a suitable non-tidal wetland mitigation site within the Supawna Meadows National Wildlife Refuge (refer to Figure 10 of this Environmental Assessment). This site is adjacent to a shallow water impoundment, which is managed by the Service for waterfowl feeding. The site grades down from upland fields, to a transitional upland area dominated by common reed, to the impoundment. Construction of seven acres of brackish emergent wetlands along the fringe of this impoundment would increase the overall habitat value of this area for waterfowl. Brackish wetland vegetation would be planted in the site to provide food and cover for waterfowl. Vegetative species would include narrow-leaved cattail (Typha angustifolia), saltmarsh bulrush (Scirpus robustus), switch grass (Panicum virgatum), sedges (Carex spp.) and rushes (Juncus spp.). Water levels within the impoundment can be manipulated to provide some inundation to the site. It is necessary to keep the water level of the impoundment somewhat shallow for waterfowl feeding. The cost of land acquisition for this site was estimated to be $2,400 per acre. The cost of excavation and grading and planting vegetation was estimated to be $18,525 per acre. As such, the total cost per acre for this mitigation alternative is $20,925 (plus E&D, S&A and contingencies).

Construction of estuarine intertidal emergent wetlands would require an upland site located adjacent to a tidal portion of the Salem River project area. A site meeting this criterion was not identified within the boundaries of the Supawna Meadows National Wildlife Refuge. As such, this alternative mitigation plan would require the purchase of private lands. Real estate appraisals conducted in the mid-1980's valued residential and agricultural land within the project area at $2,000-$2,400 per acre. Land zoned for industrial use was estimated to cost $14,000 per acre. For this analysis, it was estimated that a suitable upland site would cost $4,000 an acre. A site was not selected for this alternative, so the cost of excavation and grading and planting vegetation was estimated to be the same as for the non-tidal alternative (i.e. $18,525 per acre). The total cost per acre for this alternative was conservatively estimated to be $22,525 (plus E&D and S&A and contingencies). The costs associated with working in a tidal situation however are expected to be higher than those for a non-tidal situation because of the additional problems presented by fluctuations in water levels. Salt marsh cordgrass (Spartina alterniflora) would be planted for this alternative.

Figure 13 provides a simple display of the incremental cost difference between these two mitigation alternatives. Part A depicts the difference in unit cost. This cost difference is due to the difference in land acquisition cost. Part B depicts the cost difference as a function of percent mitigation. At 50 percent mitigation the intertidal alternative is $5,600 more expensive than the non-tidal alternative. The cost of replacing 100 percent of the lost wetland acreage with non-tidal wetlands would only provide 93 percent replacement with intertidal wetlands. Because both alternatives meet the mitigation objective, which is to replace seven acres of wetlands and their waterfowl habitat values, the construction of non-tidal estuarine emergent wetlands is the most cost effective mitigation plan. This plan was therefore selected to mitigate wetland impacts that would result from implementing the proposed plan of improvement for the Salem River navigation channel.

VII. RELATIONSHIP OF SELECTED PLAN TO ENVIRONMENTAL EQUIREMENT, PROTECTION STATUTES, AND OTHER REQUIREMENTS

Compliance with environmental quality protection statutes and other environmental review requirements have been met with distribution of this environmental assessment for review and comment. The use of upland sites for the disposal of dredged material is an authorized activity under the nationwide permit section of the U.S. Army Corps of Engineers regulatory program (33 CFR 330.5(a)(16), with receipt of a State Water Quality Certificate. A review of impacts associated with the discharge of dredged material, as required by Section 404(b)(1) of the Federal Clean Water Act, as amended (Public Law 92-500), is not necessary with selection of the existing Killcohook dredged material disposal area for deposition of all material. Table 4 provides a listing of compliance with other environmental statutes.

VIII. COORDINATION

Several Federal, state and local agencies have been contacted to coordinate planning of the Salem River Navigation Project. That correspondence is in the Coordination Appendix of the Main Report. The Delaware DNREC and Division of Fish and Wildlife and the New Jersey DEP were contacted to gather initial information regarding archaeological and historical resources, endangered and threatened species, fisheries and shellfisheries, wetlands, and coastal resources. Various non-regulatory and interstate organizations were also contacted.

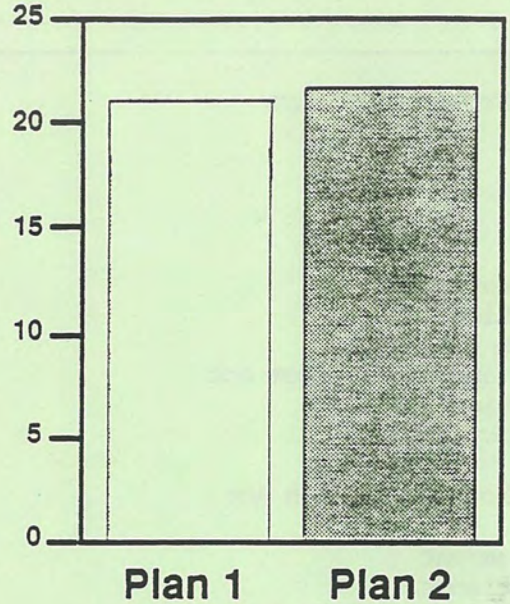
This EA has been coordinated with the following list of agencies.

Environmental Protection Agency
Office of Federal Activities
Washington, D.C.

Region II
New York, NY

FIGURE 13 **Salem River Navigation Project Incremental Cost Analysis of Alternitive Mitigation Plans**

A.



Plan 1 :Non-tidal estuarine emergent wetlands.

Plan 2 : Intertidal estuarine emergent wetlands.

B.

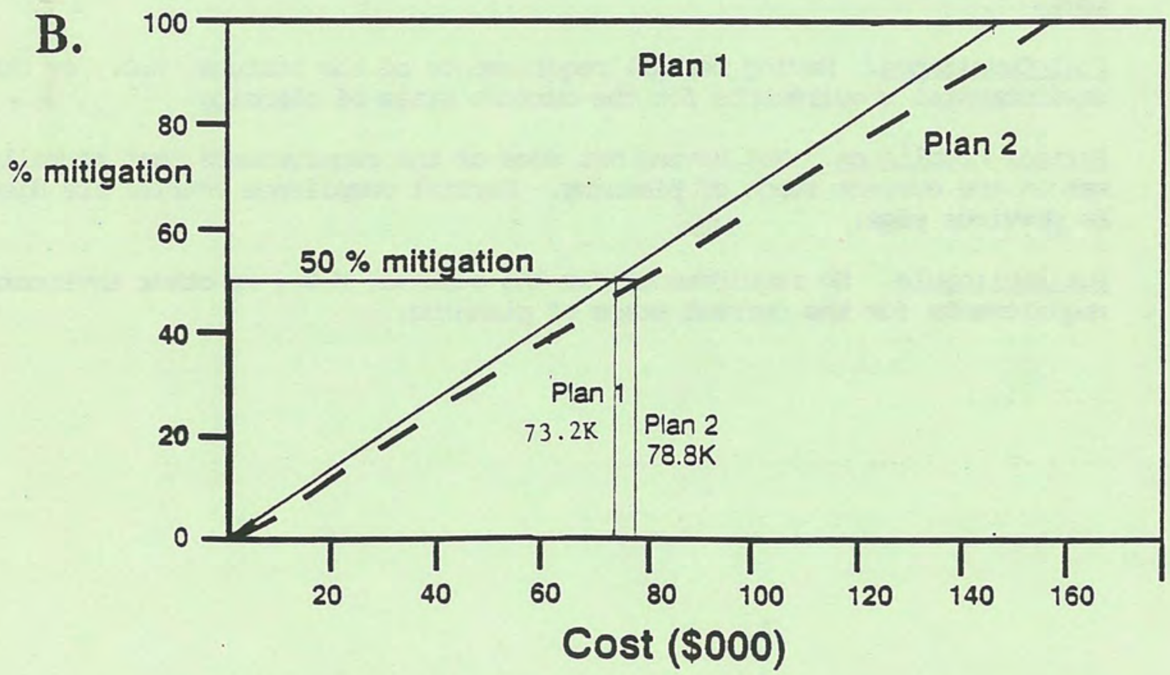


Table 4

COMPLIANCE WITH ENVIRONMENTAL QUALITY PROTECTION STATUTES AND OTHER ENVIRONMENTAL REVIEW REQUIREMENTS

ACT	COMPLIANCE
Archaeological-Historical Preservation Act	Full
Clean Air Act	Full
Clean Water Act	Full
Coastal Zone Management Act	Full
Endangered Species Act	Full
Estuary Protection Act	Full
Federal Water Project Recreation Act	Full
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act	Full
Marine Protection Research and Sanctuaries Act	Full
National Historic Preservation Act	Full
National Environmental Policy Act	Full
River and Harbor Act	Full
Watershed Protection and Flood Prevention Act	Full
Wild and Scenic River Act	Not Applicable
EO 11988, Flood Plain Management	Full
EO 11990, Protection of Wetlands	Full
Executive Memorandum on Prime and Unique Farmlands	Full
New Jersey Coastal Zone Management Plan	Full
County Land Use Plan	Full

NOTE:

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

Partial Compliance. Not having met some of the requirements that normally are met in the current stage of planning. Partial compliance entries are discussed on previous page.

Not Applicable. No requirements for the statute, E.O., or other environmental requirements for the current stage of planning.

Delaware River Basin Commission
West Trenton, NJ

National Marine Fisheries Service
Sandy Hook Laboratory
Highlands, NJ

Habitat Protection Branch
Gloucester, MA

U.S. Fish and Wildlife Service
Pleasantville, NJ

New Jersey Department of Environmental Protection - Trenton, NJ
- Office of Program Coordination (formerly the Planning Group)
- Division of Water Resources
- Division of Coastal Resources
- Division of Fish, Game and Wildlife
- Division of Parks and Forestry
  - Office of New Jersey Heritage
- Division of Local Government Services
  - Department of Community Affairs

Salem County Planning Board
Salem, NJ

Delaware Department of Natural Resources and Environmental Control - Dover, DE
- Division of Fish and Wildlife
- Division of Water Resources

Delaware Department of State
Division of Historical and Cultural Affairs
Dover, DE

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CONCLUSIONS

280. Commerce in the study area has been active since the Port began operations and projections indicate growth in the future. Currently, the authorized channel dimensions present constraints to the efficient movement of vessels. Inadequate depths and widths have caused the Port to rely on costly non-structural alternatives such as lightloading and waiting for the tides. With future increases projected, this problem will only continue to worsen. The modification plan selected and presented in this report will alleviate the problems hindering the efficient movement of commodities through the project areas with no major impacts on the environment.

RECOMMENDATIONS

281. I recommend that the existing Federal project for navigation at the Salem River, authorized by HD 68-110 in 1925 be modified to provide for the implementation of a Federal project for navigation, in accordance with the plan selected herein, with such further modifications thereto as in the discretion of the Chief of Engineers may be advisable, to include:

- Deepening of the existing Federal channel to a depth of 18 feet MLW, including realignment at Sinnicksons Landing, to provide for a channel from deep water in the Delaware River to the Port of Salem.

- Channel width of 180 feet with appropriate bend widening.

- Mitigation for the loss of 7 acres of wetlands.

- Provision of a turning area adjacent to the Port of Salem with a depth of 18 feet and diameter of 495 feet.

282. The first cost to the United States is presently estimated at $8,128,000 with annual operations, maintenance and replacement costs to the United States of $371,000.

283. This recommendation is made with the provision that, prior to the commencement of construction, the non-Federal sponsor will comply with all requirements of law concerning non-Federal sponsorship of the project.

284. The recommendations contained herein reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect program and budgeting priorities inherent in the local and state programs or the formulation of a national Civil Works construction program. Consequently, the recommendations may be modified prior to approval by the Secretary of the Army as provided for in Section 859 of the Water Resources Development Act of 1986. The sponsor, the States, interested Federal agencies and other parties will be advised of any significant modifications.

Revise w/ Attached

Kenneth H. Clow
Lieutenant Colonel, Corps of Engineers
Commanding