US Army Corps
of Engineers
Philadelphia District

Philadelphia District
North Atlantic Division

Delaware River Main Channel Deepening Project

Supplemental Environmental Impact Statement

July 1997

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

JULY, 1997

ERRATA SHEET

The quantity of sand that will be placed on sand stockpile site MS-19 has been reduced from 2.8 million cubic yards to 1.4 million cubic yards. This will reduce the area of MS-19 from 500 acres to 250 acres. The total quantity of sand for both sand stockpiles (MS-19 and L-5) will be reduced from 4.7 million cubic yards to 3.3 million cubic yards, and the total area for both sand stockpiles has been reduced from 730 acres to 480 acres.

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
(PENNSYLVANIA, NEW JERSEY, AND DELAWARE)

SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

U.S. Army Corps of Engineers, Philadelphia District
July 1997

Final Supplemental Environmental Impact Statement
Delaware River Comprehensive Navigation Study
Main Channel Deepening Project

The responsible lead agency is the U.S. Army Engineer District, Philadelphia.

Abstract: The Philadelphia District conducted Preconstruction, Engineering and Design (PED) studies for modifying the existing Delaware River Federal navigation channel (Philadelphia to the Sea Project) from the Philadelphia/ Camden waterfront to deep water in Delaware Bay. The Delaware River Main Channel Deepening Project was authorized by Congress in October 1992 as part of the Water Resources Development Act of 1992. The non-Federal sponsor who will cost share this project is the Delaware River Port Authority. The recommended plan of improvement modifies the depth of the existing navigation channel from 40 to 45 feet at mean low water, with an allowable dredging overdepth of one foot. The modified channel would follow the existing channel alignment from Delaware Bay to Philadelphia Harbor and Beckett Street Terminal, Camden, New Jersey, with no change in channel widths. The plan also includes channel bend widenings, as well as partial deepening of the Marcus Hook Anchorage to 45 feet. Approximately 33 million cubic yards of material would be dredged for initial project construction. In addition, 229,000 cubic yards of rock would be removed from the channel in the vicinity of Marcus Hook, Pennsylvania. Annual maintenance dredging for the 45-foot channel would increase to 6,007,000 cubic yards from the current 4,888,000 cubic yards for the 40-foot channel, for a net increase of 1,119,000 cubic yards. In the riverine portion of the project area, dredged material would be placed in nine active, Federal upland dredged material disposal sites, and four new upland sites identified as 17G, 15D, 15G and Raccoon Island. In Delaware Bay, dredged material from initial project construction would be used for wetland restoration at Egg Island Point, New Jersey and Kelly Island, Delaware, and for stockpiling of sand for later beach nourishment work at Slaughter and Broadkill beaches in Delaware.

The purpose of this Supplemental Environmental Impact Statement (SEIS) is to provide additional information and environmental analysis to address environmental concerns raised during review of the 1992 Feasibility Report and Environmental Impact Statement. Environmental analyses include: three- dimensional hydrodynamic modeling of the Delaware estuary to evaluate potential changes in salinity and circulation patterns; benthic invertebrate sampling to assess habitat quality at selected beneficial use sites in Delaware Bay; biological effects based testing to determine the impact of open water disposal on aquatic ecosystems; detailed environmental assessments of selected upland dredged material disposal sites; consultation with both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, pursuant to Section 7 of the Endangered Species Act; cultural resource investigations in dredging and disposal locations; and coordination with the regional oil spill response team to review the adequacy of existing Delaware River spill contingency plans.

PLEASE SEND YOUR COMMENTS
TO THE DISTRICT ENGINEER BY:

AUGUST 30, 1997

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DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT
DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

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1.0 Summary

1.1 Major Conclusions and Findings

The Final Delaware River Comprehensive Navigation Study Main Channel Deepening Interim Feasibility Report and Environmental Impact Statement was completed in February 1992. Subsequent to a public review period, the report was approved by the U.S. Army Corps of Engineers and the Board of Engineers for Rivers and Harbors, and transmitted to Congress. The project was authorized by Congress in October 1992 as part of the Water Resources Development Act of 1992. The Record of Decision for the Final Environmental Impact Statement(FEIS), dated December 17, 1992, documented supplementary environmental analyses to be conducted during the Preconstruction, Engineering and Design phase of project development to re-affirm conclusions reached during Feasibility investigations. The need for these analyses was based on the comments received during public coordination of the FEIS. The purpose of this Final Supplemental Environmental Impact Statement (FSEIS) is to report the findings of the additional studies.

The evaluation of environmental impacts associated with the proposed project included coordination of the additional investigations and results with appropriate Federal and State resource agencies. The evaluations included the upland disposal of dredged material (including wetlands/wildlife habitat; hazardous, toxic, and radioactive waste (HTRW); and groundwater impacts); beneficial use of dredged material in Delaware Bay (including investigations of benthic habitat and sediment transport); sediment quality; salinity modeling (including impacts to water quality, aquatic life, and groundwater aquifers); endangered species; cultural resources; oil spill planning; and rock blasting. A summary of the results of these environmental impact studies is given below. Detailed discussions of the impacts are presented in the following sections of this SEIS.

1.1.1 Upland Dredged Material Disposal Sites

1.1.1.1 Wildlife Habitat/Wetland Impacts

Three of the dredged material disposal areas (15D, 15G, and 17G) are mostly used for the production of row crops, primarily corn and soybeans. The fourth area, Raccoon Island, is vegetated almost entirely with common reed (Phragmites australis), with some small patches of woodlands. Most of the wildlife habitat is rated as low to moderate quality.

Approximately 396 acres of jurisdictional wetlands (ie. wetlands that are regulated under Federal and/or state law) will be impacted on the four sites. All of these wetlands are the result of past human activities. The amount of each is shown in Table 6-2; however, the most dominant type of manmade, jurisdictional wetland inside the four confined disposal facilities (CDFs) is 365 acres of Phragmites australis, or common reed, comprising approximately 90% of the wetlands present on the four sites. Common reed is generally a poor quality wetland in terms of wildlife habitat; however, it can improve water quality by removing sediment from runoff water.

In order to minimize impacts to wetlands/wildlife habitat in the upland dredged material disposal areas, the berm alignments have been changed to avoid higher quality wetlands/habitat such as forested and shrub-scrub areas. In addition, construction during sensitive times of year for wildlife species, such as nesting or migratory periods, will be avoided as much as practicable.

Since all impacts to wetlands/habitat can not be avoided, the Philadelphia District coordinated with the New Jersey Department of Environmental Protection (NJDEP) and the U.S. Fish and Wildlife Service (FWS) to find ways to manage these areas to restore environmental values that will be impacted. Both agencies recommended that each CDF be divided into cells, so that a portion could be managed as wetlands between the disposal of dredged material. The Philadelphia District tasked the research scientists at the U.S. Army Waterways Experiment Station (WES) to develop a management plan for the CDFs that would maximize their use as wetlands and wildlife habitat, while maintaining their use for the disposal of dredged material. This plan was then coordinated with the NJDEP and the FWS, as well as the Environmental Protection Agency (EPA) for their concurrence. Preliminary indications are that these agencies concur with the management plan that was developed.

Table 6-4 shows the amounts and types of wetlands that presently occur on the disposal areas, and what will be present with the proposed plan. There is a net increase of approximately 200 acres of wetlands. All of the wetlands that will occur in the disposal areas will be palustrine emergent, mostly non-tidal fresh marsh. The quality of these wetlands is expected to be better than the predominantly common reed dominated wetlands that presently occur. These wetlands will be less likely to be dominated by common reed because of the water level manipulations that will be possible using the weirs that will be present at strategic locations.

In addition, approximately 372 acres of additional area outside of the CDFs will be purchased as part of the project, due to real estate requirements. This area is presently a mosaic of habitat types consisting primarily of tidal marsh, woodlands, common reed, and ruderal areas. Much of this area is moderate to high quality wildlife habitat located adjacent to either the Delaware River or to tidal creeks, including some tidal marshes that are considered exceptional value to fish and wildlife resources (FWS 1995a). This area will be maintained as undeveloped land, and it is likely that the habitat quality will increase as the woodlands mature and ruderal and common reed areas succeed to more valuable habitats such as woodlands. In conclusion, the overall habitat value of the 1,612 acres that will be purchased for upland dredged material disposal areas will be greater during the 50 years of project life than what presently exists.

1.1.1.2 Hazardous, Toxic and Radioactive Waste (HTRW)

In accordance with the Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects, ER 1165-2-132, dated 26 June 1992, a literature search was conducted on each of the proposed upland dredged material disposal sites. The purpose of the HTRW investigation was to research available information on past or present conditions or activities, which may have resulted in the disposal or presence of HTRW on the subject sites.

Although there is no evidence to suggest that any of the sites have been used for industrial purposes or that any HTRW has ever been generated, disposed of, stored, or treated at any of the sites, there are several areas of concern that were outlined in the literature search. Potentially contaminated areas included piles of 55-gallon drums at sites 17G, 15D, and Raccoon Island, an above ground storage tank at site 17G, and an abandoned ultralite plane and pickup truck at site 15D. No areas of concern were found on Site 15G. Consequently, as part of the preliminary assessment, chemical sampling was performed on the disposal areas in these localized areas of concern.

The purpose of the sampling and testing soils from the areas was to determine the level of constituents in background and debris areas described in the preliminary assessment. The sampling locations were chosen based on their proximity to debris, drums, and other viable solid waste piles. Thirteen samples were taken at the four areas. Only three samples had compounds minimally above Federal or State regulatory levels. Background sample HTRW-13 in area 15G had an arsenic content of 22 milligrams per kilogram (mg/kg), which slightly exceeds the New Jersey Department of Environmental Protection (NJDEP) non residential cleanup criteria of 20 mg/kg. Sample HTRW-7 in area 17G had a Toxicity Characteristics Leaching Procedure (TCLP) lead level of 6 milligrams per liter (mg/l), which slightly exceeds the Federal Regulatory level of 5 mg/l set for toxicity characterization. Sample HTRW-10 in area 17G (duplicate) had a benzo(a)pyrene content of 674 micrograms per kilogram (ug/kg), which slightly exceeds the NJDEP non-residential soil cleanup criteria of 660 ug/kg. At most sampling locations, volatile and herbicide compounds were not detected. Relatively low levels of semi-volatile, pesticide, and metal compounds were detected.

Based upon the literature search and subsequent chemical testing, the minimal exceedance of the stated regulatory levels, and the proposed use of the area as a dredged material disposal site, no additional testing or remediation of these areas is required.

The planned use of sites 17G, 15D, 15G and Raccoon Island as disposal areas for the deepening of the Delaware River navigation channel will not have any adverse impacts on groundwater or lands beneath or adjacent to the sites with respect to HTRW. However, prior to utilization of these sites for the project, all debris, drums, tires, and all other solid waste must be removed and disposed of in accordance with relevant environmental laws and regulations. Recently, the storage tank at site 17G has been removed.

1.1.1.3 Groundwater

Concerns have been raised in regard to the use of the new and existing upland disposal areas and the potential impact to drinking water aquifers from leachate generated by disposal operations. It is hypothesized that water could percolate through the dredged material, leach out potential contaminants such as heavy metals, and carry them to the groundwater. Sediment testing of the channel and channel bends indicates that the dredged material meets the NJDEP Impact to Ground Water Soil Cleanup Criteria, without exception.

As a supplement to the sediment testing efforts, the United States Geological Survey was tasked with performing an evaluation of potential contaminant travel times from the proposed project disposal sites to nearby drinking water and industrial production wells. Their report determined that the disposal sites would not impact local wells as the sites provide a very small percentage of well recharge, and potential contaminant travel times were on the order of fifty to one hundred years. The mean travel times for groundwater from the new proposed disposal areas to reach any potential water supply well is in excess of 50 years, except for a cluster of wells near area 15G where the report states that "travel time to these wells could be relatively short, perhaps on the order of several years". It is important to consider all of the contributing factors when evaluating the potential negative impact of the travel times from all disposal areas. First, the existence of 20-40 feet of fine grained material from past dredging within the disposal areas greatly impedes the flow of water from the areas and increases the travel times substantially. In addition, the new dredged sediments from the 45 foot project contain no harmful levels of contamination; so in the event that the water were to reach the well from the disposal area, it would have no impact on water quality.

The aforementioned conditions with respect to travel time, recharge, contamination levels, and conclusions from a recent groundwater investigation conducted by the Corps of Engineers at Oldmans disposal area, indicate that possible risk of groundwater impacts at the dredged material disposal sites is negligible. The disposal of material in the proposed areas will have a negligible impact on the groundwater/aquifer system in both the local and regional area.

1.1.2 Beneficial Use Sites

1.1.2.1 Wetland Restoration Sites

Shore Erosion

The breakwaters and restored wetlands at Kelly Island will protect about 5,000 feet of severely eroding shoreline; those at Egg Island Point will protect about 10,000 feet. These shorelines have been eroding at the rate of 15 to 30 feet per year. The expected life of the geotextile tubes is estimated to be 30 years, so these areas will be afforded protection from erosion for up to that period of time. The Corps of Engineers will maintain the Kelly Island wetland restoration.

Water Quality

Sediment testing included bulk and elutriate analyses for heavy metals, pesticides, PCBs, PAHs, phthalates, volatile organics, and semi-volatile organics; bioassays; and bioaccumulation tests. The results of this testing indicates that the dredged material from the Delaware Bay portion of the project is acceptable for beneficial uses such as wetland creation and sand stockpiles for later beach nourishment.

Benthic Communities

No significant differences were found between the benthic communities at the proposed beneficial use sites and background conditions in Delaware Bay. No benthic resources were identified that would preclude development of the beneficial use sites. Therefore, no significant impact will occur to benthic resources due to the use of any of these sites as either wetland restorations or sand stockpiles.

Approximately 60 acres of mostly subtidal habitat adjacent to Kelly Island and 135 acres of subtidal habitat adjacent to Egg Island Point will be restored to intertidal habitat, consisting of mostly Spartina alterniflora (saltmarsh cordgrass). Prior to the severe erosion that is presently taking place, this area consisted of intertidal marsh. Nevertheless, the benthic community that exists will be replaced by an intertidal marsh community. The benthic communities of these sites, which cover about 195 acres, would be eliminated and the bottom would be changed from subtidal to intertidal wetland, averaging about +5 feet MLW. These sites were among those having the poorest quality benthic communities. They were characterized by a considerably less diverse assemblage than the background benthic communities in Delaware Bay. Compared to other candidate sites, they contained a higher abundance of opportunistic species, which are typical of disturbed environments. LC-9 (Kelly Island) was characterized by a different species composition between the two years it was sampled, which is a further indication of an unstable benthic community. LC-9 and PN1A (Egg Island Point) also had the lowest percent of equilibrium taxa among all of the candidate sites.

Wetlands

Approximately 60 acres of mostly subtidal habitat adjacent to Kelly Island and 135 acres of subtidal habitat adjacent to Egg Island Point will be restored to intertidal habitat, consisting of mostly *Spartina alterniflora* (saltmarsh cordgrass). In addition, hundreds of acres of intertidal wetlands that exist behind the restored wetlands will be protected from erosion.

Fish and Wildlife Resources

The construction of the wetland restorations will be phased to avoid and/or minimize impacts to fish and wildlife, especially to spawning horseshoe crabs and migrating and feeding shorebirds. Reconstruction of wetlands at Kelly Island and Egg Island Point will greatly benefit most wildlife species. Although approximately 195 acres of aquatic habitat will be lost, this was formerly intertidal marsh before being destroyed by erosion. The loss of this aquatic habitat is not considered to be a significant impact.

1.1.2.2 Sand Stockpiles

Shore Erosion

Studies indicate that there will be sediment dispersion from the sand stockpiles. Transport rates will be slow, however, so most of the placed material will remain in the stockpiles for decades. The stockpiled sand that does leave will move predominately landward, then spread laterally along the shore, thereby providing fill material for nourishment of sand-starved bay beaches.

Water Quality

Temporary water quality degradation is expected due to elevation of suspended sediments. Brief periods of elevated turbidity will occur as a result of sand placement. Extended periods of elevated turbidity would occur if wind or water currents cause sediments to remain in suspension. Water quality degradation would be more severe and widespread with unconfined open water disposal than if the sand were deposited behind containment devices such as geotextile tubes.

Benthic Communities

No significant differences were found between benthic communities at proposed sand stockpile sites and background conditions in Delaware Bay. No benthic resources were identified that would preclude use of the sites. Therefore, no significant impact will occur to benthic resources due to the use of any of these sites as either wetland restorations or sand stockpiles.

Approximately 730 acres (500 acres for MS-19 and 230 acres for LC-5) of subtidal aquatic habitat averaging -8 feet MLW will be covered with approximately 4.7 million cubic yards of sand to a depth of -3.0 feet MLW.

Placement of up to 4.7 million cubic yards of dredged material at the proposed sand stockpile sites would result in burial of the existing benthic community. Benthic recolonization depends upon a number of factors, which include substrate type, distance from similar habitat, and water currents. Recovery of the benthic community would be further hindered by future disturbance as the material is taken from the stockpiles for beach nourishment projects.

Benthic recolonization is dependent upon recruitment from plankton dispersed by water currents. Changes in current patterns and velocities may alter dispersal of benthic larvae. The loss of the benthic community due to dredged material disposal is expected to be a short-term adverse impact. The Corps has constructed twenty-three underwater berms for storm attenuation or beach nourishment throughout the United States (Landin, 1992). For example, results of detailed studies of benthic recovery and fish use on a berm constructed at Dauphin Island, Alabama, indicated rapid benthic recovery. Fish use of the area also was reported as greater than in surrounding waters. The benthic recovery and greater fish use are related to slope, configuration, and orientation of the berm in the current (Landin, 1992).

Long-term impacts would likely result from the use of the sites as sand sources for future beach nourishment projects if the area is subjected to repeated disturbances. A regularly disturbed bottom would not necessarily provide the same abundance or species composition as the present site condition. However, these impacts would occur to relatively small portions of the sandpiles at a frequency of every 5 to 10 years.

Fish and Wildlife Resources

The offshore areas in the vicinity of both proposed stockpile sites support important fisheries for weakfish. Additionally, the offshore areas in the vicinity of Sites L-5 and MS-19 support summer flounder, black sea bass, and drum (FWS. 1995b).

The environmental impacts of dredged material disposal in open water are similar in some ways to impacts resulting from sand dredging. Direct impacts include water quality degradation and temporary loss of the benthic community. Benthic community loss will in turn impact finfish species that feed on benthic organisms.

Deposition of large quantities of dredged material in sand stockpiles would decrease water depth at the sites from current depths to approximately -3 feet below MLW. This depth reduction could result in changes in the tidal regime and current patterns, which in turn could impact biological resources. Changes in the tidal regime may have some impact on biological resources associated with nearby rivers, as well as resources associated with adjacent beaches.

Placement of dredged material would result in some loss of finfish nursery and feeding areas. The loss of the food source would be expected to result in a temporary and localized reduction in recreationally and commercially important finfish species. As with effects to the benthic community, the repeated disturbance of the sand stockpile sites for future beach nourishment projects would likely result in long-term adverse impacts to local fisheries. However, these impacts would occur to relatively small portions of the sandpiles at a frequency of every 5 to 10 years.

1.1.2.3 Sediment Transport/Oyster Impact Investigations

Wetland Restorations

Commercially important oyster lease beds are located throughout the offshore area around Egg Island Point. Most of these lease beds are located 500 to 800 feet offshore; but in some cases lease beds are located within close proximity to the shoreline. Oyster seed beds occur to the northwest of Straight Creek; this area also supports a commercially important blue crab fishery (FWS. 1995b). In Delaware, commercially important oyster seed beds exist in the area offshore of Kent Island and Kelly Island. There are also oyster beds inside the mouth of the Leipsic River. Additionally, hard clams and blue crabs are distributed throughout the Kelly Island area. Blue crabs in this area are commercially important.

Concern was expressed by the resource agencies regarding potential impacts to oysters due to movement of sand used to build the wetland restorations at Egg Island Point and Kelly Island. In addition, concern was expressed regarding the fate of fine grained material that will be confined behind the sand berms and geotextile tubes at Kelly Island if there was a catastrophic failure of this structure. Concern was also expressed about the possible fate of sand placed in the sand stockpiles.

To address these concerns, studies were conducted to map potential sediment transport rates and pathways due to planned projects at Egg Island Point, Kelly Island, MS-19, and L-5 to assess potential impacts on neighboring shellfish areas. These studies were performed by the Waterways Experiment Station (Coastal Engineering Research Center), Offshore and Coastal Technology, Inc., and the Haskin Shellfish Research Laboratory of Rutgers University.

In order to perform the studies, numerical current and wave models were employed to aid in defining sediment transport mechanisms. Tidal current data was collected in summer 1995 at each location during typical daily conditions to define ambient conditions, and to provide some model calibration data. To aid in calibrating sediment transport estimates, suspended solids data collected over several years was supplied by the Haskin Shellfish Research Laboratory. Based upon the models and data, calculations of current-driven and wave-driven sediment transport were made for both storm and normal conditions, which were then used in a shellfish survivability computer model to assess potential impacts on neighboring shellfish beds.

Shellfish survivability modeling was performed for the wetland restoration sites by examining the effect of a 4-day and a 30-day high-turbidity event in each season of the year with a turbidity level of 2 g/l, which was found to be approximately the maximum expected concentration during an extreme storm. The 4-day storm event was selected because it is longer than the extreme storms of record. The 30-day case was selected because it could be typical of the time required to detect and address a sediment leak from the containment areas, and to provide information on the variation in impacts with the duration of turbidity.

The results of the shellfish survivability calculations show that there is no expected impacts on oyster survivability or growth due to the events considered, except at Kelly Island in the month of August. Because August storm events are much shorter than the 4-day event considered, insignificant impacts are expected on oysters during expected real storm events at that time of year. The 30-day event, although also potentially causing an impact at Kelly Island in August, is most likely to be prevented in August because that time of the year is best for performing repair work on the containment system. In addition, any 30-day event in August will exhibit turbidity concentrations that are much less than 2 g/l, and more likely 150 mg/l. Similar 30-day simulations with turbidity levels of approximately 150 mg/l in August show much less impact, with the entire spawn not being lost and no increase in mortality over ambient conditions.

A monitoring and maintenance plan will be developed during the next study phase, Plans and Specifications, before construction.

In light of the sensitivity of the oyster resources of the Kelly Island area certain measures will be planned to protect the oyster beds. The beds exist under inherently low food supplies and do not have the reserves required to easily withstand increased turbidity levels. Before the construction of the Kelly Island wetlands restoration site, oyster populations will be measured so that comparisons can be made to conditions during construction. Parameters to be measured include abundance, size (biomass) frequency, disease infection intensity, reproductive state, and recent mortality. If turbidity levels increase during construction, the same parameters would be measured to determine the extent of impacts. If the impacts are considered to be significant, restoration of the oysters damaged by the turbidity will be done.

Maintenance

Three areas of maintenance may be necessary at the Kelly Island Wetlands Restoration Project. These areas of maintenance include project structures, Mahon River navigation channel, and habitat within the wetland restoration.

Sand Stockpiles

The two stockpile sites MS-19 and LC-5 were modeled together in the same wave model and current model grids and simulations because of their proximity. In both cases, it was found that the sediment pathways were similar (i.e. net wave-driven mass transport is potentially onshore, and the potential longshore net transport is to the northwest). The stockpiles are expected to migrate slowly onshore; however, major 2- to 5-year storms can potentially transport 40,000 cubic yards in a single event in the onshore direction. Mean current-driven velocities along the coast due to astronomical tidal action were found to be to the south. Again, these transports indicate slow movement of material to the northwest and southeast, forcing the stockpiles to spread laterally.

A significant transport component is the wave-induced longshore transport potential at these sites. At Broadkill Beach (LC-5) average net transport potential is calculated to be about 230,000 cubic yards per year to the northwest (left). At Slaughter Beach (MS-19), net transport potential is calculated to be approximately 260,000 cubic yards per year in the same direction.

No change in longshore transport along the coast is calculated for the stockpiles with a crest elevation of -3 feet MLW or for either stockpile with a crest elevation of 0 feet MLW, if the stockpiles are kept a minimum of 1500-2000 feet from shore.

1.1.3 Sediment Quality

After review of sediment quality data for dredged material derived from the Delaware River Main Channel Deepening project area, it is concluded that the relative risk of contaminants in the dredged material to human health, wildlife, and especially endangered species such as the bald eagle and peregrine falcon should be very low and consequently, should not be a significant concern. The frequency of detection of contamination in sediment samples collected throughout the project area was low and therefore any detected contamination when placed in the designated disposal sites will be mixed to such a large extent that contaminant concentrations will end up very low.

1.1.3.1 Bulk Sediment Analyses

To evaluate potential human health impacts associated with disposal of channel sediments, bulk data were compared to New Jersey Department of Environmental Protection (NJDEP) Residential, Non-Residential and Impact to Groundwater Soil Cleanup Criteria (NJAC 7:26D).

A total of 91 chemical parameters were compared to the NJDEP criteria. All 91 parameters in all five reaches met the NJDEP Impact to Ground Water Soil Cleanup Criteria, without exception. All 91 parameters in all five reaches met the NJDEP Residential and Non-Residential standards, with the exception of the pesticide toxaphene and the heavy metals thallium and cadmium. Toxaphene has Residential and Non-Residential standards of 0.10 and 0.20 ppm, respectively. While toxaphene was not detected in any of the 153 sediment samples tested, the laboratory quantification limits were consistently above NJDEP standards. As such, a definitive conclusion with regard to toxaphene is not possible. Worst case concentrations of toxaphene in channel sediments, calculated solely on laboratory detection levels, range from 0.26 ppm in Reach E to 0.56 ppm in Reach A. There is no reason to believe that toxaphene is a contaminant of concern in the Delaware Estuary. Therefore, the risk that actual concentrations of toxaphene in channel sediments are above NJDEP standards is considered low.

Both the Residential and Non-Residential standards for thallium are two ppm. Mean concentrations of thallium were above the standard in Reaches A and B. Mean concentrations were 3.76 and 2.48 ppm, respectively. A total of 82 separate sediment samples were collected from Reaches A and B over three sampling events. All of these samples were analyzed for thallium. The initial event in 1991 collected 42 samples. Thirty of these samples had laboratory quantification limits greater than two ppm. Four samples had actual thallium detections greater than two ppm (5.5-9.0 ppm). Twenty additional sediment samples were collected in 1992, and the final 20 samples were collected in 1994. These 40 samples showed thallium concentrations in channel sediments to be less than two ppm. All 40 samples had laboratory quantification limits or actual detections of thallium below 0.4 ppm. While mean thallium concentrations for channel sediments in Reaches A and B are above the NJDEP standard, it appears that high detection levels from the 1991 sampling event is responsible for skewing the means. Two subsequent sampling events failed to reproduce the earlier results. Like toxaphene, there is no reason to believe that thallium is a contaminant of concern in the Delaware Estuary. Based on the above information, it is concluded that the calculated mean concentrations are high, and that the true mean thallium concentration in channel sediments is actually below two ppm.

The mean cadmium concentration of channel sediment samples collected from Reach A was 1.66 ppm. This is above the NJDEP Residential standard of one ppm, but well below the Non-Residential standard of 100 ppm. Cadmium was detected in a number of samples at concentrations above one ppm, so there is no reason to suspect that the calculated mean is high. Since the material dredged from Reach A would be placed in an upland, dredged material disposal site that would not be used for residential development, and since the mean concentration of cadmium is so far below the NJDEP Non-Residential sediment standard of 100 ppm, it is concluded that the concentration of cadmium in sediments from Reach A would not pose any significant human health concerns.

PCBs. The highest concentrations of PCB-1254 and PCB-1248 observed in one out of 49 samples from Reach B of the project area were 1.19 and 0.53 ppm, respectively. After dredging and placement in a disposal site, the overall final PCB concentration will no doubt be below 0.25 ppm. Bioaccumulation of PCBs in wetland and upland soil dwelling animals have been observed to be less than one half the concentration measured in the dredged material. For example, at the Corps of Engineers' Field Verification Program field sites, both earthworms in an upland site and sandworms in a wetland site bioaccumulated approximately 3 ppm PCBs from dredged material containing 6.7 ppm PCBs (Lee et al. 1995). FDA action levels for human consumable food have been set at 2 ppm PCBs. While there are no set action levels for wildlife food, it is reasonable to assume that foodchain components that contain above 2 ppm could represent significant risk to wildlife. It would appear that reduced concentrations of sediment PCBs, such as 0.25 ppm, should not be a significant risk to wildlife exposed to an ecosystem developed on the proposed disposal sites for dredged material from the Delaware Estuary.

Pesticides. Few sediment samples showed detected pesticides. One sediment sample out of 33 showed 0.060 ppm heptachlor epoxide (Reach A), while another sample out of 49 showed 0.06 ppm Endosulfan (Reach B), and finally a third sample out of 19 showed 0.026 and 0.045 ppm of DDD and DDE, respectively. Dredging and placement of sediments in the disposal sites will result in reduced concentrations of these pesticides. The reduced concentrations should not represent a significant risk to wildlife.

PAHs. Sediment samples did show detectable amounts of PAHs. The highest concentrations of PAHs were observed in 2 out of 49 samples in Reach B. One sample approached a total PAH concentration of 10 ppm. Concern for exposure of foodchain components to sediments containing 10 ppm or more of PAHs could be warranted. However, when this sediment is dredged and placed in a disposal site with the other 48 sampled sediments within the Reach, the resultant reduced concentration of PAHs should be approximately 0.2 ppm and of little concern or risk.

Metals. Most sediment samples showed detectable metals. Metals that were detected at levels that might be of concern were cadmium (1.66 ppm, mean concentration for Reach A) and thallium (3.76 and 2.48 ppm mean concentration for Reaches A and B, respectively). These concentrations were above NJ DEP Residential Direct Contact Soil Cleanup Criteria, which can give some perspective of sediment chemical data, but may not relate well at all to the risk to wildlife. All other metals are considered low and should not be a significant risk.

1. Cadmium. Up to 1994, 2.7 ppm cadmium was the soil concentration allowed for land receiving sewage sludge and used in crop production for human and animal food (Lee et al. 1991). Newly established EPA 503 regulations for land application of sewage sludge raised the soil levels to 34 ppm cadmium for unrestricted use of land. It would appear that dredged material containing an average concentration of 1.66 ppm cadmium should be of low risk in light of the 503 limitations. Bioaccumulation of cadmium in foodchains has been observed on dredged material containing 11 ppm cadmium (Stafford et al. 1987). Cottonwood trees that colonized the Times Beach Confined Disposal Facility at Buffalo, NY took up cadmium from the dredged material into their leaves. The leaf litter on the soil surface was inhabited by earthworms which bioaccumulated cadmium up to 100 ppm, resulting in a significant potential risk to wildlife foodchains on the disposal site. This example is an order of magnitude more sediment cadmium than that observed in Delaware River sediments and illustrates that bioaccumulation can occur at higher soil cadmium concentrations.

2. Thallium. The risk of thallium to foodchains is unknown. While there are water quality criteria for thallium for human risk assessment, there are no FDA action levels for thallium in human or animal food. The concentration of thallium observed, 2.48 and 3.76 ppm, appears to be above the NJDEP Residential Direct Contact Soil Cleanup Criteria of 2.00 ppm, however, the magnitude above the criteria is below 2X times. Concern for concentrations of potential contaminants usually becomes warranted when magnitudes above criteria approach 5X times. Until a more applicable criterion is established for the risk of thallium to wildlife foodchains, the risk to wildlife should be considered low.

1.1.3.2 Elutriate Sediment Analyses

The discussion above is related to disposal site impacts. The potential for impacts and risk to fish and wildlife is minimal from the dredging of sediments in the Delaware River, based on the collected data. Elutriate test results show very little release of contaminants of concern to the water column. Dredging will temporarily suspend sediments, but the duration and exposure will be temporary and should not result in significant risk. Bioassay tests with suspended sediments showed no toxicity or bioaccumulation of any significance. Therefore, the risk to fish and wildlife should be insignificant.

1.1.3.3 Bioassay and Bioaccumlation Testing

All water column and whole sediment bioassays resulted in 100 percent survival of all test species. The results of the water column bioassays suggest that sediment disturbance, and associated water column turbidity, at the point of dredging and at dredged material disposal locations would not result in mortality of aquatic organisms in the vicinity. Likewise, the results of the whole sediment bioassays suggest that aquatic organisms that colonize sediment placed for beneficial uses in Delaware Bay would also be unaffected by sediment contaminants.

With regard to bioaccumulation, there was no evidence that contaminants accumulated in clam tissue (*Mercenaria mercenaria*) exposed to Delaware Bay sediment at greater concentrations than clam tissue exposed to clean laboratory sediment. All of the tissue residues were representative of what one would expect in organisms exposed to uncontaminated material. With regard to bioaccumulation and the polychaete *Nereis virens*, there were no statistical differences between contaminants in worms exposed to channel sediments and worms exposed to reference sediments, with the exception of the heavy metal arsenic. The mean arsenic concentration in worms exposed to one channel sediment sample (0.700 ppm) was statistically higher than concentrations in worms exposed to reference sediment samples (0.360 and 0.460 ppm). The measured tissue concentration of arsenic in worms exposed to the channel sediment did not appear to be deleterious. No more mortality was observed in the channel sediment test worms than in worms exposed to other sediments. Furthermore, a mean tissue concentration of arsenic in worms exposed to the control sediment (0.680 ppm), which was obtained in Maine where the worms were collected, was virtually identical to that measured for the channel sediment worms (0.700 ppm). Both of these values are well below the range of acceptable background tissue arsenic concentrations for test organisms from East Coast sites, which is reported to be 1.5 to 3.9 ppm in the USEPA *Guidance Manual for Bedded Sediment Bioaccumulation Tests* (EPA-600-R-93-183). Overall, test results suggest that open water placement of Bay sediment is acceptable with regard to bioaccumulation concerns.

1.1.4 Salinity Modeling

A fundamental conclusion from the study is that deepening the existing navigation channel from 40 feet to 45 feet will result in salinity (chlorinity) increases in the Philadelphia area during a recurrence of the drought of record. However, the increases will not have an adverse impact on water supply. The present DRBC drought management plan, including reservoir storage added since the drought of record, prevents the intrusion of ocean salinity into the Philadelphia area in excess of existing standards. With the deepened channel and a recurrence of the drought of record (1961-1965), the maximum 30-day average chlorinity at River Mile (RM) 98 is about 150 parts per million (ppm).

During normal to high flow periods with the deepened channel, oyster bed areas in the lower bay will experience increases in salinity due to steeper longitudinal salinity gradients. The impact of those increases on oyster production is viewed as negligible. Changes in the subtidal circulation over the oyster beds due to channel deepening will also be minimal, e.g., less than 1 centimeters per second (cm/sec). Results from the simulation of a 1.0 ft sea level rise combined with channel deepening are ambiguous due to a number of limitations. The principal limitation is the apparent need for a model domain encompassing the entire Chesapeake Bay, not just the portion of the bay above Annapolis, MD, as was the case with the present model. Model results clearly show the need to include the exchange between the Delaware Bay and the Upper Chesapeake Bay when addressing problems dependent upon subtidal processes. The impact of this exchange with the deepened channel depends upon the direction of the net flow through the C&D Canal. The direction of the net flow is highly variable in time and depends upon the particular winds, tides, and freshwater inflows.

1.1.5 Endangered Species

1.1.5.1 Section 7 Consultation

In compliance with Section 7 (c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), biological assessments were prepared that evaluate the potential effects of the Channel Deepening Project on species listed by either the U.S. Fish and Wildlife Service (October 1995) or the National Marine Fisheries Service (September 1995). These assessments were prepared in accordance with the Joint Regulations on Endangered Species (50 CFR Section 402.12). Both of the biological assessments concluded that there will be no impact that would jeopardize the continued existence of any of the listed species, or their critical habitat, as a result of this project.

In a letter dated January 18, 1996 (See Appendix A), the U.S. Fish and Wildlife Service stated that they concur with the District's determination that the Delaware River Main Channel Deepening Project is not likely to adversely affect federally listed species under the Service's jurisdiction. This is based on implementation of the "reasonable and prudent measures to minimize impacts" that are described in Section 10.5. A Biological Opinion was issued by the NMFS on November 26, 1996 for all dredging projects permitted, funded, or conducted by the District. The Opinion stated that dredging projects within the Philadelphia District may adversely affect sea turtles and shortnose sturgeon, but are not likely to jeopardize the continued existence of any threatened or endangered species under the jurisdiction of the NMFS.

U.S. Fish and Wildlife Service (FWS)

A meeting was held in the Philadelphia District office on

December 14, 1994 with representatives from the FWS. Ms. Dana Peters, FWS, stated that the species of concern are the bald eagle and the peregrine falcon. For the bald eagle, the concerns are possible exposure to contaminants from the additional dredging, and disturbance during nesting. The FWS recommended that the following potential impacts be addressed in a biological assessment: disturbance, increased development, contaminants, and increased oil spills. FWS recommended that the assessment be coordinated with Larry Niles of the NJDEP. For the peregrine falcon, FWS recommended that the biological assessment address disturbance at their nest/roosting sites at the Walt Whitman and Commodore Barry bridges, as well as contaminants. There are presently no restrictions for dredging in the Delaware River for the peregrine falcon.

National Marine Fisheries Service (NMFS)

On August 21, 1993 NMFS forwarded a letter to the Philadelphia District formally requesting that the District conduct a district-wide consultation. Further coordination determined that the Philadelphia District would prepare a biological assessment to evaluate potential dredging impacts to right, humpback, and fin whales; and Kemp's ridley, loggerhead, leatherback, green and hawksbill sea turtles in the Delaware Estuary and along the Atlantic coasts of New Jersey and Delaware. The District would also evaluate potential dredging impacts to shortnose sturgeon in the Delaware River and Bay. A Biological Opinion was issued by the NMFS on November 26, 1996 for all dredging projects permitted, funded, or conducted by the District. The Opinion stated that dredging projects within the Philadelphia District may adversely affect sea turtles and shortnose sturgeon, but are not likely to jeopardize the continued existence of any threatened or endangered species under the jurisdiction of the NMFS. They also stated that while endangered whales may be present in the action area of these dredging projects, effects from increase dredging traffic are expected to be minimal.

1.1.5.2 Reasonable and Prudent Measures to Minimize Impacts

Species Under the Authority of the U.S. Fish and Wildlife Service (FWS)

1. Bald Eagle

Prior to construction of the upland, confined, dredged material disposal areas, the Philadelphia District will coordinate with the USFWS and the NJDEP to determine if there are any bald eagle nests within 0.25 miles or a line of site distance of 0.5 miles from an upland dredged material disposal area. If there is an active nest within these distances, construction of the site and the use of the site for the disposal of dredged material will be staged to avoid disturbance impacts.

2. Peregrine Falcon

1. Coordination with the NJDEP will occur before initiating any new work at the Raccoon Island upland dredged material disposal site between 15 March and 15 April.

2. The Philadelphia District will move the nest structure located at Egg Island Point to a safer location as determined in coordination with the NJDEP.

Species Under the Authority of the National Marine Fisheries Service (NMFS)

1. Sea Turtles

The Philadelphia District is concerned with the possible negative impacts that dredging may exert on threatened and endangered populations of sea turtles both in the Delaware Estuary and along the Atlantic coast of New Jersey and Delaware. We also recognize the need to monitor activities which may present a genuine threat to species of concern. It is the intention of the Philadelphia District to continue monitoring in soft-bottomed shipping channels such as the Delaware Estuary, when warranted. Sea turtle observer(s) shall be on board any hopper dredge working in areas of concern during the first week of the dredging operation from 1 June to 30 November. Following the first week, the observer shall be on board the dredge on a biweekly basis or as appropriate, so that the total aggregate time on board the dredge equals 50 percent of the total time of the dredging operation. While on board the dredge the observer shall provide the required inspection coverage on a rotating, six hours on and six hours off, basis. In addition, these rotating six hour periods should vary from week to week. All such dredging and monitoring will be conducted in a manner consistent with the Incidental Take Statement issued by NMFS for this District. It is also the District's opinion that any program implemented for observation or protection of sea turtles should remain somewhat flexible pending results of such procedures. The District will continue to coordinate monitoring results with NMFS, and work to develop appropriate measures to minimize impacts.

2. Whales

Due to the slow nature of right whales, it is the District's intention to slow dredging vessels to 3 - 5 mph operating speed after sun set or when visibility is low, when a right whale is known to be in the project area. Contract plans and specifications will require a hopper dredge operator to monitor and record the presence of any whale within the project vicinity.

3. Shortnose Sturgeon

The Philadelphia District will continue to follow the recommended dredging windows established by the Delaware Basin Fish and Wildlife Management Cooperative:

Hydraulic dredging, is prohibited from the Delaware Memorial Bridge to the Kinkora Range in non-Federal areas between April 15th and June 21st. No hydraulic dredging restrictions exist for the Federal channel or anchorages.

Overboard disposal and blasting are prohibited from the Delaware Memorial Bridge to the Betsy Ross bridge in all areas between March 15th and May 31st. Bucket dredging is prohibited from March 15 to May 31 from the Delaware Memorial Bridge to the Kinkora Range. In all areas in the Delaware Bay to the Delaware Memorial Bridge, turtle monitors are required from June 1 to November 30 on hopper dredges.

State Listed Species of Concern

1. Osprey

The construction and operation of the Raccoon Island dredged material disposal area may disturb ospreys that are nesting nearby. The Philadelphia District has been in contact with the NJDEP to find ways to avoid and/or minimize impacts. Ospreys are most vulnerable to disturbance during nest initiation and incubation, which occurs between March 20 and May 31 (Clark. 1995). Construction activities and operating vessels near the nest site will be avoided during this period. Activities such as berm construction may be able to be done during this period if the activities take place strictly on land, and construction vehicles are sufficiently hidden and/or their sound muted relative to the osprey's location. The District will continue to coordinate closely with the NJDEP to follow these guidelines as much as is practicable.

1.1.6 Oil Spill Planning

In general, the Delaware Main Shipping Channel is safe. Despite its length, the volume of traffic and the number of turns required, there are few casualties and few oil spills occurring in the waterway. The high degree of skill and training by pilots, navigation aids built and maintained by the U.S. Coast Guard, and an overall sense of cooperation among various waterway interests, contribute to the navigation safety of the Delaware River. Based on historical spill data, the existing oil spill contingency plan for the Delaware River/Bay appears adequate to handle the vast majority (over 99 percent) of oil spills that may occur in the area. From interviews with experts knowledgeable about the Delaware shipping channel, the channel deepening project, with its selective bend easings, will continue the record of safety in the Delaware River/Bay that has been achieved by the local waterway users. The channel deepening is expected to reduce lightering operations at the Big Stone Beach Anchorage by 40%. This is expected to reduce barge traffic servicing the benefiting oil refineries located in the Delaware River portion of the project area and therefore the likelihood of oil spills.

In addition, a combined effort between the Corps of Engineers, New Jersey Department of Environmental Protection, the US Fish and Wildlife Service and Environmental Systems Research Institute (ESRI), has resulted in The Marine Spill Analysis System (MSAS) for Arc View 2. The system is a personal computer based analysis tool that utilizes Geographic Information Systems (GIS) technologies to combine environmental data, emergency response themes, and digital imagery in order to identify natural resources at risk in the event of an oil spill. The MSAS has the capability to import spill trajectory boundaries produced by other spill models allowing for a quick calculation of quantities for those areas in danger, thus providing timely information to help protect resources threatened by the spill. A comprehensive database consisting of numerous environmental resource datasets are available to the user for impact analysis. Also, an emergency facilities database is linked to the system helping the user in deciding which emergency personnel to contact during a spill event. All output from the system can be used by the Philadelphia Area Committee for practice spill drills and to help emulate various levels of spill scenarios.

1.1.7 Rock Blasting

Adverse impacts to fish will be minimized by conducting blasting between 1 December and 15 March, as recommended by the Delaware River Basin Fish and Wildlife Cooperative, and by using techniques such as delayed blasting and "stemming" to reduce the amount of energy that would impact fish. Monitoring of impacts to fish from blasting will also be conducted.

1.1.8 Cultural Impacts

The draft report of the final cultural resources investigation and the District's finding of "No Effect" was submitted to the Pennsylvania, New Jersey and Delaware SHPO's in September and October, 1995 (see Appendix A). No further cultural resource investigations are anticipated for this project. Section 106 coordination with the Delaware SHPO is continuing and will be concluded prior to any project construction activity.

1.1.9 Environmental Windows

Table 1-1 lists the times of year that certain activities are restricted or prohibited to protect sensitive resources. The Corps of Engineers will make every effort to abide with these restrictions, however, in some cases work must be done within these windows, in the case of horseshoe crabs spawning and shorebirds. All work done within these windows will be coordinated with the Federal and state resource agencies, and no significant impacts are expected. Please refer to the reference section of SEIS for a complete discussion.

1.2 Relationship to Environmental Statutes

Table 1-1. Environmental Windows

RESOURCE	ACTIVITY	ENVIRONMENTAL WINDOW	REFERENCE SEIS SECTION
Fish	Rock Blasting Overboard Disposal in All Areas	15 March-30 Nov. (Delaware Memorial Bridge to Betsy Ross Bridge)	13.4.3
Shortnose Sturgeon	Hydraulic Dredging in Non-Federal Channels	15 April-21 June (Delaware Memorial Bridge to Kinkora Range)	10.5.2.3
Shortnose Sturgeon	Bucket Dredging in All Areas	15 March-31 May (Delaware Memorial Bridge to Kinkora Range)	10.5.2.3
Sea Turtles	Hopper Dredging in All Areas	1 June-30 November (Delaware Bay to Delaware Memorial Bridge; Sea Turtle Monitors Required)	10.5.2.1
Nesting and Migratory Birds	Construction of Upland Confined Disposal Facilities	Varies	6.6.2
Shorebirds and Horseshoe Crabs	Construction of Wetland Restorations	1 April-30 June	3.3.4.3
Pea Patch Island Wading Bird Colony	Dredging within 2600 ft of Colony	1 April-1 August	10.4.3.6
Bald Eagle and Peregrine Falcon	Construction of Upland Confined Disposal Facilities	Varies	10.5.1
Osprey	Construction of Upland Confined Disposal Facilities	20 March-31 May	10.5.3.1

In accordance with the Fish and Wildlife Coordination Act, two planning aid reports were obtained from the U.S. Fish and Wildlife Service during this study. One of the planning aid reports provided information to assist the District in the beneficial use of dredged material, and the other provided information on managing the upland dredged material disposal areas as wetlands and wildlife habitat. Both of these reports are included in the Appendix B.

In compliance with Section 7 (c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), biological assessments were prepared that evaluate the potential effects of the Channel Deepening Project on species listed by either the U.S. Fish and Wildlife Service (October 1995) or the National Marine Fisheries Service (September 1995). These assessments were prepared in accordance with the Joint Regulations on Endangered Species (50 CFR Section 402.12). Both of the biological assessments concluded that there will be no impact that would jeopardize the continued existence of any of the listed species, or their critical habitat, as a result of this project.

Based on the information developed during preparation of this Draft Supplemental Environmental Impact Statement, and the application of appropriate measures to minimize project impacts, it was determined in accordance with Section 307(c) of the Coastal Zone Management Act of 1972 that the proposed project complies with an will be conducted in a manner that is consistent with the approved Coastal Zone Management Programs of Pennsylvania, New Jersey and Delaware. Letters of conditional concurrence with our statement of Coastal Zone consistency have been provided by the three States (See Appendix A).

The Philadelphia District of the U.S. Army Corps of Engineers has been involved with the on-going Delaware Estuary Program. District personnel served on the Management Committee and the Science and Technical Advisory Committee (STAC). The District has made project presentations to the Management Committee, the STAC and the Citizens Advisory Committee (CAC). The Delaware Estuary Program has recently prepared a Comprehensive Management Plan to efficiently manage the resources of the Delaware Estuary. The Corps will remain involved to insure that their activities are consistent and supportive of the program.

In order to implement the requirements of Section 404 of the Clean Water Act, an exemption was granted under Section 404(r) when the project was authorized by Congress in October 1992, under the Water Resources Development Act of 1992. A Section 404(b)(1) evaluation has been prepared and follows Table 1-1. This evaluation concluded that the proposed action would not result in any significant environmental impacts relative to the areas of concern under Section 404 of the Clean Water Act.

Table 1-2 provides a list of Federal environmental quality

Table 1-2. Compliance with Environmental Quality Protection Statues and Other Environmental Review Requirements.

Federal Statues	Proposed Plan
Archaeological and Historical Preservation Act, as amended	Full Compliance
Clean Air Act, as amended	Full Compliance
Clean Water Act of 1977	Exempted *
Coastal Zone Management Act of 1972, as amended	See below**
Endangered Species Act of 1973, as amended	Full Compliance
Estuary Protection Act	Full Compliance
Federal Water Project Recreation Act, as amended	N/A
Land and Water Conservation Fund Act, as amended	N/A
Fish and Wildlife Coordination Act	Full Compliance
Marine Protection, Research and Sanctuaries Act	Full Compliance
National Historic Preservation Act, as amended	Full Compliance
National Environmental Policy Act, as amended	Full Compliance
Rivers and Harbors Act	Full Compliance
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic Rivers Act, as amended	N/A
Executive Orders, Memorandum, etc.:	
EO 11988 Floodplain Management	Full Compliance
EO 11990 Protection of Wetlands	Full Compliance
EO 12114 Environmental Effects of Major Federal Actions	Full Compliance
Analysis if Impacts on Prime and Unique Farmlands	Full Compliance
State and Local Policies	
Coastal Area Management Amendments 1974	Full Compliance
State/Local Permits	See Below***

NOTES: The compliance categories used in this table were assigned based on the following definitions:
Full - All requirements of the statute, E.O., or other policy and related regulations have been met for this stage of project review.
N/A - Statute, E.O., or other policy not applicable.

* This project was granted an exemption under Section 404(r) of the Clean Water Act.
** CZM has been obtained from PA and DE, and will be obtained from NJ prior to construction.
*** All appropriate state and local permits will be obtained prior to construction.

statues applicable to this document, and their compliance status relative to the current stage of project review. Aside from the approvals discussed above, no other permits or approvals are required for implementation of the proposed plan of improvement.

1.2.1 Relationship to the Delaware Estuary Plan

The Delaware Estuary Plan (September, 1996) was reviewed to determine how construction of the Main Channel Deepening Project would effect the implementation of the Plan. The Action Items of the Plan that would be effected are discussed below:

Action L3: Support the Implementation of Coastal Zone Act Management Measures.

The project will be in compliance with this act.

Action W7: Coordinate Dredging Activities and Priorities and the Management of Dredged Material Within the Region.

As described in the SEIS, this project has been coordinated with the three states, as well as Federal conservation agencies. Dredged material from this project will be used for wetland restoration and protection in New Jersey and Delaware. Confined, upland, dredged material disposal areas will be managed to provide wetland habitat. These project features were developed in coordination with the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, the New Jersey Department of Environmental Protection, and the Delaware Department of Natural Resources and Environmental Control.

Action H1: Assure Compliance with Existing Interstate Species Management Plans and Prepare Plans for Additional Appropriate Species.

As described in the SEIS, this project has been coordinated with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the conservation agencies from the three effected states. Measures have been added to avoid or minimize impacts to Federally and state listed species as well as other significant resources. Endangered Species consultation has been completed with the FWS and NMFS. Reasonable and prudent measures have been implemented to avoid and minimize impacts.

Action H4: Coordinate and Enhance Wetlands Management within the Estuary.

Refer to response W7 above.

Action H7: Implement Measures to Protect Shoreline and Littoral

Habitats that are Threatened by Sea Level Change.

Refer to response to W7 above. The wetland restoration and protection projects in New Jersey and Delaware using dredged material will help protect these areas from sea level change.

Action H8: Facilitate Coordination among the States to Update and Improve Environmental Sensitivity Index Mapping for Hazardous Spill Response Information.

The Philadelphia District has contributed funds for developing this information as part of this project.

Action T1: Implement a Toxics Management Strategy to Assist Environmental Managers in Developing Regional Prevention and Control Strategies.

The District has collected a great deal of sediment information as a result of this project, and will continue to collect additional sediment data to monitor for possible toxic material. This data is shared with the States.

Action T5: Identify the Sources of Contaminated Sediments, Examine the Process Through Which these Substances are Transported up the Food Chain, and Identify Control Strategies and Mitigation Alternatives.

The District has done extensive physical and biological testing of sediments to determine if any problem areas exist. As discussed in Section 4, no significant impacts are expected.

SECTION 404 (b) (1) EVALUATION: DELAWARE RIVER COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT

I. PROJECT DESCRIPTION

A. Location: Delaware River and Bay from Philadelphia to the Sea, with dredging and confined, upland disposal sites in Delaware and New Jersey, and various placement locations in Delaware Bay for beneficial uses (See Figure 2-2).

B. General Description: The recommended plan of improvement modifies the depth of the existing navigation channel from 40 to 45 feet at mean low water, with an allowable dredging overdepth of one foot. The modified channel would follow the existing channel alignment from Delaware Bay to Philadelphia Harbor and Beckett Street Terminal, Camden, New Jersey, with no change in channel widths. The plan also includes widening 12 of 16 existing channel bends, as well as partial deepening of the Marcus Hook Anchorage to 45 feet. Approximately 33 million cubic yards of material would be dredged for initial project construction. In addition, 229,000 cubic yards of rock would be removed from the channel in the vicinity of Marcus Hook, Pennsylvania, with approximately 70,000 cubic yards being removed by blasting and the remainder being removed by mechanical methods such as a dragline. Annual maintenance dredging for the 45-foot channel would increase to 6,007,000 cubic yards from the current 4,888,000 cubic yards for the 40-foot channel, for a net increase of 1,119,000 cubic yards. In the riverine portion of the project area, dredged material would be placed in nine active, Federal, upland, dredged material disposal sites, and four new upland sites identified as 17G, 15D, 15G and Raccoon Island. In Delaware Bay, dredged material from initial project construction would be used for wetland restoration at Egg Island Point, New Jersey and Kelly Island, Delaware, and for stockpiling of sand for later beach nourishment work at Slaughter and Broadkill beaches in Delaware. All material that will be dredged from the Delaware Bay for channel maintenance will be deposited into the existing open water site at Buoy 10, as is the present practice.

C. Authority and Purpose
Authorized by a resolution adopted by U. S. House of Representatives, Committee on Public Works dated December 1, 1970 and resolutions adopted by the U. S. Senate, Committee on Public Works, dated March 1, 1954 and September 2, 1974. The Delaware River Main Channel Deepening Project was authorized by Congress for construction in October 1992 as part of the Water Resources Development Act of 1992.

D. General Description of Dredged or Fill Material

(1) General characteristics of Material: Rock, gravel, sand and silt.

(2) Quantity of Material (cubic yards): Approximately 33 million cubic yards of material would be dredged for initial project construction consisting of 17.5 million cubic yards of sand and gravel, and 15.9 million cubic yards of silt. Most of the material dredged from Delaware Bay is sand. In addition, 229,000 cubic yards of rock would be removed from the channel in the vicinity of Marcus Hook, Pennsylvania. Annual maintenance dredging for the 45-foot channel would increase to 6,007,000 cubic yards from the current 4,888,000 cubic yards for the 40-foot channel, for a net increase of 1,119,000 cubic yards(approximately 65% sand and gravel, and 35% silt).

(3) Source of Material: Delaware River Navigation Channel from the Beckett Street Terminal, Camden, NJ to the mouth of Delaware Bay.

E. Description of the Proposed Discharge Sites

(1) Location (map): The locations of dredged material disposal sites are shown on Figure 2-2.

(2) Size (acres): Proposed confined dredged material disposal sites: 17G - 295 ac.; 15D - 320 ac.; 15G - 275 ac.; and Raccoon Island - 350 ac.; Existing Federal, dredged material disposal sites: Reedy Point. - 255 ac. (2 sites); National Park - 115 ac.; Pedricktown North and South - 1085 ac. (2 sites); Penns Neck - 325 ac.; Killcohook - 1235 ac.; and Artificial Island - 300 ac.; Wetland Restorations: Kelly Island - 60 ac; and Egg Island Point - 135 ac.; Sand Stockpiles: MS-19 (Slaughter Beach) - 500 ac; and L-5 (Broadkill Beach) - 230 ac. The open water disposal site at Buoy 10 is approximately 1000 acres in size.

(3) Type of Sites: Proposed and existing upland dredged material disposal sites adjacent to the Delaware River and open water sites in Delaware Bay.

(4) Types of Habitat: All of the proposed confined dredged material disposal sites have previously been used for disposal of dredged material. These areas are predominantly vegetated with common reed and seasonal crops, with smaller areas of oldfield vegetation, and second growth forest; they contain approximately 396 acres of wetlands consisting primarily of common reed (See Table 6-2). The existing confined dredged material disposal sites are predominately vegetated with common reed. The wetland restoration sites are intertidal areas, and the sand stockpile sites are estuarine subtidal habitats in Delaware Bay.

(5) Timing and Duration of Discharge: 3 year initial dredging duration; maintenance dredging will occur annually in selected reaches over a 50 year period.

F. Description of Disposal Method: Hydraulic pipeline dredge or hopper dredge with direct discharge to upland diked disposal area or beneficial use sites (wetland restorations and sand stockpiles) in Delaware Bay.

II. FACTUAL DETERMINATION

A. Physical Substrate Determinations

(1) Substrate Elevation and Slope: Increase in surface elevations at the open water beneficial use sites and the upland dredged material disposal sites.

(2) Sediment Type: The material to be dredged from the navigation channel is similar in grain size to the existing sediment types at the open water beneficial use sites, and the existing and proposed confined dredged material disposal areas. The rock will be placed in the Fort Mifflin dredged material disposal site, and will be significantly larger in particle size than the sand and silt that exists on the site; however, there will be no significant adverse impact.

(3) Dredged/Fill Material Movement: Not significant. There will be temporary increases in turbidity at the discharge points for the confined dredged material disposal areas, and at the beneficial use and Buoy 10 open water discharge locations. See Section 9.3 of the SEIS.

(4) Physical Effects on Benthos: Burial at beneficial use sites: Benthic evaluations have concluded that the existing benthic communities are neither significant nor unique. (See Sections 8 and 9 of the SEIS).

(5) Action Taken to Minimize Impact: Effluent from diked upland disposal areas will be controlled by adjustable weirs. Also, standard construction practices to minimize turbidity and erosion would be employed.

B. Water Circulation, Fluctuation, and Salinity Determinations

(1) Water. Consider effects on:

a. Salinity - No significant effect (See Section 5 of this document).

b. Water chemistry - No significant effect (See Section 4 of this document).

c. Clarity - Minor short-term increase in turbidity during construction at discharge sites.

d. Color - Minor short-term effect during construction.

e. Odor - No effect.

f. Taste - No effect.

g. Dissolved gas levels - No significant effect.

h. Nutrients - Minor effect.

i. Eutrophication - No effect.

j. Others as appropriate - None.

(2) Current patterns and circulation:

a. Current patterns and flow - No significant impact.

b. Velocity - No significant effects on tidal velocity and longshore current velocity regimes. See Sections 5.13 and 9.3 of this document.

c. Stratification - Thermal stratification occurs beyond the mixing region created by the surf zone at the wetland restoration sites. There is a potential for both winter and summer stratification. The normal pattern should continue post construction of the proposed project.

d. Hydrologic regime - The regime is largely marine and estuarine. This will remain the case following construction of the proposed project.

(3) Normal water level fluctuations - Construction of the proposed work would not affect the tidal regime. The wetland restoration sites are designed to permit regular tidal flushing.

(4) Salinity gradients - There should be no significant effect on existing salinity gradients. See Section 5 of this document.

(5) Actions that will be taken to minimize impacts - Use and monitoring of existing and proposed dredged material disposal area weirs for discharge of effluent to the Delaware River/Bay. Utilization of sand from a clean, high energy environment, and excavation with a hydraulic dredge would also minimize water chemistry impacts at the open water beneficial use sites and Buoy 10 maintenance dredged material disposal area.

C. <u>Suspended Particulate/Turbidity Determinations</u>

(1) Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal Sites: All silty dredged material will be placed in confined dredged material disposal sites. There will be minimal increases in suspended particulates and turbidity from upland sites due to use of adjustable weirs. There would be a short-term elevation of suspended

particulate concentrations during construction phases in the immediate vicinity of the dredging and the discharge at beneficial use sites.

(2) Effects (degree and duration) on Chemical and Physical Properties of the Water Column:

a. Light penetration - Short-term, limited reductions would be expected as a result of the discharge of effluent from confined dredged material disposal sites, and at the beneficial use disposal sites and Buoy 10 from the deposition of sand material.

b. Dissolved oxygen - There is a potential for a decrease in dissolved oxygen levels at the beneficial use sites, but the anticipated low levels of organics in the dredged material should not generate a high, if any, oxygen demand. No significant effects anticipated as a result of the short-term discharge of effluent from confined dredged material disposal sites.

c. Toxic metals and organics - No significant impacts. See Section 4 of this document.

d. Pathogens - Pathogenic organisms are not expected to be a problem in the areas to be dredged or at the dredged material disposal areas.

e. Aesthetics - No significant impact.

(3) Effects on Biota:

a. Primary production, photosynthesis - Minor, short-term effects related to turbidity. Increase in productivity due to wetland restorations.

b. Suspension/filter feeders - Minor, short-term effects related to suspended particulates outside the immediate deposition zone. Sessile organisms would be subject to burial within the deposition areas at the beneficial use sites.

c. Sight feeders - Minor, short-term effects related to turbidity.

(4) Actions taken to minimize impacts include the use of confined upland disposal areas which will minimize release of suspended solids into receiving waters which are well mixed. Approximately 50% of the area of each upland confined dredged material disposal sites will be managed as wetland habitat during the life of the project (See Section 3.2 of this document).

Appropriate siting of beneficial use sites will minimize impacts to benthic resources. Standard construction practices will also be employed to minimize turbidity and erosion.

D. Contaminant Determinations

The discharge of dredged material is not expected to introduce, relocate, or increase contaminant levels at either the confined upland dredged material disposal sites (including the water that will return to the Delaware River), or from the beneficial use sites in Delaware Bay (See Section 4 of this document).

E. Aquatic Ecosystem and Organism Determinations

(1) Effects on Plankton: The effects on plankton should be minor and mostly related to light level reduction due to turbidity. Significant dissolved oxygen level reductions are not anticipated.

(2) Effects on Benthos: Benthic communities will be displaced at the wetland restoration sites where subtidal habitat is changed into intertidal wetlands. Benthic communities that exist at the sand stockpiles will also be displaced. Recolonization is expected to occur in these areas through horizontal and in some cases vertical migrations of benthos. Impacts on benthic communities will not be significant (See Sections 8 and 9 of this document).

(3) Effects on Nekton: Only a temporary displacement is expected as nekton would probably avoid active work areas.

(4) Effects on Aquatic Food Web: Only a minor, short-term impact on the food web is anticipated. This impact would extend beyond the construction period until recolonization of beneficial use sites occurred (estimated to be up to 18 months).

(5) Effect on Special Aquatic Sites: The overall impact on wetlands will be positive due to management of the upland dredged material disposal areas for creation of wetland habitat, and use of dredged material to restore and protect tidal wetlands at Egg Island Point, NJ and Kelly Island, DE (See Section 3.2 and 6 of this document).

(6) Threatened and Endangered Species: No significant impacts are expected. Section 7 consultation has been performed with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (See Section 10 of this document).

(7) Other Wildlife: The management of the confined dredged material disposal areas for creation of wetland habitat and the wetland restoration sites will have a positive impact on wildlife resources.

(8) Actions to minimize impacts: Environmental windows will be observed to minimize impacts to aquatic resources from rock blasting, and to shorebirds, horseshoe crabs, and peregrine falcons in constructing the wetland restoration sites. A peregrine falcon nesting tower will be moved to avoid construction impacts. The upland dredged material disposal areas will be managed to create wetlands between dredged material disposal events. Construction techniques will be used to reduce the impacts of rock blasting on fish.

F. <u>Proposed Disposal Site Determinations</u>

(1) Mixing Zone Determination: The following factors have been considered in evaluating the disposal sites:

a. Depth of water at disposal locations.

b. Current velocity, direction, and variability at disposal locations.

c. Dredged material characteristics, constituents, amount, and type of material, and settling velocities.

d. Number of discharges per unit of time.

e. Use of confined upland disposal sites with controlled weirs.

An evaluation of the factors above indicates that the disposal sites and/or size of mixing zone are acceptable (See Section 4 of this document).

(2) Determination of compliance with applicable water quality standards: Extensive testing of water quality parameters has been completed and is presented in Section 4 of this document. It is anticipated that the discharges from the upland dredged material disposal areas and at the beneficial use sites will be in compliance with all state and Federal water quality standards.

(3) Potential Effects on Human Use Characteristics:

a. Municipal and private water supply - No effect.

b. Recreational and commercial fisheries - No significant adverse impacts. Wetland restorations will benefit fisheries.

c. Water related recreation - No significant impacts.

d. Aesthetics - No significant impacts.

e. Parks, national and historic monuments, national seashores, wilderness areas, etc. - Wetland restoration at Kelly Island will benefit the Bombay Hook National Wildlife Refuge.

G. Determination of Cumulative Effects on the Aquatic Ecosystem- None anticipated.

H. Determination of Secondary Effects on the Aquatic Ecosystem - Any secondary effects would be minor.

III. FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTRICTIONS ON DISCHARGE

A. No significant adaptation of the Section 404(b)(1) Guidelines were made relative to this evaluation.

B. The alternative measures considered for accomplishing the project objectives are detailed in Section 3 of the Final Environmental Impact Statement which was issued in February 1992 for which a 404(b)(1) analysis is a part.

C. It is not anticipated that the disposal of dredged material at the selected sites would violate any applicable state water quality standards. The disposal operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act. In order to implement the requirements of Section 404 of the Clean Water Act, an exemption was approved under Section 404 (r) as part of the Congressional authorization for this project, Public Law 102-580, Section 101 (6) of the Water Resources Development Act of 1992.

D. Use of the selected disposal sites is not expected to harm any endangered species or their critical habitat. Formal consultation has been completed with the U.S. Fish and Wildlife Service and initiated with the National Marine Fisheries Service (See Section 10 of this document). There are no Marine Sanctuaries designated by the Marine Protection, Research, and Sanctuaries Act of 1972 in the project area.

E. The proposed disposal of dredged material will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife will not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity, and stability, and recreational, aesthetic and economic values will not occur. Management of the upland dredged material disposal areas for wetland values and the restoration of wetlands in Delaware Bay using dredged material, will result in increased fish and wildlife habitat, erosion control, and increased water quality.

F. Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems includes limiting suspended solids in the diked upland disposal area effluent through control of weir structures. Environmental windows will be observed to minimize impacts to aquatic resources from rock blasting, and to shorebirds, horseshoe crabs, and peregrine falcons in constructing the wetland restoration sites. A peregrine falcon nesting tower will be moved to avoid construction impacts. The upland dredged material disposal areas will be managed to create wetlands between dredged material disposal events. Construction techniques will be used to reduce the impacts of rock blasting on fish.

G. On the basis of the guidelines, the proposed disposal sites for the discharge of dredged material are specified as complying with the 404 (b)(1) guidelines with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to the aquatic ecosystem.

2.0 Purpose and Need for Action

2.1 Study Authority

The Delaware River Comprehensive Navigation Study was authorized by a resolution adopted by the United States House of Representatives, Committee on Public Works, dated December 2, 1970. That resolution requested an evaluation of existing conditions affecting waterborne commerce on the Delaware River from Trenton, New Jersey, to the sea, and the identification of feasible modifications that would promote and encourage the efficient, economic and logical development of the Delaware River port system. The resolution partially reads: "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 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." Studies were also authorized by two resolutions adopted by the United States Senate, Committee on Public Works. The first resolution, adopted on March 1, 1954, requested a review of the Delaware River between Philadelphia and the sea, for the purpose of identifying the need for any modification to the existing channel dimensions and anchorage areas. The second resolution, adopted on September 20, 1974, requested development of a regional dredged material disposal plan for the tidal Delaware River, its tributaries, and Delaware Bay.

In order to implement this project, the project related costs and responsibilities are shared in accordance with the Water resources Development Act of 1986 (PL 99-662) with a non-Federal sponsor. The non-Federal sponsor for this project is the Delaware River Port Authority (DRPA).

2.2 Existing Project

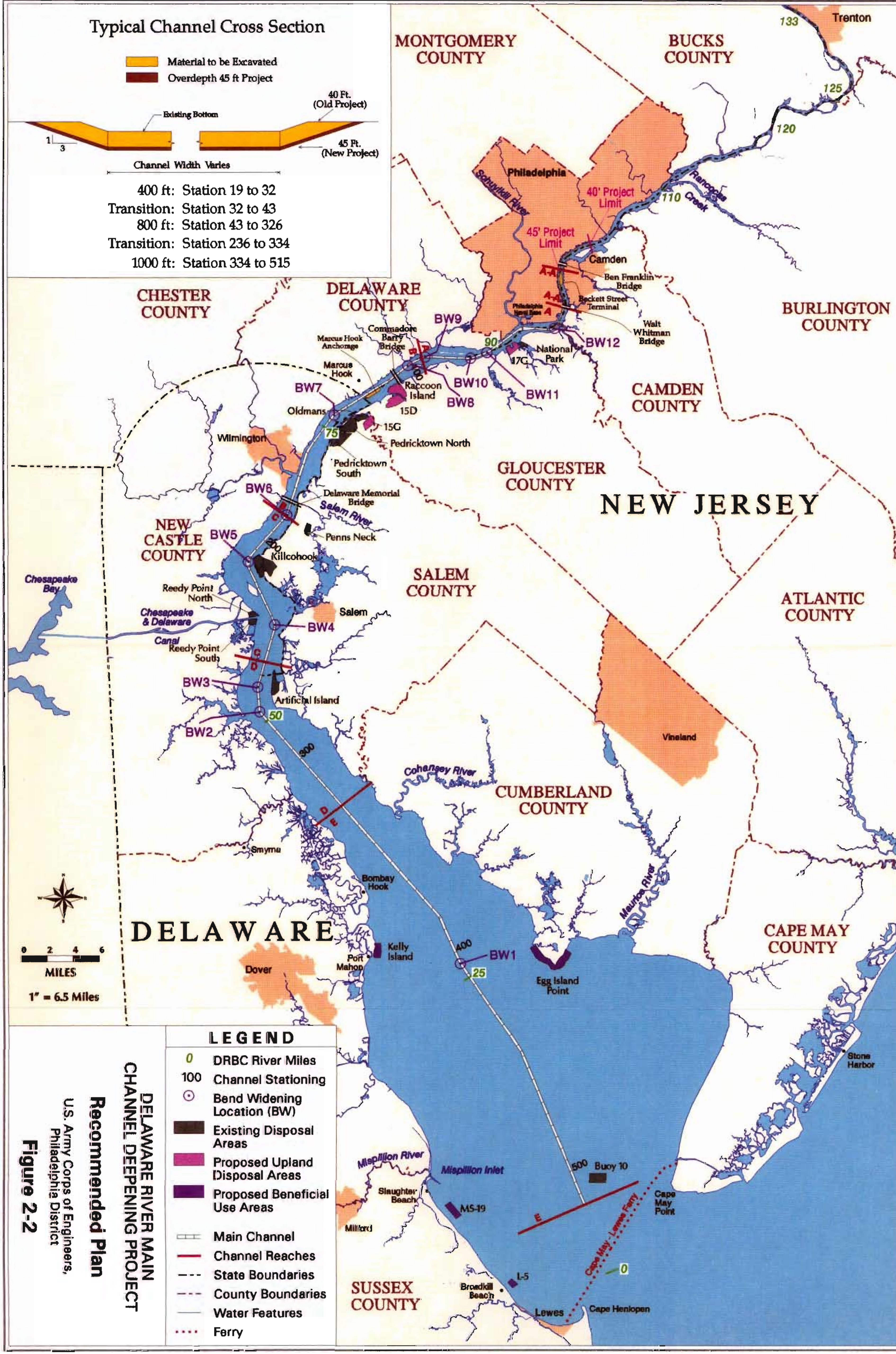
The project area encompasses the Delaware River estuary from Philadelphia, Pennsylvania to the mouth of Delaware Bay (Figure 2-1). The area extends over 100 river miles, and borders 10 counties in the Commonwealth of Pennsylvania, and the States of New Jersey and Delaware. The upstream portion of the project area includes the cities of Philadelphia, Pennsylvania and Camden, New Jersey, which together form the fifth largest metropolitan area in the United States. In conjunction with the port of Wilmington, Delaware, this area supports the largest fresh water port in the world. The area maintains a high concentration of heavy industry, including the nation's second largest complex of oil refineries and petrochemical plants (DRBC, 1988a). Below Wilmington, Delaware, the river broadens into the Delaware Bay. Although many small towns are located along the bay's margins, the surrounding drainage basin is predominantly rural. The bay supports both commercial and sport fisheries along with other recreational activities, is broad and shallow,

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Study Area

U.S. Army Corps of Engineers, Philadelphia District

Figure 2-1



DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
Recommended Plan
U.S. Army Corps of Engineers, Philadelphia District
Figure 2-2

and is surrounded by extensive salt marshes and agricultural land.

The existing Delaware River, Philadelphia to the sea, Federal navigation project was adopted in 1910 and modified in 1930, '35, '38, '45, '54 and '58 (Figure 2-2). The existing project provides for a channel from deep water in Delaware Bay to a point in the bay, near Ship John Light, 40 feet deep and 1,000 feet wide; thence to the Philadelphia Naval Base, 40 feet deep and 800 feet wide, with a 1,200-foot width at Bulkhead Bar and a 1,000-foot width at other channel bends; thence to Allegheny Avenue Philadelphia, PA, 40 feet deep and 500 feet wide through Horseshoe Bend and 40 feet deep and 400 feet wide through Philadelphia Harbor along the west side of the channel. The east side of the channel in Philadelphia Harbor has a depth of 37 feet and a width of 600 feet. All depths refer to mean low water. The 40-foot channel from the former Naval Base to the sea was completed in 1942. The channel from the former Naval Base to Allegheny Avenue was completed in 1962.

There are 19 anchorages on the Delaware River. The Mantua Creek, Marcus Hook, Deepwater Point, Reedy Point, Gloucester and Port Richmond anchorages are authorized under the Philadelphia to the sea project. The remaining 13 are natural, deep-water anchorages. The authorized anchorage dimensions are as follows:

Project	Authorized Dimensions
Mantua Creek:	40' X 2,300' X 11, 500' (mean)
Marcus Hook:	40' X 2,300' X 13, 650' (mean)
Deepwater Point:	40' X 2,300' X 5, 200' (mean)
Reedy Point:	40' X 2,300' X 8, 000' (mean)
Port Richmond:	37' X 500' (mean) X 6,400'
Gloucester:	30' X 400' (mean) X 3,500'

Mantua Creek anchorage is currently maintained to about 60% of the authorized width and a 37-foot depth. The Marcus Hook anchorage, enlarged in 1964, is maintained to authorized dimensions. The anchorage at Port Richmond is about 35 feet deep, as are the Reedy Point and Deepwater Point anchorages. The Gloucester anchorage requires no dredging and is currently deeper than authorized.

There are wide variations in the amount of dredging required to maintain the Philadelphia to the sea project. Some ranges are nearly self maintaining and others experience rapid shoaling. The 40-foot channel requires annual maintenance dredging in the amount of 4,900,000 cubic yards. Of this amount, the majority of material is removed from the Marcus Hook (44%), Deepwater Point (18%) and New Castle (23%) ranges. The remaining 15 percent of material is spread throughout the other 37 channel ranges. The historic annual maintenance quantities for the Marcus Hook and Mantua Creek anchorages are 487,000 and 157,000 cubic yards, respectively.

The Federal government has the responsibility for providing the necessary dredged material disposal areas for placement of material dredged for project maintenance. There are currently seven upland sites and one open-water site, located in Delaware Bay, that are used for this purpose.

In 1984, the Corps completed the Delaware River Dredging Disposal Study (USACE, 1984), which evaluated future dredging needs and existing dredged material disposal capacity. Dredged material disposal capacity required for continued maintenance of the existing 40-foot deep, Philadelphia to the sea, Federal navigation channel was evaluated for a 50-year study period (2005-2055). For the purpose of evaluating capacity requirements for the entire Philadelphia to the sea project, the channel was divided into five reaches. The limits of these reaches are defined in Figure 2-1. The following provides a description of the disposal area requirements for each reach during the study period. The ultimate capacity of existing sites and the number of new sites required will depend on maximum dike heights of existing disposal sites.

Reach A

Reach A extends from the upper project limit at Allegheny Avenue, Philadelphia, Pennsylvania to Billingsport Range, located near the Philadelphia International Airport. Approximately 153,000 cubic yards of material are dredged from these channel ranges on an annual basis. This material is dredged for both the Delaware River, Philadelphia to the sea project, and the Delaware River at Camden project. This material is currently placed in a single upland disposal area located at National Park, New Jersey (Figure 2-2). This site has a capacity of about 3.2 million cubic yards to a dike height of 50 feet. With the current rate of usage, this elevation would be reached in the year 2007. Raising the dike further could add an additional 3.3 million cubic yards of capacity, and extend the life of the site to 2027.

In order to continue maintenance dredging activities for the full 50-year term of the study period, an additional disposal area will be required in the vicinity of Reach A. The existing Fort Mifflin dredged material disposal site was considered, however, this site is required for the disposal of material dredged from the Schuylkill River project. As such, a new site would be required for disposal activities by the year 2027, assuming continued dike raising will occur.

Reach B

Reach B extends from Tinicum Range, located opposite of the Philadelphia International Airport to Cherry Island Range, located opposite of Wilmington, Delaware. This reach includes the Marcus Hook Range and the Marcus Hook Anchorage, which are the heaviest shoaling areas in the river. Approximately 2,400,000 cubic yards of material are dredged from Reach B on an annual basis. This material is currently placed in three dredged material disposal sites. These sites are the Federally owned Pedricktown North and Pedricktown South sites, and the adjacent Oldmans site, which is leased (Figure 2-2). These sites currently have a combined capacity of 21.3 million cubic yards to a dike height of 50 feet. Replacement sites would be needed by the base year if dikes at the Federal sites are not raised and if the Oldmans lease cannot be extended beyond the current expiration date of 1996. Raising the dikes further could add an additional 36.5 million cubic yards of capacity, and extend the life of this complex to 2030. A new site would be required by the year 2030 assuming that dike raising continues.

Reach C

Reach C extends from Deepwater Point Range, located below Wilmington, Delaware to New Castle Range, located at the mouth of the Chesapeake and Delaware Canal. Approximately 2,000,000 cubic yards of material are dredged from Reach C on an annual basis. This material is currently placed in two Federally owned sites, Penns Neck and Killcohook (Figure 2-2). These sites have a disposal capacity of 42.3 million cubic yards to a dike height of 50 feet. Based on current usage, fill would reach that elevation in year 2014. Raising the dikes further would add an additional 48.7 million cubic yards of capacity and extend the lives of these sites throughout the planning period. As such, there is sufficient dredged material disposal capacity in Reach C to conduct maintenance dredging activities for the full term of the study period, assuming dike raising continues.

Reach D

Reach D extends from Reedy Island Range, located south of the Chesapeake and Delaware Canal to Liston Range, located just north of Delaware Bay. Approximately 226,000 cubic yards of material are dredged from Reach D on an annual basis. This material is currently placed in the Federally owned dredged material disposal site on Artificial Island (Figure 2-2). The Artificial Island site has a capacity of 15.8 million cubic yards to a dike height of 50 feet. By raising the dikes further, an additional 4.9 million cubic yards of capacity would be gained. There is sufficient dredged material disposal capacity to maintain the navigation channel in Reach D for the entire 50-year study period and beyond.

Reach E

Reach E covers the remaining portion of the study area from the lower portion of Liston Range in the upper portion of Delaware Bay to naturally deep water in the lower portion of the bay. Approximately 370,000 cubic yards of material are dredged from Reach E every five years. This material is currently placed in an overboard disposal site designated as Buoy 10 (Figure 2-2). Buoy 10 is a deep trench in the lower portion of Delaware Bay, located approximately six miles northwest of Cape May Point. Sufficient capacity exists at the Buoy 10 site to continue maintenance dredging activities within Reach E for more than the 50-year study period.

About 250 piers, wharves and docks are located in the port system. Most of these service private facilities along the Delaware River. Public port facilities are located at the cities of Philadelphia, Pennsylvania; Camden, Gloucester and Salem, New Jersey; and Wilmington, Delaware. Several large oil refineries are located along the Delaware River between Philadelphia and Delaware City including Sun, Chevron, Mobil, Texaco, BP, Coastal and Atlantic. These refineries generate the majority of commodity movements on the region's waterways either by receipt of crude oil and refined products or by shipment of petroleum products and chemicals to other facilities in the region or domestic ports. Major dry and liquid bulk facilities are also found along the Delaware River at Wilmington, Delaware; Port Richmond in Northeast Philadelphia; Paulsboro, New Jersey; Greenwhich point in South Philadelphia; and along the Schuylkill River in Philadelphia. The numerous tributaries to the Delaware River support a variety of industries, and the waterways are used primarily for delivery of fuel oils and raw materials or shipment of products.

The Delaware River system can be entered or exited via the Delaware Bay entrance or through the Chesapeake and Delaware Canal. Two sets of ocean traffic lanes converge at a precautionary area at the bay entrance. Each set of lanes has a separation zone for safety between inbound and outbound vessels. The northern Cape Henlopen - Five Fathom Bank lanes have minimum depths close to the 40-foot main channel depth, and are used primarily by smaller vessels and those engaged in coastwise commerce. The southern Cape Henlopen - Delaware lanes are much deeper, with minimum depths of about 55 feet outbound and 59 feet inbound. These lanes are used by most vessels engaged in foreign commerce including the large bulk carriers and tankers, as well as for coastwise movements to the south. Each set of ocean lanes is marked by a series of buoys centrally located in each separation zone. Some vessels are piloted within the Delaware River system by members of the Pilot's Association for the Delaware River and Bay. They board incoming vessels in the pilot area at the bay entrance and at the Maryland/Delaware line in the C&D Canal.

From the bay entrance vessels can either proceed up the main Delaware River channel to the Philadelphia ports, or through naturally deep waters to the Big Stone Beach anchorage in lower Delaware Bay. This anchorage has been used for over 25 years by large tankers to lighter (primarily crude oil) onto barges. Maximum drafts for tankers entering the bay is 55 ft and lightering reduces the tanker's operation drafts to those acceptable for the 40 ft channel. In 1983 this anchorage was reclassified by the U.S. Coast Guard as a general purpose anchorage, however lightering is still the dominant activity.

The 40-foot Delaware River channel provides for two-way traffic up to the Philadelphia Navy Yard where it transitions to a 400-ft width on the west side. Within Philadelphia Harbor the 37 foot east side of the channel allows two-way traffic, with shallower vessels yielding the 40-foot channel to deeper vessels. The 40-foot channel continues upriver to the steel facility at Fairless Hills, PA as the Philadelphia to Trenton segment of the Delaware River channel. The main channel serves numerous other tributary projects which provide both one-way and two-way access to facilities engaged in foreign, coastwise, and internal commerce. The main channel is connected to the Chesapeake Bay and Port of Baltimore by the C&D Canal. The canal is used by container liner services that call at Baltimore as well as by lesser draft domestic vessels, tug and barge traffic, and pleasure craft.

The six Federally authorized anchorages as well as the 13 naturally deep U.S. Coast Guard designated areas adjoin the Delaware River channel between Philadelphia and Delaware Bay. Included are general and special purpose anchorages. Vessels are permitted to anchor for a period up to 48 hours (or longer with a Coast Guard permit). Vessel usage is recorded by the U.S. Coast Guard only for the commonly used anchorages at Big Stone Beach, Mantua Creek, Marcus Hook, and Kaighn Point Gloucester in addition to the breakwater area at the bay entrance. Vessel length restrictions are enforced at Mantua Creek (700 feet) anchorage to avoid vessels swinging outside anchorage boundaries during a change of tide. Of the upriver anchorages, only Marcus Hook provides depths compatible with the 40 foot channel. The most heavily used anchorages on the river are Marcus Hook and Mantua Creek. The dominant usage at those anchorages is by tankers for the refineries and bulk vessels, respectively. The anchorages are generally used to avoid accidents during foul weather and poor visibility; during lightering, bunkering or repairs; or while awaiting berth space or favorable tide conditions.

The Pilot's Association and Mariner's Advisory Committee have established operating procedures for safe vessel movement. Vessel sailing drafts of up to 40 feet inbound and outbound can utilize the present Delaware River, Philadelphia to the sea project.

Traffic monitoring on the Delaware River system is accomplished by the U.S. Coast Guard, Philadelphia Maritime Exchange, and Pilot's Association. A major consideration in this effort is tidal conditions. Rising tides are used to maximize cargo while maintaining safe underkeel clearance. The U.S. Coast Guard is notified of vessel arrivals at least 48 hours ahead of time. The Maritime Exchange maintains a record of scheduled arrivals and departures. The pilots coordinate among themselves to ensure safe and efficient vessel movements and they also communicate with the captains of other smaller vessels and tows operating on the river. Pilots also communicate with tug operators to arrange for docking assistance, if required. Tugs will accompany large vessels as they approach and depart port facilities for additional safety.

Vessel operations occur day or night on the major waterways using channel markers, range lights, and other physical references to guide navigation. Raycon (a radar transponder beacon, which emits a characteristic signal when triggered by the emissions of ship's radar) has been installed at selected locations at the bay entrance and Big Stone Beach anchorage. It enhances the ability of vessel operators to determine vessel location during poor visibility conditions.

Typical vessel speeds in the Delaware River vary between 5 and 12 knots. Larger tankers (275,000 DWT) operate with tug assistance during light traffic situations. Passing/meeting situations are limited at bends depending on vessel and traffic conditions. Traffic keep in touch with the Maritime Exchange.

Vessels with drafts of 37-foot or less can safely operate without use of the tides. Vessels with drafts in excess of 37-foot operating depth must rely on the tide. The critical area of concern for deep draft vessel operation in the Delaware River is the Marcus Hook Range, with its rock outcroppings in the channel. Typical travel times are about 7 1/2 hours upriver, and 12 hours downriver.

2.3 Previous Investigation

In accordance with the various study authorities, the Philadelphia District of the U.S. Army Corps of Engineers conducted a Feasibility level investigation to address and evaluate the potential for project modifications to improve navigation efficiencies in the Delaware River channel system between Philadelphia and the sea. It was determined that current Federal channel depths restrict efficient use of both present and future tankers, dry bulk carriers, and container vessels. These conditions result in significant light loading and lightering costs, vessel delays, and exclusion of some of the larger and more efficient world fleet from visiting Delaware River ports.

Based on economic and environmental analyses, a two way, full-width channel with a depth of 45 feet at mean low water (mlw) was selected as the recommended plan of improvement. From the Beckett Street Terminal located in Camden, New Jersey through Philadelphia Harbor, the 400 to 500-foot width west side channel, now at a depth of 40 feet mlw, would be deepened while the east side channel would remain 37 feet deep. Between the Philadelphia Navy Yard and Delaware Bay the existing channel would be deepened for its full 800-foot width. In the bay the full 1,000-foot width channel would be deepened. The plan would not modify existing authorized channel widths. As part of this plan, the trapezoidal access channel to Beckett Street Terminal's bulk berths would also be deepened. This would modify the Delaware River in the Vicinity of Camden Project. Use of anchorages has been limited in recent years. Only the Marcus Hook anchorage would be partially deepened to provide space for two vessels for safety purposes. Bend widenings would also be provided, as required. This plan would provide deeper access to the major import and export facilities along the main channel, including six oil refineries, the Conrail coal and iron ore facilities at Piers 122 and 124, and the Beckett Street Terminal.

During the Feasibility study, it was estimated that 50,100,00 cubic yards of material would be dredged to deepen the currently authorized 40-foot channel to 45 feet. Three upland sites, 17O, 15D, and Raccoon Island, were determined to be most suitable for meeting dredged material disposal capacity requirements associated with construction and maintenance of a deeper channel (Figure 2-2). All three sites have been used for dredged material disposal in the past. In addition, two existing upland sites would also be required. These sites are Reedy Point North and Reedy Point South, located at the confluence of the Chesapeake and Delaware Canal and the Delaware River (Figure 2-2). The existing National Park, Oldmans, Pedricktown North, Pedricktown South, Killcohook, Penns Neck and Artificial Island sites would continue to be used for disposal of material attributed to maintenance of the existing 40-foot project. In Delaware Bay, several beneficial use options were under consideration for the disposition of sandy dredged material. These options included wetland restoration and sand stockpiling for future beach nourishment efforts.

Alternatives to the recommended plan of improvement were documented in the February 1992 Final Delaware River Comprehensive Navigation Study Main Channel Deepening Interim Feasibility Report and Environmental Impact Statement (USACE, 1992). Discussions on plans eliminated from further study, the no action plan, navigational improvements considered in detail, and alternative dredged material disposal plans were provided. Plans eliminated from further study included a 50-foot channel deepening alternative; channel deepening between Philadelphia and Trenton, New Jersey; channel realignment at the Benjamin Franklin Bridge; channel realignment at Marcus Hook, Pennsylvania; anchorage modifications; and the feasibility of an oil pipeline system as an alternative to channel deepening. Navigational improvements considered in detail included three alternatives for deepening the existing channel between Philadelphia Harbor and the mouth of Delaware Bay. These alternatives were deepening the entire width of the existing channel, and two asymmetric channel designs that would deepen various widths of the inbound lane, based on different sets of design criteria. Each alternative was evaluated for deepening in one-foot increments between 41 and 46 feet mlw. Each of the three alternative channel schemes would require widening of channel bends to safely facilitate turning of larger vessels in accordance with Corps design criteria. The no action plan entailed continued maintenance of the existing 40-foot project. It was concluded that existing channel dimensions restrict the efficiency of bulk commodity vessels calling at Delaware River Ports. A significant percentage of tankers and dry bulk carriers are currently forced to employ non-structural practices such as lightering and light loading to transport their commodities to the Delaware River Valley. These practices increase transportation costs, which reduces the economic viability of the operations. In addition, inefficient channel conditions hinder the ability of Delaware River Ports to compete for waterborne commerce with other East Coast Ports.

Candidate dredged material disposal sites to meet future capacity requirements were identified during the 1984, Delaware River Dredging Disposal Study (USACE, 1984). Approximately 300 candidate sites were further considered during the Feasibility investigation. Plan formulation with regard to selection of suitable dredged material disposal sites involved several iterations of engineering, economic and environmental screening. Initial screening considered features such as archaeological zones, historic sites, recreational areas, groundwater recharge zones, groundwater protection zones, areas important to fish and wildlife, wetlands, development, navigation features, elevation and distance from dredging sites. Engineering considerations included minimum acreage requirements, accessibility for construction and maintenance, reasonable disposal pipeline routes and effluent water courses to the river. Institutional considerations included public park land, designated wildlife areas, proximity to residential communities, and consistency with Federally approved Coastal Zone Management Plans. Sites remaining after these screening iterations were subject to detailed cost analysis. Specific data with respect to site acquisition, initial dike construction, annual maintenance, site capacity and mitigation requirements were developed and evaluated to generate a relative ranking of the costs associated with each site.

2.3.2 Refinements of the Authorized Plan

The refinements of the recommended plan from the authorized plan and reasons are presented in the following paragraphs.

2.3.2.1 Upland Dredged Material Disposal Plan

The feasibility plan for disposal of Delaware River sediments from initial dredging called for use of two existing Federally owned upland disposal areas (Reedy Point North and South) and procurement of three additional sites by the sponsor, identified as 17O, Raccoon Island and 15D. The non-Federal sponsor(DRPA) would reimburse the Government on the usage of the Federal sites.

As part of the PED study, the selected disposal plan was reviewed to see if existing conditions or usage of disposal areas changed from that analyzed in the Feasibility Study. That review indicated that disposal site 17G is now available, as plans for private development have been discontinued and a portion of site 15D (about 200 acres) is not available.

Site 17G was evaluated during the Feasibility Study and was eliminated from selection due to the expectation that it would be developed prior to implementation of the proposed 45 foot project. Site 17G is located upriver from site 17O. The two sites are physically similar and were ranked closely during the screening process. As a result, site 17O which has some cultural concerns, was eliminated, and site 17G was substituted.

To compensate for the 200 acre reduction in site 15D, site 15G was added. Similar to site 17G, site 15G was evaluated during the Feasibility Study and was closely ranked with site 15D. This substitution of the two sites (17G and 15G) had no impact on the previously estimated project construction costs. Based on coordination with the sponsor, the sponsor has the ability to acquire the selected candidate sites. As a result, disposal sites identified as 17G, Raccoon Island, 15D and 15G were selected as the candidate sites for detailed engineering and environmental field testing.

Using the above sites, a re-evaluation of the feasibility disposal plan was made. An analysis was conducted of disposal capacity of the existing Federal disposal sites that are currently being used for the disposal of dredged material for the existing 40 foot project. The analysis also included the disposal of the dredged material from the initial deepening of the 45 foot project as well as the subsequent maintenance.

Re-evaluation of the disposal plan determined that the most efficient manner to dispose of the initial quantities from Reaches AA-D would be to utilize the existing Federal disposal areas (National Park, Oldmans, Pedricktown North and South, Penns Neck, Killcohook, Reedy Point North and South and Artificial Island) in combination with the four proposed sites (17G, Raccoon Island, 15D, and 15G). This disposal plan was reviewed and approved by the sponsor. The sponsor will provide an equivalent amount of disposal capacity to the Federal Government from the four proposed sites to offset the loss of disposal capacity at the existing Federal sites incurred by the 45 foot deepening project (i.e. initial dredging and incremental maintenance for 50 years).

The use of existing Federal and sponsor upland disposal areas for the initial dredging and subsequent maintenance is a cost effective plan which provides enough capacity for all initial dredging and 50 year maintenance. The acquisition of 17G, Raccoon Island, 15D, and 15G disposal areas provides the Corps of Engineers with an equivalent disposal area capacity to offset the loss of capacity incurred by the deepening project. The proximity of the proposed disposal areas to critical high shoaling areas in the Delaware River is an additional long term benefit in that future maintenance contracts will remain cost effective. In addition, the provision of the disposal capacity to the Federal Government at the proposed sites prolongs the life of the existing Federal areas and precludes the necessity for the Corps to purchase another disposal area for the next 50 years.

2.3.2.2 Beneficial Use Plan

As indicated in the Feasibility Report, the dredged material from the Delaware Bay portion of the project area was designated for beneficial use purposes (ie., wetland restoration/protection and sand stockpiling). Further benthic studies were deferred to the PED Study to finalize the design of the proposed sites. Detailed benthic studies were conducted during the PED Study phase to refine the proposed sites that were recommended in the Feasibility Report. Based on the benthic studies and the coordination with resource agencies, the location and size of the proposed sites were finalized. As a result of these refinements and coordination, the beneficial use plan consists of wetland restoration at Kelly Island, Port Mahon, Delaware, wetland protection/restoration at Egg Island Point, New Jersey and sand stockpiling offshore at Slaughter (MS-19) and Broadkill (L-5) Beaches in the State of Delaware.

2.3.2.3 Channel Bend Widening

As a result of the ship simulation modelling that was conducted by the Corps of Engineers Waterways Experiment Station and Pilot's Association for the Bay and River Delaware, the number of the channel bends requiring widening was reduced from 16 to 12.

2.3.2.4 Overdepth Reduction

Current quidance (Engineering Regulation 11130-2-307, Dredging Polices and Practices, Interim Guidance, 1 June 1991), specifies that "New work dredging plans and specifications, where hard materials exist (e.g. dense clays, rock or manmade materials), shall have a required depth, required overdepth, and an allowable overdepth". For the proposed deepening project, because of the nature of the material (i.e., most of the excavated material will consist primarily of sand or silt), only the allowable overdepth is deemed to be appropriate. This allowable overdepth has been determined to be 1 foot. As a result, the overdepth was reduced from 2 to 1 foot. This practice has successfully been used in maintaining the authorized 40 foot channel depth.

2.3.2.5 Summary

The above adjustments represent refinements to the authorized plan that was recommended in the 1992 Interim Feasibility Report. Furthermore, these refinements did not alter the environmental impacts that were presented in the Final Environmental Impact Statement.

2.4 Economic Benefits

The proposed deepening of the Delaware River channel from 40 to 45 feet will have a significant positive impact by reducing the cost of transporting commodities into and out of the port. The deepening will allow more efficient vessel loading by the current fleet, will reduce the lightering requirements of large crude oil tankers at the anchorage in the lower Delaware Bay, and will attract larger, more efficient container and dry bulk vessels to serve the port. The deepened channel is not expected to induce extra tonnage to shift to the port from competing ports. Equivalent tonnage, defined as current tonnage plus the incorporation of future commodity growth, will move through the port with either the current 40-foot channel or the deepened 45-foot channel. The 45-foot channel will allow this equivalent tonnage to be transported more cost-effectively. It is estimated that the proposed deepening will result in annual transportation savings of $40.1 million. Commodities that will benefit include crude oil imports, scrap exports, iron ore imports, and containers.

2.5 Previous NEPA Coordination

A notice of intent to prepare a Draft Environmental Impact Statement (DEIS) for the Delaware River Comprehensive Navigation Study Main Channel Deepening Project was published in the Federal Register on May 4, 1989. A notice of availability for that DEIS was published in the Federal Register on July 13, 1990. Subsequent to coordination of the DEIS it was determined that a DEIS amendment would be required to provide additional information regarding the environmental impacts of the proposed project. Areas of concern included the chemical characteristics of the sediments that would be dredged and potential water quality impacts; potential changes to salinity patterns of the Delaware Estuary as a result of channel deepening; potential impacts to groundwater resources in the project area; the feasibility of an oil pipeline system to limit the need for a navigation channel within the Delaware River; the impact of rock blasting on fishery resources in the vicinity of Marcus Hook, PA; the occurrence of wetlands in selected upland dredged material disposal sites; and an analysis of alternatives to the use of the existing open water disposal site in Delaware Bay. The DEIS amendment was comprised of seven sections that addressed each of these issues, as well as a project introduction/alternatives review section and an economic evaluation of the selected plan of improvement. A notice of availability for the DEIS amendment was published in the Federal Register on December 6, 1991. Subsequent to a 45-day public comment period, the information contained in the amendment and the comments received on the DEIS and the amendment were integrated into a Final Environmental Impact Statement (FEIS).

Subsequent to a public review and comment period, the February 1992 Final Delaware River Comprehensive Navigation Study Main

Channel Deepening Interim Feasibility Report and Environmental Impact Statement was approved by the North Atlantic Division of the U.S. Army Corps of Engineers and the Board of Engineers for Rivers and Harbors, and transmitted to Congress. The project was authorized by Congress in October 1992 as part of the Water Resources Development Act of 1992. The Record of Decision for the FEIS, dated December 17, 1992, documented supplementary environmental analyses to be conducted during the Preconstruction, Engineering and Design phase of project development to re-affirm conclusions reached during Feasibility investigations. These analyses are listed in Section 2.6, below.

2.6 PED Study Objectives

Upon approval of the Feasibility report and Environmental Impact Statement in 1992, the Preconstruction, Engineering and Design (PED) phase of study was initiated. The objectives of this study are to refine the recommended plan of improvement that was presented in the Feasibility report; to respond to outstanding resource agency concerns; and to finalize project design features.

The principal focus of this effort was to respond to environmental concerns, which were raised by Federal and State resource agencies during review of the Feasibility report and Environmental Impact Statement. The Record of Decision for the EIS states:

"Supplementary environmental analyses are planned for the Preconstruction, Engineering and Design phase of project development to verify conclusions reached during feasibility investigations. These analyses include: Three- dimensional hydrodynamic modeling of the Delaware estuary to evaluate potential changes in salinity and circulation patterns; Benthic invertebrate sampling to assess habitat quality at selected beneficial use sites in Delaware Bay; Biological effects based testing to determine the impact of open water disposal on aquatic ecosystems; Detailed environmental assessments of selected upland dredged material disposal sites; Consultation with both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, pursuant to Section 7 of the Endangered Species Act; Cultural resource investigations in dredging and disposal locations; and Coordination with the regional oil spill response teams to review the adequacy of existing Delaware River spill contingency plans. The results of these analyses will be appropriately coordinated with interested agencies and the concerned public, pursuant to the National Environmental Policy Act."

To address the outstanding environmental issues, scientific investigations were developed and conducted to collect sufficient data to evaluate the validity of conclusions reached during the Feasibility phase of study. The work efforts and results have been coordinated with appropriate resource agencies and interested individuals. The results of these studies are presented in later sections of this document. Study results have been incorporated into the final design of the proposed project.

2.7 Problems, Needs and Public Concerns

The major problem associated with the existing Delaware River, Philadelphia to the sea, Federal navigation project is an insufficient channel depth to accommodate bulk commodity vessels at design drafts. These commodities, which include crude oil, coal and iron ore, are currently shipped in partially loaded vessels due to draft restrictions.

Existing channel dimensions reduce the economic efficiency of larger ships moving through this major commercial area. Crude and refined oil products are the highest volume commodity in United States freight trade and account for the overwhelming majority of tonnage moved in the Delaware River. The refineries located along the Delaware River account for a significant portion of the refinery capacity of the United States and provide petroleum products throughout the Mid-Atlantic states. A large amount of the crude oil that comes to the Delaware River facilities is lightered. Lightering is the transfer of cargo from a large, deep-draft vessel to a smaller vessel or barge to maximize the cargo tonnage carried over a long voyage. Vessels that require a depth greater than 40 feet must transfer a portion of their cargo in Delaware Bay before they can travel upriver. In addition, many of the coal vessels and iron ore vessels are also partially loaded. Provision of a deeper channel would reduce or eliminate inefficient non-structural practices such as lightering and light loading, now employed for restricted vessels. In addition, several users are likely to utilize larger vessels if a deeper channel is provided.

A critical element in the development of any navigation study is the disposal of dredged material. Approximately 4.8 million cubic yards of material for the existing 40-foot channel project are annually dredged from the Delaware River between Philadelphia and the sea. Acquisition of disposal areas for the existing channel is now solely a Federal responsibility. There are seven active upland disposal areas for the Philadelphia to the sea project. Additional dredged material disposal sites will be needed to adequately handle dredged material from the existing Federal project past the year 2020. New disposal areas will be required for new construction and maintenance of a deeper channel. A secondary objective of this project is to upgrade present disposal areas and locate additional sites with sufficient capacity to handle deepening and maintenance dredging operations over the full 50-year project life.

Public concerns with regard to the Delaware River and bay include protection of natural resources, specifically wetlands, fisheries and wildlife; air and water quality control; protection of cultural resources; and enhancement of economic conditions within the Delaware Valley. A current concern with regard to water quality is prevention of oil spills in the river.

3.0 Proposed Plan of Improvement

3.1 Channel Design

3.1.1 Recommended Plan

The recommended plan as shown on Plates 1-4 consists of a navigation project extending from deep water in Delaware Bay to Philadelphia Harbor and to Beckett Street Terminal, Camden, New Jersey, a distance of about 102.5 miles. The plan provides for modifying the existing Delaware River Federal Navigation channel (Philadelphia to the Sea Project) from 40 to 45 feet below mean low water (MLW) with an allowable dredging overdepth of one foot. The channel side slopes are 3 horizontal to 1 vertical.

The channel width would range from 400 feet in Philadelphia Harbor, to 800 feet from the Philadelphia Navy Yard to Bombay Hook, and then 1,000 feet in Delaware Bay. The plan includes 12 bend widenings as well as provision of a two space anchorage of compatible depth at the Marcus Hook anchorage. The existing turning basin adjacent to the Naval Shipyard will not be deepened as part of the project.

The plan includes deepening access to a 45 foot depth at the bulk berths at Beckett Street Terminal in Camden, a public terminal operated by the South Jersey Port Corporation.

The project also includes the acquisition of four new upland disposal sites (17G, 15D, 15G and Raccoon Island), and relocation or placement of additional aids to navigation.

3.1.1.1 Bend Widening Details

The bends will be widened to accommodate the operating and handling characteristics of the design vessel operating at the 45 foot depth. The bends will be modified at the ranges listed below.

Horseshoe Bend-Eagle Point
Mifflin-Billingsport
Billingsport-Tinicum
Tinicum-Eddystone
Eddystone-Chester
Marcus Hook-Bellevue
Cherry Island-Deepwater
Deepwater-New Castle
New Castle-Reedy
Reedy-Baker
Baker-Liston
Cross Ledge-Miah Maull

The following is a summary of the modifications developed and recommended for each bend:

MIAH MAULL-CROSS LEDGE: 200 foot width increase at the apex of the west side of the bend.

LISTON-BAKER: Maximum width increase on the east edge of 250 feet, over a distance of 4500 feet south of the apex, and extending 3,900 feet north from the apex.

BAKER-REEDY ISLAND: 100 foot width increase at the west edge apex of the bend.

REEDY ISLAND-NEW CASTLE: Maximum widening of 400 feet at the west apex of the bend, tapering to zero over a distance of 3,200 feet south of the apex, and to zero over a distance of 4,000 feet north of the apex.

NEW CASTLE-BULKHEAD BAR, AND BULKHEAD BAR-DEEPWATER: The west edge of Bulkhead Bar range is extended by 300 feet to the south and 300 feet to the north; the widening tapers to zero at a distance of approximately 3,000 feet south of the south end of Bulkhead Bar, and 3,000 feet north of the north end of Bulkhead bar.

DEEPWATER-CHERRY ISLAND: A maximum channel widening of 375 feet is required at the eastern apex of the bend. The widening tapers to zero at a distance of about 2,000 feet both north and south of the apex.

BELLEVUE-MARCUS HOOK: The east apex of the bend requires a 150 foot widening over existing conditions, along a total length of approximately 4,000 feet.

CHESTER-EDDYSTONE: The southwest apex of the bend requires a maximum 225 foot widening, with a transition to zero at the northeast end of Eddystone range, over a linear distance of approximately 6,000 feet.

EDDYSTONE-TINICUM: The northeast apex of this bend requires a 200 foot widening, with a transition to zero at a distance of about 1,200 feet northeast and southwest of the bend apex.

TINICUM-BILLINGSPORT: The north channel edge of Billingsport was widened by 200 feet. At the northern apex of the Tinicum - Billingsport bend, this results in a maximum widening of approximately 400 feet, with a transition to zero at a distance of about 2,000 feet west of the apex.

BILLINGSPORT-MIFFLIN: The south apex of the bend was widened a maximum of 200 feet to the south, and transitioned to zero at a distance of approximately 3,000 feet northeast of the apex.

EAGLE POINT-HORSESHOE BEND: The northwest edge of Horseshoe Bend required a maximum widening of 490 feet to the north. The widening transitions to zero at a distance of approximately 4,000 linear feet west of the west end of Horseshoe Bend, and at a distance of 1,500 linear feet north of the north end of the bend.

3.1.2 Dredging

3.1.2.1 Initial Dredging

The total dredging quantity for initial project construction is estimated at 33 million cubic yards, and is distributed among the reaches as follows:

Reach AA	1,430,000 cy
Reach A	3,314,000 cy
Reach B *	8,624,000 cy
Reach C *	4,465,000 cy
Reach D	5,789,000 cy
Reach E	9,264,000 cy

* Includes rock (Reach B 211,000 cubic yards, and Reach C 18,000 cubic yards)

3.1.2.2 Maintenance Dredging

The required maintenance dredging of the 45 foot channel will increase to 6,007,000 cubic yards per year (cy/yr) from the current 4,888,000 cy/yr for the 40 foot channel, for a net increase of 1,119,000 cy/yr.

When required, advanced maintenance dredging of the channel up to 49 feet below mean low water will occur depending on the rate of shoaling. This is a continuation of the existing project maintenance practice, since benefits for the recommended project are based on maximum utilization of the 45 foot channel, and utilization of high tide stages. Approval for advanced maintenance was granted by the Corps of Engineers North Atlantic Office for the Delaware River, Philadelphia to the Sea Project on 19 June 1981.

Advanced maintenance dredging is required in critical areas to assure maintenance of the proposed depth. The high shoaling areas will continue to be dredged at least every year, where areas of less shoaling will go several years between dredging. In addition, due to dredging inaccuracies, one foot of overdredging will also continue to occur. The one foot overdepth allowance is standard practice on large dredging projects.

3.1.2.3 Dredging Techniques

The Main Channel Deepening Project will use two types of dredges (hopper dredge and pipeline dredge).

Typically, the Corps of Engineers does not specify the type of equipment that a contractor must use to dredge a channel. Each type of dredging equipment has different strengths and weaknesses. Some jobs can be accomplished by any type of dredge;

other projects require specialized equipment. Many times, one type of equipment will be more efficient than another. In these cases the bidding process usually results in the more efficient plant and equipment being used to accomplish the required dredging. Discussion of the different types of dredging equipment that would be suitable for dredging this project is provided below.

Self-Propelled Hopper Dredges: Hopper dredges are typically self-propelled seagoing vessels. They are equipped with propulsion machinery, sediment containers (i.e. hoppers), dredge pumps, and other specialized equipment required to perform their essential function of excavating sediments from the channel bottom. Hopper dredges have propulsion power adequate for required free-running speed and dredging against strong currents, and have excellent maneuverability. This allows hopper dredges to provide a safe working environment for crew and equipment to dredge bar channels or other areas subject to rough seas. This maneuverability also allows for safely dredging channels where interference with vessel traffic must be minimized.

A hopper dredge removes material from the bottom of the channel in thin layers, usually 2-12 inches, depending on the density and cohesiveness of the dredged material (Taylor, 1990). Pumps within the hull, but sometimes mounted on the dragarm, create a region of low pressure around the dragheads. This forces water and sediment up the dragarm and into the hopper. The more closely the draghead is maintained in contact with the sediment, the more efficient the dredging (i.e. the greater the concentration of sediment pumped into the hopper). Hopper dredges are most efficient for noncohesive sands and silts, and low density clay. Hopper dredges are not as efficient with medium to high density clays, or with dense sediments containing a significant clay fraction.

Dredging is usually done parallel to the centerline or axis of the channel. Sometimes, a waffle or crisscross pattern may be utilized to minimize trenching and produce a more level channel bottom (Taylor, 1990). This movement up and down the channel while dredging is called trailing, and may be accomplished at speeds of 1-6 knots depending on sediment type, sea conditions, and numerous other factors.

When an efficient load is achieved, the vessel suspends dredging, the dragarms are heaved aboard, and the dredge travels to the placement site. Because dredging stops during the trip to the placement site, the overall efficiency of a hopper dredge is dependent on the distance between the dredging and placement sites (i.e. the more distant the placement site, the less efficient the hopper dredge).

Cutterhead pipeline dredge: A cutterhead pipeline dredge is the most commonly used dredging plant in the United States. The cutterhead dredge is suitable for maintaining harbors, canals, and outlet channels, where wave heights are not excessive and suitable placement areas are nearby. It is essentially a barge hull with a moveable rotating cutter apparatus surrounding the intake of a suction pipe (Taylor, 1989; Hrabovsky, 1990). By combining the mechanical cutting action with the hydraulic suction, the hydraulic cutterhead has the capability of efficiently dredging a wide range of material, including clay, silt, sand, and gravel.

The largest hydraulic cutterhead dredges have 30 to 42 inch diameter pumps with 15,000 to 20,000 horsepower. These dredges are capable of pumping certain types of material through as much as 5-6 miles of pipeline, though up to 3 miles is more typical.

The attached pipeline also limits the maneuverability of the dredge. In addition, the cutterhead pipeline plant employs spuds and anchors in a manor similar to floating clamshell dredges. Accordingly, as with floating clamshell dredge plants, the hydraulic cutterhead should not be used in high traffic areas, and cannot be safely employed in rough seas. Cutterhead dredges are normally limited to operating in protected waterways where wave heights do not exceed 3 feet.

3.1.2.4 Dredging Schedule

Table 3-1 and Plates 24 and 25 detail the location and disposal destination of all of the initial dredged material for the project. The colors in the channel match the color of the disposal area where that material will be disposed.

Materials will be disposed at the closest available area in each range of the river. Dredged material from Reaches AA and A will be disposed at areas 17G and National Park. Reach B materials will be disposed at areas 15D, 15G, Raccoon Island, and Pedricktown North and South. Reach C materials will be disposed at Killcohook and Penns Neck, with some of the initial quantity from Reach C slated for the Reedy Point North disposal area. The material from Reach D will be disposed at Artificial Island, with a small portion of the initial quantity placed at the Reedy Point South disposal area. Reach E initial materials will be utilized to restore wetlands and create sand stockpiles.

Table 3-2 shows the quantities of material that will be dredged during the 50 year project life. A bar graph summary of each disposal area usage for the entire project is contained in Table 3-3. All operation and maintenance dredged material quantities would be placed into these areas in addition to the existing Federal sites which include National Park, Pedricktown North and South, Oldmans No. 1, Penns Neck, Killcohook and Artificial Island. Maintenance material from Reach E will be disposed at an existing subaqueous site (Buoy 10).

Due to the limited size of these proposed areas and the amount of material to be dredged, four years is required for the initial

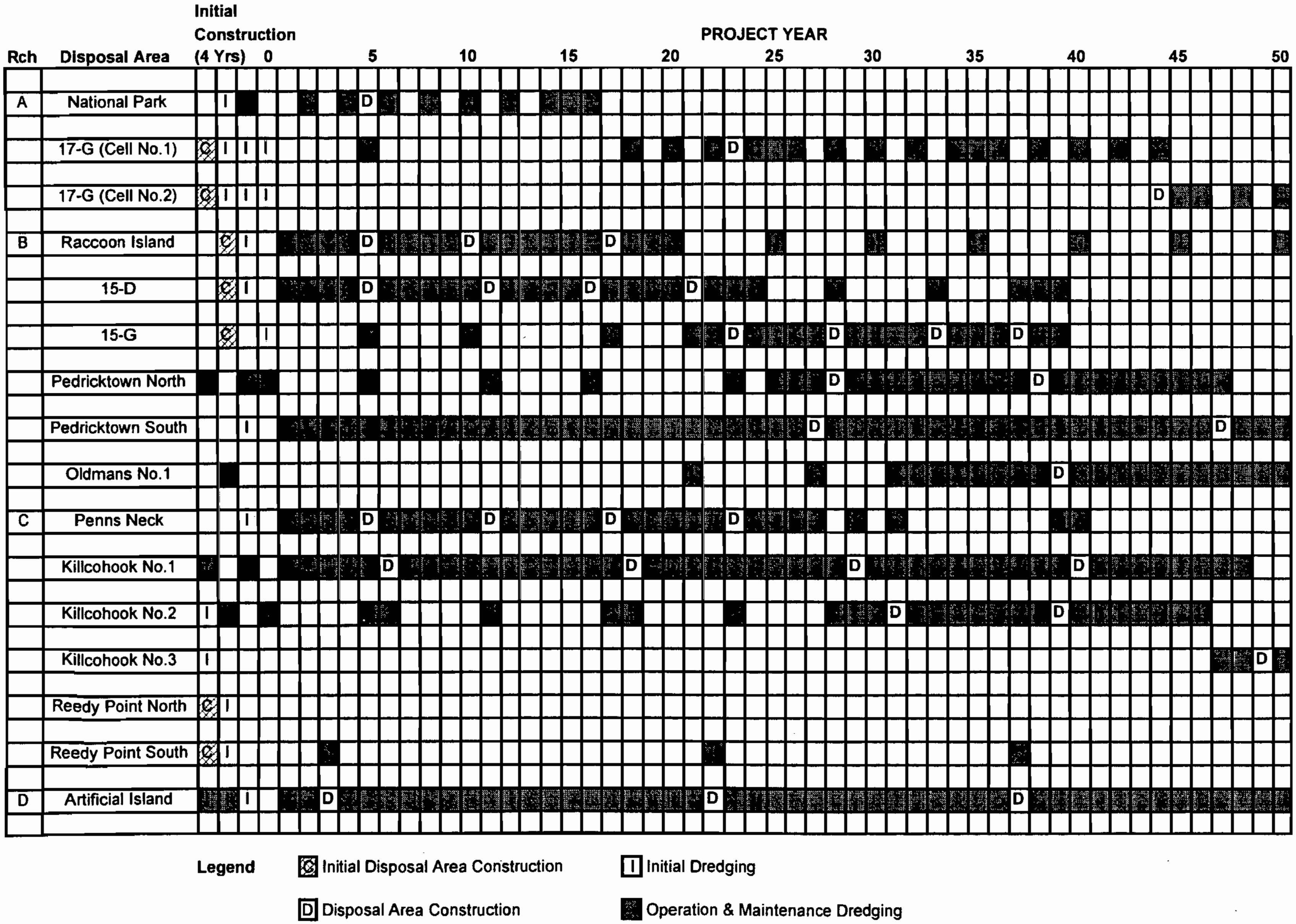
Table 3-1. Delaware River Main Channel Deepening Project
Dredging Quantities and Disposal Locations
Initial Dredging

Reach	Disposal Area	Quantity (cubic yards)
A-A	National Park	1,429,904
A	17-G	3,315,926
B	Raccoon Island	1,899,156
	15-D	581,413
	15-G	2,635,246
	Pedricktown North	1,674,958
	Pedricktown South	1,833,100
	subtotal	8,623,873
C	Penns Neck	753,568
	Killcohook No.1 via Lehigh Ave.	861,069
	Killcohook No.2 via shoreline	1,508,162
	Killcohook No.3 via shoreline	284,460
	Reedy Point North	1,057,597
	subtotal	4,464,856
D	Reedy Point South	1,009,641
	Artificial Island	4,779,220
	subtotal	5,788,861
E	Kelly Island	1,830,252
	Egg Island	2,600,148
	Slaughter Beach (MS-19)	2,858,300
	Broadkill Beach (L-5)	1,953,518
	subtotal	9,264,090
	TOTAL	32,887,510

Table 3-2. Delaware River Main Channel Deepening Project
Dredging Quantities - Maintenance (50 year period)

Reach	Disposal Area	Quantity (cubic yards)
A/AA	National Park	2,621,000
	17-G	5,729,000
	subtotal	8,350,000
B	Raccoon Island	24,350,000
	15-G	22,610,000
	15-D	28,560,000
	Pedricktown North	26,180,000
	Pedricktown South	25,950,000
	Oldmans No. 1	5,400,000
	subtotal	133,050,000
C	Penns Neck	28,269,000
	Killcohook No. 1	58,686,000
	Killcohook No. 2	19,893,000
	Killcohook No. 3	2,302,000
	subtotal	109,150,000
D	Artificial Island	19,146,000
E	Buoy 10	19,378,000
	TOTAL	289,074,000

TABLE 3-3
PROJECT DISPOSAL PLAN



project dredging. In order to assure that bulk dredging quantities do not overtop the disposal area dikes, and to ensure optimum lift thickness for drying and management of the areas, dredged quantities were efficiently distributed over the years of initial project dredging. Before beginning the actual project, a projection of disposal area capacities was made for the existing areas. Assuming a start date of year 2000, maintenance of the 40 foot project from the present to year 2000 was added to the existing disposal areas, thereby reducing their capacities. These maintenance quantities were also projected through the initial construction period of 3 years. After the initial construction was completed, the 45 foot project maintenance quantities were projected for 50 years.

3.1.3 Rock Blasting

Approximately 229,000 cubic yards of bedrock from the Delaware River near Marcus Hook would be removed to deepen the navigation channel to a depth of 45 feet mean low water. Approximately 70,000 cubic yards of bedrock will be removed by blasting. In order to remove this rock, holes drilled into the rock are packed with explosive to direct the force of the blast into the rock. The depth and placement of the holes and the size of the charges control the amount of rock that is broken. The project would be conducted by repeatedly drilling, blasting, and excavating relatively small areas until the required amount and area of bedrock is removed.

Adverse impacts to fish will be minimized by conducting blasting between 1 December and 15 March as recommended by the Delaware River Basin Fish and Wildlife Management Cooperative, and using techniques such as delayed blasting and "stemming" to reduce the amount of energy that would impact fish. Monitoring of impacts to fish from blasting will also be conducted to verify that impacts are minimal.

3.2 Delaware River, Upland Dredged Material Disposal Sites

3.2.1 Dredged Material Disposal Capacity Requirements

In order to determine the disposal needs of the project, potential disposal areas were screened as to their useful conversion to an active disposal area. After several field visits to new and existing areas, and using the most recent topographic information, a list of available disposal areas was developed. The areas include new sites 17-G, 15-D, 15-G and Raccoon Island, whose locations are shown on Plates 1 and 2. Preliminary plans called for use of the four aforementioned areas and the Federally owned Reedy Point North and South disposal areas for deposition of the initial construction dredged quantities from Reaches A through D (See Table 3-1). All operation and maintenance dredged material quantities would be placed into these areas in addition to the existing Federal sites which include National Park, Pedricktown North and South, Oldmans

No. 1, Penns Neck, Killcohook Areas 1, 2, and 3; Artificial Island Areas 1, 2, and 3 which are also shown on Plates 2 and 3, and quantities are shown on Table 3-2. Re-evaluation of the disposal scenario determined that the most efficient manner to dispose of the initial quantities would be to utilize the existing Federal disposal areas in combination with the four new areas.

All initial quantities from Reach E will be utilized for beneficial uses which are discussed in Section 3.3. Wetland restoration sites will be constructed from dredged material at Kelly Island, Delaware and Egg Island Point, New Jersey. Sand stockpiles will be created offshore of Broadkill and Slaughter Beaches in Delaware. Plates 24 and 25 detail the location and disposal destination of all of the initial dredged material for the project.

The disposal area scenario was computed for a 45 foot deep, full width navigation channel. A bar graph summary of each disposal area usage for the entire project is contained in Table 3-3, along with a summary of the dike raising years and associated cubic yards required for construction.

Materials were disposed at the closest available area in each reach of the river. Dredged material from Reaches AA and A will be disposed of in area 17-G and National Park. Reach B materials will be disposed at areas 15-D, 15-G, Raccoon Island, Pedricktown North and South, and Oldmans No. 1. Reach C materials will be disposed of at Killcohook and Penns Neck with some of the initial quantity from Reach C slated for Reedy Point North disposal area. The material from Reach D will be disposed of at Artificial Island with a small portion of the initial quantity to be pumped to Reedy Point South disposal area. As previously mentioned, Reach E initial materials will be utilized to restore wetlands and create sand stockpiles. The Reach E maintenance material will be disposed at the Buoy 10 disposal area.

3.2.2 Dredged Material Disposal Site Selection

The feasibility plan for disposal of river sediments from initial dredging called for use of two existing Federally owned upland disposal areas (Reedy Point North and South) and procurement of three additional sites by the sponsor, identified as 170, 15D and Raccoon Island. The sponsor would reimburse the Government on the usage of the Federal sites.

As part of the PED study, the selected disposal plan was reviewed to see if existing conditions or usage of disposal areas changed from that analyzed in the Feasibility Study. That review indicated that disposal site 17G is now available, as plans for private development have been discontinued; and a portion of site 15D (about 200 acres) is not available.

Site 17G was evaluated during the feasibility study and was eliminated from selection due to the expectation that it would be developed prior to implementation of the proposed project. Site 17G is located upriver from site 17O. The two sites are physically similar and were ranked closely during the screening process. As a result, disposal site 17O which has some cultural concerns, was eliminated and site 17G was substituted.

To compensate for the 200 acre reduction in Site 15D, Site 15G was added. Similarly to Site 17G, Site 15G was evaluated during the Feasibility Study and was closely ranked with Site 15D. This substitution of the two sites (17G and 15G) had no impact on the previously estimated project construction costs. Based on coordination with the sponsor, the sponsor has the ability to acquire the selected candidate sites. Potential disposal sites identified as 17G, 15D, 15G and Raccoon Island were selected as the candidate sites for detailed engineering and environmental field testing.

3.2.3 Dredged Material Disposal Site Design and Operation

3.2.3.1 General Engineering Approach for Site Management

One of the primary goals and objectives for the four new confined disposal facilities (CDFs) is development, enhancement, and management of wildlife habitat in between dredged material disposal events. In the past, Delaware River CDFs have been managed with a primary goal of maximizing storage capacity. This normally requires that the sites be drained as quickly as possible following active placement operations, that they be trenched to hasten dewatering, and that the dried dredged material be borrowed from the interior of CDFs for upgrading dikes before the next dredging cycle. This overall management approach generally conflicts with management for wetlands and wildlife habitat.

An approach which would allow for both is tied to extended cycles between uses. With extended cycles, portions of the sites can be used for temporary wetland habitat for several years, prior to the need for draining, dewatering, and dike upgrading to be ready for the next placement episode. This would call for rotation of placement between subdivisions within each CDF. The CDF sites have total surface areas ranging from 275 to 350 acres. The CDFs are amenable to subdivision into cells, each with a surface area on the order of 125 to 175 acres. A 3- to 4-year cycle for use in any one site, and placement into one of the two cells for each cycle, means that each cell will be required for placement on a 6 to 8 year cycle. Assuming between 0.75 and 1.5 million cubic yards for each event, the bulked lift thickness will be on the order of 4 to 8 feet. Material could be left in a wet condition or ponded with water if desired for a period of 3 to 4 years. During that time period, the cell would be managed as wetlands. However, some self weight consolidation would be taking place, bringing the lift thickness down to around 3 to 6 feet. This would require periodic adjustment of weirs to maintain the desired ponded area and water depths.

The lift thickness following self weight consolidation can be managed for dewatering and borrow for dike upgrading over the next time period of 3 to 4 years. Using this engineering method, each of the four CDFs could have roughly half of the surface area managed for habitat at all times, with half the site being managed for dewatering and borrow for dike upgrading. The overall engineering approach to management is described in more detail under each CDF heading. Plates 20 to 23 indicate recommended dike alignments and locations of inflow points and weirs. It is assumed with this approach that some use of the other currently operating 4 CDFs in the vicinity will be necessary. Maintaining appropriate water levels during habitat cycles should be achievable by control of outfall weir elevations.

3.2.3.2 General Habitat Considerations

In the four new CDFs, which total more than 1,200 acres (Table 3-4), there are numerous possibilities for habitat development. However, while there are numerous possibilities, most will be eliminated from consideration due to infeasible engineering, excessive costs to the project, need for intensive long-term site management, and unforeseen changes in dredging schedules and plans.

Reach B of the Delaware River (See Plate 2) is south of the urban centers of Philadelphia, PA, and Camden, NJ, and much of the area is generally rural to suburban. Reach B is also an area requiring fairly intensive dredging to maintain navigation channels in the river, which has resulted in the current necessity for three CDF's along the Delaware River in Oldmans Township, New Jersey. Oldmans Township riverfront real estate lies entirely in Reach B. Some of these are currently intensively used for dredged material placement, while the ones that are proposed for this project have been used in the past, but have been left fallow for a number of years. As a result, landowners have put them to other uses, primarily agricultural crops and haying (685 acres). These manmade areas provide considerable habitat value as they are, due to field edges, isolation, small shrub and tree areas, and the availability of palatable, abundant food supplies for upland animals (corn, wheat, and soybeans).

Passive vs. Active Management

The four new CDFs will be divided into two cells each. Each of these will have two weirs, allowing considerable flexibility for passive management through control of water depths between dredging cycles. Allowing water to remain on sites after dredging, rather than allowing all freeboard and rainwater to flow off coupled with active dewatering, will provide for appropriate <u>Phragmites australis</u> control and waterfowl/waterbird habitat. While the U. S. Fish and Wildlife Service (1995a) has recommended active management using pumps to manipulate water

Table 3-4. Delaware River Channel Deepening Project
Upland Disposal Areas
Wildlife Habitat/Vegetation Impacts

Disposal Sites Area

Habitat Types	15G	17G	Raccoon Island	15D	Totals
Row Crops	246	191	-	248	685
Common Reed	24	65	320	60	469
Woodlands	-	21	20	7	48
Ruderal	5	18	6	5	34
Non-Tidal Marsh	-	-	4	-	4
Totals	275	295	350	320	1,240

levels, this can be expensive and labor intensive, and will require on-site personnel. Instead, site management will be by use of weir boards to maintain water levels, and not by seasonal pumping.

3.2.3.3 General Habitat Development

Within the four new CDFs, a wide range of development and management possibilities exist, but are also limited to coincidence with dredging cycles, number of cells constructed, and available land and water surface within cells. In the areas that have remained ponded on the currently used CDFs, shallow water and emergent marsh habitats have developed that provide year-round values for some animals, and migratory and nesting habitat for waterfowl and waterbirds. A large portion of the National Park CDF site supports shallow water interspersed with common reed and duck weed. Many species of birds were observed in this area including American coot (Fulica americana), scaup (Aythya spp.), bufflehead (Bucephala albeola), common merganser (Mergus merganser), mallard (Anas platyrhynchos), Canada goose (Branta canadensis), great egret (Casmerodius albus), and red-winged blackbird (Agelaius phoeniceus). Several species were observed on a large shallow water area on the Oldmans CDF including northern shoveler (Anas clypeata), approximately 100 scaup, ruddy duck (Oxyura jamaicensis), northern pintail (Anas acuta), Canada goose, greater yellowlegs (Tringa melanoleuca), and lesser yellowlegs (Tringa flavipes). Additionally, the following species were observed at a shallow ponded area adjacent to the Pedricktown North site: blue-winged teal (Anas discors), bufflehead, mallard, scaup, black-crowned night heron (Nycticorax nycticorax), green heron (Butorides striatus), and bank swallow (Riparia riparia) (U.S. Fish and Wildlife Service. 1995a).

The easiest habitat types to achieve will be non-forested, and will include primarily fresh water emergent and open water habitat. These wetlands will provide habitats for migratory and resident waterfowl, wading birds, as well as other birds, mammals, amphibians, and reptiles that utilize wetlands. This is in agreement with the U.S. Fish and Wildlife Service (1995a) recommendation to implement a water management strategy for each disposal site to allow the retention of standing water from 18 inches to three feet deep over as large an area as possible and for as long as possible between disposal episodes to enhance the habitat value.

3.2.3.4 Moist Soil Management Units

The four CDF sites will be isolated from both the river and the intertidal system, as they currently are. The closest concept to the types of habitats that will be developed on the four sites is that of moist soil management units. These generally consist of diked systems where water levels are intensively managed to provide selected habitat for target species. The target species are almost always waterfowl during migration, nesting, or overwintering, depending upon the units' location within North America. This concept is consistent with objectives of the U.S. Fish and Wildlife Service's North American Waterfowl Management Plan (NAWMP). The NAWMP, an international cooperative agreement between the United States and Canada, is being implemented to restore, protect, and enhance aquatic habitats and increase waterfowl populations. The proposed project is within the Middle-Upper Atlantic Coast Habitat Area, one of five Priority Habitat Ranges in the United States. A January 1989 joint agreement between the Department of the Interior and the Department of the Army is designed to further the goals of the NAWMP. Under this agreement, consideration of NAWMP goals should be incorporated into the planning, engineering and design, and construction phases of Corps projects (U.S. Fish and Wildlife Service. 1995a).

Within such a system, a full range of "impoundment" habitats could still exist, from uplands (dikes and higher areas), to high and low emergent marsh, to shallow water ponded areas. Under active management (using pumps and seasonal drainage), cells could be drawn down and planted in waterfowl food plants, then reflooded in autumn to provide abundant migratory and winter foods within reach of dabbling ducks. The U. S. Fish and Wildlife Service Refuge System, many state Wildlife Management Areas, and a number of private landowners rely on this approach to provide maximum habitat for certain species and coincidental habitat for other species. However, active management is not always necessary in order to provide some quality habitat, and pooled water over several years will still provide considerable habitat at a much lower cost.

3.2.3.5 Confined Disposal Facility Development and Management as Wetlands

An operations and maintenance manual will be developed for the new CDFs to insure that the goals of establishing temporary wetlands on portions of the sites is achieved. This manual will describe in detail a planting wetland vegetation, controlling nuisance vegetation, such as phragmites, and controling mosquitos, if necessary. The following paragraphs describe possible scenarios for achieving these goals; however, the final plans will be developed in Plans and Specifications.

Establish Desirable Vegetation

It is unlikely that desirable wetland vegetation will become established quickly unless the water in the wetland cell is drawn down to bare substrate. Under one possible scenario, the wetland cell would receive dredged material; no dredged material would be placed in the other cell. The water in the wetland cell would be drawn down after dredging is completed, and the area would be seeded with a combination of desirable wetland species. After the plants have become established (i.e. after one growing season), dredged material would be placed into the other (non-wetland) cell, and water would be diverted from the active dredged material disposal cell into the wetland cell, to levels of 1 to 2 feet deep . These species should become established during the first growing season and remain during the 3 to 4 year period until more dredged material is placed on the cell, this procedure would be repeated to establish wetland vegetation on the other cell.

Phragmites Control

The less productive areas of the new CDFs are all vegetated with Phragmites australis, the native common reed that aggressively proliferates on wet non-saline disturbed soils along the Atlantic coast (469 acres). Finding a way to deal with the reed has been a challenge for decades, and there are generally three accepted means of control: (a) manipulation of water levels, (b) introduction of salinity, and (c) selective herbicide applications. Common reed is an excellent species for dewatering wet sites and provides good forage for livestock; however, it has almost no wildlife value.

Phragmites australis will grow on all four sites. Planting of other species on dikes and uplands will not provide enough competition, and the species will out-compete any other species planted on the four sites if conditions are favorable for the reed. Therefore, dike colonization with common reed is generally a given condition. On some of the drier CDFs in New Jersey, farmers bale common reed into hay for their livestock. In the southern United States, two additional means are used, grazing to control reed on dikes, and building gently sloped dikes that can be mowed, not options in CDFs where capacity and dike heights are of prime importance. Therefore, habitat development, enhancement, and management should concentrate on the areas between the dikes. The most practical method for the control of common reed on these sites is through the control of water levels. Keeping ponded water on portions of the sites will help to limit the occurrence of the reed.

There is a risk that phragmites would become established during a drawdown by invading rhizomes from adjacent plants. To minimize this risk, impoundment berms would be sprayed with herbicide in the late summer, prior to the drawdown. Care would be taken to avoid spraying woody vegetation. Since phragmites' seeds will germinate on bare mud, and there is a large source of seed from nearby areas, this is another possible source of invasion. However, doing the drawdown and seeding in the spring and early summer, and reflooding before phragmites goes to seed in the late summer, will minimize this risk. In addition, phragmites will have difficulty germinating on the dredged material, which will most likely be wet enough to have anaerobic conditions. For Raccoon Island, which is presently covered with phragmites, the entire area may have to be sprayed with herbicide in the late summer/early fall prior to building the berms and covering the area with dredged material. The other dredged material disposal areas are presently, primarily farmlands, and will not need the herbicide treatment prior to construction. A herbicide treatment of the "active" disposal cell may have to be done prior to establishing a wetland on this cell in the next cycle. In addition, it is likely that the berms adjacent to the "new" wetland will have to be sprayed at the beginning of each new cycle.

Mosquito Control

After the area is reflooded, an appropriate fish species would be introduced to control mosquitos. The appropriate fish species would be selected by coordinating with the New Jersey Office of Mosquito Control Coordination and the appropriated County Mosquito Control District. The fish may have to introduced each year because of winter mortality. If fish could not adequately control the mosquitos, a pesticide would have to be used.

3.2.3.6 Site Specific Recommendations

CDF 15D

Engineering

<u>Cross and Spur Dikes.</u> This CDF has approximately 320 acres. There are presently interior drainage ditches, but no clear indication of usable cross dikes. The generally rounded configuration of the site is amenable to cross diking into two cells, each with a more favorable length to width ratio as shown in Plate 22.

<u>Inflow and Weir Locations.</u> Site 15D generally slopes from west to east. Inflow points will be located at the higher elevations to the west side as indicated on Plate 22. Two weir structures will be placed in each cell on the east end, at locations of lowest elevations and existing drainage ditches. The two weirs set apart in each cell will tend to counteract short circuiting if both are used during active management. Two or more weirs also provide more flexibility in operation if one develops problems.

<u>Operations and Management.</u> The large surface area of 15D should allow placement of approximately 1.5 million cubic yards on a 3 to 4 year cycle in each cell, assuming a 6 to 8 ft bulking thickness. The general slopes now existing can be maintained, and a large portion of the lower end of a cell could be retained as a shallow ponded area for 3 to 4 years following placement. After that period, the cell would be drained and actively dewatered, followed by dike upgrading using borrow material from within the cell.

Environmental

Site 15D is now almost exclusively agricultural fields of corn and soybeans, and has a 10-foot slope differential across the site, although it visually appears relatively flat (Plate 18). The perimeter dikes have already been designated to exclude the oak forest areas on the south side of the site, and a corner on the northwest side has also been excluded near Raccoon Creek because it does not provide efficient dike flow. The engineering placement of a cross dike from west to east across 15D will split the site into two long narrow cells. This configuration will provide two excellent cells for management as moist soil units or water impoundments because of the elevational differences.

Water depths for moist soil management units are generally from 0.5 to 3 ft deep (approximately 1/2 of the north cell and 2/3 of the south cell) and would provide more brood habitat and habitat for dabbling ducks and wading birds. By contrast, impoundments may be up to 10 ft deep (approximately covering the entire cell with varying water depths) and would provide for diving ducks. Since dabbling ducks are the species that are most likely to frequent these CDFs, the shallower ponded depth will be the goal. The most waterfowl production and use will come from the shallower water depths, as will any colonizing emergent fresh and floating marsh. Wading bird species will only use the shallow water depths.

A projected water depth of 0.5 to 3 ft will still leave room initially for high marsh and the development of a brief shrub and grass community on the west ends of both cells. However, over subsequent dredging cycles, the topography inside cells will flatten, causing the entire cell to pond. It should be noted that these could also become dense stands of common reed, and the best, least-expensive way to combat large stands of reed is with flooding. Common reed can be controlled easier if water is at least two feet deep on a long-term basis. Weirs will provide some management flexibility to adjust water depths to control common reed.

CDF 15G

Engineering

Cross and Spur Dikes. CDF 15G has approximately 275 acres. There are some interior drainage ditches and low areas, but the site is generally flat. A trace of an old cross dike runs diagonally across the site, but it would require a major reworking to be usable. As with 15D, the general shape of the CDF would be amenable to cross diking into two cells. The old cross dike alignment would result in an imbalance in size, so a new alignment is desirable (Plate 23).

Inflow and Weir Locations. Site 15G could be essentially level when dikes are upgraded, but the location of the creek to the northeast requires that inflow points be located on the west side. As with 15D, two weir structures will be placed in each cell toward the east end (Plate 23).

Operations and Management. The surface area of the CDF should allow placement of between 1.0 and 1.5 million cubic yards on a 3 to 4 year cycle in each cell. Most of the area of either of the cells could be retained as a wetland or ponded area for 3 to 4 years following placement. After that period, the cell would be drained and actively dewatered, then dike upgrading would take place.

Environmental

Site 15G only has a 3-5 foot differential in elevation, making the site almost flat for ponding purposes. Therefore, ponding water to depths of 0.5 to 3 feet will result in almost 100 percent water cover in either cell, both initially and after all subsequent dredging cycles. The option of providing deeper water here would not allow more than a narrow fringe of wetlands as would be found at 15D with the deeper water option, but would provide better Phragmites australis control. Weirs will provide some management flexibility to adjust water depths to control common reed. The approximately 15 acres of home site and forest remnants near U. S. Route 130 have already been excluded from the design of the perimeter dike, and the remainder of the CDF lends itself almost entirely to providing rotational ponded habitat.

CDF 17G

Engineering

Cross and Spur Dikes. This CDF has a total area of approximately 295 acres, and is visibly divided into four areas surrounding an old rehandling basin. There is currently a high cross dike separating the two westernmost areas from the two easternmost areas. There is an old remnant of a cross dike separating the northwest from the southwest area. The central area is a few feet lower than the northeast area. Furthermore, the entire southern end of the CDF has been purchased and will be developed as a forested wetland mitigation bank.

Maintenance of the four small cells at 17G would result in difficult rotation schedules for a 4 year frequency, and require much greater depths of material being placed. Using only two cells divided at the existing high roadway (Plate 20) is preferable, and the roadway should be built and maintained atop the cross dike. The dike alignment separating the resulting west cell from the mitigation bank area should be constructed to allow for a drainage ditch for flow from both cells. This would allow for placement of two weirs each within the cells, which would have more efficient hydraulic flow.

Inflow and Weir Locations. The CDF now slopes from north to south. Inflow points have historically been on the higher north side, and should continue to be located at the higher elevations to the north as indicated on Plate 20. Two weir structures should be placed in each cell at the locations indicated.

Operations and Management. The large surface area of 17G should easily accommodate placement of around 0.75 million cubic yards on a 3 to 4 year cycle to each cell in a thinner lift than the other three sites. Assuming the general slopes now existing are maintained, a large portion at the lower end of each cell could be retained as a ponded area for 3 to 4 years following placement. After that period, the cell would be drained and actively dewatered, followed by dike upgrading with interior borrow material.

Environmental

The CDF currently has over 10 feet of elevational differences, with the highest areas along the river. Construction of a new perimeter dike to exclude the mitigation bank lands will also require construction of a new drainage ditch for the entire CDF, and positioning of three of the weirs on the new ditch (Plate 20). The fourth weir is positioned to drain into the old turning basin. As indicated on Plate 20, the lowest point in the CDF is centered near the turning basin.

The CDF can easily be divided into two cells, with the design of the largest cell so that effluent will flow around and through the turning basin. This will temporarily allow the wetlands (common reed) in this area to remain, but will ultimately cause a change in wetland type from common reed to shallow ponded water fringed by emergent marsh. Both cells can be managed to hold shallow water between dredging cycles, and the larger cell especially lends itself to this type of management. The cells will eventually flatten in topography inside dikes with subsequent dredged material placement.

It is expected that as the cells are filled, the common reed in the CDF will migrate towards the river into the highest elevations. That area of reed now is baled as hay by the landowner because it becomes dry enough to support field equipment in summer months. Weirs will provide some management flexibility to adjust water depths to control common reed.

RACCOON ISLAND

Engineering

Cross and Spur Dikes. The Raccoon Island (RI) CDF is much more complex than the other three sites. It has approximately 350 acres, but the area will be much more difficult to utilize efficiently. A currently used highway and bridge approach, an abandoned highway, and a large powerline visually divide the CDF into three areas. The areas shown on Plate 21 should be managed as one large cell and one small cell. This would require diking across the abandoned highway and essentially making one cell of two existing cells. The remaining smaller cell is due to location of the existing powerline.

Inflow and Weir Locations. The RI CDF will require a major reworking to construct or rebuild cross dikes, and the site could be assumed essentially leveled when dikes are upgraded. The location of toll bridge facilities to the south and the river to the north requires more inflow points be located at the north side as indicated on Plate 21. As with the other CDFs, two weir structures will be placed in each cell toward Raccoon Creek.

Operations and Management. The two cells at the site would be roughly 100 to 200 acres in size. The smaller area of the cell in comparison to those in 15D and 15G will mean either a smaller volume of material placed for each cycle, shorter cycles, or higher lifts for that cell, all costing more than if the area was larger. Placement of 1.0 million cubic yards over a 100-acre cell would result in a bulked lift thickness of close to 10 feet.

Environmental

The RI CDF site presents a challenge for both engineers and biologists due to the infrastructure on the site. It is over 350 acres in size, but is artificially divided into four areas due to powerlines and roads. It is also almost entirely a solid stand of *Phragmites australis* in three areas. This area will become two cells of approximately 90 and 270 acres each (the abandoned highway will be included in the large cell).

The two cells are also almost uniformly flat, so that any water retention for wetlands and wildlife ponds will cover the entire cells. This effect will aid greatly in controlling common reed, and will result in a large shallow pond with very little plant material. Therefore, a rotational plan here is crucial to providing some habitat diversity. For optimal engineering, the larger cell of the two would be more efficient for draining and intensive dewatering. For optimal habitat, the larger cell of the two would be kept as ponded areas for wildlife habitat. Therefore, on a 50-year-life rotational basis, trade-offs will be included between dredging cycles where every other rotation will favor either engineering efficiency or habitat productivity. Using the approach of one small cell and one large cell, and the abandoned highway diked and filled over, the large cell will require thinner lifts and will provide more habitat during its rotation that the smaller cell.

3.2.4 Environmental Considerations

3.2.4.1 Coordination

The plan to manage the CDFs for wetlands and wildlife habitat was developed through extensive coordination with Federal resource agencies and the New Jersey Department of Environmental Protection (NJDEP). In order to determine the type and extent of natural resources on the 4 new upland dredged material disposal areas, the Corps of Engineers contracted for an environmental assessment for each of the sites. These assessments were coordinated with the New Jersey Department of Environmental Protection (NJDEP), U.S. Fish and Wildlife Service (FWS), and the U.S. Environmental Protection Agency (EPA). In addition, visits were conducted to each of the proposed sites, as well as to currently used Corps dredged material disposal areas with personnel from the resource agencies to develop ideas for managing the new CDFs for wetlands/wildlife, as well as for the disposal of dredged material. At the request of the Corps, the FWS prepared a report (See Appendix B) presenting recommendations for management of the CDFs for wildlife. Research scientists at the U.S. Army Waterways Experiment Station (WES) assisted the Philadelphia District in developing this plan.

3.2.4.2 Summary of Environmental Features

Listed below is a summary of the environmental features that are being incorporated into the design and operation of the upland, confined, dredged material disposal areas.

a. Sites will require cross diking to provide optimum wetland/wildlife habitat. Conversely, they should probably not be cross diked to achieve most efficient engineering capability. It is recommended that cross dikes be used sparingly and effectively as noted above, with one cross dike in 15D, 15G, 17G, and Raccoon Island.

b. The new CDFs will be optimized for wetland and wildlife habitat by establishing a rotational basis for disposing dredged material among cells within each new CDF and among 4 other nearby CDFs.

c. Weirs will be positioned to provide optimum ponding and water level manipulation, using structural designs that can be utilized and managed on a long-term basis.

d. Habitat options will focus on palustrine fresh marsh (both emergent and floating, shallow water). Fringe areas will be allowed to develop as transition zones and as uplands, and common reed stands will be discouraged using water level manipulation as its best control. This will provide the most waterfowl and waterbird habitat, while still providing for general habitat diversity.

e. Where possible, existing forested wetland should be allowed to remain, and within cells at highest points, upland forest should be encouraged, to provide maximum habitat diversity.

f. Dike construction and site leveling will be accomplished in a manner that minimizes impacts within environmental windows.

g. A fixed rotation for the disposal of dredged material will be established which will maximize years and seasons of ponding within selected cells. Rotation is for a 3 to 4 year cycle per CDF (6 to 8 year rotation per cell), which will allow each cell to lie fallow and provide habitat for at least 3 to 4 years before being required again in the rotation (longer spacing may be possible depending on the need to raise dikes).

h. Continued coordination, communication, and cooperation will be encouraged among State and Federal agencies on this project so that ways to accomplish all goals for these four sites within agency missions will be accomplished.

3.2.5 50-Year Maintenance Plan

All four sites lend themselves to some imaginative topographic relief for the sake of wildlife habitat during the life of the project, and especially after the project is completed. That is, the sculpting of ponds and islands within cells to provide more habitat diversity and varying water depths after dredged material has been placed in cells over several rotational cycles and higher overall elevations are achieved. This approach is also expensive, and would not be undertaken until the sites are no longer suitable for dredged material disposal, and the environmental features could be considered permanent. There are several transitional, more upland habitat features that can be planned for two to three decades into project life that include more moist forest, more insular features, and perched ponds.

These four sites, along with the other nine Federal CDFs adjacent to the Delaware River, will be developed and filled. The sites will progress, and at the end of the project life in 2050, the four sites will have become broad flat hills in the landscape and be uplands rather than wetlands. The material in these sites is suitable for beneficial uses, and does not require any remediation after project life. Upland habitat will develop on these sites regardless of whether they are planted or not; natural colonization takes longer but the results are the same over time. The detailed management of these areas should be determined by the needs and priorities of the people who are living at the end of the project. It can be stated at this time that this area will be committed to an open space/environmental uses.

3.3 Delaware Bay Beneficial Use Sites

3.3.1 Dredged Material Disposal Capacity Requirements

The authorized Delaware River Main Channel Deepening Project will require the removal of approximately ten million cubic yards (million cubic yards) from the Reach E channel (within the Delaware Bay Estuary), and placement in four beneficial use sites, including two wetland restorations (Kelly Island and Egg Island Point) and two sand stockpiles, Broadkill Beach(L-5) and Slaughter Beach (MS-19). Plate 4 shows the locations of the beneficial use sites. Design features of the beneficial use sites are given in the following sections.

Approximately eight million cubic yards is sand and one million cubic yards is primarily clay and silt, with a fraction of sand. The one million cubic yards of fine grained material (clay and silt) dredged from the main channel between Stations 360+000 to 381+000 and 455+000 to 460+000 (see Plate 25), will be placed at a confined dredged material facility (CDF) at Kelly Island. This CDF will also be a restored wetland of approximately 90 acres. In addition, 857,000 cy of sand dredged from between Stations 350+000 to 360+000 and 381+000 to 390+000, will be used at Kelly Island for foundation dikes, sand plugs and the filling of geotextile tubes.

Egg Island Point will be filled with approximately 2.13 million cubic yards of sand, with an additional 503,000 cy of sand being used for the foundation dikes and the filling of geotextile tubes. The sand will be dredged from the channel between Stations 390+000 and 440+000 (See Plate 25). An approximately 135 acre wetland restoration will be built.

The third and fourth beneficial use of dredged material sites are sand stockpiles. Approximately 2.8 million cubic yards of sand will be placed at site Slaughter Beach (MS-19) to elevation -3.0 feet mlw. The material will be dredged from the main channel between Stations 440+000 to 455+000 and Stations 460+000 and 472+000 (See Plate 25). Approximately 1.9 million cubic yards of sand will be placed to elevation -3.0 feet mlw at the Broadkill Beach (L-5) sand stockpile site. The material will be dredged from the main channel between Stations 472+000 to 485+000 and Stations 495+000 and 511+000 (See Plate 25).

Over the life of the project (50 years) approximately 19 million cubic yards of material will be dredged from the lower Delaware Estuary (Reach E) to maintain the channel. This material is sand and grandular, and will be deposited in the open water dredged material disposal site at Buoy 10 (see Plate 25). This existing site has been used for many years for the disposal of dredged material from the lower Delaware Bay.

3.3.2 Beneficial Use Site Selection

3.3.2.1 Previous Screening

Extensive screening for potential beneficial use sites was performed and is discussed in greater detail Section 3.4.4. An Analysis of Alternatives to the Buoy 10 Disposal Area in Delaware Bay (Reach E) is presented in the Final EIS (USACE. 1992). This analysis required 5 cycles to proceed from the identification of all reasonable disposal alternatives to the establishment of the most effective yet environmentally acceptable disposal plan. Cycle 1 evaluated disposal methods and identified potential disposal areas. The following disposal methods were evaluated: subaqueous (thinlayering, hole filling to create shallows, diked containment for wetland creation, diked containment for upland/island creation, deep water overboard disposal, beachfill, sand stock pile, oyster seed bed creation, and off shore berms/shore protection); placement of material in wetlands (diked containment) to create uplands; and placement of material on uplands (diked containment). Within each area of consideration, potential disposal areas were identified through interviews with local officials, review of previous correspondence and reports, and public notices. Aerial photographs, maps, and surveys were also obtained to identify other possible locations for dredged material disposal operations.

Following the identification phase, the potential disposal areas were then evaluated and manually screened for linear features (ie. roads, rail road tracks, etc.) that would preclude site development and engineering acceptability (Cycle 2). Only those options and sites which were feasible from and engineering perspective were allowed to advance onto further examination.

Cycle 3 analyzed the remaining disposal options from institutional and environmental viewpoints. The purpose of this screening was to eliminate sites which would violate the Federally approved regulations. Environmental concerns included adverse impacts to quality ecological habitats and disturbance of cultural resources.

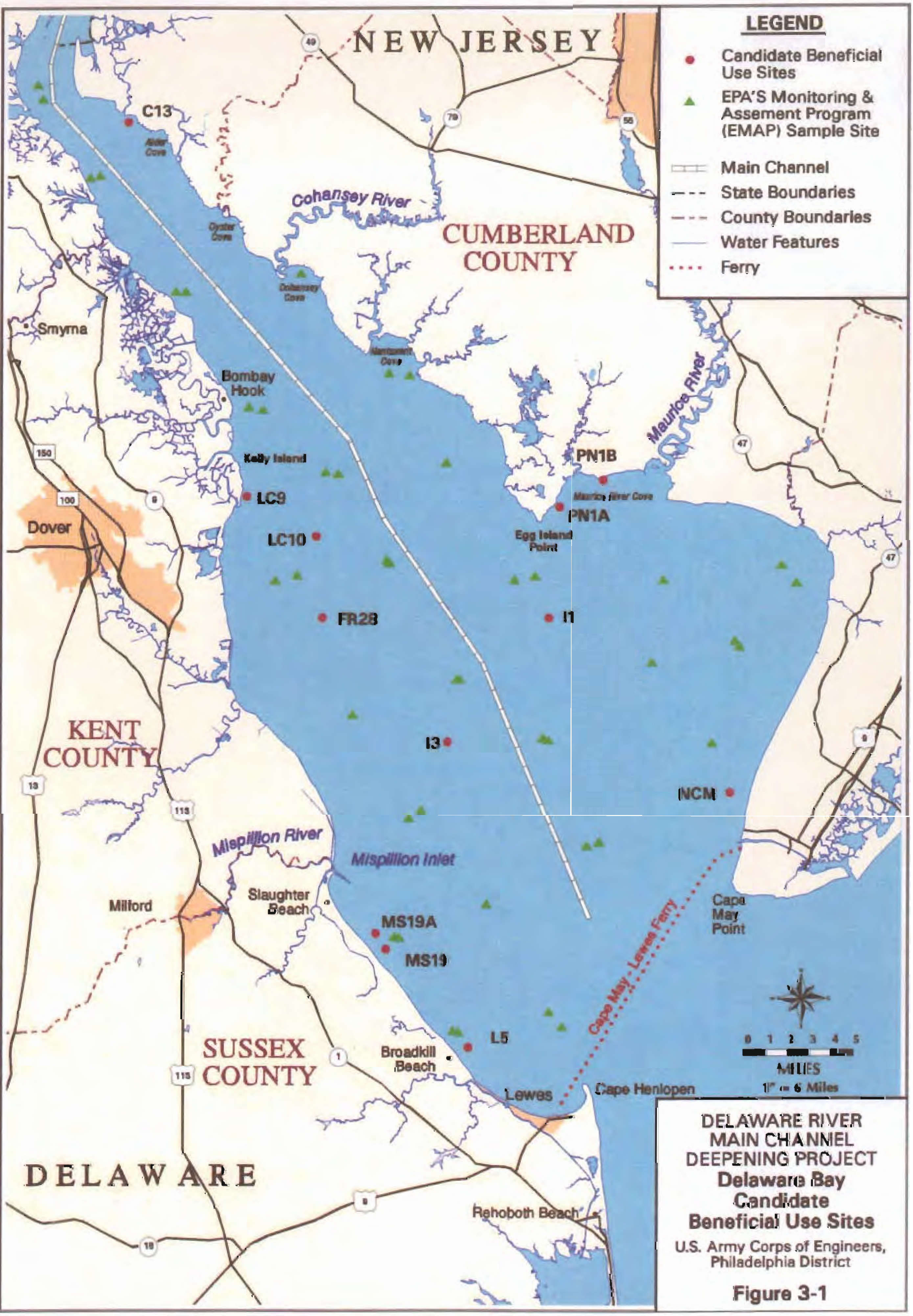
The sites that attained engineering, institutional, and environmental acceptability were then evaluated for critical cost factors and severity of impact to environmental and cultural resources (Cycle 4). The sites that remained after this screening were subjected to a more detailed incremental cost analysis, including incremental mitigation to prepare a final ranking of potential disposal sites (Cycle 5). These potential sites are listed on Table 3-5, and their locations are shown on Figure 3-1.

3.3.2.2 Benthic Screening

Benthic survey results are discussed in greater detail under Section 6.0, Benthic Habitat Investigations. Eleven proposed beneficial use sites were investigated in 1993 (Phase I). Four of these original sites were selected as beneficial use sites and were resampled in 1994 (Phase II). These sites were PNIA and LC-9 (Wetland Restoration); and LC-5 and LC-10 (Sand Stockpiles). Biological parameters that were measured included species composition, density of organisms, percent equilibrium taxa, biomass, numbers of large individuals, and commercially and/or recreationally important species. The result of these studies indicated that the significance of existing resources did not

Table 3-5. Delaware River Main Channel Deepening Project
Planning, Engineering and Design Study
Beneficial Use of Dredged Material
Disposal Alternatives for Reach E

RANGE	SITE NAME/LOCATION	TYPE
Lower Liston/ Upper Cross Ledge	LC-9/Port Mahon C-13/Alder Cove	Wetland Restoration Island Creation
Lower Cross Ledge/ Upper Miah Maull	FR-28/Offshore of Kitts Hummock Beach LC-10/Offshore of Pickering Beach	Sand Stockpile Sand Stockpile
Lower Brandywine	L-5/Offshore of Broadkill Beach MS-19/Offshore of Slaughter Beach	Sand Stockpile Sand Stockpile
Lower Miah Maull/ Upper Brandywine	PN-1/Maurice Cove Area I-3/Lower Middle Shoal	Wetland Restoration Island Creation



DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Delaware Bay Candidate Beneficial Use Sites

U.S. Army Corps of Engineers, Philadelphia District

Figure 3-1

preclude the use of any of these sites for beneficial uses.

As a result of coordination with the U.S. Fish and Wildlife Service and the State of Delaware, Site LC-10 was eliminated because it was in an oyster lease area, and Site MS-19B was substituted.

3.3.2.3 Chemical Screening

The results of chemical and biological testing of dredged material that would be placed at the beneficial use sites are discussed in greater detail under Section 4.0, Sediment Quality Investigations. Samples of sediment from the lower Delaware Bay channel (Reach E) were tested using bulk analysis procedures. Parameters included heavy metals, pesticides, PCBs, PAHs, phthalates, volatile organics, and semi-volatile organics. The mean channel sediment concentrations of detected chemicals were compared to the NJDEP Impact to Residential Soil Standards and the NJDEP Ground Water Standards. Comparison of the data to these criteria indicates that the dredged material from Reach E is acceptable for beneficial uses such as wetland creation and sand stockpiles for later beach nourishment.

To predict contaminant levels that would be liberated from sediment during dredging and disposal activities, which would then be biologically available to impact aquatic resources, 109 individual sediment strata were also evaluated through an elutriate analysis. The results of this analysis indicate that there would be no significant impacts to water quality.

In addition, bioassays and bioaccumulation tests have been run to directly test the potential toxic effects of Delaware River channel sediments on aquatic organisms. Water column and whole sediment bioassays exposed living organisms to sediment, to evaluate any differences in mortality between Delaware River channel sediment and clean laboratory sediment used as a control. Bioaccumulation tests were run with Delaware Bay sediment to evaluate the potential for bioaccumulation of contaminants by aquatic organisms that would reside in the sediment after placement in the beneficial use sites. All water column and whole sediment bioassays resulted in 100 percent survival of all test species. Test results also suggest that open water placement of Bay sediment is acceptable with regard to bioaccumulation concerns.

3.3.2.4 Cultural Screening

The results of screening beneficial use sites for cultural resources are discussed in greater detail under Section 11.0, Cultural Resource Investigations. All of the proposed beneficial use sites have been surveyed for cultural resources. None of the proposed beneficial uses of dredged material will adversely impact cultural resources.

3.3.2.5 Description of Selected Sites

As a result of all the screening processes described above, 4 sites were chosen for beneficial use of dredged material. Site locations are shown on Plate 4, and are described below:

EGG ISLAND POINT (PN1A): This 135 acre wetland restoration site is located in the Delaware Bay, adjacent to Egg Island Point, part of the Egg Island State Wildlife Management Area, Cumberland County, New Jersey.

KELLY ISLAND (LC-9): This 60 acre wetland restoration site is located in the Delaware Bay, adjacent to Kelly Island, part of the Bombay Hook National Wildlife Refuge, Port Mahon, Kent County, Delaware.

LC-5: This 230 acre sand stock pile is located about 0.33 miles offshore of Broadkill Beach, Delaware.

MS-19: This 500 acre sand stock pile is located about 0.5 miles offshore of Slaughter Beach, Delaware.

3.3.2.6 Coordination

Design of the selected beneficial use sites included extensive formal and informal coordination with Federal resource agencies including the U.S. Fish and Wildlife Service (FWS), the U.S. Environmental Protection Agency (EPA), and the National Marine Fisheries Service (NMFS), and state resource agencies including the New Jersey Department of Environmental Protection (NJDEP) and the Delaware Department of Natural Resources and Environmental Control (DDNREC). At the Corps' request, the FWS prepared a Planning Aid Report that summarized available data and information on the fish and wildlife resources of the Delaware Bay, with emphasis on those resources that would be most affected by plans being considered for the disposal of dredged material from the Main Channel deepening project (USFWS. 1995b).

A number of meetings were held with the resource agencies to coordinate the design of proposed beneficial use sites. In addition, numerous telephone conversations were held between members of the Corps' Study Team and members of the resource agencies. Additional information on coordination is given in Section 15.0, Public Involvement.

3.3.2.7 Fish and Wildlife Resources

General

The information presented in this section has been taken from the planning aid report prepared by the FWS (1995b). The Delaware Bay supports diverse and abundant fisheries and shellfisheries resources of high ecological, commercial and recreational value. Additionally, the extensive tidal marshes and shallow water areas bordering most of the Delaware Bay receives heavy use throughout the year by migratory shorebirds, waterfowl, raptors, and passerines. The interspersion of beach and marsh cover types annually hosts the second largest concentration of migrating shorebirds in the Western Hemisphere, including 80 percent of the hemispheric population of red knots (Calidris canutus).

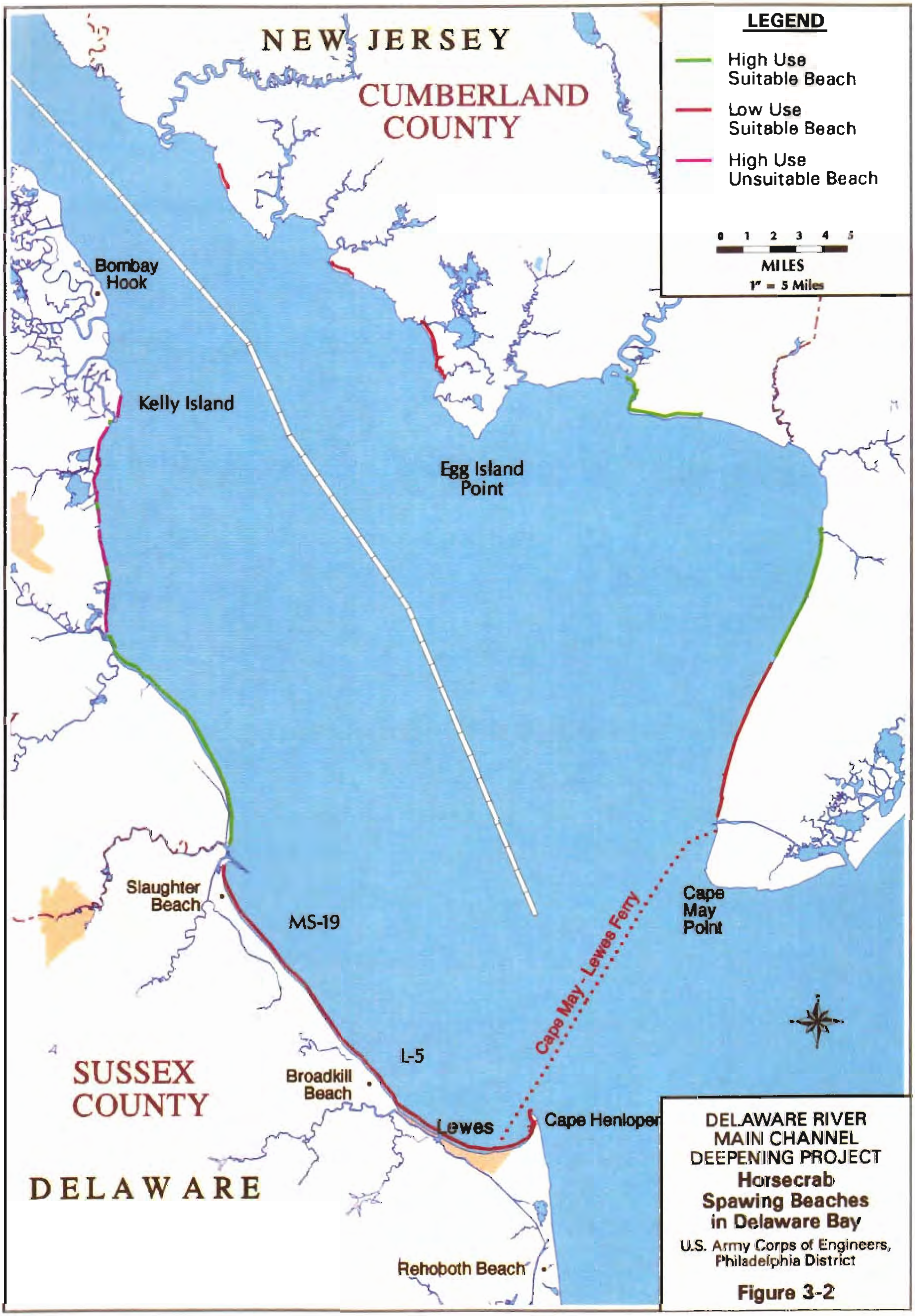
Macroinvertebrates

Horseshoe crabs. The largest population of spawning horseshoe crabs in the world is found in Delaware Bay (See Figure 3-2). Each spring, adult horseshoe crabs migrate from deep water in the Delaware Bay and the Atlantic continental shelf to spawn on Delaware Bay beaches. The minimal geologic shoreline development and smooth morphology of Delaware Bay's lower shoreline facilitates movement of horseshoe crabs and enables them to find suitable spawning beaches in large numbers. Spawning generally occurs from April to July, with the peak spawning activity occurring on full moon high tides in May and June. The average width of the intertidal area used by horseshoe crabs for spawning is about 45 feet on Delaware Bay beaches. Eggs are deposited in the upper portion of the intertidal zone in clusters approximately 6 to 8 inches below the surface. The average cluster contains between 3,000 and 4,000 eggs.

Horseshoe crab reproductive success is greatest under the following conditions: (1) the egg clusters are moistened by water with salinity of at least 8 parts per thousand; (2) the substrate around the egg clusters is well oxygenated; (3) the beach surface is exposed to direct sunlight to provide sufficient incubation; and, (4) the slope of the beach is adequate for larvae to orient and travel downslope to the water upon hatching. These conditions are found on sandy beaches along the lower portion of Delaware Bay.

The mechanism by which horseshoe crabs locate preferred spawning habitat is not completely understood. While horseshoe crabs spawn in greater numbers and with greater fecundity along sandy beaches, horseshoe crabs can tolerate a wide range of physical and chemical environmental conditions, and will spawn in less suitable habitats if ideal conditions are not encountered. Therefore, the presence of large numbers of horseshoe crabs on a beach is not necessarily an indicator of habitat suitability. It is known that shoreline areas with high concentrations of silt or peat are less favorable to horseshoe crabs, because the anaerobic conditions reduce egg survivability. It also appears that horseshoe crabs can detect hydrogen sulfide, which is produced in the anaerobic conditions of peat substrates, and that horseshoe crabs actively avoid such areas.

Beach slope is also thought to play an important role in determining the suitability of beaches for horseshoe crab spawning. Horseshoe crabs generally travel downslope after spawning and appear to become disoriented on flat areas.


NEW JERSEY
CUMBERLAND COUNTY
LEGEND
High Use Suitable Beach
Low Use Suitable Beach
High Use Unsuitable Beach
0 1 2 3 4 5
MILES
1" = 5 Miles
Bombay Hook
Kelly Island
Egg Island Point
Slaughter Beach
MS-19
Cape May Point
Cape May - Lewes Ferry
L-5
SUSSEX COUNTY
Broadkill Beach
Lewes
Cape Henlopen
DELAWARE
Rehoboth Beach
DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
Horsecrab Spawing Beaches in Delaware Bay
U.S. Army Corps of Engineers, Philadelphia District
Figure 3-2

Although the optimal beach slope is unknown, beaches visited by the FWS during February 1995 had slopes of between 3 and 7 degrees to seaward. As previously noted, beach conditions vary substantially from season to season, and these observations may not reflect beach conditions during the horseshoe crab spawning season.

In addition to the intertidal zone used for spawning, horseshoe crabs also use shallow water areas (less than two fathom depths) such as intertidal flats and shoal water as nursery habitat for juvenile life stages. Adult horseshoe crabs forage in deep water habitat during most of the year, except during the breeding season when they move into shallow and intertidal water.

The presence of offshore mud flats may also influence the use of certain beaches by spawning horseshoe crabs. Horseshoe crabs may congregate on mud flats to wait for full moon high tides, because these areas provide protection from wave energy. Female horseshoe crabs can carry over 88,000 eggs per animal. Therefore, several tidal cycles are required to complete spawning. Offshore mud flats may provide safe areas to rest between tide cycles.

Under normal conditions spawning mortality on beaches averages approximately 10 percent of the spawning individuals. Factors contributing to normal mortality include age, excessive energy expenditure during spawning, stranding, desiccation, or predation by gulls. Entrapment in man-made structures such as rip-rap, bulkheads, and jetties, and commercial harvest also account for significant additional mortality.

Annual beach surveys of Delaware Bay horseshoe crab spawning activity conducted by volunteers since 1990 appear to indicate an overall decline in the horseshoe crab population in recent years. Preliminary results from the 1995 beach surveys appear to further support the conclusion that horseshoe crab numbers are declining. Additionally, trawl surveys conducted by DDNREC appear to corroborate the findings of the beach surveys. Weather and other factors influence the timing and intensity of spawning; therefore, additional data are needed before valid conclusions can be drawn regarding population trends. Nonetheless, the observed downward trend in the existing data is reason for concern.

The beach surveys are also useful in documenting relative use of various shoreline segments by spawning horseshoe crabs. For example, the survey data indicate declining numbers of spawning horseshoe crabs on beaches experiencing the highest erosion; Kelly Island and Port Mahon, in particular. The most consistent spawning beaches in Delaware appear to be those between Kelly Island and South Bowers Beach, which have extensive mud flats offshore.

While horseshoe crabs have some commercial value, the primary importance of this species is food chain support, particularly for migratory shorebirds. Shorebirds congregate along the Delaware Bay shoreline during their northward migration each spring because the massive amounts of horseshoe crab eggs provide a food source unlike that in any other site in the Western Hemisphere. Shorebirds passing through Delaware Bay spend, on average, 15 days replenishing body fat reserves before continuing their migration to nesting areas in the Arctic. During that period, these shorebirds consume massive quantities of horseshoe crab eggs. For example, sanderling (Calidris alba) have been estimated to eat 9,000 eggs per individual per day.

The bills of most shorebirds are too short to allow them to dig up horseshoe crab egg clusters. Most shorebirds rely on successive waves of horseshoe crabs to come ashore and inadvertently dig up previously deposited egg clusters while attempting to deposit new egg clusters. Therefore, a large population of horseshoe crabs, laying many more eggs than are needed to maintain the population, is necessary to provide a sufficient food supply for migrating shorebirds. However, the minimum size of the population needed to sustain shorebird populations is unknown.

Other macroinvertebrate. Commercially and recreationally important macroinvertebrate species found in Delaware Bay include blue crab (Callinectes sapidus), American oyster (Crassostrea virginica) and hard clam (Mercenaria mercenaria). Blue crabs are abundant throughout the area, foraging in tidally influenced waters and wetlands from May through November. During the winter (December through April) blue crabs stay in water greater than 15 feet deep.

In waters within the State of Delaware, oysters occur in naturally reproducing seed beds offshore and north of Kelly Island, and in leased bed areas south of Kelly Island down to the Mispillion River area. In New Jersey waters, oyster seed beds occur from south of Artificial Island to Fortescue; lease beds occur from southwest of Egg Island Point throughout much of the lower Bay. Hard clams occur throughout the area, on soft sandy bottoms, in water with salinity greater than 12 ppt.

Maurer *et al.* (1978) found a total of 169 species of benthic macroinvertebrates in Delaware Bay over two summers of sampling (1972 and 1973). Maurer *et al.* (1978) noted that there are marked seasonal and annual fluctuations in the distributions of animal assemblages. The number of species and number of individuals increased with increasing salinity and increasing median sediment grain size.

The general composition of the benthic invertebrate community is similar to that of other temperate estuaries in the Northern Hemisphere (Maurer *et al.*, 1978). Dominant species include the polychaetes Glycera dibranchiata, Heteromustus filiformis, and Scoloplos fragilis; and mollusks such as Tellina agilis, Ensis directus, Nucula proxima, Gemma gemma, Molina lateralis, and Mytilus edulis. These species are found in community assemblages throughout the Mid-Atlantic Bight.

Finfish

Delaware Bay supports substantial recreational and commercial fisheries. Weakfish (Cynoscion regalis), summer flounder (Paralichthys dentatus), and bluefish (Pomatomus saltatrix) are the most popular recreational species, but the recreational catch also includes striped bass (Morone saxatilis), scup (Stenotomus chrysops), tautog (Tautoga onitis), spot (Leiostomus xanthurus), Atlantic croaker (Micropogonias undulatus), red hake (Urophycis chuss), black sea bass (Centropristis striata), skates, and sharks. Delaware Bay also supports important anadromous fish species including American shad (Alosa sapidissima), alewife (Alosa pseudoharengus) and blueback herring (Alosa aestivalis). Stocks of several of these species, most notably weakfish, have declined in recent years due largely to over-fishing.

Weakfish are one of the most important species in Delaware Bay in terms of abundance and value to the recreational and commercial fisheries. Weakfish are seasonal residents of Delaware Bay from April through October and spawn throughout the project area. Spawning occurs throughout the summer, but peaks in June and July. The larvae are transported by currents to the middle and upper portions of the Bay where they develop into juveniles. During the fall, after juveniles have attained a length of 4 to 6 inches, weakfish migrate to wintering areas off Virginia and North Carolina.

Striped bass occur in all seasons, throughout the project area; although young-of-the-year use the project area only sporadically, concentrating primarily in the spawning area, which is in the Wilmington/Philadelphia area of the Delaware River.

Black sea bass, scup, and tautog stay in close proximity to reefs or other hard irregular structures. These species can be found throughout the project area, during any time of the year. American shad use the project area during two time periods. In the spring and early summer (April through July) the channel and other deep areas of the bay serve as a "multi-stock" staging area for adults as they wait for water temperatures to warm upstream in the Delaware River and further up the Atlantic coast. Fish from the north Atlantic then move back out to the coast, while the Susquehanna and Delaware River stocks migrate upstream to spawn. In the fall (September through November) the "young-of-the-year" move down into the Bay as the water temperatures decrease, and then leave the Bay for the open ocean.

Reptiles

The northern diamondback terrapin (Malaclemys t. terrapin) is relatively common throughout the study area. Estuarine emergent marshes and associated creeks and near shore waters are used for foraging (April through December). Salt marsh snails and fiddler crabs form the bulk of the diamondback terrapin diet. Egg laying occurs from early June through mid-July on sandy beaches with little or no vegetation, as well as on bayshore beaches surrounding the mouth of tidal marsh creeks. Hibernation occurs in mud banks and creek bottoms within the foraging areas, as well as within the nests themselves.

The northern diamondback terrapin is a candidate for inclusion on the Federal List of Endangered and Threatened Wildlife and Plants, pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.). Candidate species receive no protection under the Endangered Species Act; however, the FWS encourages Federal agencies and other planners to consider candidate species in project planning.

Avifauna

Waterfowl. Waterfowl are abundant in tidally influenced wetlands and shallow water areas throughout the study area, reaching peak numbers in the fall and winter months. The Little Creek Management Area south of Kelly Island and the Bombay Hook National Wildlife Refuge area are important concentration areas for snow goose (Chen caerulescens), Canada goose (Branta canadensis) and dabbling ducks such as mallard (Anas platyrhynchos), American black duck (Anas rubripes), northern pintail (Anas acuta), and green-winged teal (Anas crecca). Black ducks are known to concentrate in the scalloped, cut-out areas along Kelly Island, created as the shoreline erodes. In addition, diving ducks such as scaup (Aythya sp.) and canvasback (Aythya valisineria) use the Little Creek area of the Bay itself (generally within the oyster leasing area).

Shorebirds. As many as 1.5 million shorebirds may pass through the Delaware Bay each spring; the largest concentration of shorebirds on the east coast. As previously mentioned, the shorebird stopover coincides with the spawning period of horseshoe crabs. The most commonly occurring shorebird species that migrate through Delaware Bay are the red knot, ruddy turnstone (Arenaria interpres), semipalmated sandpiper (Calidris pusilla), sanderling, dunlin (Calidris alpina), and dowitchers (Limnodromus spp.). The first four species listed comprise 97 percent of all shorebirds observed in aerial surveys conducted since 1986.

Shorebirds are dependent on a mosaic of beach and salt marsh cover types to meet their requirements for foraging, roosting, and resting. While the horseshoe crab eggs found on Delaware Bay beaches are an essential food source for migrating shorebirds, other cover types are also used extensively by shorebirds. Shorebirds feed in salt marsh ponds and creeks during high tide when bayshore beaches are inaccessible, and shorebirds roost in protected areas of the salt marsh.

Little information exists on the historical use of the Delaware Bay by migrating shorebirds. Since 1985, the NJDFGW, Endangered and Nongame Species Program, and the DDNREC, Endangered and Nongame Species Program, have conducted annual shorebird surveys along Delaware Bay. Aerial surveys of approximately 50 miles of shoreline in both Delaware and New Jersey are conducted once per week for six weeks each May and June. The Delaware portion of the survey extends from Woodland Beach south to Cape Henlopen. The New Jersey portion of the survey extends from the Cohansey River to Cape May Canal. Estimates are made of total bird numbers, by species.

The survey data indicate that the beach areas from the Mispillion River north to Simons River are the most heavily used by shorebirds. In 1990, this area accounted for over 80 percent of all the shorebirds observed in the Delaware portion of the survey. The Mispillion River area, including the mud flats of the Mispillion jetty, experience the heaviest use, both in terms of total numbers of birds and species density. Survey data also indicate heavy shorebird use along the entire New Jersey shoreline, particularly near Dennis Creek, Moores Beach, Thompson Beach, Egg Island Point, and Fortescue.

Two trends in shorebird abundance are important to note from the surveys. First, the number of sanderlings using Delaware Bay has apparently declined markedly. In 1990, sanderling were observed at only 4 Delaware beaches, all south of Big Stone Beach. Second, there is also evidence that semipalmated sandpipers are declining significantly.

Site Specific Fish and Wildlife Resources

Kelly Island

While horseshoe crabs spawn in the adjacent Kent Island area, conditions are generally not conducive to egg development, and reproductive success is probably low (Figure 3-2). The value of horseshoe crab eggs at this site may be more as a food source for migrating shorebirds, than as a source for sustaining horseshoe crab populations.

Commercially important oyster seed beds exist in the area offshore of Kent Island and Kelly Island (Figure 3-2). There are also oyster beds inside the mouth of the Leipsic River. Additionally, hard clams and blue crabs are distributed throughout the Kelly Island area. Blue crabs in this area are commercially important.

The most frequently occurring species of benthic macroinvertebrates in samples taken in the vicinity of Kelly

Island area by Maurer *et al*. (1978) in 1972 and 1973 included polychaetes such as Nephtys picta, Glycera capitata, Glycera dibranchiata, and Heteromastus filiformis; mollusks such as Tellina agilis, Nassarius trivittatus, Ensis directus, Mulinia lateralis, and Nucula proxima; and, crustaceans including Cancer irroratus, Paraphoxus spinosus, Protohaustorius wigleyi, and Pagurus longicarpus.

The Greeley-Polhemus Group (1994) found 23 macroinvertebrate species at the Kelly site, in 1993. Crustaceans (11 species) and polychaetes (5 species) dominated the samples. Dominant species included mollusks such as Mulinia lateralis, and polychaetes including Glycera dibranchiata. Small horseshoe crabs were also collected. The Greeley-Polhemus Group (1994) reported sampling problems associated with the thick cohesive silt / clay substrate, which made it difficult to dredge for commercially or recreationally important species.

Striped bass use the mouth of the Leipsic River in all seasons. This area is also a spawning area in spring and summer for riverine and anadromous fish such as American shad, river herring, and white perch (Morone americana).

Kent Island marshes provide significant shelter, wintering and breeding habitat for American black duck and other waterfowl species. Gulls, terns, and large numbers of wading birds such as glossy ibis (Plegadis falcinellus) use the Kent Island and Kelly Island areas, especially in spring.

The beach on the southern tip of Kelly Island historically supported large numbers of spawning horseshoe crabs, with corresponding heavy use by shorebirds, particularly ruddy turnstones and semipalmated sandpipers. As the beach at the southern tip of Kelly Island has eroded, horseshoe crab spawning activity has declined. While horseshoe crabs still spawn here in large numbers, conditions are generally no longer suitable for egg survival. Although horseshoe crab spawning activity has declined, shorebird use of this area has remained high. In fact, the area between Kelly Island and South Bowers Beach still supports one of the largest springtime concentrations of shorebirds in the entire Delaware Bay. This could be due in part to the inaccessibility of this area to humans.

Egg Island Point

Egg Island Point receives moderate to heavy use by horseshoe crabs. However, the shoreline conditions are generally not conducive to high spawning success, except at the tip of Egg Island Point and along the small sandy beach segments on the northwestern shoreline.

Commercially important oyster lease beds are located throughout the offshore area around Egg Island Point. Most of these lease beds are located 500 to 800 feet offshore; but in some cases lease beds are located within close proximity to the shoreline. Oyster seed beds occur to the northwest of Straight Creek, and this area also supports a commercially important blue crab fishery. See Figure 3-3 for oyster seed beds and lease areas.

The Egg Island Point area receives heavy use each spring by migratory shorebirds. Shorebirds feed in large numbers along the shoreline and along the sandy deltas at creek mouths. Additionally, the numerous small tidal and non-tidal ponds on the adjacent salt marsh provide valuable shorebird feeding and roosting habitat. The most common species using this area include ruddy turnstone, red knot, and semipalmated sandpiper.

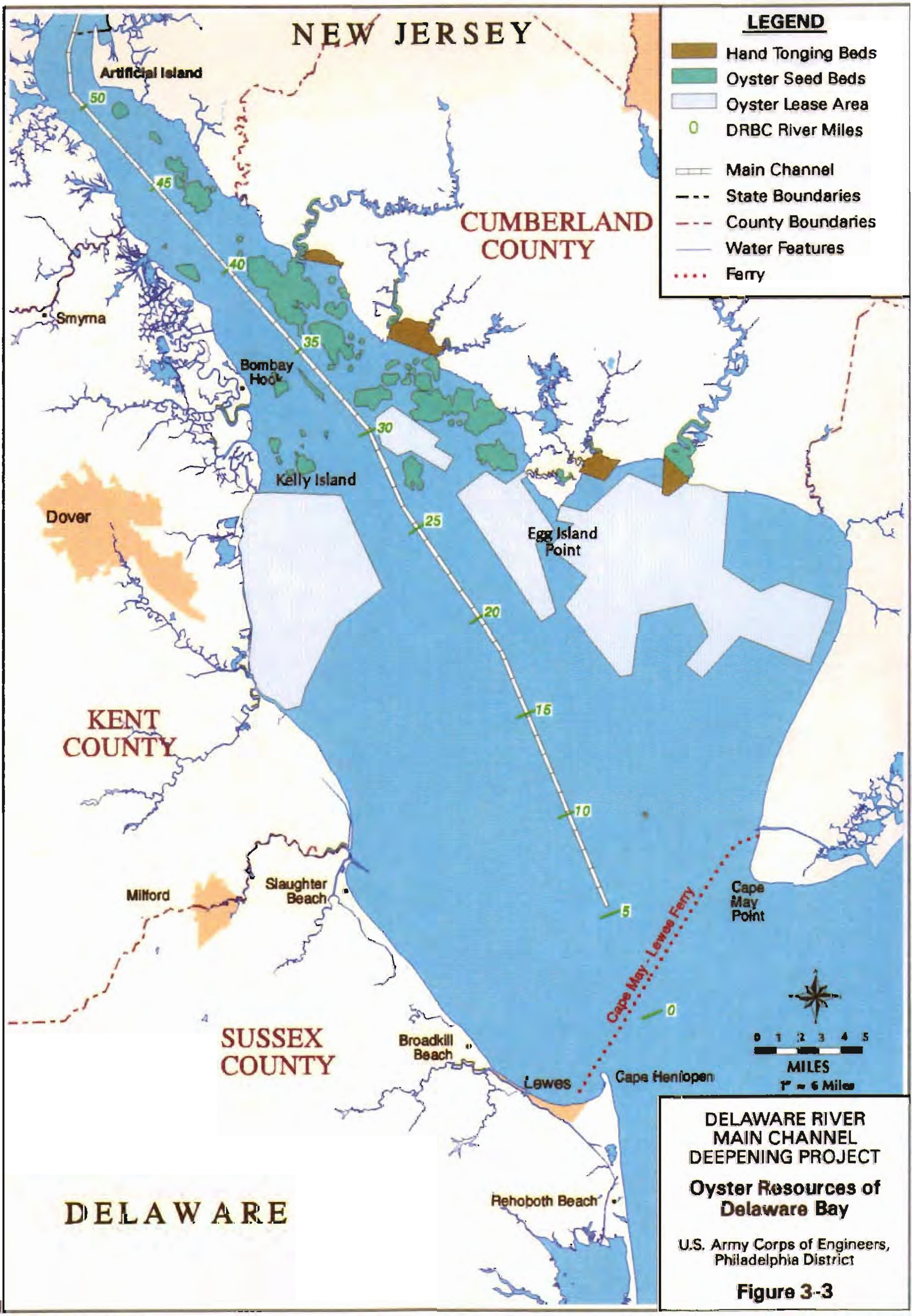
The wetlands and nearshore shallows of Egg Island Point also provide valuable habitat for a large number of migratory waterfowl. Species identified during mid-winter waterfowl surveys conducted between 1985 and 1989 include mallard, American black duck, green-winged teal, scaup, merganser (Mergus sp.), gadwall (Anas strepera), bufflehead (Bucephala albeola), American widgeon (Anas americana), Northern shoveler (Anas clypeata), Canada goose, and snow goose (FWS 1995b).

Sand Stockpiles

The most frequently occurring species of benthic macroinvertebrates in samples taken in the vicinity of Site L-5 by Maurer *et al*. (1978) in 1972 and 1973 included polychaetes such as Nephtys picta, Scoloplos fragilis, Glycera americana, Glycera capitata, Glycera dibranchiata, Aricidea cerruti, and Heteromastus filiformis; mollusks such as Tellina agilis, Nassarius trivittatus, Ensis directus, and Nucula proxima; and, crustaceans including Cancer irroratus, Paraphoxus spinosus, Protohaustorius wigleyi, and Pagurus longicarpus.

The Greeley-Polhemus Group (1994) found 51 macroinvertebrate species at Site L-5 in 1993. Crustaceans (19 species) and polychaetes (18 species) dominated the samples. Dominant species included crustaceans such as Ampelisca sp., and Cerapus tubularis; mollusks such as Mulinia lateralis, and Nucula proxima; and, polychaetes including Glycera americana and Nephtys incisa.

The area in the vicinity of Site MS-19 was sampled by Maurer *et al*. (1978) in 1972 and 1973. The dominant species included mollusks such as Ensis directus, Tellina agilis, and Nucula proxima; polychaetes including Glycera americana, Glycera capitata, Glycera dibranchiata, Nereis succinea, Nephtys picta, Capitella capitata, Aricidea cerruti, Polydora ligni, Sabellaria vulgaris, and Heteromastus filiformis; and, crustaceans including Protohaustorius wigleyi, Paraphoxus spinosus, Pagurus



DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT

Oyster Resources of Delaware Bay

U.S. Army Corps of Engineers, Philadelphia District

Figure 3-3

longicarpus, Cancer irroratus, Melita nitida, Neopanope sayi, Corophium simile, Paracaprella tenuis, and Eurypanopeus depressus.

The Greeley-Polhemus Group (1994) found a total of 62 species at Site MS-19 in samples collected in 1993. The mean density of individuals collected at this site (26,562.5 individuals per square meter) was much higher than that of any other proposed sand stockpile site. Most species were crustaceans (24 species) and polychaetes (20 species). Dominant species included crustaceans such as Ampelisca sp., Corophium sp., Cerapus tubularis, and Eurypanopeus depressus; and, mollusks such as Crepidula fornicata, and Ensis directus. Commercially and recreationally important species included knobbed whelk, horseshoe crab, blue crab, and hard clam.

3.3.3 Beneficial Use Site Design and Operation

3.3.3.1 Wave and Water Level Conditions for Delaware Bay

Information regarding water levels and waves in Delaware Bay indicate that construction of protective structures to allow for wetland restoration are challenging. The following is baseline information useful in the design of the project elements.

Water Levels. Maurmeyer (1978) found that the mean tide range is 5.5 feet MLW and the spring tide range is 6.2 feet MLW at Port Mahon, DE. The mean tide range is reasonably confirmed by the US Army Corps of Engineers (USACE 1986a) as 5.4 feet MLW. The water level that can be expected to occur once per year is about +7 feet MLW. Tables 1 & 2 provide estimates of other water levels for given return intervals based on calculations by Ocean & Coastal Technology, Inc. (OCTI) and USACE, 1986a. The values in the tables are not entirely consistent but still useful for reference.

Winds. Maurmeyer (1978) presented an analysis of the wind climate for Delaware Bay based on data from the Greater Wilmington, DE, Airport collected between 1951 and 1960. The mean annual wind speed was 11 mph and gale force winds (greater than 46 mph) occurred less than 0.3 percent of the time. Maurmeyer filtered the wind data by month and presented the data from January as representative of the winter season; April as representative of the spring; July for the summer; and October for the fall. In the winter, the mean wind speed was 12.8 mph with gale force winds occurring less than 0.7 percent of the time. Winter winds are typically from the northwest. In the summer, the winds were calmer with a mean of eight mph and with gale force winds occurring less than 0.1 percent of the time. Summer winds were usually from the southwest. Fall winds were variable with a tendency to occur from the north and northeast.

Waves. Maurmeyer discussed the wave climate for Delaware Bay based on shipboard observations. The ship observations were recorded off Slaughter Beach from 1961 to 1971. Most of the waves appear to be locally generated and not the result of waves propagating into the Bay from the Atlantic Ocean. Wave heights in the bay are generally less than two feet and exceed six feet only two percent of the time. Corresponding to the wind conditions, the highest waves occur during the winter and the smallest in the summer. However, the variability of the winds suggests that large waves may be generated from any quadrant in any season. Table 3-6 provides wave height and period for given return intervals for the Kelly Island locale based on the results of a wave hindcast conducted by Offshore and Coastal Technologies, Incorporated (OCTI).

Table 3-6. Storm event summary

Return Interval of Storm	Wave Height (feet)	Wave Period (s)	Water Level MLW (feet MLW)
2 year*	5.9	5.2	7.9
5 year	6.6	12.3	9.2
10 year	7.2	12.7	10.2
25 year	8.2	13.4	11.8

*Determined by evaluation of OCTI hindcast series.

3.3.3.2 Wetland Restorations

General

The structure designs and configurations at Kelly Island are based on ecological concerns, both in the immediate vicinity of the project and in Delaware Bay; containment of the fine-grained dredged material to be placed in the confined disposal facility (CDF), and shoreline protection. The following sections provide a description for the development of wetlands and other habitats at the project site and the associated structural designs and configurations needed to accommodate that development.

Kelly Island Wetland Restoration Design

Kelly Island has been eroding severely for many years, and has lost much of its shoreline, including almost all of its intertidal marsh (US Army Corps of Engineers. 1986a). The peat substrate that supported the ancient marsh has eroded back to remnants in many places. The loss of marsh on Kelly Island has exposed the navigation channel in the Mahon River to waves and the wetlands behind the island are threatened with overwash and loss. The loss of marsh is also adversely affecting existing habitats at the Bombay Hook National Wildlife Refuge (NWR) (USFWS. 1994).

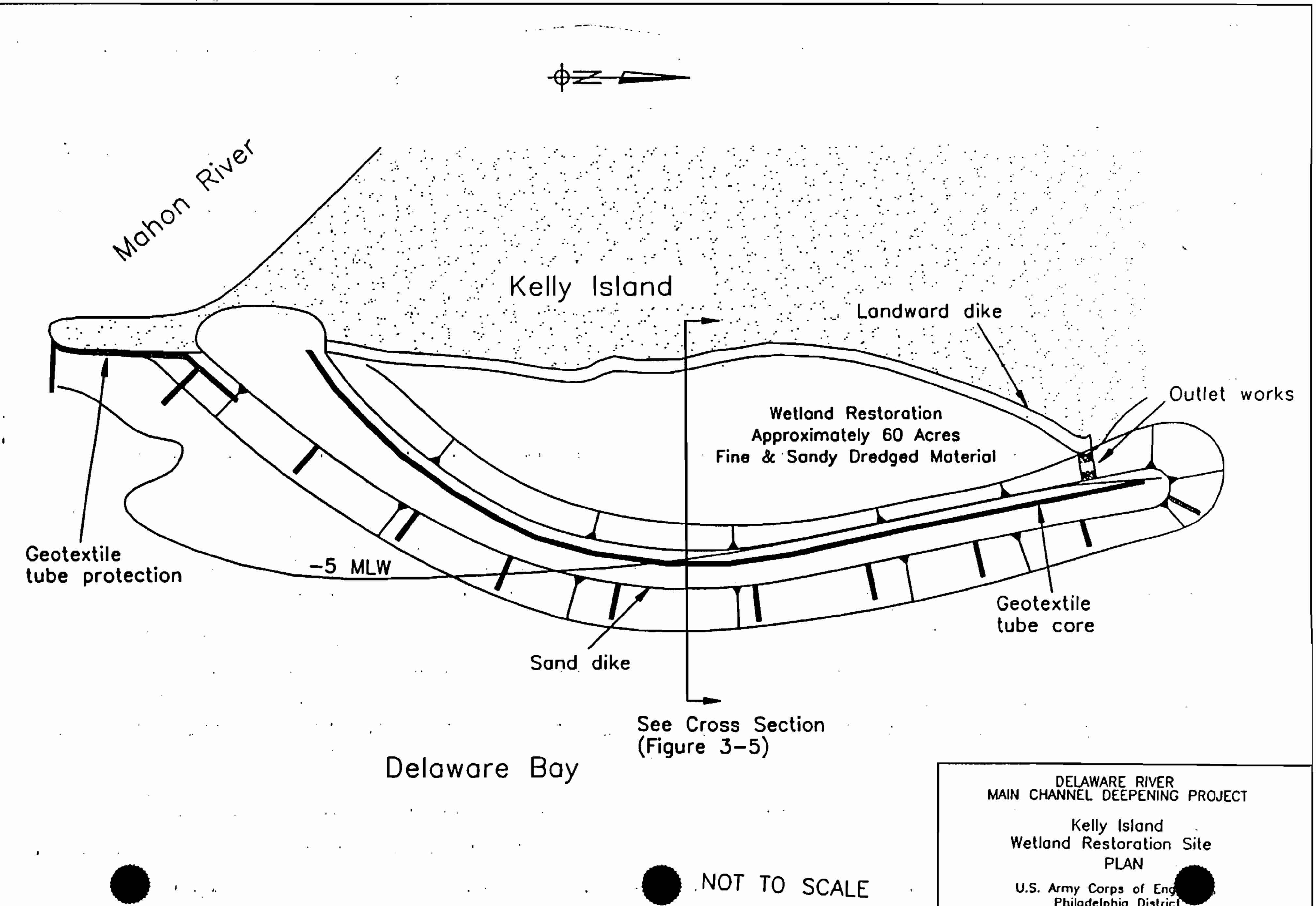
Bombay Hook NWR, including the Kelly Island area, provides considerable habitat diversity for fish and wildlife, and is one of the most important ecological areas in the Bay (USFWS. 1994). The greatest use of the eroding shoreline is by spawning horseshoe crabs at suitable beaches, feeding and resting migratory shorebirds which feed on the crab eggs, waterfowl, and occasional waterbirds such as herring gulls (Larus argentatus) and great blue herons (Ardea herodias). The wave energy and erosion has reduced feeding potential. Conditions are expected to greatly improve with construction of the project. The CDF to be built in front of Kelly Island (Figure 3-4) will provide protected waterbird feeding areas, sand beaches for crab spawning and shorebird feeding, resting areas for waterbird species, improved areas for juvenile fish within the restored salt marsh, and protection to the eroding existing marshes.

Timing of construction at Kelly Island will consider the current crab and shorebird use of the site to minimize impacts. The hydraulically-placed sand for the dikes is a limited-space effort, and only a small area will be affected at any given time during construction. The areas of construction are not currently used by crabs to spawn since they are below mean low water (MLW), and lack sand. Construction of the dikes will begin at the south end making use of access to the site from the Mahon River channel. Once the dikes are constructed, the interior of the CDF will be filled. Fine-grained material will be placed first (described below) followed by placement of sand to an elevation of +5 feet MLW. After construction, tidal channels and outlet-works adjustments will be made to aid intertidal connection. Intertidal connections are discussed in subsequent sections of this report. Optimal environmental windows will always be considered prior to and during construction to minimize impacts to the existing ecology.

Offshore Dike Design

In designing the offshore dike at Kelly Island, desired habitat and stability were examined. The offshore dike, as well as the landward dike and outlet works, must contain the dredged material during the filling process and control discharge from the site, and then continue to serve as protective structures with avenues for tidal exchange after the dredging is completed. The structures are described below.

The offshore dike will have a crest elevation of +10 feet MLW. This elevation is coincident with the water level for a return interval between 10 and 25 years (by Tables 3-6 and 3-7, respectively). It is only during rare events that this sand dike will be overtopped. The dike is expected to provide ample



DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Kelly Island
Wetland Restoration Site
PLAN

U.S. Army Corps of Engineers
Philadelphia District

Figure 3-4

Table 3-7. Water levels at Kelly Island (from USACE, 1986).

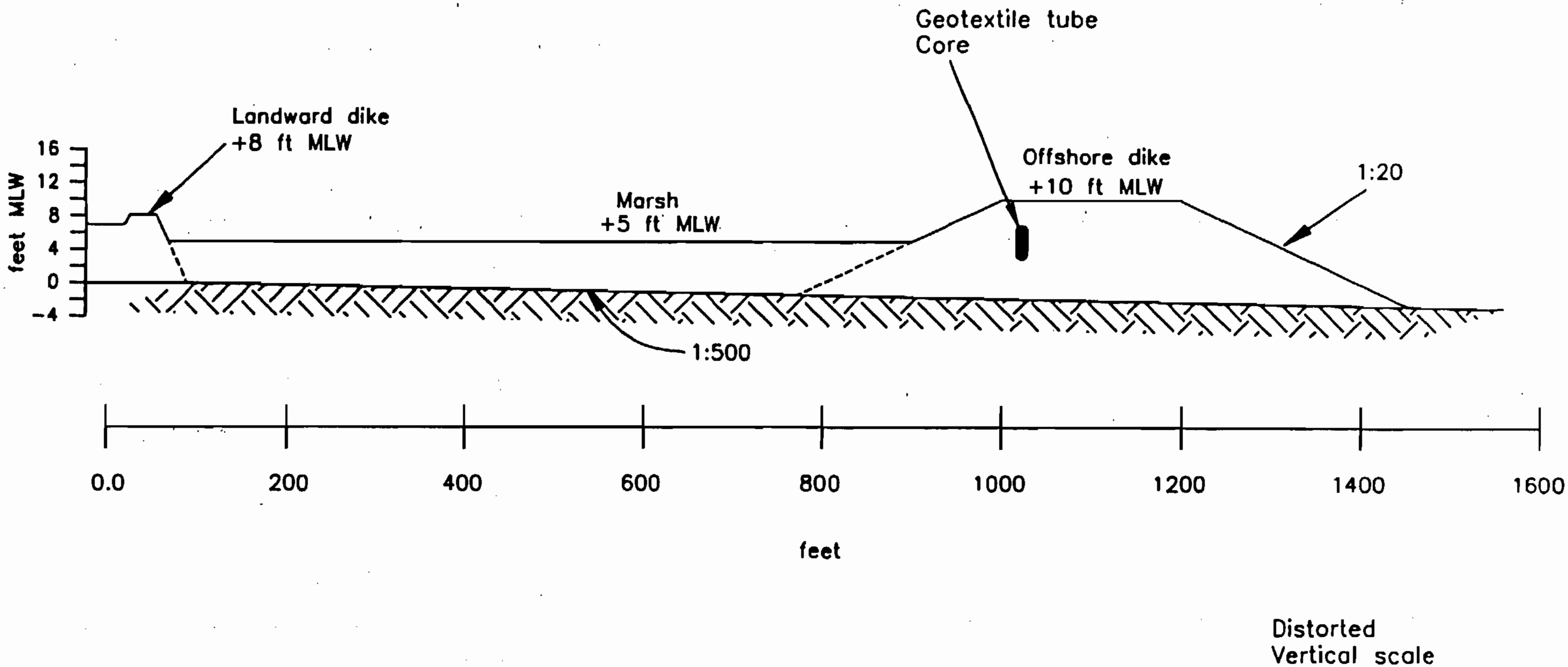
Recurrence Interval (yr)	Water Level (feet MLW)
1	7.2
2	7.7
10	8.8
50	10.6
100	11.4

spawning habitat for horseshoe crabs.

The crest width of the dike will be 200 feet at its narrowest. The volume of sand in the cross section of the dike will be constant, i.e. 845 cubic yards per yard. Therefore, the crest width of the dike in shallow water will be greater than in deeper water. The maximum crest width (at the southern intersection with the island) will be 350 feet. A representative cross-section of the project showing the offshore dike is provided in Figures 3-5. The total volume of sand required for the offshore dike is 1.7 million cubic yards (which includes a quantity sufficient to offset an estimated one foot of settlement). The offshore slopes for the dike are estimated to be 1:20 initially, and after the first year they should equilibrate to a milder 1:40 slope.

The crest-width for the dike was determined by considering the loss of 35,000 cubic yards of sand annually from the project as computed from net potential longshore sediment transport. Such losses are expected to result in a crest-width loss of about 13.5 feet per year. Additionally, a 20-foot loss of crest width was estimated due to initial equilibrium adjustment of the offshore slope, and a 30-foot loss of crest width due to a severe storm event with a 25-year return interval. Summing over a 10 year period, approximately 185 feet of crest width is needed to account for estimated losses. The value is rounded to 200 feet for the design. It is expected that after 10 years, maintenance of the offshore sand dike will be required.

The assumptions regarding the pathways taken by sand removed from the dike are that most transport will be northward and the sand will tend to stay close the shoreline as it is moves; some southerly transport will occur, eventually depositing in the Mahon River channel and will be dealt with through periodic maintenance; some of the sand will form offshore bars from time to time as the slope adjusts under different wave climates; and the sand is not expected to move into deeper bay waters. These



DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Kelly Island
Wetland Restoration Site
Geotextile Tube/Berm CROSS SECTION

U.S. Army Corps of Engineers,
Philadelphia District

Figure 3-5

assumptions are based on general transport patterns observed along sandy shorelines.

It is worth noting that the existing marsh shoreline (composed mostly of organic peat) at Kelly Island is receding at a rate on the order of 20 feet per year. Sand should be more durable and erode at a lower rate than the existing marsh substrate. Therefore, the estimated recession of the sand crest at 13.5 feet per year appears reasonable.

The southern end of the offshore dike will terminate on the island. The elevation of the crest of the dike will transition from +10 feet MLW to the +7 feet MLW (approximate) elevation of the existing marsh. The dike will extend onto the island far enough to prevent southerly waves at high water from damaging any portion of the interior of the project. The dike will also extend beyond its connection with the landward dike (discussed below).

The northern end of the offshore dike will extend approximately 300 feet beyond Deepwater Point roughly parallel to the shoreline. The outlet works for the project (discussed below) will be placed at Deepwater Point, and so the offshore dike will protect that location.

A geotextile tube will be placed within the offshore dike as a factor of safety against a breach in the dike due to an extreme event and overwash. The crest of the tube will be placed to a crest elevation of +7 feet MLW. The tube will then be buried under an additional three feet of sand bringing the crest of the dike up to elevation +10 feet MLW. The protection that the tube provides should allow time for maintenance or repair work to be planned and executed if a breach should develop.

Design for the Geotextile Tube Core

Scour Blankets. In order to prevent scour from undermining the tubes if they are exposed, a scour blanket will be placed on the seaward side of the geotextile tube. The scour blanket width will be 10-13 feet. The scour blanket (geotextile fabric) will be anchored along its seaward edge with a factory- stitched anchor tube of one to two feet in diameter. The blanket will extend completely beneath the geotextile tube with another anchor tube on the leeward side.

Geotextile Tube Segments. To make manipulation of the tubes and their construction easier, geotextile tubes about 250-300 feet in length will be used. Experience has shown that deploying more than 300 feet of geotextile tube at any one time can be difficult to control (i.e. hold in place while filling), and it is more difficult to achieve desired height.

Geotextile Tube Fabric. The fabric mesh size will be selected based on the sediment grain sizes that will be used to fill the tube and on the expected strength needed during filling. Essentially, the fabric will be capable of retaining the sandy fill used inside the tube, but be permeable enough to allow the fill material to dewater.

Filling Ports. Filling ports will be factory-installed collared holes in the tube through which sand can be pumped via the dredge pipe. The fabric collars will be about three feet long and 18 inches in diameter and sewn around the filling holes. The dredge pipe slips into the collar and a rope or strap is tied around it to hold the collar on the pipe. The filling ports will be spaced about 25 to 50 feet apart.

Fill Material. Sand will be used as fill for the geotextile tubes. Sand settles quickly inside the tube and force excess water out. Very little consolidation of the sand inside the tube will occur after construction so the final crest elevation achieved during construction will remain.

Survivability. Geotextile tube material is very resistant to rupture due to tensile stresses, but does not resist cuts, punctures, or abrasion well. Since the tubes will be buried in core of the sand dike, only the tensile strength properties of material will be important.

Landward Dike

A dike will be constructed along the edge of the existing marsh to elevation +8 feet MLW. The dike will prevent dredged material from flowing across or settling in the existing marsh. The dike will be constructed by trucking sand from the larger offshore dike to the landward dike. The dike crest width will be 20-30 feet and between 1-3 feet high. The dike will not be constructed by hydraulic placement of sand. When the CDF is filled and all dredging is completed, the dike will be leveled to tie the existing marsh to the newly restored marsh elevations. A crest elevation of + 8 feet MLW is required to account for the final elevation of fill material (+5 feet MLW) with two feet of ponding required for efficient water control during placement and one foot of freeboard above that to accommodate water level variations and small waves within the site.

Groins

Groins will be placed along the perimeter of the offshore dike to help limit longshore transport. Although the cross-section of the dike is designed to sustain sediment losses for many years without losing any of its function, groins will increase the longevity of the project, reduce potential maintenance, and add a factor of safety against the risk that sand will be transported south along the project into the Mahon River entrance. Based on USACE (1992), the groins will be about 300 feet long extending seaward from the crest of the dike. The groins will be four to five feet high, and will be 600 feet apart along the shoreline.

Geotextile tubes will be used for the groins. The tubes will be placed during construction of the dike, the landward ends of the groins will be keyed into the dike to add to their stability. The design criteria provided above for the tubes in the core of the offshore dike will be applied here, as well.

Outlet Works

The outlet works will be placed through a cross-shore sand dike at the north end of the project extending from the tip of Deepwater Point to the offshore dike. The elevation of the crest of the cross-shore dike will be +8 feet MLW which is sufficient to prevent even the annual highest high-tide from overtopping the dike (Table 2). This elevation also provides sufficient freeboard so that water levels in the site can be held high if needed. The cross-shore dike does not need additional elevation to prevent wave overtopping because it is protected from waves by the offshore dike. A geotextile tube like the one described for the offshore sand dike will be placed in the core of the cross-shore dike. The flows through the outlet works during dredging depend on the depth of water above the weir crests and the depth of flow toward the weir.

The outlet works will have outflow pipes that pass through the core of the cross-shore dike. The cross-section of the cross-shore dike will be held to a minimum to minimize the length of outlet pipe required. The actual crest width of the dike will depend on the stability of the foundation upon which the dike is built. The dike will be filled until a stable cross-section is achieved. The dike will be constructed by moving sand from the offshore dike with heavy equipment so that steeper side slopes can be achieved which will minimize the dike cross-section.

The outlet works provided at the north end of the project will control release of water during dredging. Several drop inlets (e.g. `Delaware Trunks') are planned. The capacity of the outlet works will depend on the size of the dredge pump and discharge line and water control requirement for post-construction marsh management.

An outlet works at the southern end of the project will not be necessary for dredging purposes. However, tidal connection to the southern end of the site may be desired after the marsh develops and natural flow patterns emerge. Any additional tidal connection should be achieved, for example, by small tidal guts through the existing marsh to the Mahon River and not through the offshore dike, because greater wave action at this location would cause stability problems. A tidal gut presently exists near the south end of the project that would make an ideal connection with the Mahon River.

Construction of the Dikes

Construction will begin at the southern end of the project site. Sand will be hydraulically placed near the marsh shoreline. Heavy moving equipment off-loaded from a barge in the Mahon River will be moved across the narrow spit of marsh at the southern end of the island to the sand dike when the dike crest is sufficiently above high tide. The equipment will be used to spread the sand away from dredge pipe as the mound of sand forms. As the width of the dike increases, the placement of the discharge pipe will be toward the bay side of the dike and the construction equipment will be used to push the sand landward. This approach will create a steeper slope on the landward side of the offshore dike minimizing the volume of the containment site taken up by the offshore dike's cross section. The goal of this approach is to provide the maximum capacity possible in the site to accommodate the fine-grained dredged material. The silt will therefore form the minimum possible layer thickness.

Sand will be moved off the offshore dike to construct both the landward dike and the cross-shore dike at the north end of the project, as well.

Dredged Material Placement Inside the CDF

The inflow point for fine-grained dredged material to the site should be at the southern end of the project, far from the outlet works. This maximizes the distance between the inflow and outflow points allowing the maximum amount of time for sediment particles to fall out of suspension. The large ponding depth that will be present will result in low flow velocities within the site increasing the settling time for suspended sediments.

The 200,000 yd^3 of fine-grained dredged material will be placed first. Once placed, approximately one foot of sand will be placed over it. This initial sand layer will mix with the fine material without causing a mud wave to propagate across the site. After the first layer is placed, the remaining sand will be placed to +5 feet MLW over the site which is, the intertidal elevation needed for marsh restoration. Approximately 500,000 yd^3 of sand will be required. A floating dredge pipe with a directional baffle on the end will be used. The baffle can be used to force the floating pipe to move slowly in an arc across the ponded site, distributing a consistent thickness of sand over the site.

Geotextile Tube Protection for Southern Spit

Currently, the narrow, low crested southern spit of Kelly Island is all that remains for protection of the entrance to the Mahon River. Though it is outside the containment area discussed above, protection of the Mahon River entrance is important. Therefore, a geotextile tube revetment will be constructed along the spit. The design of the tube will generally follow the design criteria mentioned above for the geotextile tube core of the offshore dike. However, the condition of the spit at the time of construction is unknown, so detailed designs cannot be made at this time.

Habitat Characteristics and Considerations

The existing marsh and channels at Kelly island have been undergoing severe erosion for many years, and the shoreline has changed dramatically in recent years. The point that protects the mouth of the Mahon River has already lost all its salt marsh, and will probably be gone before this project is built. Inside the project (behind the CDF) there are two small intertidal channels that will be temporarily blocked during construction. The impacts resulting from such activities should be short-lived, and have almost no impact on ecological integrity of Kelly Island.

It is possible that by the time construction begins the eroded point at the southern end of Kelly Island may be gone due to continued erosion. In such a case, the southern end of the project may need redesign prior to construction.

The Kelly Island wetland restoration will initially require the construction of a closed area of about 60 acres using a sand berm with a geotextile tube core. A water control structure will allow tidal inundation of the area and access for aquatic organisms. The area will be completely enclosed before any fine grained dredge material is placed inside. The filled impoundment should be allowed to settle and consolidate for approximately one year from the last deposition of dredged material. During the consolidation period, common reed should be controlled with a herbicide, such as Rodeo, wherever it appears on the adjacent wetlands, dikes, or impounded area. Early control will facilitate a more effective re-vegetation process during year two.

Planting should occur during year two using native tidal wetland plants such as saltmarsh cordgrass (Spartina alternaflora, saltmeadow cordgrass (Spartina patens), salt marsh bulrush (Scirpus robustus), salt grass (Distichlis spicata), or three square (Scirpus pungens). The combination of species to be emphasized will depend upon soil and water salinities within the wetland restoration and water exchange. Plugs of vegetation taken from the adjacent marsh and seed collected from species in other areas should be inserted and/or broadcast over the impounded area. A reasonable estimate of the length of time required for vegetation to reach optimum density is two years.

During the third year after filling, water control structures similar to those used in the State of Delaware's Little Creek Wildlife Management Area should be installed at the north end of the restoration. The structures should be connected by a winding ditch 4 meters wide by 3 meters deep using an aquatic plant excavator (cookie cutter). Several shallow (0.5 - 1.0 meters) ponds ranging in size from 1 to 1.5 hectares should be selectively created throughout the impoundment and connected to the main ditch by smaller (2 meter width) ditches. Ponds and ditches should cover between 10 and 20 percent of the surface area of the restoration. Seeding open water areas with widgeon grass from surrounding impoundments will provide desirable submerged aquatic vegetation and a detritus base for aquatic invertebrates that are heavily used by shorebirds, wading birds and waterfowl.

Proper manipulation of the water control structures is vital to maintaining daily tidal exchange and ingress and egress of estuarine fishes and other organisms. All ditches and ponds should contain some permanent water to support mosquito-predaceous fish and submerged aquatic vegetation (SAV). Complete drawdowns should only be conducted to control nuisance algal blooms or aerate soils and should occur only for brief periods. A partial tidal exchange will occur through the water control structures twice daily, permitting oxygenation of the waters and exchange of nutrients and organisms. Exposed mudflats around the pond perimeters will be maintained during the shorebird migrations but the area will be maintained at full pool level during the winter months. Daily exchanges of sheet water over the emergent vegetation in the impoundment will occur on a regular basis.

After vegetation cover has become well established (3-4 years), a long term water management schedule must be implemented. The objectives of the water management plan will be to (1) facilitate important biological functions provided by normal tidal exchange; (2) encourage growth of the most desirable emergent vegetation permitted by soil and water conditions; (3) maintain fish populations in open water ponds and ditches to provide mosquito control; (4) ensure that all commercially and recreationally important fish species are able to enter and leave the area during critical periods; and (5) minimize the release of fine grained dredge material.

The importance of the movement of water into and throughout the wetland restoration cannot be over emphasized. The productivity and diversity are dependent upon the timing and magnitude of water exchange and flow. Water exchange controls soil and water salinities which, in turn, determine the kinds and productivity of the vegetation that can be maintained. Tidal waters salinity in the vicinity of Kelly Island normally range from a low of 5-10 ppt in the winter and spring to a high of 20-30 ppt during periods of extended low rainfall and high evaporation in the summer. Given these ranges of salinities, the most likely scenario for vegetation within the impoundment is composed of saltmarsh cordgrass (Spartina alterniflora) occurring in its long form along the ditches and pond edges and in its shorter forms in lower elevations of the marsh; saltmeadow cordgrass (Spartina patens) will dominate the higher elevations within the restoration that are less often flooded; (3) salt grass (Distichlis spicata) will appear irregularly in small patches where soil salinities area lowest; (4) Widgeon grass (Ruppia maritima) should occur in dense mats and dominate the ponds and ditches; and (5) nuisance vegetation, specifically common reed will aggressively pioneer into restoration and must be periodically controlled with herbicides. If water salinities within the restoration can be maintained between 15 and 25 ppt without substantially restricting organism exchange, the introduction of species such as salt marsh bulrush (Scirpus robustus) should be tried.

The ponds and ditches within the wetland restoration should produce and support substantially more resident fish species that in the open tide marsh (Whitman 1995). Mummichogs (Fundulus heteroclitus), sheepshead minnows (Cyprinodon variegatus) and silversides are among the resident species that are most abundant and serve to control mosquito production within the restoration. Anchovy (Anchoa mitchilli) and menhaden (Brevoortia tyrannus) typically enter the impoundment in July and remain until a total drawdown in the fall allows them to re-enter the estuary. Grass shrimp (Palaemonetes spp.), an important fish and waterfowl food should be abundant in the tidal ponds and blue crabs should enter the impoundment as young, mature, and provide abundant recreational crabbing opportunities.

Recreational and commercially important fish species that will use the impounded area included Atlantic croaker, spot, weakfish and white perch. These species do not appear to achieve significant growth to stay within these areas for long periods. In the case of these species, it is important to maintain water circulation throughout the summer months. Particularly important is the exit of these species during the total fall drawdown since it is unlikely that they can survive over winter with stabilized maximum water levels.

Ditches and ponds constructed inside of the restoration area within the deposited dredge material must also be allowed to settle and consolidate after construction before water can be released through the control structures. It is expected that once the dredged material is vegetated and ponds and ditches have been constructed, water can move in and out of the restoration without a measurable amount of fine grained material escaping.

To briefly summarize habitat considerations, all aspects of the Kelly Island design have been planned with fish and wildlife as the primary beneficiaries of the project, although shoreline erosion control is paramount to both protecting the refuge and accomplishing any quality habitat development. The recommended design still has enough flexibility so that prior to construction, a re-evaluation of design plans can be made to insure the best possible habitat combinations are achieved during construction.

Egg Island Point Wetland Restoration Design: Southeastern Shoreline

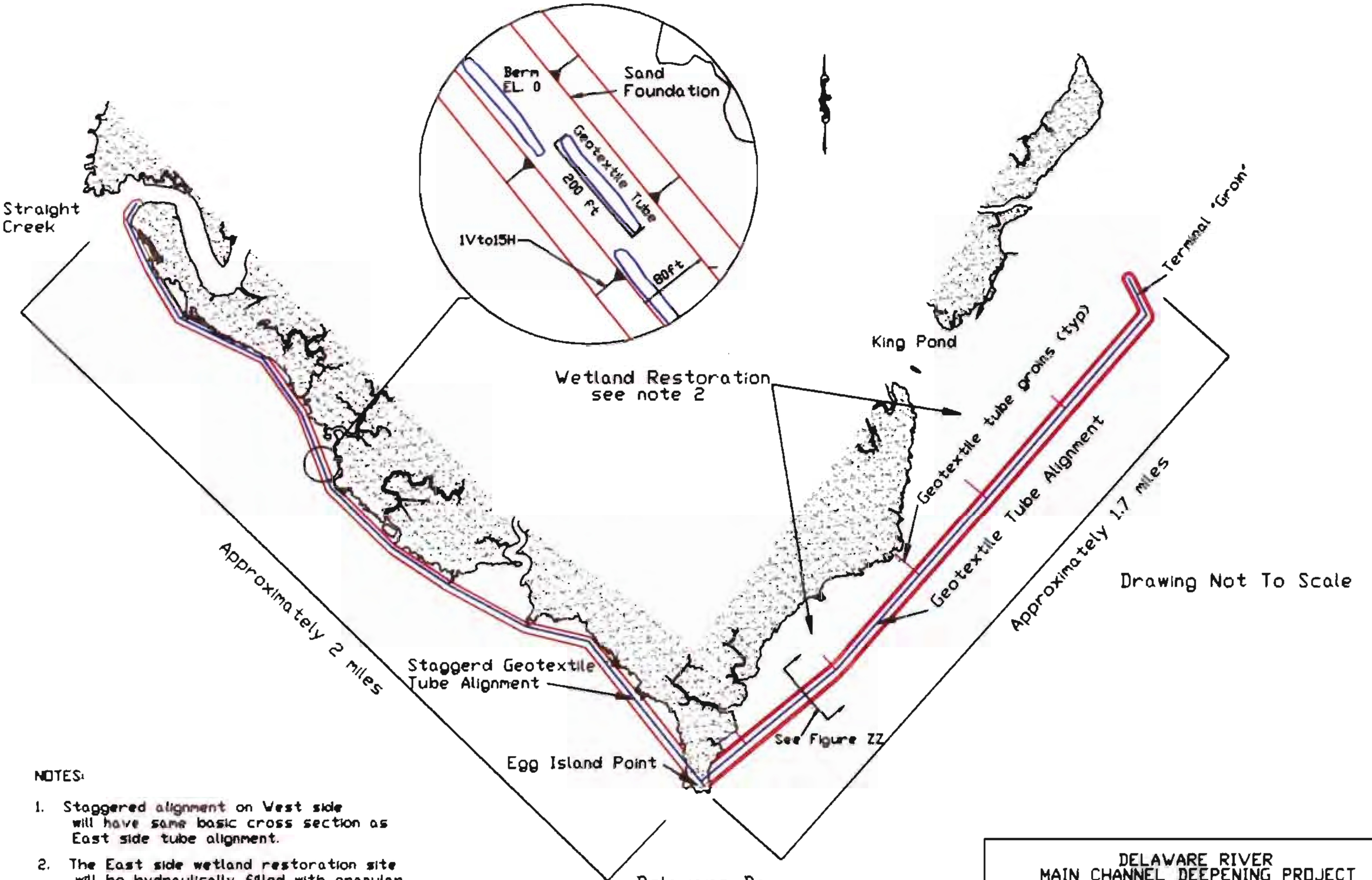
Structure Design of Geotextile Tubes

Much of the information for geotextile tubes and structures presented for Kelly Island is applicable to both shorelines of Egg Island Point. The northwest and southeast treatments, configurations, placements, and techniques differ considerably (Figure 3-6).

The southeastern side of the existing marsh at Egg Island Point will be protected by a single geotextile tube structure. The geotextile tube will be placed on top of a dredged material sand foundation built to elevation 0 feet MLW away from the eroding shoreline (Figure 3-7). The side slopes of the foundation are expected to reach 1:20. The crest elevation for the tube is expected to reach an elevation of +5 feet (±1) feet MLW. The area within the lee of the structure will be filled with sandy dredged material to an elevation of + 5 feet MLW. These elevations will be inundated daily during high tide periods which are expected to reach elevations of +5.5 feet MLW to +6.2 feet MLW (spring high tide). Consequently, waves will often overtop the project. The structure and the fill behind it should attenuate much of the wave energy.

Marsh protection structures generally extend at least a small distance above the high tide elevation to provide protection for a marsh. However, as mentioned in the sections for the Kelly Island design, observations of the local marshes and protection structures indicate that marsh vegetation may be adequately protected by structures that are between +5 feet MLW and +10 feet MLW. Since the single geotextile tube at Egg Island Point will be at +5 feet MLW with reaches of 0 to 1200 feet of very shallow water in its lee, wave energy over the structure should be attenuated sufficiently to protect the existing marsh and to support development of new marsh, especially near the existing marsh edge away from the geotextile tube.

If the structure foundation settles below 0 feet MLW or the



NOTES:

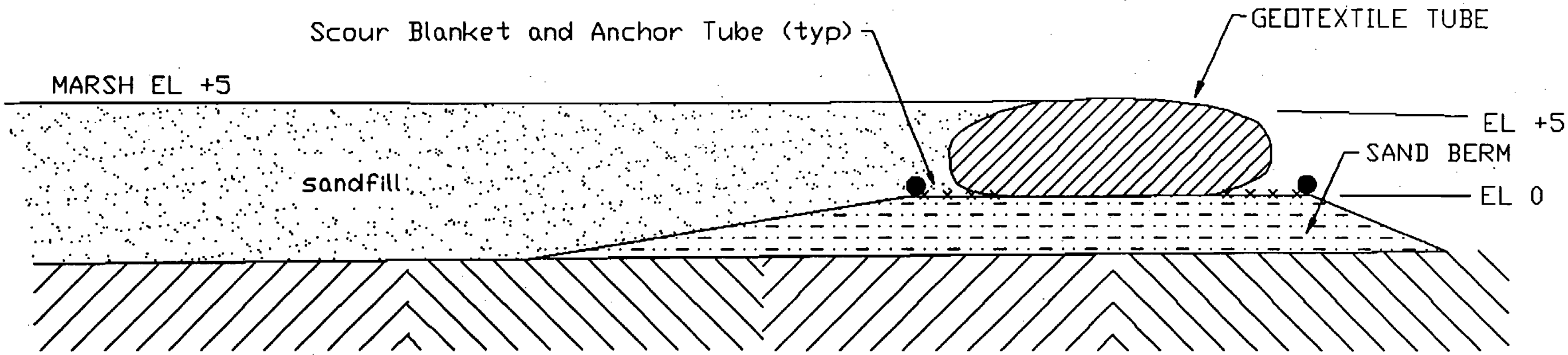
1. Staggered alignment on West side will have same basic cross section as East side tube alignment.
2. The East side wetland restoration site will be hydraulically filled with granular material to elevation +5.0.

DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Egg Island Point
Wetland Restoration Site
PLAN

U.S. Army Corps of Engineers,
Philadelphia District

Figure 3-6



Drawing not to Scale

NOTES:

1. Geotextile Tube circumference is 30 feet.
2. Final in-place width of tube is approximately 8-10 feet.
3. Sand berm top width is 80 feet w/ 1V to 20H sideslopes.
4. Scour blanket to extend 15 feet from main tube.

DELAWARE RIVER
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Egg Island Point
Wetland Restoration Site
Geotextile Tube/Berm CROSS SECTION

U.S. Army Corps of Engineers,
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Figure 3-7

geotextile tube fails to achieve or maintain a crest elevation of +5 feet MLW after construction, then a contingency for construction of a second row of tubes will be planned. A higher structure in even a few locations will increase the wave attenuation performance of the overall structure. If only a few locations along the first row of tubes fail to achieve and maintain the desired elevation, then a second row of tubes might be placed only in those locations. If a second row of tubes is placed only in selected locations, then no influence on the tidal exchange would be expected. However, if the entire structure length is protected by a second row of tubes, then an alternate design for exchange may be needed.

Scour Blanket. Using the design wave height of 6.2 feet and a water depth at the structure of 6 feet, the recommended scour blanket width should be 13 feet. The scour blanket (geotextile fabric) will be anchored along its seaward edge with a factory-stitched anchor tube of one to two feet in diameter below 0 feet MLW, and it will be buried in the substrate.

As an added precaution, the scour blanket and anchor tube will be extended to either side of the tube. It is important to have the scour blanket on the leeward side of the tube to prevent overtopping wave scour from undermining the tube. Overtopping scour problems are more likely at this site than at the Kelly Island site due to the differences in breakwater heights.

Length of Geotextile Tube Segments. Geotextile tubes about 200 feet in length will be used. The use of tubes of this length improves the structure's integrity (i.e. should any particular tube be damaged, only a small section of the structure would suffer and could be more easily repaired). Experience has also shown that deploying more than 300 feet of geotextile tube at any one time can be difficult to control or hold in place while filling.

Geotextile Tube Fabric. Fabric needs for Egg Island Point are very similar to Kelly Island. Dredged material filling the tubes will be sandy, and the same wave and wind energies occur at both Egg Island Point and Kelly Island.

Planform Design

The region behind the structure on the southeastern shoreline of Egg Island Point will be filled with sandy dredged material to elevation of +5 feet MLW. This is equal to the elevation of the geotextile tube crest. The expected occurrence of events are that the area immediately behind the tubes will be scoured somewhat and, in general, material will be moved toward the existing marsh where a small berm or dune may form. Limited observations of a geotextile tube project at Smith Island in the Chesapeake Bay indicated that the sand in the lee of the tube (beyond the immediate scour area) maintained an elevation approximating that of the geotextile tube crest. The sand sloped very gradually upward toward the existing marsh. That project has been in place for only two years, and the planted marsh on the site is beginning to establish (Blama et al. 1995).

At the Egg Island Point project, as sand behind the breakwater (tubes) is pushed back toward the existing marsh, it may cover over some of the existing marsh. The amount of sand overwash will depend on the amount of wave energy exposure that the site receives before the project is densely colonized by marsh vegetation. The sand overwash may alter the existing marsh locally but should not be considered a long-term detriment.

Waves approaching the tubes obliquely will cause material within the project to move laterally across the project. No technique is available to determine how much transport will occur. However, any dominant wave direction will move the fill material in that direction. At Egg Island Point, waves are limited from the north and east due to land boundaries, but are fully exposed to waves from the south and west. Hence, the tendency should be for material to move north and east across the project. Initially, the adjustment of sand due to the wave climate may be dramatic, but as the sand achieves a more stable profile across the project area, the amount of sediment movement should diminish and then slow as vegetation colonizes the area.

If sand moves from behind the tube breakwater under the conditions described above, it should behave the same as the sand placed in the structure foundation. Sediment transport impacts are discussed in Section 9.0.

Tidal Exchange

Since the single row of tubes will be inundated by about 0.5 to 1.0 feet MHW along the entire length of the tube, additional measures are not necessary to ensure tidal flushing. In the event that a second row of tubes is needed as discussed above, then tidal flushing may be sufficiently accomplished by leaving a few gaps in the second row of tubes. The amount of such openings should be determined after the project is constructed, and natural exchange mechanisms have had time to develop.

Most of the concern for tidal exchange is for the region between the westernmost point of the island, and the marsh point that extends nearly to the breakwater line of tubes near the center of the project. It is assumed that regardless of the structure design, there will be sufficient tidal exchange through the easternmost open end of the tube breakwater (towards the Maurice River Cove).

Egg Island Point Wetland Restoration Design: Northwestern

Shoreline

The structures will consist of a staggered alignment of single geotextile tubes with one set of tubes close to the shoreline, and a second set of tubes about 50 feet offshore. A similar configuration has worked very well on the Louisiana Gulf Coast to protect eroding shoreline and to trap sediment to rebuild salt marsh (Davis, Irish, and Landin 1995). This configuration will help protect the shoreline without slowing ingress and egress for organisms. Openings between tubes will allow nearly full tidal access, while breaking waves that travel towards the shoreline.

Each geotextile tube will be placed on top of a dredged material sand foundation built to elevation 0 feet MLW away from the eroding shoreline. The sides of the foundation are expected to reach a 1:20 slope. The geotextile tubes in the staggered rows on the northwestern shoreline will also be 200 feet long, and achieve a projected height of five feet (MLW) after filling. Fabric tensile strength, tube and port design, placement, and filling will all be very similar to that of the southeastern shoreline of Egg Island Point and Kelly Island. No filling between the tubes and the shore will be carried out, and any sediment trapped behind the breakwater will be natural accretions.

3.3.3.3 Underwater Berm/Sand Stockpile

Broadkill Beach (LC-5): This 230 acre sand stock pile is located about 0.33 miles offshore of Broadkill Beach, Delaware (Plate 4). The average depth of the existing bottom is -8.0 feet MLW with a capacity of 1.9 million cubic yards of dredged material. This would raise the bottom depth to -3.0 feet MLW, including one foot of settlement. Sand will be placed at this site which will come from the main channel between Stations 472+000 to 485+000 and Stations 495+000 and 511+000 (Plate 25).

Slaughter Beach (MS-19): This 500 acre sand stock pile is located about 0.5 miles offshore of Slaughter Beach, Delaware (Plate 4). The average depth of the existing bottom is -8.0 feet MLW with a capacity of 2.8 million cubic yards of dredged material. This would raise the bottom depth to -3.0 feet MLW, including one foot of settlement. Sand will be placed at this site which will come from the main channel between Stations 440+000 to 455+000 and Stations 460+000 and 472+000 (Plate 25).

3.3.4 Environmental Considerations

3.3.4.1 Monitoring

Both environmental and engineering monitoring at Kelly Island and Egg Island Point are important. Monitoring gives a physical and biological baseline from which to plan and design the projects.

It provides documentation of events and project results, provides lessons learned to extrapolate to future similar projects, provides a success/failure track record, and gives needed information to determine if additional work or mid-course construction corrections are necessary (Landin 1992).

Most pre-construction data have been collected, and are available in a series of contract reports at the Philadelphia District office. These provide baseline biological information, contaminants assessments, construction feasibility, evaluation of potential beneficial uses of dredged material at a number of locations in the Bay, and engineering sediment and foundation data. While there is considerable information being compiled on the use of geotextile tubes as a substitute for more expensive riprap, some of the missing information specific to Delaware Bay can be obtained in the next two to three years prior to actual project construction. The Bodkin Island, Barren Island, and Smith Island projects in Chesapeake Bay, will be observed closely to determine final designs for both Kelly Island and Egg Island Point sites. Parameters to monitor for the overall project sites can be determined during evaluation of this information.

During project construction, there is a need to closely monitor construction techniques, and to allow for field flexibility should the contractor encounter difficulties with tubes, discharge channels and weirs, sand berms, and temporary dikes. It is important to monitor effluent run-off from the Kelly Island CDF in order to meet Delaware state water quality standards. It may also be necessary to make during-construction corrections to outfalls and filling rates, should any field problems be encountered. In addition, water quality will be monitored during construction and for 3-5 years following construction.

Post-construction monitoring is the most detailed and involves a number of requirements:

a. Surveys of as-built elevations to be sure that +5 feet MLW is achieved after consolidation and settling of dredged material at Kelly Island and southeast Egg Island Point.

b. Geotextile tube observations to maintain their integrity and profile, with mid-course corrections such as patches of rips, re-tying of ports, and other maintenance built into the process at all three locations (especially critical at Kelly Island and southeast Egg Island Point).

c. Physical and engineering evaluation of structures, marsh and berm soils, weirs, CDF entrances and tidal exchange at Kelly Island, and breakwater tidal exchange at Egg Island Point at southeast and northwest locations.

d. Biological evaluation of marsh vegetation, marsh soils, fish and wildlife colonization, survival and reproduction of any planted areas, and general ecological health of the two sites.

e. Comparison of the new marsh sites to nearby marshes (e.g. Kelly Island could be compared to a healthy marsh in the Mahon River and an eroding marsh on either side of the project; and Egg Island Point could be compared to a healthy marsh near Maurice River and an eroding marsh northeast or southwest of the Egg Island Point sites).

A detailed monitoring plan will be developed during the next study phase (Plans and Specifications), and will be completed prior to construction. The Philadelphia District will continue to closely coordinate work with the States of New Jersey and Delaware, the US Fish and Wildlife Service, the NOAA National Marine Fisheries Service, the US Environmental Protection Agency, and other concerned parties.

3.3.4.2 Operation and Maintenance of Kelly Island

An operation and maintenance plan will be developed that will include repairs to prevent any breach or potential breach from occurring. The innovative design of this facility will ensure that this area will successfully provide for the restoration of valuable wetland resources.

In light of the sensitivity of the oyster resources of the Kelly Island area certain contingency measures will be planned in the extremely unlikely event a breach occurs. These seed beds, existing under inherently low food supplies, do not have the reserves required to easily withstand increased turbidity levels that may result. Before the construction of the Kelly Island wetland restoration site, oyster populations will be measured to determine the status quo so that a comparison can be made in the unlikely event of a breach. Parameters to be measured include abundance, size (biomass) frequency, disease infection intensity, reproductive state, and recent mortality. If a breach occurs, the same parameters would be measured to determine the extent of impacts. If the impacts were significant, restoration of the bottom that was damaged by the release of silt would be done.

3.3.4.3 Environmental Windows

This effort is expected to be carried forward into actual construction and monitoring of both Kelly Island and Egg Island Point. For example, environmental windows will require a phased, timed approach to construction to avoid and minimize impacts on organisms, especially the horseshoe crabs and shorebirds. Placement of sand foundations would be accomplished prior to movement of crabs to the beaches for spawning. On-site observations would dictate work activities. It is not expected that crabs will move in great numbers into the eroded peaty areas at either site since they avoid reduced sediments smelling of hydrogen sulfide and greatly prefer sandy beaches.

While horseshoe crabs are spawning and the spring migration of shorebirds is occurring, geotextile tube breakwaters will be installed piecemeal. This type of construction only requires a small work area for the placement and filling of each tube, so that crabs and birds could be in the vicinity and not be impacted. Initially, tubes would be filled at points furthest from major spawning areas, the tubes would be filled at an expected rate of one to three per day. As construction moves closer to pertinent sandy beaches, spawning, hatching, and migration activities should be completed. After that point in time, the inside of the confined disposal facility (CDF) at Kelly Island would be filled with fine-grained material, and any additional "unconfined" material would be placed behind tubes at Egg Island Point. This back-filling work and placement of sand berms inside the breakwaters will coincide with the fall migration of shorebirds, but should not present a displacement problem. Shorebirds tend to feed on freshly placed dredged material in great numbers to take advantage of the food resources coming through the dredge pipes. The dredged material would then have about six months to sort and settle before crab spawning and spring migration recurred. Utilization of freshly pumped dredged material by numerous species of birds has been well documented for many years. This is especially so for Great Lakes, Gulf Coast, and Atlantic Coast shorebirds, seabirds, and wading birds, but has also been noted for geese, some duck species, and opportunistic feeding by such species as fish crows and bald eagles (Landin, Patin, and Allen 1989; Landin, Webb, and Knutson 1989).

There should be no impact on motile organisms such as finfish. There are many finfish species utilizing Delaware Bay, but most are accustomed to the natural turbidity of the Bay (US Fish and Wildlife Service 1980, 1994). While anecdotal reports indicate that shortnose sturgeons may have been caught in the bay in the past, no studies have been done to access their current use of this area The shortnose sturgeon is an endangered species that may be found in the Bay. Dredging activities in Delaware Bay are not known to have had an impact on this species.

From June to November, trained monitors are required on hopper dredges to record all sightings of sea turtles and marine mammals and other pertinent information.

3.3.5 50-Year Maintenance Plan

Maintenance material from the Delaware River Main Channel Deepening Project in Reach E will be disposed of at the existing Buoy 10 dredged material disposal site. If in the future, the wetland restoration areas become damaged or need more material, the use of dredged material from the maintenance of the main channel could be considered. The Corps of Engineers will maintain the Kelly Island wetland restoration, and remove any material that erodes from Kelly Island into the Mahon River navigation channel. Periodic surveys of the Mahon River channel will be done to determine the impacts of sediment eroding from Kelly Island.

4.0 Sediment Quality Investigations

Concerns were expressed during the Feasibility Study regarding the chemical quality of sediments that would be disturbed during project construction, and the potential adverse effects on aquatic resources. In the riverine section of the project area, from Philadelphia to Artificial Island, channel sediments would be dredged and placed in several confined, upland dredged material disposal sites. Sediment quality concerns in this portion of the project regard turbidity generated at the point of dredging, and the turbidity associated with the discharge of effluent from the disposal areas. In Delaware Bay, channel sediments comprised primarily of sand would be used for various beneficial uses that involve placement of sediments in open water. Sediment quality concerns in this area include turbidity generated at the point of dredging and impacts associated with open water placement.

Two types of chemical quality concerns can be raised with regard to dredging and dredged material disposal activities. The first is potential short-term water quality degradation arising from disturbance of bottom sediments, and ensuing impacts to aquatic biota. Aquatic ecosystems concentrate biological and chemical substances such as organic matter, nutrients, heavy metals and toxic chemical compounds in bottom sediments. When introduced to the water column, these substances tend to bind with suspended particulate matter and eventually settle to the bottom. Dredging operations typically elevate levels of suspended particulates in the water column through agitation of the sediment. Suspension of sediment exposes associated biological and chemical constituents to dissolved oxygen, which can result in a variety of chemical reactions. Adverse impacts to water quality may include oxygen depletion and the release of chemical substances, making them biologically available to aquatic organisms through ingestion or respiration. It is generally believed that carefully designed and conducted dredging operations do not pose a significant adverse environmental threat, primarily because dredging is a temporary localized phenomenon that does not supply a persistent load of suspended sediment (USACE, 1983; Allen and Hardy, 1980). The turbidity associated with temporary dredging activities is usually less than the turbidity associated with natural flooding. In addition, most rivers that are used for navigation, including the Delaware River, are naturally turbid.

The second type of concern is long-term contamination problems associated with the dredged material disposal site. Generally, the greatest potential for environmental effects from dredged material discharge to open water lies in the benthic environment (USEPA/ACE, 1994). Deposited dredged material is not mixed and dispersed as rapidly or as greatly as the portion of the material that may remain in the water column. Bottom dwelling animals living and feeding on deposited material for extended periods represent the most likely pathways by which adverse effects to aquatic biota can occur. Placement of contaminated sediment at upland disposal sites can also result in long-term impacts such as groundwater contamination and direct uptake of contaminants by plants and animals.

To address these concerns the Corps has conducted various sediment quality studies as outlined in the national comprehensive testing strategy, developed jointly by the Corps and the U.S. Environmental Protection Agency (USEPA/ACE, 1994). This tiered testing approach provides for successive levels of investigation to be implemented on a "reason to believe" that there is potential for unacceptable adverse effects. The following provides a summary of the work efforts and findings.

4.1 Bulk Sediment Analyses

If there is reason to believe that contaminants are present, which was the case with the main channel deepening project, the first level of evaluation consists of bulk sediment analysis. This is essentially an inventory of contaminants to identify those that could potentially have an impact on the environment during dredging and dredged material disposal activities. To date, a series of 86 sediment cores have been collected within channel and bend widening locations that would be dredged during project construction. Bend widening locations provide a "worst case" picture of contaminant concentrations that would potentially be in the dredged material. These areas are not currently dredged, as such contaminants could accumulate over a long period of time. Within the channel, accumulated sediment is quickly removed to maintain project dimensions, thus precluding contaminant accumulation over time. Sample locations were determined with the assistance of the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service. Plates 5 and 6 depict locations where sediment cores were collected.

Sediment cores were collected with vibracoring equipment that employed a collection tube approximately three inches in diameter. Sediment cores were collected to proposed project depths and divided into 153 distinct sediment strata. Each sediment strata greater than six inches constituted a separate sample. Strata were then individually evaluated through grain size and chemical analyses. Sediment was removed from the interior portion of the core to minimize chemical contamination associated with the core tube. If a core consisted of a single, homogenous unit, the interior portion of the core was removed over the entire length of the core, thoroughly homogenized, and sub-sampled. Sediment from the exterior portion of the core was used for grain size analyses. Bulk chemical analyses were conducted on each strata to determine the range of contaminants and their total concentrations. The chemical parameter list included a host of heavy metals, pesticides, PCBs, PAHs and a variety of volatile and semi-volatile organics (Table 4-1). All results were reported on a dry weight basis.

Table 4-1. Chemical Parameter List for Bulk Sediment Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

<u>METALS</u>
- antimony
- arsenic
- beryllium
- cadmium
- chromium
- copper
- lead
- mercury
- nickel
- selenium
- silver
- thallium
- zinc

<u>PESTICIDES</u>
- aldrin
- dieldrin
- chlordane
- DDT, DDE & DDD
- endosulfan
- endrin
- endrin aldehyde
- heptachlor
- heptachlor epoxide
- alpha-hexachlorocyclohexane
- beta-hexachlorocyclohexane
- delta-hexachlorocyclohexane
- gamma-hexachlorocyclohexane
- toxaphene
- mirex
- methoxychlor
- parathion
- malathion
- guthion
- demeton

<u>POLYCHLORINATED BIPHENYLS (PCB) AS AROCHLORS</u>
- PCB-1242
- PCB-1254
- PCB-1221
- PCB-1232
- PCB-1248
- PCB-1260
- PCB-1016

<u>VOLATILE ORGANICS</u>

<u>VOLATILE HALOGENATED ALKANES</u>	carbon tetrachloride 1,2-dichloroethane 1,1,1-trichloroethane 1,1-dichloroethane 1,1,2-trichloroethane 1,1,2,2-tetrachloroethane chloroethane chloroform 1,2-dichloropropane methylene chloride chloromethane bromomethane bromoform dichlorobromoethane chlorodibromomethane
<u>VOLATILE HALOGENATED ALKENES</u>	1,1-dichlorethene 1,2-trans-dichlorethene trans-1,3-dichloropropene cis-1,3-dichloropropene tetrachlorethene trichlorethene vinyl chloride
<u>VOLATILE AROMATIC HYDROCARBONS</u>	benzene ethylbenzene toluene
<u>VOLATILE CHLORINATED AROMATIC HYDROCARBONS</u>	chlorobenzene
<u>VOLATILE UNSATURATED CARBONYL COMPOUNDS</u>	acrolein acrylonitrile
<u>VOLATILE ETHERS</u>	2-chlorethylvinylether

<u>ACID EXTRACTABLE ORGANICS</u>

<u>PHENOLS</u>	phenol 2,4-dimethylphenol
<u>SUBSTITUTED PHENOLS</u>	2,4,6-trichlorophenol para-chloro-meta-cresol 2-chlorophenol 2,4-dichlorophenol 4-chloro-3-methylphenol pentachlorophenol 4,6-dinitro-2-methylphenol 2-nitrophenol 4-nitrophenol 2,4-dinitrophenol

BASE NEUTRAL ORGANICS

ORGANONITROGEN COMPOUNDS	benzidine 3,3'-dichlorobenzidine 2,4-dinitrotoluene 2,6-dinitrotoluene nitrobenzene N-nitrosodimethylamine N-nitrosodiphenylamine N-nitrosodi-n-propylamine
LOW MOLECULAR WEIGHT POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)	acenaphthene naphthalene acenaphthylene anthracene phenanthrene fluorene
HIGH MOLECULAR WEIGHT (PAH)	fluoranthene benzo(a)anthracene benzo(a)pyrene benzo(b)fluoranthene benzo(k)fluoranthene chrysene benzo(ghi)perylene dibenzo(a,h)anthracene ideno(1,2,3-cd)pyrene pyrene
CHLORINATED AROMATIC HYDROCARBONS	1,2,4-trichlorobenzene hexachlorobenzene 2-chloronaphthalene 1,2-dichlorobenzene 1,3-dichlorobenzene 1,4-dichlorobenzene
CHLORINATED ALIPHATIC HYDROCARBONS	hexachlorobutadiene hexachloroethane hexachlorocyclopentadiene
HALOGENATED ETHERS	bis(2-chloroethyl)ether 4-chlorophenyl-phenylether 4-bromophenyl-phenylether bis(2-chloroisopropyl)ether bis(2-chlorethoxy)methane
PHTHALATES	bis(2-ethylhexy)phthalate butyl benzyl phthalate di-n-butyl phthalate di-n-octyl phthalate diethyl phthalate dimethyl phthalate
MISCELLANEOUS OXYGENATED COMPOUNDS	isophorone

Tables 4-2 through 4-8 provide a summary of the bulk sediment data. To facilitate this evaluation, the main channel project area was divided into five reaches (Reaches A through E), which correspond to disposal area locations. Material from Reaches A through D would be placed in several upland disposal sites. Reach A extends from the upstream project limit in Philadelphia Harbor to the Billingsport Range. Reach B extends from the Tinicum Range to the Cherry Island Range. Reach C extends from Deepwater Point Range to the New Castle Range. Reach D extends from Reedy Island Range to Ship John Light (Liston Range). Reach E is located in Delaware Bay, this material would be used for beneficial uses, such as sand stockpiling for beach nourishment and wetland creation.

To summarize the large volume of data, samples collected within each reach were grouped and the mean concentration of each chemical parameter was calculated. In many cases a chemical parameter was not detected in the sediment sample, and the laboratory reported the lowest quantifiable concentration that could be achieved with the test procedure. To include these data points in the analysis, the reported quantification limit was calculated into the mean, as if the chemical parameter had actually been present in the sediment at that concentration. This made the evaluation very conservative, because it is unlikely that the contaminant was present at that concentration. Actually, laboratories are able to detect and estimate the concentrations of many contaminants (excluding heavy metals) that are present below the quantification limits. The tables denote this with a "J", and the number of samples where this occurred. Tables 4-2 through 4-8 provide the mean concentration of each contaminant in Reaches A through E, the number of actual detections, and the detection range. Tables 4-7 and 4-8 summarize data for a variety of volatile and semi-volatile organic contaminants. Since the majority of these were not detected (60 of 64), mean concentrations are not provided by reach. The majority of contaminant parameters evaluated (88 of 130) were not detected in channel sediments. The presented mean concentration of a contaminant that was not detected in a particular reach, which is denoted in the tables by "ND" for number of detections, was calculated solely on the laboratory quantification limits. Keep in mind that this concentration is provided to indicate the mean of laboratory quantification limits, and does not actually represent the concentration of the contaminant in channel sediments.

Bulk analysis of sediments did not identify high concentrations of organic contaminants within the channel or bend widening locations. PCBs were detected in two samples. One sample was collected in the Bellevue Range, and the other was collected in the upper portion of Liston Range. The Bellevue sample contained PCB arochlors 1248 and 1254 at concentrations of 0.53 and 1.19 parts per million (ppm), respectively. The Liston sample contained PCB arochlors 1248 and 1260 at concentrations of 0.12 and 0.19 ppm, respectively. DDE, DDD, endosulfan and heptachlor

Table 4-2. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted With the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	33	49	29	19	23
Antimony					
Mean Concentration	3.19	9.93	10.00	10.70	2.35
# of Detections	3	24	23	11	ND
Detection Range	2.33-24.0	1.7-32.0	1.5-32.4	1.1-35.4	-
Arsenic					
Mean Concentration	5.97	6.41	8.37	8.97	2.35
# of Detections	20	38	29	19	23
Detection Range	0.24-26.6	1.22-18.4	0.8-52.8	1.29-17.5	0.25-6.5
Beryllium					
Mean Concentration	0.91	0.82	0.64	0.69	0.28
# of Detections	15	38	24	18	13
Detection Range	0.23-0.82	0.31-1.5	0.10-1.5	0.14-1.5	0.06-0.84
Cadmium					
Mean Concentration	1.66	0.94	1.00	0.96	0.70
# of Detections	16	19	15	10	14
Detection Range	0.50-5.24	0.11-4.0	0.09-4.8	0.35-5.2	0.32-2.8
Chromium					
Mean Concentration	15.95	26.28	28.73	37.18	12.7
# of Detections	20	41	23	13	10
Detection Range	1.45-83.2	4.5-63.7	3.49-145	10.5-60.8	2.9-39.6
Copper					
Mean Concentration	9.97	11.72	14.74	10.33	5.08
# of Detections	30	49	28	19	22
Detection Range	1.17-107	1.0-51.0	1.25-131	2.3-15.3	0.7-19.7
Lead					
Mean Concentration	18.94	19.09	24.80	19.53	7.11
# of Detections	27	44	26	19	17
Detection Range	2.96-146	4.7-120	2.9-173	3.5-102	0.20-25.2

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-2. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	33	49	29	19	23
Mercury					
Mean Concentration	0.15	0.16	0.24	0.15	0.14
# of Detections	5	9	4	ND	ND
Detection Range	0.05-0.67	0.02-0.56	0.13-1.4	-	-
Nickel					
Mean Concentration	11.20	18.30	15.79	18.33	6.70
# of Detections	31	49	29	19	17
Detection Range	4.04-24.8	4.5-38.0	3.17-32.6	4.3-31.0	1.7-21.4
Selenium					
Mean Concentration	31.67	16.53	18.78	16.37	20.08
# of Detections	13	28	19	6	11
Detection Range	0.26-155	0.21-119	0.13-136	18.3-117	13.0-121
Silver					
Mean Concentration	1.04	0.87	0.67	0.64	0.81
# of Detections	7	10	12	2	3
Detection Range	0.63-1.30	0.50-1.14	0.50-1.4	1.22-1.30	0.50-0.50
Thallium					
Mean Concentration	3.76	2.48	0.66	1.46	0.47
# of Detections	1	13	3	2	ND
Detection Range	0.19	0.17-9.0	0.17-0.32	7.0-10.5	-
Zinc					
Mean Concentration	67.41	64.46	84.88	73.88	26.01
# of Detections	33	49	29	19	23
Detection Range	1.36-607	19-240	6.82-630	12.9-219	4.1-106

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-2. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Concluded.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	12	8	6	6	12
Barium					
Mean Concentration	49.68	61.96	49.84	27.14	11.37
# of Detections	12	8	6	6	12
Detection Range	12.6-96.3	35.0-92.9	8.2-99.2	9.5-56.3	2.4-42.8
Vanadium					
Mean Concentration	21.32	29.81	37.02	19.51	9.77
# of Detections	12	7	6	6	12
Detection Range	5.8-42.7	11.0-54.7	6.1-61.8	5.6-46.8	1.8-42.8

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-3. Pesticide Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	33	49	29	19	23
Aldrin					
Mean Concentration	0.03	0.02	0.02	0.02	0.02
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Dieldrin					
Mean Concentration	0.03	0.03	0.03	0.04	0.03
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Chlordane					
Mean Concentration	0.32	0.24	0.23	0.35	0.17
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Toxaphene					
Mean Concentration	0.56	0.34	0.29	0.41	0.26
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Endrin					
Mean Concentration	0.03	0.03	0.03	0.04	0.03
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Endrin Aldehyde					
Mean Concentration	0.03	0.03	0.03	0.04	0.03
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Heptachlor					
Mean Concentration	0.03	0.02	0.02	0.02	0.02
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Heptachlor Epoxide					
Mean Concentration	0.03	0.02	0.02	0.02	0.02
Number of Detections	1	ND	ND	ND	ND
Detection Range	0.06	-	-	-	-
Endosulfan					
Mean Concentration	0.03	0.03	0.03	0.04	0.03
Number of Detections	ND	1	ND	ND	ND
Detection Range	-	0.06	-	-	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-3. Pesticide Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
DDT					
Number of Samples	33	49	29	19	23
Mean Concentration	0.04	0.04	0.03	0.05	0.03
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
DDD					
Number of Samples	31	42	27	17	19
Mean Concentration	0.03	0.03	0.03	0.04	0.02
Number of Detections	ND	ND	ND	1	ND
Detection Range	-	-	-	0.026	-
DDE					
Number of Samples	31	42	27	17	19
Mean Concentration	0.03	0.03	0.03	0.04	0.02
Number of Detections	ND	ND	ND	1	ND
Detection Range	-	-	-	0.045	-
Mirex					
Number of Samples	20	22	10	7	11
Mean Conmcentration	0.35	0.11	0.03	0.04	0.03
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Methoxychlor					
Number of Samples	29	30	16	13	23
Mean Concentration	0.07	0.09	0.12	0.11	0.10
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Parathion					
Number of Samples	20	22	10	7	11
Mean Concentration	3.64	12.08	6.61	9.44	12.01
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Malathion					
Number of Samples	20	22	10	7	11
Mean Concentration	3.64	12.08	6.60	9.43	12.00
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-3. Pesticide Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Concluded.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Hexachlorocyclohexane Alpha					
Number of Samples	33	49	29	19	23
Mean Concentration	0.03	0.02	0.02	0.02	0.02
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Hexachlorocyclohexane Beta					
Number of Samples	33	49	29	19	23
Mean Concentration	0.03	0.02	0.02	0.02	0.02
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Hexachlorocyclohexane Delta					
Number of Samples	33	49	29	19	23
Mean Concentration	0.03	0.02	0.02	0.02	0.02
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Hexachlorocyclohexane Gamma (Lindane)					
Number of Samples	33	49	29	19	23
Mean Concentration	0.03	0.02	0.02	0.02	0.02
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Guthion					
Number of Samples	20	22	10	7	11
Mean Concentration	3.64	12.10	6.64	9.47	12.03
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Demeton					
Number of Samples	20	22	10	7	11
Mean Concentration	3.99	12.16	6.61	9.44	12.01
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-4. PCB Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	33	49	29	19	23
PCB-1242					
Mean Concentration	0.30	0.21	0.15	0.23	0.17
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
PCB-1254					
Mean Concentration	0.34	0.32	0.29	0.41	0.26
Number of Detections	ND	1	ND	ND	ND
Detection Range	-	1.19	-	-	-
PCB-1221					
Mean Concentration	0.30	0.21	0.15	0.23	0.17
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
PCB-1232					
Mean Concentration	0.30	0.21	0.15	0.23	0.17
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
PCB-1248					
Mean Concentration	0.30	0.21	0.15	0.23	0.17
Number of Detections	ND	1	ND	1	ND
Detection Range	-	0.53	-	0.12	-
PCB-1260					
Mean Concentration	0.34	0.31	0.29	0.41	0.26
Number of Detections	ND	ND	ND	1	ND
Detection Range	-	-	-	0.19	-
PCB-1016					
Mean Concentration	0.30	0.21	0.15	0.23	0.17
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-5. PAH Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	33	49	29	19	23
Acenapthene					
Mean Concentration	0.53	0.47	0.51	0.52	0.35
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Naphthalene					
Mean Concentration	0.53	0.46	0.46	0.52	0.35
Number of Detections	ND	1(1J)	1(1J)	ND	ND
Detection Range	-	0.18	0.42	-	-
Acenaphthylene					
Mean Concentration	0.53	0.47	0.51	0.52	0.35
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Anthracene					
Mean Concentration	0.53	0.47	0.51	0.51	0.35
Number of Detections	ND	2(1J)	ND	1(1J)	ND
Detection Range	-	0.20-0.51	-	0.05	-
Benzo(a)pyrene					
Mean Concentration	0.53	0.48	0.46	0.51	0.35
Number of Detections	ND	2(1J)	6(5J)	3(2J)	ND
Detection Range	-	0.53-1.12	0.06-0.49	0.07-0.37	-
Benzo(b)fluoranthene					
Mean Concentration	0.54	0.47	0.48	0.50	0.35
Number of Detections	1	2(1J)	1(1J)	2(2J)	ND
Detection Range	0.67	0.49-1.02	0.82	0.07-0.08	-
Benzo(k)fluoranthene					
Mean Concentration	0.53	0.47	0.48	0.50	0.35
Number of Detections	ND	2(1J)	1(1J)	2(2J)	ND
Detection Range	-	0.49-0.83	0.82	0.06-0.09	-
Chrysene					
Mean Concentration	0.53	0.49	0.46	0.50	0.35
Number of Detections	ND	2(1J)	2(2J)	2(2J)	ND
Detection Range	-	0.71-1.27	0.05-0.62	0.09-0.10	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-5. PAH Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Concluded.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	33	49	29	19	23
Phenanthrene					
Mean Concentration	0.53	0.48	0.47	0.51	0.35
Number of Detections	ND	2(1J)	1(1J)	1(1J)	ND
Detection Range	-	0.49-0.95	0.65	0.05	-
Fluorene					
Mean Concentration	0.53	0.47	0.51	0.52	0.35
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Fluoranthene					
Mean Concentration	0.53	0.52	0.48	0.50	0.35
Number of Detections	2	2(1J)	1(1J)	2(2J)	ND
Detection Range	0.52-0.56	0.86-2.25	0.85	0.09-0.11	-
Benzo(a)anthracene					
Mean Concentration	0.53	0.49	0.51	0.50	0.35
Number of Detections	ND	2(1J)	ND	2(2J)	ND
Detection Range	-	0.59-1.52	-	0.10-0.11	-
Benzo(ghi)perylene					
Mean Concentration	0.53	0.47	0.47	0.51	0.35
Number of Detections	ND	2(1J)	1(1J)	1(1J)	ND
Detection Range	-	0.32-0.47	0.53	0.06	-
Dibenzo(ah)anthracene					
Mean Concentration	0.53	0.47	0.51	0.51	0.35
Number of Detections	ND	ND	ND	1(1J)	ND
Detection Range	-	-	-	0.06	-
Ideno(123-cd)pyrene					
Mean Concentration	0.53	0.47	0.47	0.51	0.35
Number of Detections	ND	2(1J)	1(1J)	1(1J)	ND
Detection Range	-	0.33-0.53	0.47	0.06	-
Pyrene					
Mean Concentration	0.54	0.50	0.48	0.50	0.35
Number of Detections	1	2(1J)	2(2J)	2(2J)	ND
Detection Range	0.62	0.81-1.76	0.05-0.87	0.10-0.12	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-6. Phthalate Data Summary of Bulk sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	18	28	19	12	12
Bis(2-ethylhexyl) phthalate					
Mean Concentration	0.62	0.51	0.53	0.51	0.42
Number of Detections	1(1J)	3(2J)	1(1J)	ND	ND
Detection Range	0.50	0.05-0.13	0.10	-	-
Butyl benzyl phthalate					
Mean Concentration	0.62	0.51	0.55	0.47	0.42
Number of Detections	ND	2(2J)	ND	ND	ND
Detection Range	-	0.05-0.18	-	-	-
Di-n-butyl phthalate					
Mean Concentration	0.73	0.29	0.30	0.31	0.55
Number of Detections	3(1J)	20(19J)	13(13J)	5(5J)	8
Detection Range	0.11-2.67	0.06-1.51	0.08-0.19	0.11-0.17	0.41-0.88
Di-n-octyl phthalate					
Mean Concentration	0.62	0.54	0.55	0.51	0.42
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Diethyl phthalate					
Mean Concentration	0.62	0.54	0.55	0.51	0.42
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Dimethyl phthalate					
Mean Concentration	0.62	0.54	0.55	0.51	0.42
Number of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-7. Volatile Organic Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	No. of Samples	Mean Conc.	No. of Detections	Detection Range
Volatile Halogenated Alkanes				
carbon tetrachloride	45	0.11	ND	-
1,2-dichloroethane	45	0.11	ND	-
1,1,1-trichloroethane	45	0.11	ND	-
1,1-dichloroethane	45	0.11	ND	-
1,1,2-trichloroethane	45	0.11	ND	-
1,1,2,2-tetrachloroethane	45	0.11	ND	-
chloroethane	45	0.11	ND	-
chloroform	45	0.11	ND	-
1,2-dichloropropane	45	0.11	ND	-
methylene chloride	45	0.11	41(38J)	0.003-0.875
chloromethane	39	0.02	ND	-
bromomethane	39	0.02	ND	-
bromoform	45	0.11	ND	-
dichlorobromoethane	45	0.11	ND	-
chlorodibromomethane	45	0.11	ND	-
Volatile Halogenated Alkenes				
1,1-dichlorethene	39	0.01	ND	-
1,2-trans-dichlorethene	39	0.01	ND	-
trans-1,3-dichloropropene	39	0.01	ND	-
cis-1,3-dichloropropene	39	0.01	ND	-
tetrachlorethene	39	0.01	ND	-
trichloroethene	39	0.01	ND	-
vinyl chloride	45	0.11	ND	-
Volatile Aromatic Hydrocarbons				
benzene	45	0.11	ND	-
ethylbenzene	45	0.11	3(3J)	0.001-0.009
toluene	45	0.11	6(6J)	0.002-0.007
Volatile Chlorinated Aromatic Hydrocarbons				
chlorobenzene	45	0.11	ND	-
Volatile Unsaturated Carbonyl Compounds				
acrolein	45	0.52	ND	-
acrylonitrile	45	0.28	ND	-
Volatile Ethers				
2-chlorethylvinylether	45	0.11	ND	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-8. Semi-Volatile Organic Data Summary of Bulk Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	No. of Samples	Mean Conc.	No. of Detections	Detection Range
Phenols				
phenol	45	0.59	ND	-
2,4-dimethylphenol	45	0.59	ND	-
Substituted Phenols				
2,4,6-trichlorophenol	45	0.59	ND	-
para-chloro-meta-cresol	6	0.87	ND	-
2-chlorophenol	45	0.59	ND	-
2,4-dichlorophenol	45	0.59	ND	-
4-chloro-3-methylphenol	39	0.54	ND	-
pentachlorophenol	45	2.47	ND	-
4,6-dinitro-2-methylphenol	39	2.72	ND	-
2-nitrophenol	45	0.59	ND	-
4-nitrophenol	45	2.94	ND	-
2,4-dinitrophenol	45	2.94	ND	-
Organonitrogen Compounds				
benzidine	45	2.29	ND	-
3,3'-dichlorobenzidine	45	1.02	1(1J)	0.140
2,4-dinitrotoluene	45	0.59	ND	-
2,6-dinitrotoluene	45	0.59	ND	-
nitrobenzene	45	0.59	ND	-
N-nitrosodimethylamine	45	0.59	ND	-
N-nitrosodiphenylamine	45	0.59	ND	-
N-nitrosodi-n-propylamine	45	0.59	ND	-
Chlorinated Aromatic Hydrocarbons				
1,2,4-trichlorobenzene	45	0.59	ND	-
hexachlorobenzene	45	0.59	ND	-
2-chloronaphthalene	45	0.59	ND	-
1,2-dichlorobenzene	45	0.59	ND	-
1,3-dichlorobenzene	45	0.59	ND	-
1,4-dichlorobenzene	45	0.59	ND	-
Chlorinated Aliphatic Hydrocarbons				
hexachlorobutadiene	45	0.59	ND	-
hexachloroethane	45	0.59	ND	-
hexachlorocyclopentadiene	45	0.59	ND	-
Halogenated Ethers				
bis(2-chloroethyl)ether	45	0.59	ND	-
4-chlorophenyl-phenylether	45	0.59	ND	-
4-bromophenyl-phenylether	45	0.59	ND	-
bis(2-chloroisopropyl)ether	45	0.59	ND	-
bis(2-chlorethoxy)methane	45	0.59	ND	-
Miscellaneous Oxygenated Compounds				
isophorone	45	0.59	ND	-

epoxide were the only pesticides detected. Endosulfan was detected once in the Bellevue Range sample; DDE and DDD were detected once in the Liston Range sample; and heptachlor epoxide was detected once in a sample collected from Mifflin Range. Concentrations of these pesticides were below 0.1 ppm. Polynuclear aromatic hydrocarbons (PAHs) were detected in several channel bends between Philadelphia Harbor and Artificial Island. PAHs are primarily formed through combustion of fossil fuels, and are expected to be found in highly industrialized and populated regions. PAHs were not detected in the Delaware Bay portion of the project area. PAH concentrations were generally below 2 ppm. The only exception was fluoranthene, which was detected in one sample collected in the vicinity of Tinicum Island at a concentration of 2.25 ppm. The U.S. Environmental Protection Agency has proposed sediment quality criteria (SQC) for fluoranthene, which are intended to predict toxicological effects of fluoranthene on organisms living in sediment. The freshwater criteria include a median concentration of 620 ppm, with a lower level 95 percent confidence interval of 290 ppm. These concentrations are orders of magnitude above levels found in the Delaware River navigation channel.

Of the remaining volatile and semi-volatile organic contaminants evaluated, only methylene chloride, acetone, 2-butanone, styrene and phthalates were detected at quantifiable levels. Styrene was detected in one sample and 2-butanone was detected in two samples. Concentrations of these chemicals were below 0.1 ppm. Methylene chloride was detected in several samples. Methylene chloride is mainly used as a low-temperature extractant of substances which are adversely affected by high temperature. It is also used as a solvent and as a paint remover. Because of its utility as a chemical extractant, methylene chloride is commonly used in laboratory analyses. It is likely that detection of methylene chloride was a byproduct of laboratory testing. Acetone was also detected in several samples. Acetone is also a common laboratory solvent, which was used to clean glassware and sampling implements for sample collection. Detection of acetone is also attributed to laboratory procedures.

Phthalates were also detected at more than one location. Phthalates are used in large quantities as plasticizers to improve the quality of plastics. A plasticizer is a substance added to plastics to keep them pliable or soft. Phthalates may also be used as starting or intermediate materials for a variety of industrial processes. The highest concentration was 2.67 ppm, which was reported for di-n-butyl phthalate from one sample collected in the vicinity of the Philadelphia Naval Base.

Heavy metals were found to be widely distributed throughout the project area, which was to be expected. Concentrations of metals in the predominantly sandy Delaware Bay sediments were generally lower than up-river areas. Other than that, there were no apparent contamination trends. The presence of heavy metals in channel sediments is attributed to the urban and industrialized nature of the river basin.

To evaluate potential human health impacts associated with disposal of channel sediments, bulk data were compared to New Jersey Department of Environmental Protection (NJDEP) Residential, Non-Residential and Impact to Groundwater Soil Cleanup Criteria (NJAC 7:26D). These criteria were established to provide a technical basis for evaluating levels of chemical contamination, and the associated risks to human health. They are based on currently available information, and are periodically updated as scientific knowledge is refined. Compliance with the Residential Standards allows maximum unrestricted future use of property, including residential use. Compliance with Non-Residential Standards is also acceptable provided the property owner agrees to limit future uses to non-residential activities such as an industrial work site. The soil criteria are derived through risk assessment procedures that are based on a number of assumptions. These assumptions include:

a) the body weight of an adult male is 70 kg;

b) the body weight of a child is 11.3 or 16 kg, depending on the contaminant;

c) the length of a lifetime is 70 years;

d) the number of years spent at a residential property is 30;

e) the number of years spent at a non-residential property is 25;

f) an individual visits a residential property every day of the year;

g) an individual visits a non-residential property 5 out of 7 days, 49 out of 52 weeks a year;

h) a child ingests soil at a rate of 200 mg/day between the ages of 6 months and 6 years; and

i) an adult ingests soil at a rate of 100 mg/day.

Depending on the contaminant, the human health criteria are based on an additional lifetime cancer risk of 1 of 1,000,000 or 1 of 100,000.

Comparison of the bulk sediment data to these human health criteria is considered to be a conservative evaluation. Individuals would not be exposed to the dredged material at the assumed frequencies listed in d through g, above. The Non-Residential Standards are most applicable to material that would be placed in confined, upland dredged material disposal sites. These areas would remain undeveloped as a result of disposal activities, and visitation would be minimal. Material dredged from Delaware Bay would be used for beneficial uses, primarily beach nourishment. The Residential Standards are more applicable here as people visiting the beaches would come in direct contact with the sand, and the more stringent standards provide the greatest level of safety.

A total of 91 chemical parameters were compared to the NJDEP criteria. Tables 4-9 through 4-19 provide this comparison. The mean concentrations calculated for Reaches A through E, with inclusion of laboratory quantification limits for samples where the parameter was not detected, are compared to the Residential and Impact to Groundwater Soil Cleanup Criteria. The Non-Residential standards are provided for parameters that exceeded the Residential standards. Again, since the majority of volatile and semi-volatile organic contaminants were not detected in channel sediments, mean concentrations are not presented by reach (Tables 4-18 and 4-19).

All 91 parameters in all five reaches met the NJDEP Impact to Ground Water Soil Cleanup Criteria, without exception. All 91 parameters in all five reaches met the NJDEP Residential and Non-Residential standards, with the exception of the pesticide toxaphene and the heavy metals thallium and cadmium. Toxaphene has Residential and Non-Residential standards of 0.10 and 0.20 ppm, respectively. While toxaphene was not detected in any of the 153 sediment samples tested, the laboratory quantification limits were consistently above NJDEP standards. As such, a definitive conclusion with regard to toxaphene is not possible. Worst case concentrations of toxaphene in channel sediments, calculated solely on laboratory detection levels, range from 0.26 ppm in Reach E to 0.56 ppm in Reach A. There is no reason to believe that toxaphene is a contaminant of concern in the Delaware Estuary. Therefore, the risk that actual concentrations of toxaphene in channel sediments are above NJDEP standards is considered low.

Both the Residential and Non-Residential standards for thallium are two ppm. Mean concentrations of thallium were above the standard in Reaches A and B. Mean concentrations were 3.76 and 2.48 ppm, respectively. Thallium and its compounds are used as rodenticides, fungicides, and insecticides; as catalysts in certain organic reactions; in the manufacture of optical lenses, plates and prisms; in photoelectric cells; in dyes and pigments; in fireworks; and imitation precious jewelry.

A total of 82 separate sediment samples were collected from Reaches A and B over three sampling events. All of these samples were analyzed for thallium. The initial event in 1991 collected 42 samples. Thirty of these samples had laboratory quantification limits greater than two ppm. Four samples had actual thallium detections greater than two ppm (5.5-9.0 ppm). Twenty additional sediment samples were collected in 1992, and

Table 4-9. Worst Case Mean Concentrations of Heavy Metals in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Residential Direct Contact Soil Cleanup Criteria.

Parameter	NJDEP Res. Standard	Mean Channel Sediment Concentrations Reach A	Reach B	Reach C	Reach D	Reach E
Antimony	14	3.19	9.93	10.00	10.70	2.35
Arsenic	20	5.97	6.41	8.37	8.97	2.35
Barium	700	49.68	61.96	49.84	27.14	11.37
Beryllium	1	0.91	0.82	0.64	0.69	0.28
Cadmium	1	[1.66]	0.94	1.00	0.96	0.70
Chromium	NS	15.95	26.28	28.73	37.18	12.70
Copper	600	9.97	11.72	14.74	10.33	5.08
Lead	100	18.94	19.09	24.80	19.53	7.11
Mercury	14	0.15	0.16	0.24	0.15	0.14
Nickel	250	11.20	18.30	15.79	18.33	6.70
Selenium	63	31.67	16.53	18.78	16.37	20.08
Silver	110	1.04	0.87	0.67	0.64	0.81
Thallium	2	[3.76]	[2.48]	0.66	1.46	0.47
Vanadium	370	21.32	29.81	37.02	19.51	9.77
Zinc	1500	67.41	64.46	84.88	73.88	26.01

- All concentrations in parts per million (mg/kg), dry weight.
- [ ] - Sediment concentrations in brackets exceed NJDEP residential criteria.
- NS - No NJDEP standard for this parameter.
- NJDEP residential direct contact soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.
- NJDEP non-residential direct contact soil cleanup criteria for cadmium and thallium are 100 and 2 mg/kg, respectively.
- NJDEP impact to ground water soil cleanup criteria for heavy metals are not established. These values are based upon site specific chemical and physical parameters.

Table 4-10. Worst Case Mean Concentrations of Pesticides in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Residential Direct Contact Soil Cleanup Criteria.

Parameter	NJDEP Res. Standard	Mean Channel Sediment Concentrations Reach A	Reach B	Reach C	Reach D	Reach E
Aldrin	0.040	0.03	0.02	0.02	0.02	0.02
Dieldrin	0.042	0.03	0.03	0.03	0.04	0.03
Chlordane	NS	0.32	0.24	0.23	0.35	0.17
Toxaphene	0.10	[0.56]	[0.34]	[0.29]	[0.41]	[0.26]
Endrin	17	0.03	0.03	0.03	0.04	0.03
Endrin Aldehyde	NS	0.03	0.03	0.03	0.04	0.03
Heptachlor	0.15	0.03	0.02	0.02	0.02	0.02
Heptachlor Epoxide	NS	0.03	0.02	0.02	0.02	0.02
Endosulfan	340	0.03	0.03	0.03	0.04	0.03
DDT	2	0.04	0.04	0.03	0.05	0.03
DDD	3	0.03	0.03	0.03	0.04	0.02
DDE	2	0.03	0.03	0.03	0.04	0.02
Mirex	NS	0.35	0.11	0.03	0.04	0.03
Methoxychlor	280	0.07	0.09	0.12	0.11	0.10
Parathion	NS	3.64	12.08	6.61	9.44	12.01
Malathion	NS	3.64	12.08	6.60	9.43	12.00
Hexachlorocyclohexane						
Alpha	NS	0.03	0.02	0.02	0.02	0.02
Beta	NS	0.03	0.02	0.02	0.02	0.02
Delta	NS	0.03	0.02	0.02	0.02	0.02
Gamma (Lindane)	0.52	0.03	0.02	0.02	0.02	0.02
Guthion	NS	3.64	12.10	6.64	9.47	12.03
Demeton	NS	3.99	12.16	6.61	9.44	12.01

All concentrations in parts per million (mg/kg), dry weight.

[ ] - Sediment concentrations in brackets exceed NJDEP residential criteria.

NS - No NJDEP standard for this parameter.

NJDEP residential direct contact soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

NJDEP non residential direct contact soil cleanup criteria for toxaphene is 0.2 mg/kg.

Table 4-11. Worst Case Mean Concentrations of Pesticides in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Impact to Ground Water Soil Cleanup Criteria.

Parameter	NJDEP Ground Water Standard	Mean Channel Sediment Concentrations Reach A	Reach B	Reach C	Reach D	Reach E
Aldrin	50	0.03	0.02	0.02	0.02	0.02
Dieldrin	50	0.03	0.03	0.03	0.04	0.03
Chlordane	NS	0.32	0.24	0.23	0.35	0.17
Toxaphene	50	0.56	0.34	0.29	0.41	0.26
Endrin	50	0.03	0.03	0.03	0.04	0.03
Endrin Aldehyde	NS	0.03	0.03	0.03	0.04	0.03
Heptachlor	50	0.03	0.02	0.02	0.02	0.02
Heptachlor Epoxide	NS	0.03	0.02	0.02	0.02	0.02
Endosulfan	50	0.03	0.03	0.03	0.04	0.03
DDT	500	0.04	0.04	0.03	0.05	0.03
DDD	50	0.03	0.03	0.03	0.04	0.02
DDE	50	0.03	0.03	0.03	0.04	0.02
Mirex	NS	0.35	0.11	0.03	0.04	0.03
Methoxychlor	50	0.07	0.09	0.12	0.11	0.10
Parathion	NS	3.64	12.08	6.61	9.44	12.01
Malathion	NS	3.64	12.08	6.60	9.43	12.00
Hexachlorocyclohexane						
Alpha	NS	0.03	0.02	0.02	0.02	0.02
Beta	NS	0.03	0.02	0.02	0.02	0.02
Delta	NS	0.03	0.02	0.02	0.02	0.02
Gamma (Lindane)	50	0.03	0.02	0.02	0.02	0.02
Guthion	NS	3.64	12.10	6.64	9.47	12.03
Demeton	NS	3.99	12.16	6.61	9.44	12.01

All concentrations in parts per million (mg/kg), dry weight.

NS - No NJDEP standard for this parameter.

NJDEP impact to ground water soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Table 4-12. Worst Case Mean Concentrations of PCBs in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Residential Direct Contact Soil Cleanup Criteria.

Parameter	NJDEP Res. Standard	Mean Channel Sediment Concentrations				
		Reach A	Reach B	Reach C	Reach D	Reach E
PCB-1242	0.49	0.30	0.21	0.15	0.23	0.17
PCB-1254	0.49	0.34	0.32	0.29	0.41	0.26
PCB-1221	0.49	0.30	0.21	0.15	0.23	0.17
PCB-1232	0.49	0.30	0.21	0.15	0.23	0.17
PCB-1248	0.49	0.30	0.21	0.15	0.23	0.17
PCB-1260	0.49	0.34	0.31	0.29	0.41	0.26
PCB-1016	0.49	0.30	0.21	0.15	0.23	0.17

All concentrations in parts per million (mg/kg), dry weight.

NJDEP residential direct contact soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Table 4-13. Worst Case Mean Concentrations of PCBs in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Impact to Ground Water Soil Cleanup Criteria.

Parameter	NJDEP Res. Standard	Mean Channel Sediment Concentrations				
		Reach A	Reach B	Reach C	Reach D	Reach E
PCB-1242	50	0.30	0.21	0.15	0.23	0.17
PCB-1254	50	0.34	0.32	0.29	0.41	0.26
PCB-1221	50	0.30	0.21	0.15	0.23	0.17
PCB-1232	50	0.30	0.21	0.15	0.23	0.17
PCB-1248	50	0.30	0.21	0.15	0.23	0.17
PCB-1260	50	0.34	0.31	0.29	0.41	0.26
PCB-1016	50	0.30	0.21	0.15	0.23	0.17

All concentrations in parts per million (mg/kg), dry weight.

NJDEP impact to ground water soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Table 4-14. Worst Case Mean Concentrations of PAHs in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Residential Direct Contact Soil Cleanup Criteria.

Parameter	NJDEP Res. Standard	Mean Channel Sediment Concentrations Reach A	Reach B	Reach C	Reach D	Reach E
Acenapthene	3400	0.53	0.47	0.51	0.52	0.35
Naphthalene	230	0.53	0.46	0.46	0.52	0.35
Acenaphthylene	NS	0.53	0.47	0.51	0.52	0.35
Anthracene	10000	0.53	0.47	0.51	0.51	0.35
Benzo(a)pyrene	0.66	0.53	0.48	0.46	0.51	0.35
Benzo(b)fluoranthene	0.9	0.54	0.47	0.48	0.50	0.35
Benzo(k)fluoranthene	0.9	0.53	0.47	0.48	0.50	0.35
Chrysene	9	0.53	0.49	0.46	0.50	0.35
Phenanthrene	NS	0.53	0.48	0.47	0.51	0.35
Fluorene	2300	0.53	0.47	0.51	0.52	0.35
Fluoranthene	2300	0.53	0.52	0.48	0.50	0.35
Benzo(a)anthracene	0.9	0.53	0.49	0.51	0.50	0.35
Benzo(ghi)perylene	NS	0.53	0.47	0.47	0.51	0.35
Dibenzo(ah)anthracene	0.66	0.53	0.47	0.51	0.51	0.35
Ideno(123-cd)pyrene	0.9	0.53	0.47	0.47	0.51	0.35
Pyrene	1700	0.54	0.50	0.48	0.50	0.35

All concentrations in parts per million (mg/kg), dry weight.

NS - No NJDEP standard for this parameter.

NJDEP residential direct contact soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Table 4-15. Worst Case Mean Concentrations of PAHs in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Impact to Ground Water Soil Cleanup Criteria.

Parameter	NJDEP Ground Water Standard	Mean Channel Sediment Concentrations				
		Reach A	Reach B	Reach C	Reach D	Reach E
Acenapthene	100	0.53	0.47	0.51	0.52	0.35
Naphthalene	100	0.53	0.46	0.46	0.52	0.35
Acenaphthylene	NS	0.53	0.47	0.51	0.52	0.35
Anthracene	100	0.53	0.47	0.51	0.51	0.35
Benzo(a)pyrene	100	0.53	0.48	0.46	0.51	0.35
Benzo(b)fluoranthene	50	0.54	0.47	0.48	0.50	0.35
Benzo(k)fluoranthene	500	0.53	0.47	0.48	0.50	0.35
Chrysene	500	0.53	0.49	0.46	0.50	0.35
Phenanthrene	NS	0.53	0.48	0.47	0.51	0.35
Fluorene	100	0.53	0.47	0.51	0.52	0.35
Fluoranthene	100	0.53	0.52	0.48	0.50	0.35
Benzo(a)anthracene	500	0.53	0.49	0.51	0.50	0.35
Benzo(ghi)perylene	NS	0.53	0.47	0.47	0.51	0.35
Dibenzo(ah)anthracene	100	0.53	0.47	0.51	0.51	0.35
Ideno(123-cd)pyrene	500	0.53	0.47	0.47	0.51	0.35
Pyrene	100	0.54	0.50	0.48	0.50	0.35

All concentrations in parts per million (mg/kg), dry weight.

NS - No NJDEP standard for this parameter.

NJDEP impact to ground water soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Table 4-16. Worst Case Mean Concentrations of Phthalates in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Residential Direct Contact Soil Cleanup Criteria.

Parameter	NJDEP Res. Standard	Mean Channel Sediment Concentrations Reach A	Reach B	Reach C	Reach D	Reach E
Bis(2-ethylhexyl) phthalate	49	0.62	0.51	0.53	0.51	0.42
Butyl benzyl phthalate	1100	0.62	0.51	0.55	0.47	0.42
Di-n-butyl phthalate	5700	0.73	0.29	0.30	0.31	0.55
Di-n-octyl phthalate	1100	0.62	0.54	0.55	0.51	0.42
Diethyl phthalate	10000	0.62	0.54	0.55	0.51	0.42
Dimethyl phthalate	10000	0.62	0.54	0.55	0.51	0.42

All concentrations in parts per million (mg/kg), dry weight.

NJDEP residential direct contact soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Table 4-17. Worst Case Mean Concentrations of Phthalates in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Impact to Ground Water Soil Cleanup Criteria.

Parameter	NJDEP Ground Water Standard	Mean Channel Sediment Concentrations				
		Reach A	Reach B	Reach C	Reach D	Reach E
Bis(2-ethylhexyl) phthalate	100	0.62	0.51	0.53	0.51	0.42
Butyl benzyl phthalate	100	0.62	0.51	0.55	0.47	0.42
Di-n-butyl phthalate	100	0.73	0.29	0.30	0.31	0.55
Di-n-octyl phthalate	100	0.62	0.54	0.55	0.51	0.42
Diethyl phthalate	50	0.62	0.54	0.55	0.51	0.42
Dimethyl phthalate	50	0.62	0.54	0.55	0.51	0.42

All concentrations in parts per million (mg/kg), dry weight.

NJDEP impact to ground water soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Table 4-18. Worst Case Mean Concentrations of Volatile Organics in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Residential Direct Contact, and Impact to Ground Water Soil Cleanup Criteria.

Parameter	NJDEP Ground Water Standard	NJDEP Res. Standard	Mean Sed. Conc.
Volatile Halogenated Alkanes			
carbon tetrachloride	1	2	0.11
1,2-dichloroethane	1	6	0.11
1,1,1-trichloroethane	50	210	0.11
1,1-dichloroethane	10	8	0.11
1,1,2-trichloroethane	1	22	0.11
1,1,2,2-tetrachloroethane	1	34	0.11
chloroethane	NS	NS	0.11
chloroform	1	19	0.11
1,2-dichloropropane	NS	10	0.11
methylene chloride	1	49	0.11
chloromethane	10	520	0.02
bromomethane	1	79	0.02
bromoform	1	86	0.11
dichlorobromoethane	1	11	0.11
chlorodibromomethane	1	110	0.11
Volatile Halogenated Alkenes			
1,1-dichlorethene	10	8	0.01
1,2-trans-dichlorethene	50	1000	0.01
trans-1,3-dichloropropene	1	4	0.01
cis-1,3-dichloropropene	1	4	0.01
tetrachlorethene	NS	NS	0.01
trichloroethene	1	23	0.01
vinyl chloride	10	2	0.11
Volatile Aromatic Hydrocarbons			
benzene	1	3	0.11
ethylbenzene	100	1000	0.11
toluene	500	1000	0.11
Volatile Chlorinated Aromatic Hydrocarbons			
chlorobenzene	1	37	0.11
Volatile Unsaturated Carbonyl Compounds			
acrolein	NS	NS	0.52
acrylonitrile	1	1	0.28
Volatile Ethers			
2-chlorethylvinylether	NS	NS	0.11

All concentrations presented in parts per million (mg/kg), dry weight.
NS - No NJDEP standard for this parameter.
NJDEP soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Table 4-19. Worst Case Mean Concentrations of Semi-Volatile Organics in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to NJDEP Residential Direct Contact, and Impact to Ground Water Soil Cleanup Criteria.

Parameter	NJDEP Ground Water Standard.	NJDEP Res. Standard	Mean Sed. Conc.
Phenols			
phenol	50	10000	0.59
2,4-dimethylphenol	10	1100	0.59
Substituted Phenols			
2,4,6-trichlorophenol	10	62	0.59
para-chloro-meta-cresol	100	10000	0.87
2-chlorophenol	10	280	0.59
2,4-dichlorophenol	10	170	0.59
4-chloro-3-methylphenol	100	10000	0.54
pentachlorophenol	100	6	2.47
4,6-dinitro-2-methylphenol	NS	NS	2.72
2-nitrophenol	NS	NS	0.59
4-nitrophenol	NS	NS	2.94
2,4-dinitrophenol	10	110	2.94
Organonitrogen Compounds			
benzidine	NS	NS	2.29
3,3'-dichlorobenzidine	100	2	1.02
2,4-dinitrotoluene	10	1	0.59
2,6-dinitrotoluene	10	1	0.59
nitrobenzene	10	28	0.59
N-nitrosodimethylamine	NS	NS	0.59
N-nitrosodiphenylamine	100	140	0.59
N-nitrosodi-n-propylamine	10	0.66	0.59
Chlorinated Aromatic Hydrocarbons			
1,2,4-trichlorobenzene	100	68	0.59
hexachlorobenzene	100	0.66	0.59
2-chloronaphthalene	NS	NS	0.59
1,2-dichlorobenzene	50	5100	0.59
1,3-dichlorobenzene	100	5100	0.59
1,4-dichlorobenzene	100	570	0.59
Chlorinated Aliphatic Hydrocarbons			
hexachlorobutadiene	100	1	0.59
hexachloroethane	100	6	0.59
hexachlorocyclopentadiene	100	400	0.59
Halogenated Ethers			
bis(2-chloroethyl)ether	10	0.66	0.59
4-chlorophenyl-phenylether	NS	NS	0.59
4-bromophenyl-phenylether	NS	NS	0.59
bis(2-chloroisopropyl)ether	10	2300	0.59
bis(2-chlorethoxy)methane	NS	NS	0.59
Miscellaneous Oxygenated Compounds			
isophorone	50	1100	0.59

the final 20 samples were collected in 1994. These 40 samples showed thallium concentrations in channel sediments to be less than two ppm. All 40 samples had laboratory quantification limits or actual detections of thallium below 0.4 ppm. While mean thallium concentrations for channel sediments in Reaches A and B are above the NJDEP standard, it appears that high detection levels from the 1991 sampling event is responsible for skewing the means. Two subsequent sampling events failed to reproduce the earlier results. Like toxaphene, there is no reason to believe that thallium is a contaminant of concern in the Delaware Estuary. Based on the above information, it is concluded that the calculated mean concentrations are high, and that the true mean thallium concentration in channel sediments is actually below two ppm.

The mean cadmium concentration of channel sediment samples collected from Reach A was 1.66 ppm. This is above the NJDEP Residential standard of one ppm, but well below the Non-Residential standard of 100 ppm. Cadmium was detected in a number of samples at concentrations above one ppm, so there is no reason to suspect that the calculated mean is high. Since the material dredged from Reach A would be placed in an upland, dredged material disposal site that would not be used for residential development, and since the mean concentration of cadmium is so far below the NJDEP Non-Residential sediment standard of 100 ppm, it is concluded that the concentration of cadmium in sediments from Reach A would not pose any significant human health concerns.

Heavy metals and polynuclear aromatic hydrocarbons (PAHs) were the two groups of contaminants primarily encountered in channel sediments. The bulk sediment data for several parameters within these groups were also compared to sediment quality guidelines relating to the potential for adverse biological effects in estuarine sediments (Long et al., 1995). Adverse biological effects include measures of altered benthic communities, histopathological disorders in demersal fish, and toxicity. Through a comprehensive review of available data on sediment effects, Long established two guideline values. These two values are referred to as effects range-low (ERL) and effects range-median (ERM). Long et al. (1995) state: "The two guideline values, ERL and ERM, delineate three concentration ranges for a particular chemical. The concentrations below the ERL value represent a minimal-effects range; a range intended to estimate conditions in which effects would be rarely observed. Concentrations equal to and above the ERL, but below the ERM, represent a possible-effects range within which effects would occasionally occur. Finally, the concentrations equivalent to and above the ERM value represent a probable-effects range within which effects would frequently occur."

These guidelines are most appropriate for Reach E sediment, where material would largely be placed in the aquatic environment for beneficial uses. In Reaches A through D, material would be removed from the aquatic environment and placed in confined, upland sites. As such, any adverse impacts to aquatic resources would be precluded.

Long established ERL/ERM criteria for nine heavy metals. Mean concentrations of these nine metals are compared to the ERL/ERM criteria in Table 4-20. Again, mean concentrations are presented for Reaches A through E. Mean concentrations of the nine heavy metals in Reach E sediment are all below ERL values. Cadmium and nickel are the only metals that have an individual sample concentration above the ERLs. One Reach E sample had a cadmium concentration of 2.8 ppm and a nickel concentration of 21.4 ppm (refer to detection ranges presented in Table 4-2). Both of these values are on the low side of the possible effects range between the ERL and ERM values.

With regard to Reaches A through D, mean concentrations of arsenic, cadmium, mercury and silver were above ERL values in some reaches. Again all of these mean concentrations are on the low end of the possible effects range between the ERL and ERM values. While a number of individual samples had metal concentrations above the ERLs, only mercury and zinc had sample concentrations above the ERMs (Table 4-2). One Reach C sample had a mercury concentration of 1.4 ppm, which is above the ERM of 0.71 ppm. One Reach A sample and one Reach C sample had zinc concentrations of 607 and 630 ppm, respectively. These are above the ERM value of 410 ppm.

Bulk sediment data for 12 individual PAHs were also compared to ERL/ERM criteria (Table 4-21). PAHs were detected much less frequently than heavy metals. Benzo(a)pyrene was most frequently detected. As can be seen on Table 4-21, benzo(a)pyrene was only detected in 11 of the 153 samples analyzed. Unfortunately, the calculated means (Table 4-5), based predominantly on quantification limits, are above the majority of ERLs, and even above the ERMs for acenapthene and dibenzo(ah)anthracene. PAHs were not detected in Reach E sediment. The mean quantification limit for the 23 samples analyzed was 350 parts per billion (ppb) for each individual parameter. Only benzo(a)pyrene, chrysene, fluoranthene and pyrene have ERLs above 350 ppb. For the remaining parameters, 350 ppb falls between the ERL and ERM values, and is above the ERM of 260 ppm for dibenzo(ah)anthracene.

As a result of the high quantification limits relative to the ERL/ERM PAH criteria, it is only possible to compare criteria to actual PAH detections. Table 4-21 provides the number of individual PAH detections out of 153 samples analyzed, the number and concentrations of detections greater than the corresponding ERL values, and the ERL/ERM criteria. As can be seen from the table, there were few actual detections above the ERLs and none above the ERMs. These data suggest that the sediments in Reaches A through D are not highly contaminated with PAHs, and that the potential for adverse biological effects is not great, especially

Table 4-20. Worst Case Mean Concentrations of Heavy Metals in Delaware River, Philadelphia to the Sea, Federal Navigation Channel Sediment Compared to ERL/ERM Criteria.

Parameter	ERL/ERM Criteria	Mean Channel Sediment Concentrations Reach A	Reach B	Reach C	Reach D	Reach E
Arsenic	8.2/70	5.97	6.41	[8.37]	[8.97]	2.35
Cadmium	1.2/9.6	[1.66]	0.94	1.00	0.96	0.70
Chromium	81/370	15.95	26.28	28.73	37.18	12.70
Copper	34/270	9.97	11.72	14.74	10.33	5.08
Lead	46.7/218	18.94	19.09	24.80	19.53	7.11
Mercury	0.15/0.71	[0.15]	[0.16]	[0.24]	[0.15]	0.14
Nickel	20.9/51.6	11.20	18.30	15.79	18.33	6.70
Silver	1.0/3.7	[1.04]	0.87	0.67	0.64	0.81
Zinc	150/410	67.41	64.46	84.88	73.88	26.01

- All concentrations in parts per million (mg/kg), dry weight.
- [ ] - Sediment concentrations in brackets exceed ERL criteria.

Long, E.R, D.A. MacDonald, S.L. Smith, and F.C. Calder. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19(1):81-97.

Table 4-21. Summary of PAH Bulk Sediment Data Collected in the Delaware River, Philadelphia to the Sea, Federal Navigation Channel Compared to ERL and ERM Criteria.

Parameter	No. of Detections	Detections > ERL	ERL	ERM
Acenapthene	0/153	None	16	500
Naphthalene	2/153	180, 420	160	2100
Acenaphthylene	0/153	None	44	640
Anthracene	3/153	200, 510	85.3	1100
Benzo(a)pyrene	11/153	490, 530, 1120	430	1600
Chrysene	6/153	620, 710, 1270	384	2800
Phenanthrene	4/153	490, 650, 950	240	1500
Fluorene	0/153	None	19	540
Fluoranthene	7/153	850, 860, 2250	600	5100
Benzo(a)anthracene	4/153	590, 1520	261	1600
Dibenzo(ah)anthracene	1/153	None	63.4	260
Pyrene	7/153	810, 870, 1760	665	2600

- All concentrations in parts per billion (ug/kg), dry weight.

Long, E.R., D.A. MacDonald, S.L. Smith, and F.C. Calder. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19(1):81-97.

considering that this material would be removed from the aquatic system.

Overall, concentrations of contaminants in channel sediments are considered low. Channel sediments to be dredged from Reaches A through D are sufficiently clean for placement in confined, upland sites. In the Delaware Bay portion of the project area, where material would be used for beneficial uses such as beach nourishment, comparison of data to NJDEP Residential and ERL/ERM criteria suggests that the proposed plan is also acceptable.

4.2 Elutriate Sediment Analyses

While bulk analysis provides an accurate characterization of contaminants associated with the sediments, it does not provide insight into the potential impacts on water quality and aquatic resources associated with sediment disturbance. To predict contaminant levels that would be liberated from sediment during dredging and disposal activities, which would then be biologically available to impact aquatic resources, sediment samples were also evaluated through an elutriate analysis. This test mimics the sediment disturbance that would occur, and determines contaminant levels that would be released. The elutriate test provides the second tier of testing in the national comprehensive testing strategy.

A total of 107 separate sediment samples taken from sediment cores that were also used for bulk analysis were tested using the elutriate procedure. See Plates 7 and 8 for sediment core sample locations. An elutriate sample was prepared by combining sediment and Delaware River water to achieve a slurry concentration of 150 grams/liter. The slurry was thoroughly mixed, and after a settling period, the supernatant water was extracted from the test cylinder. The water sample was appropriately filtered, and analyzed for a variety of chemical parameters. All 107 samples were analyzed for heavy metals, pesticides, PCBs and polynuclear aromatic hydrocarbons. Forty-five samples were analyzed for the complete list of chemical parameters (Table 4-1).

Heavy metals were frequently detected in sediment elutriate samples. See Table 4-22 for a summary of the heavy metal elutriate results. Antimony and selenium were not detected in any of the 107 samples analyzed. Beryllium and mercury were each detected in three samples. Beryllium was detected in three Reach E samples, all at concentrations of 10 parts per billion (ppb). Mercury was detected once in Reaches B, C and D. Mercury concentrations ranged between 0.26 and 0.95 ppb. Silver was detected in seven samples collected in Reaches C, D and E. Silver concentrations ranged between 10 and 40 ppb. Cadmium, chromium, nickel and thallium were each detected in 10 to 20 percent of the 107 samples. Cadmium was detected in Reaches B, C, D and E at concentrations ranging between 10 and 40 ppb. Chromium was detected in Reaches A and B at concentrations

Table 4-22. Heavy Metal Data Summary of Elutriate Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	20	40	23	13	11
Antimony					
Mean Concentration	54.5	43.25	57.39	63.08	321.82
# of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Arsenic					
Mean Concentration	35.69	12.86	14.78	11.87	134.36
# of Detections	1	5	7	7	7
Detection Range	65	6-92.9	8-57	5-33	190-220
Beryllium					
Mean Concentration	5	4.4	4.39	4.62	15.91
# of Detections	ND	ND	ND	ND	3
Detection Range	-	-	-	-	10
Cadmium					
Mean Concentration	5.5	6	7.39	9.23	46.36
# of Detections	ND	5	2	2	4
Detection Range	-	10	20	20	40
Chromium					
Mean Concentration	43.85	22.68	15.65	20	81.82
# of Detections	11	2	ND	ND	ND
Detection Range	28-180	77-130	-	-	-
Copper					
Mean Concentration	47.63	23.18	19.74	21.54	87.27
# of Detections	14	15	3	2	4
Detection Range	22-119	20-130	24-30	30	50-80
Lead					
Mean Concentration	35.82	14.25	4.87	10.28	48.72
# of Detections	9	24	10	3	4
Detection Range	4-127	2-260	3-24	4-5.6	0.2-170

All concentrations presented in parts per billion (ug/l).
ND - Not Detected.

Table 4-22. Heavy Metal Data Summary of Elutriate Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	20	40	23	13	11
Mercury					
Mean Concentration	0.87	0.24	0.11	0.15	0.2
# of Detections	ND	1	1	1	ND
Detection Range	-	0.95	0.26	0.3	-
Nickel					
Mean Concentration	86.55	40.5	51.74	55.38	308.18
# of Detections	7	1	3	2	4
Detection Range	42-660	60	40-100	40	110-170
Selenium					
Mean Concentration	4.85	3.7	8.52	11.31	297.27
# of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Silver					
Mean Concentration	18.5	11.25	12.17	13.85	74.55
# of Detections	ND	ND	1	2	4
Detection Range	-	-	10	10	20-40
Thallium					
Mean Concentration	32.1	9.45	11.22	30.69	321.82
# of Detections	ND	ND	7	4	ND
Detection Range	-	-	2-6	3-4	-
Zinc					
Mean Concentration	383.1	135.48	53.35	37.38	149.09
# of Detections	16	35	14	5	4
Detection Range	93-1160	23-921	24-150	21-70	40-90

All concentrations presented in parts per billion (ug/l).
ND - Not Detected.

ranging between 28 and 180 ppb. Nickel was detected in all Reaches at concentrations ranging between 40 and 660 ppb. Thallium was detected in Reaches C and D at concentrations ranging between 2 and 6 ppb. Arsenic, copper, lead and zinc were most frequently detected. These heavy metals were detected in all Reaches in 25, 36, 47 and 69 percent of the 107 samples, respectively. Arsenic concentrations ranged between 5 and 220 ppb. Copper concentrations ranged between 20 and 130 ppb. Lead concentrations ranged between 2 and 260 ppb. Zinc concentrations ranged between 21 and 1160 ppb.

The presence of organic contaminants in sediment elutriates was limited. Refer to Table 4-23 for a summary of organic contaminants detected, and the detection range. PCBs were not detected. Pesticides were only detected in three of 107 samples, which were all collected from Reach B. The pesticide malathion was detected in two samples at concentrations of 2.6 and 6.3 parts per billion (ppb). The pesticide endosulfan was detected in one sample at a concentration of 6 ppb. Polynuclear aromatic hydrocarbons were only detected in one of 107 samples, which was collected from Reach E. Five individual PAHs were detected in this sample for a combined concentration of 13 ppb. No other organic contaminants were detected in samples collected from Delaware Bay. Phthalates were detected in 41 of the 45 samples evaluated. Phthalate concentrations ranged between 1 and 134 ppb. Methylene chloride, a common laboratory contaminant, was detected in five of 45 samples, which were all collected from Reach A. Concentrations ranged between 9 and 30 ppb. 2,4,6 Trichlorophenol was detected in three samples (3 of 45) collected from Reach B at concentrations between 6 and 13 ppb. Bis(2-chloroethyl) ether was detected in one (1 of 45) Reach B sample at a concentration of 62 ppb.

Based on the elutriate analysis results, it is concluded that dredging and dredged material disposal operations would not significantly impact water quality within the Delaware River. The majority of organic contaminants evaluated were not present in any of the sediment elutriates. The few that were encountered were detected on a very limited basis. All concentrations were considered to be relatively low. While more frequently encountered, concentrations of heavy metals in sediment elutriates were also considered low. The metals arsenic, copper, lead and zinc were the only contaminants detected in greater than 20 percent of the samples. Elevated concentrations of contaminants in Delaware River water resulting from dredging or dredged material disposal operations would be lower than the elutriate analysis results, as a result of mixing and dilution with the large volume of water in the river.

4.3 Toxicity Characteristic Leaching Procedure (TCLP) Analyses

In 1994, 20 sediment cores were collected between Philadelphia Harbor and lower Delaware Bay and analyzed using the USEPA Toxicity Characteristic Leaching Procedure (TCLP), as provided in

Table 4-23. Organic Contaminant Data Summary of Elutriate Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	20	40	23	13	11
Bis(2-ethylhexyl) phthalate					
# of Detections	4	10	13	6	ND
Detection Range	1-134	1-16	6-59	16-49	-
Butyl benzyl phthalate					
# of Detections	ND	1	ND	ND	ND
Detection Range	-	2	-	-	-
Di-n-butyl phthalate					
# of Detections	ND	17	6	6	ND
Detection Range	-	1-37	2	2-5	-
Diethyl phthalate					
# of Detections	ND	1	ND	ND	ND
Detection Range	-	2	-	-	-
Methylene chloride					
# of Detections	5	ND	ND	ND	ND
Detection Range	9-30	-	-	-	-
Bis(2-chloroethyl) ether					
# of Detections	ND	1	ND	ND	ND
Detection Range	-	62	-	-	-
2,4,6 Trichlorophenol					
# of Detections	ND	3	ND	ND	ND
Detection Range	-	6-13	-	-	-
Malathion					
# of Detections	ND	2	ND	ND	ND
Detection Range	-	2.6-6.3	-	-	-
Endosulfan					
# of Detections	ND	1	ND	ND	ND
Detection Range	-	6	-	-	-

All concentrations presented in parts per billion (ug/l).
ND - Not Detected.

Table 4-23. Organic Contaminant Data Summary of Elutriate Sediment Sample Analyses Conducted Within the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Reach A	Reach B	Reach C	Reach D	Reach E
Number of Samples	20	40	23	13	11
Fluoranthene					
# of Detections	ND	ND	ND	ND	1
Detection Range	-	-	-	-	3
Pyrene					
# of Detections	ND	ND	ND	ND	1
Detection Range	-	-	-	-	3
Chrysene					
# of Detections	ND	ND	ND	ND	1
Detection Range	-	-	-	-	3
Benzo(b)fluoranthene					
# of Detections	ND	ND	ND	ND	1
Detection Range	-	-	-	-	2
Benzo(k)fluoranthene					
# of Detections	ND	ND	ND	ND	1
Detection Range	-	-	-	-	2

All concentrations presented in parts per billion (ug/l).
ND - Not Detected.

40 CFR Part 261. Sediment core collection locations are shown on Plates 7 and 8. The cores were divided into 44 separate samples, based on observed sediment stratification. Some cores were homogeneous throughout, and were simply divided in half to provide a top and bottom sample.

The TCLP test entails adjusting the sediment and water to a pH of 4.93, and leaching contaminants from the sediment. The samples were leached for volatile organics using zero headspace extraction, and were leached for extractable organics and heavy metals by rotation. The samples were then analyzed for a specific set of contaminants, which have established criteria that represent maximum allowable regulatory levels. A sediment that has a contaminant concentration equal to or greater than the respective regulatory level is considered to exhibit the characteristic of toxicity, and would be treated as a hazardous waste. As the TCLP test simulates the pH changes that sediments may experience when exposed to air and acidic rain in an upland disposal area, the data can also be used to evaluate potential groundwater and surface water impacts.

Table 4-24 provides a list of the TCLP contaminant parameters, the maximum allowable regulatory levels, and the maximum concentrations detected in Delaware River channel sediments. The heavy metals arsenic, barium, cadmium, chromium and lead were the only contaminants detected through the TCLP analysis. Maximum sample detections of these metals were at least one order of magnitude below the respective criteria. As such, channel sediment samples did not exhibit the characteristic of toxicity, and would not be considered a hazardous material.

4.4 Biological Effects Based Testing

In the Record of Decision, which was prepared at the end of the Environmental Impact Statement process, the Corps committed to conducting biological effects based testing to more fully evaluate sediment quality concerns. These tests provide a third tier of sediment investigation. A water column, or suspended solid particulate phase bioassay can be run to evaluate water quality concerns associated with the release of contaminants from sediment into dredging or disposal site water. A whole sediment, or benthic bioassay can be run to evaluate impacts to benthic organisms residing at open water disposal sites. These bioassays are used to provide information on the toxicity of individual contaminants, and also to indicate possible interactive effects of multiple contaminants. Lastly, if there is reason to believe that bioaccumulation is of concern, the potential uptake of contaminants by aquatic organisms at an open water disposal site can be evaluated with a bioaccumulation test. Unless there is continuous dredging/discharge, bioaccumulation from the material remaining in the water column is considered to be of minor concern due to the short exposure time and low exposure concentrations resulting from rapid dispersion and dilution. An overwhelming preponderance of evidence from years of studies has

Table 4-24. USEPA Toxicity Characteristic Leachate Procedure (TCLP) Criteria Compared to Delaware River Channel Sediment Samples. Concentrations in mg/l.

Parameter	Maximum Allowable Concentration	Maximum Sample Detection
Metals		
Silver	5.0	ND
Arsenic	5.0	0.42
Barium	100.0	1.25
Cadmium	1.0	0.013
Chromium	5.0	0.029
Mercury	0.2	ND
Lead	5.0	0.193
Selenium	1.0	ND
Herbicides and Pesticides		
2,4,-D	10.0	ND
2,4,5-TP (Silvex)	1.0	ND
Endrin	0.02	ND
Heptachlor	0.008	ND
Heptachlor Epoxide	0.008	ND
Methoxychlor	10.0	ND
Chlordane	0.03	ND
Toxaphene	0.5	ND
Lindane	0.4	ND
Semi-Volatile Organics		
Pentachlorophenol	100.0	ND
2,4,6-Trichlorophenol	2.0	ND
2,4,5-Trichlorophenol	400.0	ND
2-Methylphenol (o-Cresol)	200.0	ND
4-Methylphenol (p-Cresol)	200.0	ND
3-Methylphenol (m-Cresol)	200.0	ND
O,M,P Cresol (Total Cresols)	200.0	ND
1,4-Dichlorobenzene	7.5	ND
2,4-Dinitrotoluene	0.13	ND
Hexachlorobenzene	0.13	ND
Hexachlorobutadiene	0.5	ND
Hexachloroethane	3.0	ND
Nitrobenzene	2.0	ND
Pyridine	5.0	ND
Volatile Organics		
Methyl ethyl ketone	200.0	ND
Tetrachloroethylene	0.7	ND
Trichloroethylene	0.5	ND
Benzene	0.5	ND
Carbon tetrachloride	0.5	ND
Chlorobenzene	100.0	ND
Chloroform	6.0	ND
1,2-Dichloroethane	0.5	ND
1,1-Dichloroethylene	0.7	ND
Vinyl Chloride	0.2	ND

demonstrated that the potential of water column impacts of contaminants released from dredged material disposal are generally negligible (USACE, 1988).

Bioassays and bioaccumulation tests have been run to directly test the toxic effects of Delaware River channel sediments on aquatic organisms. The water column and whole sediment bioassays exposed living organisms to sediments, to evaluate any differences in mortality between Delaware River channel sediments and clean laboratory sediments used as a control. Early life stages of fish, crustaceans, molluscs, zooplankton and polychaete worms were tested. Young organisms are more sensitive than adults to the effects of sediment contamination, and are considered to be better indicators of problems.

4.4.1 Water Column and Whole Sediment Bioassays

A total of 38 sediment samples were collected and used for bioassay analyses. Sample locations are shown on Plates 9 and 10. In the riverine portion of the project area, 28 sediment samples were collected. One sample was collected from approximately each channel range and each channel bend between the Beckett Street Terminal and Artificial Island. In Delaware Bay, an additional 10 sediment samples were collected from the channel in areas that would require dredging. Sediment samples were collected with two types of grab samplers, the PONAR Grab and Wildco-Petersen Grab. Both units are capable of penetrating a minimum of six inches into the bottom substrate. A sufficient quantity of Delaware River water was also collected at six water sample locations to run all analyses.

To assess the potential effects of dredging and disposal activities on water quality, acute water column bioassays were run on the elutriate of all 38 sediment samples, and unfiltered Delaware River water. Procedures followed those outlined in the USEPA/USACE Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (EPA-823-B-94-002). Each sediment sample was combined with unfiltered Delaware River water in a sediment -to- water ratio of 1:4 on a volume basis. The mixture was thoroughly agitated, allowed to settle for one hour, and the supernatant was removed. Two dilutions were prepared from the 100 percent elutriate sample using unfiltered river water, 10 and 5 percent. Subsamples of each dilution, unfiltered river or bay water and laboratory control water were analyzed for total suspended solids. Table 4-25 provides pertinent sediment quality data for sediment samples including the percentage of silt/clay, the concentration of organic carbon (TOC), and the concentration of suspended sediment (SS) in the 100 percent elutriate sample. The concentrations of suspended sediment in Delaware River water samples are also provided. The water sample used to prepare the sediment elutriates is listed before the sediment samples.

The water column bioassays consisted of two controls, laboratory

Table 4-25. Sediment Quality Data for Delaware River Channel Sediment Samples Collected for Bioassay Testing.

Sediment Sample Location	Percent Silt/Clay	TOC (mg/kg)	SS Conc. 100% Elut. (mg/l)
Laboratory Water	-	-	9
Mifflin Range Water	-	-	14
Beckett St. Terminal	34.7	7000	1530
Range M	44.1	7000	308
Bend AF	31.8	4000	408
W. Horseshoe Range	0.2	580	28
Bend G	23.4	3100	434
Mifflin Range	14.8	2000	372
Bend H	57.7	8000	1840
Billingsport Range	14.2	5000	1310
Chester Range Water	-	-	4
Bend I	11.0	650	231
Tinicum Range	59.9	3800	131
Bend J	0.2	5000	37
Eddystone Range	0.4	540	156
Bend K	42.9	3000	592
Bend L	28.1	3000	406
Bellevue Range Water	-	-	13
Marcus Hook Range	97.2	5000	102
Bend M	96.2	4000	28
Bellevue Range	36.4	5000	31
Bend N	82.7	4000	324
Deepwater Range Water	-	-	23
Cherry Island Range	66.5	2100	30
Bend O	95.1	4500	29
Deepwater Range	82.5	4800	138
Bend PQ	0.6	900	171
New Castle Range	60.6	3000	276
Bend R	87.4	5000	414
Baker Range Water	-	-	18
Reedy Island Range	8.0	1200	166
Bend S	17.1	1400	144
Baker Range	97.4	2600	210
Bend T	24.4	1500	209
Delaware Bay #1	97.2	4000	839
Miah Maull Range Water	-	-	42
Delaware Bay #2	0.4	400	326
Delaware Bay #3	0.7	230	161
Delaware Bay #4	8.9	900	84
Delaware Bay #5	59.9	4000	88
Delaware Bay #6	5.1	1500	123
Delaware Bay #7	0.5	500	129
Delaware Bay #8	0.3	200	286
Delaware Bay #9	0.4	330	259
Delaware Bay #10	2.3	1400	265

water and unfiltered river or bay water, and each of the three dilutions (ie. 100, 10 and 5 percent). Five replicates of each dilution and the controls were set up for each of three test species. Ten organisms were tested in each replicate sample. Each test was run for a duration of 48 hours.

For the 28 riverine samples, test species were the fathead minnow (Pimephales promelas), a water flea (Ceriodaphnia dubia) and an amphipod (Hyalella azteca). All organisms were obtained from Aquatic Research Organisms (ARO), a commercial laboratory located in Hampton, New Hampshire. The minnows were hatched the morning prior to test initiation, and were approximately 24 hours old. Stock cultures of adult C. dubia were obtained to yield enough neonates for testing the day of arrival. Juvenile H. azteca were originally obtained from the U.S. Fish and Wildlife Service. The amphipods were acclimated to laboratory conditions for two days prior to test initiation, and were approximately eight days old at the start of the test.

For the 10 Delaware Bay samples, test species were the sheepshead minnow (Cyprinodon variegatus), the American oyster (Crassostrea virginica) and a mysid shrimp (Mysidopsis bahia). Juvenile sheepshead minnow were obtained from ARO, and acclimated to test salinity and laboratory conditions for one day prior to test initiation. Larval mysid shrimp were approximately 4 days old prior to test initiation. Adult oysters in spawning condition were obtained and induced to spawn. Fertilized embryos were used to initiate tests approximately two hours after fertilization.

After 48 hours of exposure, 100 percent survival was recorded for all six species at all test concentrations, and in both the lab water and water controls. With no mortality observed, statistical evaluation of the data was unnecessary.

In Delaware Bay, dredged material would be placed in open water for beneficial uses, as previously discussed. Acute whole sediment bioassays were run to assess the potential sediment quality impacts to benthic organisms that would reside at the site after placement. The 10 Delaware Bay sediment samples were tested. Procedures again followed those outlined in the USEPA/USACE testing manual. Sediment samples were initially gross sieved using a 1.00 mm stainless steel sieve to remove larger material, macroinvertebrates, and interstitial water. Each sample was then thoroughly homogenized, placed into test containers, and allowed to settle for 24 hours before test organisms were introduced.

Test species included an infaunal amphipod (Ampelisca abdita), a burrowing polychaete (Nereis virens) and a bivalve mollusc (Mercenaria mercenaria). Immature A. abdita were field collected by East Coast Amphipod, a commercial laboratory located in Kingston, Rhode Island. The amphipods were collected in Fishing Cove, Wickford Harbor. The organisms were sieved using a 0.5 mm mesh, and randomly distributed into test containers. The amphipods were of approximately uniform size at test initiation, with a size range of two to four mm. N. virens were field collected in Maine by ARO. The worms were of approximately uniform size at test initiation, with an average length of 6.3 cm. M. mercenaria were collected from southern Chesapeake Bay. The clams were of approximately uniform size at test initiation, with an average hinge length of two to four cm.

The tests consisted of a control sediment, reference sediment, and each of the 10 Delaware Bay channel sediment samples. The control sediment was collected at the same time the test organisms were collected. The reference sediment was collected from proposed Delaware Bay beneficial use sites (Plate 10), and represent conditions that currently exist at these locations. Five replicate samples were run for each species per test; 20 amphipods and polychaetes, and 10 molluscs were tested in each replicate sample. The tests were run for a period of 10 days. After 10 days of exposure, 100 percent survival was recorded for all three species in all test, reference, and control sediment. Statistical evaluation was unnecessary due to the absence of mortality.

4.4.2 Bioaccumulation Testing

Bioaccumulation tests were also run with Delaware Bay sediment to evaluate the potential for bioaccumulation of contaminants by aquatic organisms that would reside in the sediment after placement in the beneficial use sites. It was not necessary to evaluate the bioaccumulation potential of up-river channel sediments, as this material would be removed from the aquatic environment, thus precluding contaminant accumulation in aquatic resources. Two separate bioaccumulation tests were run. See Plate 11 for sediment sample locations. In 1993, five of the 10 Delaware Bay sediment samples collected for bioassays were tested. The five Delaware Bay samples with the highest percentage of fine grain silts and clays were used (Delaware Bay #1, 4, 5, 6 and 10), as fine grain sediment has a greater potential to retain contaminants than coarse grain sands. Again, sediment samples collected from candidate beneficial use sites were used as reference sediment to represent existing conditions at these locations. The bivalve mollusc Mercenaria mercenaria was used as the test organism. The clams were of approximately uniform size at test initiation, with an average hinge length of two to four cm.

Sediment samples were initially gross sieved using a 1.00 mm stainless steel sieve to remove large organic material, macroinvertebrates, and interstitial water. Each sample was then homogenized, placed into test containers, and allowed to settle for 24 hours. M. mercenaria were exposed to approximately three cm of sediment for 28 days. Five replicate test chambers (10 clams per replicate) were prepared for each sediment sample. Test animals were not fed during the test. Clams that died during the test period were removed and discarded daily. After

28 days, surviving individuals were placed in clean, sediment-free water for 24 hours to purge their digestive tracts. The clams were not fed during this purging period. Fecal material was siphoned from the purging chamber twice during the 24-hour period. After the purging period, clam tissue was removed from the shell, combined among replicates for each sediment sample, homogenized, and analyzed for heavy metals, pesticides, PCBs, and PAHs (Table 4-1).

Clam mortality was observed during the final stages of testing, possibly due to starvation since the specimens were not fed during testing. Upon examination at the conclusion of the test, even the live clams appeared flaccid and emaciated. Due to the degree of mortality, live clams from all five replicates were pooled for each test sediment, to provide sufficient tissue for chemical analysis. Pesticides, PCBs, and PAHs were not detected in any of the tissue samples from clams exposed to Delaware Bay channel sediment, or sediment from candidate beneficial use sites. Of the 12 metals, seven were found in quantifiable concentrations in one or more samples (Table 4-26).

Copper, selenium and zinc were the only metals detected in clam tissue exposed to Delaware Bay channel sediment. Zinc was detected in all five tissue samples from clams exposed to channel sediments, with a concentration range of 10.3 to 11.8 mg/kg. Zinc was also detected in all tissue samples from clams exposed to beneficial use site and control sediments, with a concentration range of 12.1 to 16.0 mg/kg. Since zinc concentrations in clams exposed to channel sediments were consistently lower than concentrations in clams exposed to beneficial use site and control sediments, bioaccumulation of zinc is not a concern with regard to placement of Delaware Bay channel sediment at beneficial use site locations.

Copper was also detected in all clam tissue samples exposed to channel, beneficial use site and control sediments. Copper concentrations in channel samples ranged between 1.39 and 1.91 mg/kg. Concentrations in beneficial use site and control samples ranged between 1.64 and 2.34 mg/kg. These ranges are similar, and placement of channel sediment at beneficial use site locations would not be expected to result in any increased bioaccumulation of copper in marine benthic organisms. These concentrations are also below the 2.9 to 5.5 mg/kg copper range reported by Murphy (1990) for hard shell clam tissue collected from Chincoteague Bay, Maryland. Although copper has a high bioaccumulation tendency in marine shellfish and crustaceans, it constitutes a relatively low human health hazard (USEPA, 1978).

Selenium was detected in two of the five tissue samples from clams exposed to channel sediment, at concentrations of 0.256 and 0.342 mg/kg. Selenium was not detected in clams exposed to beneficial use site sediments, but was detected in the control sediment at a concentration of 0.454 mg/kg. Selenium concentrations in clam tissue were at the lower end of the range

Table 4-26. Metal Concentrations (mg/kg - wet weight) of *Mercenaria mercenaria* Tissue from 28-Day Bioaccumulation Tests of Delaware Bay Channel and Beneficial Use Site Sediments.

Sediment Sample	Arsenic	Chromium	Copper	Lead	Mercury	Selenium	Zinc
Channel Sediment							
DB#1	<0.2	<1.00	1.39	<2.00	<0.07	0.342	10.5
DB#4	<0.2	<1.00	1.85	<2.00	<0.07	<0.200	11.8
DB#5	<0.2	<1.00	1.73	<2.00	<0.07	0.256	10.3
DB#6	<0.2	<1.00	1.91	<2.00	<0.07	<0.200	11.2
DB#10	<0.2	<1.00	1.82	<2.00	<0.07	<0.200	11.8
Beneficial Use Site Sediment							
BUS#2	<0.2	1.04	1.76	<2.00	0.47	<0.200	12.7
BUS#3	<0.2	<1.00	1.95	<2.00	<0.07	<0.200	15.5
BUS#5	0.4	1.16	1.64	<2.00	<0.07	<0.200	12.1
BUS#6	<0.2	1.02	2.31	2.42	<0.07	<0.200	16.0
Control Sediment							
Control	0.5	<1.00	2.34	<2.00	<0.07	0.454	13.2

reported for "bivalve" molluscs (0.1 to 0.9 mg/kg) as a human food source reported by the FDA (1982a and 1982b). Selenium also tends to have a low bioaccumulation tendency in marine shellfish or crustaceans, and presents a low hazard to humans relative to other metals such as mercury and lead (USEPA, 1978).

Arsenic, chromium, lead and mercury were also detected in one or more clam tissue samples. However, these detections were in samples exposed to beneficial use site or control sediments. As such, placement of channel sediments at beneficial use site locations is not a concern with regard to bioaccumulation of these metals. Overall, there was no evidence that contaminants accumulated in clam tissue exposed to Delaware Bay sediment at greater concentrations than clam tissue exposed to clean control sediment. All of the tissue residues were representative of what one would expect in organisms exposed to uncontaminated material.

In 1994, two additional samples of channel sediment were collected from areas containing fine grained material. Two reference sediment samples collected at candidate beneficial use sites LC9 and LC10, and a control sediment were also obtained for analysis. The burrowing polychaete Nereis virens was used as the test organism. The control sediment was obtained in Maine, where the worms were collected. Sediment samples were collected with a PONAR Grab sampler, sufficiently weighted to penetrate bottom sediments to a depth of six inches. Five replicates of each sediment were tested. Twenty individual worms were used in each test replicate, all approximately 8 to 12 cms in length. The worms were not fed during the 28-day test period. At the end of the 28-day period, all dead worms were discarded, living worms were purged in clean water, and the worms in each test replicate were pooled and analyzed for heavy metals, pesticides, PCBs, and PAHs (Table 4-1).

Again, pesticides, PCBs and PAHs were not detected in any of the worm tissue samples. The metals arsenic, chromium, copper, lead and zinc were the only parameters measured above detection levels in some or all of the 25 replicate tissue samples. Table 4-27 presents the mean concentrations of these metals for each test sediment.

With replicate data available for each of the test sediments, it was possible to statistically evaluate the concentration differences of the five metals between channel, beneficial use site and control sediments. The data for arsenic, copper and zinc met all parametric distributional assumptions. Therefore, the navigation channel sediments were compared to the reference sediments using ANOVA and Dunnett's Multiple Comparison procedure. Since the data for chromium and lead did not meet the distributional assumption of variance homogeneity, the nonparametric Steel's Many-One Rank test was used for comparison. There were no statistical differences between metal content in worms exposed to channel sediments and worms exposed to reference sediments, with the exception of arsenic. The mean arsenic

Table 4-27. Mean Metal Concentrations (mg/kg - wet weight) of *Neresis virens* Tissue from 28-Day Bioaccumulation Tests of Delaware Bay Channel and Beneficial Use Site Sediments.

Sediment Sample	Arsenic	Chromium	Copper	Lead	Zinc
Channel Sediment					
Channel 1	0.380	0.200	2.308	0.200	32.44
Channel 2	0.700	0.266	2.736	0.300	30.48
Beneficial Use Site Sediment					
LC9	0.360	0.339	2.864	0.440	24.50
LC10	0.460	0.300	2.886	0.280	32.72
Control Sediment					
Control	0.680	0.834	3.742	1.900	33.30

concentration in worms exposed to one channel sediment sample (0.700 mg/kg) was statistically significantly higher ($p=0.05$) than concentrations in worms exposed to beneficial use site sediment samples (0.360 and 0.460 mg/kg). The measured tissue concentration of arsenic in worms exposed to the channel sediment did not appear to be deleterious. No more mortality was observed in the channel sediment test worms than in worms exposed to other sediments. Furthermore, a mean tissue concentration of arsenic in worms exposed to the control sediment (0.680 mg/kg), which was obtained in Maine where the worms were collected, was virtually identical to that measured for the channel sediment worms (0.700 mg/kg). Both of these values are well below the range of acceptable background tissue arsenic concentrations for test organisms from East Coast sites, which is reported to be 1.5 to 3.9 mg/kg in the USEPA Guidance Manual for Bedded Sediment Bioaccumulation Tests (EPA-600-R-93-183). Overall, these test results suggest that open water placement of Bay sediment is acceptable with regard to bioaccumulation concerns.

4.5 Bulk Sediment Analyses at Associated Berthing Areas

An associated feature of the main channel deepening project is the deepening of berthing areas used for docking ships at the various industrial facilities and port terminals along the Delaware River. These berths are currently maintained at a depth that accommodates ships loaded with cargo for transiting the 40-foot channel. With deepening to 45 feet, ships would be more fully loaded to take advantage of the increased channel depth. Berthing areas would also require deepening to allow the ships to dock and load or unload cargo.

To examine sediment quality within these berthing areas a series of 16 sediment cores were collected at seven different industrial facilities and port terminals. These facilities were Beckett Street Terminal, Packer Avenue Terminal, Conrail, Sun Oil Refinery - Fort Mifflin, Sun Oil Refinery - Hog Island, Tosco Refinery, and Sun Oil Refinery - Marcus Hook (Figure 4-1). Vibrocoring equipment was used to collect the sediment cores, similar to the technique used in the main channel. Cores were divided into 35 separate samples based on observed sediment stratification, and all samples were tested for the chemical parameter list provided as Table 4-1.

Tables 4-28 through 4-32 provide a data summary for the contaminants that were detected in the various berthing locations. The Sun Oil refineries are abbreviated on these tables to identify the location of the facility (ie. Fort Mifflin - FM, Hog Island - HI, and Marcus Hook - MH). These tables provide the mean concentration of the contaminants detected at each facility, the number of actual detections, and the detection range. All 35 samples from all seven facilities were also combined to provide an overall mean concentration and detection range. This data presentation is comparable to the bulk summary data provided for the main channel. Refer to the previous

DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT

Berth Facilities Sediment Sampling Locations

U.S. Army Corps of Engineers, Philadelphia District

Figure 4-1

Table 4-28. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Antimony					
Mean Concentration	1.24	0.55	2.50	1.44	1.07
# of Detections	4	4	4	6	2
Detection Range	0.57-1.6	0.38-0.98	0.59-5.3	0.73-3.0	2.0-2.4
Arsenic					
Mean Concentration	10.9	1.64	9.43	6.69	9.07
# of Detections	4	4	5	8	6
Detection Range	0.54-14.8	0.59-4.10	0.97-19.5	0.82-14.2	3.2-25.2
Beryllium					
Mean Concentration	0.10	0.29	0.40	0.30	0.07
# of Detections	1	3	3	5	2
Detection Range	0.31	0.15-0.73	0.16-0.78	0.14-0.69	0.05-0.25
Cadmium					
Mean Concentration	1.19	0.09	3.21	1.68	1.00
# of Detections	4	3	5	7	6
Detection Range	0.05-2.0	0.04-0.15	0.08-8.0	0.05-5.2	0.06-3.2
Chromium					
Mean Concentration	55.98	16.18	73.56	48.25	54.82
# of Detections	4	4	5	8	6
Detection Range	26.2-71.0	3.6-32.8	7.5-197	6.0-128	16.0-169
Copper					
Mean Concentration	46.28	5.43	70.28	41.61	28.20
# of Detections	4	4	5	8	6
Detection Range	11.8-65.7	3.4-6.8	2.3-165	1.9-104	4.2-97.0
Lead					
Mean Concentration	57.1	4.35	88.02	49.70	39.12
# of Detections	4	4	5	8	6
Detection Range	6.8-79.8	1.3-7.3	2.8-205	2.9-154	4.4-140

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-28. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted Wi[th] Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Antimony			
Mean Concentration	1.18	0.61	1.21
# of Detections	3	3	26
Detection Range	0.7-1.9	0.52-0.96	0.38-5.3
Arsenic			
Mean Concentration	8.70	3.78	7.29
# of Detections	4	4	35
Detection Range	1.10-14.9	1.4-6.4	0.54-25.2
Beryllium			
Mean Concentration	0.04	0.02	0.18
# of Detections	1	ND	15
Detection Range	0.05	-	0.05-0.78
Cadmium			
Mean Concentration	1.51	0.17	1.35
# of Detections	3	3	31
Detection Range	0.11-3.0	0.09-0.39	0.04-8.0
Chromium			
Mean Concentration	59.35	22.25	48.51
# of Detections	4	4	35
Detection Range	5.0-114	9.1-37.8	3.6-197
Copper			
Mean Concentration	40.05	15.73	36.67
# of Detections	4	4	35
Detection Range	1.2-78.8	8.0-24.7	1.2-165
Lead			
Mean Concentration	53.60	10.20	44.95
# of Detections	4	4	35
Detection Range	1.8-110	1.6-22.8	1.3-205

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-28. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Mercury					
Mean Concentration	0.32	0.12	0.42	0.27	0.29
# of Detections	3	ND	3	3	1
Detection Range	0.33-0.46	-	0.39-0.85	0.39-0.55	0.97
Nickel					
Mean Concentration	29.65	4.86	26.26	20.14	18.98
# of Detections	4	4	5	8	6
Detection Range	18.9-37.2	0.12-11.9	4.7-47.2	4.7-32.7	10.7-34.9
Selenium					
Mean Concentration	1.21	0.31	1.65	0.81	0.72
# of Detections	3	1	5	6	4
Detection Range	1.2-2.0	0.51	0.31-2.5	0.45-1.3	0.32-2.2
Silver					
Mean Concentration	1.31	0.07	2.12	1.12	1.03
# of Detections	4	2	4	6	5
Detection Range	0.15-2.30	0.06-0.10	0.11-4.4	0.12-3.0	0.19-3.5
Thallium					
Mean Concentration	2.05	0.47	1.58	1.25	1.26
# of Detections	4	1	3	6	6
Detection Range	0.79-2.7	0.80	1.6-3.1	0.89-2.2	0.62-2.2
Zinc					
Mean Concentration	222.0	18.70	356.5	189.3	123.8
# of Detections	4	4	5	8	6
Detection Range	42.1-319	2.0-44.5	16.7-817	18.1-467	30.3-337

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-28. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted With Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Mercury			
Mean Concentration	0.36	0.13	0.28
# of Detections	2	ND	12
Detection Range	0.52-0.64	-	0.33-0.97
Nickel			
Mean Concentration	20.98	14.43	19.60
# of Detections	4	4	35
Detection Range	3.9-34.6	7.7-21.8	0.12-47.2
Selenium			
Mean Concentration	0.73	0.24	0.78
# of Detections	3	ND	22
Detection Range	0.37-1.3	-	0.31-2.5
Silver			
Mean Concentration	1.26	0.13	1.05
# of Detections	3	2	26
Detection Range	0.16-2.8	0.09-0.30	0.06-4.4
Thallium			
Mean Concentration	1.48	0.88	1.28
# of Detections	4	4	28
Detection Range	0.60-2.6	0.59-1.3	0.59-3.1
Zinc			
Mean Concentration	192.9	46.68	170.3
# of Detections	4	4	35
Detection Range	9.6-380	22.2-98.6	2.0-817

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-28. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Barium					
Mean Concentration	135.1	18.78	182.5	101.0	78.28
# of Detections	4	4	5	8	6
Detection Range	98.2-159	6.5-47.3	15.6-258	11.2-180	40.8-160
Vanadium					
Mean Concentration	47.68	24.48	70.38	31.88	43.05
# of Detections	4	4	5	8	6
Detection Range	29.2-58.3	8.2-63.5	6.3-158	5.3-66.7	16.2-123

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-28. Heavy Metal Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Concluded.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Barium			
Mean Concentration	101.6	69.90	94.53
# of Detections	4	4	35
Detection Range	14.0-184	43.1-104	6.5-258
Vanadium			
Mean Concentration	49.45	32.05	40.27
# of Detections	4	4	35
Detection Range	5.9-87.0	24.6-44.8	5.3-158

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.

Table 4-29. PAH Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Acenapthene					
Mean Concentration	0.65	0.33	1.19	1.03	0.47
# of Detections	ND	1 (1J)	ND	2 (1J)	1 (J)
Detection Range	-	0.14	-	1.6-1.7	0.10
Naphthalene					
Mean Concentration	0.65	0.32	0.93	0.75	0.47
# of Detections	ND	1 (1J)	2 (2J)	ND	1 (1J)
Detection Range	-	0.04	0.07-0.11	-	0.09
Acenaphthylene					
Mean Concentration	0.65	0.31	1.19	0.75	0.53
# of Detections	ND	1 (1J)	ND	ND	ND
Detection Range	-	0.07	-	-	-
Anthracene					
Mean Concentration	0.65	0.35	0.95	0.58	0.38
# of Detections	ND	1 (1J)	2 (2J)	2 (2J)	2 (2J)
Detection Range	-	0.22	0.11-0.14	0.15-0.16	0.09-0.16
Benzo(a)pyrene					
Mean Concentration	0.18	0.36	0.33	0.31	0.29
# of Detections	3 (3J)	2 (1J)	4 (4J)	6 (5J)	5 (4J)
Detection Range	0.10-0.13	0.04-0.62	0.14-0.46	0.04-0.50	0.14-0.50
Benzo(b)fluoranthene					
Mean Concentration	0.20	0.40	0.43	0.40	0.46
# of Detections	3 (3J)	1 (1J)	3 (3J)	5 (4J)	2 (1J)
Detection Range	0.12-0.14	0.41	0.36-0.50	0.06-0.56	0.22-0.51
Benzo(k)fluoranthene					
Mean Concentration	0.19	0.41	0.19	0.32	0.44
# of Detections	3 (3J)	1	2 (2J)	5 (5J)	2 (2J)
Detection Range	0.10-0.16	0.45	0.34-0.57	0.04-0.36	0.20-0.36

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-29. PAH Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Acenapthene			
Mean Concentration	0.56	0.43	0.70
# of Detections	ND	ND	4 (3J)
Detection Range	-	-	0.10-1.70
Naphthalene			
Mean Concentration	0.42	0.43	0.59
# of Detections	1 (1J)	ND	5 (5J)
Detection Range	0.09	-	0.04-0.11
Acenaphthylene			
Mean Concentration	0.56	0.43	0.64
# of Detections	ND	ND	1 (1J)
Detection Range	-	-	0.07
Anthracene			
Mean Concentration	0.42	0.43	0.52
# of Detections	1 (1J)	ND	8 (8J)
Detection Range	0.07	-	0.07-0.22
Benzo(a)pyrene			
Mean Concentration	0.16	0.43	0.30
# of Detections	4 (4J)	ND	24 (21J)
Detection Range	0.05-0.30	-	0.04-0.62
Benzo(b)fluoranthene			
Mean Concentration	0.30	0.43	0.38
# of Detections	2 (2J)	ND	16 (14J)
Detection Range	0.10-0.21	-	0.06-0.56
Benzo(k)fluoranthene			
Mean Concentration	0.31	0.43	0.45
# of Detections	2 (2J)	ND	15 (14J)
Detection Range	0.12-0.20	-	0.04-0.57

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-29. PAH Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Chrysene					
Mean Concentration	0.21	0.45	0.47	0.39	0.51
# of Detections	3 (3J)	1	3 (3J)	5 (4J)	2 (1J)
Detection Range	0.12-0.18	0.62	0.42-0.54	0.04-0.61	0.42-0.61
Phenanthrene					
Mean Concentration	0.18	0.60	1.05	0.37	0.47
# of Detections	3 (3J)	1	2 (2J)	4 (4J)	2 (1J)
Detection Range	0.08-0.15	1.20	0.35-0.43	0.09-0.48	0.18-0.58
Fluorene					
Mean Concentration	0.65	0.33	1.19	0.75	0.53
# of Detections	ND	1 (1J)	ND	ND	ND
Detection Range	-	0.15	-	-	-
Fluoranthene					
Mean Concentration	0.25	0.70	0.64	0.53	0.54
# of Detections	3 (3J)	1	3 (1J)	5 (4J)	2 (1J)
Detection Range	0.17-0.23	1.60	0.70-0.88	0.08-0.92	0.24-0.92
Benzo(a)anthracene					
Mean Concentration	0.17	0.46	0.40	0.39	0.47
# of Detections	3 (3J)	1	3 (3J)	4 (3J)	2 (1J)
Detection Range	0.08-0.12	0.65	0.32-0.40	0.21-0.50	0.25-0.50
Benzo(ghi)perylene					
Mean Concentration	0.65	0.35	0.97	0.48	0.48
# of Detections	ND	1 (1J)	2 (2J)	2 (2J)	1 (1J)
Detection Range	-	0.20	0.14-0.20	0.13-0.15	0.13

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-29. PAH Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Chrysene			
Mean Concentration	0.32	0.43	0.41
# of Detections	2 (2J)	ND	16 (13J)
Detection Range	0.11-0.27	-	0.04-0.62
Phenanthrene			
Mean Concentration	0.30	0.43	0.49
# of Detections	2 (2J)	ND	14 (12J)
Detection Range	0.09-0.21	-	0.08-1.20
Fluorene			
Mean Concentration	0.56	0.43	0.64
# of Detections	ND	ND	1 (1J)
Detection Range	-	-	0.15
Fluoranthene			
Mean Concentration	0.35	0.31	0.49
# of Detections	2 (2J)	1 (1J)	17 (12J)
Detection Range	0.14-0.36	0.08	0.08-1.60
Benzo(a)anthracene			
Mean Concentration	0.30	0.43	0.37
# of Detections	2 (2J)	ND	15 (12J)
Detection Range	0.09-0.21	-	0.08-0.65
Benzo(ghi)perylene			
Mean Concentration	0.56	0.43	0.55
# of Detections	ND	ND	6 (6J)
Detection Range	-	-	0.13-0.20

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-29. PAH Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Ideno(123-cd)pyrene					
Mean Concentration	0.65	0.35	0.95	0.43	0.48
# of Detections	ND	1 (1J)	2 (2J)	3 (3J)	1 (1J)
Detection Range	-	0.23	0.10-0.16	0.12-0.14	0.14
Pyrene					
Mean Concentration	0.26	0.54	0.63	0.88	0.52
# of Detections	3 (3J)	2 (1J)	3 (2J)	6 (4J)	2 (1J)
Detection Range	0.18-0.26	0.04-1.30	0.72-0.82	0.07-2.30	0.30-0.77

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-29. PAH Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Concluded.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Ideno(123-cd)pyrene			
Mean Concentration	0.56	0.43	0.54
# of Detections	ND	ND	7 (7J)
Detection Range	-	-	0.10-0.23
Pyrene			
Mean Concentration	0.36	0.31	0.55
# of Detections	2 (2J)	1 (1J)	19 (14J)
Detection Range	0.16-0.38	0.08	0.04-2.30

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-30. Pesticide and PCB Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
4,4'-DDE					
Mean Concentration	0.05	0.02	0.05	0.06	0.08
# of Detections	2 (2J)	ND	3 (2J)	3 (2J)	2
Detection Range	0.04-0.05	-	0.07-0.08	0.07-0.15	0.12-0.26
4,4'-DDD					
Mean Concentration	0.06	0.02	0.06	0.05	0.04
# of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
4,4'-DDT					
Mean Concentration	0.06	0.02	0.06	0.05	0.04
# of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
Endrin					
Mean Concentration	0.06	0.02	0.06	0.05	0.03
# of Detections	ND	ND	ND	ND	1 (1J)
Detection Range	-	-	-	-	0.03
PCB Aroclor 1254					
Mean Concentration	0.12	0.12	0.24	0.24	0.20
# of Detections	3 (3J)	ND	2 (2J)	1 (1J)	2 (1J)
Detection Range	0.10-0.15	-	0.14-0.31	0.19	0.16-0.55

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-30. Pesticide and PCB Data Summary of Bulk Sediment Sample Analyses Conduct[ed] Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Concluded.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
4,4'-DDE			
Mean Concentration	0.05	0.03	0.05
# of Detections	2	ND	12 (6J)
Detection Range	0.08	-	0.04-0.26
4,4'-DDD			
Mean Concentration	0.04	0.03	0.04
# of Detections	ND	2 (1J)	2 (1J)
Detection Range	-	0.02-0.05	0.02-0.05
4,4'-DDT			
Mean Concentration	0.04	0.17	0.06
# of Detections	ND	1	1
Detection Range	-	0.57	0.57
Endrin			
Mean Concentration	0.04	0.03	0.04
# of Detections	ND	ND	1 (1J)
Detection Range	-	-	0.03
PCB Aroclor 1254			
Mean Concentration	0.16	0.14	0.19
# of Detections	2 (2J)	ND	10 (9J)
Detection Range	0.21-0.23	-	0.10-0.55

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-31. Semi-Volatile Organic Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Di-n-butyl phthalate					
Mean Concentration	0.20	0.40	0.96	0.75	0.30
# of Detections	3 (3J)	ND	2 (2J)	ND	3 (3J)
Detection Range	0.11-0.16	-	0.09-0.24	-	0.06-0.10
Bis(2-ethylhexyl) phthalate					
Mean Concentration	0.83	0.24	2.63	1.18	0.74
# of Detections	4 (1J)	2 (2J)	5 (2J)	5 (2J)	4 (2J)
Detection Range	0.48-1.30	0.05-0.09	0.06-4.70	0.11-3.20	0.06-1.70
Di-n-octyl phthalate					
Mean Concentration	0.65	0.40	1.05	0.75	0.53
# of Detections	ND	ND	1 (1J)	ND	ND
Detection Range	-	-	0.15	-	-
1,4-Dichlorobenzene					
Mean Concentration	0.65	0.40	1.19	1.02	0.53
# of Detections	ND	ND	ND	2	ND
Detection Range	-	-	-	1.40-1.80	-
1,2,4-Trichlorobenzene					
Mean Concentration	0.65	0.40	1.19	1.00	0.53
# of Detections	ND	ND	ND	2	ND
Detection Range	-	-	-	1.40-1.60	-
4-Chloroaniline					
Mean Concentration	0.65	0.40	1.19	0.75	0.53
# of Detections	ND	ND	ND	ND	ND
Detection Range	-	-	-	-	-
2,4-Dinitrotoluene					
Mean Concentration	0.65	0.40	1.19	1.08	0.53
# of Detections	ND	ND	ND	2	ND
Detection Range	-	-	-	1.80-1.90	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-31. Semi-Volatile Organic Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Di-n-butyl phthalate			
Mean Concentration	0.28	0.06	0.47
# of Detections	2 (2J)	4 (4J)	14 (14J)
Detection Range	0.08-0.13	0.05-0.11	0.05-0.24
Bis(2-ethylhexyl) phthalate			
Mean Concentration	1.00	0.37	1.05
# of Detections	3 (1J)	4 (2J)	27 (12J)
Detection Range	0.05-2.60	0.20-0.60	0.05-4.70
Di-n-octyl phthalate			
Mean Concentration	0.56	0.43	0.64
# of Detections	ND	ND	1 (1J)
Detection Range	-	-	0.15
1,4-Dichlorobenzene			
Mean Concentration	0.56	0.43	0.73
# of Detections	ND	ND	2
Detection Range	-	-	1.40-1.80
1,2,4-Trichlorobenzene			
Mean Concentration	0.56	0.43	0.72
# of Detections	ND	ND	2
Detection Range	-	-	1.40-1.60
4-Chloroaniline			
Mean Concentration	0.42	0.43	0.65
# of Detections	1 (J)	ND	1 (1J)
Detection Range	0.10	-	0.10
2,4-Dinitrotoluene			
Mean Concentration	0.56	0.43	0.73
# of Detections	ND	ND	2
Detection Range	-	-	1.80-1.90

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-31. Semi-Volatile Organic Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Continued.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Phenol					
Mean Concentration	0.65	0.40	1.19	1.31	0.53
# of Detections	ND	ND	ND	3 (1J)	ND
Detection Range	-	-	-	0.10-3.10	-
Pentachlorophenol					
Mean Concentration	3.23	2.03	5.96	4.06	2.68
# of Detections	ND	ND	ND	2	ND
Detection Range	-	-	-	3.50-3.90	-
2-Chlorophenol					
Mean Concentration	0.65	0.40	1.19	1.26	0.53
# of Detections	ND	ND	ND	2	ND
Detection Range	-	-	-	2.20-2.90	-
4-Methylphenol					
Mean Concentration	0.33	0.40	0.63	0.63	0.44
# of Detections	2 (2J)	ND	3 (3J)	1 (1J)	1 (1J)
Detection Range	0.08-0.13	-	0.32-1.40	0.16	0.10
4-Chloro-3-methylphenol					
Mean Concentration	0.65	0.40	1.19	1.35	0.53
# of Detections	ND	ND	ND	2	ND
Detection Range	-	-	-	2.90	-
4-Nitrophenol					
Mean Concentration	3.23	2.03	5.96	3.94	2.68
# of Detections	ND	ND	ND	2	ND
Detection Range	-	-	-	3.10-3.30	-
N-Nitroso-di-n-propylamine					
Mean Concentration	0.65	0.40	1.19	0.98	0.53
# of Detections	ND	ND	ND	2	ND
Detection Range	-	-	-	1.40-1.50	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-31. Semi-Volatile Organic Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Concluded.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Phenol			
Mean Concentration	0.56	0.43	0.79
# of Detections	ND	ND	3 (1J)
Detection Range	-	-	0.10-3.10
Pentachlorophenol			
Mean Concentration	2.83	2.13	3.41
# of Detections	ND	ND	2
Detection Range	-	-	3.50-3.90
2-Chlorophenol			
Mean Concentration	0.56	0.43	0.78
# of Detections	ND	ND	2
Detection Range	-	-	2.20-2.90
4-Methylphenol			
Mean Concentration	0.44	0.43	0.49
# of Detections	1 (1J)	ND	8 (8J)
Detection Range	0.15	-	0.08-1.40
4-Chloro-3-methylphenol			
Mean Concentration	0.56	0.43	0.80
# of Detections	ND	ND	2
Detection Range	-	-	2.90
4-Nitrophenol			
Mean Concentration	2.83	2.13	3.38
# of Detections	ND	ND	2
Detection Range	-	-	3.10-3.30
N-Nitroso-di-n-propylamine			
Mean Concentration	0.56	0.43	0.70
# of Detections	ND	ND	2
Detection Range	-	-	1.40-1.50

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-32. Volatile Organic Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel.

Parameter	Tosco	Beckett	Conrail	Packer	Sun FM
Number of Samples	4	4	5	8	6
Methylene Chloride					
Mean Concentration	0.01	0.004	0.01	0.01	0.01
# of Detections	4 (4J)	4 (4J)	3 (3J)	6 (6J)	6 (6J)
Detection Range	0.01	0.003-0.005	0.005-0.01	0.003-0.01	0.003-0.01
Toluene					
Mean Concentration	0.02	0.01	1.35	0.01	0.02
# of Detections	1 (1J)	ND	1	3 (3J)	ND
Detection Range	0.003	-	6.70	0.003-0.01	-
Acetone					
Mean Concentration	0.02	0.01	0.02	0.02	0.02
# of Detections	ND	ND	ND	1	ND
Detection Range	-	-	-	0.04	-
Ethylbenzene					
Mean Concentration	0.02	0.01	0.01	0.02	0.02
# of Detections	ND	ND	1 (1J)	ND	ND
Detection Range	-	-	0.003	-	-
Xylenes					
Mean Concentration	0.02	0.01	0.02	0.02	0.02
# of Detections	ND	ND	1 (1J)	ND	ND
Detection Range	-	-	0.01	-	-

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

Table 4-32. Volatile Organic Data Summary of Bulk Sediment Sample Analyses Conducted Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel. Concluded.

Parameter	Sun HI	Sun MH	ALL
Number of Samples	4	4	35
Methylene Chloride			
Mean Concentration	0.01	0.01	0.01
# of Detections	4 (4J)	4 (3J)	31 (30J)
Detection Range	0.004-0.01	0.01-0.02	0.003-0.02
Toluene			
Mean Concentration	0.01	0.01	0.20
# of Detections	1 (1J)	ND	6 (5J)
Detection Range	0.002	-	0.002-6.70
Acetone			
Mean Concentration	0.02	0.01	0.02
# of Detections	ND	ND	1
Detection Range	-	-	0.04
Ethylbenzene			
Mean Concentration	0.02	0.01	0.02
# of Detections	ND	ND	1 (1J)
Detection Range	-	-	0.003
Xylenes			
Mean Concentration	0.02	0.01	0.02
# of Detections	ND	ND	1 (1J)
Detection Range	-	-	0.01

All concentrations presented in parts per million (mg/kg), dry weight.
ND - Not Detected.
(#J) - Number of detections below quantification limits; concentrations are estimated values.

portion of this section for a discussion of how these tables were derived.

Similar to the data collected from the main channel, the most frequently encountered contaminants were heavy metals and polynuclear aromatic hydrocarbons (PAHs). Concentrations of these contaminants were generally in the range of those found in the main channel. PCB aroclor 1254 and the pesticide 4,4'-DDE were found at all of the facilities except the Beckett Street Terminal and the Sun Oil refinery at Marcus Hook. Concentrations ranged between 0.16 and 0.55 ppm for PCB aroclor 1254, and between 0.12 and 0.26 ppm for 4,4'-DDE. The pesticides 4,4'-DDD and 4,4'-DDT were found at the Sun Oil refinery at Marcus Hook at concentrations ranging between 0.02 and 0.57 ppm. Endrin was the only other pesticide detected. Endrin was detected in one sample collected from the Sun Oil refinery at Fort Mifflin, at a concentration of 0.03 ppm.

Of the semi-volatile organic contaminants, di-n-butyl phthalate and bis(2-ethylhexyl) phthalate were most frequently found, which is also similar to the main channel. These contaminants were found at concentrations ranging between 0.05 and 0.24 ppm, and 0.05 and 4.70 ppm, respectively. The only other semi-volatile organic contaminant frequently detected was 4-methylphenol. This compound was detected at all of the facilities except the Beckett Street Terminal and the Sun Oil refinery at Marcus Hook. Concentrations ranged between 0.08 and 1.40 ppm. Of the volatile organic contaminants, methylene chloride was most frequently detected. Methylene chloride was detected in 31 of the 35 samples at concentrations ranging between 0.003 and 0.02 ppm. As previously stated methylene chloride is commonly used in laboratory analyses, and it is likely that detection of this compound was a byproduct of laboratory testing. Toluene was the only other volatile organic contaminant frequently detected. Toluene was detected in six of the 35 samples at concentrations ranging between 0.002 and 6.70 ppm.

Table 4-33 lists the mean sediment contaminant concentrations within the various port facilities that exceed NJDEP Residential Soil Cleanup Criteria. The contaminants that exceeded these standards at some facilities include the heavy metals cadmium and thallium, the PAH ideno(123-cd)pyrene, and the semi-volatile organic contaminants 2,4-dinitrotoluene and N-nitrosodi-n-propylamine. Mean cadmium concentrations exceeded the NJDEP Residential standard of 1 ppm at the Tosco, Sun Oil - Fort Mifflin and Sun Oil - Hog Island refineries, and the Conrail and Packer Avenue terminals. Mean cadmium concentrations at these facilities ranged between 1.00 and 3.21 ppm. Cadmium concentrations detected in individual sediment samples were similar to those detected in samples from the main channel. Concentrations in samples collected from the port facilities ranged between 0.04 and 8.0 ppm; concentrations in samples collected from the main channel ranged between 0.09 and 5.24 ppm. As discussed with the main channel data, the NJDEP

Table 4-33. Worst Case Mean Concentrations of Sediment Contaminants Within Selected Berthing Areas Along the Delaware River, Philadelphia to the Sea, Federal Navigation Channel that Exceed NJDEP Residential Direct Contact Soil Cleanup Criteria.

Parameter	NJDEP Res. Standard	Mean Facility Sediment Concentrations				
		Tosco	Conrail	Packer	Sun FM	Sun HI
Cadmium	1	1.19	3.21	1.68	1.00	1.51
Thallium	2	2.05				
Ideno(123-cd) pyrene	0.9		0.95			
2,4-Dinitro toluene	1		1.19	1.08		
N-nitrosodi-n-propylamine	0.66		1.19	0.98		

All concentrations in parts per million (mg/kg), dry weight.

NJDEP residential direct contact soil cleanup criteria from: NJDEP. April 1994. Revisions to the soil cleanup criteria. Site Remediation News 6(1): 17-19.

Non-Residential sediment standard for cadmium is 100 ppm. Since the material dredged from the port facilities would be placed in an upland, dredged material disposal site that would not be used for residential development, and since the mean concentration of cadmium is so far below the NJDEP Non-Residential sediment standard of 100 ppm, it can be concluded that the concentration of cadmium in these sediments would not pose any significant human health concerns.

The mean thallium concentration derived from samples collected from berths at the Tosco refinery was 2.05 ppm. This concentration is slightly above both the NJDEP Residential and Non-Residential standards of 2 ppm. Three of the four samples collected at this location had thallium concentrations above 2 ppm (ie. 2.2 - 2.7 ppm). The mean concentrations of thallium at the other six facilities were all below the standard of 2 ppm. The mean concentration of thallium derived from all 35 samples was 1.28 ppm. This slight exceedence at the Tosco refinery berthing area is not expected to result in any significant impacts due to dredging and upland dredged material disposal operations.

The mean concentration of the PAH ideno(123-cd) pyrene at the Conrail facility was 0.95 ppm, which exceeded the NJDEP Residential standard of 0.9 ppm. Of the five sediment samples analyzed from the Conrail berthing area, two samples had ideno(123-cd) pyrene at concentrations of 0.10 and 0.16 ppm. These concentrations are below the Residential standard. One sample had a quantification limit of 3.60 ppm, which was included in the calculation of the mean. This high quantification limit elevated the mean concentration, and is the reason why the Residential standard was exceeded. It is reasonable to assume that the true mean concentration of ideno(123-cd) pyrene at the Conrail facility is below 0.9 ppm. The Non-Residential standard for this contaminant is 4 ppm. This standard was met in all cases.

The semi-volatile organic compounds 2,4-dinitrotoluene and N-nitrosodi-n- propylamine were the only other contaminants that did not meet NJDEP Residential standards at all facilities. The Residential standards for these compounds are 1 and 0.66 ppm, respectively. These standards for both compounds were exceeded at the Conrail and Packer Avenue facilities. Mean concentrations of 2,4-dinitrotoluene at the Conrail and Packer Avenue berthing areas were 1.19 and 1.08 ppm, respectively. Mean concentrations of N-nitrosodi-n-propylamine at the Conrail and Packer Avenue berthing areas were 1.19 and 0.98 ppm, respectively. These compounds were not detected at the Conrail facility. Similar to ideno(123-cd) pyrene, the high quantification limit of 3.60 ppm for one sample at the Conrail site is responsible for elevating the calculated mean concentrations of these compounds above the Residential standards. Again, it is reasonable to assume that the true mean concentrations of these compounds at the Conrail facility are below the Residential standards. At the Packer

Avenue Terminal, both compounds were detected in two of the eight sediment samples analyzed. 2,4-dinitrotoluene was detected at concentrations of 1.80 and 1.90 ppm. N-nitrosodi-n-propylamine was detected at concentrations of 1.40 and 1.50 ppm. Three additional samples had quantification limits above the Residential standards (ie. 1.10, 1.30 and 1.30 ppm). The Non-Residential standards for 2,4-dinitrotoluene and N-nitrosodi-n-propylamine are 4 and 0.66 ppm, respectively. Since these compounds were only detected in two of the 35 sediment samples analyzed, it is not anticipated that any significant environmental impacts would result from dredging and dredged material disposal operations involving sediment from these port facilities.

In conclusion, the bulk sediment data derived from 35 sediment samples collected within seven port facilities along the Delaware River did not significantly differ from data derived from the main navigation channel. Heavy metals and polynuclear aromatic hydrocarbons (PAHs) were the chemical parameters most frequently detected. Concentrations were similar to what is found in the navigation channel, upstream of Delaware Bay. Phthalates were the next most frequently encountered, which was also the case for the navigation channel. Concentrations were again similar. The pesticide 4,4'-DDE and PCB aroclor 1254 were detected more frequently in the berthing areas than the navigation channel. Concentrations of these parameters were low, and no significant adverse environmental impacts are anticipated as a result of dredging and upland dredged material disposal operations. The remaining compounds in the sediments were detected on a limited basis, and at low levels. Overall, these test results suggest that sediments within port facility berthing areas are sufficiently clean to conclude that dredging and upland dredged material disposal operations would not result in any significant environmental impacts.

High Resolution PCB Analyses

The PCB content of Delaware River, Philadelphia to the Sea navigation channel sediments were investigated in 1991, 1992 and 1994; however, the laboratory analyses were based on the traditional Arochlor method of determining PCB content in sediments which had detection limits averaging about 0.21 mg/kg (or 210 ppb) dry weight. Recent advances in PCB analyses have developed state-of-the-art techniques which can detect congener-specific PCBs in parts per billion and coplanar PCBs in parts per trillion. In 1994, the Delaware Estuary Program conducted PCB tests using these high resolution techniques on sediments collected at 16 shallow water stations from areas ranging from Egg Island Point, New Jersey to Neshaminy Creek, Pennsylvania (Arthur D. Little, 1994). This study indicated that PCB contaminants were widespread throughout the estuary and suggested concentrations were highest in upper industrialized portions of the river. In addition, high resolution tissue testing conducted by Greene and Miller (1994) revealed that striped bass contained

PCBs ranging from 0.499 to 2.25 ppm. In an earlier study between the Schuylkill River and Burlington Island the Delaware River Basin Commission (DRBC, 1988, as cited by Greene and Miller, 1994) reported PCB contamination in channel catfish above the FDA limit of 2.0 ppm, and concentrations ranging from 0.1 to 1.4 ppm for white perch. Health advisories on the consumption of channel catfish, all bottom feeding fish, and striped bass have been issued for the estuary. Because of concern over PCB contamination in Delaware estuary sediments and finfish, additional sampling using high resolution PCB analyses were conducted within the Delaware River, Philadelphia to the Sea, Federal navigation channel. The following discussion is taken from the report of the investigation conducted by Versar, Inc. (1997).

PCBs are a class of synthetic organic compounds used primarily in the electronic industry. The class is comprised of 209 individual compounds, more commonly referred to as congeners. Individual congeners are identified by the number and position of insertion of chlorine atoms on a biphenyl group. The biphenyl group is a framework for the PCB molecule and is comprised of two linked benzene rings. PCBs are extremely stable compounds, and degrade slowly in the environment. Microbial decomposition of PCBs occurs in natural environments, but the rate depends on the degree of chlorination and the position of the atoms on the biphenyl molecule. PCBs with four or fewer chlorine atoms decompose at a greater rate than those with more atoms. PCBs have very low solubilities in water, and in natural conditions, they typically adsorb to suspended particles or in bottom sediments. Adsorption rates among PCB congeners increase with the degree of chlorination. Most of the PCBs used in industry are termed Arochlor groups. Arochlor groups are identified by a four digit number that defines their composition. The first two digits identify the Arochlor as a mixture of PCBs and the last two digits express the percentage of chlorine content by weight. For example, Arochlor 1260 is a PCB mixture with an average chlorine content of 60 percent.

The toxicity of PCBs is directly related to the reactivity of the chlorine atoms inserted on the biphenyl group. The reactivity of the atoms is determined by their position on the two benzene rings. Chlorine atoms in the outer portions of the rings (e.g., meta and para positions) are more reactive, and thus more toxic than those in the inner part. The inner positions are closer to the bond that joins the two benzene rings, which limits their reactivity. Another factor that determines PCB toxicity is molecular geometry. Current research indicates that non-ortho substituted coplanar congeners, where both benzene rings basically lie in the same plane, are the most toxic forms of PCB. The toxicity of PCB coplanar congeners is generally regarded as comparable to that of dioxin.

For this investigation, sediment samples were collected at 15 sites ranging from 10 miles north of Cape May, New Jersey to

Penn's Landing, Philadelphia, Pennsylvania. Samples were collected the first week of October 1996. Sediment sample locations are shown on Figure 4-2. All collections were conducted in the navigation channel. At each station, four separate five foot cores were taken with a vibrocore (a hydraulically activated boring device) containing a three inch diameter plexiglass liner. The plexiglass liner allowed the core to be removed from the device intact for sectioning. Sample locations for the four cores taken at each station were randomized using the following procedures: 1) the vessel anchored at the selected sampling coordinates; 2) four random numbers between 0 and 250 feet were selected (250 feet was the maximum anchor line length the vessel could deploy after the initial setting of the anchor); and 3) the anchor line was deployed for the number of feet selected for each sample.

After retrieving the core, the plastic liners were cut longitudinally. Each core was then split into two separate samples. The top three inches of the core was separated from the remaining sub-surface portion of the core. Sediment from the top portion of the core was removed using pre-cleaned stainless steel knives and spoons and placed in a pre-cleaned stainless steel bowl. The bowl was placed on ice in a closed cooler to reduce the temperature of the sample and to prevent contamination. In a similar manner, sediment for the sub-surface portion of the core was removed using a second set of pre-cleaned stainless steel utensils and bowl. Between collections the surface and sub-surface collection bowls were stored in separate coolers. Only sediment from the inner portion of the core was sampled. Sediment sampling for the lower sub-surface core was conducted uniformly along its entire length so that all layers would be equally represented in the sample.

Sediment sub-sampling procedures were repeated for all four cores taken at each station. After each coring, the surface and sub-surface sediments were added to their respective bowls. After all four cores were collected, the surface and sub-surface bowls were thoroughly homogenized and transferred into factory sealed 500 ml I-Chem Jars for a total of 30 samples. Sediments remaining in the bowls were transferred to whirl-pacts for grain size and total organic carbon analyses. All samples for chemical testing and TOC were stored in the dark at four degrees Celsius until analysis.

Laboratory analyses of the 30 sediment samples were conducted by Midwest Research Institute (MRI) using High Resolution Gas Chromatography (HRGC) and High Resolution Mass Spectrometry (HRMS). The HRGC/HRMS analytical method used by MRI was developed as a modification of EPA SW-846 Method 8290. The analytical approach to the 30 sediment samples included analyses for 75 PCB congeners at a detection limit of 2 to 5 ng/g (parts per billion). Additionally, all samples were analyzed for five of the more toxic, non-ortho substituted coplanar PCB congeners (IUPAC numbers 77, 81, 126, 127, and 169) using HRGC/HRMS to a

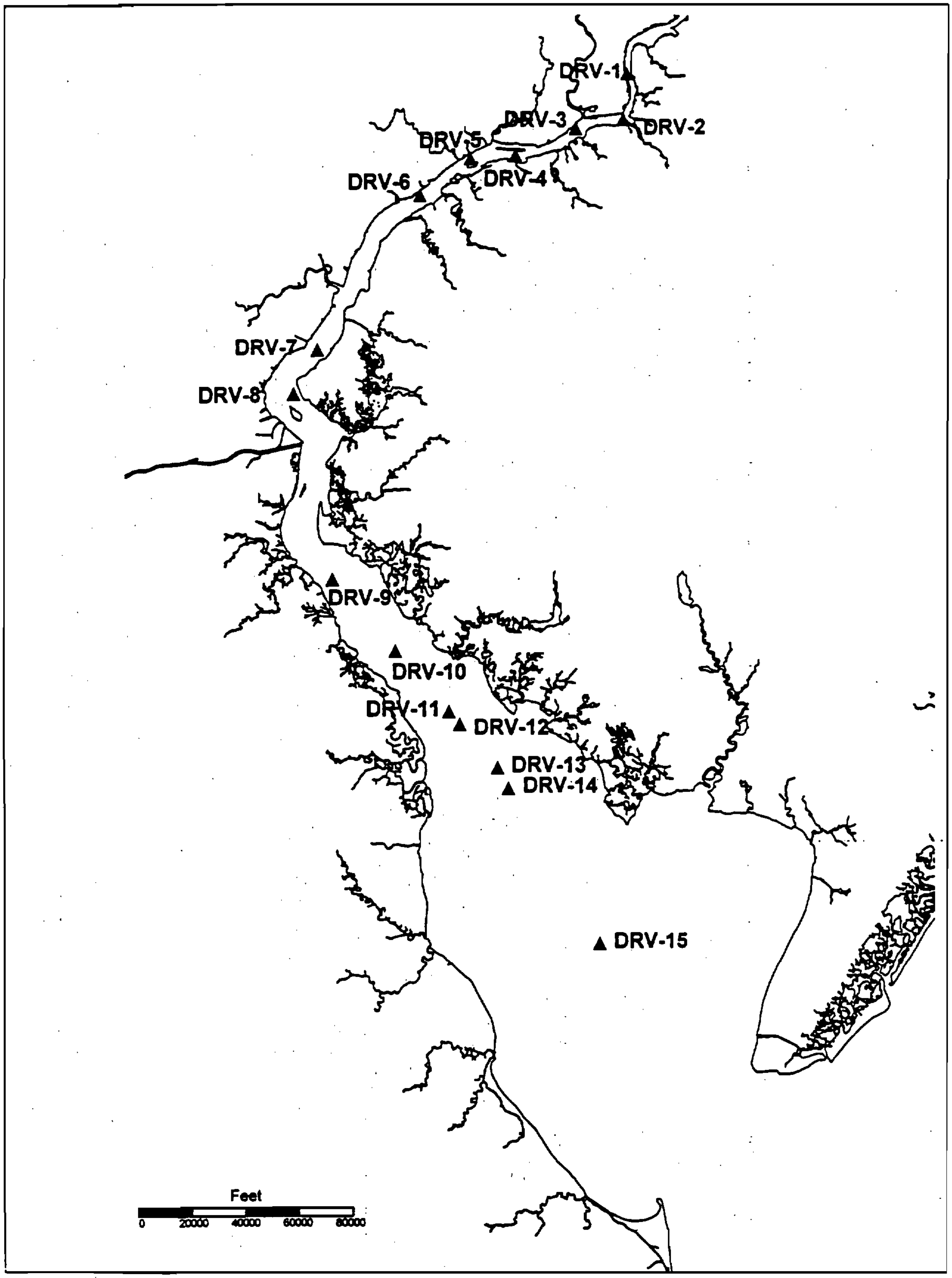


Figure 4-2. Locations of primary sampling stations for the PCB sediment cores collected in the Delaware River, Philadelphia to the Sea Federal Navigation Project in October 1996

detection limit of 1 pg/g (parts per trillion). All sediment PCB congener concentrations were reported on a dry weight basis.

Total PCBs were calculated by summing the concentrations of all congeners found in each sample. Non-detects were treated as zeros for all analyses. To evaluate potential sediment toxicity, total PCB concentrations were compared to Long et al's. (1995) Effects Range-Low (ERL) and Effects Range-Median (ERM) marine and estuarine sediment guideline values (22.7 and 180 ng/g, respectively). The ERL concentration is the threshold at which biological effects of PCBs begin to occur while the ERM concentration is the point at which biological effects are likely to occur. Sediment concentrations were also compared to draft guidelines for the protection of human health (33.8 ng/g) recently developed by Mr. Rick Greene of the Delaware Department of Natural Resources and Environmental Control. The human health guideline is a biomagnification-based sediment quality criteria where no increase in cancer at a rate of 1 in 100,000 would be expected for humans consuming fish.

Out of a total 75 PCB congeners assayed, 32 were detected in sediments collected from the Delaware River, Philadelphia to the Sea navigation channel. The tetra homolog IUPAC 77 was detected in all but one of the sediment samples. Among the samples which had detectable concentrations, the tetra homolog, IUPAC 44, had the greatest concentration (14.4 ng/g). However, this congener was only observed in one sample. Other congeners which were detected in a single sample included IUPAC numbers 42, 47, 66, 70, 80, 118, 84/101, 168, 170/190, 189, 194, and 205. The second most commonly observed congeners were IUPAC numbers 81 and 169, which were found in 13 of the 30 collections. IUPAC number 169 (hexa homolog) was the third most commonly detected PCB congener. Among the four most frequently detected congeners listed above, all were tested in the parts per trillion range. For all other PCB congeners which were measured in the parts per billion range, no one congener was consistently found in the samples as the frequency of detections ranged from only 1 to 7.

The concentrations of all PCB congeners were summed to determine the total PCB distribution among the surface and sub-surface collections at the 15 sites included in the study (Figure 4-3). Relative to sediment guidelines established by Long et al. (1995) for the protection of aquatic biota (22.7 ng/g), and sediment limits suggested by the Delaware DNREC for the protection of human health (33.8 ng/g), most of the channel sediments had PCB concentrations below levels of concern. Surface and sub-surface PCB concentrations at Stations DRV-11 through DRV-15 in the lower bay ranged from below detection limits to only 0.01 ng/g. Total PCB concentrations above aquatic and human health guidelines were observed at Station DRV-6 (Marcus Hook Range) in the surface sediments, and at Stations DRV-6 and DRV-4 (Tinicum Range) in the sub-surface sediments. Surface concentrations at Marcus Hook were approximately two times greater than the ERL, and 1.2 times greater than DNREC's guidance value for the protection of human

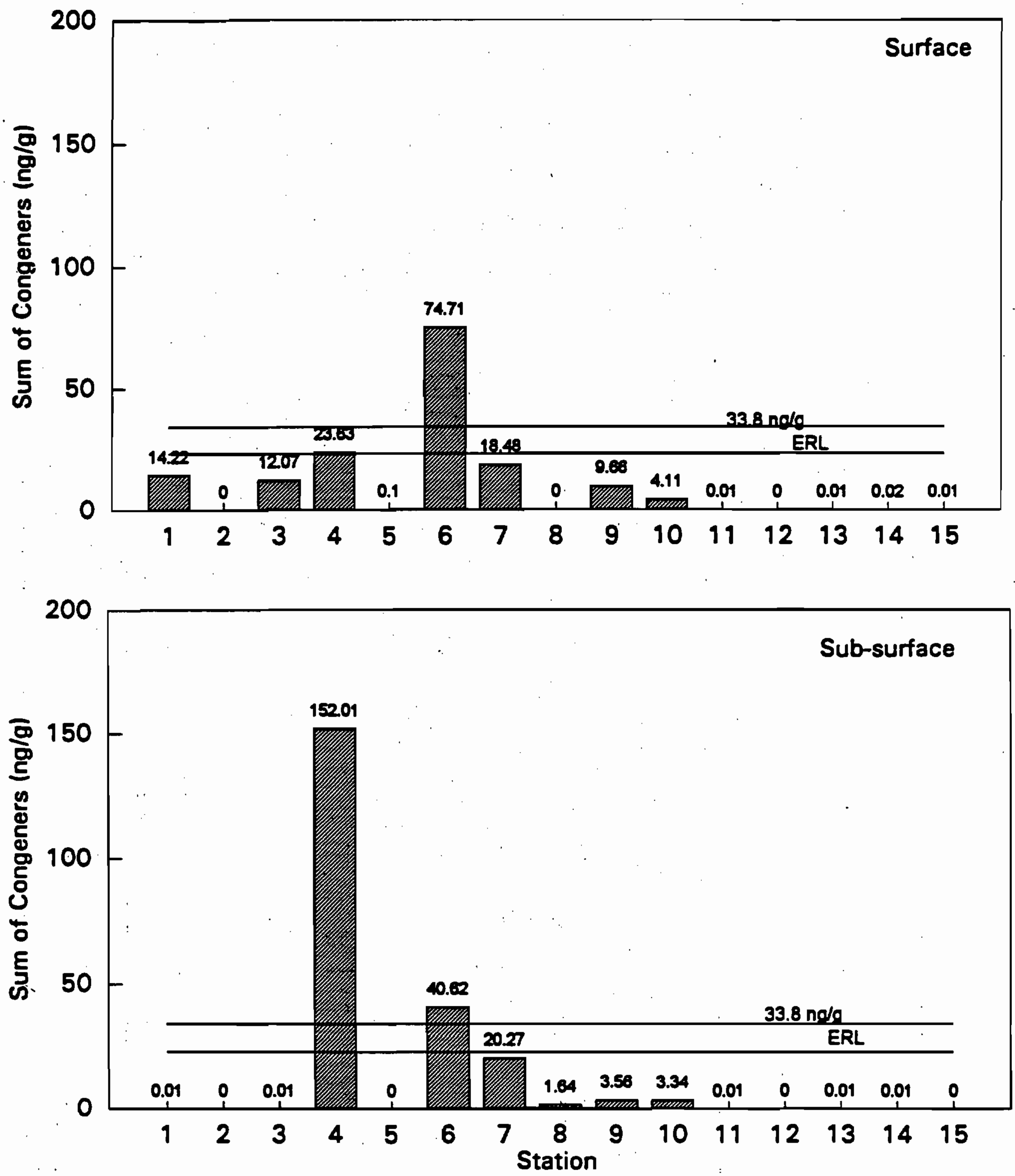


Figure 4-3. Concentrations of total PCBs (ng/g) in surface (0-3") and sub-surface (3" to 5') sediments collected in the Delaware River, Philadelphia to the Sea Federal navigational channel in October 1996

health. Among the surface sediments, the greatest concentration was observed at Station DRV-6 (Marcus Hook Range) where the PCB congeners totaled 74.7 ng/g dry weight. Surface sediments at Stations DRV-5 (Eddystone Range) through DRV-1 (Reach M near Philadelphia) were either equal to or well below the ERL value indicating generally low sediment toxicity conditions. Sub-surface concentrations at the Tinicum Range station (DRV-4) were over six times greater than the ERL value as the sum of the PCB congeners totaled 152 ng/g. All concentrations observed in the navigation channel sediments were below Long et al.'s (1995) Effects Range-Median (ERM) sediment guidance value of 180 parts per billion.

4.6 Trace level analysis of the non-ortho substituted coplanar PCB congeners (in the parts per trillion range) followed a similar pattern of low concentrations in the lower estuary (Stations DRV-11 through 15), higher values in the mid-estuary (New Castle Range through Tinicum Range), and intermediate levels from the Mifflin Range (DRV-3) to Reach M near downtown Philadelphia. A regression analysis of total PCBs (excluding the five coplanar forms) versus total coplanar concentrations was significant (R^2=0.80) indicating that the coplanar PCBs were correlated well with total PCBs as would be expected. The PCB congener IUPAC 77 (3,3',4,4'-Tetrachlorobiphenyl) was the most common coplanar congener found comprising over 99 percent of the five coplanar PCBs tested in the study. Average coplanar PCB concentrations among all surface sediments (0.133 ng/g) were generally lower than sub-surface concentrations which averaged about 0.277 ng/g. The greatest concentration of coplanar PCBs in surface sediments was observed in the Marcus Hook Range (Station DRV-6) where the total concentration among the four composited samples was 0.713 ng/g. In contrast, the sub-surface sediments from the New Castle Range (Station DRV-8) showed the greatest coplanar PCB concentration at 1.635 ng/g.

Surface PCB concentrations observed in the navigation channel during this study were compared to surface PCB concentrations observed in a recent study conducted by Arthur D. Little for the Delaware Estuary Program (Arthur D. Little, 1994). Only the surface concentrations from this study were compared because the Arthur D. Little study only conducted surface grab samples. The Arthur D. Little study used the same high resolution methods; thus, the data are directly comparable. All of the sediments for the Arthur D. Little study were taken from shoal habitats and at stations which were often located in the mouths of major tributaries to the Delaware River. Figure 4-4 shows the position of each station sampled for the Arthur D. Little study, relative to samples collected for this study. The Arthur D. Little study also partitioned the contaminant results into four estuary reached (A through D) for data analysis. Reach A was located up-river and included an area ranging from the mouth of the Neshaminy Creek to north of the Ben Franklin Bridge. Reach B ranged from the mouth of Mantua Creek to Raccoon Creek, Reach C ranged from Stone Creek to just north of the C&D Canal, and Reach

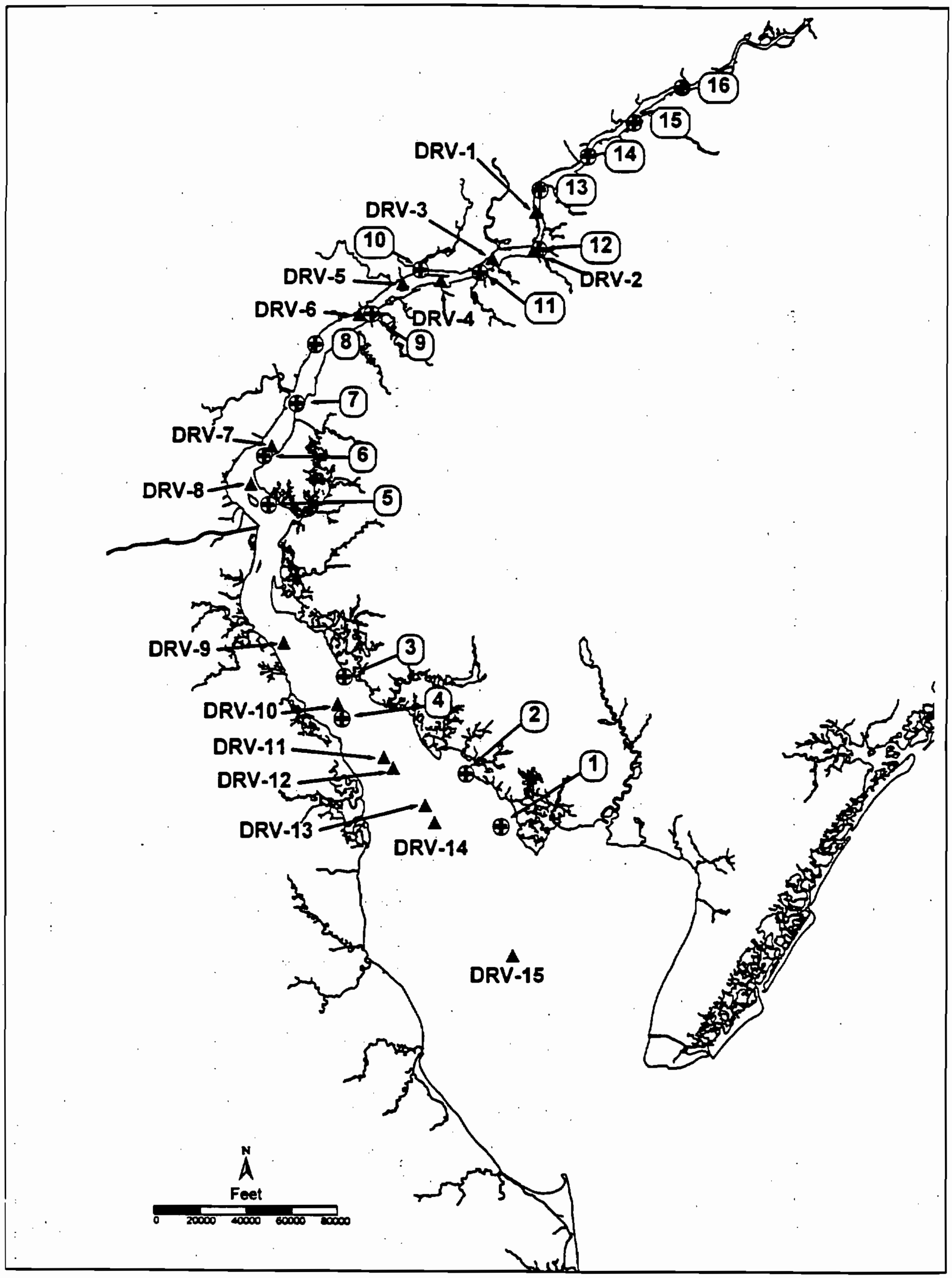


Figure 4-4. Comparison of station locations for the primary stations sampled in the Delaware River, Philadelphia to the Sea Federal navigation channel in October 1996 and stations sampled by the Arthur D. Little study in May 1993

D was located in the lower bay and ranged from south of Artificial Island to Egg Island Point, New Jersey. Data from this study were categorized into approximately the same reaches and the mean concentrations of the sum of the congeners were compared. No comparison of shoal and channel concentrations were available for Reach A as no sampling was conducted north of Philadelphia during this study.

The results of this comparison suggest that PCB concentrations in the navigation channel are much lower than concentrations observed in the shoal habitats sampled by Arthur D. Little (Figure 4-5). Mean concentrations in the up-river shoal areas (177.8 ng/g) were more than eight times greater than those observed in the channel sediments (21.9 ng/g). Lower concentrations were observed in the shoal samples from Reaches C and D relative to Reach B. However, average total PCB concentrations in the navigation channel in Reaches C and D were 9 and 28 times lower than the respective shoal concentrations. Analysis of variance tests indicated that these differences were significant suggesting that the accumulation of PCBs in the estuary occurs primarily in shoal areas outside the navigation channel.

The dredged material disposal plan for the Delaware River, Philadelphia to the Sea main channel deepening project includes using dredged material from the lower portion of the estuary (Liston Range to Crossledge Range) for the creation of shallow marsh habitat around Egg Island Point in New Jersey, and Kelly Island in Delaware. In addition, some of the sediments will be stockpiled in the lower Delaware Bay at sites L-5 and MS-19 for use in future beach replenishment activities along the Delaware shoreline. A major environmental concern expressed by the State of Delaware was that placement of material containing high levels of PCBs could expose aquatic and terrestrial natural resources to toxic concentrations and potentially increase the biomagnification of PCBs through the food chain.

The results of this study indicate that these concerns are unwarranted as the sediments slated for the beneficial projects contain only trace concentrations of PCBs (Figure 4-3). Sediments for the wetland creation and sand stockpile projects will be taken from sampling areas DRV-11, 12, 13, 14, and 15. These particular areas had the lowest concentration of PCBs found in the entire study region. Furthermore, the results of the comparison of channel concentrations and shoal concentrations reported by Arthur D. Little (1994) indicate that PCB contamination in the navigation channel is significantly lower than levels observed in shallower non-channel areas (Figure 4-5). Thus, use of channel sediments for construction of wetlands and beach nourishment projects may have an added benefit by capping shallow water sediments known to have higher PCB concentrations. PCB levels reported by Arthur D. Little at the stations closest to the Egg Island Point project (Station 1; Figure 4-4) had a total concentration of 36.9 ng/g while this study suggests that

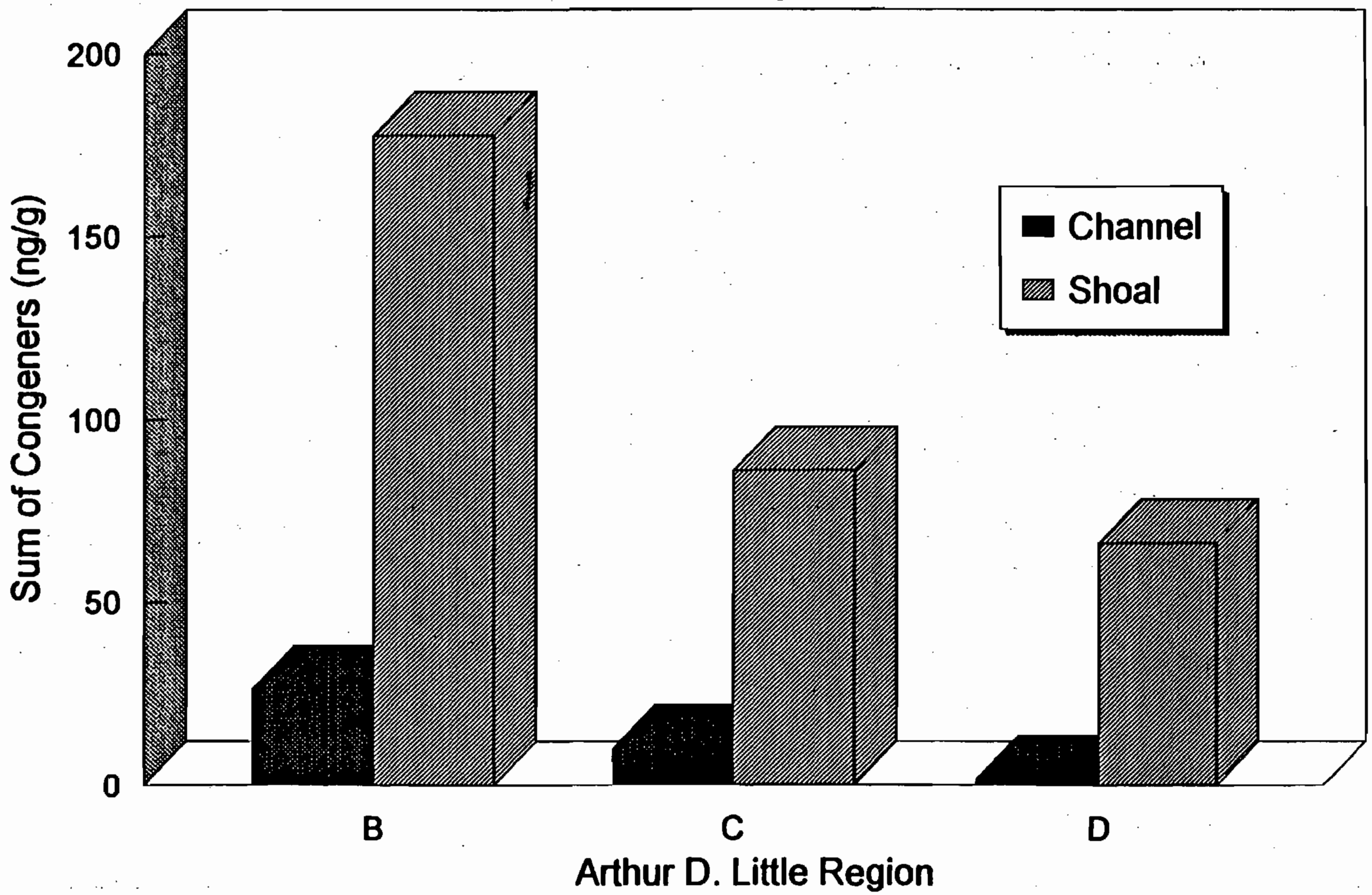


Figure 4-5. Comparison of total PCB concentrations (ng/g) observed in the navigational channel to concentrations observed in the shoal sampling conducted by Arthur D. Little in May 1993

the navigation channel sediments that will be placed there may only have an average concentration of 0.003 ng/g.

One mechanism where dredging activities can potentially mobilize PCBs in the estuary is through the discharge of water from upland disposal sites. In the riverine portion of the project area, dredged material is placed in seven upland disposal sites located between Artificial Island and the Schuylkill River. Discharge water from these sites may contain PCBs dissolved in the pore water of the dredged sediments. In addition, the process of dredging and pumping the dredge slurry to the upland disposal sites may increase dissolved PCB concentrations due to changes in sediment/interstitial water equilbrium. However, PCB solubilities are known to be extremely low ranging from 0.00009 mg/l for nonachlorobiphenyl to 0.17 mg/l for some tetrachlorobiphenyls (USEPA, 1987). PCBs are also known to firmly attach to organic particles and fine grained sediments. Thus, only a very small percentage of the PCBs in dredged material will be discharged in the dissolved phase. The specific percentage of PCBs that will be released will depend on the solubilities and concentrations of the various congeners in the material. This is usually measured for a particular sediment in elutriate tests. Although no high resolution sediment tests were conducted in conjunction with high resolution elutriate tests, a recent study conducted in Wilmington Harbor, Delaware suggests that PCB discharges from upland disposal sites pose no appreciable risk to aquatic biota in the Delaware River (Greeley-Polhemus Group, 1994).

Using high resolution tests the Greeley-Polhemus Group (1994) quantified the concentration of PCB congeners in the sediments and in weir discharge of the upland disposal site which received the material dredged for maintenance of the harbor (the same contract lab used for this study conducted the PCB analysis). A total of 12 congeners were detected in two composite samples of the sediments prior to dredging, the sum of which averaged 23.1 ng/g. Two separate 24 hour composite samples of the weir discharge waters were collected during the dredging operations and only one congener (IUPAC 77) was detected in extremely low concentrations which averaged only 0.00004 ug/L.

Efficient operation of upland disposal sites can reduce the mobilization of PCBs in the estuary by removing the majority of the suspended material. Maintenance of the proper ponding levels (by adjusting the weir height) increases the retention time of water within the upland site allowing suspended material more time to settle out. In addition, many of the upland sites used in the Delaware River contain large stands of Phragmites and other upland vegetation. Typically the dredged slurry is pumped into the site as far inland as possible and upgradient of the vegetation. This effectively maximizes the distance a parcel of water must traverse to the discharge weir. In addition, the flows of turbid water discharged from the dredge pipe is further detained by the plant material increasing the removal of suspended solids. In recent monitoring of weir discharges for the Wilmington Harbor and Salem River dredging projects, TSS levels at the weir were often much less than background concentrations measured in the river.

5.0 Hydrodynamic and Salinity Modeling

5.1 Introduction

The spatial and temporal distribution of salinity within the Delaware Estuary has been an important water quality issue for over 60 years. Although salt occurs naturally in Atlantic Ocean water at the bay mouth and in very low concentrations in upland discharges, the estuary system is susceptible to adverse impacts from man-made changes in the factors which affect salt distribution. There are two basic categories of human impacts which can affect salt distribution in the estuary. The first category includes impacts on the supply of freshwater to the system, such as: reservoir construction and management; out of basin transfers of water; and in basin consumptive uses of water. The second category includes factors which may affect the interaction of freshwater inflows with ocean derived saltwater within the estuary, such as changes to the three dimensional geometry of the estuary. The proposed deepening of the Delaware River navigation channel falls within the second category.

In the region from Trenton (RM 134) downstream to Wilmington (RM 70), Delaware River water is utilized for a number of industrial and municipal water supply purposes. The City of Philadelphia obtains its municipal water supply by withdrawal of river water at Torresdale (RM 110). Many industrial users directly obtain both process and cooling water from the river in the Trenton to Wilmington reach. Above RM 98, the river provides a portion of the recharge to aquifers which supply groundwater in the Camden Metropolitan area in New Jersey. This heavily urbanized area of the river is thus sensitive to increases in salinity which might adversely affect industrial and municipal water uses, particularly under drought conditions. Salinity is also a key factor regulating the distribution of both fauna and flora in an estuarine environment. While salinities fluctuate seasonally and from year to year, a permanent shift in salinity patterns could adversely impact a variety of ecosystem components, depending on the magnitude of the change. In order to estimate the potential for the proposed channel deepening to affect salinity distribution, a model-based approach was adopted.

5.2 Objectives

The principal goal of the modeling effort was to identify and quantify any impacts of the proposed 5 foot channel deepening on spatial and temporal salinity distribution. It was considered necessary that a number of modeling scenarios be developed to represent a range of boundary and forcing conditions of potential importance to both human and non-human resources of the Delaware

Estuary.

5.3 Previous Investigations

A number of research efforts have been performed during the past five decades, and particularly within the last ten years, which have contributed to the understanding of the principal physical processes relevant to circulation and salinity distribution in the Delaware Estuary. Prior to any decision to develop a new model specifically to address the impacts of the proposed channel deepening, a careful review of recent and historic research was performed to determine if any previous research or existing modeling methodology suited the specific needs of this study. The following section presents an overview of significant research efforts reviewed for potential applicability to this study.

Mason and Peitch (1940) presented a report titled "Salinity Movement and its Causes in the Delaware River Estuary" on work performed for the Sun Oil Company, Marcus Hook, Pennsylvania. Their research was motivated in part by proposals in 1930 to divert water from the upper basin of the Delaware River to New York City, which coincided with drought conditions occurring in the Delaware Basin between 1929 and 1932. They conducted an empirical investigation of salt movement in the estuary in response to a range of freshwater inflows during the period 1930 to 1936. This work resulted in calculated mean discharges required to "stabilize" the location of the 50 ppm isochlor at a range of locations from Torresdale downstream to Artificial Island. The data utilized in this study predated the channel modifications accomplished between 1939 and 1942. This work deepened the navigation channel to 40 feet from the bay mouth to the Philadelphia Navy Yard (RM 92).

Durfor and Keighton (1954), and Keighton (1966), present results of empirical studies performed by the US Geological Survey (USGS). These studies documented the chemical characteristics of the Delaware River between Trenton, NJ, and Marcus Hook, PA, based on analysis of hundreds of water samples collected between 1949 and 1952. This work was used to develop relationships between the electrical conductivity of the water and its total dissolved solids and chlorinity concentrations, and is still considered valid. The conductivity-salinity and conductivity-chlorinity relationships are important because the existing US Geological Survey (USGS) and DRBC salt front monitoring program in the estuary is based on measurement of conductivity. Conductivity values are then converted to chlorinity using Keighton's relationships. The later work by Keighton documented the continuing evolution of knowledge of the interaction of freshwater discharges and salinity distribution, based on flow and salinity data obtained between 1949 and 1963, for then-existing conditions of channel and estuary geometry.

The Philadelphia District of the US Army Corps of Engineers initiated a "Long Range Spoil Disposal Study" in 1967 to investigate short- and long-term solutions to the problem of Delaware River dredged material disposal. A comprehensive set of prototype observations was collected over three periods in 1968 and 1969 to document currents, salinity, and suspended sediment concentrations. These measurements were obtained primarily to assess the impact of these parameters on the high shoaling rate experienced in the Marcus Hook range of the navigation channel. The data obtained in this study provide quantitative data on water, salt, and suspended sediment fluxes during the range of hydrologic conditions occurring in the observation periods.

Although each of the previously discussed research efforts contributed to the improvement of knowledge regarding salinity distribution and the importance of freshwater inflow for the Delaware Estuary, none of these studies was capable of providing insight into how salinity distribution might respond to changes in estuary geometry. The investigations summarized in the following paragraphs differ from the preceding studies in that they utilize prototype data to develop models with the ability to predict changes in circulation and salinity resulting from changes in estuary geometry and boundary conditions.

The Delaware River Basin Commission (DRBC) has supported the development and evolution of a 1-dimensional salinity model for the Delaware Estuary for the past 20 years. The model, referred to as the Transient Salinity Intrusion Model (TSIM), represents the geometry of the estuary with a series of 100 cross sections between the bay mouth and Trenton. In this model, flow and salt transport are treated as laterally and vertically averaged at each section. The model has been used by DRBC as a planning tool for simulation of various scenarios of drought management and reservoir operation. The model has also been used in a number of studies to assess the impacts of potential changes in forcing functions, including sea level rise, depletive uses, and out of basin transfers.

During the Feasibility Study phase for the proposed deepening project, the Philadelphia District contracted with DRBC in 1988 to apply the TSIM in assessing the impacts of the proposed channel deepening under hydrologic conditions of the drought of record, 1961 through 1965, but with 1986 depletive uses assumed and the present reservoir regulation scheme in place. The model predicted that the maximum intrusion of the "salt front", defined as the seven-day average location of the 250 ppm isochlor, during a repeat of year 1965 hydrologic conditions would extend 1.3

miles further upstream (to RM 97.8) with the 45 foot deep channel as compared to the location with the existing 40 foot channel. Other less severe hydrologic conditions represented by years 1961-1964 would cause lesser changes. The model also predicted that the maximum 30-day average chlorinity at RM 98 would increase from 130 to 143 ppm during October 1965, the period with the highest observed salinity encroachment during the 1961 to 1965 drought. It should be noted here that present water quality standards supported by DRBC call for 30-day average chlorinity at RM 98 to be below 180 ppm. This standard was adopted to provide protection against salinity intrusion into aquifers exposed on the river bottom above RM 98. Above RM 98, there are significant exposures of the Potomac-Raritan-Magothy (PRM) aquifer which supply groundwater for the Camden, New Jersey, Metropolitan area. It is also noted that DRBC has discussed a more restrictive 30-day chlorinity standard, 150 ppm chlorinity, for RM 98.

Wong and Garvine (1984) and Wong (1991) present analyses of tide and current observations in Delaware Bay, the Chesapeake and Delaware (C&D) Canal, and upper Chesapeake Bay. Their studies document the influence of the C&D Canal on currents and water levels in the Delaware estuary at sub-tidal frequencies (i.e. for periods longer than the 12.4 hour tidal cycle.) The work of Wong and Garvine, and other investigators from the University of Delaware, has shown that atmospheric forcing (wind) on the continental shelf and over Chesapeake Bay exerts a significant effect on transport processes in the upper portion of Delaware Bay. Wong developed a linearized, frequency-dependent analytical model to simulate the impacts of the C&D Canal on Delaware Bay at sub-tidal frequencies. Wong's work also showed that at tidal frequencies the circulation in Delaware Bay is largely controlled by the ocean tides occurring at the mouth of the bay.

Galperin and Mellor (1990) used the extensive set of prototype circulation (currents, tide, salinity, etc.) data collected by the National Ocean Service (NOS) in 1984 and 1985 to develop a 3-dimensional circulation model of the Delaware estuary and adjacent Atlantic Ocean shelf. Their model utilized a 1 km square grid in the Delaware Estuary and a 5 x 4 km grid on the shelf. The model was calibrated to the NOS 1984-85 observations, and used to investigate sub-tidal residual circulation and three-dimensional flow fields.

Walters (1992) investigated salt transport processes of Delaware Bay in response to potential climate-driven sea level changes. Walters developed a 3-dimensional finite-element model with forcing provided by harmonic (synthetic mean tidal) water levels at the bay mouth, under low flow (5,000 cfs) conditions. The model was used to predict the tidal hydraulic and salinity changes associated with a potential 1 meter rise in sea level.

DiLorenzo et al (1992) developed a model for USEPA's Delaware Estuary program to investigate the effects of historic dredging on the tidal hydraulics and salinity distribution of the Delaware estuary. The investigators also evaluated the salinity impacts associated with the deepening of the Delaware River navigation channel to 45 feet. The model used in this investigation was the 3-dimensional finite element RMA-10, which was operated in vertically-averaged (2-D) mode. The model was calibrated to December 1985 and March-April 1987 prototype data sets. The model was then used to hindcast tidal hydraulic and salinity conditions associated with the geometry of the estuary in 1890, which predated significant estuary geometry changes resulting from channel dredging and associated shoreline modifications (disposal area construction).

Model results showed that there were significant impacts resulting from the channel deepening and shoreline changes accomplished between 1890 and the present. For example, the model successfully reproduced the observed historic increase in tidal range at Trenton, New Jersey from 4 feet in 1890 to 8 feet presently. The model also showed increases in salinity on the order of 5 to 25 percent at a number of locations in the middle portion of the estuary between 1890 and the present under modeled boundary conditions. In contrast, the model comparisons of the existing estuary geometry (40 foot channel) with the 45 foot channel in place showed insignificant changes in tidal hydraulic parameters and salinity under the range of boundary conditions simulated.

The research described in the preceding paragraphs was carefully reviewed for potential applicability to the present study. It is reiterated here that principal objective of modeling in the PED phase was to <u>define impacts on salinity and circulation caused by the proposed channel modifications</u>. These modifications consist of deepening the navigation channel from 40 to 45 feet across its full width, which is 1,000 feet between RM 7 and RM 41, 800 feet from RM 41 to RM 95, and 400 to 500 feet from RM 95 to the upstream limit of proposed deepening, RM 99. This review showed that although there have been significant improvements in our understanding of and predictive capabilities for salt transport and distribution processes in the Delaware Estuary, there was no modeling tool available in 1992 (the start of Pre-Construction Engineering and Design (PED) study scoping) which uniquely met the specific requirements of this study, i.e., the ability to evaluate the salinity and circulation impacts of 5 feet of channel deepening under a wide range of inflow and tidal boundary conditions. As a result, it was determined that a new, project-specific model was required.

5.4 Modeling Methodology Adopted

The Philadelphia District coordinated with the Hydraulics Laboratory (HL) of the US Army Corps of Engineers Waterways Experiment Station (WES) to discuss options for model development and application to meet the specific needs of the PED study. Based on previous work at WES for the Philadelphia District and others, the decision was made to apply the 3-dimensional numerical hydrodynamic/salinity model, CH3D-WES (Curvilinear Hydrodynamics in Three Dimensions), in this study.

CH3D-WES simulates the most important physical factors affecting circulation and salinity within the modeled domain. As its name implies, CH3D-WES makes computations on a curvilinear, or boundary fitted, planform grid. Physical processes affecting baywide hydrodynamics that are modeled include tides, wind, density effects (salinity and temperature), freshwater inflows, turbulence, and the effect of the earth's rotation. The representation of vertical turbulence is crucial to a successful simulation of stratification in the bay. The boundary fitted coordinates feature of the model provides enhancement to fit the scale of the navigation channel and irregular shoreline of the bay and permits adoption of an accurate and economical grid schematization. The vertical dimension is Cartesian which allows for modeling stratification on relatively coarse horizontal grids.

The following sections of this report present an overview and summary of the 3D hydrodynamic/salinity modeling studies performed to assess the impacts of channel deepening.

5.5 Prototype Data Collection Program

In order to assure the validity of the model to assess potential effects of channel deepening on salinity and circulation, it was first necessary to test the ability of the model to reproduce flow and salt distribution under existing channel geometry (40 foot channel). The prototype data necessary for model validation include: freshwater inflows; tides at the Delaware Bay entrance, at Annapolis, Maryland (MD), and at various interior stations; wind data at one or more stations; and currents and salinity at locations throughout the system. With such a large area to be modeled, there is a lack of historic synoptic data sets covering Delaware Bay, the Chesapeake and Delaware Canal, and upper Chesapeake Bay suitable for model validation. Therefore, a one-year prototype data collection program was proposed and implemented by the WES Hydraulics Laboratory, Prototype Measurements Branch. A separate WES technical report ("Delaware Bay Field Data Report", March 1995) was prepared to document this effort.

The field data collection program consisted of short term and long term continuous recording of tide, velocity, temperature, and salinity data. Two short term (two-week) field data sets covered the periods 12-25 October 1992 and 19-30 April 1993. These data sets were collected from boats. The two-week periods were utilized to obtain data representing the range of tidal conditions during neap-spring tidal cycles. The data collection stations were positioned at various locations from Wilmington, Delaware to the entrance of Delaware Bay, as well as within the C&D Canal and in Upper Chesapeake Bay. A total of seven data collection ranges with 2 to 4 stations per range were monitored for current and salinity at 3 to 5 depths.

The long-term data collection program was performed over the October 1992 to October 1993 period. A total of ten moored stations was maintained at various times throughout Delaware Bay, the C&D Canal, and the Upper Chesapeake Bay to provide data on water surface elevations, velocity, and salinity at an interval of 15 minutes. Due to equipment problems and the loss of several instruments, all stations did not record data for the complete year. A more complete discussion of model verification and the application of the prototype data sets is presented in a later section on "Model Verification".

5.6 Interagency Coordination

A series of open workshops was held periodically at the District office in order to bring together members of the research and regulatory communities and interested members of the public with the District and WES investigators to discuss the proposed modeling plan, and to identify areas and conditions which are considered to be of particular importance. These workshops provided a mechanism for discussion and comment on the progress and focus of the modeling effort. This process offered District and WES staff a continuing insight into the concerns of other agencies in order to assure that the modeling effort addresses the most important issues associated with channel deepening. This process also assured that interested parties, in particular the agencies with review and comment authority on the project and final report, had the opportunity to participate actively in addressing the most significant circulation, salinity, and water quality issues related to the proposed deepening. Workshops were held in July 1992, April 1993, August 1993, December 1993, June 1994, and June 1995. At the June 1994 coordination workshop, channel deepening production scenarios were determined and ranked in importance. These scenarios address the most important combinations of assumed boundary conditions, including inflow, season, reservoir regulation schemes, and sea level, deemed to be the most critical to the potential for changed/increased salinity intrusion.

5.7 Model Sensitivity Tests

Before model verification to prototype events was initiated, several sensitivity studies were conducted in order to optimize the application of the model to relevant salinity and circulation issues. These studies included tests of grid and computational time step convergence, and a sensitivity test to assess the impact of channel deepening on conditions at the mouth of Delaware Bay.

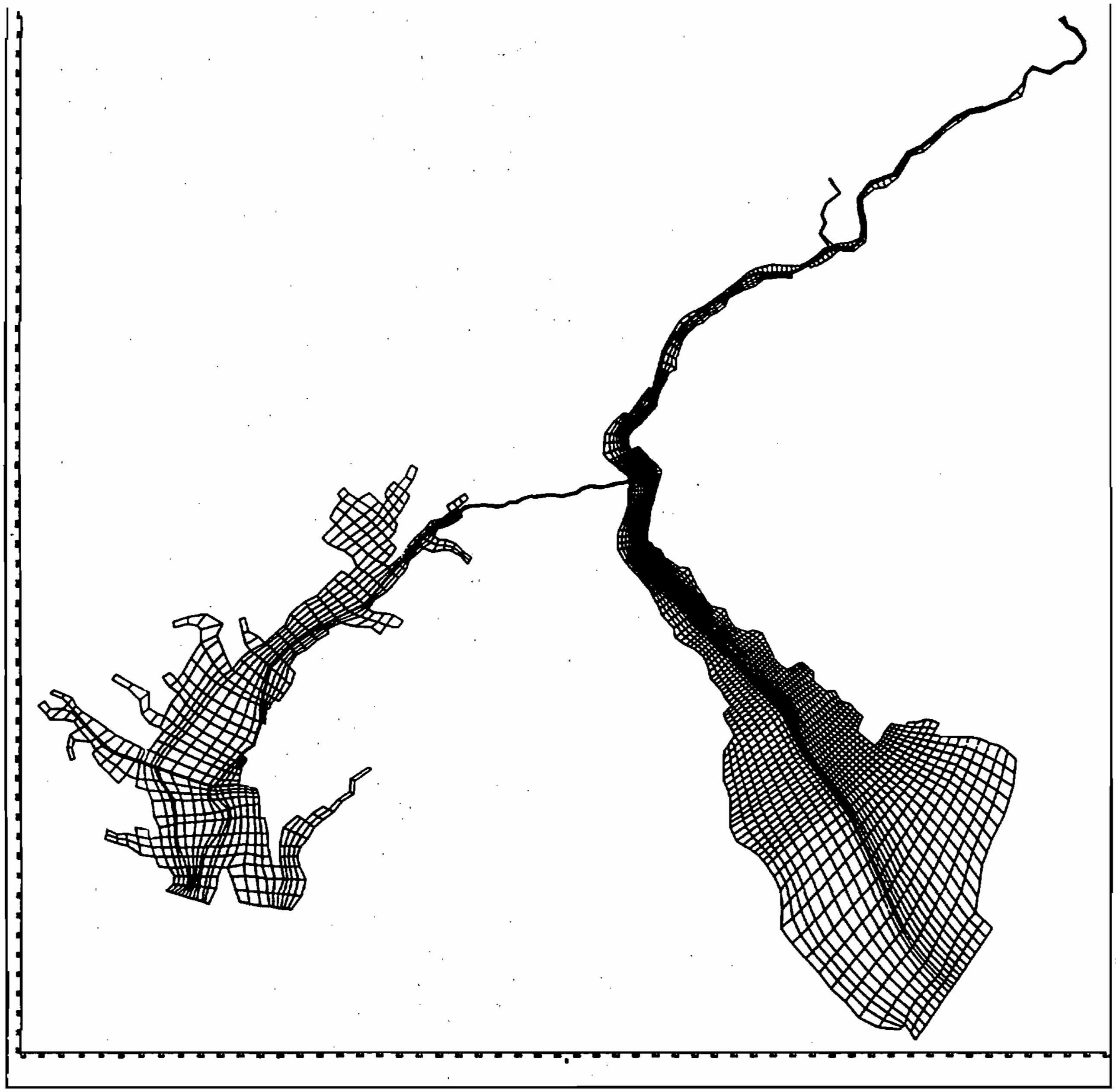
5.7.1 Grid Convergence Results

The initial planform boundary-fitted grid for the modeled system was generated with model grid lines which followed the navigation channels in the Delaware and Upper Chesapeake Bays and represented the geometry reasonably while keeping the total number of grid cells to a minimum. Although the grid was considered suitable for this study based upon experience, an integral part of grid generation for any numerical model study is to assess the impact of the grid on the computed solution.

To address this question, the initial grid resolution was doubled in lower Delaware Bay, with the results from this grid compared with results obtained from the initial grid. Computed results from both grids at selected locations were virtually identical. Thus, based upon the grid convergence runs, the initial grid was considered suitable for this study. However, coordination with resource agencies revealed that additional spatial resolution was desired in the lower bay where oyster beds exist, and in the vicinity of Philadelphia where water supply intakes and groundwater recharge areas exist. Thus, the grid presented in Figure 5-1 was selected as the final grid to be utilized in this study. This grid contains 3,500 planform cells. With a maximum of 18 layers in the vertical, the total number of computational cells is 13,000. Each of the vertical layers is 5 feet thick, except the top layer which varies in thickness with the tide. Typical horizontal dimensions of the grid in the Delaware River are 400 feet by 1,000 feet, whereas those in the lower bay are 1,000 feet by 3,000 feet.

5.7.2 Time Step Convergence Results

As is the case with any numerical model, the solution scheme employed in CH3D-WES contains truncation errors associated with not only the spatial discretization (described above) but also



DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

FINAL MODEL GRID

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-1

the computational time step. Thus, there is a need to assess the impact of the time step on the solution being computed. This was accomplished by making model runs with decreasing time steps and comparing computed results at several locations throughout the computational grid. Results showed that there was a noticeable difference between the solution generated using a 4 minute time step and that generated using a time step of 2 minutes. However, the solutions generated using a 2 minute step and a 1 minute time step were virtually identical. Results were similar at several locations where comparisons were made. Therefore, all computations were subsequently made using a 2 minute time step.

5.8 Selection of the Tidal Boundary for Delaware Bay

An issue with regard to numerical hydrodynamic/salinity models of estuaries is the appropriate location for the tidal/salinity boundary used to drive the model. The concern is whether the model can be verified with the tidal/salinity boundary at the bay mouth, or if the boundary must be located out on the shelf, away from the localized geometric, hydraulic, and salinity gradients often present at the bay mouth. The field data collection program for this study obtained data for model verification with the seawardmost data collected at the mouth. However, before the observed data at the bay mouth could be used to drive model runs under existing and deepened conditions, the impact of the deepening on conditions at the mouth had to be determined.

To provide insight, computations were made on a numerical grid that extended approximately 50 miles offshore of the bay mouth. Model runs were made with the existing (40 foot) and deepened (45 foot) channels. September 1984 data obtained from Hsieh, Johnson, and Richards (1993) provided a portion of the boundary condition data for the model runs. However, the water surface elevation time-series used to drive the model's open water boundaries were derived from harmonic analysis using Schwiderski's Global Ocean Random-Point Tide (RPTIDE) program (Schwiderski and Szeto, 1981). Tidal elevations along the cross-shore boundaries were linearly interpolated between tidal elevations at the coast and the offshore boundary. Constant salinity was specified along the open ocean boundaries.

Comparison of the water surface elevations at the bay mouth with and without the deepened channel showed difference of less than 0.1 cm. This demonstrated that the deepened channel has negligible impact on the water surface elevations at the bay mouth. Similarly, comparisons of computed near-surface and near-bottom velocities and salinity at the same locations showed a maximum difference in velocity of 0.41 cm/sec, with the maximum difference in salinity of 0.06 ppt. The impact of the deepened channel on velocity and salinity at the bay mouth is thus considered negligible. These results show that since the channel deepening begins approximately 6 miles inside the bay mouth, the impacts on existing flow conditions at the mouth are negligible. Therefore, the numerical grid selected as a result of the grid convergence tests was considered appropriate for use without the ocean segment. The tidal and salinity boundary conditions for all subsequent model runs were specified with observed data at the bay mouth.

5.9 Model Verification

Field data collected during October 1992 and April 1993, along with data from the drought period of June-November 1965, were used to verify the 3-dimensional hydrodynamic/salinity model. Results from the simulations with each of these data sets are presented in the following sections.

5.9.1 October 1992 Simulation

During October 1992 inflow conditions were slightly below long-term averages for this month, with mean discharge on the Delaware River at Trenton, New Jersey approximately 5,000 cfs. Surface and bottom salinity field data indicate that salinity was typically higher by about 2 ppt at the northern (NJ) side of the bay mouth compared to the southern (Lewes, DE) side. Thus, the Lewes salinities were applied at the southern end of the bay mouth and then linearly increased across the bay mouth by 2 ppt at the northern end to approximate the observed lateral salinity gradient. There was no lateral salinity variation prescribed at the Annapolis boundary. There was little vertical salinity stratification at the Delaware Bay mouth during this period, whereas salinity differences between the surface and bottom of the water column at Annapolis, MD were about 5 ppt.

Wind data were available at four locations, namely, Baltimore-Washington International Airport (BWI), Dover (Delaware) Air Force Base, Wilmington International Airport, and Millville (NJ) Municipal Airport. It is important to note that these data are for winds over land. Factors to convert the BWI data to winds over water were obtained from Johnson, et. al. (1991). Factors for the other stations were not available. Thus, after experimentation with various combinations of wind fields it was decided to apply one wind field over the entire grid that was an average of all of the records. The factors for conversion of over land winds to over water winds were selected to be 2.0 for the north-south component and 1.0 for the east-west component.

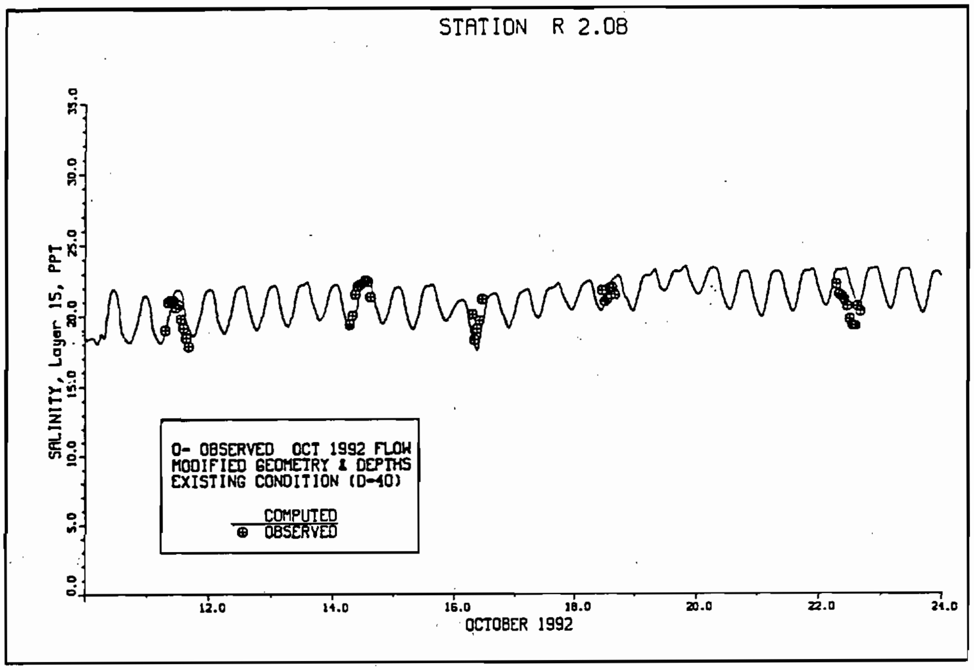
To begin a numerical simulation, the initial states of the model variables must be specified. Generally the starting water surface is treated as flat, and there is no fluid motion. The initial conditions are "flushed" from the system at the speed of a free-surface gravity wave, i.e., the square root of the water depth times the acceleration of gravity. However, since the 3D model is a variable density model, salinity is modeled and directly coupled with the solution for the fluid motion through the water density. Thus, the initial salinity field must be specified. Greater accuracy is required for specifying the starting salinity distribution, since the effects of initial salinity conditions are removed from the system at the speed of the residual flow velocity which is typically on the order of 5-10 cm/sec. Therefore, to reduce the model "spin up" time, the initial salinity field was constructed using available field data, and held constant for the first five days of the simulation. The 3D numerical model was then run for the month of October 1992.

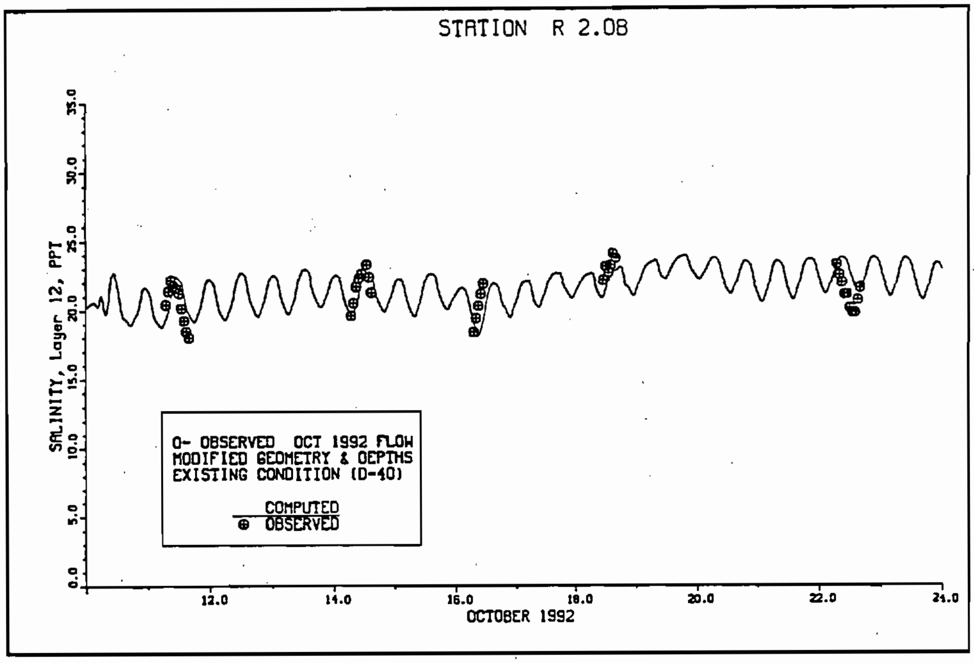
Comparisons of model to prototype water surface elevations and tidal velocities showed that the model successfully reproduced the hydrodynamics of the Delaware Bay-C&D Canal-Upper Chesapeake Bay system, including the flow exchange between the two bays. Comparisons of computed and observed salinities during October 1992 at selected sites are presented in Figure 5-2 (Delaware Bay, RM 30), and Figure 5-3 (Delaware River, RM 69). The absolute value of salinity is reproduced well, as is the longitudinal salinity distribution within the estuary. For these inflow conditions, maximum salt concentrations of about 3-4 ppt occur at Range 7, which is at RM 69. This corresponds well with the data collected for this period and with observations noted by other researchers, e.g., Cohen and McCarthy (1962).

5.9.2 April 1993 Simulation

Inflow conditions during April 1993 were high compared to long-term averages for this period. The freshwater inflow at Trenton peaked at over 100,000 cfs, and averaged nearly 50,000 cfs during the month of April. Unlike the October 1992 conditions, Delaware Bay was partially stratified during April 1993, and Upper Chesapeake Bay was highly stratified. Lateral variations in boundary conditions and initial flow and salinity fields, as discussed for the October 1992 simulations, were also applied for this simulation.

Modeled water surface elevations and velocities were in good agreement with prototype data. Surface and bottom salinity comparisons are presented in Figure 5-4 (RM 45). The effect of the high flow conditions is obvious, as salinity levels are pushed further down the estuary as compared to conditions in October 1992, with a resulting steeper longitudinal salinity





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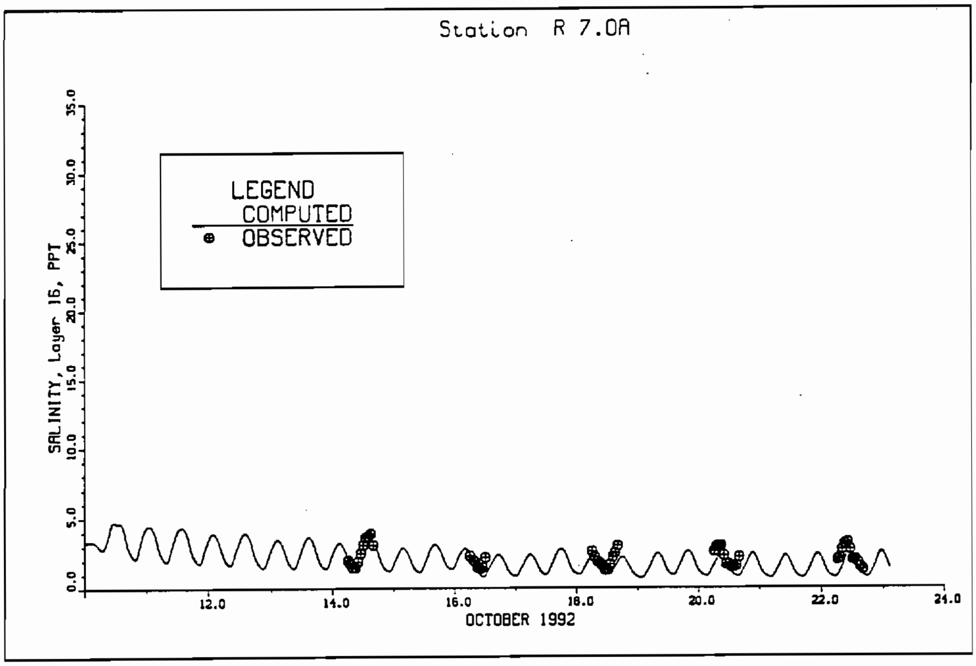
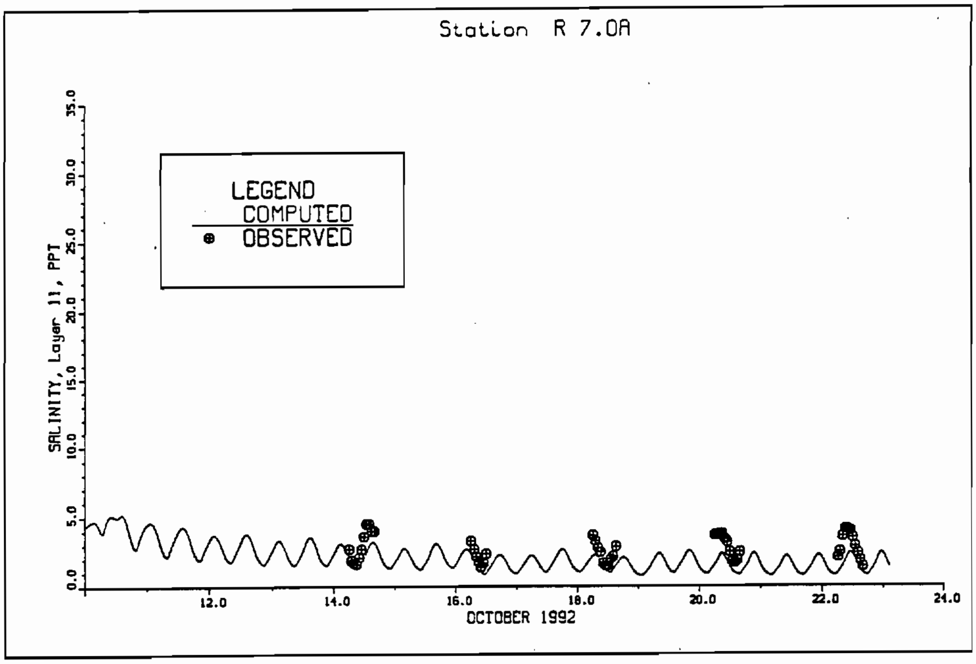
October 1992 Model and Prototype Salinity, RM 30

U.S. Army Corps of Engineers, Philadelphia District

Figure 5-2





DELAWARE RIVER
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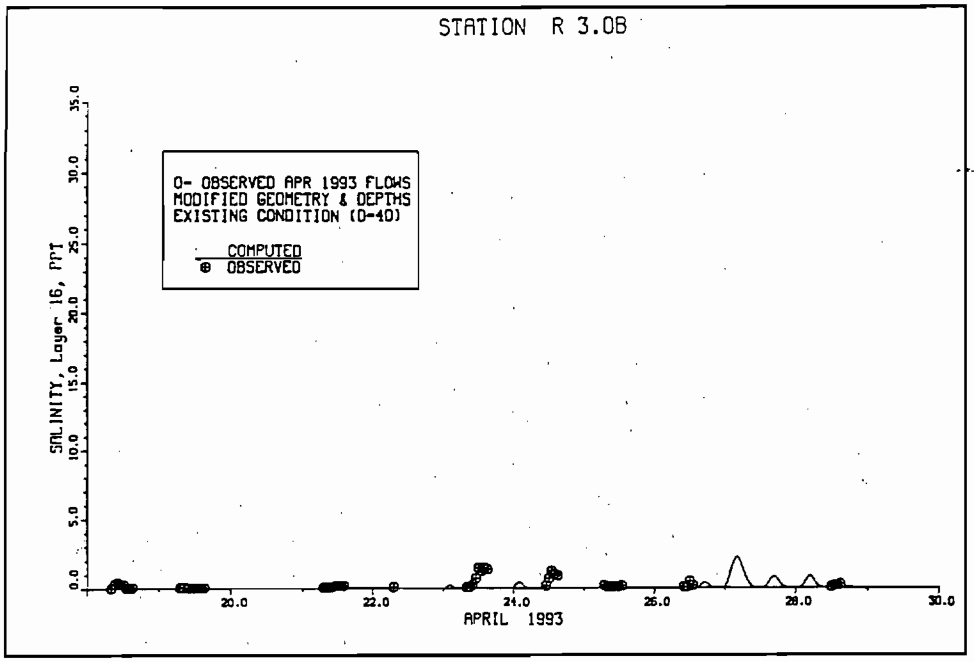
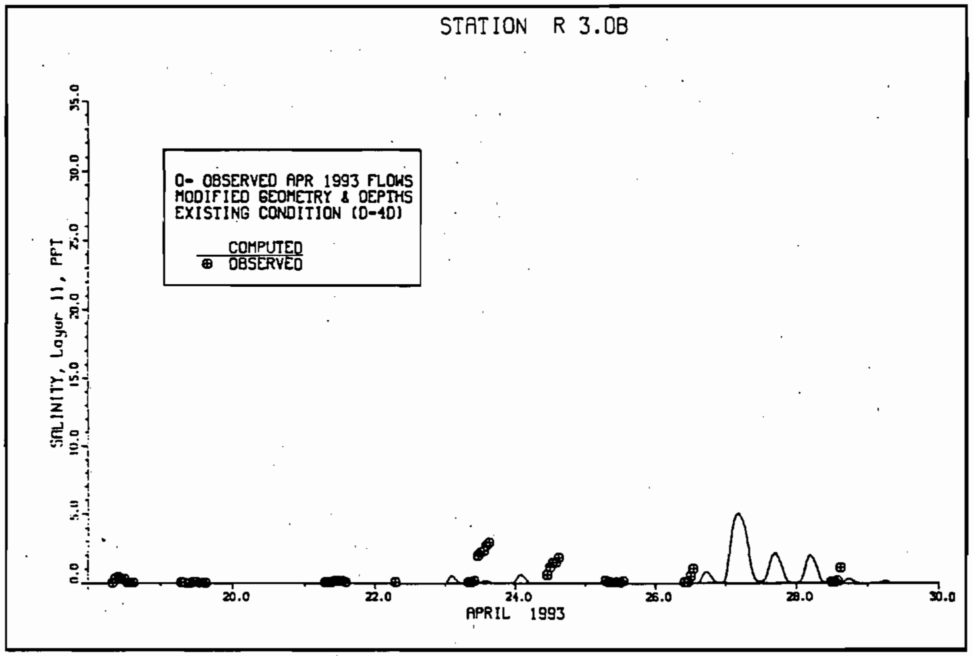
October 1992 Model and Prototype Salinity, RM 69

U.S. Army Corps of Engineers, Philadelphia District

Figure 5-3





DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

April 1993 Model and Prototype Salinity, RM 45

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Figure 5-4

gradient. Vertical salinity stratification predicted by the model under this high-flow condition agreed well with prototype data. For example, at Range 3.0 B (RM 45), differences between near surface and near bottom salinities are computed to be about 5 ppt for some periods, whereas for the lower-flow event in October 1992, salinities over the water column were relatively well-mixed. These results demonstrate that the numerical model responds properly to changing freshwater inflows.

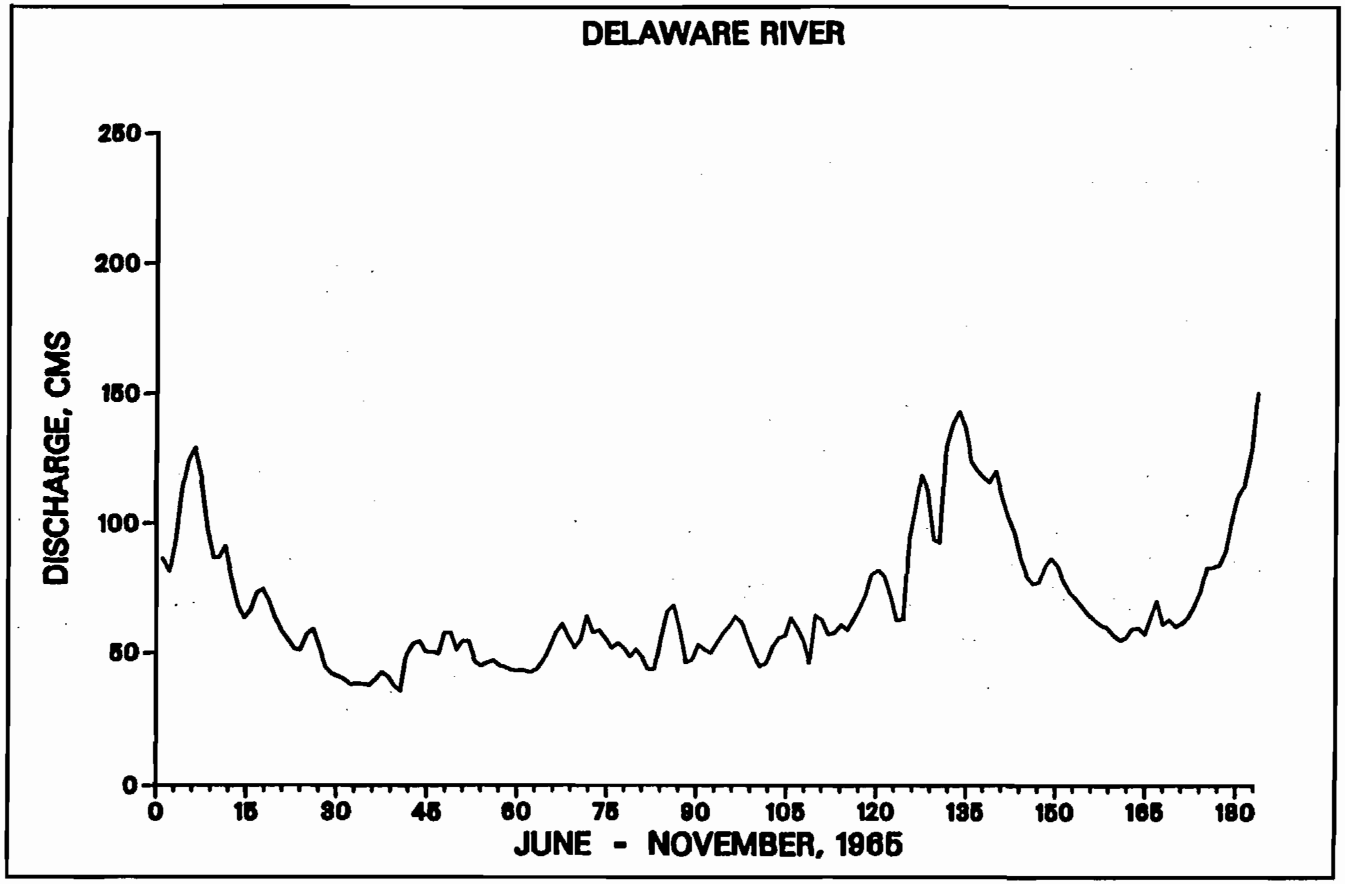
5.9.3 June-November 1965 Simulation

The final flow event reproduced for model verification was the drought period of June-November 1965. The discharge hydrographs for the Delaware and Schuylkill Rivers are presented in Figures 5-5 and 5-6, and show that the extremely low flows were about 20% of the average annual flows. These conditions resulted in the movement of salinity upriver to the vicinity of Philadelphia. Accurately reproducing the conditions which occurred in this period was considered critical because the drought of 1961 to 1966 now represents the DRBC drought planning scenario for the management of basin freshwater resources.

Tide, wind, and salinity boundary condition data for this period were constructed from data obtained by USGS, NOS, DRBC, and NWS. Salinity data at Annapolis, MD were not available for this period. Therefore, salinities were specified to be 19 ppt near the bottom and 15 ppt near the surface by using computed results from the Chesapeake Bay numerical model of Johnson, et al (1991) for flow conditions approximating those occurring during this period. No lateral salinity variation was prescribed at either boundary. For the results presented herein, 21 inflow points were prescribed, with 15 ppm background chlorinity attached to the fresh water inflow at Trenton, NJ and at the Schuylkill River at Philadelphia, PA.

Observed data for comparison with model results were limited for this simulation. No current velocity data were available. Comparison of observed and modeled near-surface salinity was possible for two locations in the upper river, at RM 82 near Chester, Pa, and at the Ben Franklin Bridge in Philadelphia (RM 100). Continuous conductivity data were collected at these locations.

In order to reasonably compare model-predicted salinity values to measured conductivity data in the estuary, it is useful to first review the methods by which chlorinity and salinity are measured or calculated. In sea water, chloride ions constitute a relatively constant fraction of the total dissolved solids (TDS), typically about 55% by weight. Thus "average sea water" with a TDS concentration of about 34 ppt has a chlorinity of about 19



DELAWARE RIVER
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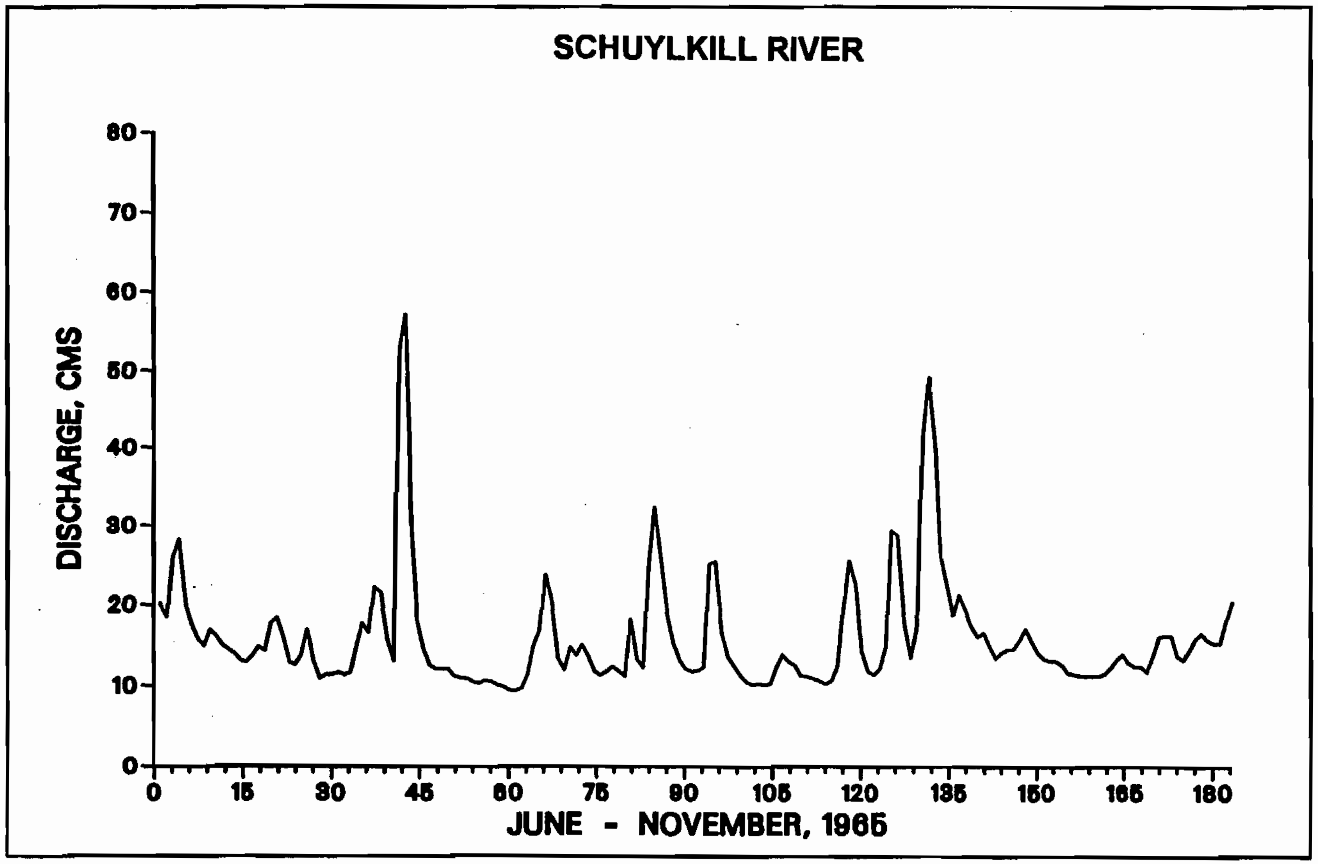
Delaware River Inflow Hydrograph, June - November 1965

U.S. Army Corps of Engineers, Philadelphia District

Figure 5-5

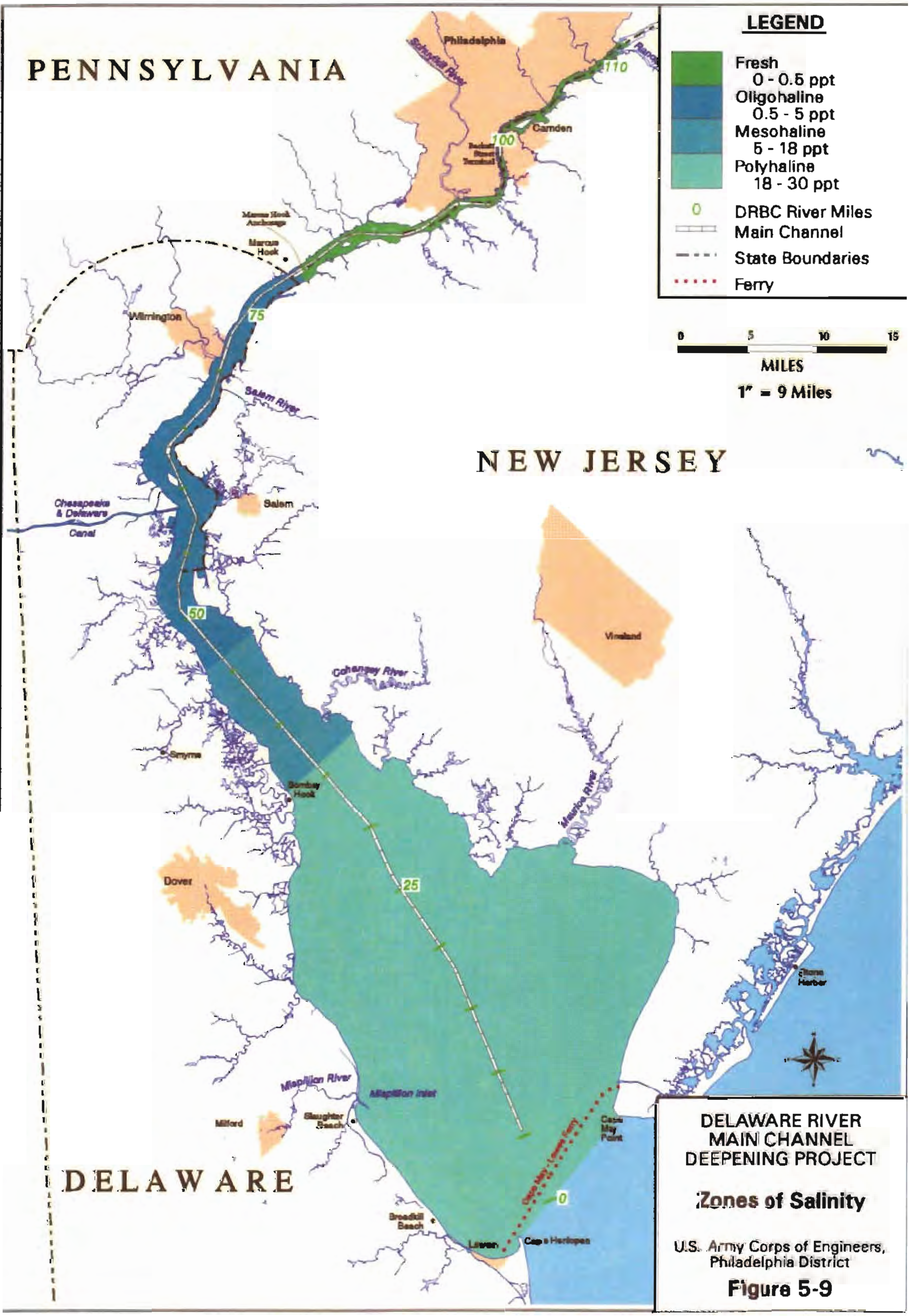


DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Schuylkill River Inflow Hydrograph,
June - November 1965

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-6



DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT

Zones of Salinity

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-9

ppt. Even as sea water is diluted in the estuary to very low salinity values, the ratio of chlorides to TDS remains effectively constant. In the numerical model simulations, the ocean boundary condition includes a specified time history of salinity in terms of TDS (ppt). As the model simulates the transport, dispersion, and dilution of this ocean-derived salinity within the estuary, it assumed that chlorinity at any point is 55% of the model value of (ocean-source) salinity.

However, due to the predominance of other ionic species, chlorides typically constitute a smaller fraction of TDS in tributary inflows of fresh water to the Delaware Estuary, as compared to sea water. For example, USGS regularly collects water samples above the head of tide on the Delaware River at Trenton and on the Schuylkill River at Philadelphia. Analysis of these samples shows that chlorides in tributary inflows averaged about 9% of TDS in 1964-65, and about 13% in the period 1988-92.

USGS maintains permanent, continuous water quality monitoring stations on the Delaware River in the vicinity of Philadelphia. Measurements at these stations include conductivity and temperature, but not direct measurement of chlorinity. In lieu of direct chlorinity measurement, DRBC has developed and adopted empirical relationships between conductivity and chlorinity. Chlorinity at water quality monitoring stations is computed from the observed conductivity data using the following relationships developed by DRBC:

Conductivity Range K = Specific Conductance (microsiemens/cm at 25°C)	**Equation:** Cl (ppm) = f(K)
$K < 249.6$	$8.092 \times 10^{-4}\ (K)^{1.7687}$
$249.6 \le K \le 525.7$	$3.236 \times 10^{-5}\ (K)^{2.3518}$
$K \ge 525.7$	$2.686 \times 10^{-2}\ (K)^{1.2789}$

For example, based on these equations, the range of conductivities from 0 to 525.7 corresponds to computed chlorinities from 0 to 81 ppm, respectively. It is noted here that the DRBC equations are based on an empirical best-fit to a finite number of analyzed water samples. Therefore, the predicted value of chlorinity is an approximation, not an absolute measure of the chloride ion concentration. Confidence limits for these conductivity-chlorinity relationships have not been established. Therefore, exact correlation is not expected when comparing model-predicted chlorinity to conductivity-predicted chlorinity. Instead, acceptable verification of model results is demonstrated if the model produces reasonable agreement in spatial and temporal salinity distribution and trends with respect to the spatially-limited prototype conductivity-chlorinity data available.

Figures 5-7 and 5-8 present comparisons of model versus prototype salinity at RM 82 and RM 100, for November 1965. It can be seen that the model reproduces the up-estuary movement of salinity during extremely low flow periods quite well, especially trends in the salt movement, and transient events such as occurred around 18 November.

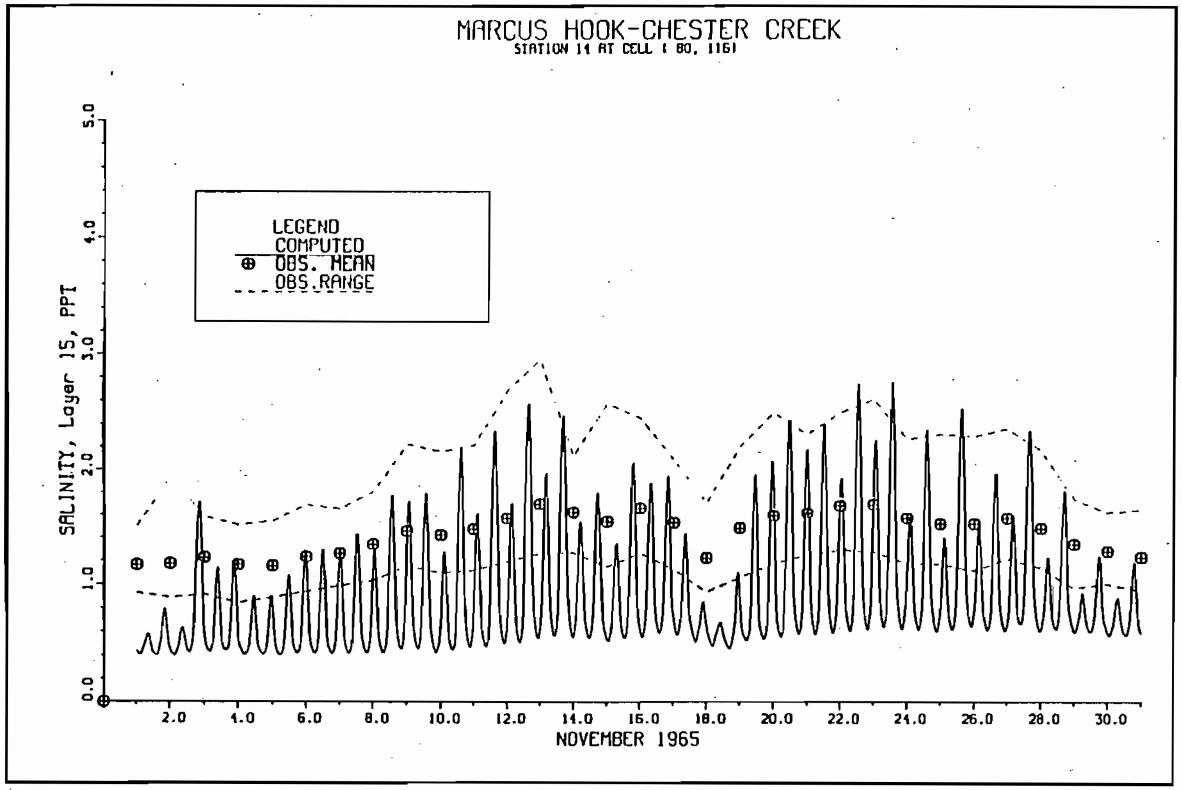
In summary, model verification has covered a wide range of inflow conditions ranging from the high inflows during April 1993 to extreme low flows during 1965. The model has been shown to reproduce water levels, flow velocities, and salinities well over this range of events. Bottom friction and horizontal diffusivity are the two principal parameters which are varied to attain verification of the model. These parameters were established for the October 1992 simulation, and were held constant for the other two verification simulations (April 1993 and June-November 1965), and for the production runs discussed in the following section.

5.10 Resources That Were Evaluated

5.10.1 Water Supply

The U.S. Environmental Protection Agency criterion for chlorides in domestic water supplies is 250 mg/l (USEPA, 1986). This criterion is based more on palatability than on health protection. For health purposes it is more important to consider sodium intake. It has been determined that for very restricted sodium diets, 20 mg/l in water would be the maximum, while for moderately restricted diets 270 mg/l would be maximum (USEPA, 1986). To date, the USEPA has not recommended maximum sodium concentrations for domestic water supplies. The State of New Jersey has adopted a sodium standard of 50 mg/l for drinking water.

In 1967, the DRBC adopted water quality standards to maintain acceptable salinity distribution throughout the tidal portion of the Delaware River (USACE, 1982). Seasonal streamflow objectives at Montague and Trenton, NJ, were established by DRBC for drought conditions in the Delaware River Basin. The flow objectives are defined as a function of season and the location of the "salt front," the seven-day average location of the 250 ppm isochlor.

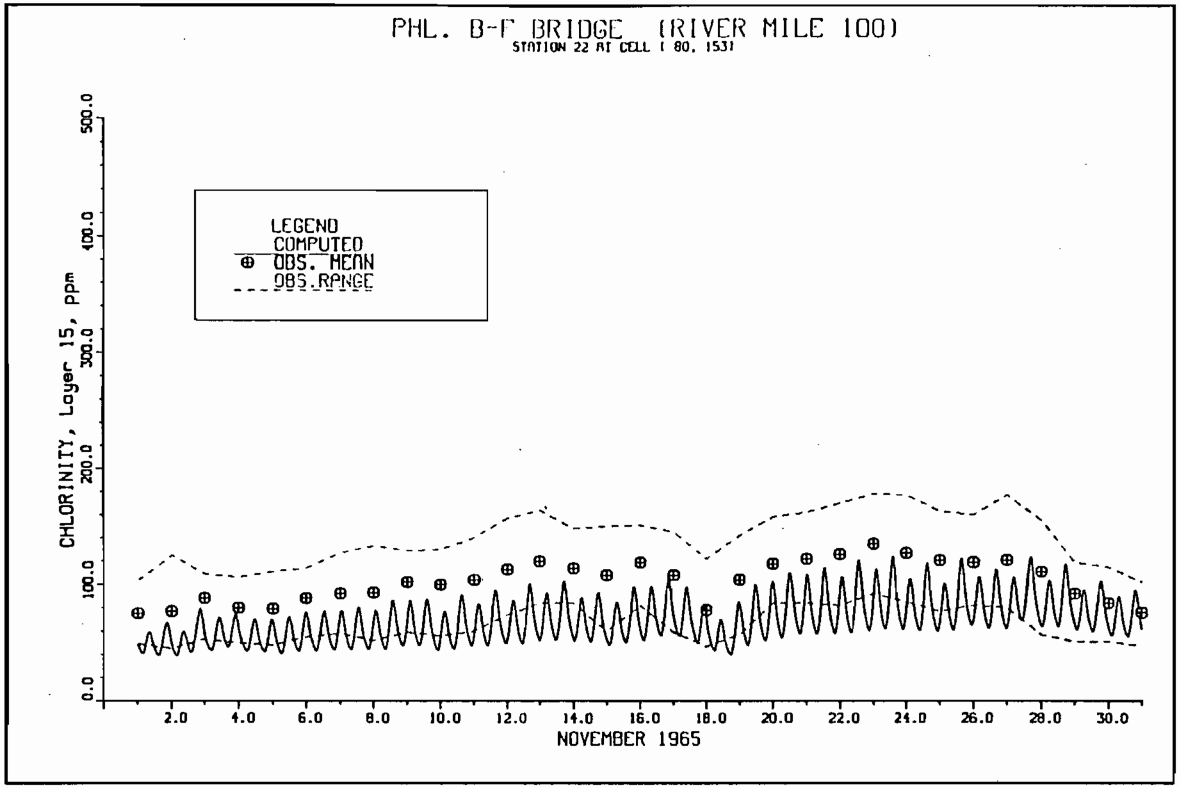


DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

November 1965 Model and Prototype Salinity, RM 82

U.S. Army Corps of Engineers, Philadelphia District

Figure 5-7



DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

November 1965 Model and Prototype Salinity, RM 100

U.S. Army Corps of Engineers, Philadelphia District

Figure 5-8

The location of the salt front is considered, along with Delaware River Basin reservoir storage, to manipulate reservoir releases to meet the flow objectives.

To evaluate potential impacts to water supplies, model output provided the maximum intrusion of the 250 mg/l isochlor and the 30-day average of the chloride concentration at River Mile 98. A 30-day average chloride concentration of less than 180 mg/l at RM 98 is the current DRBC chloride standard for the estuary. The RM 98 standard was established with the intent of protecting groundwater supplies in the Camden-metropolitan area of New Jersey from salt contamination. Based on the ratio of chloride ion to sodium ion concentration in sea water, a chlorinity of 180 mg/l is approximately equal to a sodium ion concentration of 100 mg/l. Considering the maximum rate of aquifer recharge from the Delaware River, and the State of New Jersey drinking water standard of 50 mg/l for sodium, the existing chloride standard was set at River Mile 98 as a reasonable interim objective for protecting the aquifer system.

The Potomac-Raritan-Magothy aquifer system is a significant water supply source for the Camden, New Jersey metropolitan area. River Mile 98 is the estimated seaward limit of the major connection between the estuary and the aquifer system (DRBC, 1981). Within the area of hydraulic connection between the river bed and the PRM aquifer, a portion of aquifer recharge, estimated by USGS (Navoy and Carleton, 1995) to be on the order of 23% of the total aquifer recharge, is from the Delaware River. Maintenance of appropriate salinity concentrations at River Mile 98 is intended to protect the aquifer system from salt water intrusion.

Additional USGS information provided by Navoy (USGS letter, January 1996) indicates that transient high-chlorinity events in the vicinity of RM 98 may not be as detrimental to PRM aquifer water quality as previously assumed. This is due to the combined effects of the travel time of river water recharging the aquifer, and the dilution of the recharging water within the aquifer. USGS has identified the vicinity of RM 105 (Pennsauken, NJ) as the zone of river-proximal wells with significant drawdown and hence a larger potential impact from transient high chlorinity water in the Delaware River. USGS ground water modeling of transient high-chlorinity events comparable to the drought of record indicate that ground water quality in river-proximal wells will not violate potability standards. These recent findings by USGS are not reflected in the DRBC standard for chlorinity at RM 98; the 30-day average chlorinity standard for RM 98 remains as "less than 180 ppm." The DRBC Flow Management Technical Advisory Committee (1996) has undertaken a comprehensive review and reconsideration of the basin drought operations plan and modeling assumptions with respect to the appropriateness of the present RM 98 chlorinity standard. The DRBC (1989) indicated that the Parties to the Good Faith Agreement for the Delaware River Basin recommended a more stringent salinity objective at River Mile 98 for aquifer protection. This objective would have a 30-day average of less than 150 mg/l of chlorides. In order to meet this more stringent objective, it has been determined that additional reservoir storage would be required to maintain the necessary streamflow within the Delaware River at Trenton, New Jersey (USACE, 1982). As such, this contemplated salinity objective would not be put in place until additional reservoir storage is available.

5.10.2 Aquatic Resources

Salinity distribution in the Delaware Estuary is primarily the result of saltwater inflow from the adjacent Atlantic Ocean and freshwater flow from the Delaware Basin drainage area (Smullen et al., 1983). The mixing of fresh and salt water forms a gradient from less than 0.5 parts per thousand (ppt) in the tidal river to about 32 ppt at the mouth of the bay (Ichthyological Associates, 1980). The U.S. Fish and Wildlife Service (1981a) characterized four salinity zones within the Delaware Estuary. These are polyhaline (18 - 30 ppt) from the mouth of the bay to the vicinity of the Leipsic River (River mile 34), mesohaline (5 - 18 ppt) from the Leipsic River to the vicinity of the Smyrna River (River Mile 44), oligohaline (0.5 - 5 ppt) from the Smyrna River to the vicinity of Marcus Hook (River Mile 79), and fresh 0.0 - 0.5 ppt) from Marcus Hook to Trenton (Figure 5-9).

The Delaware Estuary salinity gradient is not a static environmental condition, but one subject to short and long-term change. Due to variations in factors such as freshwater flow, tidal height and stage, and weather conditions, specific salinities move within the estuary from 10 to greater than 20 miles. The upper and lower zones of the estuary are dominated by fresh water and salt water flows, respectively. The extreme dominance of one type of water in each of these zones maintains relatively stable salinity levels over time. The mid-estuary serves as a mixing zone for fresh and salt water. As such, this zone is more heavily influenced by fluctuations in tidal and river flow, and subject to greater variations in salinity.

Vegetation, aquatic organisms, and to a lesser degree, wildlife distribute themselves within the estuary, based on their salinity tolerances. Freshwater organisms, those that can not tolerate high salinity, restrict their distribution to the freshwater portion of the estuary generally located above Wilmington, Delaware. Marine organisms, those that require high salinities, restrict their distribution to the lower bay. Organisms that can function over a broad range of salinity will inhabit the portion of the estuary that is within their tolerance range. It should be kept in mind that salinity is only one environmental factor affecting the distribution of organisms within the estuary. It would be necessary to consider a variety of other factors to precisely define the limits of a particular species within the estuary.

In 1981, the U.S. Fish and Wildlife Service prepared a planning aid report in support of the Philadelphia District's Delaware Estuary Salinity Intrusion Study (USFWS, 1981a). That report provides a discussion of how various components of the Delaware Estuarine ecosystem relate to salinity, and require specific salinity patterns to carry out portions of their life cycle. The following excerpt from the report characterizes the influence of salinity on the oligo-mesohaline portion of the estuary:

> "The information we have reviewed shows that salinity exerts strong influence on the Delaware estuarine ecosystem. Briefly, it influences the distribution of marsh plants, benthic invertebrates, fishes and certain wildlife. Relatively few aquatic species are tolerant of the entire salinity gradient from fresh water to salt water. Most species occupy portions of the gradient beyond which survival is threatened. Salinity affects seed germination and growth of marsh plants; oyster drill predation and probably MSX disease in the oyster seed beds; movement of blue crab larvae; location of blue crab spawning, nursery and mating grounds; movement of fish eggs and larvae; location of spawning, nursery and feeding grounds of fishes; muskrat production; and, waterfowl feeding and resting grounds. The overall effect of the salinity gradient is to create numerous niches, fostering wide ecologic diversity and high productivity. Literally hundreds of plant and animal species, some with populations numbering in the many thousands, utilize the Delaware estuary."

The report concludes that a shift in salinity patterns could result in a variety of impacts, which would cumulatively lower the overall productivity of the estuarine system. While more stable, relative to salinity, the freshwater and polyhaline zones of the estuary could also be affected by extreme events of drought or flood.

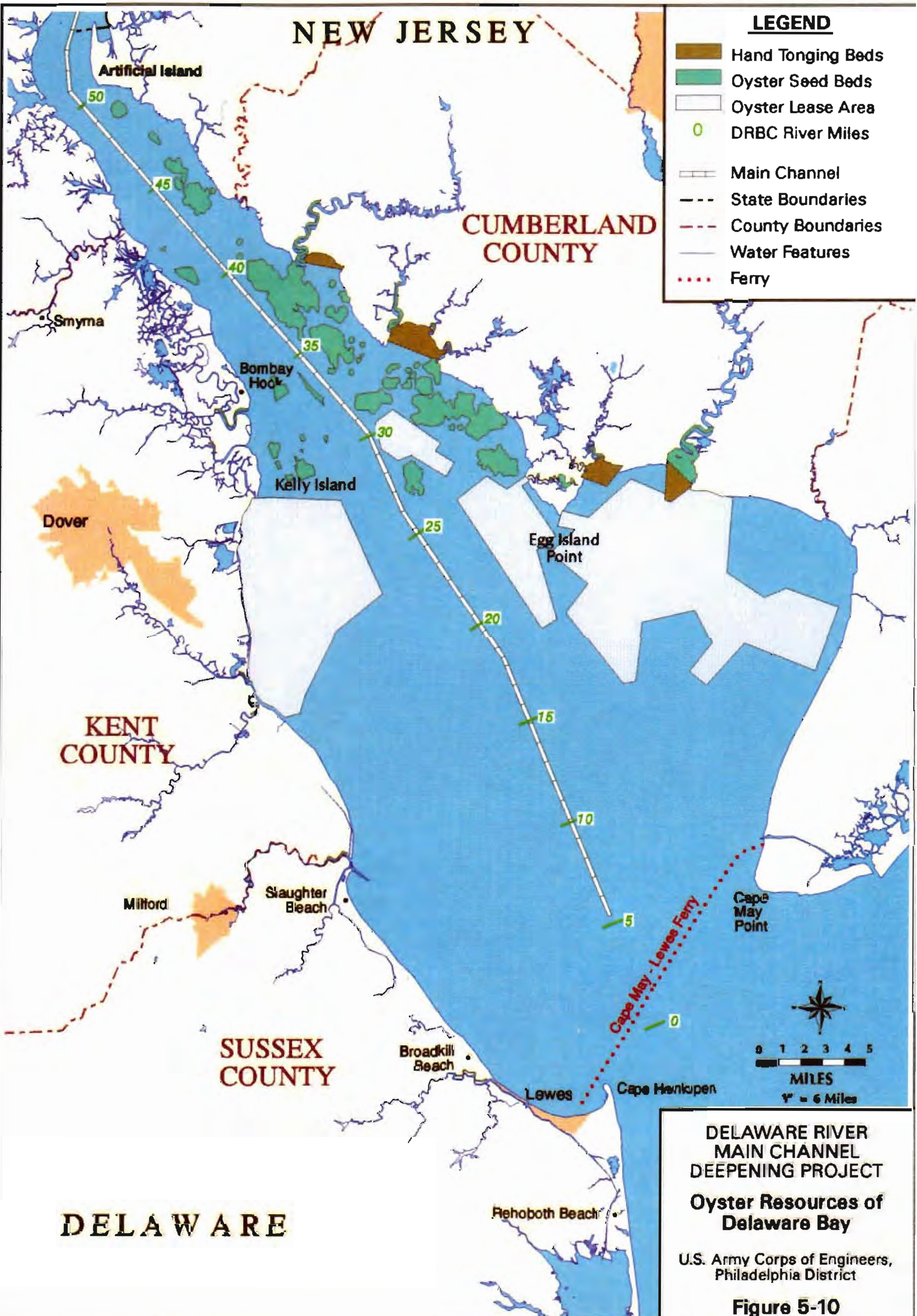
Based on the 1989 DRBC 1-D salinity modeling of the drought of record and the computed movement of the 250 mg/l isochlor with a deepened channel, concerns were raised relative to a potential increase in salinities throughout the estuary, and the ecological impacts associated with such an increase. In order to address these concerns, the WES 3-D model was used to provide data pertaining to the movement of three other isohalines for the existing and deepened channel geometries. Isohalines were selected to cover various locations in the estuary and/or to correspond to salinities of significance relative to various components of the estuarine ecosystem. The isohalines were 15 ppt (equivalent to approximately 8303 mg/l chlorinity), 10 ppt salinity (5535 mg/l chlorinity), and 5 ppt salinity (2768 mg/l chlorinity).

The isohaline corresponding to 15 ppt salinity was selected because it is considered significant relative to the protection of the American oyster (Crassostrea virginica) in Delaware Bay. Traditionally, the Delaware Bay oyster industry has been dependent on two locations within the bay. In waters within the State of Delaware, oysters occur in naturally reproducing seed beds offshore and north of Kelly Island and in leased bed areas south of Kelly Island down to the Mispillion River area. In New Jersey waters, oyster seed beds occur from south of Artificial Island to Fortescue; lease beds occur from southwest of Egg Island Point throughout much of the lower Bay (See Figure 5-10). These low salinity seed bed areas provide a refuge for young oysters to grow, free from predation and competition that limits survival success in higher salinity, downbay water. It has been common practice to remove young oysters from these beds in May and June, and transplant them to privately leased beds. The higher salinity in this area promotes faster growth of the oysters, bringing them to market size in less time.

A major predator of the oyster in Delaware Bay is the oyster drill (Urosalpinx sp.). The oyster drill can cause substantial damage to oyster beds when present in abundance. Reproductive success and distribution of the oyster drill is correlated with salinity levels (USFWS, 1979). Salinities below 15 ppt will control reproduction and limit drill infestation, thus minimizing damage to oyster beds.

Delaware Bay oysters are also subject to high mortalities during outbreaks of a sporozoan parasite classified as Perkinsus marinus. This parasite is commonly referred to as MSX. The initial MSX kill in Delaware Bay occurred in 1957 when nearly half the oysters on the New Jersey leased grounds died within six weeks. A second kill in 1958 spread over all of the lower bay and onto the seed beds as far upbay as the Cohansey River.

Patterns of MSX occurrence suggest that salinities of about 15 ppt or greater favor the spread of the organism. While salinity does not account for all phases of MSX activity, 15 ppt salinity or less appears to be sufficient to protect the oyster. Based on the above, the 15 ppt isohaline was tracked in the model to



DELAWARE RIVER
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Oyster Resources of Delaware Bay

U.S. Army Corps of Engineers, Philadelphia District

Figure 5-10

assess potential impacts to oysters from the oyster drill and MSX. Powell (1995) states that there would be no problems for oysters with an average salinity increase of up to 1 ppt; a increase in the range of 1 ppt to 5 ppt may cause problems; and an increase greater than 5 ppt would cause problems for oysters.

The isohaline corresponding to a salinity of five ppt was selected because it relates to a shift in tidal wetland vegetation from freshwater to brackish. Walton and Patrick (1973) stated that salinity appears to be the principal factor influencing the composition of emergent vegetation along the Delaware Estuary. A variety of freshwater species such as wild rice (Zizania aquatica), arrowhead (Sagittaria spp.), dotted smartweed (Polygonum punctatum), and spatterdock (Nuphar luteum) cannot tolerate salinities above five ppt for extended periods of time (USFWS, 1981b). Prolonged exposure to high salinities result in plant stress and ultimately death of vegetation. High salinities also inhibit seed germination processes. The combined result of these impacts would be lower productivity. Freshwater tidal wetland habitats occur in the Delaware Estuary from Trenton, New Jersey to Wilmington, Delaware (Schuyler, 1988). Shoreline plant species that usually grow in brackish conditions now extend farther upstream in the Delaware River than they did earlier in the 20th century. Conversely, common shoreline species usually associated with freshwater conditions have not been found as far downstream as they have in the past. These upstream and downstream distributional changes indicate that an increase in dissolved solids and chlorides has occurred in the Delaware River (Schuyler, Andersen, and Kolaga. 1993).

The third isohaline tracked with the 3-D Model corresponded to a salinity of 10 ppt. This isohaline can fluctuate over a 30-mile stretch of the estuary, generally between Egg Island Point and Artificial Island. This portion of the estuary provides valuable spawning and nursery habitat for a variety of estuarine fishes. A shift in salinity patterns could reduce the amount of habitat available for spawning and early growth. This isohaline was also selected because it is midway between isohalines corresponding to five and 15 ppt, which were selected for the reasons stated above. Results of the isohaline tracking are presented and discussed in the following paragraphs.

5.11 Simulations to Assess the Impacts of a 45 Foot Channel

Several scenarios were identified and selected for application in the 3-D model to address the impact of channel deepening on salinity distribution and subtidal circulation in the Delaware Estuary. The selection of these sets of conditions was based on coordination accomplished through the interagency workshops described earlier in this section of the report. The selected scenarios include:

1. The June-November 1965 drought of record, with Delaware River discharges adjusted to reflect the existing reservoir regulation plan and corresponding flows ("Regulated 1965");

2. Long-term monthly-averaged inflows with June-November 1965 wind and tide forcings; and

3. A high flow transition period, represented by the April-May 1993 prototype data set.

Each of these periods was simulated first with the existing 40 foot navigation channel, and then with the proposed 45 foot channel in place.

Several types of model output were developed to aid in the analysis and presentation of impacts of channel deepening. These include time series plots of salinity at several locations throughout the modeled system; time history of 30-day average chlorinity at RM 98; the location of the 30-day average 180 ppm and 7-day average 250 ppm isochlors as a function of time; the location of monthly averaged salinity contours of 0.25 ppt, 5.0 ppt, 10.0 ppt, and 15.0 ppt; and subtidal circulation plots.

Since the model computes the transport and distribution of salinity (total dissolved solids), rather than chlorinity as is used by DRBC for water quality standards in the Philadelphia area, model values of salinity were converted where necessary to equivalent values in chlorinity units using the relationship described previously in the section on the June-November 1965 verification. The principal chlorinity-based water quality standards adopted by DRBC for the Philadelphia region include: the seven-day average location of the 250 ppm isochlor (adopted as the "salt front"); and the 30-day average chlorinity at RM 98 (180 ppm chlorinity is the standard for maximum allowable chlorinity intended to protect groundwater recharge from the river into the PRM aquifers which supply groundwater to the Camden Metropolitan area in New Jersey).

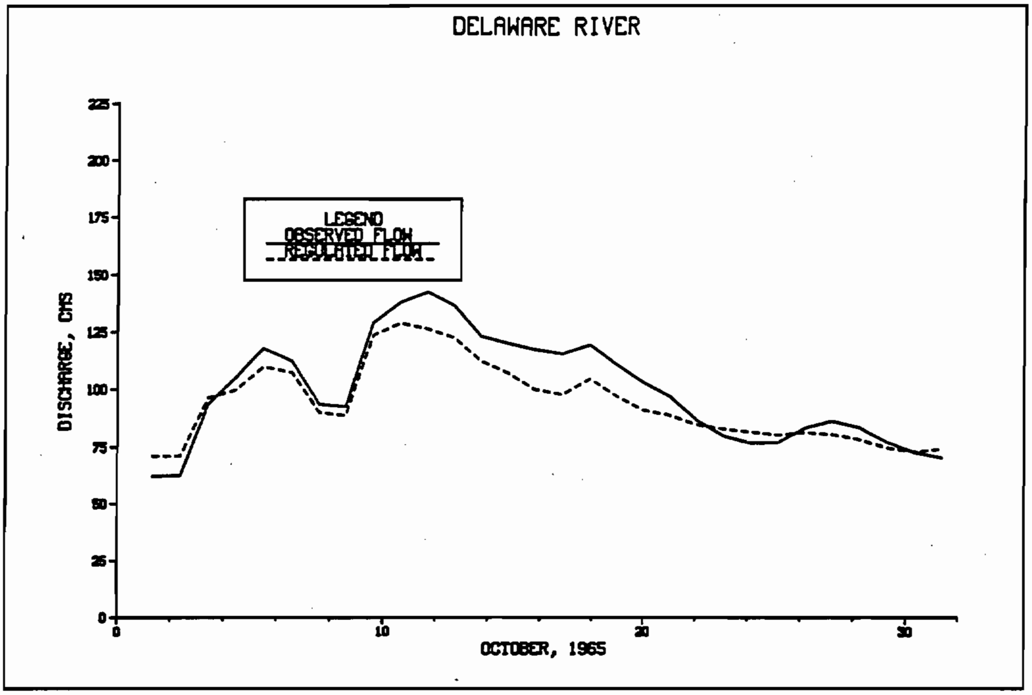
5.11.1 Regulated June-November 1965 Simulation

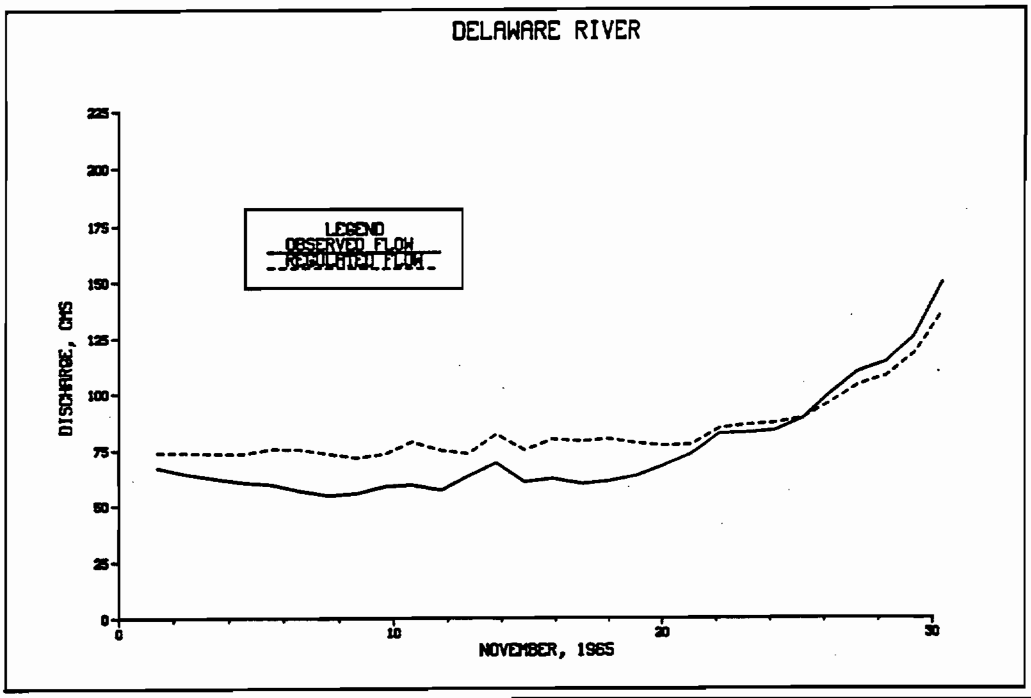
This simulation is considered the most critical of the scenarios modeled. It represents the salinity impacts of channel deepening accompanying a recurrence of the drought of record, modified to reflect the existing drought management plan which allows for augmented flows at Trenton, New Jersey in the interest of salinity repulsion. A comparison of the hypothetical regulated flow at Trenton and the actual flows that occurred during this period October-November 1965 is presented in Figure 5-11. The historic and regulated flow data were provided by DRBC. All other model boundary conditions were the same as in the historic June-November 1965 data set. The figure shows that when the actual flow is greater than about 3500 cfs (99 cms) the regulated flow is lower, whereas when the actual flow dropped below about 2625 cfs (74 cms) the regulated flow is higher. As will be demonstrated in the results presented below, the regulated flow scenario produces salinity conditions in the Philadelphia vicinity which are not as severe as those which occurred under the actual 1965 flow conditions.

Time series plots for the regulated November 1965 period showing the impact of channel deepening on the salinity regime at selected sites throughout the bay and river sections of the Delaware Estuary are presented in Figures 5-12, 5-13, and 5-14. The top panel of each figure show model-predicted near-bottom salinity for the 40 and 45 foot channels. The bottom panel shows the salinity difference between the 40 and 45 foot channels. The data show that deepening the channel has practically no impact on salinities in the lower bay, i.e., at RM 27. At RM 69, the salinity increase attributable to channel deepening is approximately 0.5 ppt, with absolute salinities on the order of 4 to 6 ppt. At RM 98, the maximum instantaneous near-bottom chlorinity for the deepened channel attains a value of about 270 ppm in the November 1965 simulation. The chlorinity increase due to deepening at RM 98 averages about 50 ppm for the November 1965 simulation.

Figure 5-15 displays data on the 30-day average chlorinity at RM 98, near-surface and near-bottom, for the month of November 1965. It can be seen that although the deepened channel increases the 30-day average near-bottom chlorinity from about 120 ppm to 160 ppm at RM 98 in November, the DRBC standard of 180 ppm is never attained. Near-surface 30-day average chlorinity for the same period remains below 150 ppm with the deepened channel. It should be noted that the USGS conductivity-temperature measurements at RM 100 are obtained from a near-surface sensor in the river.

A number of summary tables have been created from the large amount of data generated by the model to characterize the distribution of salinity throughout the estuary for the regulated July-November 1965 simulation, and to characterize the range of salinity impacts associated with the channel deepening. Table 5-1 presents the monthly maximum values of the 30-day average chlorinity at RM 98. For the months of July through November 1965, values are presented for the 40 foot channel, the 45 foot channel, and the difference between them. Table 5-2 shows the typical monthly range in salinity at the 16 sites at which data



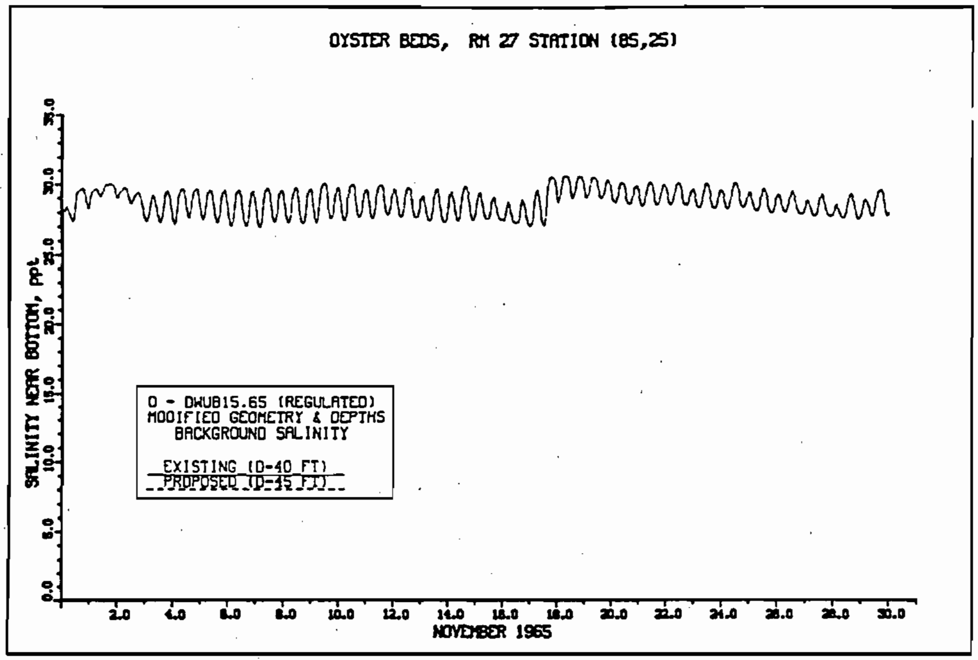


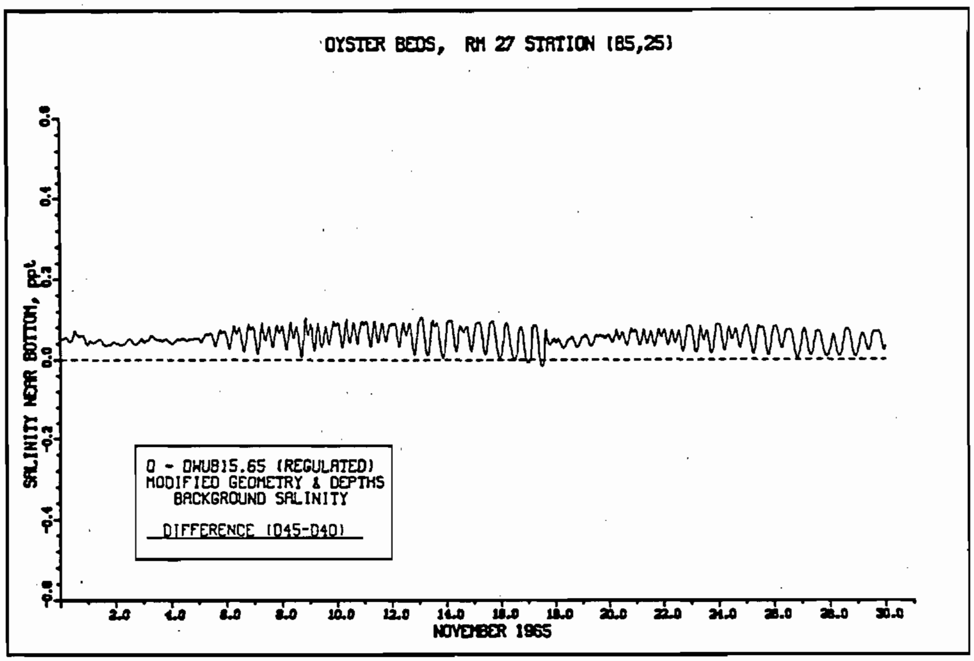
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

October - November 1965 Historic and Regulated Flows, Delaware River at Trenton

U.S. Army Corps of Engineers, Philadelphia District

Figure 5-11



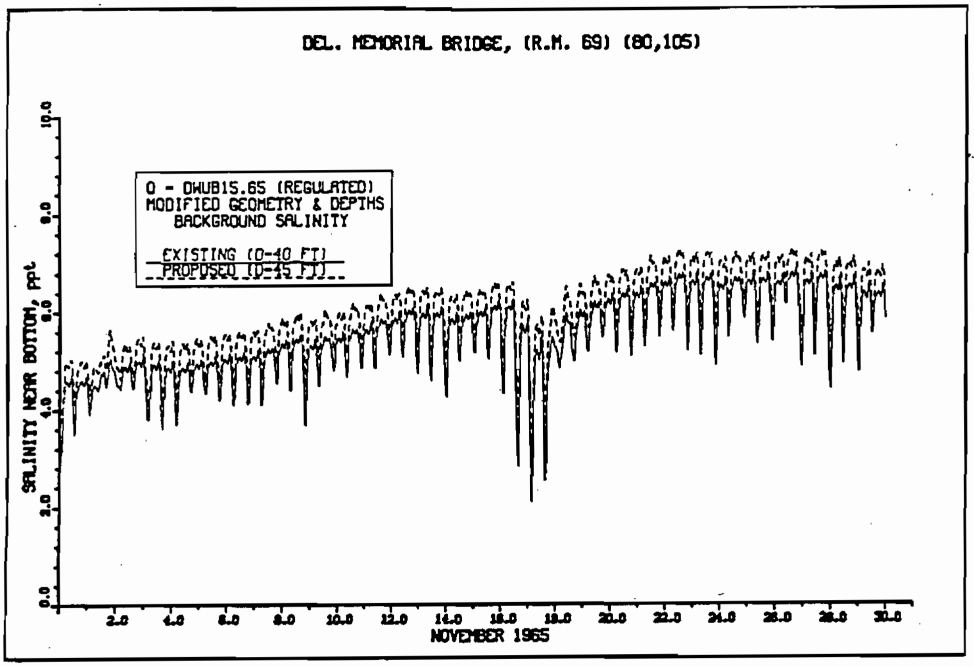


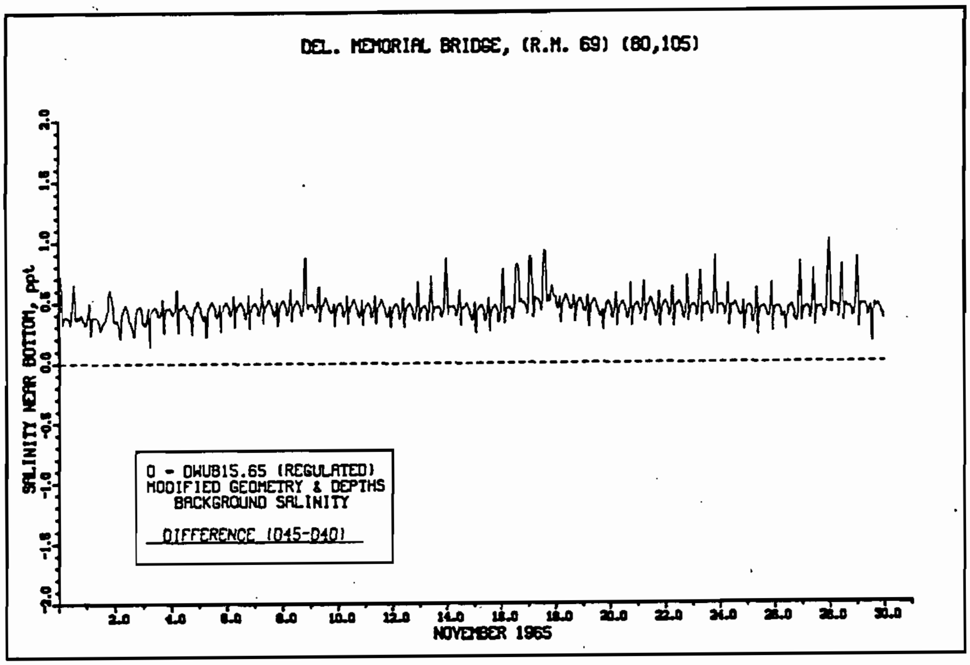
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Regulated Nov 1965 Scenario
RM 27 Bottom Salinity,
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-12



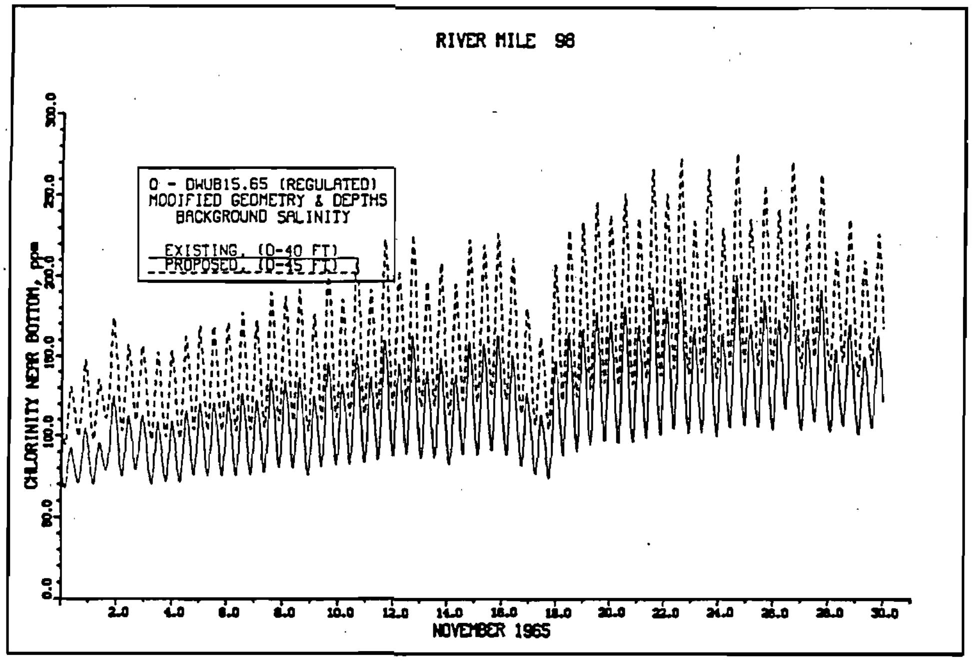


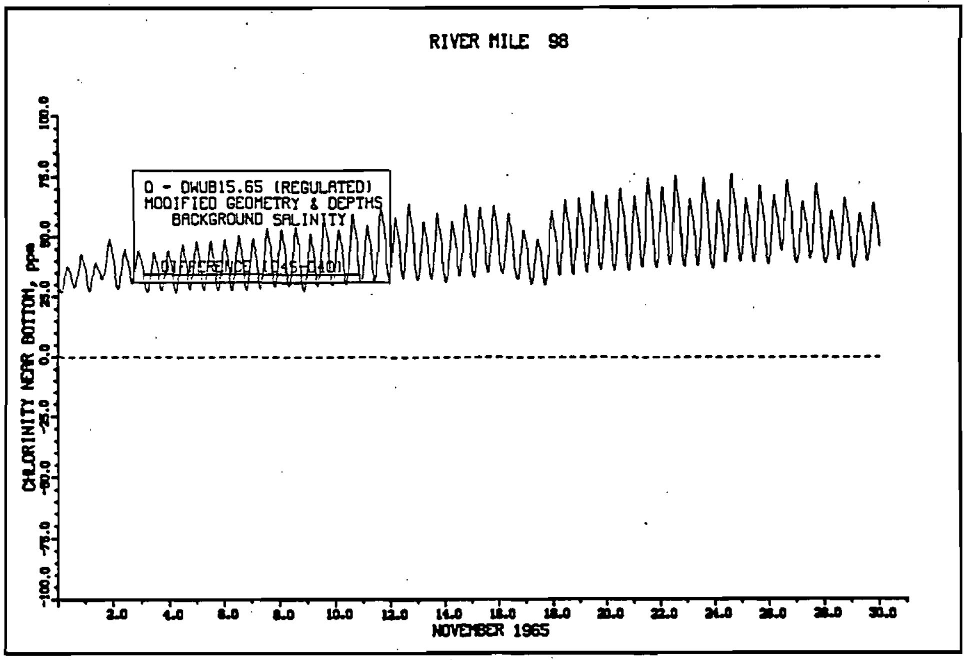
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Regulated Nov 1965 Scenario
RM 69 Bottom Salinity,
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-13



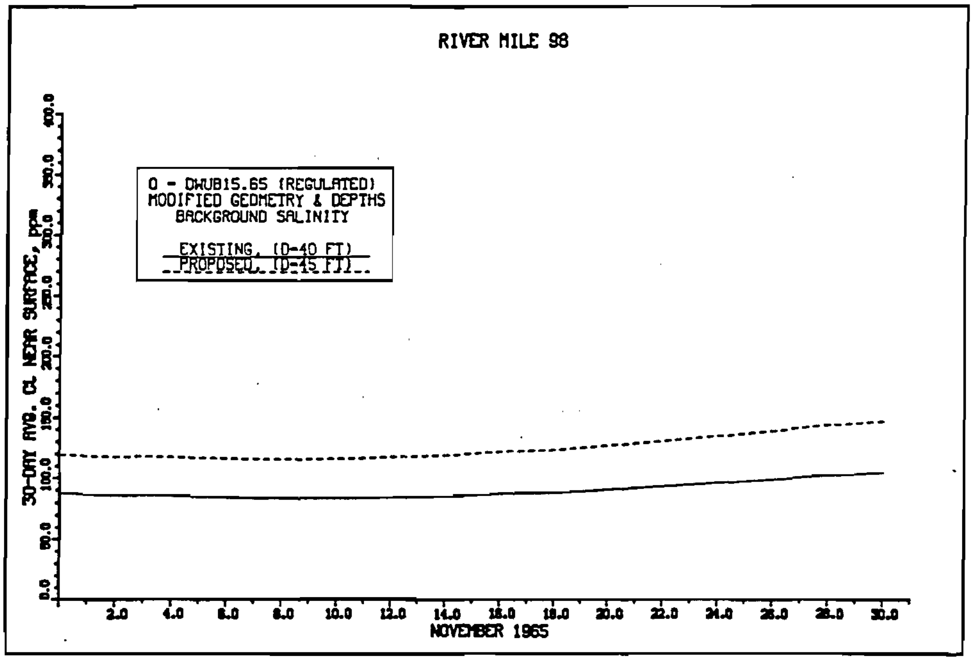


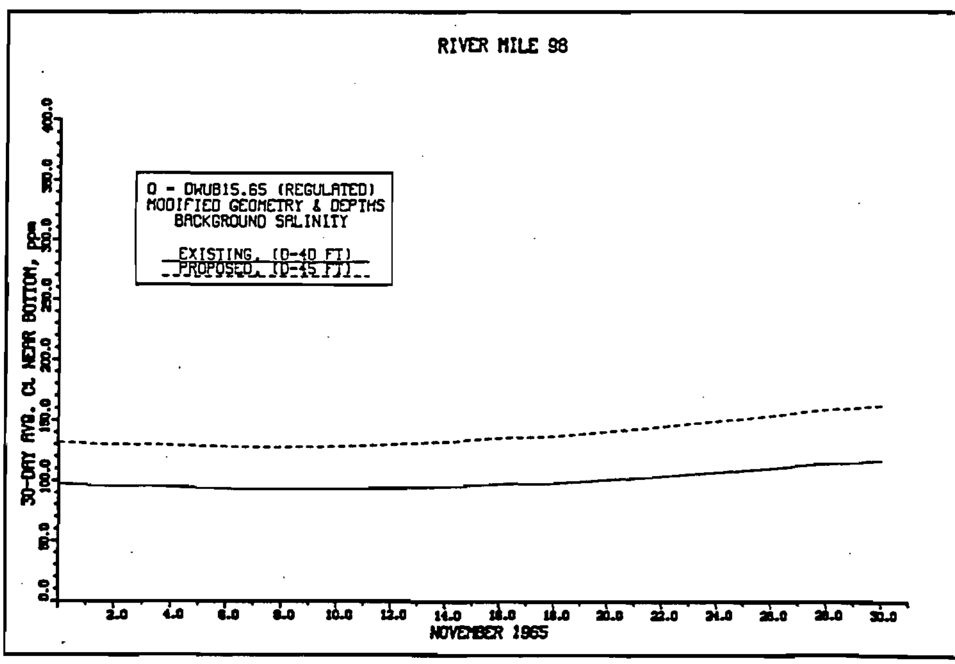
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Regulated Nov 1965 Scenario
RM 98 Bottom Salinity,
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-14





DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Regulated Nov 1965 Scenario
RM 98 30-day Average Chlorinity
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-15

Table 5-1. Thirty-day Average Chlorinity (ppm) at RM 98.
Scenario: Regulated Drought, July - November 1965.
Monthly Maximum Values, Near-Surface and Near-Bottom.
3-D Model Results.

	JULY 1965		AUGUST 1965		SEPT 1965		OCTOBER 1965		NOVEMBER 1965	
	SURF	BOT	SURF	BOT	SURF	BOT	SURF	BOT	SURF	BOT
40 FT CHANNEL	44	49	73	81	98	105	101	109	109	118
45 FT CHANNEL	59	62	96	108	128	137	132	144	150	163
DIFFERENCE	15	13	23	27	30	32	31	35	41	45

Table 5-2. Salinity at Selected Locations within Delaware Estuary.
Scenario: Regulated Drought, July - November 1965.
Salinity Range with 40 ft Channel, and Difference with 45 ft Channel.
3-D Model Results.

SALINITY DIFFERENCES DUE TO DEEPENING FROM 40 TO 45 FT

	JULY 1965 SALINITY (ppt)		AUGUST 1965 SALINITY (ppt)		SEPTEMBER 1965 SALINITY (ppt)		OCTOBER 1965 SALINITY (ppt)		NOVEMBER 1965 SALINITY (ppt)	
LOCATIONS	Month Range 40 ft Channel	Month Avg Diff @ 45	Month Range 40 ft Channel	Month Avg Diff @ 45	Month Range 40 ft Channel	Month Avg Diff @ 45	Month Range 40 ft Channel	Month Avg Diff @ 45	Month Range 40 ft Channel	Month Avg Diff @ 45
RM 100 (ppm Cl)	10 - 55	15	40 - 80	25	60 - 100	25/30	50 - 120	25/30	60 - 135	35/40
RM 98 (ppm Cl)	15 - 65	15	50 - 90	25	70 - 125	30/35	60 - 130	30/35	70 - 165	45/50
RM 79	0.3 - 2.0	0.2	0.4 - 2.0	0.2	0.5 - 2.0	.2/.3	0.5 - 2.0	.2/.3	0.5 - 3.0	.3/.4
RM 69	2 - 5	0.1/0.2	2 - 5	.2/.3	3 - 5	.2/.3	3 - 5	.3/.4	3 - 7	.4/.5
RM 54	6 - 11	0.2/0.4	6 - 11	.2/.3	6 - 12	.2/.4	7 - 13	.4/.6	8 - 17	.4/.6
RM 43 (OYST. A)	15 - 21	0.1	14 - 21	0.1	15 - 22	0.1	16 - 23	0.1	18 - 26	.05
(OYST. B)	15 - 20	0	13 - 20	.05	16 - 20	.05	15 - 22	.05	17 - 24	0
(OYST. C)	15 - 20	0	13 - 20	.05	16 - 20	0	14 - 21	.05	16 - 24	0
RM 38 (OYST. D)	21 - 25	0	19 - 24	.05	21 - 25	.05	21 - 27	0	24 - 28	0
(OYST. E)	19 - 23	0	18 - 22	.05	20 - 23	0	19 - 24	0	22 - 26	0
(OYST. F)	19 - 22	0	18 - 21	0	19 - 21	0	18 - 22	0	20 - 25	0
RM 36	21 - 26	0/0.1	20 - 26	0/0.1	22 - 26	0/0.1	23 - 28	0/0.1	25 - 29	0/0.1
RM 27 (OYST. G)	25 - 28	.05	24 - 28	.05/0.1	25 - 29	.05	25 - 30	.05	27 - 30	.05
(OYST. H)	22 - 25	.05	22 - 25	.05	22 - 26	.05	23 - 27	.05	24 - 28	.05
(OYST. I)	20 - 24	0	20 - 23	.05	20 - 23	.05	21 - 24	0	22 - 26	0
RM 24	26 - 30	.05/0.1	25 - 29	.05/0.1	27 - 30	.05/0.1	27 - 31	.05/0.1	29 - 31	.05

NOTE: Column "MONTH AVG DIFF @ 45" - if single value shown, diff. at surface and bottom are approx. equal.
If two values shown, first is diff. at surface, second is diff. at bottom.

were saved during the 40- and 45-foot channel simulations. For each month of the simulation, the first column of data presents the range of salinity with the 40 foot channel, and the second column presents the change attributable to the deepening to 45 feet. Note that data at RM 98 and RM 100 are presented in units of "ppm Cl" rather than in units of "ppt salinity" applied to other data save points. This change of units was adopted to facilitate comparison of model data from RM 98 and 100 to the DRBC standards, which are defined in units of ppm chlorinity.

Table 5-2 shows the monthly salinity range and differences due to deepening at selected locations for the July to November 1965 period. In the polyhaline portion of the estuary, represented by River Miles 24 and 27, the model predicts monthly average salinity increases on the order of 0.0 to 0.1 ppt. In the mesohaline portion of the estuary, represented by data at RMs 36, 38, and 43, the model predicts monthly average salinity increases on the order of 0.0 to 0.1 ppt. In the oligohaline portion of the estuary, represented by RMs 54, 69, and 79, the model predicts monthly average salinity increases on the order of 0.2 to 0.6 ppt. In the fresh water portion of the estuary, represented by RMs 98 and 100, the model predicts chlorinity increases in the range of 15 to 50 ppm.

Table 5-3 presents a summary of the seven-day average location of the 250 ppm isochlor (the "salt front" per DRBC definition) for the regulated July through November 1965 simulation. Results are tabulated as "minimum RM", "maximum RM", and "average RM", reflecting the upstream/downstream movement of this indicator as a result of dynamic boundary conditions of inflow, tide, source salinity, and wind. These results indicate that in the Regulated 1965 Drought simulation there would have been a 4.0-mile increase in maximum penetration of the salt front in November (from RM 92.2 to RM 96.2, Table 5-3), and a 45 ppm increase in 30-day average chlorinity at River Mile 98 in November (Table 5-1), attributable to the deepened channel.

Table 5-3 shows that with the 40 ft channel, the maximum intrusion of the 7-day average 250 ppm isochlor ranged between RM 83.4 in July and RM 92.2 in November. For the 45 ft channel, the maximum intrusion ranged between RM 84.8 and RM 96.2. Thus the 7-day average 250 mg/l isochlor (salt line) is predicted to penetrate further upstream during a recurrence of the drought of record with a deepened channel. This increase in penetration is predicted to range from 1.4 to 4.0 miles.

Table 5-4 provides summary data on the monthly-average location of selected isohalines for the 40 foot and 45 foot channels. The data are presented in two categories, "maximum intrusion" and

Table 5-3. Seven-day Average Location of 250 ppm Isochlor, by River Mile (RM). Scenario: Regulated Drought, July - November 1965. Values with 40 ft and 45 ft Channels, and Differences. 3-D Model Results.

LOCATION OF 7-DAY AVG 250 ppm ISOCHLOR

	MIN RM			MAX RM			AVG RM		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
JULY	81.0	80.2	-0.8	83.4	84.8	1.4	82.2	82.5	0.3
AUGUST	80.0	83.2	3.2	84.0	87.2	3.2	82.0	85.2	3.2
SEPT	81.4	85.6	4.2	87.8	90.8	3.0	84.6	88.2	3.6
OCT	81.0	85.0	4.0	88.8	92.0	3.2	84.9	88.5	3.6
NOV	81.4	86.6	5.2	92.2	96.2	4.0	86.8	91.4	4.6

Table 5-4. Monthly-averaged Location of Selected Isohalines, by River Mile (RM).
Scenario: Regulated Drought, August - November 1965.
Values with 40 ft and 45 ft Channels, and Differences.
3-D Model Results.

MONTHLY AVG LOCATION OF 0.5 ppt ISOHALINE (RM)

	MAX INTRUSION			AVG ACROSS FRONT		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
AUGUST	85.8	88.9	3.1	83.3	86.2	2.9
SEPT	88.4	88.9	0.5	85.3	88.4	3.1
OCTOBER	86.6	88.9	2.3	85.3	88.4	3.1
NOVEMBER	88.9	92.8	3.9	88.4	91.7	3.3

MONTHLY AVG LOCATION OF 5 ppt ISOHALINE (RM)

	MAX INTRUSION			AVG ACROSS FRONT		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
AUGUST	66.9	68.0	1.1	64.0	64.7	0.7
SEPT	69.1	69.9	0.8	65.7	66.9	1.2
OCTOBER	69.9	69.9	0.0	66.9	68.0	1.1
NOVEMBER	73.9	75.0	1.1	70.6	71.5	0.9

MONTHLY AVG LOCATION OF 10 ppt ISOHALINE (RM)

	MAX INTRUSION			AVG ACROSS FRONT		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
AUGUST	54.3	54.8	0.5	53.3	53.3	0.0
SEPT	55.3	55.8	0.5	54.3	54.8	0.5
OCTOBER	57.3	57.8	0.5	55.3	56.3	1.0
NOVEMBER	60.6	61.1	0.5	60.1	60.3	0.2

MONTHLY AVG LOCATION OF 15 ppt ISOHALINE (RM)

	MAX INTRUSION			AVG ACROSS FRONT		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
AUGUST	47.1	47.7	0.6	45.8	46.5	0.7
SEPT	48.4	49.1	0.7	47.7	47.7	0.0
OCTOBER	49.9	51.7	1.8	47.7	49.1	1.4
NOVEMBER	54.8	54.8	0.0	53.3	53.8	0.5

"average across front." This distinction is made to reflect the fact that the model shows the month-average locations of the selected isohalines to penetrate further upstream in mid-channel than at the shorelines. Thus "maximum intrusion" represents the location of a given isohaline attained at or near mid-channel, whereas "average across front" effectively represents the mean location of a given isohaline for each month. For the simulation of the drought of record, the incremental intrusion attributable to channel deepening ranged from 0.5 to 3.9 miles for the 0.5 ppt isohaline. For the 5.0 ppt isohaline, the incremental intrusion ranged from 0.0 to 1.2 miles; for the 10.0 ppt isohaline, 0.0 to 1.0 miles; and for the 15.0 ppt isohaline, 0.0 to 1.8 miles.

The 15 ppt isohaline, which is considered important to the survivability of the American oyster, would shift a maximum of 1.8 miles with the channel deepening. A change of salinity of less than 1 ppt will have no impact on oysters (Powell. 1995. Personal Communication). As seen from Table 5-2, the change in salinity in the oyster seed beds and lease areas, due to the 45 foot channel, was a maximum of 0.1 ppt. Data in Table 5-2 also indicate that the oyster seed bed areas will be exposed to salinity in excess of 15 ppt during a recurrence of conditions existing in the drought of record with or without the channel deepening. These data indicate that the deepened channel will not add significantly to the salinity levels at the oyster seed bed areas during severe drought conditions.

In its 1981 Planning Aid Report, the U.S. Fish and Wildlife Service indicated that a shift in salinity zones would also shift spawning and nursery areas for estuarine fishes. Such a shift could move eggs and larvae closer to the Salem Nuclear Generating Station (RM 53), which could possibly result in greater impingement and entrainment losses. Eggs and larvae of some species could also be moved closer to the Philadelphia pollution zone, which could result in lower survivability. The 10 ppt isohaline, which can fluctuate naturally over a 30 mile zone of the estuary and represents a reach that provides valuable spawning and nursery habitat for a variety of fishes, moved upstream an average of from 0.0 to 1.0 miles with the deepened channel (Table 5-4). Table 5-2 shows that the maximum monthly average increase in salinity within the mesohaline zone was 0.1 ppt. This does not represent a significant increase, and will not significantly impact the fish resources in this area.

The U.S. Fish and Wildlife Service (1981) also indicated that higher salinities could result in lower plant productivity, which could reduce food supplies for waterfowl and other wildlife. The 5 ppt isohaline represents a transition from fresh water to brackish vegetation. This isohaline would experience incremental intrusion due to channel deepening between 0.0 miles and 1.2 miles during a recurrence of the drought of record (Table 5-4).

Freshwater aquatic vegetation extends as far down stream as Wilmington, Delaware (Schuyler. 1988) at approximately RM 69. Table 5-2 shows that model-predicted salinity at RM 69 attained or exceeded 5 ppt from July thru November with the existing 40 ft channel. At RM 69, the largest increment in salinity attributable to channel deepening is 0.5 ppt. At RM 79, salinity does not exceed 3.0 ppt between July and November 1965 with the 40 foot channel. The largest increment in salinity in this period attributable to channel deepening is 0.4 ppt. It is possible that there would be a temporary, minor decrease in the distribution and productivity of freshwater aquatic plants, especially in the lower reaches of their range, during a severe drought with the deepened channel. After the drought period ends, the freshwater aquatic vegetation would be expected to recover.

In the freshwater portion of the estuary (0.0 - 0.5 ppt), the model predicts that during a recurrence of the drought of record, monthly average chlorinity would increase on the order of 15 to 50 ppm (Table 5-2) with the deepened channel. This chlorinity increment corresponds to a salinity increment between 0.03 and 0.09 ppt TDS. This portion of the estuary normally extends from Marcus Hook, Pennsylvania to Trenton, New Jersey. Salinities less than 0.5 ppt would not stress wetland vegetation in this portion of the estuary. Likewise, freshwater fishes can also tolerate low salinities. Many freshwater species that occur in the Delaware River are found in salinities as high as 10 ppt. Salinities less than 0.5 ppt would not influence the distribution of freshwater fishes in this portion of the estuary.

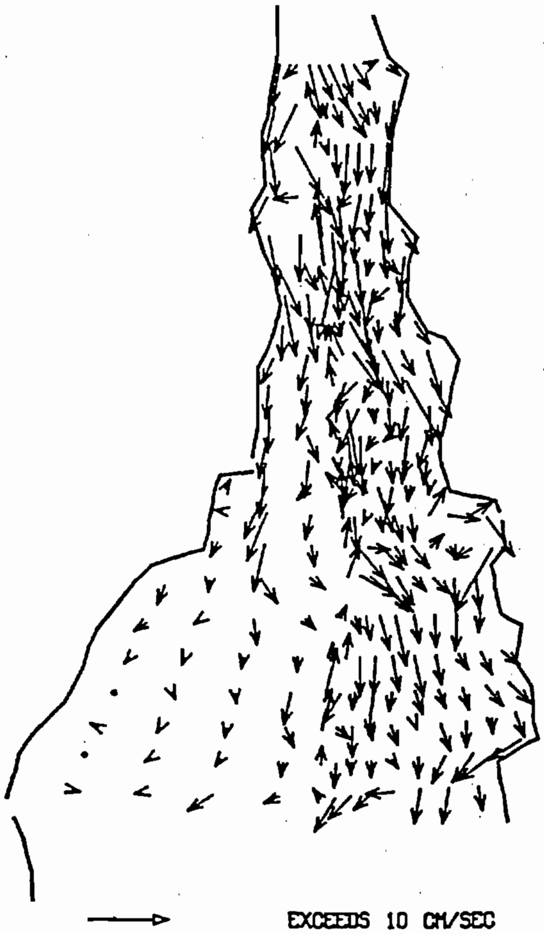
To this point, the discussion has focused on the predicted spatial (upstream) shift in salinity distribution attributable to the proposed deepening during a recurrence of the drought of record. There is a natural seasonal salinity cycle within the estuary that reflects typical seasonal changes in fresh water inflow. Salinity typically increases in the estuary from a minimum in April to a maximum in October or November, and then decreases to the following April. A salinity shift with a deepened channel means that a given salinity would reach a particular point in the estuary somewhat earlier than it would with the existing channel condition. On average, channel deepening with a recurrence of the drought of record would result in a given isohaline being from 0.0 to 3.3 miles further upstream compared to the 40 ft channel condition (Table 5-4). This shift is not considered large enough to diminish overall estuarine productivity, and is significantly less than salinity fluctuations resulting from semi-diurnal tidal exchange. As noted in Table 5-2, the greatest salinities occur in October and November. This time of the year is not considered significant relative to biological activity such as plant growth, fish spawning or nursery activities, blue crab spawning or nursery activities, or benthic productivity.

The impact of channel deepening on circulation in the estuary is illustrated in Figure 5-16. The plot shows near-surface residual current velocity for the month of November 1965. Residual current is defined as the average velocity over a period of time sufficiently long to remove the effects of the periodic, short-term tidal circulation. This type of plot was generated to address environmental concerns for potential circulation changes in the vicinity of oyster beds. The results show that changes in the residual circulation caused by channel deepening will be significantly less than 1.0 cm/sec, compared to total residual currents of less than 10.0 cm/sec.

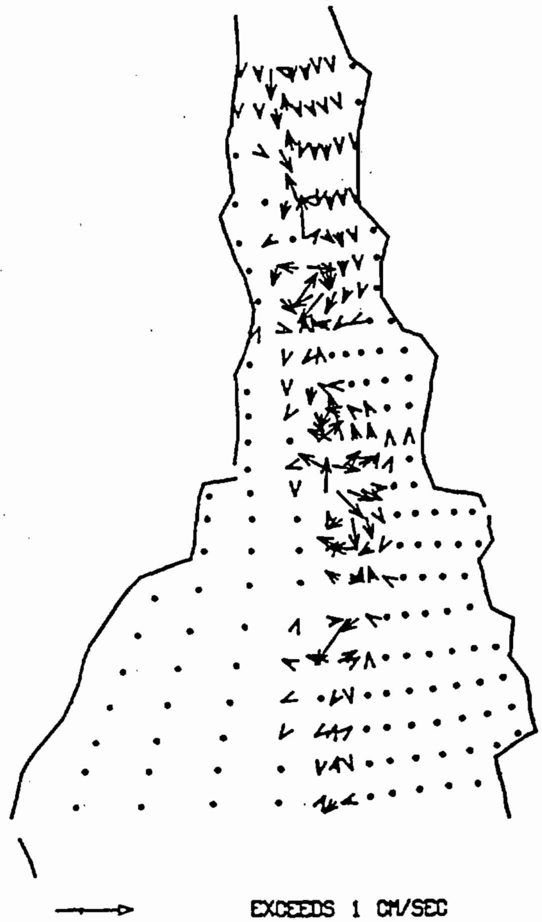
Based on the simulation of a recurrence of the drought of record with the present DRBC regulated inflow scheme in place, it is concluded that the predicted changes in Delaware Estuary salinity patterns resulting from a five-foot deepening of the existing navigation channel would not result in a perceptible decline in estuarine productivity or adversely impact water supplies in the vicinity of Philadelphia. The predicted upstream movement in salinity due to deepening would be significantly less than the seasonal changes in salinity distribution resulting from normal variations in river flow. The highest salinities would occur in October and November when significant biological functions such as spawning and nursery activities and plant growth do not occur.

5.11.2 Simulation of Monthly Average Flows

The simulations described in the preceding section, with regulated inflows during a recurrence of the drought of record, are particularly important with regard to impacts of channel deepening on Philadelphia area salinities. However, to provide insight on potential impacts during more normal conditions, model runs were made using the June-November 1965 winds, tides, and salinity boundary conditions combined with long-term average monthly inflows specified for the Delaware, Schuylkill, and Susquehanna Rivers. Figures 5-17 and 5-18 present time series of salinity at RM 27 and at RM 69, locations for which results were presented in the preceding discussion of the regulated June-November 1965 simulation. There is no ocean-derived salinity present at RM 98 for the monthly-averaged inflow condition, thus no plot of RM 98 salinity is presented. Under monthly-averaged inflow conditions, the maximum salinity at RM 69 is less than 1.0 ppt compared to 5-7 ppt for the regulated June-November 1965



a. Existing channel



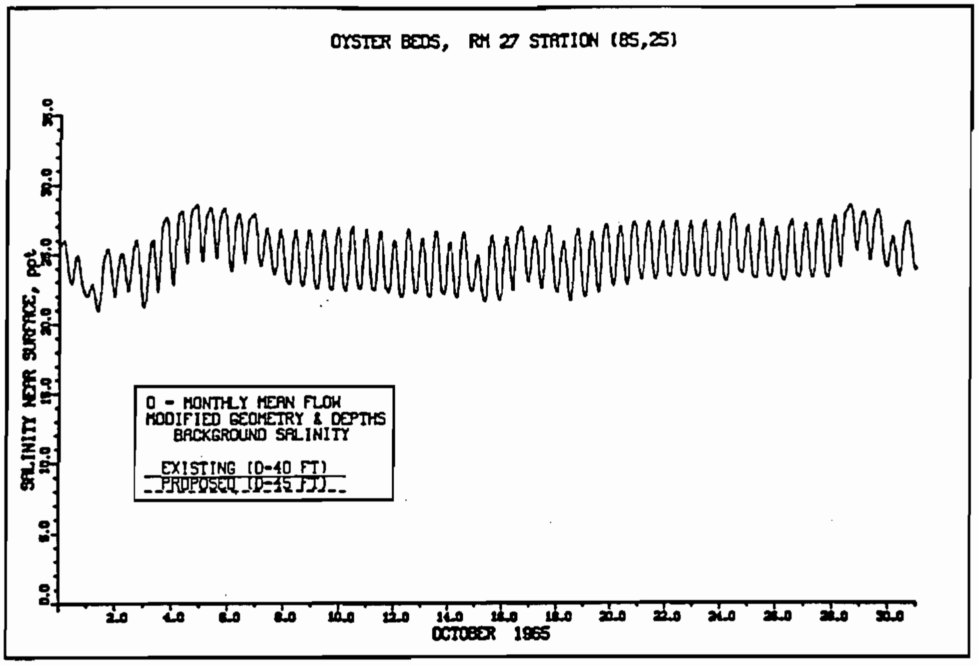
b. Impact of deepened channel

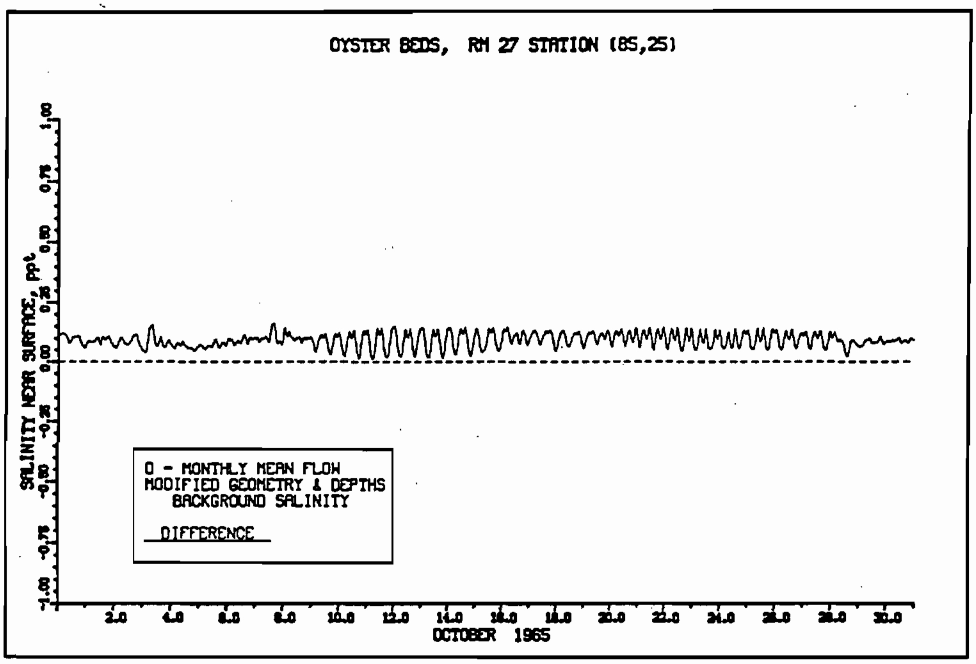
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Regulated Nov 1965 Scenario
Residual Near-surface Currents
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-16



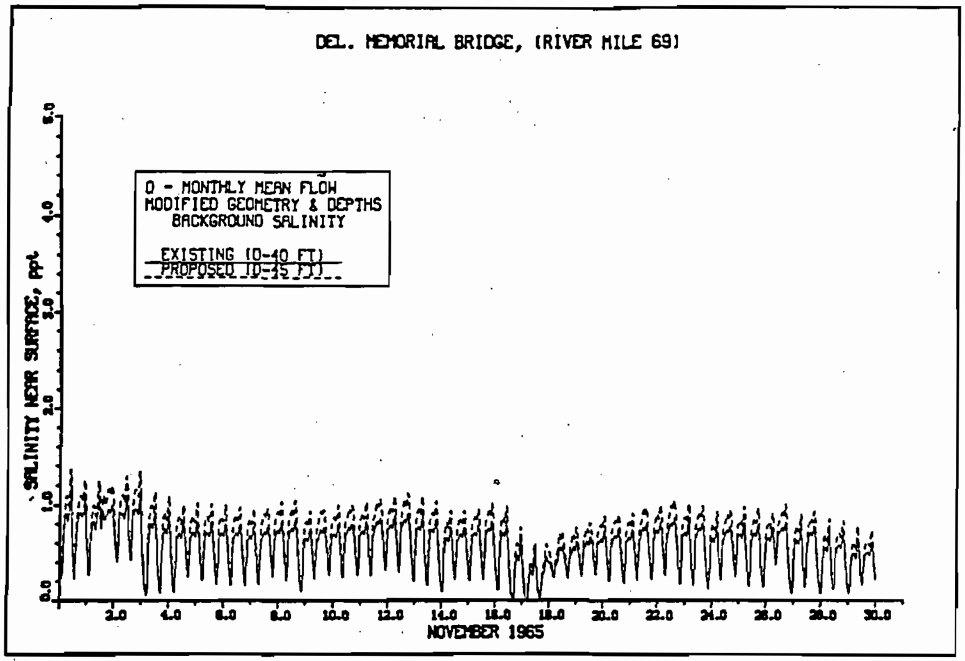


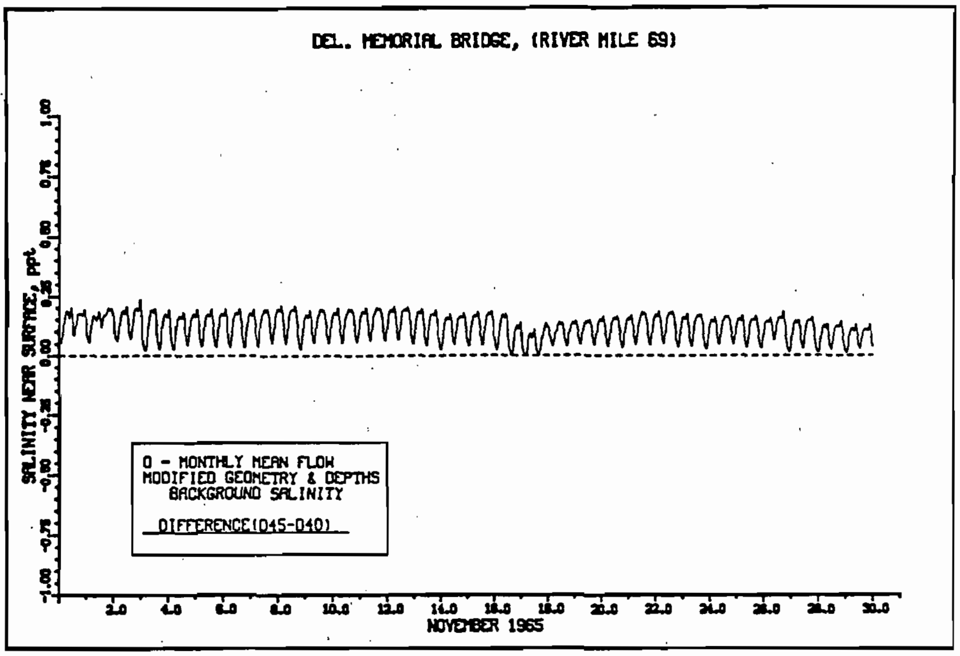
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Monthly Averaged Inflow Scenario, November
RM 27 Surface Salinity
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-17





DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Monthly Averaged Inflow Scenario, November
RM 69 Surface Salinity
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-18

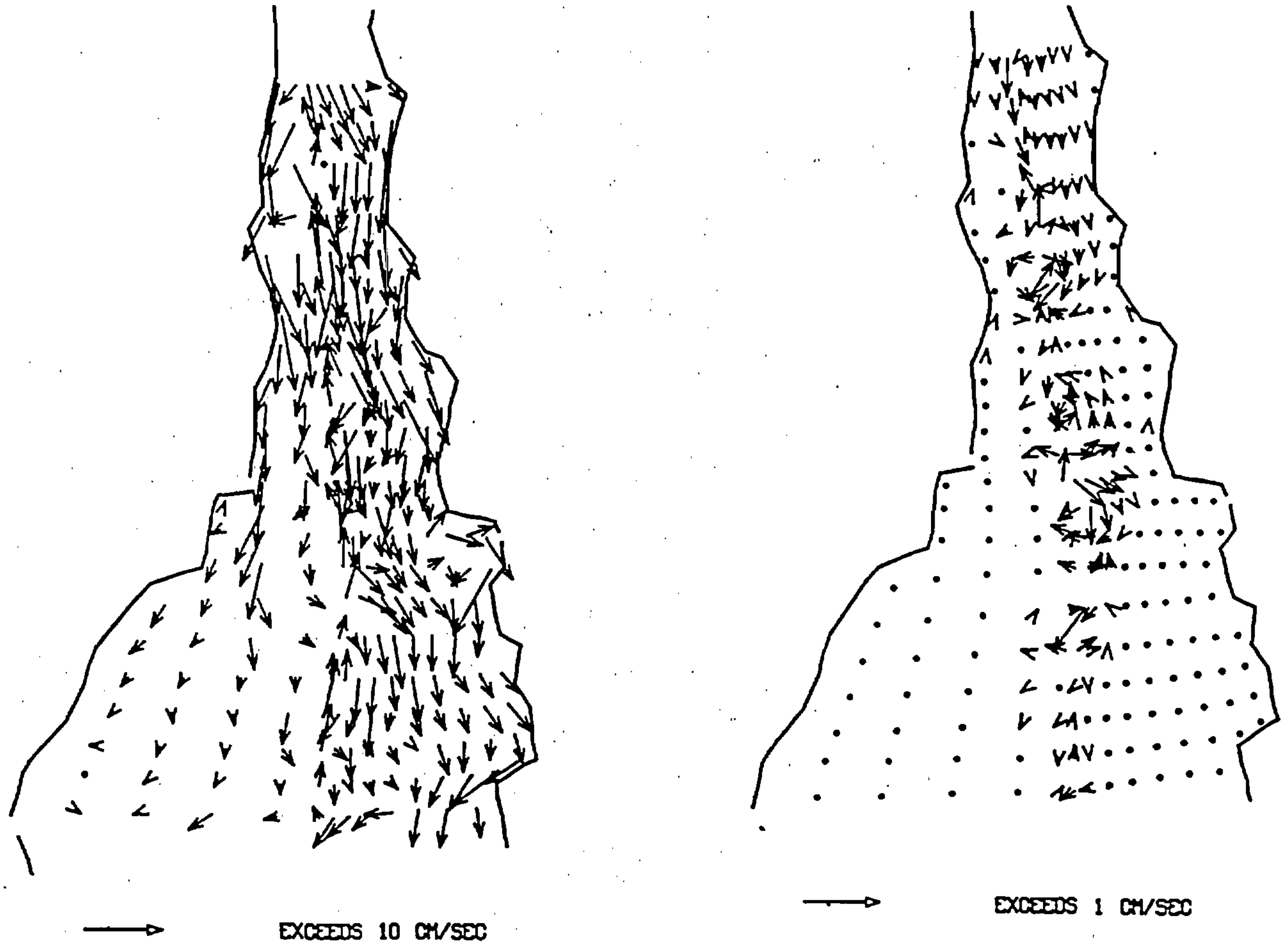
condition.

Figure 5-19 displays the impact of channel deepening on residual circulation for the November monthly-average flow condition. The impact is similar to that for the regulated drought condition, i.e., changes in the residual circulation due to channel deepening are less than 1.0 cm/sec.

Table 5-5 shows the typical monthly range in salinity at the 16 sites at which data were saved during the 40 foot channel and 45 foot channel simulations. For each month of the simulation, the first column of data presents the range of salinity with the 40 foot channel, and the second column presents the change attributable to the deepening to 45 feet. In the polyhaline portion (18 - 30 ppt) of the estuary, represented by River Miles 24 and 27, salinity will increase from 0.05 ppt to 0.15 ppt; in the mesohaline portion (5 - 18 ppt) of the estuary, represented by RMs 36, 38 and 43, salinity will increase from 0.05 ppt to 0.3 ppt; in the oligohaline portion (0.5 - 5 ppt) of the estuary, represented by RMs 54, 69, and 79, salinity will increase from 0 ppt to 0.8 ppt; and in the fresh water portion (0 - 0.5) of the estuary, represented by RMs 98 and 104, no salinity was present in either the existing or deepened channel scenario.

Table 5-6 presents the monthly averaged location of the 0.5, 5, 10, and 15 ppt isohalines for the 40 foot and 45 foot channel simulations, and the difference between them. Results of this comparison show that channel deepening leads to a maximum of 1.7 miles additional intrusion of the 15 ppt isohaline in October, with the other tracked isohalines intruding smaller distances with the channel deepening. Salinities typically increase within the estuary from July and August to a maximum in November. The range of incremental intrusion due to deepening for the tracked isohalines was: 0.5 ppt (0 - 1.1 miles); 5.0 ppt (0.5 - 1.5 miles); 10.0 ppt (0 -0.9 miles); and 15.0 ppt (0 - 1.7 miles).

Larger changes in the salinity due to channel deepening are predicted at locations over the oyster beds in the lower bay for the long-term monthly mean flow conditions compared to the changes computed for the regulated drought of record scenario. This is because the longitudinal salinity gradient is steeper due to the effects of the increased freshwater inflows. A general conclusion from modeling this scenario is that deepening the channel will have no impact on salinity conditions in the upper river since ocean salinity does not intrude that far. However, minor salinity changes are predicted over the oyster beds in the lower bay. The 15 ppt isohaline, which is considered important to the survivability of the American oyster, would shift up to 1.7 miles with the channel deepening. A change of salinity of up to 1 ppt will have no impact on oysters (Powell. 1995. Personal



Existing channel

Impact of deepened channel

DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Monthly Averaged Inflow Scenario, November
Residual Near-surface Currents
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-19

Table 5-5. Salinity at Selected Locations within Delaware Estuary.
Scenario: Monthly-averaged Inflows, July - November.
Salinity Range with 40 ft Channel, and Difference with 45 ft Channel.
3-D Model Results.

SALINITY DIFFERENCES DUE TO DEEPENING FROM 40 TO 45 FT

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER	
	SALINITY (ppt)		SALINITY (ppt)		SALINITY (ppt)		SALINITY (ppt)		SALINITY (ppt)	
LOCATIONS	Month Range 40 ft Channel	Month Avg Diff @ 45	Month Range 40 ft Channel	Month Avg Diff @ 45	Month Range 40 ft Channel	Month Avg Diff @ 45	Month Rang 40 ft Channe	Month Avg Diff @ 45	Month Range 40 ft Channel	Month Avg Diff @ 45
RM 100	0	0	0	0	0	0	0	0	0	0
RM 98	0	0	0	0	0	0	0	0	0	0
RM 79	< 0.04	0	< 0.04	0	< 0.05	0	< 0.06	0	< 0.06	0
RM 69	0.2 - 1.0	.05	0.2 - 0.8	0.1	0.3 -1.0	0.1	0.7 - 1.6	0.2/.25	0.2 - 1.2	0.15/0.2
RM 54	1 - 6	.05/0.1	1 - 6	0.3/0.4	2 - 7	0.3/0.5	3 - 8	0.15	2 - 9	0.5/0.8
RM 43 (OYST. A)	8 - 17	0.2/0.3	7 - 17	0.25	10 - 17	0.2	10 - 20	0.2	13 - 21	.15/0.2
(OYST. B)	8 - 15	0.2	7 - 15	0.2	10 - 16	0.2	10 - 18	0.15	11 - 19	0.1
(OYST. C)	8 - 14	0.2	7 - 14	0.2	10 - 15	0.15	9 - 16	0.1	9 - 17	0.1
RM 38 (OYST. D)	16 - 22	0.5	14 - 21	.05/0.1	17 - 22	.05/0.1	17- 24	.05/0.1	20 - 26	.05
(OYST. E)	14 - 19	0.1	12 - 18	0.1	15 - 19	.05/0.1	15 - 20	.05	16 - 22	.05
(OYST. F)	13 - 17	0.1	11 - 16	0.1	14 - 17	.05/0.1	13 - 18	.05	14 - 20	0.1
RM 36	17 - 24	0/0.2	16 - 24	.05/0.2	17 - 24	.05/.20	19 - 25	.05/0.2	21 - 27	.05/0.2
RM 27 (OYST. G)	22 - 27	.05/0.1	19 - 26	0.1	21 - 27	0.1	22 - 28	0.1	24 - 28	0.1
(OYST. H)	17 - 23	0.05	17 - 22	0.1	18 - 22	0.1	19 - 24	0.1	20 - 25	0.1
(OYST. I)	15 - 21	.05/0.1	15 - 19	0.1	16 - 20	0.1	16 - 20	0.1	18 - 21	0.1
RM 24	24 - 29	.05/0.1	22 - 28	.05/0.1	24 - 29	0.1/.15	25 - 30	0.1	27 - 30	0.1

NOTE: Column "MONTH AVG DIFF @ 45" - if single value shown, diff. at surface and bottom are approx. equal.
If two values shown, first is diff.at surf[illegible] second is diff. at bottom.

Table 5-6. Monthly-averaged Location of Selected Isohalines, by River Mile (RM).
Scenario: Monthly-averaged Inflows, August - November.
Values with 40 ft and 45 ft Channels, and Differences.
3-D Model Results.

MONTHLY AVG LOCATION OF 0. 5 ppt ISOHALINE (RM)

	MAX INTRUSION			AVG ACROSS FRONT		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
AUGUST	73.0	73.9	0.9	70.6	70.6	0.0
SEPT	75.0	76.1	1.1	72.2	73.0	0.8
OCTOBER	76.1	76.1	0.0	73.9	73.9	0.0
NOVEMBER	73.9	75.0	1.1	71.5	72.2	0.7

MONTHLY AVG LOCATION OF 5 ppt ISOHALINE (RM)

	MAX INTRUSION			AVG ACROSS FRONT		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
AUGUST	53.3	53.8	0.5	51.7	52.6	0.9
SEPT	54.8	56.3	1.5	53.3	54.8	1.5
OCTOBER	57.8	58.3	0.5	55.8	56.3	0.5
NOVEMBER	57.8	58.8	1.0	55.8	56.8	1.0

MONTHLY AVG LOCATION OF 10 ppt ISOHALINE (RM)

	MAX INTRUSION			AVG ACROSS FRONT		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
AUGUST	46.5	47.1	0.6	44.1	44.9	0.8
SEPT	49.1	49.1	0.0	47.1	47.1	0.0
OCTOBER	50.8	51.7	0.9	48.4	49.1	0.7
NOVEMBER	52.6	52.6	0.0	49.9	49.9	0.0

MONTHLY AVG LOCATION OF 15 ppt ISOHALINE (RM)

	MAX INTRUSION			AVG ACROSS FRONT		
MONTH	40 FT	45 FT	DIFF	40 FT	45 FT	DIFF
AUGUST	41.9	42.4	0.5	38.9	38.9	0.0
SEPT	42.9	44.1	1.2	40.4	41.4	1.0
OCTOBER	45.8	46.5	0.7	42.4	44.1	1.7
NOVEMBER	47.1	47.1	0.0	43.4	44.9	1.5

Communication). As seen in Table 5-5, the maximum change in salinity due to the 45 foot channel was 0.3 ppt in the oyster areas. These data indicate that the deepened channel will not add significantly to the salinity levels at the oyster seed bed areas under these conditions.

A shift in salinity zones would also shift spawning and nursery areas for estuarine fishes. Such a shift could move eggs and larvae closer to the Salem Nuclear Generating Station which is located at RM 53, which could possibly result in greater impingement and entrainment losses. Eggs and larvae of some species could also be moved closer to the Philadelphia pollution zone, which could result in lower survivability. The 10 ppt isohaline, which can fluctuate over a 30 mile stretch of the estuary and represents a reach that provides valuable spawning and nursery habitat for a variety of fishes, moved upstream from 0 to 0.9 miles with the deepened channel (Table 5-6). Table 5-5 shows that the maximum increase in salinity within this reach (the mesohaline) was 0.3 ppt. This does not represent a significant increase, and is not likely to impact the fish resources in this area.

Higher salinities could result in lower plant productivity, which could reduce food supplies for waterfowl and other wildlife. The 5 ppt isohaline represents a shift from fresh water to brackish vegetation. This isohaline would have a maximum additional intrusion of from 0.5 miles in August to 1.5 miles in September. Freshwater aquatic vegetation extends as far down stream as Wilmington, Delaware (Schuyler. 1988) which is at approximately River Mile (RM) 69. Table 5-5 shows that salinity at RM 69, both with and without the deepened channel, will not exceed 1.6 ppt in long-term monthly mean inflow scenario. The highest increment of increase in salinity that is attributed to the channel deepening at RM 69 is 0.25 ppt. At RM 79 there is no change in salinity with channel deepening. These predicted changes should not cause any significant impacts to aquatic vegetation. In the freshwater portion of the estuary (0.0 - 0.5 ppt) no salinity would occur under the long-term monthly mean inflow scenario.

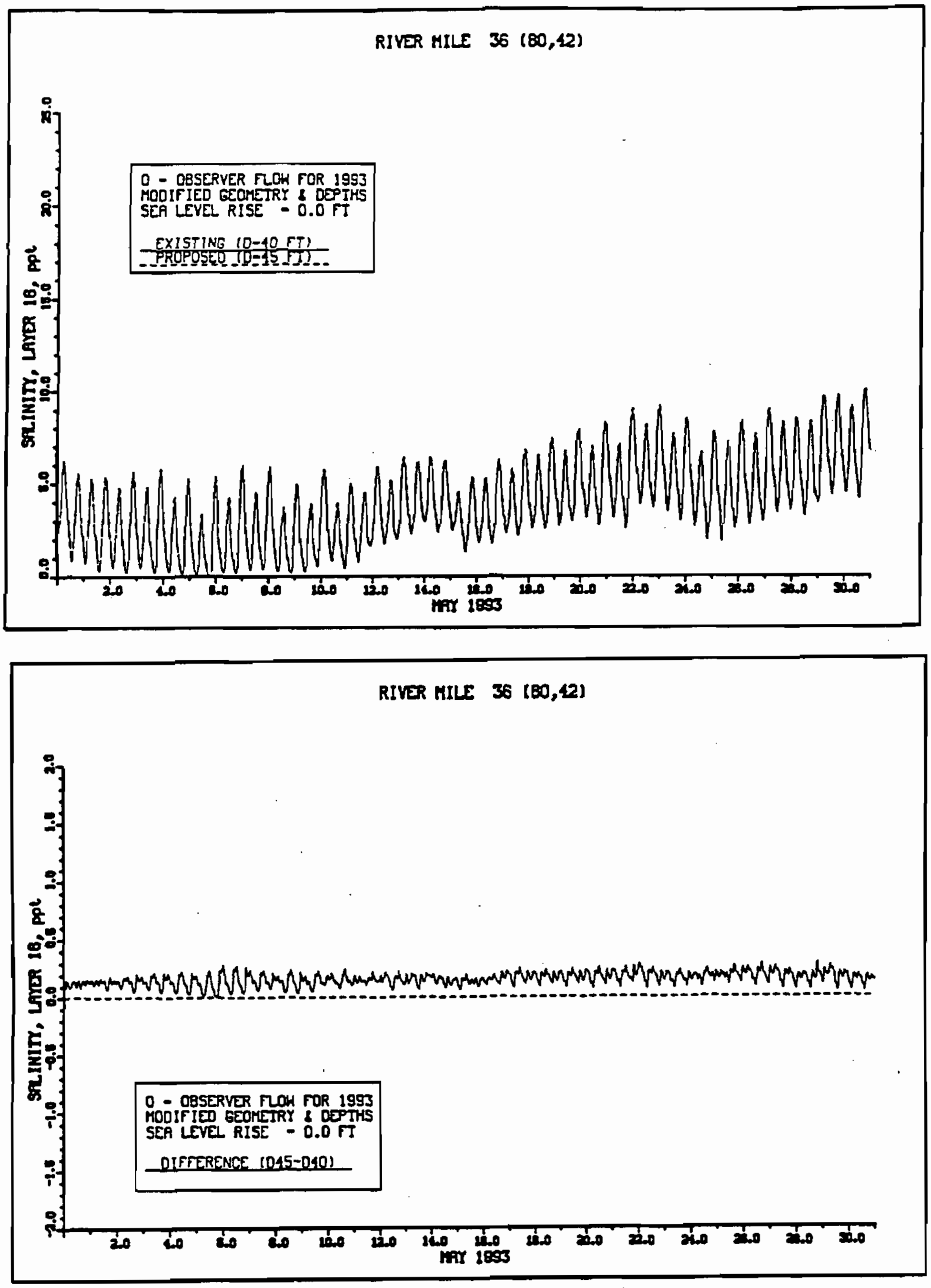
As previously mentioned, there is a natural, seasonal salinity cycle within the estuary that reflects seasonal changes in freshwater flow. Salinities increase in the estuary from a minimum in April to a maximum in October or November, and then decrease to the following April. For most of the year, a salinity shift with a deepened channel means that a particular salinity would reach a particular point in the estuary a little earlier than it would with the existing channel condition. On average, deepened channel salinities would be in the range of 0.0 to 1.7 miles ahead of existing channel salinities, at any particular time of the year. This time shift is not considered large enough to diminish estuarine productivity, and is likely to be less than salinity fluctuations resulting from daily tidal changes. As noted in Table 5-5, the greatest salinities occur in October and November. This time of the year is not considered significant relative to biological activity such as plant growth, fish spawning or nursery activities, blue crab spawning or nursery activities, or benthic productivity.

Based on the results of the 3-D model data sets for long-term mean monthly flows, it is concluded that the predicted changes in Delaware Estuary salinity distribution resulting from a five-foot deepening of the existing navigation channel, would not result in a perceptible decline in estuarine productivity or adversely impact water supplies in the vicinity of Philadelphia. The predicted upstream movement in salinity would be much less in comparison to yearly fluctuations in salinities resulting from variations in river flow. The highest salinities would occur in October and November when significant biological functions such as spawning and nursery activities, and plant growth do not occur.

5.11.3 April-May 1993 Simulations.

During coordination workshops for the 3D modeling, there was an interest expressed in analyzing the impact of channel deepening during transitional flow periods toward the end of typical spring freshet inflows. High freshwater inflow occurred during April 1993, with a monthly mean discharge at Trenton of 49,000 cfs. A substantial drop in this flow occurred, with a May mean discharge of 11,000 cfs at Trenton, New Jersey. The average wind field, tides, and salinity boundary conditions were all derived from prototype measurements at locations previously discussed for the October 1993 verification. No lateral variations were prescribed in the water surface elevations at the bay mouth, but lateral variations in the bay mouth salinities were specified.

The impact of the large freshwater inflow during most of April 1993 and the subsequent transition to lower flows during May is evident in Figures 5-20 and 5-21, which show the May 1993 time series of near-surface and near-bottom salinities, respectively, at RM 36. The top panel of each figure shows the salinity comparisons for the 40 foot and 45 foot channel simulations, and the bottom panel shows the model predicted salinity difference between the 40 and 45 foot channel conditions. Maximum salinities near the surface during the first half of May are about 5 ppt with maximum bottom salinities about 10 ppt. Minimum salinities occurring during each tidal cycle are essentially zero throughout the water column during the first half of May. This is indicative of a condition in which the near-bottom salinity at RM 36 varies by as much as 10 ppt over a single tidal cycle.

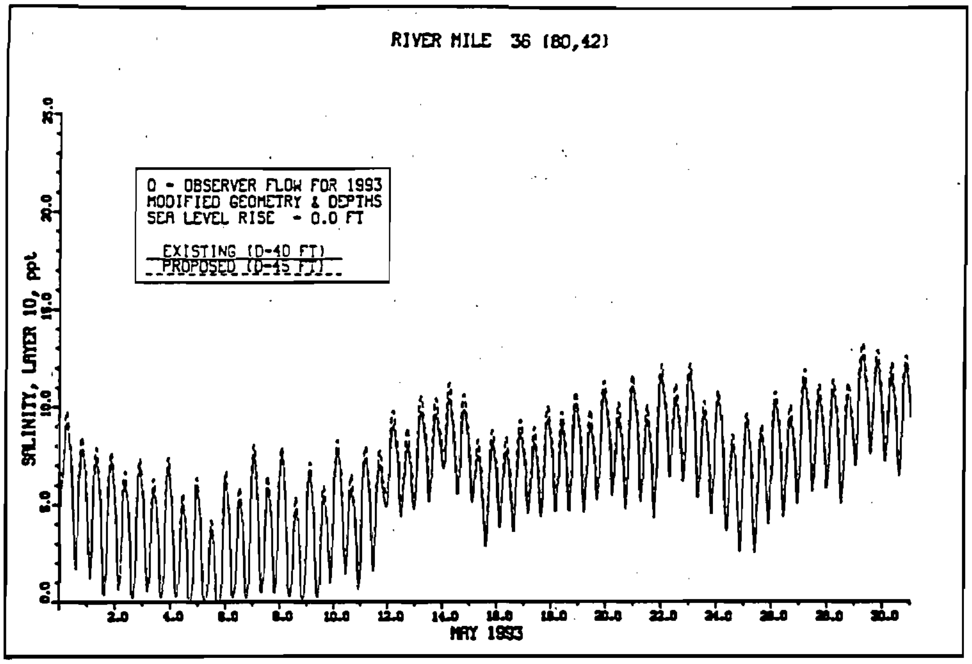


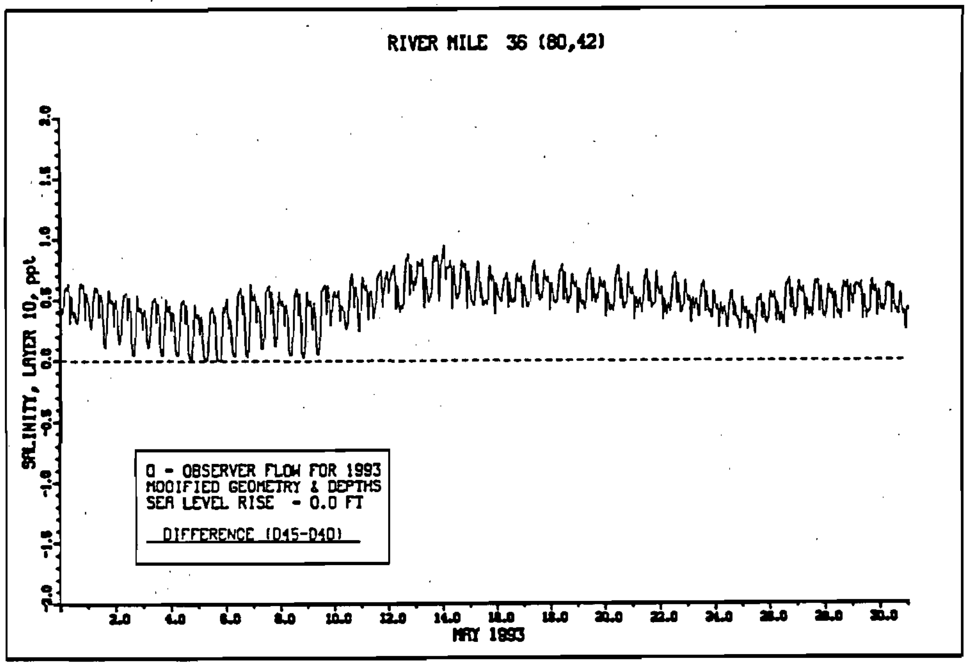
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

May 1993 Simulation
RM 36 Surface Salinity
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-20





DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

May 1993 Simulation
RM 36 Bottom Salinity
40 ft vs 45 ft Channel Comparison

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-21

In the April-May 1993 period, freshwater inflow began to decrease around the first of May, and salinities at RM 36 begin to rise near the middle of May. The channel deepening results in salinity increases at RM 36 on the order of 0.1 to 0.2 ppt near the surface and about 0.5 ppt near the bottom toward the end of May. Model results showed no salinity at any time during the simulation at RM 54 and all locations above RM 54. These results also indicate that relatively strong stratification can develop in Delaware Bay during high flow periods. Detailed graphical and tabular results, as presented for the previous two simulation scenarios, have not been prepared for the April-May 1993 simulation because of the dominance of the fresh water (i.e., zero salinity) inflow over much of the length of the estuary. There should be no significant impacts to the environmental resources in the Delaware Estuary due to deepening for the spring high-flow transitional period. Because there is no salinity recorded above RM 54, there will be no impacts to water supply at Philadelphia, including the freshwater aquifers. In addition, there will be no impacts to freshwater aquatic vegetation, since this occurs above RM 69. Nor should there be any adverse impacts to oysters, since the increase in salinity at the oyster seed bed areas will stay below 15 ppt and will increase by less than 1 ppt.

5.11.4 Simulations to Assess the Impact of Sea Level Rise

One of the issues identified during interagency coordination on the model involved the potential salinity impact of channel deepening combined with sea level rise. In order to address this concern, the regulated June-November 1965 boundary conditions were adopted, with the addition of an assumed sea level rise of one foot. The tidal boundary conditions at the mouth of Delaware Bay were increased by 1.0 foot (0.30 m). To determine the proper amount to raise the tide signal at Annapolis, MD, the Chesapeake Bay model of Johnson, et al (1991) was run for September 1983 conditions. The data set used in that study was adjusted with the tidal signal at the Chesapeake Bay mouth increased by 1.0 ft (0.30 m). The 1.0 ft tidal increase at the Chesapeake Bay mouth raised the mean water level at Annapolis by 0.90 ft (0.27 m). This value was then added to the June-November 1965 tide at Annapolis. It should be noted that the C&D Canal was not included in the Johnson, et. al. (1991) study. Thus, the 0.9 feet increase in the mean tide at Annapolis, MD may not be completely realistic. The most accurate way to address this issue would be to model the entire Chesapeake Bay and Delaware Bay system. One other limitation of the manner in which the sea level rise impact has been determined is that surface area of the bays will increase with sea level rise. However, the surface area of the estuary was not modified in this simulation.

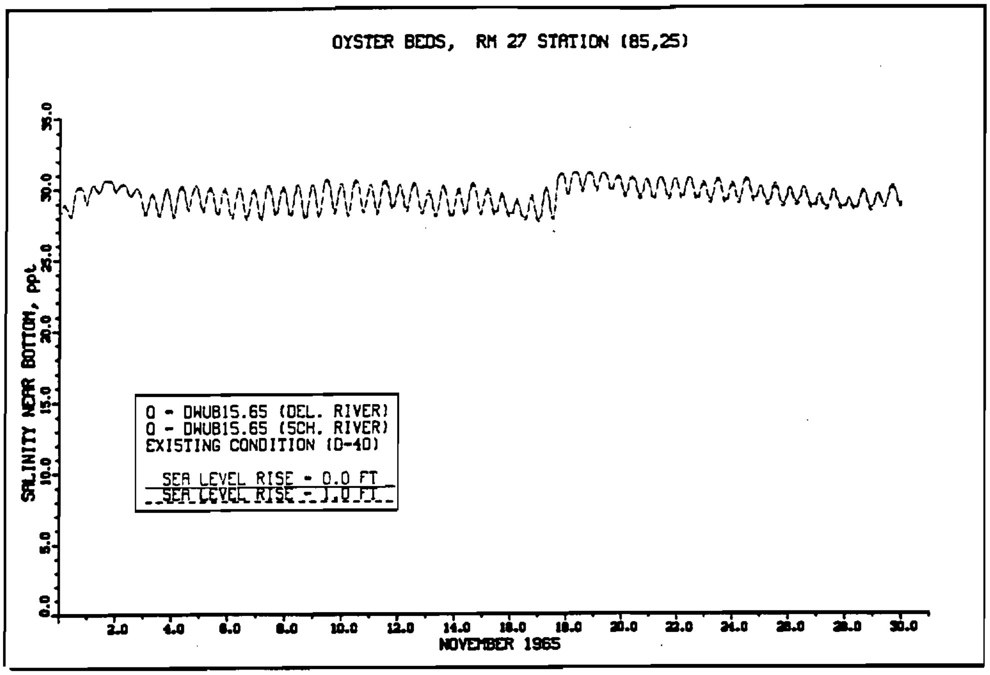
Time series plots of salinity at two locations showing the impact of the selected 1.0 foot sea level rise scenario are presented for November 1965 in Figures 5-22 (RM27), 5-23 (RM 69), and 5-24 (RM 98). These plots show increases in salinity due to the rise in sea level in some locations but decreases at other locations. The greatest decrease occurs over the oyster beds in the lower bay near RM 27, with the greatest increase occurring at RM 69. The modeled salinity response of the system between RM 27 and RM 69 raises interesting questions. Generally, it would be expected that the overall salinity in the bay would increase with a rise in sea level, because the increased flow area at the mouth results in an increase of salt transported through the mouth on flood tide. In addition, the increase in conveyance area along the estuary decreases the retarding effect of the freshwater inflow, resulting in an increase in salt intrusion. However, if flow diversions are created as a result of the sea level rise, such as flow through the C&D Canal, the salinity could decrease in some locations. In addition, the impact of raising the mean tide level by 1.0 foot at the Delaware Bay mouth and by 0.90 feet at Annapolis, MD may impact the net transport through the canal. This could also have an impact on the salinity regime.

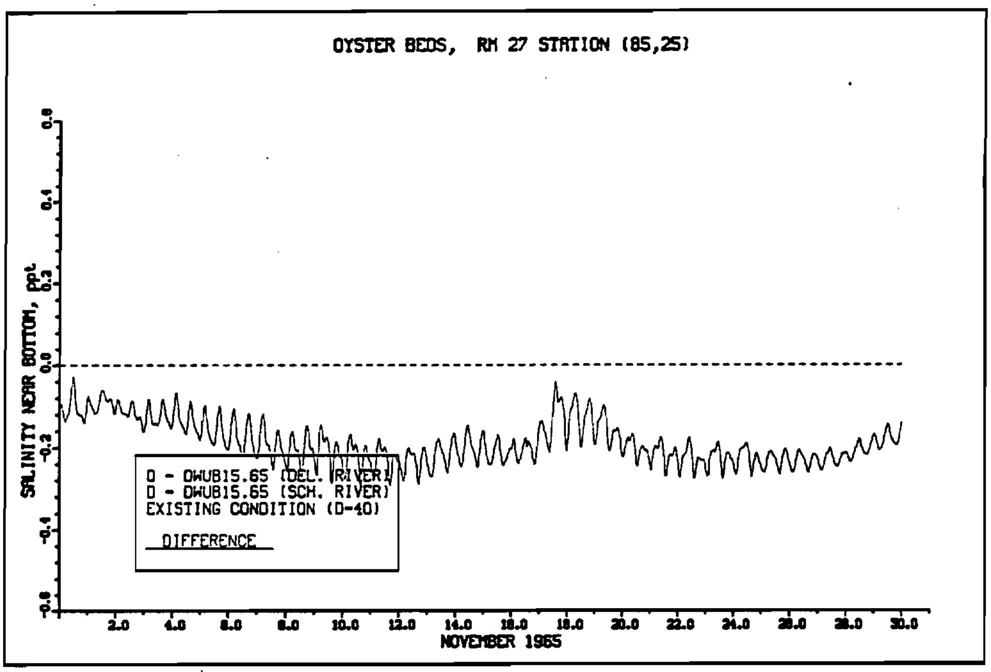
5.12 Summary

A 3D numerical model of the Delaware Bay-Chesapeake and Delaware Canal-Upper Chesapeake Bay system has been developed and applied to assess the impact of deepening the existing Federal Delaware River navigation channel from 40 to 45 feet. In addition, the model has been applied to determine the impact of a sea level rise of 1.0 foot. To provide data for model verification, as well as for comparison of salinity distribution with the 40 foot and 45 foot channels, a one-year field data collection program was conducted. These data, along with data from the June-November 1965 portion of the drought of record, constituted the study data bases.

Before verifying the model, several sensitivity experiments were conducted. These consisted of grid convergence runs, time step convergence runs, and model runs to investigate the impact of the deepening project on flow conditions at the mouth of Delaware Bay. After the sensitivity runs were completed, the final numerical grid and computational time step were selected for both model verification and model production runs.

Model verification involved reproducing the conditions



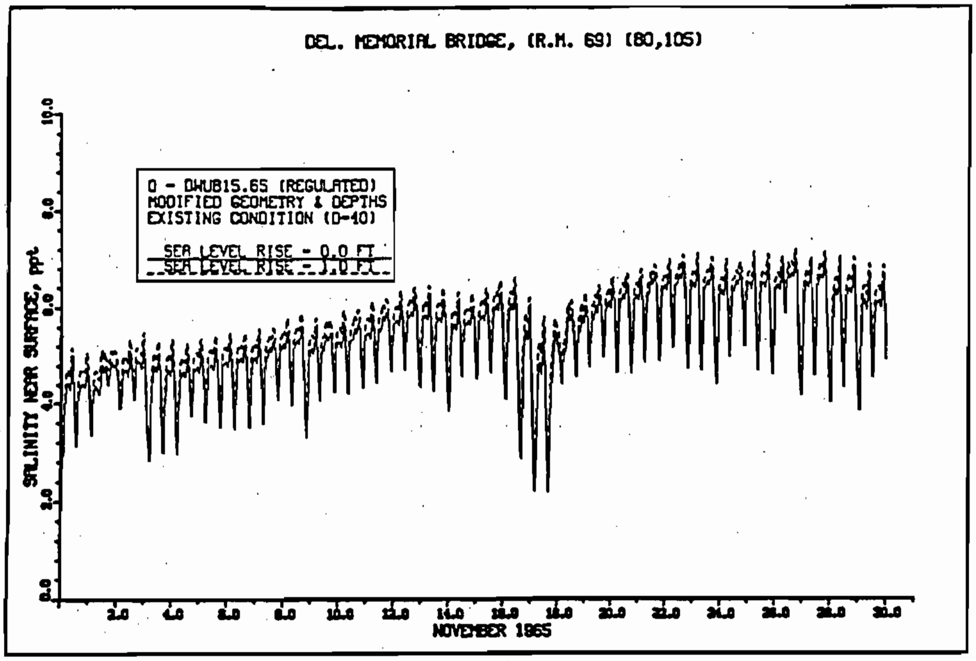


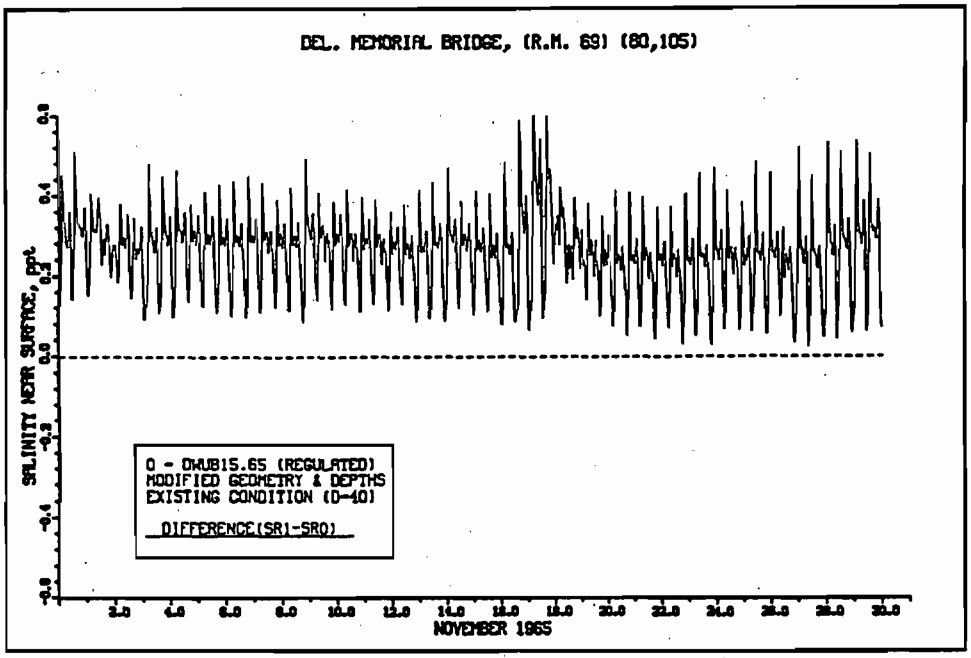
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Sea Level RiseScenario
RM 27 Salinity Comparison
Existing Sea Level vs 1 ft Rise

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-22



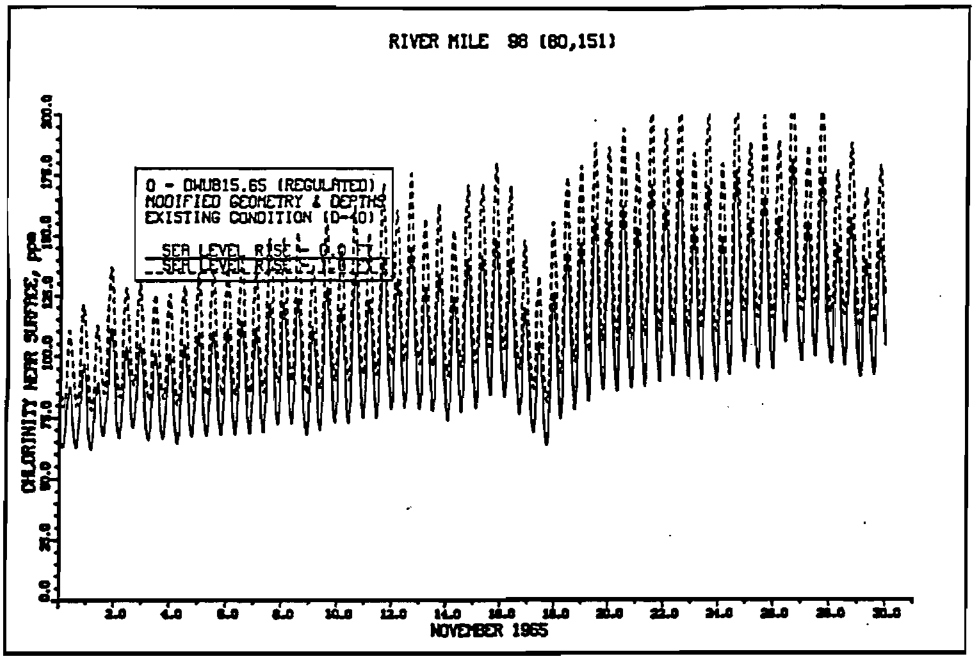


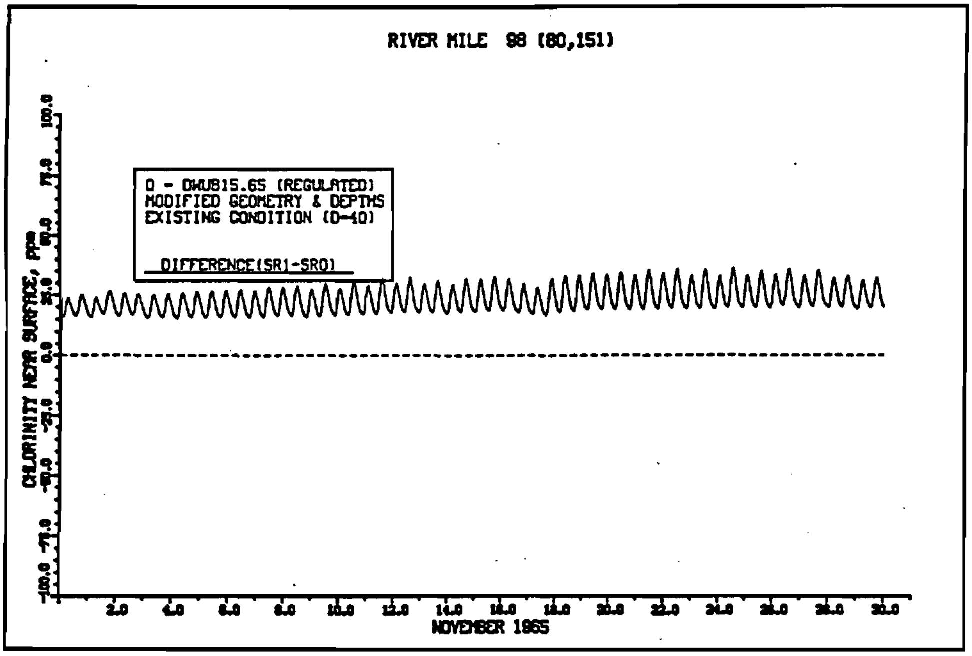
DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Sea Level RiseScenario
RM 69 Salinity Comparison
Existing Sea Level vs 1 ft Rise

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-23





DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

Sea Level RiseScenario
RM 98 Salinity Comparison
Existing Sea Level vs 1 ft Rise

U.S. Army Corps of Engineers,
Philadelphia District

Figure 5-24

experienced during October 1992 (normal fall), April 1993 (high flow spring), and June-November 1965 (drought of record). The historical data for June-November 1965 represented an extreme low flow event during the 1961 to 1965 drought of record for the Delaware River Basin. Reproducing the drought event was considered crucial since municipal and industrial water supplies in the upper river may be adversely affected by encroaching salinity during such events.

Results from model runs with a 45 foot channel were compared with results from the existing 40 foot channel runs to assess the impact of channel deepening. Typical comparisons consisted of time series plots of salinity at several locations, locations of various time-averaged isohalines, and the impact on residual circulation patterns in the bay. In addition to the impact of channel deepening, the 3D model was applied to address questions concerning the impact of a sea level rise on the salinity regime of Delaware Bay.

5.13 Conclusions

A fundamental conclusion from the study is that deepening the existing navigation channel from 40 feet to 45 feet will result in salinity (chlorinity) increases in the Philadelphia area during a recurrence of the drought of record. However, the increases will not have an adverse impact on water supply. The present DRBC drought management plan, including reservoir storage added since the drought of record, prevents the intrusion of ocean salinity into the Philadelphia area in excess of existing standards. With the deepened channel and a recurrence of the drought of record, the maximum 30-day average chlorinity at RM 98 is about 150 ppm.

Historic groundwater withdrawals from the Potomac-Raritan-Magothy (PRM) aquifer in Camden County, New Jersey, have depressed the potentiometric surface of the aquifer system to a level as much as 100 feet below sea level in the central portion of the county. This has led to a condition in which a portion of the total recharge to the (PRM) aquifer system in Camden County is derived from Delaware River water. The present Delaware River Basin Commission drought management standard for RM 98 chlorinity is a maximum 30-day average of 180 ppm. This standard was adopted in order to limit the recharge by river water with elevated chlorinity into the PRM aquifers exposed at the bed of the Delaware River above RM 98 under low flow conditions.

Investigations of Camden County groundwater resources by the US Geological Survey (Navoy. 1996) have indicated that the rate of aquifer recharge from the river is principally controlled by groundwater withdrawals. Deepening of the Delaware River navigation channel will have a negligible effect on the recharge characteristics of the aquifer. Although the proposed channel deepening is predicted by the salinity model to increase RM 98 chlorinity with a recurrence of the drought of record, the resulting 30-day average chlorinity will still be below the present standard of 180 ppm. Transient increases in chlorinity of the river water recharging the aquifer under drought conditions will cause no loss of potability in the groundwater resource. Thus, it is concluded that the proposed channel deepening will not have a significant adverse impact on the hydrogeology or groundwater resources of Camden County, New Jersey. Increases in salinity attributable to channel deepening that could occur during a recurrence of the 1961-65 drought are unlikely to cause any additional adverse effect to environmental resources; freshwater aquatic vegetation will experience temporary decreases in distribution and productivity in the vicinity of RM 69, during a recurrence of the drought of record, but is expected to recover when the drought is over.

During normal to high flow periods with the deepened channel, oyster bed areas in the lower bay will experience increases in salinity due to steeper longitudinal salinity gradients which accompany high flow conditions. The impact of those increases on oyster production is viewed as negligible. Changes in the subtidal circulation over the oyster beds due to channel deepening will also be minimal, e.g., less than 1 cm/sec. Impacts that may occur to other environmental resources are also considered to be insignificant.

Results from the simulation of a 1.0 foot sea level rise combined with channel deepening are ambiguous due to a number of limitations. The principal limitation is the apparent need for a model domain encompassing the entire Chesapeake Bay, not just the portion of the bay above Annapolis, MD, as was the case with the present model. Model results clearly show the need to include the exchange between the Delaware Bay and the Upper Chesapeake Bay when addressing problems dependent upon subtidal processes. The impact of this exchange with the deepened channel depends upon the direction of the net flow through the Chesapeake and Delaware Canal. The direction of the net flow is highly variable in time and depends upon the particular winds, tides, and freshwater inflows.

6.0 Upland Dredged Material Disposal Sites

6.1 Contaminant Literature Search

In accordance with the Hazardous, Toxic and Radioactive Waste (HTRW) Guidance for Civil Works Projects, ER 1165-2-132, dated 26 June 1992, a literature search was conducted by Dynamac Corporation, under contract to the U.S. Army Corps of Engineers, Philadelphia District. The survey included four properties located in Gloucester County, New Jersey. Two properties are located in Logan Township and are identified as Raccoon Island and Site 15D; and two properties are located in West Deptford Township and are identified as Sites 17-G and 17-O. Site 17-O was eliminated from further consideration as 17G became available. Site 15-G was investigated by ERM, Inc. for the site owner, Sun Oil.

The purpose of the HTRW investigation was to research available information on past or present conditions or activities which may have resulted in the disposal or presence of HTRW on the subject sites.

Using the information obtained from the literature search, a preliminary assessment of areas 15-D, 17-G and Raccoon Island was performed by the Philadelphia District. The three disposal areas are very similar in that they all have been historically utilized as dredged material disposal areas. Past and present chemical analysis of the Delaware River sediments, conducted by the Philadelphia District, indicate that minor amounts of regulated substances exist in the proposed dredged material. Information pertaining to the chemical quality of Delaware River sediments can be found in Section 4.0 of this report.

According to information obtained for the Preliminary Environmental Assessment of Site 15G that was done for Sun Oil, the area within the site is being used for agricultural purposes. This site was also formerly used for the disposal of dredged material. There was no evidence found that would indicate that the property has ever been used for industrial purposes. Additionally, no evidence was found which would indicate that any industrially-derived HTRW has ever been generated, disposed of, stored, or treated at this site.

Although there is no evidence to suggest that any of the sites have been used for industrial purposes or that any HTRW has ever been generated, disposed of, stored, or treated at any of the sites, there are several areas of concern that were outlined in the Dynamac Corporation Literature search. Potentially contaminated areas included piles of 55-gallon drums at sites 17G, 15D, and Raccoon Island, an above ground storage tank at site 17G, and an abandoned ultralite plane and pickup truck at site 15D. No areas of concern were found on Site 15G. Consequently, as part of the preliminary assessment, chemical sampling was performed on the disposal areas in these localized areas of concern. This chemical testing is discussed below.

In addition to investigating HTRW within the dredged material disposal areas, the potential for contamination from off-site sources was also evaluated using the information obtained as part of the literature search. As a result of this investigation, it was concluded that off-site impacts from nearby facilities pose a low risk to the groundwater regime under the proposed disposal areas. Although there are several facilities that are CERCLA (Comprehensive Environmental Response, Compensation and Liability Act of 1980) and RCRA (Resource Conservation and Recovery Act of 1976) listed within one mile of the areas, no impacts to the off-site groundwater have been reported.

As a result of the recommendations in the Preliminary Assessment, the Philadelphia District retained Black & Veatch Waste Science, Inc. to sample and analyze near surface soils from the dredged material disposal areas. The purpose of sampling and testing soils from the areas was to determine the level of constituents in background and debris areas described in the preliminary assessment. Soil samples were collected by use of a hand auger and shovel. The sampling locations were chosen based on their proximity to debris, drums, and other viable solid waste piles. Thirteen samples were taken at the four areas; their locations are shown on Plates 12 thru 15. All samples were taken within two feet of the ground surface. One background soil sample was analyzed by Toxicity Characteristic Leachate Procedure (TCLP), as well as for Target Analyte List (TAL), Volatile and Semi-Volatile Organic Compounds, Target Compound List (TCL), PCBs, pesticides, herbicides, total sulfur, total cyanide, and pH. The other nine samples were taken around areas of debris or drums. These samples were analyzed by TCLP (see Table 6-1).

Only three samples had compounds minimally above Federal or State regulatory levels. Background sample HTRW-13 in area 15G had an arsenic content of 22 mg/kg, which slightly exceeds the New Jersey Department of Environmental Protection (NJDEP) non residential cleanup criteria of 20 mg/kg. Sample HTRW-7 in area 17G had a TCLP lead level of 6 mg/l, which slightly exceeds the Federal Regulatory level of 5 mg/l set for toxicity characterization. Sample HTRW-10 in area 17G (duplicate) had a benzo(a)pyrene content of 674 ug/kg, which slightly exceeds the NJDEP non-residential soil cleanup criteria of 660 ug/kg. At most sampling locations, volatile and herbicide compounds were not detected. Relatively low levels of semi-volatile, pesticide, and metal compounds were detected.

Based upon the conducted literature search, preliminary environmental assessment, and subsequent chemical testing (ie. to detect contamination caused by localized dumping), the minimal exceedance of the stated regulatory levels, and the proposed use of the area as a dredged material disposal site, no additional testing or remediation of these areas is required. The pile of tires, drums, and any other solid waste on the site will be

Table 6-1. Chemical Sampling and Testing for Hazardous, Toxic and Chemical Waste (HTRW) at Upland Dredged Material Disposal Sites.

Sample Number	Location	Type	Analysis
HTRW-1	Raccoon Island	Soil - Debris Pile	TCLP only
HTRW-2	Raccoon Island	Soil - Debris Pile	TCLP only
HTRW-3	Raccoon Island	Soil - Background	TCLP & Bulk
HTRW-4	Area 17G	Soil - Debris Pile	TCLP only
HTRW-5	Area 17G	Soil - Debris Pile	TCLP only
HTRW-6	Area 17G	Soil - Debris Pile	TCLP only
HTRW-7	Area 17G	Soil - Debris Pile	TCLP only
HTRW-8	Area 17G	Soil - Debris Pile	TCLP only
HTRW-9	Area 17G	Soil - Debris Pile	TCLP only
HTRW-10	Area 17G	Soil - Background	TCLP & Bulk
HTRW-11	Area 15D	Soil - Debris Pile	TCLP only
HTRW-12	Area 15D	Soil - Background	TCLP & Bulk
HTRW-13	Area 15G	Soil - Background	TCLP & Bulk
RB-1	N.A.	Water	Bulk only
TB-1/TB-2	N.A.	Water	TCLP VOAs
HTRW-Dupl[2]	Area 17G	Soil - Background	TCLP & Bulk
HTRW-6QA[3]	Area 17G	Soil - Debris Pile	TCLP only

RB=Rinsate Blank
TB=Trip Blank
Dupl=Duplicate
QA=Quality Assurance

Notes:

1. Bulk analytes are Target Analyte List (TAL), Metals, Target Compound List (TCL) Volatile and Semivolatile Organic Compounds, (VOA) TCL PCBs and pesticides, herbicides, total sulfur, total cyanide, and pH.
2. Duplicate sample of HTRW-10
3. The QA sample location was specified by Corps

removed and disposed of in accordance with relevant environmental laws and regulations.

The planned use of sites 17G, 15D, 15G and Raccoon Island as disposal areas for the deepening of the Delaware River navigation channel will not have any adverse impacts on the groundwater or lands beneath or adjacent to the sites with respect to HTRW. However, prior to utilization of these sites for the project, all debris, drums, tires, and all other solid waste must be removed and disposed of in accordance with relevant environmental laws and regulations.

6.2 Wetland Delineations

Wetlands are those areas that are inundated or saturated to the surface by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Jurisdictional wetlands are those wetlands protected by Section 404 of the Clean Water Act, and/or those areas specified by state or local regulation. Wetlands in New Jersey, as specified by the New Jersey Freshwater Wetlands Act (NJAC 7-7:A), are those areas that satisfy the mandatory technical criteria set forth in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, Federal Interagency Technical Committee for Wetland Delineation (1989). The Corps of Engineers and other Federal agencies use the Corps of Engineers Wetlands Delineation Manual (U.S. Army Corps of Engineers. 1987) to delineate wetlands. Wetlands are identified by the presence and field identification of three wetland parameters: hydrophytic vegetation, hydric soils and wetland hydrology.

Wetlands generally include swamps, marshes, bogs and similar areas. Some areas that are only infrequently saturated or intermittently vegetated, or even routinely farmed may also be jurisdictional wetlands. Areas regulated as wetlands in New Jersey include vegetated channels and ditches excavated in otherwise dry ground, if the wetland hydrology parameter is identified. New Jersey also regulates a buffer area around the identified wetland perimeter as if it were also a wetland.

The width of this buffer, or transition area, is based on an assignment of a resource value to the wetland. New Jersey regulations include three resource value classes: exceptional, intermediate, and ordinary. Exceptional resource value wetlands, defined as containing or likely to contain rare, threatened, or endangered species, or high value communities, are assigned a 150-foot wide buffer. Ordinary resource value wetlands (ditches or wetlands less than 5,000 square feet in area) have no specified transition area. Intermediate value wetlands, those that are neither exceptional nor ordinary in resource value, are assigned a 50-foot wide transition area. It is thus not uncommon that the protected transition areas for exceptional and intermediate resource value wetlands extend beyond the legal boundaries of the properties on which they are found.

Many activities conducted in jurisdictional wetlands (and transition areas) are regulated by law and normally require a permit from a state and/or a federal agency. In southern New Jersey, the regulatory agencies are the New Jersey Department of Environmental Protection (NJDEP), Division of Wetland Regulation, and the U.S. Army Corps of Engineers, Philadelphia District. Regulated activities may include dredging or filling, draining, grading, the removal or modification of vegetation, and/or the placement of structures of various kinds.

The type of permit needed or available is specified by NJAC 7-7:A, and Section 404 of the CWA, and possibly Section 10 of the Rivers and Harbors Act, if the wetland is at or below mean high water of a tidal water and/or ordinary high water of a non-tidal navigable waterway. Permitted impacts to wetlands often require mitigation of such impacts. Mitigation, as defined by the Council on Environmental Quality, may include (in order of preference) (1) avoidance of impacts; (2) minimization of impacts; (3) rectification by repairing, rehabilitating, or restoring the effected environment; (4) elimination or reduction of impacts over time; and (5) compensation through replacement. The primary mitigation measure recommended by both federal and state regulatory agencies is avoidance of impacts where possible and practicable.

Wetland delineations were performed for each of the four (4) upland disposal areas that have been selected for the project as part of environmental assessments (EA) that were done for each area [Dames and Moore. 1994 (a), (b), (c), and (d)]. The Dames and Moore EAs describe a larger area for each disposal site than was finally selected; therefore, the areas of wetlands described as impacted in the EA is generally larger than what will be actually impacted, as shown in Table 6-2. All of the upland disposal sites were formerly used for the disposal of dredged material.

6.2.1 General Site Characteristics

6.2.1.1 Physiography and Climate. The disposal sites are within the Atlantic Coastal Plain Physiographic Province, and are underlain by unconsolidated sediments consisting primarily of sand and gravel. The area experiences a typically humid and temperate climate that is influenced considerably by the Atlantic Ocean. The average annual precipitation of approximately 40 inches is well distributed throughout the year. The average daily maximum temperatures range from 41°F to 86°F, and the average daily minimum temperatures range from 24°F to 65°F. The

Table 6-2. Delaware River Main Channel Deepening Project
Upland Disposal Sites - Existing Wetlands

Site	Area	Wetland Type
15G	6 acres	Palustrine - Emergent [Primarily ditches or farmed]
17G	33 acres	Palustrine - Emergent [Primarily common reed dominated or farmed]
	1 acres	Palustrine - Forested/Shrub-Scrub
	34 acres	Total
Raccoon Island	289 acres	Palustrine - Emergent [Primarily common reed dominated]
	26 acres	Palustrine - Forested/Shrub-Scrub
	315 acres	Total
15D	37 acres	Palustrine - Emergent [Primarily common reed dominated or farmed]
	4 acres	Palustrine - Forested/Shrub-Scrub
	41 acres	Total

TOTAL WETLAND IMPACTS:

365 acres	Palustrine - Emergent [Primarily common reed dominated or farmed]
31 acres	Palustrine - Forested/Shrub-Scrub
396 acres	Total

soils freeze for short periods from November through March (SCS, 1969). The length of the frost-free period is approximately 190 days between mid- to late-April and mid- to late-October.

6.2.1.2 Soils. The majority of the upland disposal sites have been mapped as Made land that consists of dredged material from the Delaware River and its tributaries. Typically this material, which ranges in size from clay to boulders, was hydraulically dredged and pumped to diked containment areas. The larger materials, including sands, gravels and cobbles, would drop out quickly in the vicinity of the discharge pipe. Whereas, the silt and clay-sized particles would remain in suspension and gradually settle out in the lower elevation areas of the containment area. Depositional events would generally occur over a period of time with the discharge pipe being moved to different locations within the containment area. The deposits of fine and coarse-textured materials are therefore variable across the site and are typically stratified.

The thickness of the dredged material is approximately 10 to 20 feet, and it may cover a variety of native soil types, many of which were former tidal marshes. The coarse-grained dredged materials are generally low in organic content, low in water holding capacity, and highly permeable. The fine-grained dredged material is also low in organic content, but may retain some moisture and is generally low in permeability. These characteristics vary considerably from point to point across the site, and at different depths within the profile, because of the depositional characteristics described above; however, the great majority of the materials over the site consist mainly of fine-grained sediment. Since the surface soils consist of dredged material that developed under anaerobic conditions in the Delaware River, the soils commonly exhibit hydric characteristic based on color. Therefore, soil color is not particularly useful on these sites as a hydric soil indicator. Other indicators, such as manganese and iron concretions, and high organic content and organic streaking in sandy soils, proved to be much better indicators for determining hydric soil tendencies. Conditions conducive to the development of wetlands were created in locations where thick layers of finer-grained material remain within 1 to 2 feet of the present ground surface. This is especially apparent in subtle depressions where runoff seasonally collects.

6.2.2 Raccoon Island. The subject site is located in Logan Township, Gloucester County, New Jersey in the lower Delaware River basin. The wetlands that were delineated on Raccoon Island are shown on Plate 13. Note that the impacted wetlands are within the proposed berm line and amount to approximately 315 acres, most of which are dominated by common reed.

The primary hydrological regime of Raccoon Island is precipitation and overland flow. The drainage patterns of Raccoon Island are shown on Plate 21. Raccoon Island is divided almost in half by Ferry Road which runs through the site in a northwest to southeast direction. The road is drained by two ditches that are located on both sides of the road. These ditches also drain the outer edges of nearby berms.

The southwestern half (west of Ferry Road) of Raccoon Island is almost completely enclosed by berms. The only obvious drainage in this area are four drainage pipes which breach the berm along the southern edge of the parcel. The exact area of drainage associated with these pipes is unknown.

The northeast half (east of Ferry Road) of Raccoon Island primarily drains northeast toward a tidal basin of the Delaware River. This basin is approximately 10 to 15 feet below the existing ground surface of the site. Unlike the southwestern half, there are no berms in this portion of Raccoon Island that completely enclose the area which may confine the hydrology and alter drainage.

Most of the natural plant communities have been altered and replaced with a ruderal community which consists of aggressive weedy species that are adapted to disturbed areas. This type of habitat includes roadsides, disturbed areas, waste places, etc. The majority of these disturbed areas are wetlands. For example, the berms surrounding the southwestern half of the site are laid out such that they retain water and create wetland hydrology.

Probably the most abundant species is common reed (Phragmites australis) which is ubiquitous in most of the unmanaged sites. This plant, even though it is listed as a facultative wetland species, seems to colonize any disturbed area, even habitats that are considered upland. For example, common reed was found growing on top of the adjacent berms. However, the community of common reed is not very vigorous in the dry habitat. In wet areas below the berms common reed is very vigorous and dense, creating a wetland monoculture (low vegetative diversity).

Other weedy species such as long-bristled smartweed (Polygonum cespitosum), Canada golden rod (Solidago canadensis), and wrinkled goldenrod (Solidago rugosa) are common throughout the site. There are some small upland forested areas within the site where black cherry (Prunus serotina), white mulberry (Morus alba), and black willow (Salix nigra) colonized island-like mounds of spoil material. The dominant herbaceous layer of these forests consists of nimble-will (Muhlenbergia schreberi), and stinging nettle (Urtica dioica). There are small areas of shrub-forested wetlands throughout the site dominated by black willow that amount to approximately 26 acres.

Federally-listed threatened and endangered plants and New Jersey plants of concern were not observed onsite.

6.2.3 Site 15G. The site is located in Oldmans Township, Salem County, New Jersey. The wetlands that were delineated on Site 15G are shown on Plate 15. Note that the impacted wetlands are within the proposed berm line and amount to approximately 6 acres composed of ditches and farmland.

The drainage patterns of Site 15G are shown on Plate 23. Most of the water that is available to support wetland hydrologic conditions on Site 15G is delivered as precipitation and collects in depressional areas through sheet flow. The site's perimeter dike, which was originally constructed to contain the dredged material slurry, a north-south oriented interior berm, a man-made ditch, and subtle topographic features have defined four primary site drainage basins. Drainage is conducted via several constricted ditches.

Throughout the site, several small depressional areas are present that collect runoff, and perhaps receive shallow groundwater discharges. These depressional areas may retain water for periods of sufficient duration to create wetland hydrologic conditions. This is particularly true if the near-surface soils of the depressional area are fine grained and slowly permeable.

Most of the natural plant communities have been altered and replaced with agricultural crops which primarily consist of corn and soybeans. The fields are sprayed regularly to control crop pests and weedy vegetation. Although these fields are regularly maintained for crop production, invasive plant species that are typical of a ruderal community are also present.

Federally-listed threatened and endangered plants and New Jersey plants of concern were not observed onsite.

6.2.4 Site 15D. The site is located in Logan Township, Gloucester County, New Jersey. The wetlands that were delineated on Site 15D are shown on Plate 14. Note that the impacted wetlands are within the proposed berm line and amount to approximately 41 acres composed primarily of common reed dominated and farmland. There are approximately 4 acres of forested wetlands on the site.

The topographic relief at Site 15D is very subtle; the drainage patterns are shown on Plate 22. Eleven drainage ditches have been installed at evenly spaced intervals to intercept water and drain the site. Many of these ditches support wetlands within their banks where water is impounded during wet periods. In areas not drained by these ditches, gradual depressional areas are present that appear to collect precipitation and surface water runoff.

Most of the natural plant communities that occurred on Site 15D have either been altered or replaced by disturbance associated with placement of dredged material and/or current agricultural practices. Exotic plant species have also displaced native plants in former natural areas that have no overstory cover. During field surveys, no Federally-protected or plant species of special concern were observed. The major plant community types are described below:

6.2.4.1 Ruderal Community. This type of habitat is usually found along roadsides, fields, lawns, and various waste places. On Site 15D, ruderal plants comprise most of the species found in wetlands located within the perimeter.

The most abundant species are common reed (Phragmites australis) and Asiatic tearthumb (Polygonum perfoliatum) which are ubiquitous in most of the unmanaged portions of the site. These plants, even though they are listed as facultative wetland species, seem to colonize any disturbed area, even habitats that are considered upland, such as the perimeter dike. For example, common reed and Asiatic tearthumb were found on the dike in association with upland species such as blackberry (Rubus sp.) and pokeweed (Phytolacca americana). In the lower lying areas, common reed and Asiatic tearthumb were associated with several wetland species such as soft rush (Juncus effusus), sensitive fern (Onoclea sensibilis), spatter dock (Nuphar luteum), and spotted touch-me-not (Impatiens capensis).

6.2.4.2 Agricultural. The dominant plant species that occurs in the agricultural fields is soybeans. Mixed in with the soybeans are many of the ruderal species of plants. An aggressive weed control program by the farmer, however, has kept the ruderal species in check during the growing season.

6.2.4.3 Woodlands. One small black willow (Salix nigra) dominated wetland of about 3.5 acres exists within the bermed area.

Federally-listed threatened and endangered plants and New Jersey plants of concern were not observed onsite.

6.2.5 Site 17G. The subject site is located in Woodbury Township, Gloucester County, New Jersey. The wetlands that were delineated on Site 17G are shown on Plate 12. Note that the impacted wetlands are within the proposed berm line and amount to approximately 34 acres composed primarily of common reed dominated wetland and farmland. There is approximately one (1) acre of forested and shrub-scrub wetlands on the site. Most water available to support wetland hydrological conditions is delivered as precipitation. The prevalent coarse-grained, high-permeability surface materials generally limit the formation of natural channels.

The topographic surface created by past fill events is generally flat, with only slight gradients (generally less than 2%) imposed to drain water away from specific activity areas. Intervening spaces have, as a result, often become topographic depressions. For the most part, discharge points have not been provided. The depressions collect run-off waters from higher areas (and perhaps shallow groundwater seepage) and retain it for periods sufficient to create wetland hydrological conditions, if near-surface dredged material layers are fine-grained.

The interior berms (generally along dirt roads) within the site boundary have created five subsections that are hydrologically isolated from each other. These berms act as a barrier to surface water migration. The topography and drainage patterns are shown on Plate 20.

Several drainage tiles have been installed beneath the cultivated fields to drain surface water from the site. These subsurface tiles drain water from the cornfields and discharge it outside the perimeter berm via culverts. Field observations and discussions with the resident farmer indicate that the drainages have been very effective in drying out the site. Consequently, these drained areas of Site 17G have been converted from possible wetlands to upland habitat over the past 20-25 years.

The plant communities of Site 17G consist of a mosaic of woodlands, emergent marsh, and cultivated fields. Cultivated fields consisting of corn (Zea mays) and soybeans (Glycine max) dominate the landscape, covering over half the site. Several of these fields contain substantial areas of jurisdictional wetlands, particularly in areas of relatively low relief.

The second most prevalent cover type is common reed stands that occupy the berms, roadside edges, drainage ditches, and uncultivated "plains." Common reed dominates both wetland habitats and disturbed uplands.

Hardwood stands occupy portions of the spoil banks and fragmented patches of the interior. Mixed upland hardwoods occur on berm tops and slopes, while mixed wetland hardwoods occupy the more mesic zone. Common upland hardwood species on the site are black cherry (Prunus serotina), mulberry (Morus alba), and black locust (Robinia pseudoacacia). Dominant wetland hardwoods include red maple (Acer rubrum), box elder (Acer negundo), and green ash (Fraxinus pennsylvanica).

A tidal emergent marsh is prominent outside the berms along the Delaware River, within the tidal basin, and along Woodbury Creek. Dominant emergents include yellow cow-lily (Nuphar luteum), pickerel weed (Pontederia cordata) and various sedges and rushes.

One species found on Site 17G, Frank's sedge (Carex frankii), is listed in the special plants of New Jersey by the New Jersey National Heritage Program (1993). No State- protected or Federally-listed plants were observed.

6.3 Habitat Assessments

As was mentioned in the preceding section, all of the upland dredged material disposal areas were formerly used for the disposal of dredged material. Three of the areas (15D, 15G, and

17G) are mostly used for the production of row crops, primarily corn and soybeans. Raccoon Island is vegetated almost entirely by common reed (Phragmites communis) with some small patches of woodlands. Table 6-3 shows the areas of each habitat type that will be impacted, as well as the value rating for each habitat type. The habitats for each disposal area are described below.

6.3.1 Habitat Evaluation Criteria. Four criteria were used to evaluate the relative value of the habitats. These criteria are A) structural diversity, B) occurrence of species, C) presence of wildlife corridors, and D) occurrence of rare, threatened, and endangered species. These criteria are adapted from those used by the Natural Resources Advisory Board (1988), and details are presented in Dames and Moore (1994 a,b,c and d).

The wildlife habitat assessment criteria used to assign relative values for each cover type are discussed below. Each criterion was assigned a numerical score (3-high, 2-moderate, 1-low) according to its perceived value. Criteria scores were summed for each habitat type and divided by four to provide an average score.

6.3.1.1 Criterion A - Structural Diversity. This criterion considers the diversity in a cover type that results from layering or tiering of vegetation. Cover types with greater structural diversity generally provide habitat for a larger number of wildlife species.

HIGH (3 points): Mixtures of scrub/shrub and forested wetland cover types, lower perennial and intermittent riverine cover types, limnetic and littoral cover types.

MODERATE (2 points): Mixtures or monocultures of emergent aquatic wetlands, ponds, adjacent marshes, forests and tree/grasslands.

LOW (1 point): Mixtures or monocultures of native and introduced grasses, croplands, pasturelands, wet meadows, and urban areas.

6.3.1.2 Criterion B - Species Occurrence. This criterion considers the ability of a cover type to provide habitat for the wildlife species expected to be potentially present based on the review of documents and communications with government wildlife biologists. The total number of bird and mammal species potentially inhabiting each cover type was divided by the potential number of species likely to occur regionally. The resulting percentage yields a comparative value of each habitat

Table 6-3. Delaware River Main Channel Deepening Project
Upland Dredged Material Disposal Sites
Habitat Type Area and Value Rating

HABITAT TYPE AND EVALUATION ELEMENT	RELATIVE VALUE	HABITAT VALUE RATING	TOTAL ACRES EXISTING	TOTAL ACRES WITH PROJECT
Woodlands (WO)		Moderate to high	48	0
Structural Diversity	2			
Species Occurrence	2			
Wildlife Movement Corridors	3			
Threatened and Endangered Species	2			
TOTAL RELATIVE VALUE (Sum/4)	2.25			
Common Reed (CR)		Low to moderate	469	0
Structural Diversity	1			
Species Occurrence	1			
Wildlife Movement Corridors	2			
Threatened and Endangered Species	1			
TOTAL RELATIVE VALUE (Sum/4)	1.25			
Non-Tidal Marsh (NTM)		Moderate to high	4	620
Structural Diversity	2			
Species Occurrence	2			
Wildlife Movement Corridors	2			
Threatened and Endangered Species	3			
TOTAL RELATIVE VALUE (Sum/4)	2.25			

Table 6-3. (continued) Delaware River Main Channel Deepening Project Upland Dredged Material Disposal Sites Habitat Value Rating				
Agriculture (AG) Structural Diversity Species Occurrence Wildlife Movement Corridors Threatened and Endangered Species TOTAL RELATIVE VALUE (Sum/4)	1 2 1 1 1.25	Low to moderate	685	0
Ruderal Area (RA) Structural Diversity Species Occurrence Wildlife Movement Corridors Threatened and Endangered Species TOTAL RELATIVE VALUE (Sum/4)	1 1 1 1 1	Low	34	0
Active Dredge Disposal Area Structural Diversity Species Occurrence Wildlife Movement Corridors Threatened and Endangered Species TOTAL RELATIVE VALUE (Sum/4)	1 1 2 1 1.25	Low to moderate	0	620
TOTALS			1240	1240

considered. Note that the total for all of the habitats may exceed 100 percent as some species utilize more than one habitat. Points were assigned based on the suitability of the cover type to support wildlife as shown below:

HIGH (3 points): Cover type provides habitat for 66 to 100 percent of the bird and mammal species potentially found in the area.

MODERATE (2 points): Cover type provides potential habitat for 33 to 66 percent of the bird and mammal species potentially found in the area.

LOW (1 point): Cover type provides potential habitat for less than 33 percent of the bird and mammal species potentially found in the area.

6.3.1.3 Criterion C - Wildlife Movement Corridors. This criterion considers the need for wildlife to have continuous cover to allow for unhindered movement between habitat areas. For example, forested areas provide corridors within which wildlife can move without being readily observed during much of the year. In contrast, open agricultural fields may expose wildlife to observations by humans or predators. Points were assigned as follows:

HIGH (3 points): Cover type is a component of a specified corridor for most of the year.

MODERATE (2 points): Cover type is not a component of a specified corridor but is located adjacent to an important corridor area.

LOW (1 point): Cover type has limited value as a wildlife corridor for most of the year.

6.3.1.4 Criterion D - Threatened and Endangered Species (TES). This criterion considers the ability of a habitat to support species which are recognized by Federal or State agencies as threatened, endangered or a candidate species. Points were assigned as follows:

HIGH (3 points): The cover type area provides potentially preferred habitat for a TES species, and a TES of wildlife has been confirmed as using the area; or the cover type area is known to support a TES of plant.

MODERATE (2 points): The cover type area provides potentially preferred habitat for TES, but such species is not confirmed at present to be using the cover type area.

LOW (1 points): The cover type does not provide any potentially preferred habitat for TES.

6.3.2 Habitat Descriptions. Most of the following habitat types are found on all the disposal areas; only Raccoon Island does not have agriculture. Habitat types were assessed and relative habitat values assigned using the criteria specified above. All habitat types have been affected by dredged material disposal and activities that have occurred on the assessment area over the past 50 years.

6.3.2.1 Woodland. Included in this unit are areas of lands dominated by woody vegetation within and in the immediate vicinity of the disposal site. For the most part, woody vegetation is confined to the berm areas and composed of monocultures or mixtures of early-successional hardwood species such as black locust(Robinia pseudoacacia), black willow (Salix nigra) and black cherry (Prunus serotina). White mulberry (Morus alba), sumac(Rhus sp.) and princess tree(Paulownia tomentosa) are common. The cherry/mulberry mixture provides an important seasonal food source for perching birds, small and medium-sized mammals and deer.

Woodlands often extend as corridors on exterior and interior berms as well as isolated islands surrounded by either agriculture or common reed. The berm-fringe woodlands are often contiguous and continuous with native woodlands and provide corridors to the large tidal marsh areas that are adjacent to all the proposed disposal areas. These conditions favor immigration of native wildlife species. This habitat was rated from moderate to high.

6.3.2.2 Common Reed. These areas are mostly monocultures of common reed (Phragmites australis), an aggressive invader species throughout the northern coastal plain region. This reed preferentially occupies disturbed ground in well-drained to regularly-flooded conditions. Once common reed becomes dominant it excludes most other species, lowering the food and cover value for most wildlife. Areas dominated by common reed can support a wide variety of wildlife species where the common reed is interspersed with shallow water and/or areas of tidal influence, and other species (particularly food plants) are present (U.S. Fish and Wildlife Service. 1995). However, most of the common reed areas in the disposal areas consist of monotypic stands with no standing water and provide low wildlife value. Shading by trees and grazing appear to be options for controlling common reed. If cut and bailed early in the season, common reed is usable as fodder. This habitat was rated from low to moderate.

6.3.2.3 Tidal Marsh. This is a regularly flooded, vegetated zone that serves as a feeding, breeding and spawning area for many wildlife species. The New Jersey Natural Heritage Program lists this community type as "Mixed Tidal Fresh Marsh" and considers it locally important as a generic habitat type. The tidal marsh component exists as a fringe area, adjacent to all of the proposed disposal sites; however, they are outside the areas that would be directly impacted by the disposal of dredged material. The tidal marsh is comprised of a primarily herbaceous plant community of annual and perennial rooted and floating emergent species. Early in the season, arrowhead (Sagittaria latifolia), spatter-dock (Nuphar luteum) and pickerelweed (Pontederia cordata) dominate the community. Later, bulrushes (Scirpus spp.), marsh grasses and, particularly, native wild rice (Zizania aquatica) proliferate. Many of the tidal marshes that are adjacent to the CDFs are considered exceptional value to fish and wildlife resources (USFWS. 1995a).

6.3.2.4 Nontidal Marsh. The non-tidal marsh, like the tidal marsh, is comprised of a primarily herbaceous plant community of annual and perennial rooted and floating emergent plants. Species that would be expected to occur include arrowhead (Sagittaria latifolia), spatter-dock (Nuphar luteum), pickerelweed (Pontederia cordata), common reed (Phragmites communis), duckweeds (Lemna spp. and Spirodela spp.), waterlily (Nymphaea tetragona), and broad-leaved cattail (Typha latifolia). This habitat is rated from moderate to high.

6.3.2.5 Ruderal Area. Ruderal areas include areas of highly and recently disturbed soils that support only annual weeds such as buttonweed (Diodia teres), flannel mullien (Verbascum thapsus) and common mugwort (Limosella subulata). Often, substrates are coarse, excessively well-drained and nutrient impoverished materials that offer little upon which a perennial community can establish. Much of these areas remain barren for most of the growing season. It is expected that many years of weathering and deposition of organic materials will be necessary before normal succession can occur. According to Martin *et. al.* (1951), some weeds may provide a food source to some birds and small mammals. This habitat type is rated low in value.

6.3.2.6 Agricultural Area. The agricultural land that exists in the disposal areas is generally used for corn, wheat, and soybeans. It should be noted that cropped areas provide an inadvertent food source for many wildlife species throughout the growing season, especially when they border other wildlife habitats (Martin *et. al.*, 1951). This is especially valuable when the agricultural area exists adjacent to another habitat type that can provide cover for the times of year when the agricultural fields are bare. This habitat type is rated to have a low to moderate value.

6.3.2.7 Wildlife Species. Due to the similar habitats present on each of the disposal areas (except for the lack of agriculture on Raccoon Island), similar species were observed on each area.

The most abundant mammal species captured in the Sherman live traps was the white-footed mouse (Peromyscus leucopus). Although the white-footed mouse was not captured at each area, it, and the meadow vole (Microtus pennsylvanicus), which was also captured, would be expected to be wide spread. A more intensive sampling program would be needed to further identify and confirm the presence of small mammals at the assessment areas.

Medium and large mammals expected to occur include the eastern cottontail (Sylvilagus floridanus), red fox (Vulpes fulva), raccoon (Procyon lotor), gray squirrel (Sciurus carolinensis), and white-tail deer (Odocoileus virginianus).

Species of birds that were either observed or expected to occur in the disposal areas include the Canada goose (Branta canadensis), willow flycatcher (Empidonax minimus), barn swallow (Hirundo rustica), gray catbird (Dumetella carolinensis), American robin (Turdus migratorius), yellow warbler (Dendroica petechia), red-winged blackbird (Agelaius phoeniceus), common grackle (Quiscalus quiscula), European starling (Sturnus vulgaris), song sparrow (Melospiza melodia), mourning dove (Zenaida macroura), eastern kingbird (Tyrannus tyrannus) and northern rough-winged swallow (Stelgidopteryx serripennis).

Reptiles and amphibians that are likely to occur in the disposal areas include the common snapping turtle (Chelydra serpentina), eastern box turtle (Terrapene carolina), eastern garter snake (Thamnophis sirtalis), Fowler's toad (Bufo woodhousii), and bull frog (Rana catesbeiana).

The NJDEP reports that the shortnose sturgeon (Acipenser brevirostrum), Atlantic sturgeon (Acipenser oxyrhynchus), American shad (Alosa sapidissima), white perch (Morone americana), striped bass (Morone saxatilis), and largemouth bass (Micropterus salmoides) occur in aquatic habitats in the immediate vicinity of the assessment area.

6.3.3 Assessments of Individual Dredged Material Disposal Areas.

Raccoon Island is mostly covered with common reed with small areas of woodlands, shrubs, ruderal area and non-tidal marsh interspersed. Tidal marsh exists adjacent to, but outside of the proposed disposal area (Plate 17). The osprey (Pandion haliaetus), a State-listed threatened species, occasionally forages in the tidal marsh habitat and nests adjacent to this site. The peregrine falcon (Falco peregrinus), a Federally-listed endangered species, may also use this habitat. Due to their high value to waterfowl, the marshes of Raccoon Creek have been designated by the USFWS (1995a) as focus areas for needed protection under the Atlantic Coast Joint Venture, an effort being undertaken pursuant to the North American Waterfowl Management Plan (NAWMP).

Sites 17G (Plate 16), 15D (Plate 18), and 15G (Plate 19) are primarily used for agricultural crops. Site 15G has the lowest habitat diversity, being composed almost entirely of one large agricultural field with a fringe of common reed, woodlands and ruderal areas. The bald eagle (Haliaeetus leucocephalus), a Federally-listed threatened species, may forage and/or roost in this area and in the adjacent tidal marsh. The State-listed endangered pied-billed grebe (Podilymbus podiceps) may also inhabit the adjacent tidal marsh. Due to their high value to waterfowl, marshes of Oldmans Creek have also been designated by the USFWS (1995a) as focus areas for needed protection under the NAWMP. In addition, the wetland complex, including Site 15G and the adjacent tidal marsh, is designated a priority wetland by the USFWS under the Emergency Wetlands Resources Act (EWRA) because of its national ecological significance. This wetland complex is also a priority wetland as designated by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency. 1994) under the Clean Water Act (62 Stat. 1155, as amended; 33 U.S.C. 1251 *et seq.*). Oldmans Creek and adjacent marshes are of exceptional value to fish and wildlife resources.

Site 15D has slightly more habitat diversity than Site 15G, but is also primarily composed of large agricultural fields with small areas of common reed, woodlands and ruderal areas. The bald eagle, a Federally-listed threatened species, may forage and potentially roost in this area and in the adjacent tidal marsh. The State-listed threatened osprey (Pandion haliaetus) also forages in the adjacent tidal marshes. Due to their high value to waterfowl, marshes of Raccoon Creek have also been designated by the USFWS (1995a) as focus areas for needed protection under the Atlantic Coast Joint Venture. Site 15D is also adjacent to a priority wetland as designated by the U.S. Department of the Interior (DOI) under the Emergency Wetlands Resources Act (EWRA) (P.L. 99-645; 100 Stat. 3582). Raccoon Creek and adjacent marshes are of exceptional value to fish and wildlife resources.

Although Site 17G is primarily composed of agricultural areas and common reed, it has greater habitat diversity than either Site 15D or 15G because of greater interspersion of habitat types. The bald eagle, a Federally-listed threatened species, may forage and roost in this area, especially in the adjacent tidal marshes. The Delaware River, Woodbury Creek, and adjacent marshes are of exceptional value to fish and wildlife resources (FWS. 1995a).

6.4 Habitat Management During Operations

A summary of habitat management of the upland dredged material disposal areas is given below. A detailed description of the design and operation of these sites is given in Section 3.2.3.

One of the primary goals and objectives for these four CDFs is development, enhancement, and management of wildlife habitat through the beneficial uses of dredged material. In the past, the Delaware River CDFs have been managed with a primary goal of maximizing storage capacity. This normally requires that the sites be drained as quickly as possible following active placement operations, that they be trenched to hasten dewatering, and that the dried dredged material be borrowed from the interior of CDFs for upgrading dikes before the next dredging cycle. This overall management approach generally conflicts with management for wetlands and wildlife habitat.

An approach that provides for both is tied to extended cycles between uses. With extended cycles, portions of the sites can be used for temporary wetland habitat for several years, prior to the need for draining, dewatering, and dike upgrading to be ready for the next placement episode. This calls for rotation of placement between subdivisions within each CDF. The CDF sites have total surface areas ranging from 275 to 350 acres. The CDFs are amenable to subdivision into cells, each with a surface area on the order of 125 to 175 acres. A 3- to 4-yr cycle for use in any one site, and placement into one of the two cells for each cycle, means that each cell will be required for placement on a 6 to 8 year cycle. Assuming between 0.75 and 1.5 MCY for each event, the bulked lift thickness will be on the order of 4 to 8 feet. Material will be left in a wet condition or ponded with water if desired for a period of 3 to 4 years. During that time period, the cell will be managed as wetlands. However, some self weight consolidation would be taking place, bringing the lift thickness down to around 3 to 6 feet. This will require periodic adjustment of weirs to maintain the desired ponded area and water depths.

The lift thickness following self weight consolidation can be managed for dewatering and borrow for dike upgrading over the next time period of 3 to 4 years. Using this engineering method, each of four CDFs could have roughly half of the surface area managed for habitat at all times, with half the site being managed for dewatering and borrow for dike upgrading. With this approach, some use of the other 4 CDFs in the vicinity will be necessary.

The four new CDFs will be divided into two cells each. Each of these will have two weirs, allowing considerable flexibility for passive management through control of water depths between dredging cycles. Allowing water to remain on sites after dredging rather than allowing all freeboard and rainwater to flow off, coupled with active dewatering, will provide for appropriate Phragmites australis control and waterfowl/waterbird habitat.

The easiest habitat types to achieve will be non-forested, and will include primarily fresh water emergent and open water habitat. These wetlands will provide habitats for migratory and resident waterfowl, wading birds, as well as other birds, mammals, amphibians, and reptiles that need wetlands.

6.5 Habitat Management Subsequent to Use

All of the four sites lend themselves to some imaginative topographic relief for the sake of wildlife habitat during the life of the project, and especially after the project is completed. That is, the sculpting of ponds and islands within cells to provide more habitat diversity, and varying water depths after dredged material has been placed in cells over several rotational cycles and higher overall elevations are achieved. This approach is also expensive, and should not be undertaken until the sites are no longer required for dredged material disposal purposes. There are several transitional, more upland habitat features that can be planned for two to three decades into project life that include more moist forest, more insular features, and perched ponds.

These four sites, along with the other eleven CDFs adjacent to the Delaware River, will be developed and filled. The sites will progress, and at the end of the project life in 2050, the four sites will have become broad flat hills in the landscape and be uplands rather than wetlands. The material in these sites is suitable for beneficial uses, and does not require any remediation after project life. Upland habitat will develop on these sites regardless of whether they are planted or not; natural colonization takes longer but the results are the same over time. The detailed management of these areas should be determined by the needs and priorities of the people who are living at the end of the project. It can be stated at this time that this area will be committed to open space/environmental uses.

6.6 Assessment of Impacts Associated With Use of Sites

6.6.1 Impacts to Wetlands

6.6.1.1 Avoiding Impacts

It will be impossible to avoid impacts to all existing habitats within the four CDFs. Those habitats that fall within the mainline dikes will be destroyed and regained repeatedly over the next 50 years. The re-alignment of the dikes to avoid existing forested and shrub areas is planned, and this will protect much of the quality wetlands and other forested habitat. Dike alignments will not protect those wetlands that are covered with Phragmites australis, but these will be replaced over time with higher quality wetlands.

6.6.1.2 Wetland Impacts

A determination of 396 acres of jurisdictional wetlands impacted on the four sites has been provided, all of which are manmade wetlands. The acreage of wetlands in each site is shown in Table 6-2. The most dominant type of manmade, jurisdictional wetland inside the four CDFs is 365 acres of Phragmites australis, or common reed, and farmed, which are approximately 90% of the wetlands present on the four sites. Table 6-4 shows the amounts and types of wetlands that presently occur on the disposal areas and what will be present with the proposed plan. There is a net increase of approximately 200 acres of wetlands. All of the wetlands that will occur in the disposal areas will be palustrine emergent, mostly non-tidal fresh marsh. The quality of these wetlands is expected to be better than the predominantly common reed dominated wetlands that presently occur. These wetlands will be less likely to be dominated by common reed because of the water level manipulations that will be possible using the weirs that will be present at strategic locations.

There are only 4 acres of non-tidal marsh that is not common reed. Replacement of this habitat will be relatively easy on a temporary basis, as cells are filled and dewatered. Each dewatering cell generally has a shallow pond area remaining at the weir that vegetates in fresh marsh. Care must be taken to keep this final ponded area from growing in Phragmites australis; however, the ponding for several years in each cell in rotation will significantly retard growth and expansion of the reed.

Forested wetlands have been lost in large acreages throughout the New Jersey/Delaware/Pennsylvania area, resulting in requests for more attention to re-forestation and management of this habitat type. The forested wetland mitigation bank scheduled for the south end of CDF 17G is a good example. It is possible and generally recommended on the four sites to isolate and protect approximately 50 acres of existing shrub and tree areas for continued succession, and also to include additional upland areas along outer dike toes that can develop as shrub and tree areas, to compensate for and supplement the 39.54 acres of wet shrubs and trees being impacted. While the upland forest habitats within the CDFs are not subject to jurisdiction, efforts will be made to protect as much of the existing forest as possible. The entire 1240 acres will become uplands over time. It is also possible to include in a long-term management plan for parts of each CDF to be planted or colonized as moist forest (not wetland forest) at a later stage of development. While not wetlands, they can still provide considerable wildlife habitat as upland forest near an urban area.

6.6.2 Impacts to Wildlife

6.6.2.1 Environmental Windows. Environmental windows for nesting and migratory species that may occur on the four sites will generally be observed. Since a rotational management plan that will allow certain cells in CDFs to remain undisturbed is being considered, those cells and remaining existing wooded areas outside of cells will not be disturbed regardless of the dredging activity. Dike construction and upgrading are best carried out in late summer and fall months due to drier soil conditions, and those on-site activities are far more likely to have a potential impact on nesting or migratory species than the actual placement of the hydraulically-pumped material within the cell. Earth moving for dikes and land leveling totally removes existing habitat and nests, whereas pumping material will cover up nesting that may have begun prior to placement. This will not be a factor if pumping is begun before nesting season. Pumping material may require a few on-land personnel, but in general is not an intensive on-land activity like dike construction.

Table 6-4. Delaware River Main Channel Deepening Project, Upland Confined Dredged Material Disposal Sites - Wetland Impacts

Upland Dredged Material Disposal Sites	Site 17G (Acres)		Site 15D (Acres)		Site 15G (Acres)		Raccoon Island (Acres)		Totals (Acres)	
Wetland Type/ Wetland Acres*	Exist.	With Proj.	Exist.	With Proj.	Exist.	With Proj.	Exist.	With Proj.	Exist	With Proj.
Palustrine Emergent (PEM)	33[1]	145	37[1]	160	6[2]	135	289[3]	175	365[3]	615
Palustrine Forested/Shrub -Scrub	1		4				26		31	
Totals	34	145	41	160	6	135	315	175	396	615

* Area is rounded to the nearest acre.
1. Primarily common reed dominated or farmed.
2. Primarily ditches or farmed.
3. Primarily common reed dominated.

6.6.2.2 Impacts to Wildlife Habitat. Table 6-3 compares the types and area of habitats that presently exist on the 4 CDFs with what will occur when the sites are developed, and during the 50 year period that they will be used for the disposal of dredged material. Approximately 93% of the existing habitat is rated as low to moderate quality, consisting of common reed or agricultural land. Through the rotation of placement of dredged material between subdivisions within each CDF, approximately 600 acres or 50% of the area of the new CDFs will be maintained as shallow, non-tidal marsh with an expected habitat rating of moderate to high.

As previously noted, adverse impacts to most of the forested and shrub-scrub habitat within the CDFs will be avoided by aligning the new dike to avoid these areas. Nevertheless, 48 acres of this moderate to high rated habitat will be impacted by the project. However, approximately 372 acres of additional area outside of the CDFs will be purchased as part of the project due to real estate requirements. This area is presently a mosaic of habitat types consisting primarily of tidal marsh, woodlands, common reed, and ruderal areas. Much of this area is moderate to high quality wildlife habitat located adjacent to either the Delaware River or to tidal creeks including some tidal marshes that are considered exceptional value to fish and wildlife resources (FWS 1995a). This area will be maintained as undeveloped land, and it is likely that the habitat quality will increase as the woodlands mature and ruderal and common reed areas succeed to more valuable habitats such as woodlands. In conclusion, the overall habitat value of the 1612 acres that will be purchased for upland dredged material disposal areas will be greater during the 50 years of project life than what presently exists on this area.

7.0 Groundwater Investigations of Dredged Material Disposal Sites

7.1 Geology and Groundwater. The study area lies within the coastal plain physiographic province and is underlain by unconsolidated sands and clays of Cretaceous, Tertiary, and Quaternary age. 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 of the Delaware River and are progressively deeper toward the Atlantic Ocean. Rock outcrops will be encountered in the vicinity of Marcus Hook, Pennsylvania, during the channel deepening. The unconsolidated sediments consist of pervious and impervious layers which form a series of aquifers and aquicludes.

The primary aquifer units along the Delaware River are the Potomac-Raritan-Magothy formations and the Cape May and Columbia formations. The Potomac-Raritan-Magothy aquifers are exposed at various locations at or near the surface in a narrow band along both sides of the Delaware River between Trenton and Pennsville, New Jersey. The Cape May and Columbia formations cover practically all of Delaware and portions of Southern New Jersey. In many locations in or adjacent to the Delaware River, these aquifer units are mantled by sands and clays of recent alluvial deposits. The municipal water wells in southern New Jersey generally withdrawal their water from the Potomac-Raritan-Magothy formation. It is considered the sole source aquifer for the region.

The thickness of the Potomac-Raritan-Magothy formations is as much as 500 feet. Many industries and public water companies in the region obtain groundwater from this formation. There are four major aquifers within the formation. In the vicinity of the project's four new disposal areas, the uppermost aquifer is 50 to 120 feet below the surface, the second ranges from 105 feet to 250 feet, the third from 300 feet to 390 feet, and the lowermost aquifer is 400 feet to 500 feet below the surface. The upper water bearing zone is usually artisan and is separated from the surface sediments by clay beds with a minimum ten-feet thickness in the vicinity of the disposal areas. Communities along the river obtain their water from the basal part of the lower aquifer. Impermeable clay layers separate all of the water bearing zones.

Groundwater flow is generally toward the main river in a typical river basin. However, the groundwater regime in the project area, specifically the New Jersey side of the river, has been disturbed by urbanization. This information has been documented in numerous reports. The U.S.G.S. Atlas HA-697 dated 1986 estimates a leakage of 70 million gallons per day (MGD) from the Delaware River into the Potomac-Raritan-Magothy aquifer system in the project area. A reversal of the natural groundwater flow due to overpumping of the aquifer has occurred. Prior to municipal and industrial pumping, water flow in the aquifer was towards the river. Where large groundwater withdrawals have locally reversed the original aquifer flow patterns, aquifer recharge by river water results. This is due to the fact that permeable sand and gravel in the river are in direct contact with the sediments which comprise the Potomac-Raritan-Magothy system. Although a large volume of river water is presently infiltrating the aquifer from the river, no contamination or salinity problems have been reported. Since the amount of aquifer recharge from the river is controlled by the pumping rate of private and public wells, any deepening of the channel will not increase the amount of intrusion.

7.2 Dredged Material Disposal Area Groundwater

The confined upland dredged material disposal areas, previously discussed in Sections 3.2 and 6.0, will be utilized to provide 50 years of capacity for the 45 foot project in Reaches A through D. All of the sites (proposed and existing) other than Reedy Island North and South, are located in New Jersey (See Plates 1 - 4). The sites are all situated near the Delaware River shore, have similar subsurface conditions, contain varied amounts of fine grained dredged material, and overlie the Potomac-Raritan-Magothy aquifer.

The existing 40 foot navigation project has historically been maintained through the use of annual maintenance dredging. The material dredged from the existing 40 foot channel has been deposited in upland dredged material disposal areas in New Jersey for long term storage. As part of the proposed 45 foot deepening project, four new upland disposal areas will be used in conjunction with existing Federal sites. Several concerns have been raised in regards to the use of these sites. The main concern involves the potential impact to drinking water aquifers from leachate generated by the disposal operations. It is hypothesized that water could percolate through the dredged material, leach out potential contaminants such as heavy metals, and carry them to the groundwater. As a first step in the investigation, sediment testing of the Delaware River channel and channel bends was conducted. The sediment testing, discussed earlier in the report in Section 4.0, concluded that the materials are sufficiently clean to meet all NJDEP Impact to Ground Water Soil Cleanup Criteria.

As a supplement to the sediment testing efforts, the United States Geological Survey was tasked with performing an evaluation of potential contaminant travel times from the proposed project disposal sites to nearby drinking water and industrial production wells. The report entitled, "Evaluation of Groundwater Flow from Dredged Material Disposal Sites in Gloucester and Salem Counties, New Jersey" (USGS. 1995), determined that the disposal sites would not impact local wells as the sites provide a very small percentage of well recharge and potential contaminant travel times were on the order of fifty to one hundred years. The mean travel times for groundwater from the new proposed disposal areas to reach any potential water supply well is in excess of 50 years, except for a cluster of wells near area 15G where the report states that "travel time to these wells could be relatively short, perhaps on the order of several years". The proposed (site 15G) and existing (Oldmans, Pedricktown North and South) disposal areas are in the contributing area to these wells. Oldmans disposal area is centrally located among the sites between areas 15G and Pedricktown North. This site has been used over 40 years by the Corps of Engineers for disposal of maintenance material from the existing Delaware River 40 foot project. Recently, a detailed groundwater investigation of the Oldmans disposal area has been completed by the Corps of Engineers. The investigation concluded that potential environmental impacts to this site should not preclude further expansion and continued use of this site as a dredged material disposal area.

It is important to consider all of the contributing factors when evaluating the potential negative impact of the travel times from all disposal areas. First, the existence of 20-40 feet of fine grained material from past dredging within the disposal areas greatly impedes the flow of water from the areas and increases the travel times substantially. In addition, the new dredged sediments from the 45 foot project contain no harmful levels of contamination; so in the event that the water were to reach the well from the disposal area, it would have no impact on water quality.

The aforementioned conditions with respect to travel time, recharge, contamination levels, and conclusions from the recent groundwater investigation conducted by the Corps of Engineers at Oldmans disposal area indicate that possible risk of groundwater impacts at the dredged material disposal sites is negligible. The disposal of material in the proposed areas will have a negligible impact on the groundwater/aquifer system in both the local and regional area.

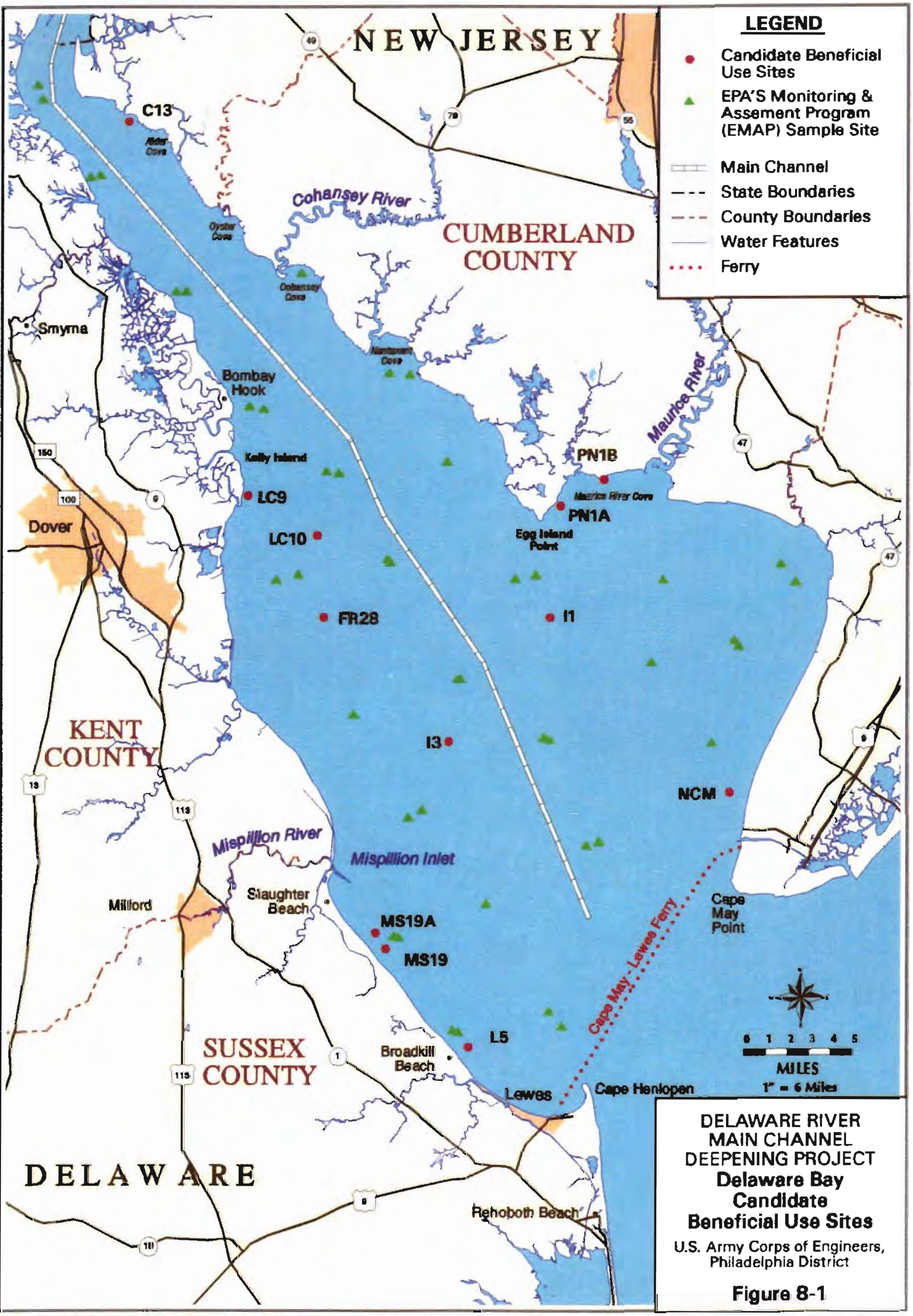
8.0 Benthic Habitat Investigations

8.1 Beneficial Use Site Investigations

Eleven candidate beneficial use sites were identified in Delaware Bay (Table 8-1, Figure 8-1). Options for beneficial use sites which were investigated include sand stockpiling in the bay for future beach replenishment activities along Delaware Bay shorelines, wetlands restoration and protection against erosion, and island creation to provide habitat. During Phase I of this study, data were collected on benthic macroinvertebrate resources at each candidate site to characterize the site and assess overall habitat quality (Greeley-Polhemus 1994a). Sampling procedures focused on measuring the overall diversity and density of the benthic community and included a survey of commercially or recreationally important species such as oysters, clams, blue crabs, and horseshoe crabs. On the basis of the Phase I report, four of the candidate beneficial use sites were selected that satisfied project needs, including cost, and minimize impacts to benthic resources. During Phase II, additional data were collected on the four sites to further characterize habitat quality. A twelfth site, MS-19B, was later added in 1995 and evaluated by Verser, Inc. (Chaillou and Weisberg. 1995).

Table 8-1. Candidate beneficial use sites

Site Name	Acreage	Beneficial Option
FR 28	500	Sand Stock Pile
L5	500	Sand Stock Pile
LC10	500	Sand Stock Pile
MS19A	500	Sand Stock Pile
MS19B	500	Sand Stock Pile
NCM	500	Sand Stock Pile
I1	250	Island Creation
I3	250	Island Creation
C13	250	Island Creation
LC9	350	Wetland Creation
PN1A	250	Wetland Creation
PN1B	250	Wetland Creation



DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT
Delaware Bay Candidate Beneficial Use Sites
U.S. Army Corps of Engineers, Philadelphia District
Figure 8-1

8.2 Evaluation of Benthic Resources of Candidate Beneficial Use Sites

Twelve sites were compared to background conditions in the Delaware Bay to determine any particular attributes that would assist in the beneficial use site selection process. The candidate sites were evaluated on the basis of four attributes: (1) physical characteristics, (2) presence of "unique" species, i.e., species which were not collected at other sites or in the surrounding Delaware Bay, (3) presence of commercially or recreationally important species, and (4) condition of the benthic macroinvertebrate community.

8.2.1 Physical Characteristics

Candidate sites were consistently shallower than the average for the rest of Delaware Bay, which is most likely attributed to the fact that the candidate sites are nearshore and away from the navigation channel (Table 8-2). Average channel depth exceeds 15 m; the deepest station of the candidate sites was 7.9 m at site I3.

The candidate sites were almost evenly divided according to mud or sand sediment type (seven sites versus five sites) (Table 8-2). Seven of the sites were significantly muddier than the average for the surrounding Delaware Bay. Only two sites, I1 and I3, were significantly sandier. Sites I1, I3, MS19A, and MS19B had sandy substrates at all sampling stations; site PN1B had a muddy substrate. All other sites were a combination of mud and sand sediment types.

Among the candidate sites, the percentage of total organic content tended to increase relative to silt-clay content (Table 8-2). The sandiest sites (silt-clay content less than 20%) had total organic content values less than 2%.

The candidate sites were predominantly polyhaline (salinity of 18 - 30 ppt), similar to the surrounding Delaware Bay (Table 8-2). The one exception was site C13, which was mesohaline (salinity of 5 -18 ppt). Only site MS19B, which is located in the lower bay, was significantly saltier (30.7 ppt) than the average for the surrounding Delaware Bay (23.4 ppt), though salinity differences may be largely affected by the stage in tide which they are measured. All sites were well-oxygenated and met state water quality standards of 5 ppm. Sites LC9, LC10, and NCM had significantly higher average bottom temperatures than the surrounding Delaware Bay. The maximum temperature of 30.1 C was measured at site LC9. Surface and bottom water quality measurements were very similar at each site, indicating a well-mixed system.

8.2.2 Presence of Unique Species

Evaluating potential effects on biodiversity of a system is an important aspect of environmental assessments associated with federal actions (CEQ 1993). One way to assess potential effects on biodiversity at a site is to identify whether any species are unique or abundant only at that site within those sites sampled.

A total of 248 species were found at either the candidate sites or in the surrounding Delaware Bay. Of those, 35 were unique to a particular candidate site (Table 8-3).

Ten of the 12 candidate sites contained at least one species that was collected only at that site. Site L5 contained 10 species not found in the other collections, which was the highest among the candidate sites. Sites C13 and PN1B were the only sites that contained no unique species.

Of the unique species that were found, none were so important as to preclude the placement of dredged material at the site. The majority of unique species fell into one of four categories:

- Of the 35 species, three are epifaunal taxa that are not well sampled by benthic infaunal gear. Their collection at individual sites is likely an artifact of attachment to surface debris.

- Five are abundant marine organisms that were collected at Delaware Bay sites near the Atlantic Ocean. Examples of these species are Notocirrus spiniferus and Aricidea fragilis, both large polychaete worms, and Paranthus rapiformis, commonly known as the onion anenome. All three species were found at site MS19B, which is located close to the mouth of the Delaware Bay.

- Another seven species are close relatives of other species on the taxa list that we believe are unique because of differences in taxonomic uncertainties among the laboratories that processed the samples.

- Sixteen species were so rare at the site (abundance < $2.0/m^2$) that it is unlikely to be an important or unique habitat for the species.

Of the remaining four species (Pagurus annulipes, Kurtziella cerina, Almyracuma proximoculi, and Pagurus annulipes), one each was found at L5 (in 1993 only), I1, PN1A (in 1994 only), and LC10 (in 1994 only). None of these taxa are considered rare in Delaware Bay (Watling and Maurer 1973).

Table 8-2. Means of physical parameters at candidate sites (standard error in parentheses). Shaded values are significantly different from background values observed in the Delaware Bay.

	C13	FR28	L5		LC9		LC10		PN1A		MS19A	MS19B	NCM	PN1B	I1	I3	Back-ground
			93	94	93	94	93	94	93	94							
Depth (m)	4.3 (0.3)	4.1 (0.1)	4.3 (0.2)	5.4 (0.1)	1.2 (0.1)	2.1 (0.2)	3.2 (0.2)	3.7 (0.2)	2.0 (0.3)	1.3 (0.1)	3.4 (0.1)	3.1 (0.2)	5.6 (0.3)	0.9 (0)	5.7 (0.2)	4.3 (1.3)	6.9 (0.7)
Silt-clay Content (%)	74 (12)	43 (2)	39 (7)	62 (4)	79 (11)	87 (5)	49 (8)	82 (1)	75 (14)	65 (13)	19 (3)	16 (2)	38 (12)	83 (8)	15 (<1)	4 (1)	23 (4)
Total Organic Content (%)	8.36 (1.76)	2.34 (0.13)	3.28 (0.46)	4.28 (0.27)	8.94 (1.77)	12.94 (0.61)	3.51 (0.83)	5.67 (0.38)	10.10 (1.97)	8.22 (2.22)	2.10 (0.17)	0.92 (0.05)	5.01 (1.27)	12.86 (3.19)	1.78 (0.12	1.08 (0.12)	
Surface DO (ppm)	8.7 (0.3)	7.8 (0.1)	9.1 (0.3)	8.4 (0.2)	5.7 (0.2)	6.2 (0.3)	8.8 (0.2)	6.8 (0.2)	6.6 (0.8)	6.5 (0.3	8.2 (0.2)	8.9 (0.4)	7.3 (0.1)	6.6 (0.1)	14.6 (0.5)	8.4 (0.1)	7.3 (0.2)
Bottom DO (ppm)	7.9 (0.3)	7.6 (0.1)	8.2 (0.2)	7.7 (0.1)	5.7 (0.2)	NM	8.4 (0.2)	5.7 (0.1)	6.0 (0)	NM	7.8 (0.1)	9.1 (0.6)	7.2 (0.1)	NM	12.5 (0.7)	8.5 (0.2)	6.5 (0.2)
Surface Salinity (ppt)	11.2 (0.1)	25.1 (0.1)	28.9 (0.2)	24.3 (0.4)	22.0 (0.3)	14.7 (0.5)	21.9 (0.8)	14.8 (0.5)	20.9 (0.1)	18.1 (0.1)	28.4 (0.2)	29.3 (0.4)	25.3 (0.4)	19.3 (0.2)	21.4 (0.7)	27.5 (0.2)	22.1 (1.1)
Bottom Salinity (ppt)	11.1 (0.2)	25.0 (<0.1)	28.1 (0.2)	24.3 (0.5)	21.6 (0.2)	NM	21.9 (0.8)	15.3 (0.3)	20.5 (0)	NM	28.2 (0.1)	30.7 (0.7)	25.6 (0.4)	NM	22.0 (0.4)	27.3 (0.2)	23.4 (0.9)
Surface Temperature (°C)	25.3 (0.4)	25.9 (0.3)	26.6 (0.4)	22.5 (0.4)	29.9 (0.5)	27.6 (0.2)	28.1 (0.3)	27.9 (0.2)	25.2 (0.2)	25.2 (0.1	26.3 (0.4)	24.5 (0.1)	26.7 (0.3)	24.8 (0.1)	23.6 (0.2)	25.7 (0.4)	24.9 (0.2)
Bottom Temperature (°C)	25.4 (0.4)	25.5 (0.2)	25.1 (0.3)	22.2 (0.4)	29.0 (0.3)	NM	27.3 (0.2)	27.7 (0.2)	24.0 (0)	NM	25.5 (0.3)	24.4 (0.1)	26.3 (0.3)	NM	23.4 (0.2)	24.3 (0.2)	24.5 (0.3)

Table 8-3. Abundance ($\#/m^2$) of species found only at single sites	C13	FR28	L5		LC9		LC10		PN1A		MS19A	MS19B	NCM	PN1B	I1	I3
			93	94	93	94	93	94	93	94						
Cnidaria : Hydrozoa Hydrozoa								0.48								
Cnidaria : Anthozoa Paranthus rapiformis												0.57				
Platyhelminthes : Turbellaria Planaridae				1.60												
Annelida : Polychaeta Aricidea fragilis												6.25				
Capitella capitata							1.44									
Clymenella torquata			9.13													
Notocirrus spiniferus												0.57				
Opheliidae											1.44					
Paranaitis speciosa												0.57				
Pherusa affinis			0.48	1.2												
Phyllodoce groenlandica															0.54	
Podarke obscura			1.92													
Tharyx setigera																0.96
Annelida : Hirudinea Hirudinea			0.48													
Mollusca : Gastropoda Bittium alternatum																0.48
Crepidula maculosa												0.57				
Kurtziella cerina															18.82	
Nudibranchia						0.48										
Urosalpinx cinerea				0.40												
Mollusca : Bivalvia Geukensia demissa				0.48												
Pandora gouldiana															0.54	
Tellina tenella															1.08	
Tellina versicolor		0.96														
Arthropoda : Cumacae Almyracuma proximoculi										5.77						

Table 8-3. (Continued)

	C13	FR28	L5		LC9		LC10		PN1A		MS19A	MS19B	NCM	PN1B	I1	I3
			93	94	93	94	93	94	93	94						
Arthropoda : Isopoda Idotea balthica											0.48					
Arthropoda : Amphipoda Aeginina longicornis			6.73													
Gammarus palustris						1.44										
Lysianopsis alba															0.54	
Microdeutopus gryllotalpa			5.77													
Paraphoxus spp.											60.58					
Arthropoda : Decapoda Emerita talpoida			0.48													
Ovalipes ocellatus													0.48			
Pagurus acadianus								0.48								
Pagurus annulipes								2.88								
Panopeus herbstii															30.11	
Total Number of Species	0	1	10		2		2		1		3	6	1	0	6	2

8.2.3 Presence of Commercially or Recreationally Important Species

Sites containing high abundances of commercially or recreationally important species are generally considered to be less preferable as beneficial use sites than sites with low abundances. Eleven of the 12 sites contained at least one species of commercial or recreational value, but only eight of those 11 sites contained infaunal species (Table 8-4).

Infaunal species are immobile and at greater risk from placement of dredged material than surface dwelling taxa that can migrate from the affected area. Of the eight sites, five contained Mercenaria mercenaria (northern quahog) but abundance was fairly low, less than $4.0/m^2$). Softshell clams were collected at sites LC9 and PN1A, but only in 1994. Atlantic surf clams were found only at site I3.

8.2.4 Benthic Community Response Measures

8.2.4.1 Biodiversity

None of the candidate sites had a significantly greater species richness or diversity than background conditions for the Delaware Bay across all four habitats (mesohaline/mud, mesohaline/sand, polyhaline/mud, and polyhaline/sand) (Tables 8-5 through 8-8). Site MS19B had the greatest mean number of species (18.45/sample) in any habitat. Site PN1A had the fewest mean number of species for either polyhaline habitat but it was only low in 1993; values for this site increased by a factor of two in 1994. Site MS19B also had the highest Shannon-Wiener index (3.19). Site LC9 had the lowest Shannon-Wiener index (0.34), significantly lower than the background condition, and was consistently low across both habitat and sampling years.

8.2.4.2 Abundance

Only two sites, MS19A and LC9, had a significantly higher benthic macroinvertebrate density than the surrounding Delaware Bay. In both cases, greater abundance resulted from an overwhelming abundance of a single species, rather than from an increased abundance of a balanced community. At site MS19A, total abundance was dominated by amphipods (96%), primarily Ampelisca, an opportunistic species. For site LC9, bivalves contributed almost 95% of the abundance in either mud or sand habitat in 1993, but the proportion was considerably lower in 1994. Mulinia lateralis, an opportunistic bivalve, was the dominant species.

Sites LC10 and PN1A had a considerably lower abundance than the surrounding Delaware Bay, but differences for both sites were habitat and year specific.

Table 8-4. Mean abundance (#/m^2) of commercial and recreational species collected at each of the candidate sites

	FR28	L5		LC9		LC10		PN1A		MS19A	MS19B	NCM	PN1B	I1	I3
		93	94	93	94	93	94	93	94						
Northern quahog *Mercenaria mercenaria*	2.40					1.44	0.48				0.57	3.85		3.76	
Atlantic surfclam *Spisula solidissima*															58.65
Softshell clam *Mya arenaria*					30.29				14.42						
Knobbed whelk *Busycon carica*			0.40							1.44					
Blue crab *Callinectes sapidus*							0.48	3.85		3.37		0.96	48.08		
Horseshoe crab *Limulus polyphemus*	29.33	0.96	0.40	6.87	18.75	3.37	0.48	0.96	5.77	92.31		6.25			

Table 8-5. Mean benthic macroinvertebrate condition in the mesohaline/mud habitat within candidate sites (standard error in parentheses). Shaded values are significantly different from background values observed in Delaware Bay.

	C13	Background
Number of Species (#/sample)	5.44 (0.65)	11.00 (1.73)
Shannon-Wiener Index	1.88 (0.17)	2.42 (0.22)
Percent of Abundance as Opportunist Species	33.76 (6.18)	23.78 (6.92)
Percent of Abundance as Equilibrium Species	10.37 (6.11)	0.14 (0.10)
Total Abundance (#/m^2)	374 (80)	2,915 (686)
Amphipod Abundance (#/m^2)	119 (39)	389 (85)
Bivalve Abundance (#/m^2)	20 (4)	127 (57)
Polychaete Abundance (#/m^2)	52 (10)	1,430 (477)
N	16	15

Table 8-6. Mean benthic macroinvertebrate condition in the mesohaline/sand habitat within candidate sites (standard error in parentheses). Shaded values are significantly different from background values observed in Delaware Bay.

	C13	Background
Number of Species (#/sample)	5.50 (0.29)	14.50 (1.85)
Shannon-Wiener Index	2.11 (0.11)	2.83 (0.25)
Percent of Abundance as Opportunist Species	49.12 (10.21)	57.30 (6.88)
Percent of Abundance as Equilibrium Species	0	1.39 (0.52)
Total Abundance (#/m^2)	308 (45)	3,006 (1,055)
Amphipod Abundance (#/m^2)	29 (6)	81 (36)
Bivalve Abundance (#/m^2)	10 (10)	1,483 (902)
Polychaete Abundance (#/m^2)	149 (40)	559 (138)
N	4	12

Table 8-7. Mean benthic macroinvertebrate condition in polyhaline/mud habitats within candidate sites (standard error in parentheses). Shaded values are significantly different from background values observed in Delaware Bay.

	FR28	L5		LC9		LC10		PN1A		PN1B	NCM	Back-ground
		93	94	93	94	93	94	93	94			
Number of Species (#/sample)	15.05 (0.39)	15.00 (1.21)	11.45 (0.47)	7.20 (0.37)	8.55 (0.49)	13.31 (0.83)	12.30 (0.41)	5.50 (0.39)	10.69 (1.01)	8.05 (0.75)	16.80 (1.12)	17.50 (1.68)
Shannon-Wiener Index	2.68 (0.04)	2.48 (0.06)	2.22 (0.08)	0.36 (0.07)	1.01 (0.10)	2.55 (0.10)	2.31 (0.05)	1.99 (0.14)	1.41 (0.16)	1.25 (0.16)	2.67 (0.11)	2.43 (0.15)
Percent of Abundance as Opportunist Species	64.59 (1.83)	52.78 (3.11)	63.01 (2.70)	96.69 (0.67)	31.89 (4.44)	21.54 (2.79)	58.21 (2.02)	27.85 (5.51)	31.56 (5.65)	57.92 (8.05)	8.50 (2.69)	66.17 (6.61)
Percent of Abundance as Equilibrium Species	0.38 (0.09)	1.43 (0.64)	0.15 (0.06)	0	0.39 (0.10)	0.23 (0.16)	0.16 (0.06)	0	0.37 (0.21)	0	2.48 (0.42)	0.04 (0.03)
Total Abundance (#/m²)	3,939 (201)	6,434 (1,403)	3,108 (206)	37,234 (5,035)	16,089 (1,874)	1,833 (190)	4,540 (272)	383 (104)	11,081 (1,685)	7,705 (2,235)	3,474 (348)	5,771 (1,225)
Amphipod Abundance (#/m²)	767 (83)	2,256 (655)	768 (161)	1,421 (1,101)	37 (11)	375 (70)	242 (31)	165 (98)	736 (204)	4,185 (2,124)	1,053 (273)	144 (31)
Bivalve Abundance (#/m²)	2,129 (129)	2,712 (576)	1,538 (71)	35,051 (4,709)	4,662 (1,190)	113 (29)	916 (142)	0	2,709 (644)	886 (260)	125 (18)	508 (226)
Polychaete Abundance (#/m²)	268 (17)	133 (31)	38 (6)	45 (5)	421 (177)	977 (97)	1,562 (100)	29 (11)	216 (53)	109 (21)	1,452 (165)	2,790 (958)
N	20	12	44	20	40	16	40	16	16	20	20	12

Table 8-8. Mean benthic macroinvertebrate condition in the polyhaline/sand habitat within candidate sites (standard error in parentheses). Shaded values are significantly different from background values observed in Delaware Bay.

	FR28	L5		LC9	LC10	PN1A		MS19A	MS19B	NCM	I1	I3	Back-ground
		93	94	93	93	93	94						
Number of species (#/sample)	13.20 (0.53)	14.11 (0.55)	13.75 (1.55)	7.75 (0.41)	12.79 (0.52)	5.50 (0.87)	11.25 (1.25)	13.30 (0.58)	21.48 (0.79)	13.05 (0.83)	18.45 (0.78)	8.85 (0.49)	23.86 (1.06)
Shannon-Wiener Index	2.79 (0.06)	2.28 (0.10)	1.99 (0.09)	0.34 (0.05)	2.61 (0.08)	1.59 (0.54)	2.18 (0.11)	1.32 (0.07)	3.19 (0.06)	2.40 (0.16)	2.63 (0.14)	1.69 (0.21)	2.85 (0.08)
Percent of Abundance as Opportunist Species	56.83 (2.14)	65.14 (3.43)	75.92 (1.01)	97.30 (0.52)	23.80 (2.30)	47.51 (19.56)	80.28 (1.22)	69.23 (3.20)	39.43 (2.45)	17.30 (6.17)	44.16 (4.34)	1.44 (0.85)	44.90 (2.98)
Percent of Abundance as Equilibrium Species	0.17 (0.10)	1.40 (0.28)	0	0.05 (0.05)	0.35 (0.13)	0	3.59 (1.62)	0.05 (0.01)	4.54 (0.49)	2.19 (0.96)	0.54 (0.16)	3.57 (0.72)	0.79 (0.16)
Total Abundance (#/m^2)	2,394 (104)	3,873 (398)	3,510 (90)	30,767 (3,773)	1,644 (125)	6,716 (6,364)	2,082 (388)	26,549 (2,040)	6,825 (795)	5,063 (2,302)	2,935 (549(	2,462 (374)	7,934 (792)
Amphipod Abundance (#/m^2)	575 (49)	1,824 (203)	250 (83)	861 (528)	275 (31)	6,490 (6,407)	10 (10)	25,451 (2,041)	2,134 (446)	3,891 (2,294)	1,235 (547)	1,738 (433)	1,563 (474)
Bivalve Abundance (#m/^{2})	1,055 (92)	1,187 (173)	2,630 (179)	29,214 (3,507)	162 (22)	0	1,240 (168)	429 (87)	1,424 (122)	167 (38)	190 (23)	163 (19)	588 (50)
Polychaete Abundance (#/m^2)	175 (15)	126 (11)	48 (18)	48 (8)	801 (64)	111 (53)	548 (245)	79 (12)	2,117 (297)	626 (85)	1,032 (93)	251 (19)	4,530 (507)
N	20	28	4	8	24	4	4	40	40	20	20	20	95

8.2.4.3 Life History Strategy Measures

Disturbed habitats are often characterized by a predominance of relatively short-lived, tolerant species (opportunistic species) with relatively high reproductive and recruitment rates (Boesch 1973, 1977; Pearson and Rosenberg 1978; Rhoads et al. 1978; Dauer 1991, 1993; Dauer et al. 1992). Disturbed sites tend to be recolonized initially and quickly by opportunistic species. In contrast, undisturbed or unstressed habitats are often characterized by large, relatively long-lived species (equilibrium species) that are slow to recolonize when the habitat has been disturbed (Warwick. 1986; Dauer. 1993). Thus, candidate sites with a high frequency of equilibrium taxa and a low frequency of opportunistic taxa would be the poorest candidates to recover quickly from dredging impacts.

Seven sites had a higher frequency of equilibrium species than background conditions in Delaware Bay. Site MS19B had the greatest percentage of equilibrium species (4.5%). Sites PN1A and L5 had a significantly greater frequency of equilibrium species, but the differences were habitat and year-specific.

Three sites had more opportunistic species than background conditions in Delaware Bay. Site LC9 contained the highest percentage, averaging 97% in 1993.

8.2.4.4 Large Organisms

Sites containing higher abundances of large individuals are generally indicative of long-lived established benthic communities that will require a longer period to recover from stress (Warwick 1986; Dauer 1993). The number or percentage of large organisms (>2 cm) could not be compared between the candidate beneficial use sites and the background conditions in the bay because animal size was not measured in the EMAP sampling program. Among the candidate sites, sites MS19B and MS19A had the greatest number of species with body lengths exceeding 2 cm, 16 and 15 species respectively (Table 8-9). This was at least twice as high as at any other site. PN1A, PN1B, and C13 had the lowest number of species with large individuals.

MS19B was also the site with the highest percentage of large individuals within species. Approximately 91% of razor clams (<u>Ensis directus</u>) at site MS19B were large individuals, substantially higher than the seven other sites where it was found. Large individuals of <u>Glycera americana</u> were also found at site MS19B in percentages of total individuals approximately three to eight times greater than six other sites where it was collected. Of the 15 species with large individuals at site MS19A, only <u>Ensis directus</u> had a percentage greater than 10%.

Table 8-9. Percent of organisms greater than 2 cm (sites where smaller specimens were also found are indicated with zeros; species for which no specimens greater than 2 cm were found are not listed)

Species Group-Species Name	C13	FR28	L5		LC9		LC10		PN1A		MS19A	MS19B	NCM	PN1B	I1	I3
			93	94	93	94	93	94	93	94						
Cnidaria : Anthozoa																
Actiniaria				2.1				0		0		0	0			
Nemertinea																
Cerebratulus lacteus		2.5		0	6.0	1.5	9.2	2.5	20.0				0	5.0		
Nemertinea	0	2.5	0	2.1			0		0		7.5	0	0	0	0	0
Annelida : Polychaeta																
Aricidea fragilis												5.0				
Asabellides oculata												15.6				
Clymenella torquata			2.5													
Diopatra cuprea										10.9		10.0				
Drilonereis spp.											2.5					
Eumida sanguinea															5.0	
Glycera americana		2.5	21.3	4.2			2.5			0	2.5	20.0	7.5		5.0	
Glycera capitata		0		4.2			0				2.5					0
Glycera dibranchiata		2.5			30.7		2.5	7.5	0			12.5	2.5	7.5	15.0	
Glycera spp.				0	0		0		0						0.5	
Goniadidae		0	0		0		0		0		2.5		0	0	0	0
Leitoscoloplos robustus												34.5				
Marenzelleria viridis	15.0															
Nephtys incisa			7.5										5.0			
Nephtys spp.				0												10.0
Nephtys picta				0							7.5		0			6.3
Nereis spp.	2.5				0	2.5	0				7.5				0	
Notocirrus spiniferus												2.5				
Opheliidae											5.0					
Orbinia ornata			0								2.5		0			
Orbiniidae													0	2.5		

Table 8-9. (Continued)

Species Group-Species Name	C13	FR28	L5		LC9		LC10		PN1A		MS19A	MS19B	NCM	PN1B	I1	I3
			93	94	93	94	93	94	93	94						
Paraprionospio pinnata				0								10.0				
Pectinaria gouldi		0	2.5				0				2.5	5.0	0		0	
Pherusa affinis			0	2.1												
Polychaeta		0		0		2.5				0	0		0			
Polydora cornuta												1.3				
Prionospio spp.		2.5	2.5							0	0					
Scoletoma tenuis												1.3				
Scoloplos rubra				2.1				5.5		5.0		2.5				0
Scoloplos spp.		15.0	2.5	2.1	3.6	0	9.4		0		0		5.0	0	2.1	0
Spiochaetopterus costarum							0					61.9	0		0	
Spiophanes bombyx			0												10.0	0
Terebellidae		0	0							0			5.0	0		
Annelida : Hirudinea																
Hirudinea			2.5													
Mollusca : Gastropoda																
Busycon carica				0							7.5					
Crepidula convexa		0					0	0			2.5		0		0	
Crepidula fornicata											2.5		0		0	
Eupleura caudata		0									0	2.5			0	
Ilyanassa obsoleta				0	0	1.5	0	2.7	0	0				0		
Mollusca : Bivalvia																
Anadara ovalis			0										0		5.0	
Ensis directus		12.5	0	6.3			7.5	5.50			17.5	90.6	17.5		25.0	28.8
Mya arenaria						0.6				0						
Spisula solidissima																5.7
Yoldia limatula		0	0	0.7								0				
Arthropoda : Merostomata																
Limulus polyphemus		7.5	0	0	0	0	2.5	2.5	0	0	0		7.5			

Table 8-9. (Continued)

Species Group-Species Name	C13	FR28	L5		LC9		LC10		PN1A		MS19A	MS19B	NCM	PN1B	I1	I3
			93	94	93	94	93	94	93	94						
Arthropoda : Decapoda																
Cancer irroratus													0			10.0
Crangon septemspinosa	0	0	0	0	0.7	2.5	0	0	0	0	0	2.5	0	0	0	0
Eurypanopeus depressus		0					0	0			2.5				0	
Pagurus spp.		0					0	2.5		0	0	0	0		0	0
Rhithropanopeus harrisi	2.5	0	0		0		0				0		0		0	
Echinodermata : Holothuroidea																
Holothuroidea					0	2.1					0				0	
Total Number of Species with Organisms >2 cm	3	8	7	8	4	7	6	7	1	2	15	16	7	3	8	5

8.3 Assessment of Potential Impacts

8.3.1 General

No significant differences were found between any candidate site and background conditions in Delaware Bay that would preclude its selection as a beneficial use site. Therefore, no significant local effect will occur to benthic resources of Delaware Bay due the use of any of these sites as either wetland restorations or sand stockpiles.

There are a variety of potential effects associated with the placement of dredged material on top of benthic communities in estuarine environments. The most immediate of these effects is burial (Hirsch et al. 1978). The extent and magnitude of burial effects are dependent upon the thickness and composition of the emplaced dredged material. Many benthic infauna, particularly siphonate suspension feeders and deep-dwelling fauna, are able to migrate vertically to pre-existing sediment depths (Maurer et al. 1978; Saila et al. 1972; Schafer 1972; Shulenberger 1970). Vertical migrations approaching 3 feet and more have been documented from a variety of fauna, demonstrating a large adaptive ability to recover from burial. Benthic fauna with more limited abilities for vertical migrations in emplaced sediments will experience significant mortalities; however, the immediate changes in benthic community composition, abundance, and biomass caused by these mortalities are typically short-term impacts. Horizontal migration of benthic fauna from unimpacted areas and larval resettlement can bring about rapid recolonization of areas that have been disturbed by the emplacement of dredged materials (Ranasinghe, and Richkus 1993; Van Dolah et al. 1984; Mauer et al. 1978; Oliver et al. 1977). Initially, recolonization is dominated by opportunistic species whose reproductive capacity is large, and whose environmental requirements are often flexible enough to allow then to occupy disturbed areas (Boesch and Rosenberg 1981; McCall 1977). With additional time (months to several years), and if environmental conditions permit, the initial surface dwelling opportunistic species will be replaced by benthic species representing a more mature community.

The ultimate recovery of benthic communities from the emplacement of dredged material is dependent upon the type of dredged material emplaced and the extent and magnitude of any modifications of the existing environmental habitat. Existing regulations and practices extremely limit the emplacement of dredged material containing contaminants at concentrations that are potentially toxic to biota; therefore, acute and chronic toxic responses limiting the recovery of affected benthic communities are normally not a concern. Habitat modification is a concern in those cases where the dredged material represents a sediment type significantly different from existing sediments (Mauer et al. 1978). Changing from a muddy sediment habitat to a coarse sand sediment habitat will significantly change the composition of the benthic assemblage at a site. Changing from a muddy-sand to a sandy-mud will have less severe impacts. These changes are not necessarily undesirable and their influence on the estuary as a whole are most likely negligible; however, they are potential changes.

The emplacement of dredged material may also modify habitat by changing water depth. At the sand stockpile sites, the amount of dredged material targeted for placement may raise the height of the substrate by as much as 5 feet. Changes in the depth of subtidal sediments of 3 feet are likely to cause little change in the composition, abundance, and biomass of benthic communities that are deeper than about 9 feet. Most of the Delaware Estuary contains a heterotrophic benthos dependent upon planktonic autotrophic production for food (Frithsen et al. 1991). Small changes in water depth are likely not to favor significant benthic autotrophy by diatoms or macrophytes due to the extremely turbid nature of the estuary. Changes in the depth of subtidal sediments that are shallower than 6 feet may affect benthic communities due to greater exposure to physical stress caused by waves and surface currents. These physical effects may be most significant during storms when significant amounts of energy can be transferred from the surface to the sediments.

The loss of the benthic community due to dredged material disposal would be expected to be a short-term adverse impact. The Corps has constructed twenty-three underwater berms for storm attenuation or beach nourishment throughout the United States (Landin, 1992). For example, results of detailed studies of benthic recovery and fish use on a berm constructed at Dauphin Island, Alabama, indicated rapid benthic recovery. Fish use of the area also was reported as greater than in surrounding waters. The benthic recovery and greater fish use are related to slope, configuration, and orientation of the berm in the current (Landin, 1992).

Long-term impacts would likely result from the use of the sites as sand sources for future beach nourishment projects if the area is subjected to repeated disturbances. A regularly disturbed bottom would not necessarily provide the same abundance or species composition as the present site condition. However, these impacts would occur to relatively small portions of the sandpiles at a frequency of every 5 to 10 years.

8.3.2 Site Specific Impacts at Selected Beneficial Use Sites

8.3.2.1 Wetland Restoration Sites

PNIA and LC-9 are the beneficial use sites that were selected for wetland restoration/shore protection. The benthic communities of these sites, which cover about 225 acres, would be eliminated and the bottom would be changed from subtidal to intertidal wetland, averaging about +5 feet MLW. These sites were among those having the poorest quality benthic communities. They were characterized by a considerably less diverse assemblage than the background benthic communities in Delaware Bay. Compared to other candidate sites, they contained a higher abundance of opportunistic species, which are typical of disturbed environments. LC-9 was characterized by a different species composition between the two years it was sampled, which is a further indication of its unstable benthic community. LC-9 and PN1A (as well as PN1B) also had the lowest percent of equilibrium taxa among all of the candidate sites.

8.3.2.2 Sand Stockpiles

The beneficial use sites that were selected for sand stockpiles are L-5 and MS-19B. These sites would be covered with sand, changing the average depth from -8.0 feet MLW to about -3.0 feet MLW. The present substrate of L-5 has significantly more silt/clay content than MS-19B (51% vs. 16%). A change to a total sand substrate at L-5 will have a greater likelihood to change the benthic community that is present than at MS-19B which presently has essentially a sand substrate. It is likely that both benthic communities will change since they are both less than 6 feet and will be subjected to greater exposure to physical stress caused by waves and surface currents. As mentioned, these effects may be most significant during storms when significant amounts of energy can be transferred from the surface to the sediments. L-5 is similar in quality to LC-9 and PN1A as described above. Site MS-19B had one of the highest quality benthic communities among the 12 potential beneficial use sites, and would be expected to sustain greater impacts due to the lower recovery potential of its benthic macroinvertebrate community. Species richness was highest among the candidate sites at MS19B. It contained a higher abundance of equilibrium species, which are typically indicative of a stable, diverse, mature community, than the background benthic communities of the Delaware Bay. Site MS19B also contained the highest frequencies of individuals and the greatest number of species with body length greater than 2 cm, again indicative of a stable, mature assemblage, as well as infaunal species having commercial/recreational value. Although MS-19 has a higher quality benthic community than the other 12 sites that were evaluated, there were no significant differences found between it and the background conditions of the Delaware Bay that would preclude its use.

No significant differences were found between any candidate site and background conditions in Delaware Bay that would preclude its selection as a beneficial use site. Therefore, no significant impact will occur to either the diversity or overall populations of benthic resources due the use of any of these sites as either wetland restorations or sand stockpiles.

9.0 Impacts Associated With Beneficial Use Sites

9.1 Wetland Restoration Sites

9.1.1 Shore Erosion

The breakwaters and restored wetlands at Kelly Island will protect about 5,000 feet of severely eroding shoreline; those at Egg Island Point will protect about 10,000 feet. These shorelines have been eroding at the rate of 15 to 30 feet per year. The expected life of the geotextile tubes is estimated to be 30 years, so the Egg Island Point restoration will be afforded protection from erosion for up to that period of time. The Kelly Island wetland restoration will be maintained for the life of the project to insure that the fine grained material will escape.

9.1.2 Water Quality

The results of chemical and biological testing of dredged material that would be used for beneficial use sites are discussed in greater detail under Section 4.0, Sediment Quality Investigations. Sediment testing included bulk analysis and elutriate analyses for heavy metals, pesticides, PCBs, PAHs, phthalates, volatile organics, and semi-volatile organics; bioassays; and bioaccumulation tests. The results of this testing indicates that the dredged material from Reach E is acceptable for beneficial uses such as wetland creation and sand stockpiles for later beach nourishment.

9.1.3 Benthic Communities

Benthic survey results are discussed in greater detail under Section 8.0, Benthic Habitat Investigations. No significant differences were found between any of the beneficial use sites and background conditions in Delaware Bay that would preclude its use. Therefore, no significant impact will occur to benthic resources due the use of any of these sites as either wetland restorations or sand stockpiles.

Approximately 60 acres of mostly subtidal habitat adjacent to Kelly Island and 135 acres of subtidal habitat adjacent to Egg Island Point will be restored to intertidal wetland habitat, consisting of mostly Spartina alternaflora (saltmarsh cordgrass). Prior to the severe erosion that is presently taking place, this area consisted of intertidal marsh. Nevertheless, the benthic community that exists will be replaced by an intertidal marsh community. The benthic communities of these sites, which cover about 195 acres, would be eliminated and the bottom would be changed from subtidal to intertidal wetland, averaging about +5 feet MLW. These sites were among those having the poorest quality benthic communities. They were characterized by a considerably less diverse assemblage than the background benthic communities in Delaware Bay. Compared to other candidate sites, they contained a higher abundance of opportunistic species, which are typical of disturbed environments. LC-9 was characterized by a different species composition between the two years it was sampled, which is a further indication of its unstable benthic community. LC-9 and PN1A also had the lowest percent of equilibrium taxa among all of the candidate sites.

9.1.4 Wetlands

Approximately 60 acres of mostly subtidal habitat adjacent to Kelly Island and 135 acres of subtidal habitat adjacent to Egg Island Point will be restored to intertidal habitat, consisting of mostly Spartina alternaflora (saltmarsh cordgrass). In addition, hundreds of acres of intertidal wetlands that exist behind the restored wetlands will be protected from continued erosion.

9.1.5 Fish and Wildlife Resources

The construction of the wetland restorations will be phased to avoid and/or minimize impacts to fish and wildlife, especially to spawning horseshoe crabs and migrating and feeding shorebirds as described under Section 3.3.4.4. Reconstruction of wetlands at Kelly Island and Egg Island Point will greatly benefit most wildlife species. Although approximately 195 acres of aquatic habitat will be lost, this was formerly intertidal marsh before being destroyed by erosion. The loss of this aquatic habitat is not a significant impact.

9.1.5.1 Kelly Island

The primary species of concern at Kelly Island under its present condition are the horseshoe crabs which spawn at nearby sand beaches, the migrating and feeding shorebirds, waterfowl, and waterbirds in general. The engineering design previously described will enhance habitat for all of these species, and in addition, will provide a sheltered intertidal area for juvenile fish species certain times of the year (See Figure 3-4 and 3-5).

The capability of the Kelly Island site to enhance habitat, and slow erosion losses behind the CDF, will off-set short-term impacts. To minimize the risk of any mishaps taking place during construction, field monitoring will be in place to insure correct filling procedures, dike, and outlet works construction, achievement of marsh elevations, and other aspects of a high quality project.

The sand dike is designed to have slopes and elevations conducive for horseshoe-crab spawning. Erosion of the dike is inevitable, but the quantity of sand placed will allow crab spawning for many years. Maintenance of the dike will extend this time for at least the life of the project (50 years).

9.1.5.2 Southeast Egg Island Point

One of the major considerations for southeast Egg Island Point is the blocking of the tidal channel that was once a tidal pool within the marsh. It has eroded to the point of no longer being a pond, but being part of the Bay, and provides an area of extensive intertidal mud flats. An evaluation conducted by the Corps indicates that there will be tidal access from the other side of Egg Island Point, via Straight Creek. No real blockage of the tidal creek will occur, although its flow direction will be altered. In addition, the blocking of the channel on the southeast side of Egg Island Point should protect the mud flats and adjacent marsh from continued erosion.

Another area of concern is the provision of spawning areas for horseshoe crabs, which use the Egg Island Point area more abundantly than they do the Kelly Island area. Habitat characteristics that crabs require are sandy, aerated, unvegetated beaches. The sand placed in the lee of the breakwater at southeast Egg Island Point will be at an elevation to attract crabs. A greater long-term problem will be the vegetation that may ultimately cover the sand, with a resulting loss of crab spawning habitat. Slopes and elevations will be conducive to both spawning and non-trapping of crabs within the site. This location should provide abundant crab spawning habitat, at least for the short-term.

The danger of crabs being trapped within the fill area is lessened by the broad extent of sandy beach that will be constructed behind the breakwater. The most likely potential for crab trapping will be directly behind the breakwater in pools that may form from overtopping and scour. The natural formation of tidal channels in dredged material sites should accommodate crab movements, but it is likely that some crabs will be trapped.

There are a number of other species that will benefit from protection of the southeast Egg Island Point site, such as waterbirds, shorebirds, and juvenile fish. All of these species will use the low marsh and tidal pools. Since Egg Island Point also has more high marsh and shrubby areas than Kelly Island, any washback of sand into the high marsh zone should serve to enhance that habitat. This would provide both additional crab spawning areas along fringes and potential tern, gull, and other waterbird nesting areas.

Most of the habitat characteristics and considerations for Kelly Island are also part of Egg Island Point, and the same species will benefit from the projects. The protection of the rapidly eroding shoreline marshes, and the resultant additions to habitat at Egg Island Point will more than off-set any detrimental short-term effects from construction activities.

There are two areas that are believed to require planting with *Spartina alterniflora* because of possible scour problems: a 200 foot strip, about 200 feet shoreward of the tubes; and the area near the point. These areas would be subject to greater wave erosion. However, the recommendation to allow natural colonization for at least part of the site comes from both cost-savings and the need at Egg Island Point for more bare sand for both crabs and birds. The situation is different at southeast Egg Island Point than at Kelly Island, where fine-grained material is being placed, and the bare sand is a very important habitat type that fits requirements for several species.

9.1.5.3 Northwest Egg Island Point

The northwest Egg Island Point site will have no fill material placed and is designed to trap sediment to nourish the eroded marshes on that side. Any accumulations of sediment will benefit Egg Island Point wildlife by adding to the existing marsh, providing sand areas for crab spawning, and protecting from beach scour. Some of the area that will be protected by the staggered rows of tubes is presently crab spawning beaches. These should be enhanced, since nearly full tidal access from the Bay to the beaches will be present using the staggered configuration (Figure 3-6). Any high marsh that should accrete as a result of the design will further enhance use by wildlife, especially by crabs and waterbirds.

The staggered row design planned at northwest Egg Island Point is a tested, proven habitat restoration technique for the Gulf Coast. It is expected to provide the same type of benefits in Delaware Bay.

9.2 Sand Stockpiles

9.2.1 Shore Erosion

Studies done by the Corps of Engineers indicate that there will be significant sediment dispersion from the sand stockpiles. Transport rates will be slow, however, so most of the placed material will remain in the stockpiles for decades. The stockpile sand that does leave will move predominately landward, then spread laterally along the shore, thereby providing fill material for nourishment of sand-starved bay beaches.

9.2.2 Water Quality

Temporary water quality degradation is expected due to elevation of suspended sediments. Brief periods of elevated turbidity will occur as a result of sand placement; however, sand is heavy and should settle quickly. Extended periods of elevated turbidity may occur if wind or water currents cause sediments to remain in suspension. Water quality degradation would be more severe and widespread with unconfined open water disposal than if the sand were deposited behind containment devices such as geotextile tubes.

9.2.3 Benthic Communities

No significant differences were found between candidate sand stockpile sites and background conditions in Delaware Bay that preclude selection as beneficial use sites. Therefore, no significant impact will occur to either the diversity or overall populations of benthic resources due to the use of these sites as sand stockpiles.

Benthic survey results are discussed in greater detail under Section 8.0, Benthic Habitat Investigations. Approximately 730 acres (500 acres for MS-19 and 230 acres for LC-5) of subtidal aquatic habitat averaging -8 feet MLW will be covered with approximately 4.7 million cubic yards of sand to a depth of -3.0 feet MLW.

Placement of up to 4.7 million cubic yards of dredged material at the proposed sand stockpile sites would result in burial of the existing benthic community. Benthic recolonization depends upon a number of factors, which include substrate type, distance from similar habitat, and water currents. Recovery of the benthic community would be further hindered by future disturbance as the material is taken from the stockpiles for beach nourishment projects.

Benthic recolonization is dependent upon recruitment from plankton dispersed by water currents. Changes in current patterns and velocities may alter dispersal of benthic larvae. The loss of the benthic community due to dredged material disposal would be expected to be a short-term adverse impact. The Corps has constructed twenty-three underwater berms for storm attenuation or beach nourishment throughout the United States (Landin, 1992). For example, results of detailed studies of benthic recovery and fish use on a berm constructed at Dauphin Island, Alabama, indicated rapid benthic recovery. Fish use of the area also was reported to be greater than in surrounding waters. The benthic recovery and greater fish use are related to slope, configuration, and orientation of the berm in the current (Landin, 1992).

Long-term impacts would likely result from the use of the sites as sand sources for future beach nourishment projects if the area is subjected to repeated disturbances. A regularly disturbed bottom would not necessarily provide the same abundance or species composition as the present site condition. However, these impacts would occur to relatively small portions of the sandpiles at a frequency of every 5 to 10 years.

The beneficial use sites that were selected for sand stockpiles are L-5 and MS-19B. These sites would be covered with sand, changing the average depth from -8.0 feet MLW to about -3.0 feet MLW. The present substrate of L-5 has a significantly greater silt/clay content that MS-19B (39-62% vs. 16%). A change to a total sand substrate at L-5 will have a greater effect to change the benthic community that is present than at MS-19B which presently has essentially a sand substrate. It is likely that both benthic communities will change since they are both less than 6 feet and will be subjected to greater exposure to physical stress caused by waves and surface currents. As mentioned, these effects may be most significant during storms when significant amounts of energy can be transferred from the surface to the sediments. L-5 is similar in quality to LC-9 and PN1A as described above. Site MS-19B had one of the highest quality benthic community among the 12 potential beneficial use sites, and would be expected to sustain greater impacts due to the lower recovery potential of its benthic macroinvertebrate community. Species richness was highest among the candidate sites at MS19B. It contained a higher abundance of equilibrium species, which are typically indicative of a stable, diverse, mature community, than the background benthic communities of the Delaware Bay. Site MS19B also contained the highest frequencies of individuals and the greatest number of species with body length greater than 2 cm, again indicative of a stable, mature assemblage, as well as infaunal species having commercial/recreational value. Although MS-19 has a higher quality benthic community than the other 12 sites that were evaluated, there were no significant differences found between it and the background conditions of the Delaware Bay that would preclude its use.

9.2.4 Fish and Wildlife Resources

The offshore areas in the vicinity of both proposed stockpile sites support important fisheries for weakfish. Additionally, the offshore areas in the vicinity of Sites L-5 and MS-19 support summer flounder, black sea bass, and drum (FWS. 1995b).

The environmental impacts of dredged material disposal in open water are similar in some ways to impacts resulting from sand dredging. Direct impacts include water quality degradation and temporary loss of the benthic community. Benthic community loss will in turn impact finfish species that feed on benthic organisms.

Deposition of large quantities of dredged material in sand stockpiles would decrease water depth at the sites from current depths to approximately -3 feet below MLW. This depth reduction could result in changes in the tidal regime and current patterns, which in turn could impact biological resources. Changes in the tidal regime may have some impact on biological resources associated with nearby rivers as well as resources associated with adjacent beaches.

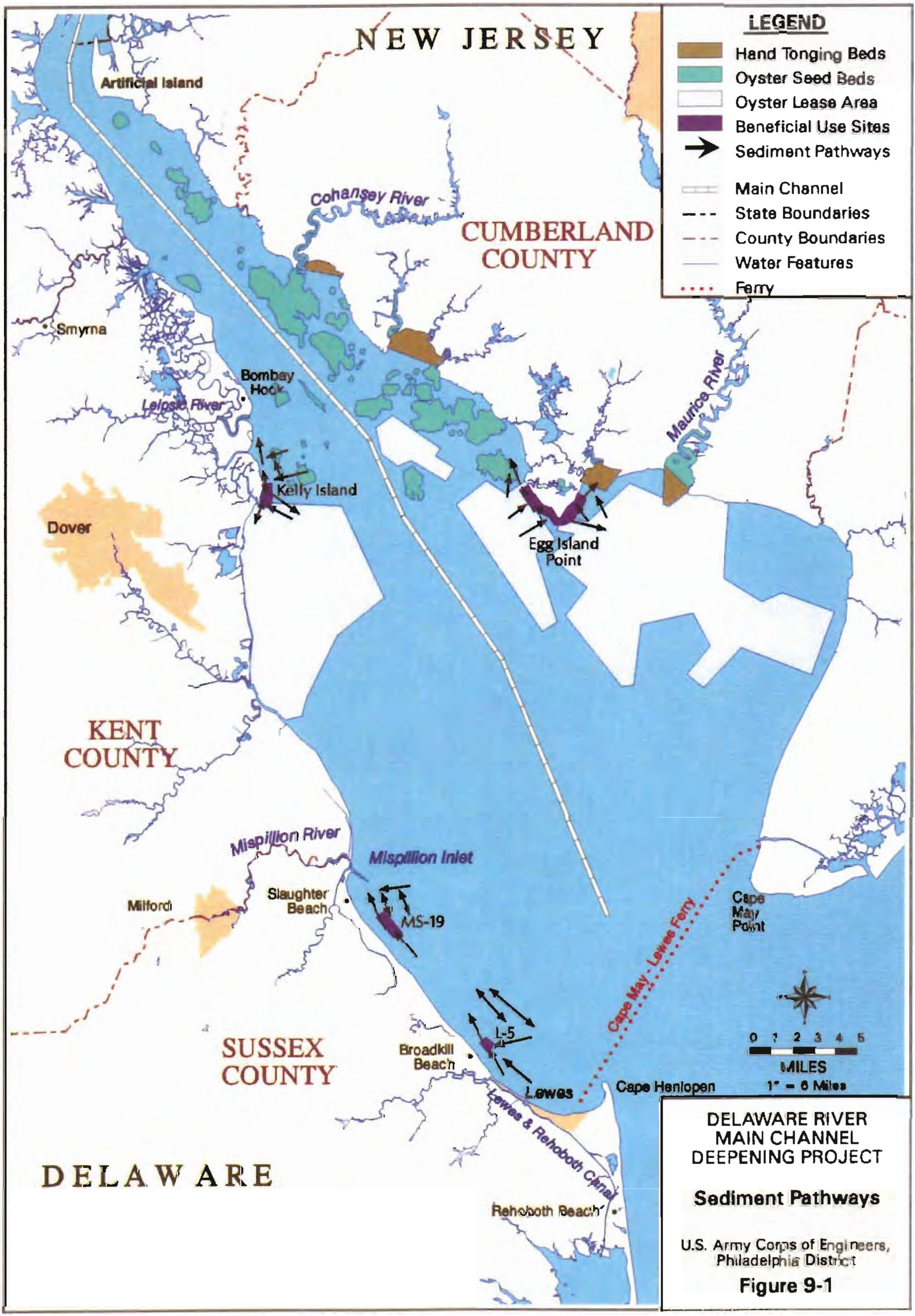
Placement of dredged material would result in some loss of finfish nursery and feeding areas. The loss of the food source would be expected to result in a temporary and localized reduction in recreationally and commercially important finfish species. As with effects to the benthic community, the repeated disturbance of the sand stockpile sites for future beach nourishment projects would likely result in long-term adverse impacts to local fisheries. However, these impacts would occur to relatively small portions of the sandpiles at a frequency of every 5 to 10 years.

9.3 Sediment Transport/Oyster Impact Investigations

Commercially important oyster lease beds are located throughout the offshore area around Egg Island Point. Most of these lease beds are located 500 to 800 feet offshore; but in some cases lease beds are located within close proximity to the shoreline. Oyster seed beds occur to the northwest of Straight Creek and this area also supports a commercially important blue crab fishery (USFWS. 1995b). In Delaware, commercially important oyster seed beds exist in the area offshore of Kent Island and Kelly Island (Figure 9-1). There are also oyster beds inside the mouth of the Leipsic River. Additionally, hard clams and blue crabs are distributed throughout the Kelly Island area. Blue crabs in this area are commercially important.

Concern was expressed by the resource agencies about potential impacts that may occur to oysters due to movement of sand used to build the wetland restorations at Egg Island Point and Kelly Island. In addition, concern was expressed about the fate of fine grained material that will be confined behind the sand berms and geotextile tubes at Kelly Island if there was a catastrophic failure of this structure. Concern was also expressed about the possible fate of the sand placed in the sand stockpiles.

In order to address these concerns, the four Delaware Bay beneficial use sites were evaluated for potential sediment transport impacts resulting from their placement. Two independent investigations were performed to address sediment transport impacts from these sites. The first investigation was conducted by Offshore and Coastal Technology, Inc. and included the development and application of a fine-scale numerical model of all four sites which simulated wave and current energy under a range of scenarios. The results of the wave and current energy modeling were then applied to estimate rates and pathways of potential sediment transport at the four sites under both "normal" and storm conditions. The results were also used to assess potential impacts of suspended sediment dispersal on nearby oyster beds using an oyster impact model developed by the Haskin Shellfish Research Laboratory of Rutgers University. A second analysis was performed specifically to address the relative stability/mobility of sediment to be placed at the two sand stockpile sites. This effort was based on application of the Corps of Engineers EBERM (Empirical BERM fate) methodology. EBERM utilizes site-specific wave data and stockpile geometry for the proposed project in comparison with similar data obtained from prototype, monitored stockpile sites in a variety of hydraulic environments. The methods and results of the fine-scale numerical hydraulic model of all four sites will be presented first, followed by discussion of the EBERM



DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT

Sediment Pathways

U.S. Army Corps of Engineers,
Philadelphia District

Figure 9-1

investigation.

9.3.1 Fine-Scale Numerical Hydrodynamic and Sediment Transport Modeling

The numerical simulation of currents was performed with a two-dimensional finite difference model of Delaware Bay with 0.25 minute grid resolution in latitude and longitude. The tidal boundary for both normal and storm conditions was the Delaware Bay mouth. The current model was validated with prototype current data collected at the four sites in June and July 1995. The wave modeling utilized the directional spectral steady state model STWAVE. Wave data for the model were obtained from previous work, which developed hindcast data for a six-year "normal" period (1987-1993) and for historical severe storm events, including 15 hurricanes and 15 northeasters. The two models were exercised independently for both storm and normal condition simulations.

Current velocity output from the current model was used to develop estimates of shear stress on the sediment bed. Sediment transport is assumed to take place when the shear stress from the current flow exceeds the threshold of shear stress for the sediment. As long as the current-generated shear stress exceeds the critical shear stress for the sediment, the material can be transported with the ambient current. Sediment transport in the wave model is simulated through several mechanisms. Wave-induced orbital bottom velocities can generate sufficient shear stress at the bed to mobilize sediment. Waves can also generate residual currents which transport sediment in the direction of wave propagation, and longshore currents which transport material in the longshore direction of wave propagation.

The numerical models were used to generate conditions under which sediment is expected to be transported at each of the project disposal sites. At Egg Island Point and Kelly Island, the models were used to develop potential pathways of sediment that may move along the foundation of the geotextile tubes, or in the vicinity of the project area if the containment tubes were to be compromised. The sediment will be transported under normal tide and wave conditions at a long term rate, and will be transported under storm tide and wave conditions at more extreme rates that could be of concern to shellfish grounds. In addition, the Kelly Island area will contain a large amount of silt material that may move out into the bay under a catastrophic failure of the containment system. That case is assumed to be long term leaching of material into the bay under primarily normal tidal conditions. At the stockpile sites, LC-5 and MS-19, long term transport rates are of primary concern, in addition to the potential pathways of sediment toward and along adjacent shorelines.

9.3.1.1 Model Results

Egg Island Point, NJ, Wetland Restoration Site

Based upon the results of the wave and current simulations for Egg Island Point and adjacent areas, sedimentation rates and pathways were delineated. Figure 9-1 also presents the sediment pathways determined for the area.

To the west of the point, transport along the shoreline and the immediate offshore area was found to be dominated by tidal currents with the net tidal and storm transport directed to the north. Wave-driven sediment transport is generally onshore. The models do not indicate a significant mechanism that would transport sediment toward the shellfish areas to the west. With current speeds peaking at 40-45 centimeters per second (cm/s) during typical tidal conditions and 80 cm/s during extreme storm conditions, scour of sand similar in size to that planned for placement here can occur and current-driven longshore transport potential is calculated to be on the order of 5000 cubic yards per year (net). In an extreme storm (2-year and higher), current-driven transport potential along the shoreline is calculated to be on the order of 500 cubic yards per day of storm, and approximately 36,000 cubic yards of material per year potentially transported along the project's perimeter and from its external foundation to the northwest due to storms.

At locations to the east of the point, lower typical and storm current speeds of 30-40 cm/s and 85 cm/s, respectively, induce slightly lower potential sediment transport rates. Current-driven transport along the shoreline is directed along shore toward the NE at a rate of approximately 3500 cubic yards per year (net), including toward the east and possibly southeast of Egg Island Point. Annually, approximately 32,000 cubic yards of material can be potentially transported by currents in these same directions due to storms. Wave-driven transport is directed onshore. Wave-driven longshore potential transport rates are calculated to be 75,000-150,000 cubic yards (net) to the northeast on the eastern side of the point and the northwest on the western side of the point. Storm erosion analysis indicates that offshore-directed sediment transport is not likely due to the extremely flat offshore bottom slopes. The simulations do indicate, however, a potential material pathway is toward the east and possibly toward the southeast where shellfish lease areas exist.

Potential transport rates are an indication of possible rates of natural removal of placed material from the area. With containment systems in place, only exposed sand will be subject to scouring at approximately the rates given above. However, if containment systems fail, transport to the NE, E, and NW will proceed at approximately those rates and shoreline recession will also proceed at rates similar to or slightly faster than recent historical shoreline recession.

Impacts on Shellfish

The sedimentation rates induced by sand placement in the Egg Island Point area could have an impact on neighboring shellfish beds. Impacts are primarily due to an interruption in filter-feeding by the shellfish, which could cause a long-term reduction in health or population depending upon the length and severity of the interruption. Interruption in this project is considered to be due to an increase in suspended sediment concentration in the water column over the shellfish areas due the newly-available sediment material in the containment site.

The primary effect on shellfish will take place during storms when the greatest potential for mobilization of sediment occurs. At Egg Island Point, a review of the hindcasted storm simulations and calculations of transport rates yields the following:

Recurrence	Peak Bottom Current (cm/s)	Duration (hours)	Potential Transport Conc. (mg/l)	
			Ambient (Silt)	Proposed Fill (Sand)
1yr	50	36-48	250	15
10yr	60	48-60	500	30
20yr	65	48-60	700	45
50yr	75	24-72	1200	75
100yr	85	24-48	2000	125

In the table provided above, an estimate of extreme peak hourly storm bottom current speeds was estimated from the hindcasted population of storms, which yielded 10 events exhibiting a storm-generated component over and above the normal astronomical tidal current. Also provided is a storm duration associated with each particular storm frequency, which indicates that storms of the 1yr to 50 yr range are northeasters, while hurricanes become significant at the 50yr-100yr level. Ambient sediment transport concentrations are presented for each storm frequency, based upon a review of typical and annual sediment loadings provided by the Haskin Shellfish Laboratory, taken continually over a year's time. Based upon a general mean sediment concentration of 40 mg/l in normal tidal currents peaking at 40 cm/s, storm values were determined by scaling to more extreme conditions based upon a velocity to the fourth power ratio, the accepted functionality for total sediment load. This is likely a conservative assumption given that the supply of sediment to the water column is not unlimited. Finally, an estimate of potential sediment transport concentrations is provided given an unlimited supply of material from the Egg Island Point fill.

The table provided above indicates that storm-induced sediment transport of new material potentially is much less than the ambient sediment loading in the water column during most storm events. The Haskin Shellfish Laboratory investigation of the conditions required for impact on oyster survivability indicates that any 4-day event with the combined effect of ambient material plus the new source of material will have no observable effect on shellfish. The longest extreme storm event found in the historical record and included in the hindcast was the March 1962 storm which lasted approximately 60 hours, but caused relatively low current speed increases at Egg Island Point (about 50 cm/s). The peak current speed event was found to be the 1944 hurricane, but that event caused increased current speeds for less that 24 hours which is typical of a summer/fall hurricane. The shellfish survivability model indicated that an August storm event of greater than 4 days and less than 30 days duration would be required for a significant impact on the population. Again, extreme events of record in that time of year are rare hurricanes which typically last no longer than 48 hours.

Kelly Island, DE, Wetland Restoration Site

Based upon the results of the wave and current simulations for Kelly Island and adjacent areas, sedimentation rates and pathways were delineated. Figure 9-1 presents the sediment pathways determined for the area.

Numerical flow modeling indicates that typical tidal current speeds decrease from south-to-north along the Kelly Island area, peaking at 50 cm/s at the southern end (Port Mahon), to 40 cm/s along the central section of the island, and 35 (ebb)- 55 (flood) cm/s at the northern end. The storm currents peak at approximately 80 cm/s along the entire area. Typical current-driven transport rates are on the order of 5000 cubic yards per year alongshore (net to south). In an extreme storm (2-year and higher), current-driven transport along the shoreline is calculated to be potentially on the order of 500 cubic yards per day during a 2-year event, and potentially approximately 29,000 cubic yards of material per year transported annually along the project's perimeter and potentially from its external foundation to the north and south due to storms. All model runs indicate a strong sediment pathway in the north-south direction along all of Kelly Island, and sand transport should feed neighboring beaches or shoal the Port Mahon channel unless measures are taken to prevent shoaling. Wave transport is primarily onshore and alongshore at a potential annual rate of approximately 25,000-50,000 cubic yards (net) to the north. The sediment pathways discerned from the model results indicate that shellfish lease areas to the east should not be significantly impacted by sand placed at this project site. Although predominant winds are directed to the east during normal conditions, the corresponding wind-driven currents are not calculated to be sufficient to carry material offshore nor to significantly change the north-south direction of tidal currents. Storm wind-driven currents during both hurricanes and northeasters are onshore-directed (i.e. from the easterly quadrants), and are thereby expected to keep sediments moving close to the shoreline. Strong winter northwesterly winds may induce some offshore-directed sediment motion; however, this generally occurs during the months when shellfish are virtually dormant.

As in the Egg Island Point case and barring erosion of upland silt disposal areas, the potential rate of sediment transport will remain the same, but the amount of readily available material for transport could increase if containment systems fail.

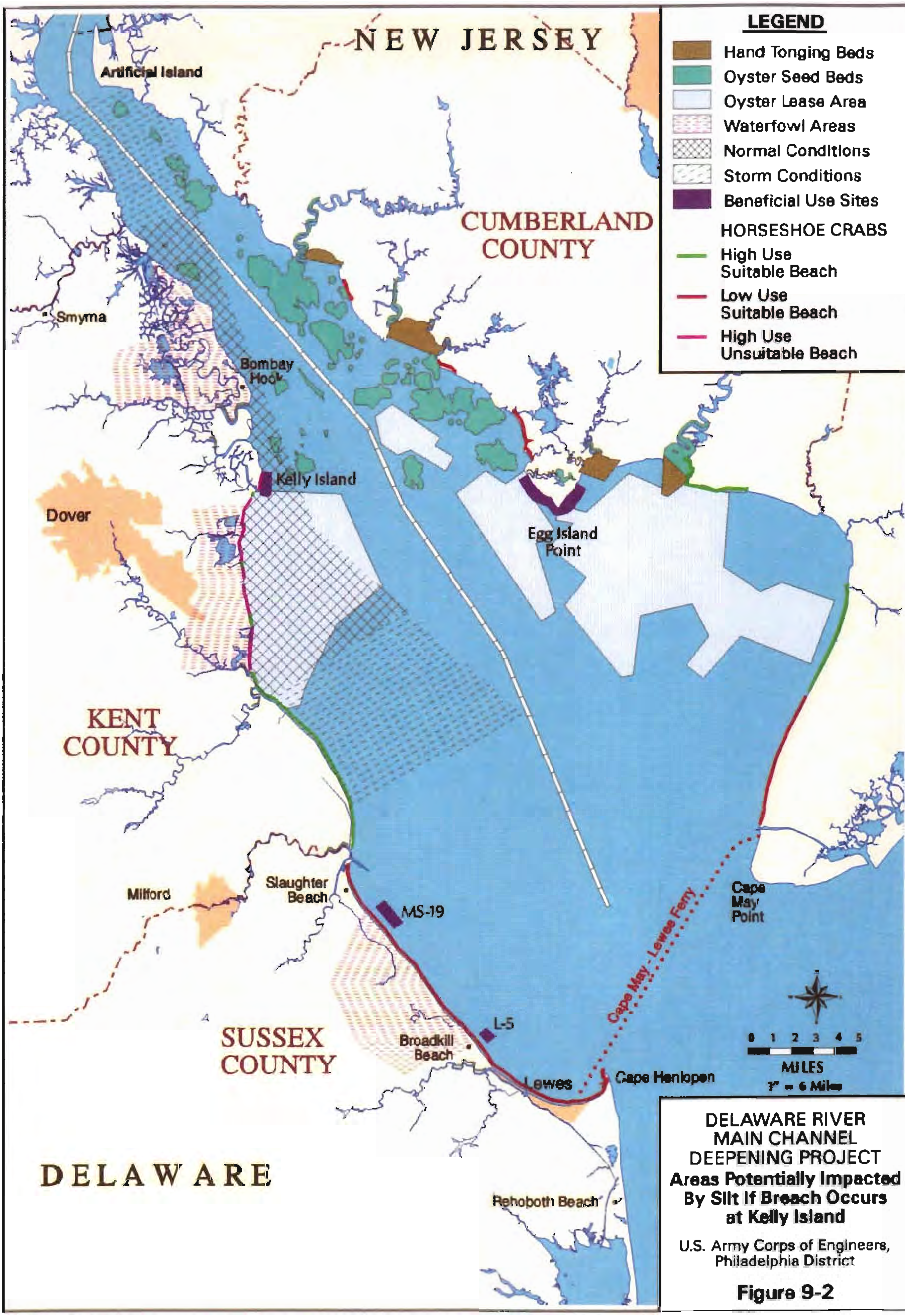
Kelly Island Silt Dispersion

Possible release of silt from the Kelly Island upland containment area is analyzed by assessing the fall velocity of 0.05mm material and its transport characteristics. Silt will generally be eroded from an area when flow velocities exceed approximately 30 cm/s and deposit only at slack tide. During a typical tidal cycle, silt material is calculated to have the potential to travel a maximum of approximately 3.6 nautical miles to the northern quadrant and southern quadrant from Kelly Island. Assuming that material will be transported along Kelly Island in a 100-foot wide swath (about 1/2 a normal-condition wavelength), the potential total sediment loading (or erosion) rate is calculated to be about 45 cubic yards per hour of normal-condition tide.

A more catastrophic assumption would be failure of containment structures and release of material during a storm. Following the same reasoning during an extreme storm, the material would travel approximately 7 nautical miles toward the northerly and southerly quadrants. In the storm case, the potential average total sediment loading (or erosion) rate is calculated to be approximately 1500 cubic yards per hour of storm tide condition, with rates peaking at 3500 cubic yards per hour at the peak of a major storm event. During a 100-year event, storm flows are estimated to have the approximate potential to transport a total of 100,000 cubic yards of silt material from the site split to the northerly and southerly quadrants. This approximately equates to 66 hours of erosive currents during the event. Conservatively assuming this material to cover 7 square nautical miles of seafloor, this equates to an average covering of approximately 1/8 inch of silt. The projected area of coverage based upon this analysis just barely overlaps the western edge of leased oyster bottoms to the southeast of Kelly Island. The anticipated silt dispersion is conservatively shown in Figure 9-2. The offshore extent of the sediment coverage area shown in the figure is considered to be a most-likely boundary for sediment deposition based upon the modeling results, but could easily vary by 25-50% due to variability in specific storm characteristics and site-specific details of the bathymetry.

Impacts on Shellfish

The sedimentation rates induced by sand placement in the Kelly



DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Areas Potentially Impacted By Silt If Breach Occurs at Kelly Island

U.S. Army Corps of Engineers, Philadelphia District

Figure 9-2

Island site could have an impact on neighboring shellfish beds. Impacts are again primarily due to an interruption in filter-feeding by shellfish, which could cause a long-term reduction in health or population depending upon the length and severity of the interruption. Interruption in this project is considered to be due to an increase in suspended sediment concentration in the water column over the shellfish areas due the newly-available sediment material in the containment site.

As at Egg Island Point, the primary effect on shellfish will take place during storms when the greatest potential for mobilization of sediment occurs. At Kelly Island, a review of the hindcasted storm simulations and calculations of transport rates yields the following:

Recurrence	Peak Bottom Current (cm/s)	Duration (hours)	Potential Transport Conc. (mg/l)	
			Ambient (Silt)	Proposed Fill (Sand)
1yr	70	36-48	120	60
10yr	90	48-60	325	160
20yr	110	48-60	730	350
50yr	135	24-72	1650	800
100yr	150	24-48	2530	1215

In the table provided above, an estimate of extreme peak hourly storm bottom current speeds was estimated from the hindcasted population of storms, which yielded 10 events exhibiting a storm-generated component over and above the normal astronomical tidal current. Also provided is a storm duration associated with each particular storm frequency as explained for Egg Island Point. Ambient sediment transport concentrations are presented for each storm frequency based upon the data provided by Haskin Shellfish Laboratory. Again, scaling to more extreme conditions was performed for the listed recurrence levels. This is likely a conservative assumption given that the supply of sediment to the water column is not unlimited. Finally, an estimate of potential sediment transport concentrations is provided given an unlimited supply of material from the Kelly Island sand fill.

The table provided above indicates that storm-induced sediment transport of new material is again potentially significantly less than background levels of turbidity in the water column during most storm events. Again, the Haskin Shellfish Laboratory investigation of the conditions required for impact on oyster survivability indicates that only a 4-day event will have an observable effect on the shellfish and only if that event occurs in August. The longest extreme storm event found in the historical record was the March 1962 storm which lasted approximately 60 hours with a peak flow speed of about 100 cm/s. The peak current speed event was found to be the 1944 hurricane (139 cm/s), but that event caused increased current speeds for less that 24 hours which is typical of a summer/fall hurricane.

For the silt material (diameter of 0.05mm), the potential peak transport concentration during typical tide conditions adjacent to Kelly Island is calculated to be approximately 90 mg/l which is approximately 30% higher than the highest turbidity levels reported in historic data. During extreme events, the concentrations are calculated to be approximately the following:

Recurrence	Peak Bottom Current (cm/s)	Duration (hours)	Potential Transport Conc. (mg/l)	
			Ambient (Silt)	Proposed Fill (Sand)
1yr	70	36-48	120	850
10yr	90	48-60	325	2300
20yr	110	48-60	730	5150
50yr	135	24-72	1650	11000
100yr	150	24-48	2530	18000

It should be noted that the extremely high concentrations during the very extreme events are theoretical in nature and are probably beyond conditions for which sediment transport relationships are valid. However, the values indicate that during a long term leaching process (say 30 days), the concentrations of sediment in the water column may increase to the daily range of 90-100 mg/l, which is well-below levels modeled by the Haskin Shellfish Laboratory that have an adverse effect on the oyster beds. However, at the 10yr event and higher, a catastrophic failure of the containment structures will bring concentrations above levels of adverse effect, but the durations of the storms are relatively short and will limit or prevent adverse effects on the oyster beds.

LC-5 and MS-19 Stockpile Sites

The two stockpile sites MS-19 and LC-5 were modeled together in the same wave model and current model grids and simulations because of their proximity. In both cases, it was found that the sediment pathways were similar, i.e. net wave-driven mass transport is potentially onshore, and the longshore potential net transport is to the northwest. Sediment pathways are illustrated in Figure 9-1. Net wave-driven potential transport is found to be approximately 15000 cubic yards per year in the onshore direction at MS-19 and 5000 cubic yards per year at LC-5. These values indicate that the stockpiles are expected to migrate slowly onshore; however, major 2- to 5-year storms can potentially transport 40,000 cubic yards in a single event in the onshore direction. Mean current-driven velocities along the coast due to astronomical tidal action were found to be about 30-40 cm/s flows at MS-19 and 40-60 cm/s at LC-5. The net transport potential due to these flows are calculated to be approximately 10,000 cubic yards per year at MS-19 and 5,000 cubic yards per year at LC-5 to the south. Again, these transports indicate slow movement of material to the northwest and southeast, forcing the stockpiles to spread laterally.

A significant transport component is the wave-induced longshore transport potential at these sites. At Broadkill Beach (LC-5) average net transport potential is calculated to be about 230,000 cubic yards per year to the northwest (left), and at Slaughter Beach (MS-19) net transport potential is calculated to be approximately 260,000 cubic yards per year in the same direction.

No change in longshore transport along the coast is calculated for the stockpiles with a crest elevation of -3 feet MLW, or for either stockpile with a crest elevation of 0 feet MLW if the stockpiles are kept a minimum of 1500-2000 feet from shore.

Since there are no oyster resources near the sand stockpiles, there will be no impacts. Impacts to other benthic resources are discussed in Section 8.0.

9.3.1.2 Summary and Conclusions

A sediment transport and shellfish survivability study was performed for four sites on the Delaware Bay. The objectives of the study were (1) to map potential sediment transport rates and pathways due to planned projects at Egg Island Point, Kelly Island, MS-19 and LC-5 and (2) to assess potential impacts on neighboring shellfish areas.

In order to perform the study, numerical current and wave models were employed to aid in defining sediment transport mechanisms. Tidal current data was collected in summer 1995 at each location during typical daily conditions to define ambient conditions and to provide some model calibration data. To aid in calibrating sediment transport estimates, suspended solids data collected over several years was supplied by the Haskin Shellfish Research Laboratory. Based upon the models and data, calculations of current-driven and wave-driven sediment transport were made for both storm and normal conditions, which were then used in a shellfish survivability computer model to assess potential impacts on neighboring shellfish beds.

The modeling studies indicated sediment transport characteristics as shown in Table 9-1 for the wetland restoration sites and in Table 9-2 for the sand stockpile sites.

Shellfish survivability modeling was performed for the wetland restoration sites by examining the effect of a 4-day and a 30-day high-turbidity event in each season of the year with a turbidity level of 2 g/l, which was found to be approximately the maximum expected concentration during an extreme storm. The 4-day storm event was selected because it is longer than the extreme storms of record. The 30-day case was selected because it could be typical of the time required to detect and address a sediment leak from the containment areas and to provide information on the variation in impacts with the duration of turbidity.

The results of the shellfish survivability calculations show that there are no expected impacts on oyster survivability or growth

Table 9-1. Sediment Transport Findings at Wetland Restoration Sties (Sand 0.30mm)

	Egg Island Point, NJ	Kelly Island, DE
Normal Current-Driven Transport Potential	5,000 cu yd/yr (net to southeast)	5,000 cu yd/yr (net to south)
Normal Wave-Driven Longshore Transport Potential	75-150,000 cu yd/yr (net to north)	25-50,000 cu yd/yr (net to north)
Storm Current-Driven Transport Potential	30-40,000 cu yd/yr (net to north)	30,000 cu yd/yr (net to south)
Dominant Sediment Pathways	Onshore and alongshore to the north on both sides of the point; slight easterly-driven sediment to the east of the point	Onshore and alongshore to the north and south; slight southeasterly-driven transport to the south of Port Mahon
Silt (0.05mm) Dispersion Potential	not applicable	Normal Tide Transport Potential: 45 cy/hr Normal Tide Travel Distance: 3.5nm Mean Storm Transport Potential: 1500 cy/hr Storm Transport Travel Distance: 7 nautical mi.

Table 9-2. Sediment Transport Findings at Stockpile Sites (Sand 0.30mm)

	L-5	MS-19
Net Wave-Driven Mass Transport Potential	Normal: 5,000 cy/yr (net onshore) Storm: 40,000 cy/yr (net onshore)	Normal: 15,000 cy/yr (net to south) Storm: 40,000 cy/yr (net onshore)
Net Current Driven Transport Potential	5,000 cy/yr (net to south)	10,000 cy/yr (net to south)
Wave-Driven Longshore Transport Potential	175-300,000 yd/yr (net to north)	200-350,000 cy/yr (net to north)
Dominant Sediment Pathways	Onshore and alongshore to the north	Onshore and alongshore to the north
Impact of Stockpile Crest Elevation	Crest at -3'MLW appears to have minimal effect on nearshore transport processes	Crest at -3'MLW appears to have minimal effect on nearshore transport processes

due to the events considered except at Kelly Island in August. Because August storm events are much shorter than the 4-day event considered, insignificant impacts are expected on oysters during real storm events at that time of year. The 30-day event, although also potentially causing an impact at Kelly Island in August, is most likely to be prevented in August because that time of the year is best for performing repair work on the containment system. In addition, any 30-day event in August will exhibit turbidity concentrations that are much less than 2 g/l and more likely 150 mg/l. Similar 30-day simulations with turbidity levels of approximately 150 mg/l in August show much less impact, with the entire spawn not being lost, and no increase in mortality over ambient conditions.

The sand and geotextile tube dredged material containment facility at Kelly Island has been analyzed and designed to prevent the discharge of fine grained material into Delaware Bay. The design minimizes the risk to oyster resources due to catastrophic failure of the structure. Worst case scenarios have been utilized to model foundation and geotextile tube stability, settlement and bearing capacity, and erosional failure. Protection against scour is being provided by protective blankets. In addition, several other geotextile tube projects are being monitored to gain additional knowledge that will insure that this project will succeed. An operation and maintenance manual will be developed for this site, which will include a monitoring plan providing for periodic observation of the Kelly Island structure, especially during the critical late summer period.

9.3.1.3 Operation and Maintenance of Kelly Island

An operation and maintenance plan will be developed that will include repairs to prevent any breach or potential breach from occuring. The innovative design of this facility will ensure that this area will successfully provide for the restoration of valuable wetland resources.

In light of the sensitivity of the oyster resources of the Kelly Island area certain contingency measures will be planned in the extremely unlikely event a breach occurs. These seed beds, existing under inherently low food supplies, do not have the reserves required to easily withstand increased turbidity levels that may result. Before the construction of the Kelly Island wetland restoration site, oyster populations will be measured to determine the status quo so that a comparison can be made in the unlikely event of a breach. Parameters to be measured include abundance, size (biomass) frequency, disease infection intensity, reproductive state, and recent mortality. If a breach occurs, the same parameters would be measured to determine the extent of impacts. If the impacts were significant, restoration of the bottom that was damaged by the release of silt would be done.

Maintenance

Three areas of maintenance may be necessary at the Kelly Island Wetlands Restoration Project. One area of maintenance includes project structures such as the geotextile tube groins, geotextile tube armor on the southern spit of the island, drop inlets and outlet pipes, weirs, offshore and cross-shore sand dikes, and the geotextile tube cores in those sand dikes. Another area of maintenance is the Mahon River channel to ensure that material eroding from the Kelly Island wetland restoration is not impacting the navigation channel. The third area of maintenance is needed for development of the marsh to create tidal connections to stagnant pools, increase (or decrease) tidal flushing, encourage propagation of desirable plant species, and eradicate undesirable species. The Corps of Engineers will be responsible for maintenance of the structure and the DNREC will manage the site for wetland, wildlife, and fisheries values.

Project Structure Maintenance

The offshore sand dike was designed by assuming that up to 35,000 yd^3 of material per year would be removed from the structure over a 10 year period (plus a factor of safety).

Plans will be made to replenish the volume of sand lost from the structure over the first 10 years of the project. To be consistent with the design approach, it was be assumed that 350,000 yd^3 of sand will be required after 10 years. Prior to maintenance a hydrographic survey would be conducted to determine the actual volume of sand required. If it is less than 350,000 cy, maintenance could be postponed or a replacement volume of sand provided.

Annual inspections of the structure will be made to ensure its integrity. Of particular concern is damage due to overtopping that may occur during an extreme event (e.g. water level with 10-25 year expected return interval). If a breach forms in the structure, the geotextile tube core will limit the damage, but the problem will be repaired. In this case, repair could probably be accomplished with earth moving equipment using existing sand in the structure. If the geotextile tube in a breach is damaged, a determination will be made as to whether it should be repaired or replaced. In general, any breach should have only local effects and so repair may not be necessary. The breach could simply be filled.

Wind transport from the crest of the structure may be a problem. If necessary, it will be reduced or eliminated by planting suitable vegetation or by using a sand fence.

The cross-shore dike is not expected to lose any sand to transport processes. However, if the structure is overtopped during severe weather, a breach may form through its cross-section. If a breach forms in the structure, the geotextile tube core should limit the damage, but the problem will be repaired. In this case, repair could be accomplished with earth moving equipment using existing sand in the structure.

Annual inspections of the cross-shore dike be conducted to determine the condition of the dike and the outlet works. Likely problems with the outlet works will include clogging of the outlet pipes with sand and deterioration of timber weir boards, or mechanical components.

The geotextile tube groins should be considered temporary. The only way that they should be considered permanent is if they are regularly inspected and maintained. The cross-shore orientation of a groin makes it susceptible to damaging waves, erosion and undermining. The seaward end of the tube groin will not be prevented from lateral motion very well and so may be moved by large waves. Accumulation of sand is expected on the updrift side of the tube with sediment losses on the downdrift side. This will tend to destabilize the tube and cause it to roll slightly in the downdrift direction. As with any exposed geotextile tube, the fabric is always susceptible to damage by abrasion and punctures. Tube groins are even more susceptible to damage because of their orientation. They tend to intercept debris being transported longshore.

The groins will be inspected annually. The groins will be inspected after the winter season and, when possible, in the fall. A complete failure of the groins is not expected, though some damage may occur. The tube groins should continue to function for several years. Replacement of failed tubes will only be done if it is clear that loss of sand through longshore transport (especially in the southerly direction) is a problem. Otherwise, replacement of the tubes will be foregone and replacement of sediment lost to longshore transport at some future time will be considered. (See discussion of maintenance of the offshore dike above.) If southerly transport is evident and threatens navigation in the Mahon River channel, a determination of the rate of transport will be made. It may be more cost effective to dredge the river channel than to replace the geotextile tube groins. However, it may also be reasonable to dredge the channel and use the material to fill new geotextile tube groins.

The tube recommended for protection of the southern spit of Kelly Island is considered temporary. The tube will be inspected annually for damage. If the tube is damaged, a determination will be made regarding repair or replacement with another tube or other material. The structure is important because it limits wave propagation directly into that portion of the Mahon River leading to the boat launch.

Mahon River Navigation Channel Impacts From Kelly Island

The amount of sand that may be transported into the Mahon River navigation channel is very difficult to estimate. The net transport is expected to be 35,000 yd^3/yr to the north. Tidal currents and waves out of the north will tend to move some material south, but the volume is uncertain. Further, sand that does move south may not enter the navigation channel. Therefore, the channel will be surveyed annually to determine whether shoaling in the channel is a problem. Channel maintenance will be planned for every three years. However, annual surveys (at least for the first 5 years) will indicate whether this is a reasonable estimate for maintenance.

If dredging is required due to sand accumulation, the sandy material removed from the channel could be placed on the offshore sand dike to postpone its maintenance requirements (as discussed above).

Habitat Maintenance

During the development of the marsh after placement of the dredged material, some topographic shaping and active management may be necessary to ensure the marsh develops as anticipated by all parties. This work may require cutting new tidal channels to stagnant pools, increasing or decreasing the amount of water allowed to flow through structures, developing new inlet structures, creating high marsh zones or open water pools, vegetating areas that have not vegetated naturally, eradicating nuisance plant species (e.g. *phragmites*), and other similar maintenance work. Most of the evolution of the marsh can occur naturally, however some aspects may require active management.

Other habitats such as those for horseshoe crabs, migratory birds, and shore birds will be monitored for functional development, colonization, and other life requirement aspects. If the development of the habitats is inadequate, then modification or maintenance will be required.

In general annual or more frequent inspections should be conducted to observe and document the development of all of the ecological characteristics of the project.

9.3.2 EBERM Analysis

The EBERM analysis evaluated the long-term potential for stability/mobility of sediments to be placed at the offshore stockpile sites near Slaughter Beach (MS-19) and Broadkill Beach (L-5), Delaware. The six-year normal condition wave database referenced in the preceding section of this report was used to characterize wave conditions at the stockpile sites. The wave data were ordered in terms of wave height, and statistical measures of wave height adopted in the EBERM methodology were extracted from the database. Additionally, near-bed oscillatory peak speeds were calculated from the wave data base, and compiled into a frequency distribution. Based on consideration of each site's local geometry and configuration of the proposed disposal mounds, wave crest and trough peak speeds were calculated to determine cross-shore transport potential.

The wave, sediment, and geometric data generated for the Slaughter Beach and Broadkill Beach stockpiles were compared to similar data for a number of previously monitored sites in the EBERM database. It was determined that both sites will experience persistent transport of sand in the landward direction. The nature of the EBERM analysis is such that transport rates are not explicitly computed. Rather, comparison of the pertinent EBERM criteria for Broadkill and Slaughter Beaches with criteria from the monitored sites suggests that the onshore transport will occur over a period of decades. The sediment which is transported landward will be gradually dispersed in the alongshore direction at both sites, contributing sand to nearshore environments which presently experience a net sediment deficit. The EBERM analysis thus independently confirmed the findings of the more computationally intensive work performed with the wave and current models discussed in the previous section.

9.4 Impacts of Placing Sand on Broadkill and Slaughter Beaches

The sand stockpiles (MS 19 and L 5) will provide Delaware a source of sand to nourish Broadkill and Slaughter beaches. The

impacts of place sand on Delaware Bay beaches is described in the *Broadkill Beach, DE, Interim Feasibility Study, Final Feasibility Report and Environmental Impact Statement*, dated September, 1996.

10.0 Endangered Species Concerns

Table 10-1 lists all Federally listed endangered and threatened species, and table 10-2 lists all state listed endangered and threatened species that are known to occur in or near areas that may be impacted by this project.

10.1 Federally Endangered Species of Concern

10.1.1 Species Under the Authority of the U.S. Fish and Wildlife Service (FWS)

10.1.1.1 Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle was listed as an endangered or threatened species throughout the United States in 1978; the Chesapeake Bay Region (CBR) bald eagle population was determined to be threatened in 1995. The bald eagles in the project area are covered under the *Chesapeake Bay Region Bald Eagle Recovery Plan: First Revision* (USFWS. 1990).

The CBR bald eagle occupies shoreline habitat of the Chesapeake and Delaware Bays and their tributaries. The eagle requires large blocks of undisturbed mature forested habitat in proximity to aquatic foraging areas. The principal threat to its continued recovery is habitat loss due to shoreline development and other land use changes. The CBR eagle is also threatened by acute toxicity caused by continued use of certain contaminants, shooting, accidents, and natural environmental events (USFWS. 1990).

Bald eagles have been documented to be sensitive to human activity and disturbance, particularly during the breeding season, although sensitivity varies greatly between individuals (Mathisen, 1968; Stalmaster and Newman, 1978; USFWS, 1990; Grubb and King, 1991). The breeding cycle of CBR bald eagles can generally be divided into four phases with each phase having an associated level of sensitivity to human disturbance (Cline, 1990; Figure 10-1). Eagles are most sensitive early in the nesting cycle when nest selection, nest building, incubation and brooding occur (Mathisen, 1968). Bald eagles are moderately sensitive to disturbance when young are older and preparing to fledge. After young are fledged and before nest selection begins, the bald eagles are least sensitive to disturbance. Most bald eagle nests are located in large wooded areas associated with marshes and other water bodies. Sometimes nests are built in isolated trees located in marshes, farmland or clear cuts. Nest sites are typically remote from areas of intense human activity, although some have been observed near railroad tracks, highways, airfield runways and human residences (USFWS, 1990). Primary factors contributing to breeding habitat suitability are distance from human activity, availability of suitable nest trees, and an adequate forage base (USFWS, 1986).

Table 10-1 Delaware River Main Channel Deepening Project
Federally Listed Species
That Occur in the Project Area

1. Species Under the Authority of the U.S. Fish and Wildlife Service (FWS):

Bald Eagle (Haliaeetus leucocephalus) - Threatened *
Peregrine Falcon (Falco peregrinus) - Endangered *
Sensitive Joint-Vetch (Aeschynomene verginica) - Threatened

2. Species Under the Authority of the National Marine Fisheries Service (NMFS):

Loggerhead Sea Turtle (Caretta caretta) - Threatened *
Kemp's Ridley Sea Turtle (Lepidochelys kempii) -Endangered*
Green Turtle (Chelonia mydas) -Endangered *
Hawksbill Sea Turtle (Eretmocheys imbricata) - Endangered *
Leatherback Sea Turtle (Dermochelys coriacea) - Endangered*
Finback Whale (Balaenoptera physalus) - Endangered *
Right Whale (Eubalaena glacialis) - Endangered *
Humpback Whale (Megaptera novaeanjliae) - Endangered*
Shortnose Sturgeon (Acipenser brevirostrum) - Endangered *

3. Action: Biological Assessments have been prepared for those species (*) that were requested by either the FWS or the NMFS. See Sections 10.3, 10.4, and 10.5 for a discussion of the biological assessments including the "reasonable and prudent" measures to minimize impacts.

Table 10-2 Delaware River Main Channel Deepening Project
State Listed Species
That Occur in the Project Area

1. New Jersey

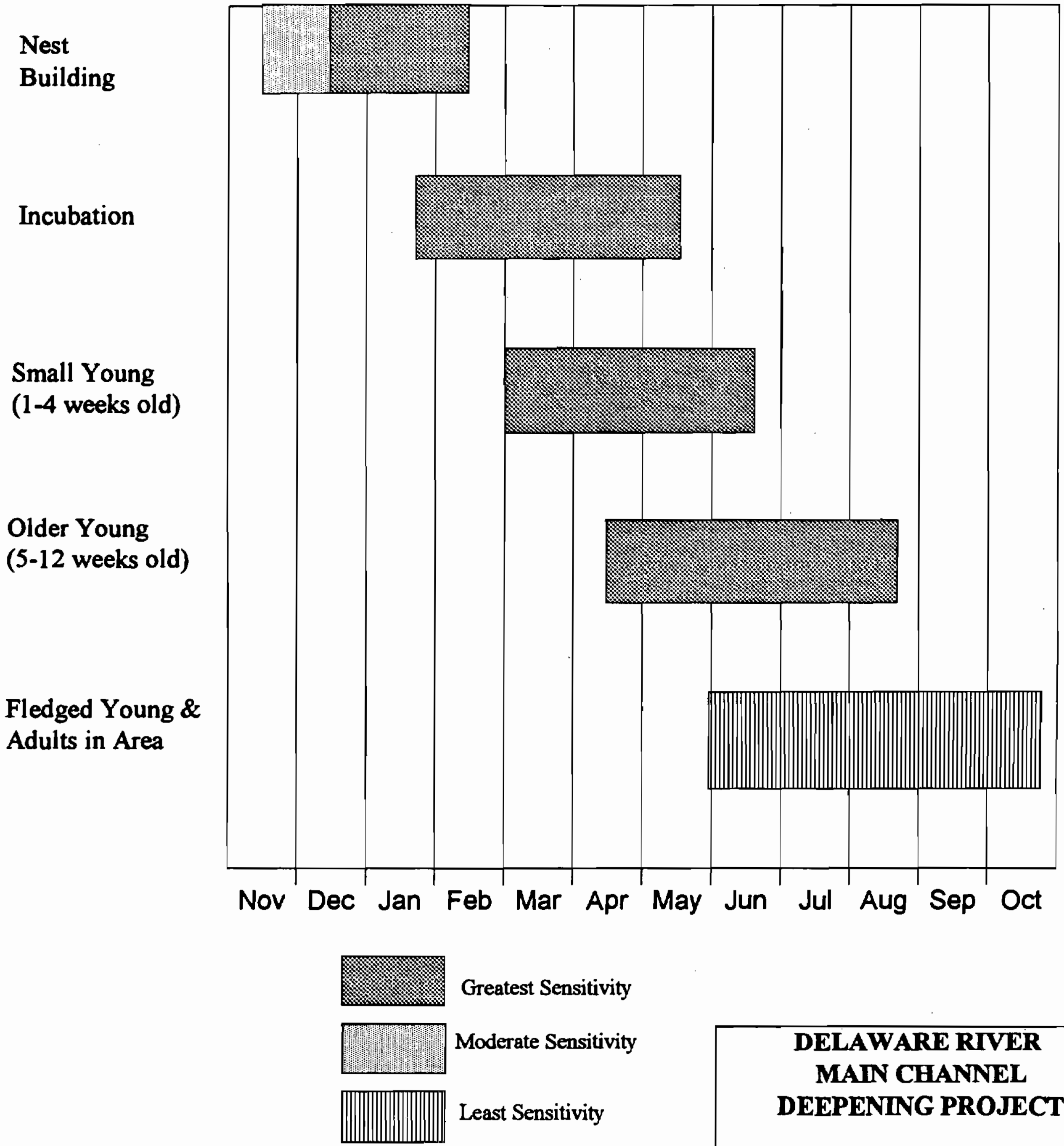
Bald Eagle (Haliaeetus leucocephalus) - Endangered
Peregrine Falcon (Falco peregrinus) - Endangered
Osprey (Pandion haliaetus) - Threatened
Great Blue Heron (Ardea Herodias) - Threatened (Breeding)
Northern Harrier (Circus cyaneus) - Endangered (Breeding)
Pied-Billed Grebe (Podilymbus podiceps) - Endangered (Breeding)
Loggerhead Sea Turtle (Caretta caretta) - Threatened
Kemp's Ridley Sea Turtle (Lepidochelys kempii) -Endangered
Green Turtle (Chelonia mydas) -Endangered
Hawksbill Sea Turtle (Eretmocheys imbricata) - Endangered
Leatherback Sea Turtle (Dermochelys coriacea) - Endangered
Finback Whale (Balaenoptera physalus) - Endangered
Right Whale (Eubalaena glacialis) - Endangered
Humpback Whale (Megaptera novaeanjliae) - Endangered
Shortnose Sturgeon (Acipenser brevirostrum) - Endangered
Sensitive Joint-Vetch (Aeschynomene verginica) - Endangered
Engelmann's Flatsedge (Cyperus engelmannii) - Endangered

2. Delaware

Bald Eagle (Haliaeetus leucocephalus) - Endangered
Peregrine Falcon (Falco peregrinus) - Endangered
Loggerhead Sea Turtle (Caretta caretta) - Threatened
Kemp's Ridley Sea Turtle (Lepidochelys kempii) -Endangered
Green Turtle (Chelonia mydas) -Endangered
Hawksbill Sea Turtle (Eretmocheys imbricata) - Endangered
Leatherback Sea Turtle (Dermochelys coriacea) - Endangered
Finback Whale (Balaenoptera physalus) - Endangered
Right Whale (Eubalaena glacialis) - Endangered
Humpback Whale (Megaptera novaeanjliae) - Endangered
Shortnose Sturgeon (Acipenser brevirostrum) - Endangered

3. Pennsylvania

Peregrine Falcon (Falco peregrinus) - Endangered



Source: Cline, 1990

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Bald Eagle Sensitivity to Human Disturbance

U.S. Army Corps of Engineers, Philadelphia District

Figure 10-1

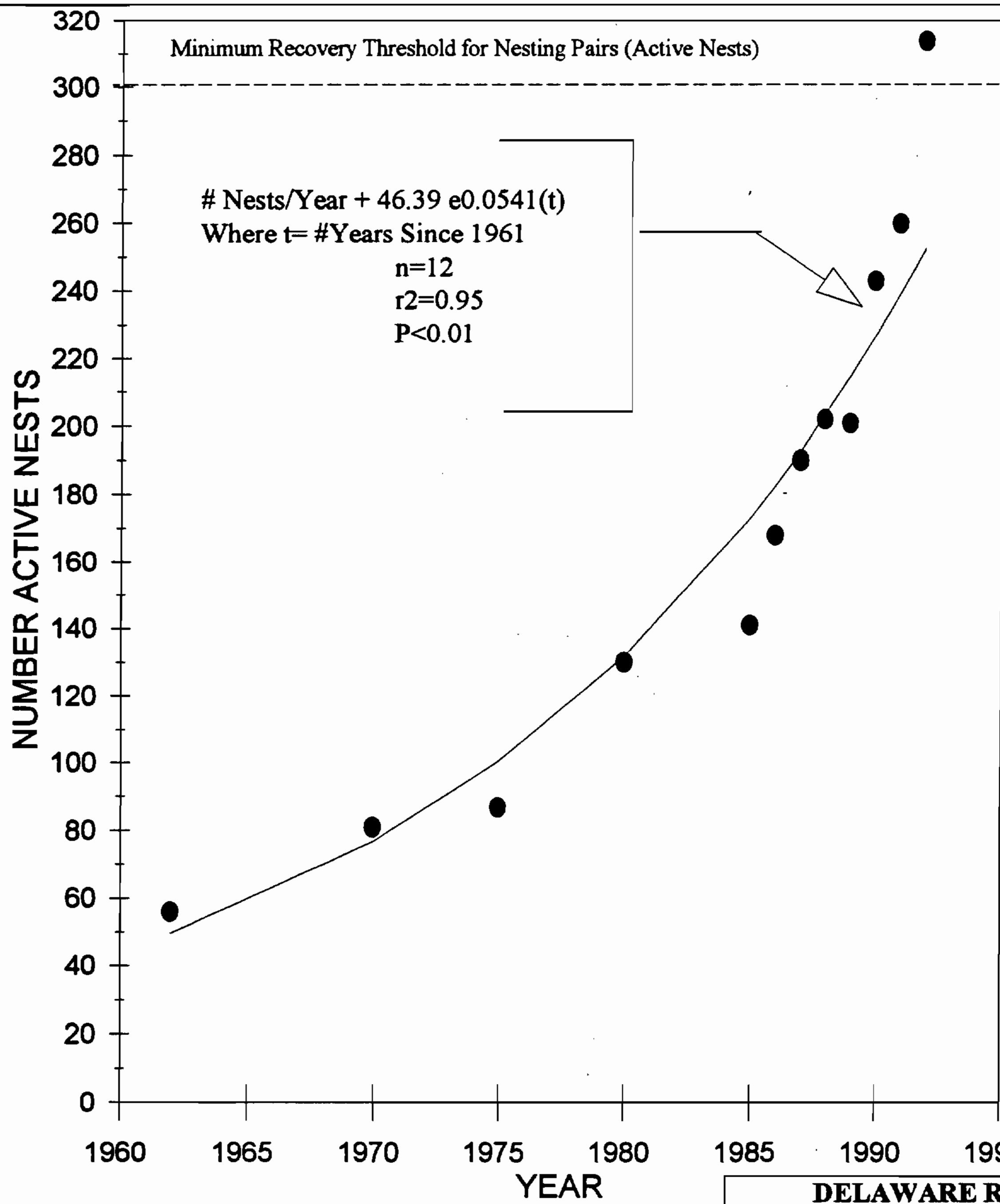
In the CBR, the bald eagle is found feeding most often along river, lake, and bay shoreline, or perched in the trees bordering them; and in extensive freshwater marshes on hillocks, muskrat houses, bare sand or mud bars, and isolated trees. Since they typically snatch fish from the water's surface, shallow water is an important component of live fish availability to eagles. Most bald eagle nests are less than 1.6 km from feeding areas, although some nests are up to 3.2 km from their primary food source (USFWS. 1990).

The CBR bald eagle population was listed as endangered in 1978 (43 CFR 6233) and, at that time, the major limiting factor for the population was identified as lowered productivity resulting from pesticide contamination (USFWS, 1990). Secondary limiting factors included shooting, disturbance, and habitat destruction. A recovery plan for the CBR bald eagle population was released in 1982. The original plan was revised in 1990 (USFWS, 1990). The draft version of the revised recovery plan lists 11 known major bald eagle concentration areas in the CBR, including one in southern New Jersey (USFWS. 1990).

The CBR bald eagle population has exponentially increased from 1962 to 1992, as evidenced by increases in the number of active nests (an index of nesting pairs) (Figure 10-2). In part, this has been a result of improved population recruitment, indexed by young/nest/year, since 1985 (Figure 10-3). The population growth curve (Figure 10-2) exhibits an instantaneous rate of increase of 0.0541 (N = 46.39e; where t = number of years since 1961). This translates into a 5.6% average increase in the number of active nests per year, although from 1991-1992 the number of active nests increased by nearly 20%. These rates compare favorably with the maximum growth rate of 11% predicted by the USFWS for the Northern States bald eagle population (USFWS, 1983). The population would double to roughly 600 nests by the year 2007, based on these population data and growth rates, and in absence of increased environmental resistance (i.e., density dependent factors such as limited available habitat) (NASA. 1993).

The CBR bald eagle population is approaching thresholds judged to indicate full recovery. For full recovery, the CBR must contain 300 to 400 nesting pairs with a productivity level of 1.1 eaglets per active nest sustained over 5 years (USFWS, 1990). The current documented population of 307 nesting pairs already exceeds the lower range of the goal. Based upon the population data discussed above and in absence of increased environmental resistance, the CBR bald eagle population would exceed 400 nesting pairs around 2001. The goal of producing 1.1 or more eaglets per active nest per year has been sustained from 1985 to 1992 (1993 data were not available), exceeding the 5 year requirement (NASA. 1993).

Nesting habitat availability has recently replaced pesticide contamination as the major limiting factor on the CBR bald eagle population (USFWS, 1990). Density dependent influences will



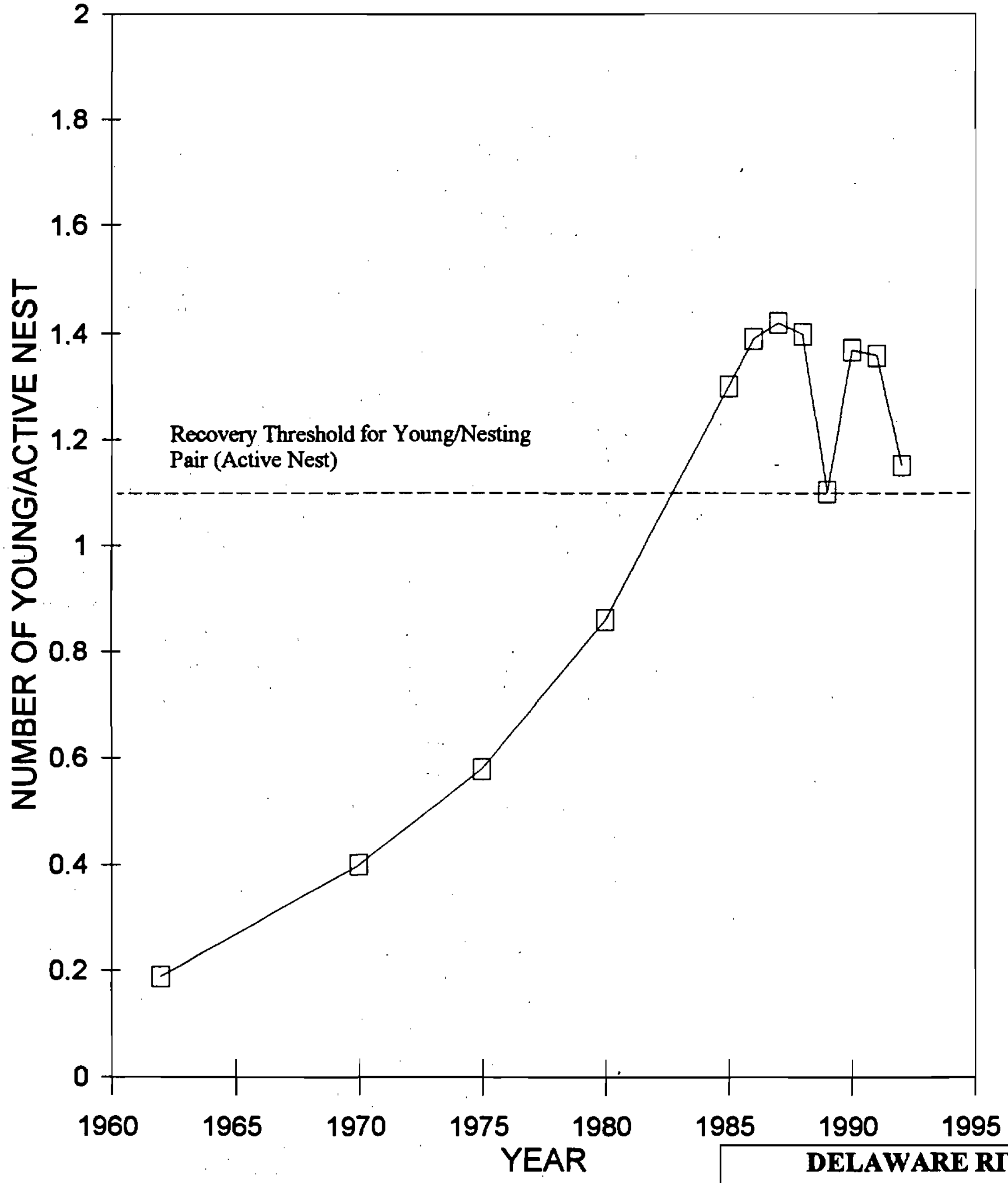
Source: USFWS, 1990; USFWS, 1993b

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Number of Active Bald Eagle Nests in the Chesapeake Bay Region for Selected Years from 1962 to 1992

U.S. Army Corps of Engineers, Philadelphia District

Figure 10-2



Source: USFWS, 1990; USFWS, 1993b

**DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT**

Bald Eagle Young/Nest in the Chesapeake Bay Region for Selected Years from 1962 to 1992

U.S. Army Corps of Engineers, Philadelphia District

Figure 10-3

limit the availability of unoccupied nesting habitat and will ultimately slow the population growth as the number of nesting pairs increases. One result of the increased competition for nesting areas will be greater use of suboptimum nest areas.

Additional factors limiting population growth include habitat destruction and disturbance, shooting, continued use of certain environmental contaminants, natural phenomena, and accidents. Although all limiting factors are addressed to the extent possible, current recovery efforts are particularly focused on improving habitat availability, protecting existing habitat, and eliminating mortality due to shooting (USFWS. 1990).

Bald Eagle Populations in the Project Area

New Jersey. Clark et. al. (1994) reports that there were six (6) active bald eagle nests in the project area. Four (4) of these nests produced 8 young in 1994, while two (2) of the nests failed to produce young that year. One pair of eagles that nested near Raccoon Creek (designated as the Raccoon Creek site) is suspected to be the same pair that nested near Gibbstown in the past. The nest is located less than 2 miles from one of the proposed dredged material upland disposal sites (15D). This site and one near Welchville (the Home Run site) have not produced young in the last 2 years and are believed to have contaminant problems. Infertile eggs collected from the Home Run site had a high enough level of PCBs to cause death (Clark. 1995. Personal Communication). None of the other nests are located within 4 miles of either the Federal navigation channel, upland disposal areas, or beneficial use sites; however, eagles from all the nests would be expected to forage along the Delaware Bay.

Thirty-one bald eagles were counted in the 1994 bald eagle winter survey along the Delaware Bay coastline. The Maurice and Cohansey River drainages held the highest concentrations, while the Maurice River watershed continued to support the greatest number of wintering bald eagles in southern New Jersey (Clark et. al. 1994).

Preliminary results of contaminant testing by the New Jersey Department of Environmental Protection of blood and feather samples from eaglets along the New Jersey side of the Delaware Bayshore indicate that eaglets have moderate to high levels of DDT compounds compared to eaglets from the Great Lakes (Clark et. al. 1994). Studies by Steidl et. al. (1991 a and c) compared reproductive success in Delaware Bay and Atlantic coast osprey populations in New Jersey. The Delaware Bay population had lower reproductive success, and the eggs from this population contained significantly higher levels of DDE, DDD, PCB's, dieldrin, and heptachlor epoxide than Atlantic coast eggs. This suggests that contaminants from within the Bay contributed to reduced hatching success in this population.

Delaware. Gelvin-Innvaer (1994) reports that there were 10 active bald eagle nests in Delaware in 1994. Six of these nests produced 7 chicks to banding age, yielding a productivity of 0.7 chicks per occupied nest. In 1995 there were about 10 past or present eagle nest locations where the birds would be expected to forage along the Delaware Bay (Gelvin-Innvaer. 1995. Personal Communication). Trends in the numbers of banding-aged chicks, occupied nests, and successful nests have increased in the past 17 years, especially since the mid-1980's (Gelvin-Innvaer. 1994). One nest that is located in the Bombay Hook National Wildlife Refuge is about 6 miles from the Kelly Island beneficial use site (Smith. 1995. Personal Communication). Another eagle nest is located in the Prime Hook National Wildlife Refuge, about 0.5 miles from the shore of Delaware Bay (O'Shea. 1995. Personal Communication). As in New Jersey, contaminants are suspected to be a factor in nest failures at three nest sites including the one at Bombay Hook. Disturbance, habitat loss and habitat degradation increasingly threaten the long-term maintenance and expansion of eagle numbers in Delaware (Gelvin-Innvaer. 1994).

Eighteen bald eagles were reported to have wintered in Delaware in 1994; however, no significant concentrations of wintering eagles occur in Delaware (Gelvin-Innvaer. 1994).

Pennsylvania. In the Pennsylvania portion of the study area, the bald eagle is a transient; there are no nests or wintering concentrations (Brauning. 1995. Personal Communication).

10.1.1.2 Peregrine Falcon (Falco peregrinus)

The peregrine falcon was placed on the Federally Protected Migratory Bird List in March, 1972. In 1970, the U.S. Fish and Wildlife Service listed the American peregrine falcon under the Endangered Species Conservation Act of 1969, and in 1984, all peregrines in the lower 48 states were listed under the Endangered Species Act of 1973 as endangered by similarity of appearance. The peregrine falcons in the project area are covered under the Peregrine Falcon (Falco peregrinus), Eastern Population Recovery Plan - 1991 Update (USFWS. 1991).

The peregrine falcon nests on high cliffs, tall buildings, and bridges. It requires an uncontaminated avian prey base and undisturbed nest sties. The primary threats to the eastern population at the present time are disturbance of habitat by humans at existing sites and predation by great horned owls, which may limit population expansion in the southern Appalachians, Great Lakes, and southern New England/Central Appalachians recovery regions, except at urban sites.

Prey for the peregrine consists primarily of common passerine bird species such as bluejays, flickers, meadowlarks and pigeons. During migration and on the wintering grounds, passerines, shorebirds and waterfowl are taken while starlings, other passerines, and pigeons serve as the principal source of food for falcons occupying metropolitan areas.

Population trends of peregrines can be monitored with greater reliability than with many other birds because these falcons exhibit a high degree of nest site fidelity. An inventory of eastern peregrine eyries conducted in the late 1930s and early 1940s showed 408 eyries in the eastern United States, Canada, Labrador, and Greenland. Of these sites, 275 were located in the eastern United States and at least 210 were active eyries.

Former breeding distribution of the eastern population extended from northern New England through the Adirondacks and along the Appalachian Range to Georgia and Alabama. Populations also existed in the upper Mississippi River area of Wisconsin and Minnesota. Tree nesting populations were also present in Tennessee and Kentucky.

Falcons generally reach sexual maturity at age three. Usually, the male arrives first at a cliff site and performs a series of aerial acrobatic displays to attract a mate. Historically in the eastern region, peregrine pairs were usually on their breeding grounds and had re-established territories by March. Their eggs, usually four in a clutch, were laid in late March and April; if this clutch was lost early in the laying period, a second clutch was laid. Reintroduced birds are following this pattern. Peregrines vigorously defend the immediate area surrounding their nesting ledge, but are more tolerant to human intrusion into their hunting territory.

Incubation lasts 32-34 days. The female does most of the incubating and brooding while the male hunts. The juvenile peregrines are most vulnerable during their first year when they are still developing their flying skills and learning to hunt. This is the period when the birds are especially vulnerable to shooting or predation, and the first year mortality from all causes is much higher than in subsequent years.

In the early 1960s the number of peregrine falcons nesting in the United States declined rapidly, with extensive use of organochlorine pesticides considered to be the primary cause. High levels of organochlorines, particularly the widely used insecticide DDT, proved lethal to birds, and sublethal doses induced reproductive failure. DDE, a metabolite of DDT, disrupted calcium metabolism so that peregrine falcons accumulating sufficient DDE residues produced abnormally thin-shelled eggs, which often broke before hatching. Eggshell thinning in combination with other effects of organochlorines upon reproduction greatly reduced the nesting success of peregrine falcons, and the recruitment rate of young peregrine falcons fell below the number necessary to replace natural and pesticide-caused mortalities. Subsequently, peregrine falcon numbers dwindled to the point where, by the mid-1960s, the breeding population of the peregrine falcon in the eastern United States was extirpated. Due to successful efforts to captively breed and reintroduce peregrine falcons into areas where they once bred, as well as new areas, the peregrine again breeds in many regions of the Northeast, and have steadily increased in numbers (Steidl et. al. 1991).

Protection of peregrines from the effects of pesticides has been indirectly enhanced through the Federal Pesticide Control Act and similar state laws. These acts led to restricted use of chlorinated hydrocarbons in the United States. As a result, the mean DDT and dieldrin levels in indicator species such as starlings have declined significantly since 1967. During the past few years, there have been eggs recovered from coastal sites in the mid-Atlantic region that contained relatively high residues of DDE. The source of the material is uncertain, but migrating prey is suspected. Although the worst offenders have been banned, environmental contamination persists as a localized threat to the full recovery of these raptors.

Direct human disturbance of nesting birds is the primary threat to the eastern peregrine population at this point. In combination with this, great horned owls prey on young (and occasionally adult) peregrines.

Alteration of peregrine falcon nesting and migrating/wintering habitat is occurring at a low to moderate level, particularly in the coastal reaches of the eastern population's range. Many nests have been established within publicly owned areas; protection of this habitat is secured. Migratory and wintering peregrine habitat is more at risk, although protection of this habitat is also proceeding in many areas concomitant to protection of shorebird habitat. In addition, illegal shooting of peregrine falcons in the eastern United States remains a sporadic cause of bird mortality.

Natural increases in peregrine population levels are anticipated over the long run, given sufficient protection of the species' habitat. If implementation of recovery activities continues, reclassification of this population of the peregrine falcon should be possible when the number of nesting pairs reaches approximately one-fourth to one-third of the historical population level. As the population continues to grow, full recovery will be achieved when approximately one-half the historical number of 350 nesting pairs is shown to be self-sustaining and distributed across the falcon's former range (USFWS. 1991).

Peregrine Falcon Populations in the Project Area

New Jersey. Within the New Jersey portion of the study area there are 5 nest locations. Three of the locations are on bridges over the Delaware River between New Jersey and Pennsylvania (Benjamin Franklin, Walt Whitman, and Commodore Barry). The other locations are at the Heislerville Wildlife Management Area and near Egg Island Point, both in Cumberland

County. The same pair may be using the last two locations in different years (Clark. 1994 and Clark. Personal Communication). Production of young at New Jersey sites near the Delaware River and Bay has been lower than those from other parts of the state. Eggshell thinning due to contaminants continues to be a problem. Eggshell thickness reported from eggs collected from 1985-88 in New Jersey averaged 16.4% below pre-DDT levels and apparently has decreased steadily since 1979. This decrease in eggshell thickness suggests that falcons continue to be exposed to environmental contaminants. All peregrine populations where egg thinning exceeded 17% were either declining or became extirpated (Steidl, et. al. 1991). In addition, total PCBs and chlordane in New Jersey and other eastern peregrine falcon eggs continue to be higher than those from other parts of the country, while total DDT remains high (Clark. 1994).

Delaware. Peregrine falcons have nested on the Delaware Memorial Bridge that connects Delaware to New Jersey. They have also attempted to nest on high buildings in Wilmington. There is no recent data on peregrine falcons in Delaware (Gelvin-Innvaer. Personal Communication).

Pennsylvania. Peregrine falcons have nested on two bridges in the project area (Walt Whitman and Commodore Barry) and have been cooperatively monitored by the Pennsylvania Game Commission and the New Jersey Department of Environmental Protection. Eggs from the first clutch from these two nests were removed and hacked in urban locations in Pennsylvania and New Jersey. The two pairs of falcons failed to renest (Clark. 1994). Productivity in captive-rearing facilities was higher than historically has been experienced with bridge-nesting peregrines (Brauning. 1994).

Migratory. In addition to the peregrine falcons that nest within the project area, many migrate through with up to 800 passing by Cape May, New Jersey in the fall, as well as a few birds that winter in the area (Herpetological Associates, Inc. 1992).

10.1.1.3 Other Species

Sensitive Joint-Vetch (Aeschynomene verginica). This plant species is listed as threatened. The New Jersey Natural Heritage Program database has identified that this species may occur at the 4 proposed new dredged material disposal areas. It is an obligate wetland species that occurs in freshwater tidal marshes. It was not observed during the vegetation inventories that were performed on these sites (Dames and Moore. 1994a, b, c, and d). Since there are no freshwater tidal marshes within the proposed dredged material disposal areas, there will be no impact to this species.

Bur-Marigold (Bidens bidentoides) - This plant species is listed as a candidate species for Federal listing. The New Jersey Natural Heritage Program database has identified that this species may occur at the 4 proposed new dredged material disposal areas. It is a wetland species that occurs on tidal shores and mudflats. It was not observed during the vegetation inventories that were performed on these sites (Dames and Moore. 1994a, b, c, and d). Due to the disturbed nature of these sites, it is unlikely that this species occurs within the proposed dredged material disposal areas.

10.1.2 Species Under the Authority of the National Marine Fisheries Service (NMFS)

Listed species that may occur within Delaware Bay include loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempi*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*) sea turtles; and the right(*Eubalaena glacialis*), humpback (*Megaptera novaeangliae*), and fin (*Balaenoptera physalus*) whales. The shortnose sturgeon (*Acipenser brevirostrum*) has been known to inhabit the Delaware River and bay. All of these species are endangered, except for the loggerhead sea turtle, which is threatened.

10.1.2.1 Sea Turtles

Sea turtles spend most of their lives in an aquatic environment, and males of many species may never leave the water (Hopkins and Richardson 1984, Nelson 1988). The recognized life stages for these turtles are egg, hatchling, juvenile/subadult, and adult (Hirth 1971).

Reproductive cycles in adults of all species involve some degree of migration in which the animals return to nest at the same beach year after year (Hopkins and Richardson 1984). Nesting generally begins about the middle of April and continues into September (Hopkins and Richardson 1984, Nelson 1988, Carr 1952). Mating and copulation occur just off the nesting beach. A nesting female moved shoreward by the surf lands on the beach, and if suitable crawls to a point above the high water mark (Carr 1952). She then proceeds to excavate a shallow body pit by twisting her body in the sand (Bustard 1972). After digging the body pit she proceeds to lay her eggs, size and egg shape is species specific (Bustard 1972). Incubation periods for loggerheads and green turtles average 55 days, but range from 45 to 65 days depending on local conditions (Nelson 1988).

Hatchlings emerge from the nest at night, breaking the egg shell and digging their way out of the nest (Carr 1952). They find their way across the beach to the surf by orienting to light reflecting off the breaking surf (Hopkins and Richardson 1984). Once in the surf, hatchlings exhibit behavior known as "swim frenzy," during which they swim in a straight line for many hours (Carr 1986). Once into the waters off the nesting beach, hatchlings enter a period known as the "lost year". It is not known where this time is spent, what habitat this age prefers, or mortality rates during this period. It is currently believed the period encompassed by the "lost year" may actually turn out to be several years. Various hypotheses have been put forth about the "lost year." One is that hatchlings may become associated with floating sargassum rafts offshore. These rafts provide shelter and are dispersed randomly by the currents (Carr 1986). Another hypothesis is that the "lost year" for some species may be spent in a salt marsh/estuarine system (Garmon 1981).

The functional ecology of sea turtles in the marine and/or estuarine ecosystem is varied. The loggerhead is primarily carnivorous and has jaws well-adapted to crushing mollusks and crustaceans, and grazing on encrusted organisms attached to reefs, pilings and wrecks. The Kemp's ridley is omnivorous and feeds on swimming crabs and crustaceans. The green turtle is a herbivore and grazes on marine grasses and algae while the leatherback is a specialized feeder preying primarily upon jellyfish. Until recently, sea turtle populations were large and subsequently played a significant role in the marine ecosystem. This role has been greatly reduced in most locations as a result of declining turtle populations. These population declines are a result of natural factors such as disease and predation, habitat loss, commercial overutilization, and inadequate regulatory mechanisms for their protection. This has led to several species being in danger, or threatened with extinction.

However, due to changes in habitat use during different life history stages and seasons, sea turtle populations are difficult to census (Meylan 1982). Because of these problems, estimates of population numbers have been derived from various indices such as numbers of nesting females, numbers of hatchlings per kilometer of nesting beach, and number of subadult carcasses (strandings) washed ashore (Hopkins and Richardson 1984).

10.1.2.2 Whales

A former resource of the Delaware Estuary, whales convinced Dutch settlers to establish their first permanent settlement in Delaware on Cape Henlopen, in 1631. Since then the numbers of whales off of the New Jersey and Delaware coast have decreased. Records indicate that the endangered humpback whales (Megaptera novaeangliae), fin whales (Balaenoptera physalus) and right whales (Eubalaena glacialis) were occasionally sighted in the Delaware Estuary. However, since the introduction of the Endangered Species Act in 1973, whales have been sighted with increasing frequency along the New Jersey and Delaware Coast, and have become the subject of a growing whale watch industry in the mid-Atlantic.

Humpback Whale Humpback whales are found throughout the oceans of the world, migrating from tropical and subtropical breeding grounds in winter to temperate and Arctic feeding grounds in summer (Evans, 1987). Several stocks occur in the northwestern Atlantic. Adults and newborns of the Gulf of Maine migrate from summer feeding grounds off the coast of New England to winter breeding grounds along the Antillean Chain of the West Indies, primarily on Silver Bank and Navidad Bank north of the Dominican Republic. Some individuals remain in the Gulf of Maine throughout the year.

Until recently, humpback whales in the mid-Atlantic were considered transients. Few were seen during aerial surveys conducted in the early 1980's (Shoop, et al., 1982). However, since 1989, sightings of feeding juvenile humpbacks have increased along the coast of Virginia, peaking in the months of January through March in 1991 and 1992 (Swingle, et al., 1993). Studies conducted by the Virginia Marine Science Museum indicate that the whales are feeding on, among other things, bay anchovies, and Atlantic menhaden. In concert with the increased sightings, strandings of whales have increased in the mid-Atlantic during this time, with 32 strandings reported between New Jersey and Florida since January 1989. Sixty percent of those that were closely investigated showed either signs of entanglement, or vessel collision (Wiley, et al., 1992).

Fin Whale During the summer, in the eastern North Atlantic, fin whales can be found along the North American coast to the Arctic and around Greenland. The wintering areas extend from the ice edge south to the Caribbean and the Gulf of Mexico.

Fin whales in the North Atlantic feed on fish: herring, cod, mackerel, pollock, sardines, and capelin, as well as squid, euphausiids, and copepods. Peak months for breeding in the North Atlantic are December and January. Although fin whales are sometimes found singly, or in pairs, they commonly form larger groups of 3-20, which may in turn coalesce into a broadly spread concentration of a hundred or more individuals, especially in the feeding grounds (Gambell, 1985). The fin whale was a prime target for commercial whaling after the Norwegian development of the explosive harpoon in 1864. The number of whales in the North Atlantic was quickly depleted.

Fin whales are often spotted in mid-Atlantic waters. Some fin whales were seen off the Delmarva peninsula during aerial surveys conducted in the early 1980's (Shoop, et al., 1982). Since 1989, sightings of feeding juvenile fin whales have increased along the coast of Virginia in the same area as the humpback whales. Fin whales are more difficult to study due to their speed. However, it is believed that they are feeding with the humpback whales, on bay anchovies and menhaden.

Right Whale The northern right whale is the world's most endangered large whale. Current estimates place the total number of remaining animals at no more than 600 (NMFS 1991). Right whales have been protected from commercial whaling since 1949. The right whale was placed on the list of endangered species in 1973, and it remains so today.

The north Atlantic right whale is one of the most endangered large whales in the world. Right whales are often near shore in shallow water, and sometimes sighted in large bays. Populations concentrate in five known areas; coastal Florida and Georgia, the Great South Channel east of Cape Cod, Massachusetts, Cape Cod Bay and Massachusetts Bay, the Bay of Fundi, and Browns and Baccaro Banks south of Nova Scotia. The population appears to migrate seasonally.

In recent years, two to six northern right whales have been sighted each winter off Long Island and off of New Jersey Beaches. In February 1983, an animal stranded in New Jersey was identified as a two-year old northern right whale that had first been photographed in the Bay of Fundi in 1981 (NMFS 1991). It is now believed that a portion of the North Atlantic right whale population is migrating along the United States east coast each year from Iceland to Florida. There is growing evidence that calves are born when the whales are at the southern end of their migration, in the Atlantic off northeastern Florida, Georgia, and possibly the Carolinas.

10.1.2.3 Shortnose Sturgeon

The shortnose sturgeon (Acipenser brevirostrum) is an endangered species of fish found in major rivers of eastern North America, from the Saint John's River in Florida to the Saint John River in New Brunswick, Canada. This species may also be found in estuaries and in ocean regions adjacent to river mouths. Although typically an anadromous species, landlocked populations of shortnose sturgeon are known to exist. In September 1986 the Philadelphia District initiated formal consultation under Section 7 of the Endangered Species Act of 1977 (16 U.S. C. 1531 et seq.), with regard to maintenance dredging of the Delaware River Federal Navigation Projects from Trenton to the sea and potential impacts to the Federally endangered shortnose sturgeon (Acipenser brevirostrum). "A Biological Assessment of Shortnose Sturgeon (Acipenser brevirostrum) Population in the Upper Tidal Delaware River: Potential Impacts of Maintenance Dredging" was forwarded to NMFS for their review.

Shortnose sturgeon spawn in freshwater, usually above tidal influence. In northern latitude river systems, spawning grounds are generally characterized by fast flows (40-60 cm/sec) and gravel or rubble bottoms. Spawning occurs in the spring. In the Delaware River, spawning normally occurs during the middle 2 weeks of April (Meehan, 1910; Hoff, 1965; Brundage, 1982).

Shortnose sturgeon range from the Saint John River, New Brunswick, Canada, to the Saint John's River, Florida (Dadswell et al., 1984). Throughout its range, the shortnose sturgeon occurs in rivers, estuaries, and occasionally in the sea. Populations tend to be most abundant in, and upstream from the estuarine section of the inhabited river system.

Sampling by O'Herron and Able in the Trenton - Roebling, New Jersey region during October, 1985, through March, 1986, confirms the existence of an annually occurring overwintering aggregation of shortnose sturgeon in the immediate vicinity of Duck Island Creek. An overwintering population of 2122 adults was calculated using the modified Schnable population estimator (Ricker, 1975).

In the fall, the bulk of the population migrates downstream and utilizes the lower estuary as an overwintering area (Hastings, 1983b). This group includes non-ripening adults, ripe but not running males, and older juveniles. The remaining portion of the population, including ripening adults, some non-ripening adults, and juveniles, overwinters in freshwater near the spawning grounds. In the spring, when water temperatures reach 8 to 9° C, adults migrate from the lower estuary and freshwater overwintering sites, upstream to upper tidal and lower non-tidal spawning grounds (Dovel, 1978; Squires, 1982). In the Delaware River, recent studies indicate that the area below Scudder's Falls is commonly used by shortnose sturgeon to spawn (Brundage, 1984). After spawning, adults migrate downstream to summer foraging areas. Some remain in freshwater while others move to mid-estuary.

10.2 State Endangered Species of Concern

Table 10-2 also shows state-listed species that may be impacted by the project.

10.2.1 New Jersey. The bald eagle, peregrine falcon, and sensitive joint-vetch are also Federally listed species and are discussed above.

10.2.1.1 Osprey (Pandion haliaetus). This species is listed as threatened by New Jersey. In recent years ospreys have nested near one of the proposed dredged material disposal areas (Raccoon Island). They are also likely to forage along the tidal creeks bordering the proposed dredged material disposal areas, as well as in the vicinity of Egg Island Point.

10.2.1.2 Great Blue Heron (Ardea Herodias). The breeding population of this wading bird is listed as threatened by New Jersey. No breeding areas (rookeries) are known from any of the project areas. The great blue heron feeds in wetlands and shallow water areas and is likely to occur in these habitats in the dredged material disposal areas.

10.2.1.3 Northern Harrier (Circus cyaneus). The breeding population of this raptor is listed as endangered by New Jersey. This bird of prey of grasslands and marshes has been reported in the vicinity of Egg Island Point.

10.2.1.4 Pied-Billed Grebe (Podilymbus podiceps). The breeding population of this species of waterfowl is listed as endangered by New Jersey. This bird has been reported from the tidal marshes adjacent to dredged material site 15G. It may also occur in other open water areas.

10.2.1.5 Engelmann's Flatsedge (Cyperus engelmannii). This plant species is listed as endangered by New Jersey. It is a wetland species and is known from emergent marshes, shores, and tidal mudflats. The New Jersey Natural Heritage Program database has identified that this species may occur at the 4 proposed new dredged material disposal areas. It was not observed during the vegetation inventories that were performed on these sites (Dames and Moore. 1994a, b, c, and d). Due to the disturbed nature of these sites, it is unlikely that this species occurs within the proposed dredged material disposal areas.

10.2.2 Delaware and Pennsylvania. The species listed in Table 10-2 by Delaware and Pennsylvania are also listed on the Federal list and are discussed above.

10.3 Section 7 Consultation

In compliance with Section 7 (c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), biological assessments were prepared that evaluate the potential effects of the channel deepening on species listed by either the U.S. Fish and Wildlife Service (October 1995) or the National Marine Fisheries Service (September 1995). These assessments were prepared in accordance with the Joint Regulations on Endangered Species (50 CFR Section 402.12). Both biological assessments concluded that there will be no impact that would jeopardize the continued existence of any of the listed species, or their critical habitat, as a result of this project.

In a letter dated January 18, 1996 (See Appendix A) the U.S. Fish and Wildlife Service stated that they concur with the District's determination that the Delaware River Main Channel Deepening Project is not likely to adversely affect federally listed species under the Service's jurisdiction. This is based on implementation of the "reasonable and prudent measures to minimize impacts" that are described in Section 10.5. A Biological Opinion was issued by the NMFS on November 26, 1996 for all dredging projects permitted, funded, or conducted by the District. The Opinion stated that dredging projects within the Philadelphia District may adversely affect sea turtles and shortnose sturgeon, but are not likely to jeopardize the continued existence of any threatened or endangered species under the jurisdiction of the NMFS.

10.3.1 U.S. Fish and Wildlife Service

In a planning aid report (USFWS. 1989), the U.S. Fish and Wildlife Service (FWS) stated that the endangered peregrine falcon has nested or attempted to nest on Delaware River bridges within the project area, and that aside from occasional transient individuals, no other federally listed or proposed threatened or endangered species under FWS jurisdiction are known to occur within the project area. The report further stated that it is unlikely that the areas potentially impacted by the proposed project provide essential habitat for peregrines.

In a letter forwarding the Draft Fish and Wildlife Coordination Act Report, Section 2(b) (USFWS. 1992), the FWS stated that both the peregrine falcon and the bald eagle nested within the project area and requested that the Corps prepare a biological assessment to address potential project related adverse impacts to these species. The letter further stated that aside from occasional transient individuals, no other federally listed or proposed threatened or endangered species under FWS jurisdiction are known to occur within the project area.

A meeting was held in the Philadelphia District office on December 14, 1994 with representatives from the FWS. Ms Dana Peters, FWS, stated that the species of concern are the bald eagle and the peregrine falcon. For the bald eagle, the concerns are possible exposure to contaminants from the additional dredging, and disturbance during nesting. The FWS recommended that the following potential impacts be addressed in a biological assessment: disturbance, increased development, contaminants, and increased oil spills. FWS recommended that the assessment be coordinated with Larry Niles of the NJDEP. For the peregrine falcon, FWS recommended that disturbance at their nest/roosting sites at the Walt Whitman and Commodore Barry bridges, as well as contaminants, would need to be addressed in the biological assessment. There are presently no restrictions for dredging in the Delaware River for the peregrine falcon.

10.3.2 National Marine Fisheries Service (NMFS)

In September 1995 the Philadelphia District initiated formal consultation under Section 7 of the Endangered Species Act of 1977 (16 U.S. C. 1531 et seq.), with regard to maintenance dredging of Delaware River Federal Navigation Projects from Trenton to the sea, and potential impacts to the Federally endangered shortnose sturgeon (Acipenser brevirostrum). " A Biological Assessment of the Shortnose Sturgeon (Acipenser brevirostrum) Population in the Upper Tidal Delaware River: Potential Impacts of Maintenance Dredging" was forwarded to NMFS for their review.

It was determined by the Corps that maintenance dredging activities in the southern reaches of the Delaware River, specifically from Philadelphia to the sea, were not of concern with respect to impacting shortnose sturgeon. The area, between Philadelphia and Wilmington, was considered the "pollution zone" and is only utilized as a migratory route by adults during the early spring and late fall. South of Wilmington the shortnose sturgeon population is limited to adults due to increased salinity.

The Corps has followed certain recommended dredging windows established by the Delaware River Basin Fish and Wildlife Management Cooperative (Cooperative), and has conducted informal consultation for maintenance dredging activities. The Cooperatives' Fisheries Technical Committee (FTC) decided to implement the following restrictions as part of the Cooperatives Dredging Policy effective as of April 1997:

> Hydraulic dredging, is prohibited from the Delaware Memorial Bridge to the Kinkora Range in non-Federal areas between April 15th and June 21st. No hydraulic dredging restrictions exist for the Federal channel or anchorages.
>
> Overboard disposal and blasting are prohibited from the Delaware Memorial Bridge to the Betsy Ross bridge in all areas between March 15th and May 31st. Bucket dredging is prohibited from March 15 to May 31 from the Delaware Memorial Bridge to the Kinkora Range. In all areas in the Delaware Bay to the Delaware Memorial Bridge, turtle monitors are required from June 1 to November 30 on hopper dredges.

The Philadelphia District will continue to follow these recommended dredging windows established by the Delaware Basin Fish and Wildlife Management Cooperative. Dredging for the Channel Deepening Project would occur from Philadelphia through the mouth of the Bay.

On August 17, 1992, the Philadelphia District met with NMFS regarding Section 7 and its applications to existing and proposed hopper dredging projects in the Philadelphia District. Due to the possibility of multiple District projects utilizing hopper dredges, it was determined that it would be practical to conduct a cumulative, district-wide consultation.

On August 21, 1993 NMFS forwarded a letter to the Philadelphia District formally requesting that the District conduct a district-wide consultation. Further coordination determined that the Philadelphia District would prepare a Biological Assessment to evaluate impacts to include right, humpback, and fin whales; and Kemp's ridley, loggerhead, leatherback, green and hawksbill sea turtles in the Delaware Estuary and the Atlantic coasts of New Jersey and Delaware. The District would also evaluate impacts to shortnose sturgeon in the Delaware River and Bay.

A Biological Opinion was issued by the NMFS on November 26, 1996 for all dredging projects permitted, funded, or conducted by the District. The Opinion stated that dredging projects within the Philadelphia District may adversely affect sea turtles and shortnose sturgeon, but are not likely to jeopardize the continued existence of any threatened or endangered species under the jurisdiction of the NMFS. They also stated that while endangered whales may be present in the action area of these dredging projects, effects from increase dredging traffic are expected to be minimal.

10.4 Assessment of Potential Impacts

10.4.1 Species Under the Authority of the Fish and Wildlife Service (FWS)

10.4.1.1 Bald Eagle

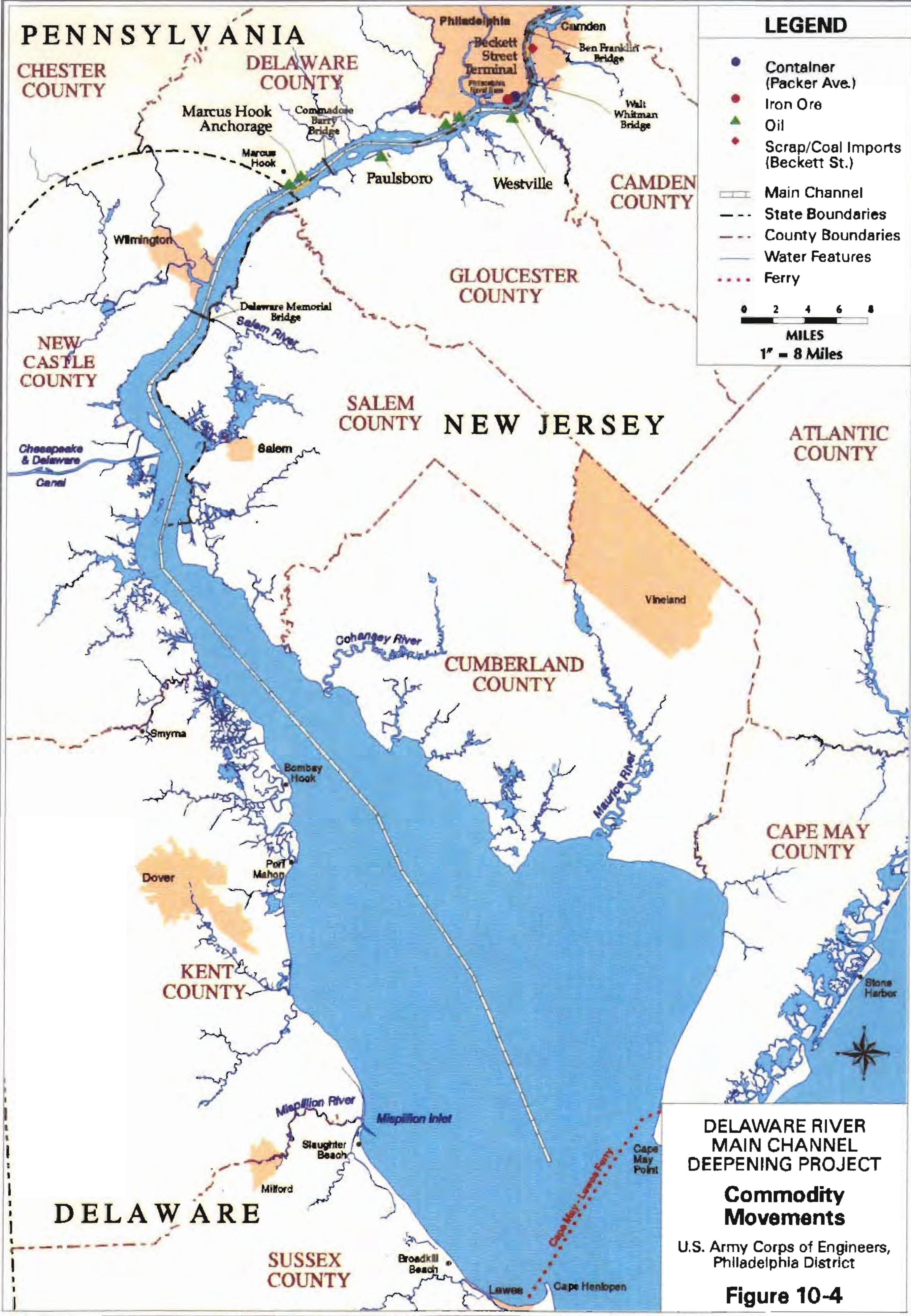
Disturbance of Nest Sites

1. Construction and Use of Upland Dredged Material Disposal Areas. One pair of eagles that nested near Raccoon Creek (designated as the Raccoon Creek site) is suspected to be the same pair that nested near Gibbstown in the past. The nest is located between 1.5 and 2 miles from one of the proposed dredged material upland disposal sites (15D). The FWS requires a buffer zone of 0.25 miles or a line of site buffer of 0.5 miles from the nest from January to July to avoid disturbance (Peters. Personal Communication). There would be no adverse impact provided that the eagles continue to nest in the locations that have been used in the past. At this time we can not tell if an eagle nest will be located near an upland disposal area in the year 2000 when the upland sites would be constructed. A contingency plan will be developed based on FWS recommendations. Construction of the site and use of the site for disposal of dredged material could be staged to avoid disturbance impacts where work would be performed within the dates recommended by Cline (1985).

2. Construction of Kelly Island and Egg Island Point Wetland Restoration Sites. The Kelly Island beneficial use site is about 6 miles from an eagle nest in the Bombay Hook National Wildlife Refuge, and there would be no impacts to the nesting bald eagles from construction of the site. There are no suitable bald eagle nesting trees near either the Kelly Island wetland restoration site or the Egg Island Point wetland restoration site.

Potential for Increased Development

There should be no impacts to bald eagles from increased development due to the channel deepening project. Although the greatest economic benefit for the channel deepening project is to the petroleum industry, the oil refining facilities in the project area are not expected to increase as a result of this project. The refinery capacity is expected to increase modestly in the future through technology changes, upgrading facilities, expansion, and new development in order to accommodate projected commodity flow. However, the economic benefits of this project will result from increased efficiency of oil transportation predominantly due to decreased lightering, and there is no additional increased development projected due to this project. The locations of the six oil refineries that will benefit from this project are shown in Figure 10-4 and consist of the following facilities: Sun Oil, Marcus Hook, PA; Tosco Oil, Marcus Hook, PA; Mobil Oil, Paulsboro, NJ; Sun Oil, Ft. Mifflin, PA; Sun Pipeline, Ft. Mifflin, PA; and Coastal Eagle Point Oil, Westville, NJ. None of the known current locations of eagle nests are near these refineries.



PENNSYLVANIA
CHESTER COUNTY
DELAWARE COUNTY
Philadelphia
Beckett Street Terminal
Camden
Ben Franklin Bridge
Walt Whitman Bridge
Marcus Hook Anchorage
Commadore Barry Bridge
Marcus Hook
Paulsboro
Westville
CAMDEN COUNTY
Wilmington
Delaware Memorial Bridge
Salem River
GLOUCESTER COUNTY
NEW CASTLE COUNTY
SALEM COUNTY
NEW JERSEY
ATLANTIC COUNTY
Chesapeake & Delaware Canal
Salem
Vineland
Cohansey River
CUMBERLAND COUNTY
Smyrna
Bombay Hook
Maurice River
CAPE MAY COUNTY
Dover
Port Mahon
KENT COUNTY
Stone Harbor
Mispillion River
Mispillion Inlet
Slaughter Beach
Milford
Cape May Point
Cape May - Lewes Ferry
DELAWARE
SUSSEX COUNTY
Broadkill Beach
Lewes
Cape Henlopen
LEGEND
Container (Packer Ave.)
Iron Ore
Oil
Scrap/Coal Imports (Beckett St.)
Main Channel
State Boundaries
County Boundaries
Water Features
Ferry
0 2 4 6 8
MILES
1" = 8 Miles
DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
Commodity Movements
U.S. Army Corps of Engineers, Philadelphia District

Figure 10-4

Potential for Increased Oil Spills

There should be no impacts to bald eagles from increased oil spills due to the channel deepening project. Although the channel deepening project will enable oil tankers to bring larger quantities of oil directly to the oil refineries, with less lightering in the Delaware Bay; this will be done more safely than it is under present conditions. Under present conditions, large oil tankers with full cargos need to transfer a portion of their cargos to smaller barges in the lower, deeper portion of Delaware Bay so that they can negotiate the 40 foot channel upriver. This process is called "lightering", and it is in this operation that there is a greater possibility for oil being spilled. With the new, deepened channel, lightering will be reduced approximately 40% for benefitting facilities. In addition, the navigation channel will be widened at certain bends such as the bend at Marcus Hook, PA. This is the only location in the estuary where bedrock is exposed, and over 37% of the major oil spills that have occurred since 1973 have taken place at this location by groundings. The widening and deepening of the navigation channel at Marcus Hook should reduce the possibility of oil spills in the Delaware Estuary. Information concerning oil spill planning in the Delaware estuary is presented in Section 12.0.

10.4.1.2 Peregrine Falcon

Disturbance of Nest Sites

1. Construction and Use of Upland Dredged Material Disposal Areas.

A pair of peregrine falcons has nested on the Commodore Barry bridge which crosses the Delaware River between Pennsylvania and New Jersey. The bridge is adjacent to the proposed Raccoon Island upland dredged material disposal site. The time when nesting peregrines are the most sensitive to disturbance is at the beginning of the nesting period (15 March to 15 April). During this period no work should be initiated; however, it may be possible to continue ongoing work without disturbing the falcons (Clark. 1995. Personal Communication). The Philadelphia District will coordinate closely with the USFWS and the NJDEP before work would be performed during this critical period.

2. Restoration of Wetlands at Egg Island Point and Kelly Island.

Another pair of peregrine falcons has nested on a structure near Egg Island Point where the Philadelphia District plans to restore a wetland that is eroding at a rate of up to 30 feet per year. Conversations with the NJDEP (Clark. 1995. Personal Communication) indicate that the nest structure is in danger of being destroyed by the continuing erosion. The Philadelphia District would move the nest structure to a safer location as determined in coordination with the NJDEP. The restoration of wetlands at Egg Island Point and Kelly Island should have a beneficial impact by restoring and protecting tidal wetlands that provide habitat for waterfowl and shorebirds, which are prey species for peregrine falcons.

10.4.1.3 Contaminants

After review of available data for dredged material derived from the Delaware River Main Channel Deepening Project (see Section 4.0), it would appear that the relative risk of contaminants in the dredged material to wildlife and especially endangered species such as the bald eagle and peregrine falcons should be very low and consequently, should not be a significant concern. The frequency of detection of contamination in sediment samples collected throughout the project was low, and therefore any detected contamination when placed in the designated disposal sites will be mixed to such a large extent that contaminant concentrations will end up very low.

PCBs. The highest concentrations of PCB-1254 and PCB-1248 observed in one out of 49 samples from Reach B of the project were 1.19 and 0.53ppm, respectively. After dredging and placement in a disposal site, the overall final PCB concentration will no doubt be below 0.25 ppm. Bioaccumulation of PCBs in wetland and upland soil dwelling animals have been observed to be less than one half the concentration measured in the dredged material. For example, at the Corps of Engineers' Field Verification Program field sites, both earthworms in an upland site and sandworms in a wetland site bioaccumulated approximately 3 ppm PCBs from dredged material containing 6.7 ppm PCBs (Lee et al. 1995). The Food and Drug Administration (FDA) action levels for human consumable food have been set at 2 ppm PCBs. While there are no set action levels for wildlife food, it is reasonable to assume that foodchain components that contain above 2 ppm could represent significant risk to wildlife. It would appear that reduced concentrations of sediment PCBs, such as 0.25 ppm, should not be a significant risk to wildlife exposed to an ecosystem developed on the proposed disposal sites for dredged material from the Delaware Estuary.

Pesticides. Few sediment samples showed detected pesticides. One sediment sample out of 33 showed 0.060 ppm heptachlor epoxide (Reach A), while another sample out of 49 showed 0.06 ppm Endosulfan (Reach B), and finally a third sample out of 19 showed 0.026 and 0.045 ppm of DDD and DDE, respectively. Dredging and placement of sediments in the disposal sites will result in reduced concentrations of these pesticides. The reduced concentrations should not represent a significant risk to wildlife.

PAHs. Sediment samples did show detectable amounts of PAHs. The highest concentrations of PAHs were observed in 2 out of 49 samples in Reach B. One sample approached a total PAH concentration of 10 ppm. Concern for exposure of foodchain components to sediments containing 10 ppm or more of PAHs could be warranted. However, when this sediment is dredged and placed in a disposal site with the other 48 sampled sediments within the Reach, the resultant reduced concentration of PAHs should be approximately 0.2 ppm and of little concern or risk.

Metals. Most sediment samples showed detectable metals. Metals that were detected at levels that might be of concern were cadmium (1.66 ppm, mean concentration for Reach A) and thallium (3.76 and 2.48 ppm mean concentration for Reaches A and B, respectively). These concentrations were above NJ DEP Residential Direct Contact Soil Cleanup Criteria, which can give some perspective of sediment chemical data, but may not relate well at all to the risk to wildlife. All other metals were relatively low and should not be a significant risk.

1. Cadmium. Up to year 1994, 2.7 ppm cadmium was the soil concentration allowed for land receiving sewage sludge and used in crop production for human and animal food (Lee et al. 1991). Newly established EPA 503 regulations for land application of sewage sludge raised the soil levels to 34 ppm cadmium for unrestricted use of land. It would appear that dredged material containing an average concentration of 1.66 ppm cadmium should be of low risk in light of the 503 limitations. Bioaccumulation of cadmium in foodchains has been observed on dredged material containing 11 ppm cadmium (Stafford et al. 1987). Cottonwood trees that colonized the Times Beach Confined Disposal Facility at Buffalo, NY took up cadmium from the dredged material into their leaves. The leaf litter on the soil surface was inhabited by earthworms which bioaccumulated cadmium up to 100 ppm, resulting in a significant potential risk to wildlife foodchains on the disposal site. This example is an order of magnitude more sediment cadmium than that observed in Delaware River sediments and illustrates that bioaccumulation can occur at higher soil cadmium concentrations.

2. Thallium. The risk of thallium to foodchains is unknown. While there are water quality criteria for thallium for human risk assessment, there are no FDA action levels for thallium in human or animal food. The concentration of thallium observed 2.48 and 3.76 ppm appears to be above the NJDEP Residential Direct Contact Soil Cleanup Criteria of 2.00 ppm, however, the magnitude above the criteria is below 2X (times). Concern for concentrations of potential contaminants usually becomes warranted when magnitudes above criteria approach 5X. Until a more applicable criterion is established for the risk of thallium to wildlife foodchains, the risk to wildlife should be considered low.

Water Column Impacts The discussion above is related to disposal site impacts. The potential for impacts and risk to wildlife and especially the bald eagle and peregrine falcon is minimal from the dredging of sediments in the Delaware River, based on the collected sediment data. Elutriate test data show very little release of contaminants of concern to the water column. Dredging will temporarily suspend sediments, but the duration and exposure will be temporary and should not result in significant risk to fish or wildlife. Bioassay tests with suspended sediments showed no toxicity or bioaccumulation of any significance. Therefore, the risk to fish and ultimately the bald eagle or peregrine falcon should be insignificant.

10.4.1.4 Other Listed Species

Sensitive Joint-Vetch (Aeschynomene verginica). This species occurs in freshwater tidal marshes. Since this type of habitat will not be impacted, their will be no impact to this species.

Bur-Marigold (Bidens bidentoides). This species was not observed during the vegetation inventories that were performed on the upland dredged material disposal sites (Dames and Moore. 1994a, b, c, and d). Due to the disturbed nature of these sites, it is unlikely that this species occurs within the proposed dredged material disposal areas. Therefore, there should be no impact to this species.

10.4.2 Species Under the Authority of the National Marine Fisheries Service (NMFS)

10.4.2.1 Dredging Equipment and Methods

The primary potential impacts to these species are from dredging. A variety of dredge types and techniques will be employed, dependent upon the characteristics of the channel, availability of disposal, local environmental regulations, types of material to be removed, and proposed timing of the dredging. The Channel Deepening Project will use two types of dredges (hopper and pipeline dredge).

Typically, the USACE does not specify the type of equipment that a contractor must use to dredge a channel. Each type of dredging equipment has different strengths and weaknesses. Some jobs can be accomplished by any type of dredge; other projects require specialized equipment. Many times, one type of equipment will be more efficient than another. In these cases the bidding process usually results in the more efficient plant and equipment being used to accomplish the required dredging. Discussion of the different types of dredging equipment that would be suitable for dredging this project is provided below.

Self-Propelled Hopper Dredges: Hopper dredges are typically self-propelled seagoing vessels. They are equipped with propulsion machinery, sediment containers (i.e., hoppers), dredge pumps, and other specialized equipment required to perform their essential function of excavating sediments from the channel bottom. Hopper dredges have propulsion power adequate for required free-running speed and dredging against strong currents, and have excellent maneuverability. This allows hopper dredges to provide a safe working environment for crew and equipment to dredge bar channels or other areas subject to rough seas. This maneuverability also allows for safely dredging channels where interference with vessel traffic must be minimized.

A hopper dredge removes material from the bottom of the channel in thin layers, usually 2-12 inches, depending on the density and cohesiveness of the dredged material (Taylor, 1990). Pumps within the hull, but sometimes mounted on the dragarm, create a region of low pressure around the dragheads. This forces water and sediment up the dragarm and into the hopper. The more closely the draghead is maintained in contact with the sediment, the more efficient the dredging (i.e., the greater the concentration of sediment pumped into the hopper). Hopper dredges are most efficient for noncohesive sands and silts, and low density clay. Hopper dredges are not as efficient with medium to high density clays, or with dense sediments containing a significant clay fraction.

Dredging is usually done parallel to the centerline or axis of the channel. Sometimes, a waffle or crisscross pattern may be utilized to minimize trenching and produce a more level channel bottom (Taylor, 1990). This movement up an down the channel while dredging is called trailing, and may be accomplished at speeds of 1-6 knots depending on sediment type, sea conditions, and numerous other factors.

In the hopper, the slurry mixture of sediment and water is managed to settle out the dredged material solids and overflow the supernatant water. When an efficient load is achieved, the vessel suspends dredging, the dragarms are heaved aboard, and the dredge travels to the placement site. Because dredging stops during the trip to the placement site, the overall efficiency of a hopper dredge is dependant on the distance between the dredging and placement sites (i.e., the more distant the placement site, the less efficient the hopper dredge).

Cutterhead pipeline dredge: A cutterhead pipeline dredge is the most commonly used dredging plant in the United States. The cutterhead dredge is suitable for maintaining harbors, canals, and outlet channels, where wave heights are not excessive and suitable placement areas are nearby. It is essentially a barge hull with a moveable rotating cutter apparatus surrounding the intake of a suction pipe (Taylor, 1989; Hrabovsky, 1990). By combining the mechanical cutting action with the hydraulic suction, the hydraulic cutterhead has the capability of efficiently dredging a wide range of material, including clay, silt, sand, and gravel.

The largest hydraulic cutterhead dredges have 30 to 42 inch diameter pumps with 15,000 to 20,000 horsepower. These dredges are capable of pumping certain types of material through as much as 5-6 miles of pipeline, though up to 3 miles is more typical.

The attached pipeline also limits the maneuverability of the dredge. In addition, the cutterhead pipeline plant employs spuds and anchors in a manor similar to floating clamshell dredges. Accordingly, as with floating clamshell dredge plants, the hydraulic cutterhead should not be used in high traffic areas, and cannot be safely employed in rough seas. Cutterhead dredges are normally limited to operating in protected waterways where wave heights do not exceed 3 ft.

10.4.2.2 Sea Turtles

Presently, NMFS has determined that pipeline dredges are unlikely to adversely affect sea turtles (biological opinion from NMFS to Corps of Engineers for dredging of channels in the Southeastern United States from North Carolina through Cape Canaveral, Florida November 25, 1991). Pipeline dredges are relatively stationary and only influence small areas at any given time. For a turtle to be taken with a pipeline dredge, it would have to approach the cutterhead and be caught in the suction. This type of behavior would appear unlikely, but may be possible. This position, of course, could change if new information suggests that sea turtle/pipeline dredge interactions occur.

Only the hopper dredge has been implicated in the mortality of endangered and threatened sea turtles. Among the several possible causes of death to sea turtles is the potential entrainment of individuals in hopper dredging apparatus.

Impacts from dredging in the Delaware Estuary to listed species of sea turtles are dependent on the timing of the operations and the type of equipment employed. No impacts to any listed species of sea turtle would be expected if dredging were to be completed between December and May, or if equipment other than hopper dredges were employed to complete the work. However, there are potential impacts associated with hopper dredging conducted between June and November, when sea turtles may be present in the Delaware Estuary. Any of the five species of sea turtles could transit the channel during the warmer months, but only loggerhead and Kemp's ridley turtles are likely to be foraging in the channels, near the channel bottoms. The leatherback turtle is a pelagic feeder, with minimal bottom exposure. The number of loggerheads and Kemp's ridleys foraging in the Delaware Estuary is unknown, and it is not understood what percentage of the population within this area will avoid entrainment.

Dredging the main channel will take crabs and other benthic organisms from the area. Some of these organisms will survive the process, but be transported from the channel to the respective dredged material placement site. Hence, the food resource values of these areas might be temporarily reduced for sea turtles. Because of the mobility of crabs and rapid recolonization of disturbed benthic communities in estuarine environments, resource values will begin to recover immediately.

Other threats to sea turtles in the Delaware Estuary and nearshore areas include drowning in trawl nets, entanglement and drowning in crab pot lines and pound net leader hedging, wounding from boat propellers, incidental capture at the Salem Generating Station, and entanglement, ingestion, and other complications from contact with marine debris, including petroleum products.

Even though any loss of an endangered or threatened species is important, the magnitude of the losses of loggerhead and Kemp's ridley sea turtles from hopper dredging within the Philadelphia District would not be expected to significantly impact the U.S. Atlantic Coast populations of these sea turtle species.

10.4.2.3 Whales

Impacts to listed species of whales is unlikely with any type of dredging equipment. During operation, a dredge moves very slowly. Only during dredge transit to and from a work area or disposal site does the speed increase. The only means of potential impact is thought to be by collisions between vessels and whales during transit. In light of the existing vessel traffic, this potential is considered insignificant.

10.4.2.4 Shortnose Sturgeon

The construction of the Channel Deepening project is not expected to impact the shortnose sturgeon. The project area begins in the worst section of the Chester-Philadelphia "pollution zone" where dissolved oxygen concentrations are relatively low from May through October. In recent years water quality in this section of the river has improved because of controls on non-point source pollution. As a result, the use of this area by shortnose sturgeon has increased, although no data is available to document the extent of increase. This "pollution zone" begins to dissipate in the vicinity of Wilmington, DE. It is probable that the river between Philadelphia and Wilmington is only utilized as a migratory route by adults during early spring and late fall. However it should be noted that because water quality has improved, this area could be considered a more valuable habitat. South of this reach to the sea, the shortnose sturgeon population is limited to adults due to increased salinity. Habitat destruction would be minimal in this area because a large percentage of the new construction and all of the maintenance dredging would occur in existing Federal navigation channel, which comprise a small portion of the river. In addition, studies conducted by Rutgers University did not identify any adult sturgeon mortalities as a result of dredging operations in the Delaware River between Philadelphia and Trenton. It is expected that adult sturgeon would usually, actively avoid a working dredge. However, in March 1996, three sub-adults were found in a dredged material disposal pool on Money Island, near the Newbold Range of the river. Both a hopper dredge and a cutterhead pipeline dredge were using the disposal site at the time the fish were found. Money Island is north (upstream) of the

Main Channel Deepening Project, between Philadelphia and Trenton, in an area where shortnose sturgeons are known to occur in greater numbers.

10.4.3 State Listed Species of Concern

Only New Jersey has species listed that do not also occur on the Federal list. Impacts to these species are discussed below:

10.4.3.1 Osprey (Pandion haliaetus)

The construction and operation of the Raccoon Island dredged material disposal area may disturb ospreys that are nesting nearby. The Philadelphia District has been in contact with the NJDEP to find ways to avoid and/or minimize impacts. Ospreys are most vulnerable to disturbance during nest initiation and incubation which occurs between March 20 and May 31 (Clark. 1995). Construction activities and operating vessels near the nest site will be avoided during this period. Activities such as berm construction may be possible during this period if the activities take place strictly on land, and construction vehicles are sufficiently hidden and/or their sound muted relative to the osprey's location. The District will coordinate closely with the NJDEP to follow these guidelines as much as is practicable.

10.4.3.2 Great Blue Heron (Ardea Herodias)

The management of approximately half of the upland dredged material disposal areas as wetlands, and the restoration of wetlands at Egg Island Point will benefit the heron by providing additional foraging habitat.

10.4.3.3 Northern Harrier (Circus cyaneus)

The restoration of wetlands at Egg Island Point will benefit this species by providing additional foraging habitat.

10.4.3.4 Pied-Billed Grebe (Podilymbus podiceps)

The management of approximately half of the upland dredged material disposal areas as wetlands will benefit this species by providing additional nesting and foraging habitat.

10.4.3.5 Engelmann's Flatsedge (Cyperus engelmannii)

It is unlikely that this species occurs on the upland dredged material disposal areas; therefore, there should be no impact.

10.4.3.6 Pea Patch Island Heronry

Since the early 1970's Pea Patch Island has provided nesting habitat to 5,000 to 12,000 pairs of wading birds (Parsons. 1996). Pea Patch Island is located in the New Castle Range of the Delaware River, immediately west of the Federal navigation channel (See Plate 2). The wading birds feed in wetlands adjacent to the Delaware Estuary in Delaware and New Jersey.

Dredging Operations Near Pea Patch Island

Dredging to maintain the 40 foot Federal navigation channel has been done since 1942. Table 10-3 shows the distances of areas near Pea Patch Island that have been dredged over the last 20 years. These areas usually need to be dredged annually and the dredged material is removed by hydraulic dredge and transported by pipeline to the Killcohook disposal area, which is located nearby in New Jersey and Delaware. The majority of the dredging in the New Castle Range occurs downstream of Pea Patch Island (Tetra Tech, Inc. 1991). In addition, dredging usually occurs between August and December, except when an emergency occurs and dredging needs to be done to prevent ships from running aground.

Table 10-3. Dredging Distances from Pea Patch Island Wading Bird Colony:

Location	40 Foot Channel	45 Foot Channel	Side of Channel
Upstream	3,600 ft	3,600 ft	New Jersey
Downstream	4,400 ft*	2,800 ft	Delaware and New Jersey

* A small area adjacent to Pea Patch Island and 2,600 ft from the wading bird colony was dredged within the last 2 years.

The 45 foot channel will require an initial removal of 50,000 cubic yards from the areas no closer than 2,600 feet from the heronry. Maintenance dredging is estimated to be required yearly at these locations. The average yearly maintenance dredging quantities for the entire New Castle Range are estimated to be 1,126,000 cubic yards.

Potential for Impacts to Wading Birds

Concern has been expressed that dredging operations could adversely impact (1) the nesting wading birds on Pea Patch Island and (2) wading birds that need to fly over dredging operations to reach foraging areas in wetlands in Delaware and New Jersey. In addition there is concern that the continuing erosion of the island will be aggravated by the channel deepening project. Table 10-3 shows the distance between dredging operations and the Pea Patch Island wading bird colony for the 40 and 45 foot channels. The closest potential feeding areas to the new dredging are the mud flats immediately northeast of Pea Patch Island, which are used by young herons that have just learned to fly for feeding (Parsons. Personal Communication). These mud flats are about 2,400 feet from an area of the navigation channel which periodically requires maintenance dredging. Additional nearby feeding areas are the wetlands on Pea Patch Island adjacent to Fort Delaware and the wetlands downstream of Fort Mott State Park in New Jersey, almost a mile away.

Impacts from dredging operations to build and maintain the 45 foot Federal navigation channel should not have a significant impact on the wading bird nesting colony on Pea Patch Island or their foraging activities. The critical period for the wading bird nesting colony is from April to July when the birds are breeding. Although nesting declines in July, some nesting, and occasionally significant nesting can occur in August (Parsons. Personal Communication). Dredging is normally done between August and December unless there is an emergency need. The fact that this colony has developed and grown on Pea Patch Island during a period where dredging has taken place to maintain the 40 ft channel, indicates a tolerance for the current level of dredging activity. Landin (Personal Communication) reports that the placement of dredged material within 100 yards of a wading bird colony should not have an adverse impact. She reports that the placement of dredged material can be an attractant to feeding herons and other waterbirds, because they scavenge the waters coming from the dredge pipe for food. In addition, any wading birds that forage on the mud flats northeast of Pea Patch Island must be used to the dredging that presently occurs, or any wading birds that forage in the wetlands adjacent to Fort Delaware must be used to disturbance during the tourist season.

Erosion Effects of the 45 Foot Channel

As part of the final design, potential shoreline erosion to Pea Patch Island was considered with regard to changes in current velocities and vessel-generated waves for the deepened channel compared to the existing channel. Changes in current velocity were evaluated through the application of a hydrodynamic model of the Delaware River and Bay. This model was used to determine if the channel deepening would lead to current velocity changes at the shoreline of Pea Patch Island, and thus to increased erosion potential. The potential role of ship waves on shoreline erosion was also evaluated specifically for Pea Patch Island. The objective was to determine if vessels using the deepened channel would generate larger waves than presently occur with the existing 40 foot channel. Procedures presented in "Bank Protection for Vessel Generated Waves" (Robert Sorensen, 1986, Lehigh University Imbt Hydraulics Laboratory Report IHL-117-86) were utilized for this evaluation.

Comparison of the model-predicted current velocities for the 40 ft and 45 ft channel geometries at Pea Patch Island showed negligible velocity differences attributable to the deepened channel. It was thus concluded that the channel deepening will have a negligible effect on current velocities and water levels at the subject shoreline, and there will be no shoreline erosion induced or exacerbated by the channel deepening.

channel. It was thus concluded that the channel deepening will have a negligible effect on current velocities and water levels at the subject shoreline, and there will be no shoreline erosion induced or exacerbated by the channel deepening.

The principal variables considered in the ship wave analysis included vessel shape characteristics, vessel draft, vessel speed, sailing direction, and distance from the shoreline. The analysis assumed that tankers, due to their size, speed, and number of transits, constituted the critical class of vessels for this analysis. Further, based on data developed for the economic analysis of the proposed deepening, it was assumed that the fleet distribution would be identical for the 40 and 45 foot channels, with vessels simply loaded five feet deeper. The results indicated that maximum wave heights at the shoreline of Pea Patch Island would increase in the order of 4 per cent for the case of the design vessel loaded to a five-foot greater depth. Thus it was concluded that the deepening project would not detectably increase the existing shoreline erosion problem related to ship waves.

10.5 Reasonable and Prudent Measures to Minimize Impacts

10.5.1 Species Under the Authority of the U.S. Fish and Wildlife Service (FWS)

10.5.1.1 Bald Eagle

Prior to construction of the upland dredged material disposal areas, the Philadelphia District will coordinate with the USFWS and the NJDEP to determine if there are any bald eagle nests within 0.25 miles or a line of site distance of 0.5 miles from an upland dredged material disposal area. If there is an active nest within these distances, construction of the site and the use of the site for the disposal of dredged material will be staged to avoid disturbance impacts.

10.5.1.2 Peregrine Falcon

1. Coordination with the USFWS and the NJDEP before initiating any new work at the Raccoon Island upland dredged material disposal site between 15 March and 15 April.

2. The Philadelphia District will move the nest structure located at Egg Island Point to a safer location as determined in coordination with the NJDEP.

10.5.2 Species Under the Authority of the National Marine Fisheries Service (NMFS)

10.5.2.1 Sea Turtles

The Philadelphia District is concerned with the possible negative impacts that dredging may exert on threatened and endangered populations of sea turtles both in the Delaware Estuary and along the Atlantic Coast of New Jersey and Delaware. We also recognize the need to monitor activities which may present a genuine threat to species of concern. However, we are concerned that a monitoring program based on the investigations and observations within the South Atlantic shipping channels, may not be the most reasonable approach to conserving sea turtles in the Philadelphia District.

It is the intention of the Philadelphia District to continue monitoring in soft-bottomed shipping channels such as the Delaware Estuary, when warranted. Sea turtle observer(s) shall be on board any hopper dredge working in areas of concern during the first week of the dredging operation from 1 June to 15 November. Following the first week, the observer shall be on board the dredge on a biweekly basis or as appropriate so that the total aggregate time on board the dredge equals 50 percent of the total time of the dredging operation. While on board the dredge the observer shall provide the required inspection coverage on a rotating, six hours on and six hours off, basis. In addition, these rotating six hour periods should vary from week to week. All such dredging and monitoring will be conducted in a manner consistent with the Incidental Take Statement issues by NMFS for this District. It is also the District's opinion that any program implemented for observation or protection of sea turtles should remain somewhat flexible pending results of such procedures. The District will continue to coordinate monitoring results with NMFS, and work to develop appropriate measures to minimize impacts.

10.5.2.2 Whales

Due to the slow nature of Right whales it is the District's intention to slow down dredging vessels to 3 - 5 mph operating speed after sun set or when visibility is low when a Right whale is known to be in the project area. Contract plans and specifications will require the hopper dredge operator to monitor and record the presence of any whale within the project vicinity.

10.5.2.3 Shortnose Sturgeon

The Philadelphia District will continue to follow the recommended dredging windows established by the Delaware Basin Fish and Wildlife Management Cooperative:

> Hydraulic dredging, is prohibited from the Delaware Memorial Bridge to the Kinkora Range in non-Federal areas between April 15th and June 21st. No hydraulic dredging restrictions exist for the Federal channel or anchorages.
>
> Bucket dredging, overboard disposal, and blasting are prohibited from the Delaware Memorial Bridge to the Betsy Ross bridge in all areas between March 15th and May 31st. From the Delaware Memorial Bridge to Trenton overboard

disposal and blasting are prohibited, but bucket dredging is permitted between June 1st and November 30th.

10.5.2.4 Incidental Take Statement

Section 7(b)(4) of the Endangered Species Act requires that, when a proposed agency action is found to be consistent with section 7(a)(2) of the act and the proposed action may incidentally take individuals of listed species, NMFS must issue a statement that specifies the impact of any incidental taking of endangered or threatened species. Only incidental takings caused by activities approved by the agency, that are identified in the Biological Opinion and that comply with the specified reasonable and prudent alternatives, and terms and conditions, are exempt from the takings prohibition of section 9(a), pursuant to section 7(o) of the ESA.

For projects within the Philadelphia District, the anticipated incidental take by injury or mortality is as follows:

three (3) shortnose sturgeon; and

four (4) loggerhead, or one (1) Kemp's ridley or green sea turtle.

No takes resulting in injury or mortality of endangered marine mammals are expected; therefore, no incidental take for marine mammals is authorized. Consultation must be reinitiated if the take level for any one species is exceeded.

10.5.3 State Listed Species of Concern

10.5.3.1 Osprey

The construction and operation of the Raccoon Island dredged material disposal area may disturb ospreys that are nesting nearby. The Philadelphia District has been in contact with the NJDEP to find ways to avoid and/or minimize impacts. Ospreys are most vulnerable to disturbance during nest initiation and incubation which occurs between March 20 and May 31 (Clark. 1995). Construction activities and operating vessels near the nest site will be avoided during this period. Activities such as berm construction may be possible during this period if the activities take place strictly on land, and construction vehicles are sufficiently hidden and/or their sound muted relative to the osprey's location. The District will coordinate closely with the NJDEP to follow these guidelines as much as is practicable.

11.0 Cultural Resources

11.1 Prehistoric and Historic Settlement in the Delaware Valley

The following narrative is reprinted from Section 4.4 of the 1992 Final Environmental Impact Statement. A more detailed discussion of the historical settlement of the Delaware Valley and the types of cultural resources that may be found in the project area is provided in the cultural resources investigation reports prepared by Cox (1995) and Cox & Hunter (1995). These reports are on file at the Philadelphia District office.

11.1.1 Paleogeography of the Delaware Valley and Estuary

Of the many geological processes affecting a system as complex as the Delaware Estuary, the present form of the estuary is largely the result of two principal events, one occurring over a hundred million years ago and the second occurring during the last twenty thousand years. The first event was the creation of the Fall Zone during the uplift of the Appalachian Mountains. This zone, which generally extends from Baltimore through Newark, Delaware, Philadelphia, and Trenton to New York City, marks the transition between the harder rocks of the Piedmont uplands and the softer sediments of the lower-lying coastal plain. The differences in elevation, stream gradient, and underlying rock structure between the two areas mean that the Fall Zone also represents changes in stream flow pattern and sediment deposition within the Delaware estuary. Not only does it represent the break between tidal and nontidal waters, the rapids coming off the highlands means it also marks the landward limit of ship travel. (Interestingly, many colonial cities were built along the Fall Zone).

The second factor creating the present topography of the Delaware estuary was the dramatic change that took place at the end of the Ice Ages. Circa 15,000 years ago, with so much water locked up in glacial ice, sea level would have been over four hundred feet lower, and the mouth of the Delaware estuary 75 miles farther to the east, than at present. As the ice melted and the glaciers retreated, massive amounts of debris were washed downstream to the Fall Zone and then out over the coastal plains of New Jersey and the Delmarva Peninsula. By 10,000 years ago, the estuary mouth had moved inland to some 10-40 miles offshore, and sea level was rising at a rate of up to 6 feet every 100 years. As the climate continued to ameliorate, the ecology of the Delaware Valley began changing from a glacial environment of tundra and boreal forests to a more transitional environment of mixed forests and grasslands. It was sometime during this period that humans first entered the Delaware Valley. With the continued rise in sea level, the Delaware River and Bay eventually evolved from a freshwater glacial stream to the present drowned estuary system.

11.1.2 Prehistoric Peoples in the Delaware Valley

The archaeological record of the occupation of the Delaware Valley by prehistoric peoples, well summarized by Custer (1984), is consistent with the generalized patterns of cultural development for the Middle Atlantic states. Three major prehistoric periods are recognized: Paleoindian (15,000 years Before Present, or B.P., to 8,500 B.P.), Archaic (8,500 B.P. - 5,000 B.P.), and Woodland (5,000 B.P. - 400 B.P.). The first peoples into the Delaware Valley would have been Paleoindian hunter gatherers. Apart from the Zierdt (Werner 1964) and Shawnee-Minisink (McNett et al., 1977) sites, few Paleoindian period sites have been found in the Delaware Valley, especially in the lower portion of the valley covered by the Philadelphia to the sea project. This low density of sites is partly the result of the low population density and nomadic lifestyle of the peoples from this period, but it is also attributable to the subsequent inundation of many sites by the rising water level in the Delaware Bay during the past 10,000 years, and the burial of sites under thick layers of alluvium and later cultural deposits. Archaic period peoples responded to the changed environmental conditions of the post-Pleistocene by exploiting a greater variety of resources. The archaeological record from this period suggests an increased population size, a greater reliance on processing of plant foods, and exploitation of the newly available estuarine resources of the Delaware River. The relative abundance of sites from this period has led to the definition of the Delaware Valley Archaic complex (Kinsey 1972). Sites are known for the Upper Delaware, but the lack of information from the lower Delaware and Bay area reflects site inundation through sea level rise and the destruction of sites through flooding.

The prehistoric period that is best represented in the Delaware Valley is the Woodland period, which is characterized by the introduction of pottery, increasing cultural diversity, and the evolution of a sedentary lifestyle that increasingly relied on agriculture. Sites from the Woodland period are typically found in estuarine settings, including coastal marshes and brackish rivers. Several National Register listed prehistoric sites have been found in the Delaware River and Bay area within one mile of shore. By the 1600's the Delaware Basin had been settled by the Lenape Indians, one of the tribes of Algonquin Indians.

11.1.3 Historic Settlement of the Delaware Valley

The first recorded European exploration of the Delaware Bay was by Henry Hudson in 1609, under commission from the Dutch East India Company to seek a northwest passage to China and Japan. The following year the area was visited by an English captain in search of food for the settlement of Jamestown, who named the region in honor of the governor of the Virginia colony, the Baron DeLaWarr. The Dutch were the first Europeans to exploit the rich resources of the Delaware Valley and the first to settle in the area. They quickly set up a fur-trading network with the Indians along the Delaware River, and built outposts, such as Fort Nassau (1623), near present-day Gloucester Point, New Jersey, to support the trade network. In 1630, they also established a short-lived whaling colony named Zwaanendael, near present-day Lewes, Delaware. The Swedes put an end to the Dutch monopoly of the region in 1638 by building Fort Christina, near present-day Wilmington, Delaware. By the 1640's both the Dutch and the Swedes had established outposts as far upriver as Trenton, and battled each other for supremacy in the Delaware Valley. In 1651, the Dutch relocated their headquarters from Fort Nassau to Fort Casimir (now New Castle, Delaware), and founded the town of New Amstel adjacent to it. As the capital of the Dutch colony along the Delaware, New Amstel quickly grew into a thriving trade center. In 1654, the Dutch captured all Swedish posts, only to be conquered by armed British fleets in the 1660's during the Anglo-Dutch wars.

With the Treaty of Westminster in 1674, the British gained control of all Dutch North American colonies, including Delaware Bay. The lack of detailed mapping of the lands around the bay led to ambiguities in the royal grants for these lands, which resulted in long-running disputes over the ownership of lands along the western side of the bay. These disputes were not finally resolved until the eighteenth century, with the creation of the Mason-Dixon line (Heite 1988). By the latter part of the seventeenth century, the typical landholding pattern along the shores of the Delaware consisted of long narrow tracts of land, each fronting along the river. In 1675, John Fenwick, one of the proprietors of western New Jersey, established a settlement at Salem, which quickly became the center of government along the eastern banks of the Delaware. In 1682 William Penn obtained his royal charter for the colony of Pennsylvania, which included a portion of the west bank of the Delaware. With the establishment of Philadelphia as the colony's capital, the political and commercial focus of the western side of the Delaware shifted northward from New Amstel (renamed New Castle under English dominion) to Philadelphia. By 1700, Philadelphia had a population of more than 20,000.

During the ensuing decades, Philadelphia flourished not only as the commercial center in the Delaware Basin, but also as the principal port city on the Atlantic coast, and the center of trade with England. Philadelphia was doubly blessed by its location: the Delaware River and its tributaries provided easy transportation of goods into and out of the city, and the good soils and favorable climate of the region allowed grain, especially wheat, to become the principal export. Grain farming began the process of massive landscape alteration that continued over the next two centuries. Cutting the forests and plowing the soil to create farmland increased soil runoff and increased the silt load carried to the Delaware River and its tributaries. Processing the increasing quantity of grain being produced led to the development of mills to convert the grain into flour. While the earliest mills were tidally driven, eventually nearly every stream in the basin had been dammed to power a grist mill (Heite 1988). Towns and roads to support agriculture and trading appeared throughout the Delaware estuary, and by the time of the Revolution, the region was flourishing.

The more than one hundred years of English dominion came to an end with the Revolutionary War. Although the British captured Philadelphia in September, 1777, the colonists retained control of the Delaware River and effectively cut off the British from the only supply route available to them. In an effort to gain control of that supply route, the British launched a large fleet of naval warships to defeat the colonial forces controlling the river. Maps prepared at that time document the locations of the defensive structures used by the colonists to defend the river, including three forts and two tiers of submerged river obstructions, known as chevaux-de-frise, along with a fleet of 57 vessels. Several naval engagements between the British and the revolutionary forces took place along the Delaware River south of Philadelphia; more than 44 vessels were lost (Cox 1984).

As the new country entered the nineteenth century, new commercial activities developed in the Delaware Valley. In the upper estuary, the vast pine and hemlock forests supported thriving timber and tannery enterprises, which in turn necessitated more efficient means of transportation. Initially it was possible to simply raft items down the Upper Delaware. However, with the discovery of the rich mineral deposits in the region - coal, sand, clay, limestone, copper, and iron - a more reliable and economical method of transportation was required. There followed a series of transportation developments, all of which had their origin and/or florescence in the Delaware Valley region, beginning with turnpike construction, followed by the canal building era, and culminating with the appearance of the railroads.

By the mid-nineteenth century, the upper Delaware estuary was industrialized and experiencing rapid population growth. The Delaware Bay, however, with its tidal marshes and minimally navigable rivers, was not as well suited to industrial development, but rather remained principally tied to agriculture (Heite 1988) (This distinction between the lower and upper estuaries of the Delaware remains valid today.) The one commercial activity that was common to both the upper and lower estuaries was fishing, an activity that had flourished in the Delaware Basin since humans first settled in the region. Oysters, sturgeon, herring, and shad were abundant in the estuary and supported a thriving fishing industry into the twentieth century, and even up to the present, although at reduced levels.

By the late nineteenth century, industrial development in the Delaware Valley was in full swing. The development of the steam engine brought new industries to the region, ones that were no longer linked directly to the estuary, except as a transportation corridor (Heite 1988). Steam-powered railroad engines and cars were produced in Philadelphia and Wilmington; the canning industry thrived in Camden and Dover; and steamships were built in Philadelphia and Wilmington. With the invention of the Bessemer process of steel making, steel mills grew into massive industrial complexes at Bethlehem, New Castle, and Trenton. Finally, the success of the DuPont chemical company along the Brandywine River, and the discovery of oil led to a massive chemical and oil refining industry in the Delaware Valley.

11.1.4 Shipping and Shipbuilding

One Delaware Valley industry that deserves special mention is shipbuilding. Shipbuilding has been one of the most important and most famous industries of the Delaware Valley for more than three centuries. By 1700, at least four commercial shipyards were operating in Philadelphia (Cox 1988). Shipyards sprang up all along the Delaware River, and by the Revolutionary War, Philadelphia had eclipsed Boston as the shipbuilding capital of the colonies. John Fitch successfully operated the world's first steamboat along the Delaware River shoreline during the 1780's. By the nineteenth century, the shipyards of the Delaware Valley were the country's leaders in the production of iron-hulled steamships. Naval vessels for the Revolutionary War and Civil War were constructed at Delaware River shipyards. In 1900, the New York Shipbuilding Company began constructing the world's largest self-contained shipbuilding plant in south Camden. With the onset of World War I, the Philadelphia Navy Yard was expanded to become the largest navy yard with the largest drydock in the world. To help with the war effort, the American Shipbuilding Company converted Hog Island, in south Philadelphia, into the site of the largest shipbuilding plant in the world. Shipbuilding in the Delaware Valley is presently at the lowest level it has been since 1700.

Shipbuilding originally started along the Delaware River to enhance trade, which in turn increased settlement throughout the Delaware Valley. Because the Delaware River/Bay is situated roughly halfway between New York Bay and the mouth of the Chesapeake Bay, and provides the only break in a dangerous 295 mile stretch of the Atlantic coast, it was a natural site for port development.

By the colonial period, Delaware Valley port cities were engaged in trade with other colonies, Europe, and the Caribbean. Maritime commerce to and from the port cities along the Delaware River played a major role in the economic development of the entire Delaware Valley, and eventually led to Philadelphia's emergence as the lead port city on the river. In the early 1700's, Philadelphia ranked third behind Boston and New York in the volume of shipping clearing the port, and by the start of the Revolutionary War Philadelphia had surpassed both cities to become the most active port in North America. With the advent of steamships in the nineteenth century, passenger service became a major port activity.

11.1.5 Navigational Hazards and Improvements

The volume of shipping in the Delaware estuary over the last three centuries, in combination with the navigational hazards in the waterway, inevitably led to shipwrecks. Although the total number of wrecks will never be known, more than 145 documented shipwrecks have occurred in the Delaware River/Bay (Cox 1984). That there were hazards to be overcome in safely navigating the bay and river was soon learned by the early explorers. Soundings of the Delaware estuary, undertaken by the mid seventeenth century, enabled mariners to avoid at least some of the hazards, but better mapping was needed. Although Augustine Herrman, the person to first propose a canal to connect the Delaware and Chesapeake Bays, produced the first reliable map of the Delaware Estuary shoreline in the mid seventeenth century (Heite 1988), the first comprehensive navigational chart, with bottom contours, was not made until 1756 (Cox 1988).

By 1766, a single governmental body, the Wardens of the Port of Philadelphia, was established to direct channel and harbor improvements (GAI 1983). One of their first activities was to authorize the removal of the chevaux-de-frise, submerged wooden frames used by the colonists to defend the river during the Revolutionary War. Most had been removed by 1784, but during channel dredging in the 1940's dredges are reported to have struck one or more of the frames (Cox 1988). One of the earliest improvements to navigation on the Delaware was the 1803 construction of ice piers off New Castle, Delaware. Until the middle of the nineteenth century, the Delaware River froze over almost every winter, and the resulting ice floes posed a serious threat to ships. The ice piers served as refuge for sailing vessels and helped to break up ice floes as they came down the river (Cox 1988). Other early navigational improvements included the stabilization of river banks, the diking and in-filling of low-lying areas, and the removal of islands (GAI 1983).

However, the major navigation hazard in the Delaware River has always been shoaled waters (Cox 1988). Dredging the river to remove shoals and maintain a navigable channel has been ongoing since 1800. At that time limited, man-powered dredging was possible; by the 1840's, steam dredge boats were used to maintain channels and to build harbors (GAI 1983). Currently there are eighteen major shoals or sand bars near the main channel of the Delaware River. Historically, mariners were required to navigate through these shoals in a winding channel. To monitor the locations of shoals and to facilitate safe navigation, the National Ocean Survey and its predecessor has conducted regular hydrographic surveys of the Delaware River and Bay, since at least 1840.

In its natural state, the Delaware River downstream of Philadelphia had a natural depth of 20 feet (deeper in some places) and a controlling depth of approximately 17 feet (Boggs 1929). By the last quarter of the nineteenth century, the typical ocean-going vessel had a draft of 20-24 feet, and could no longer safely negotiate past all the obstructions except at high tide. From 1877 to 1882, several of the major natural obstructions, large portions of the rock shoals between Chester and Marcus Hook and the shoals near Petty Island and Fort Mifflin, were removed. But it was not enough to permit safe passage of deep-draft ships. Finally, in 1885, Congress authorized the permanent and systematic improvement of the Delaware River, and gave the Army Corps of Engineers the responsibility of dredging and maintaining the channel, anchorages, dikes and harbors. The 1885 legislation called for a channel 26 feet deep and 600 feet wide from Philadelphia to deep water in Delaware Bay. The transition from sail to steam power rendered the 26 foot deep channel obsolete and led Congress in 1896 to authorize an increase in channel depth to 30 feet. The existing Delaware River, Philadelphia to the Sea Federal channel project was initially authorized by the Rivers and Harbors Act of 1910 and has been modified several times to its presently authorized forty foot depth.

11.1.6 Fort Delaware, Pea Patch Island

The following brief discussion on the history of Fort Delaware and Pea Patch Island is summarized from Catts, Coleman and Custer (1983). During the early 19th century, Pea Patch Island was an unstable land surface located in the middle of the Delaware River and flooded daily during high tide. However, its strategic position made it an ideal location for a major defensive fortification for the protection of Wilmington, Philadelphia, and the Delaware entrance to the C & D Canal. Construction of fortifications began with the building of an embankment and drainage ditches in 1813-1814 to create a land surface stable enough to be inhabited throughout the tidal cycle. The area enclosed by the embankment initially contained approximately 70 acres and was later expanded to 80 acres.

The real work of fortifying the island began 1815 when construction of a masonry pentagonal-shaped fort was approved. Placement of foundation pilings and grillage was completed in 1819. Many difficulties delayed construction, including wash-outs at high tide, failing foundations and sickness. Construction of the fort was far enough advanced in the fall of 1824 to allow a garrison, one company (52 men) of the 2nd Regiment of Artillery, to take quarters there. Repairs of cracked and settling walls and construction of the barracks and officers quarters continued until 1927, when the fort was finally completed. With its completion, Fort Delaware became the primary defense of the Delaware River. Its armament consisted of 234 guns, 10 howitzers, and 28 carronades. The fort's peace time garrison was never more than 100 men. Garrison duty at Fort

Delaware was anything but pleasant. The troops had to contend with storms, flooding, disease, and boredom. Members of the garrison were constantly employed in repairing the existing embankment walls or construction of new ones.

The new fort didn't last long. In 1831 a fire completely gutted the structure and a subsequent inspection found it to be irreparable. It was decided that a larger fort, based on a new design and supported by stronger foundations, would be built. Between 1834 and 1838, the walls of "old Fort Delaware" were completely torn down and the material placed on the exterior slope of the embankment. Unfortunately, construction of the new fort was soon halted over a lawsuit concerning ownership of the land. This delay lasted for 10 years until the suit was finally settled in 1848.

The construction of the new fort was essentially completed in 1860, creating the largest masonry fort in the United States. In April, 1862, the federal government decided to use Fort Delaware as a prisoner-of-war camp for captured Confederates. The first prisoners to arrive were 250 Virginians captured at Kernstown. Soon after, temporary prison barracks were constructed to accommodate over 2,000 prisoners. By the end of June, 1863, barracks for 10,000 prisoners had been erected outside of the fort. Besides the barracks, the prisoners had the use of a kitchen and bakery, sutler's shop, "sinks" or latrines, and a hospital. The hospital was actually two distinct buildings; a general hospital and a contagious hospital. Both were completed late in the summer of 1863 just in time to receive the tremendous influx of prisoners recently taken at Gettysburg and Vicksburg. By 1865, the majority of the 49 structures located outside of the fort walls supported the prison camp. On the whole, living conditions for both the garrison and the prisoners were poor. Diseases such as smallpox, typhoid fever, scurvy, malaria, and chronic diarrhea were common and prevalent. The end of the war came in April, 1865, and by August, Fort Delaware had been vacated as a Confederate prisoner-of war camp.

By 1870, Fort Delaware, although no more than 10 years old, was considered obsolete. The garrison was withdrawn and the post turned over to the Corps of Engineers. By 1880, the fort was beginning to suffer from neglect and a lack of funds. In 1884 the Wilmington newspaper reported that the population of the island was 20 people (6 families), with half living inside the fort.

Based on the findings of the Endicott Board, a Congressional committee formed in 1890 to survey the condition of coastal defenses in the United States, the decision was made to modernized Fort Delaware again. This new work began in 1894, which included a massive two-story concrete emplacement for 12-inch guns built inside the fort. Within the walls of the new "Endicott" section, there was space for barricks, gun rooms, radio rooms, fire control rooms, ammunition rooms, and a power house for the engines. By 1900 the majority of the construction was completed and Fort Delaware was now part of a coastal defense system, linking Forts Dupont and Mott, and further down the river, Fort Salisbury.

By the fall of 1901, the Corps of Engineers had turned over the fort to the Artillery for administration and garrison duty. Early in 1904 the Artillery detachment was withdrawn, and once again the island was turned over to the Corps. It was quickly decided to use the island for disposal of dredged material, which was obtained from the new 30 foot channel being built in the Delaware River, in an attempt to protect the island and its new modernized fort from consistant flooding. The island embankment was raised 3 to 5 feet in preparation for filling, as well as selected structures outside the fort. Deposition continued on the island until 1908, when an estimated 2 million cubic yards of fill had been pumped onto the island.

From the First World War to the beginning of the Second World War, Fort Delaware was viewed as an outpost of Fort Dupont. A small detachment of solders from Fort Dupont were stationed there to warn off trespassers, paint mines and other equipment, and to care for the modern guns. Throughout the 1930's, the 621 Coast Artillery Battalion, U.S. Army Reserves, held annual encampments at the fort. Following World War II, Fort Delaware and Pea Patch Island were declared surplus to Army needs and all of the island, except a small 18 acre tract adjacent to the navigation channel on the eastern side, was turned over to the State of Delaware for civilian use. From that time until 1951, when the state turned the island over to the State Park Commission to maintain it, the fort suffered greatly at the hands of vandals and treasure hunters. Much of the damages caused in those brief years is to some extent still being repaired today. Fort Delaware is listed on the National Register of Historic Places.

Failure of the embankment along the southeastern portion of the island in the 1970's initiated severe erosion along the shoreline that continues to the present. This erosion has exposed, and continues to expose, archaeological material and foundations related to the historic military occupation of the fort. In cooperation with Delaware State Parks, the Corps retrieved eight wooden gun carriages from this eroding shoreline in 1991 and completed their conservation under a contract with the State of Delaware in the Spring of 1997. Philadelphia District is working closely with Delaware State Parks and their contractor, S.T. Hudson Engineers, Inc., to review plans and specifications for the placement of shoreline protection and to secure funding for this work under the existing federal project.

11.2 Cultural Resources Investigations

In order to fulfill our responsibilities under the National Historic Preservation Act of 1966, as amended, the Philadelphia District has conducted several cultural resources investigations to locate significant cultural resources in the project area and to assess potential project impacts on those resources. Beginning in the late 1970's, a cultural resources overview and sensitivity analysis for the Delaware River and Bay from Philadelphia to the sea was prepared in a report entitled "Cultural Resources Overview and Sensitivity Analysis for the Delaware River and Shoreline" (Gilbert/Commonwealth 1979). This study was designed to collect cultural resources data to assist in the preliminary development of a regional dredged material disposal plan for the tidal portions of the waterway. The study identified 162 historic sites and districts within one mile of the Delaware River and Bay area shoreline from Trenton, New Jersey to Lewes, Delaware. The sensitivity analysis was inconclusive regarding the deposition of resources in the main shipping channel. No fieldwork was undertaken. In a follow-up investigation entitled "Delaware River Comprehensive Navigation Study (interim): Cultural Resources Sensitivity Reconnaissance" (GAI Consultants Inc. 1983), researchers assessed the potential for significant cultural resources within several proposed dredging and disposal sites between Wilmington and north of Philadelphia. This study added 30 new historic sites to the 1979 inventory and concluded that "previously dredged deep channels and anchorages have virtually no potential for containing significant cultural remains".

In "Fort Elfsborg 1643: A Background Study of the History of Elsinboro Point or Fort Elfsborg, Elsinboro Township, Salem County, New Jersey and New Castle County, Delaware" (Heite & Heite 1986), the authors attempted to map the location of Fort Elfsborg and concluded that the most likely location was off Elsinboro Point between the high water mark and the main shipping channel. A "Sensitivity Level Investigation of Cultural Resources in the Vicinity of the Main Navigational Channel, Delaware River, Wilmington to the Sea, and a Proposed Deepwater Port" (Cox 1986) assigned cultural resource sensitivity designations of high, medium, or low to three segments of the waterway from Wilmington to the Atlantic Ocean, to facilitate plans for deepening or widening the existing navigation channel and anchorages, and creating a deepwater port. In a continuing effort to identify potential dredged material disposal areas, the Philadelphia District conducted fieldwork in New Jersey and Delaware to assess the cultural resource potential at proposed disposal areas along the Delaware River in 1985. The report of this study is entitled "Preliminary Cultural Resource Reconnaissance Investigation of Thirteen Disposal Areas" (Heite and Heite 1986a).

A remote sensing survey was first conducted in selected project areas in 1987. The results of this work is described in a report entitled "Submerged Cultural Resources Investigations, Delaware River Main Navigational Channel, Philadelphia, PA to Artificial Island, NJ" (Cox 1988). Researchers utilized magnetometer and side-scan sonar to investigate fourteen channel bend-widening locations. Sixty-six remote sensing targets were identified, of which 6 exhibited strong submerged cultural resources characteristics.

In the following study, entitled "Submerged Cultural Resources Investigations, Delaware River Main Channel Deepening Project, Delaware, New Jersey and Pennsylvania" (Cox 1995), underwater archaeologists conducted ground truthing operations at high probability targets first identified in 1987 (Cox 1988). Two of these submerged targets were determined potentially eligible for listing in the National Register of Historic Places. The first target, E-1, 1:5, was tentatively identified as a rock filled timber crib associated with Revolutionary War period construction. The second target, E-2, 4:16, was identified as the remains of the wood-hulled, side-paddle steamboat "Excelsior" (both of these underwater sites were re-visited in 1994 during the Phase I & II investigation referenced below [Cox & Hunter 1995]). Additional remote sensing surveys were also conducted in project areas not previously investigated for cultural resources. An intense remote sensing survey utilizing magnetometer, side-scan sonar, sub-bottom profile and bathymetric data was conducted in forty-eight separate project locations extending over eighty linear miles. Survey locations were first identified in an analysis presented by Jan Ferguson, District Archaeologist, in the 1992 FEIS, Section 5.1.12, and was later refined by utilizing up-to-date channel depth information and maintenance dredging records. The primary goal of the analysis was to identify all previously undredged project areas that would be impacted by project construction (see Section 11.3.2, below, for a reprint of Ferguson's analysis). The project areas surveyed during this study include, 1) three channel bend widening locations at Liston-Cross Ledge, Cross Ledge-Miah Maull and Miah Maull-Brandywine intersections (all other bend widening locations were previously surveyed by Cox in 1987), 2) thirty-five nautical miles of channel side-slope areas, and 3) 2,200 acres of channel deepening locations. The remote sensing survey identified 154 magnetic and acoustic anomalies and recommended additional Phase II investigation at 11 of these targets (see Figure 11-1).

The final study, prepared in a draft report entitled "Submerged and Shoreline Cultural Resources Investigations, Disposal Areas and Selected Target Locations, Delaware River Main Channel Deepening Project, Delaware, New Jersey & Pennsylvania" (Cox & Hunter 1995), conducted multi-purpose research that included a remote sensing survey of potential underwater disposal areas, low-tide shoreline survey, underwater inspection of 11 previously documented and 2 newly discovered remote sensing targets, and detailed Phase II level recording of two previously identified targets. Target E-1, 1:5 was initially identified as a rock filled timber crib associated with Revolutionary War period construction (Cox 1995). Phase II investigations re-identified the site as a largely intact sectional canal coal barge dating from the period circa 1830-60 and of a type widely used on the Lehigh Canal and Delaware Canal navigation systems. The barge is still filled with large pieces of hand broken coal which indicates the vessel may have sunk in the 1830s or 1840s. The other target, E-2, 4:16, is the remains of the side paddle-wheel steamer "Excelsior", which was built in Wilmington in 1880 and operated in the Mid-Atlantic region until it burned and sank in 1892. Shoreline structural remains of two lighthouse sites and oyster harvesting related facilities were identified in wetland restoration study areas in New Jersey and Delaware. The results of this investigation, and the others discussed above, are presented in greater detail, as appropriate, in the Environmental Effects Section 11.3, below. All referenced reports are on file at the Philadelphia District office.

11.3 Impacts on Cultural Resources

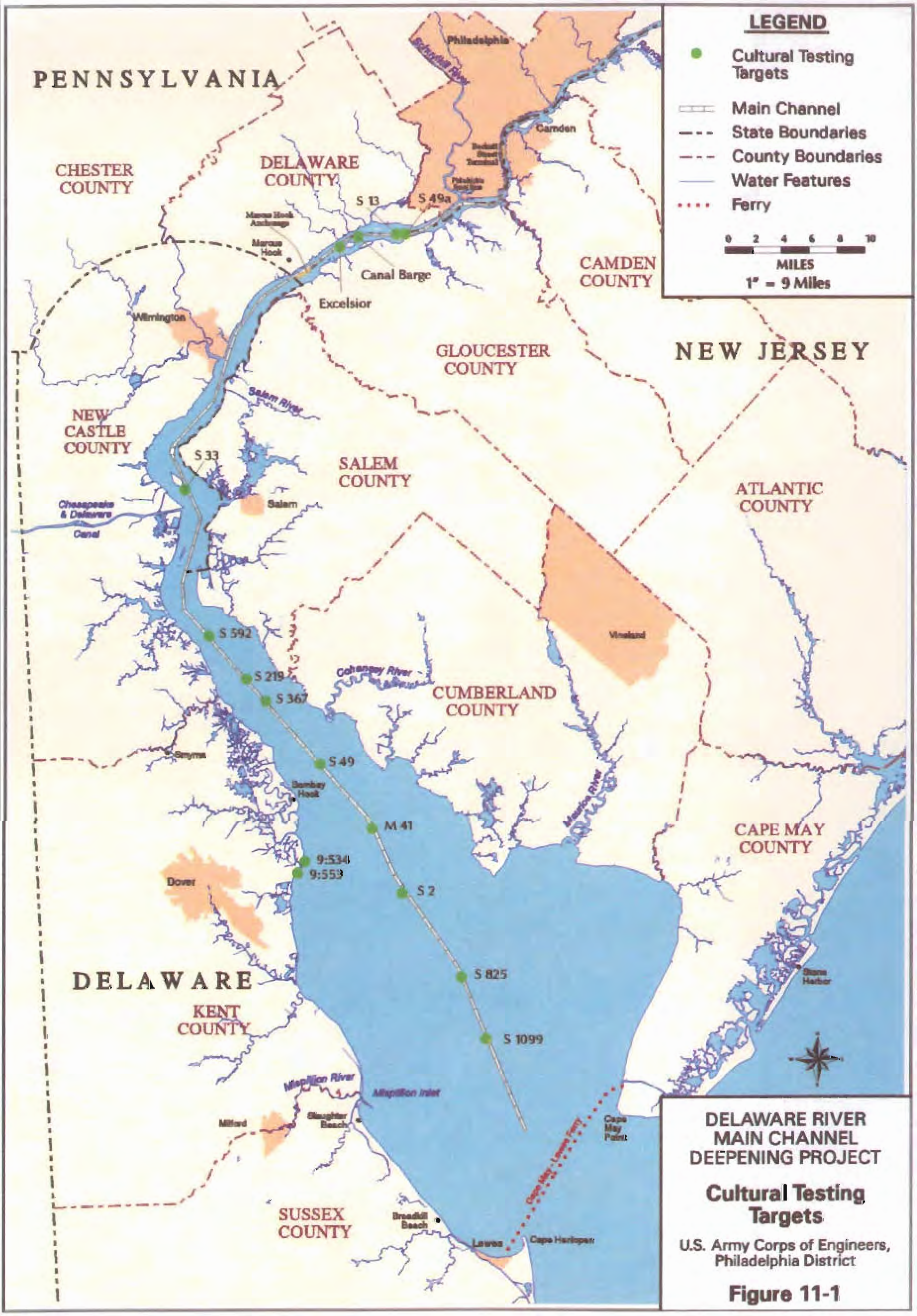
11.3.1 Project Impact Areas for Cultural Resource Review

Proposed project construction has the potential to impact cultural resources in seven areas. These are 1) channel bend widening areas, 2) channel bottom and side-slope locations, 3) one anchorage site, 4)upland dredged material disposal locations, and beneficial use sites including 5) wetland restoration areas and 6) submerged dredged material stockpile locations, and 7) selected shoreline areas. In channel, channel-bend and anchorage areas, potential impacts to historic properties could result from the dredging of bottom sediments. Reactivation, expansion and continued use of existing upland dredged material disposal sites, and the creation of new beneficial use sites and submerged stockpile locations could potentially impact cultural resources during construction and dredged material placement. Higher ship generated waves resulting from deeper draft vessels could increase shoreline erosion of historic archaeological deposits.

11.3.2 Impacts to Cultural Resources

The following revised discussion on potential project impacts to cultural resources is taken largely from the 1992 FEIS (Section 5.1.12). While prehistoric and historic utilization of the Delaware River and Bay has been both extensive and intensive, it is anticipated that dredging the Federal navigation channel has the potential to impact three categories of cultural resources. First, there could be impacts to objects that were placed in the river either as an aid to navigation (e.g., dikes, fixed buoys) or as a hindrance to navigation (e.g., the chevaux-de-frise of the Revolutionary War). Second, channel modification could affect shipwrecks, and third, channel deepening could potentially increase shoreline erosion and destroy significant historic archaeological resources along the southeastern shoreline of Pea Patch Island.

Before examining in detail the potential for effects on these categories of resources, it is necessary to briefly consider why impacts from dredging are not expected for other categories of cultural resources. While many of the shoreline sites utilized by prehistoric peoples would have been inundated by sea level


LEGEND
Cultural Testing Targets
Main Channel
State Boundaries
County Boundaries
Water Features
Ferry
0 2 4 6 8 10
MILES
1" = 9 Miles
PENNSYLVANIA
NEW JERSEY
DELAWARE
CHESTER COUNTY
DELAWARE COUNTY
CAMDEN COUNTY
GLOUCESTER COUNTY
NEW CASTLE COUNTY
SALEM COUNTY
ATLANTIC COUNTY
CUMBERLAND COUNTY
CAPE MAY COUNTY
KENT COUNTY
SUSSEX COUNTY
Philadelphia
Camden
Wilmington
Salem
Vineland
Dover
Milford
Lewes
Cape Henlopen
Smyrna
Bombay Hook
Slaughter Beach
Broadkill Beach
Cape May Point
Marcus Hook
Salem River
Cohansey River
Maurice River
Mispillion River
Mispillion Inlet
Schuylkill River
Chesapeake & Delaware Canal
Cape May - Lewes Ferry
S 13
S 49a
Canal Barge
Excelsior
S 33
S 592
S 219
S 367
S 49
M 41
9:534
9:553
S 2
S 825
S 1099
DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
Cultural Testing Targets
U.S. Army Corps of Engineers, Philadelphia District
Figure 11-1

rise, there are a number of reasons why those sites would not be located in the vicinity of the navigation channel. First, the deepest part of the river bed, which would not have been dry land during any of the time that the Delaware Estuary has been occupied by humans. Additionally, although sea level rise has submerged some of the earlier shoreline, landfilling activities along the river banks over the past three centuries of historic settlement have extended the shoreline out into the river along large stretches of the river (Cox 1984). Thus, many previously inundated prehistoric sites may have been destroyed through these activities or may now be buried under landfill. Similarly, many historic period cultural resources along the shoreline, such as piers, wharves, and bulkheads, may also have been destroyed by, or incorporated into, landfilling activities. Other historic period resources remain, but are located either along the present waterfront, or on or alongside the islands in the river, or in the back channels between the islands and the banks of the river. None of these areas will be affected by proposed dredging activities. Thus, there is virtually no likelihood that prehistoric sites or the remnants of any historic shoreline structures would be found in any of the areas proposed for dredging, including bend widening, channel deepening and anchorage deepening locations.

Potential impacts to submerged objects, namely shipwrecks and objects placed in the river to hinder or enhance navigation, were evaluated. Of the several kinds of objects that might have been placed in the river to enhance navigation, none would be expected to be in the channel. Objects such as dikes, ice piers, etc. would have been constructed perpendicular to, or adjacent to, the channel, but not within the channel. Therefore, while deepening the channel would not impact any of these structures, widening the channel, especially at the bends, could conceivably impact them. Similarly, deepening and widening the channel could impact objects that had been deliberately placed in the channel to hinder navigation. In the Delaware River, the most famous examples of such obstructions are the chevaux-de-frise, wooden frames that held upright timbers tipped with iron spikes, used during the Revolutionary War to defend Delaware River forts against British attack. Although most of the chevaux-de-frise were removed in the 1780's (Cox 1988), the Corps encountered remains of several of the frames near Fort Mifflin during the 1930's while dredging the channel down to 40 feet. Although it is possible that one or more of the chevaux-de-frise still remain in the navigation channel, the very nature of the placement of these obstructions (upright in the channel) makes it more than likely that past dredging episodes have removed significant portions of them. It is highly unlikely, therefore, that any intact chevaux-de-frise remain in the navigation channel. Nevertheless, it is possible that even fragments of a chevaux-de-frise could be considered potentially significant.

As discussed in the 1992 FEIS, Section 4.4, ships have traveled through the Delaware Estuary for the last three hundred years.

The Institute for Conservation Archaeology's 1979 landmark study of the potential for submerged cultural resources along the Atlantic coast continental shelf gave the area encompassing the Upper Delaware Bay extending into the Delaware River a "moderately heavy" rating for both known and predicted density of submerged cultural resources. The sheer volume of shipping and the natural hazards present in the Delaware River have resulted in at least 145 documented shipwrecks between Philadelphia and the sea (Cox 1984, Cox & Hunter 1995; Appendix A). The National Ocean Survey's Automated Wreck and Obstruction Information System lists 83 obstructions in that same stretch of the waterway, most of which are reputed to be shipwrecks (AWOIS listing, June 12, 1987). Many of these shipwrecks, if even partially intact, would be significant on the basis of age (rare late eighteenth and early nineteenth century vessels) and/or historical association (e.g., vessels sunk during the Revolutionary War).

In order to better assess the likelihood that implementing the proposed project would actually impact objects or shipwrecks in or adjacent to the navigation channel, it is necessary to briefly review both the sedimentology of the river bottom and the history of channel improvements in the Delaware River. Except for a few locations where there are rock outcrops, the bed of the Delaware River below Philadelphia is generally sand and gravel overlaid with mud and silt. These are predominantly Holocene sediments that are generally less than 30 feet thick; in places, bedrock is within ten feet of the channel bottom.

Rock outcroppings, generally manifested as ledge rock, are encountered near Chester and Marcus Hook, and in the upper portion of Philadelphia Harbor. Geologically, the Delaware River and Bay can be divided into an upper estuary and lower estuary, with the dividing line between the two located near Bowers Beach, Delaware and the Cohansey River in New Jersey. The upper estuary, especially that portion of it below Philadelphia, is a fairly simple tidal river, with a river bottom as described above. The stretch of the river between Marcus Hook, Pennsylvania and Artificial Island, New Jersey is a major depositional area within the estuary. The lower estuary, with its broad coastal marshes, sand beaches, deep estuarine flats of coarse bottom sediments, and numerous mid-bay shoals and channels, is more geologically diverse than the upper estuary (Kraft 1988). The coarse bottom sediments of the lower estuary are thought to have been brought in from upriver at a time of lower sea level, or to have resulted from wave erosion along the shoreline; the present river regimen very seldom moves sand or other coarse material downstream into the lower bay (Kraft 1988). The dominant topographic feature of the lower estuary is the large number of long shoals that point finger-like to the north and west. Tidal forces have created these shoals, many of which have deep troughs between them. While the location of these shoals and troughs was largely determined by stream erosion patterns of the late Pleistocene, the changes in tidal currents that have occurred as a result of sea level rise have led to changes in the shape of many of the shoals, a process that continues today (Kraft 1988). Both the presence of the shoals and their tendency to undergo modification have long affected navigation in the lower estuary.

The presence of shoals is also a problem in the upper estuary. In its original condition, the Delaware River below Philadelphia was obstructed by numerous bars and shoals which reduced the minimum usable depth to 17 feet at mean low water (House Document No. 733, 1910). Prior to the start of systematic improvement of the river in the 1880's, a ship sailing upriver to Philadelphia needed as much as four days to complete the trip if it had to wait for high tides to pass over the shoals (Boggs 1929). Many of the original shoals have been removed or at least reduced by channel dredging over the last century. Since the start of systematic improvements to the Delaware estuary, over one billion cubic yards of material have been removed. The dredging, combined with the construction of dikes and jetties, has altered the natural regimen of the river with respect to currents, depths, and tidal conditions. Present-day shoaling in the navigation channel is still partly a result of the net transport of sediment downstream, but it is also largely the result of the build up of areas where the ebb and flood flows of material do not take the same course, and a result of sediments sliding from the sides of the channel into the channel, which is causing a gradual lowering of the river bed for some distance on either side of the channel. To maintain the present 40-foot navigation channel, up to 5 million cubic yards are dredged annually.

Systematic improvements to the river began in 1885 and are summarized in Table 5-26 of the 1992 FEIS. It is clear from this table that there has been considerable disturbance to the river bottom over the last century, and in many areas, historic resources that might once have been present would long since have been removed or destroyed. Nevertheless, there are still portions of the river bed that have not been substantially altered and within which the potential for historic resources must be carefully evaluated. These areas include (1) the proposed bend widening areas at the intersections of ranges, which, although adjacent to the present channel, quite likely have not been dredged before, (2) undisturbed channel side-slope areas, and (3) naturally deep areas within the main channel that may have never been dredged or may have only been minimally dredged. It would not be surprising to find shipwrecks in undredged areas adjacent to the channel, such as the locations proposed for bend widening. Typically, a vessel that encounters disaster while navigating the river would be deposited just off the channel, either because a navigational error led the ship off course where it ran aground and was abandoned or because the stricken vessel was able to maneuver to the closest shallow water in an effort to save the crew and the boat (Cox 1986). Despite the significant amount of dredging that has taken place over the last century, there are still areas of the river and bay which are naturally deep, and which therefore may never have been dredged or may have been only minimally dredged. While surveys of the Delaware River has been conducted since the mid-nineteenth century, many of these early surveys contain insufficient data to accurately determine the depth at any particular location. Systematic dredging of the river began in 1885, with a navigation channel 26 feet deep by 600 feet wide completed in 1898. By 1909 the channel had been deepened to 30 feet, and subsequent deepenings through the 1960's have created the present 40 foot deep channel.

Current maintenance dredging practices for the Delaware River, known as advance maintenance dredging, require dredging deeper than 40 feet (in some cases as deep as 44 or 45 feet), to ensure a minimum 40 foot channel throughout the year. Since the entire channel is now at least 40 feet deep, that was used as the starting depth for researching naturally deep areas; any historic resource that sank in an area of less than 40 feet of water, even though it might have settled some into the river bottom deposits, would most likely not have settled more than a couple of feet, and therefore would have already been impacted, if not destroyed, by previous channel dredging. Dredging operations in 1948 cut through what is believed to have been two shipwrecks during deepening of the Mantua Creek anchorage to 37 feet (Cox 1988). Hydrographic surveys of the Delaware River conducted by the Corps in 1909, just after completion of dredging the 30 foot channel, show seven locations along the channel with depths of 40 feet or greater between Philadelphia Harbor and Bombay Hook Point (U.S. Congress, 1910).

By 1937, after completion of the 35 foot channel and the creation of four anchorage areas, hydrographic surveys show twenty-three areas with depths of at least 40 feet, including the original seven, between Philadelphia and Bombay Hook Point, plus additional deep areas from Bombay Hook point to the mouth of the bay (U.S. Congress 1938). Of the twenty-three deep areas north of Bombay Hook identified in the 1937 survey, only the original seven from the 1909 survey are of concern. Since the remaining deep areas did not show up in the 1909 detailed survey, they are most likely the result of the dredging work in the channel that took place between 1909 and 1937. It is also possible that some of these "new" areas were used as sources of borrow for the creation of disposal areas such as Artificial Island and Killcohook. Any resource that may have been present in these areas prior to their deepening would have been disturbed, if not completely destroyed, by dredging activities.

Therefore, that leaves for consideration the original seven locations with depth of at least 40 feet, plus those areas within the channel in Delaware Bay that were identified as having a depth of 40 feet or greater in the 1937 survey but which were beyond project limits, and therefore not covered, in the 1909 survey. Above Bombay Hook, the deep areas total a little less than nine miles, while in the bay deep areas may cover more than thirty seven miles in length. In addition, the Corps analyzed hydrographic surveys and old dredging records to determine whether any of these areas are deep as a result of pre-1909 work in the channel, and whether any area has been deepened through dredging work. It is known that considerable quantities of material have been removed from areas in the Delaware River channel and used as fill for the construction of landfill along the shore, and in major highway projects. For the deep areas in the bay, a detailed examination of hydrographic charts identified those areas that are deeper than 50-55 feet and which therefore are below any possible impact as a result of deepening the channel to 45 feet. The results of this analysis identified 62 channel areas that are within the zone of potential impact and which do appear to be naturally deep and not previously dredged. These areas include 17 bend widening areas, 33 channel side-slope locations, and 12 channel deepening sites.

The disposal of dredged material is planned for 13 existing upland dredged material disposal areas (these include 4 inactive and 9 active disposal sites), 2 submerged sand stockpile sites and 2 wetland restoration locations. Reactivation of old disposal areas requires new dike construction and dredged material placement. These activities have the potential to impact prehistoric and historic cultural resources. Each of these sites is located along the shore of the Delaware River at the confluence of tributaries. It is not surprising, therefore, that each site is found in an area rich in prehistoric and historic resources. Submerged sand stockpile locations and wetland restoration areas have the potential to contain cultural resources such as submerged and shoreline shipwreck sites, historic structural remains and archaeological deposits. Placement of dredged material and the excavation associated with berm construction during wetland restoration has the potential to impact surface material and buried archaeological deposits.

11.3.3 Channel Bend Widening Areas

In order to ascertain the presence/absence of potentially significant historic resources at the areas proposed for bend widening, three remote sensing investigations utilizing a combination of magnetometer, side-scan sonar, sub-bottom profiler and underwater diving operations were conducted at 17 range intersections (Cox 1988, Cox 1995, Cox and Hunter 1995). Of the 71 targets identified in bend widening locations, 7 were considered to be high probability targets exhibiting shipwreck characteristics (see Table 11-1). Underwater ground truthing operations were conducted in the summers of 1993 and 1994 on 6 of these targets to determine the nature, extent and potential National Register of Historic Places eligibility of each target (Cox 1995, Cox and Hunter 1995). The seventh high probability location, Target L1:15, was not investigated because of its location outside of the project area. The results of Phase I and Phase II studies found that two of these submerged sites, both in New Jersey waters, are eligible for listing in the National Register of Historic Places. The first target, E-1, 1:5, was tentatively identified as a rock filled timber crib associated with Revolutionary War period construction (Cox 1995). The site was revisited in 1994 during Phase II investigations and re-identified as an extremely rare and largely intact section of a sectional canal coal barge dating from the period circa 1830-60 (Cox & Hunter 1995). This type of vessel was widely used on the Lehigh Canal and Delaware Canal navigation systems. The barge is still filled with large pieces of hand broken coal, which indicates the vessel may have sunk in the 1830s or 1840s. The second site, E-2, 4:16, was identified as the remains of the wood-hulled, side-paddle steamboat "Excelsior" (Cox 1995, Cox and Hunter 1995). The "Excelsior" was built in Wilmington in 1880 and operated in the Mid-Atlantic region until it burned and sank in 1892.

The Philadelphia District concurs with the researchers findings and considers the "Coal Barge" Site (E-1, 1:5) and the "Excelsior" Site (E-2, 4:16) eligible for listing in the National Register of Historic Places. Detailed underwater mapping of both targets show that each vessel, and its associated debris field, is located just outside of the project area. However, because of their close proximity to the channel's edge, a 200 foot buffer around each site will be established and closely monitored during construction to ensure that both sites are not impacted.

The draft report of the 1993 fieldwork (Cox 1995), which included the results of ground truthing on the 5 targets first identified in 1987, was reviewed by the Pennsylvania, Delaware, and New Jersey State Historic Preservation Office's. Both Pennsylvania and Delaware SHPO's concurred with the reports findings and recommendations (see Pertinent Correspondence section of the Main Report; PASHPO letter dated July 20, 1994, DESHPO letter dated November 21, 1994). In a letter dated February 10, 1995, the NJSHPO also concurred with the report findings that the site of the steamboat "Excelsior" (E-2, 4:16) was eligible for listing in the National Register. Although not considered National Register eligible on the basis of information provided in the report, the NJSHPO recommended further study at Site E-1, 1:5, which was thought to be a timber crib related to Revolutionary War period construction.

Subsequent Phase II investigations conducted in 1994 re-identified Site E-1, 1:5 as a relatively intact mid-19th century sectional canal barge eligible for listing in the National Register and reconfirmed the significance of the "Excelsior" Site E-2, 4:16 (Cox & Hunter 1995). The draft report of this investigation and the District's finding of "No Effect" was submitted to the Pennsylvania, Delaware and New Jersey SHPO's for review and comment in the fall of 1995 (see Pertinent Correspondence section of the Main Report; letters dated September 28, October 6, and October 17, 1995).

Table 11-1. High Probability Remote Sensing Targets.						
Project Location	Target #	State	Phase 1 Remote	Phase 1 Diving	Phase 2 Diving	NR Eligibility
Channel Bend	A4:4	Pennsylvania	Cox 1988	Cox 1995		Not Eligible
Channel Bend	E-1, 1:5 (Coal Barge)	New Jersey	Cox 1988	Cox 1995	Cox & Hunter 1995	Eligible
Channel Bend	E-2, 4:16 (Excelsior)	New Jersey	Cox 1988	Cox 1995	Cox & Hunter 1995	Eligible
Channel Bend	L3:10	New Jersey	Cox 1988	Cox 1995		Not Eligible
Channel Bend	L1:15	New Jersey	Cox 1988	Not in Project		N/A
Channel Bend	I4:9	Delaware	Cox 1988	Cox 1995		Not Eligible
Channel Bend	M41	Delaware	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S13	Pennsylvania	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S49a	Pennsylvania	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S219	New Jersey	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S367	New Jersey	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S2	Delaware	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S49	Delaware	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S592	Delaware	Cox 1995	Cox & Hunter 1995		Not Eligible

Table 11-1. High Probability Remote Sensing Targets. (Continued)						
Channel & Side-Slope	S33	Delaware	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S1099	Delaware	Cox 1995	Cox & Hunter 1995		Not Eligible
Channel & Side-Slope	S825	Delaware	Cox 1995	Cox & Hunter 1995		Not Eligible
Beneficial Use Site	9:534	Delaware	Cox & Hunter 1995	Cox & Hunter 1995		Not Eligible
Beneficial Use Site	9:553	Delaware	Cox & Hunter 1995	Cox & Hunter 1995		Not Eligible

11.3.4 Channel Deepening and Side-Slope Areas

Thirty-three channel side-slope areas totaling 35 nautical miles and 12 channel deepening locations totaling 2,200 acres were surveyed for submerged cultural resources in 1993 (Cox 1995). No significant cultural resources were located in channel deepening or channel side-slope areas. Analysis of remote sensing data identified 149 magnetic and/or acoustic targets within these locations. Ten of these sites were recommended for further investigation as high probability targets (see Table 11-1). Underwater archaeologists investigated these 10 targets in 1994 and determined that 9 targets exhibited modern debris not considered historically significant (Cox and Hunter 1995). The tenth location, Target M 41, exhibited several modern iron I-beams associated with a large buried ferrous object. The target site is 57 feet deep and is outside of the area of potential impact. The site is well below the proposed project channel depth of 45 feet and will not be subjected to dredging activity.

11.3.5 Marcus Hook Anchorage

The proposed plan of improvement calls for the deepening of the Marcus Hook anchorage to 45 feet. The anchorage is located on the south side of the channel across from Marcus Hook, Pennsylvania and lies in New Jersey, Delaware, and Pennsylvania waters. The current limits of the existing anchorage were created in the late 1950's when the project was dredged to a depth of 40 feet. Proposed anchorage deepening to 45 feet will be restricted to previously dredged areas within the existing anchorage boundaries. Any historic features or shipwreck sites that may once have been in the anchorage area would have been destroyed during previous dredging episodes. The District anticipates that proposed dredging will have no effect on significant cultural resources. Therefore, no remote sensing investigations were conducted in the Marcus Hook anchorage.

11.3.6 Upland Dredged Material Disposal Sites

Proposed project plans call for the use of 13 upland sites for the disposal of dredged material. Four sites are inactive. The Philadelphia District anticipates that the reactivation of these sites, 15D, 15G, 17G and Raccoon Island, for dredged material disposal will have no effect on significant prehistoric or historic resources. New dike and drainage ditch construction, as well as access and staging locations required during construction, will be limited to existing right-of-way or disposal area interiors containing at least 20 feet of fill. No construction is planned for undisturbed locations outside of, or immediately adjacent to, these existing disposal areas. There is a National Register property, the Salisbury Farm site, located in the vicinity, but it is well outside of the boundaries of disposal site 15D and will not be adversely impacted by the proposed use of site 15D (Heite & Heite 1986). The remaining 9 disposal sites are currently used for the disposal of maintenance dredged material and will not be subjected to new construction. The District anticipates that the continued use of nine active disposal sites, 1) National Park, 2) Oldman's, 3) Pedricktown North, 4) Pedricktown South, 5) Killcohook, 6) Penns Neck, 7) Artificial Island, 8) Reedy Point North and 9) Reedy Point South will have no effect on significant cultural resources. The NJSHPO concurred with the District's findings of "No Effect" for disposal sites 15D, 15G, 17G and Raccoon Island in a letter dated July 28, 1994. The DESHPO also concurred with the District's findings of "No Effect" for the Reedy Point North and Reedy Point South disposal sites in a letter dated August 2, 1994 (see Pertinent Correspondence section of the Main Report).

11.3.7 Submerged Sand Stockpile Locations

Two proposed submerged sand stockpile areas, LC-05 and MS-19, were investigated for cultural resources in 1994 and 1995 (Cox & Hunter 1995, 1995a). A remote sensing survey utilizing magnetometer, side-scan sonar and bathymetric data identified 5 targets in the LC-05 location. Researchers determined that the lack of signature duration, dispersion and intensity of target data suggests that they are associated with either isolated objects or modern debris and do not represent significant cultural resources. No targets were identified in MS-19. Based on the results of these finding, the placement of dredged material in these locations will have "No Effect" on significant cultural resources.

11.3.8 Wetland Restoration Areas

Two proposed wetland restoration areas, Egg Island Point, New Jersey (PN-1a) and Kelly Island, Delaware (LC-09), were investigated for submerged and shoreline cultural resources (Cox & Hunter 1995, 1995a). Proposed construction in the Egg Island Point project area (PN-1a) involves the construction of a 150 acre dredged material containment site located adjacent to the shoreline and immediately east of Egg Island Point, and a 2 mile long staggered geotube erosion control structure west of Egg Island Point. Wetland restoration on Kelly Island, Delaware (LC-9) will also involve construction of a dredged material containment site consisting of dike construction, outflow channel excavation, and dredged material placement.

A low-tide shoreline cultural resources survey in the Egg Island Point project area (PN-1a) identified the second location of the 19th century Egg Island Point Lighthouse. The original 1837 lighthouse site is now located just offshore to the south. No other historic shoreline sites were located in the study area. A remote sensing survey was conducted in a 2 mile long, 290 acre offshore study area extending from Oranoaken Creek south to Egg Island Point. Two targets resembling modern debris or single isolated objects were identified. Remote sensing was not conducted along the shoreline project area east of Egg Island Point. Staggered geotube placement in a previously eroded and highly active offshore surf zone is not anticipated to impact significant cultural resources.

Remote sensing and shoreline cultural resources investigations were also conducted in the Kelly Island (LC-9) wetland restoration project area. A remote sensing survey identified two targets exhibiting shipwreck characteristics within the proposed placement area. Phase 1 ground truthing operations identified these two submerged sites, Target 9:534 and Target 9:553, as debris associated with a modern clam dredge and a navigational buoy. The shoreline survey identified the location of the Port Mahon Lighthouse site and the concrete foundations of a 1940's oyster shucking house. These two historic sites are located well south of the Kelly Island wetland restoration area and will not be impacted by proposed construction. No other cultural resources were identified in the project area.

11.3.9 Fort Delaware, Pea Patch Island

The District has re-evaluated the potential for increased shoreline erosion on Pea Patch Island resulting from the proposed deepening of the Delaware River Main Channel. This research analyzed various data to determine 1), if deepening the channel would increase current velocities and head values, and impact channel side-slope profiles, 2) if vessels using the deepened 45 foot channel would generate larger waves than presently occur with the 40 ft. channel, and 3) if these predicted changes in current velocities, head values, side-slope profiles and wave heights would detectably increase the shoreline erosion on Pea Patch Island (see Appendix C).

Comparison of model-predicted current velocities for the 40 ft and 45 ft channel geometrics at Pea Patch Island showed negligible velocity differences attributable to the deepened channel. It was thus concluded that the channel deepening will have a negligible effect on current velocities and water levels at the subject shoreline, and there will be no shoreline erosion induced or exacerbated by the channel deepening.

The principal variables considered in the ship wave analysis included vessel shape characteristics, vessel draft, vessel speed, sailing direction, and distance from the shoreline. The analysis assumed that tankers, due to their size, speed, and number of transits, constituted the critical class of vessels for this analysis. Further, based on data developed for the economic analysis of the proposed deepening, it was assumed that the fleet distribution would be identical for the 40 and 45 foot channels, with vessels simply loaded five feet deeper. The results indicated that maximum wave heights at the shoreline of Pea Patch Island would increase in the order of 4 per cent for the case of the design vessel loaded to a five-foot greater depth. Thus it was concluded that the deepening project would not detectably increase the existing shoreline erosion problem related to ship waves.

A review of existing shoreline profiles and hydrographic data adjacent to Pea Patch Island show that the majority of channel depths are well below the proposed new dredging depth of 45 feet. Only minimal new dredging in isolated high spots will occur in the vicinity of Pea Patch Island. This proposed work will not significantly effect the existing channel side-slope profiles and will not result in a movement of the federal channel closer to the island.

Based on the above analyses, it is the opinion of the Philadelphia District that deepening the channel to a depth of 45 feet will not increase shoreline erosion on Pea Patch Island, and consequently, will not impact significant cultural resources along the shoreline.

11.4 Section 106 Coordination

In order to fulfill our responsibilities under the National Historic Preservation Act of 1966, as amended, the Philadelphia District has worked closely with the Pennsylvania, New Jersey and Delaware State Historic Preservation Offices to coordinate extensive cultural resources investigations in the project area. This work involved a synthesis of previous investigations, documentary research, a remote sensing survey, underwater investigations and a shoreline survey (Cox 1988, Cox 1995, Cox &

Hunter 1995, 1995a). Project areas include bend widening, channel deepening, channel side-slope, submerged sand stockpile and wetland restoration areas. Nineteen high probability targets exhibiting cultural resource characteristics were identified out of a total of 225 remote sensing targets documented in project areas. Phase I underwater ground truthing operations and Phase II underwater site investigations identified 2 of these 19 targets as significant cultural resources eligible for listing on the National Register of Historic Places - the Canal Barge Site (E-1, 1:5) and the "Excelsior" Steamboat Site (E-2, 4:16). Both sites are located in New Jersey waters. No significant submerged cultural resources were identified in Delaware or Pennsylvania. Phase I shoreline surveys were conducted in two proposed wetland restoration locations on Egg Island Point, New Jersey (PN-1a) and Kelly Island, Delaware (LC-9). These low-tide surveys identified the remains of lighthouse foundations in both study areas and concrete footings along the shoreline in the vicinity of Port Mahon, Delaware. There are no shoreline or upland project areas located in Pennsylvania. Cultural resources investigations were not conducted in the 13 upland disposal areas and the Marcus Hook Anchorage due to previous dredging and disposal activities at these locations.

Based on the results of cultural resources investigations, the Philadelphia District finds that the proposed project will have "No Effect" on significant cultural resources. The District plans to completely avoid the Canal Barge Site (E-1, 1:5), the "Excelsior" Steamboat Site (E-2, 4:16) and the Egg Island Point Lighthouse Site by placing a 200 foot buffer around each location and then monitoring each site to ensure that no impacts will occur to these sites during construction. Although Phase 1 survey data did not determine the National Register eligibility of the Port Mahon Lighthouse site and the Oyster Shucking House site identified in the Kelly Island (LC-9) study area, both sites are located well south of the wetland restoration construction area and will not be impacted by construction activities.

The draft report of the final cultural resources investigation (Cox & Hunter 1995) and the District's finding of "No Effect" was submitted to the Pennsylvania, New Jersey and Delaware SHPO's in September and October, 1995 (see Pertinent Correspondence section of the Main Report). The Pennsylvania and New Jersey SHPO's concurred with the District's finding in letters dated November 21, 1995 (PASHPO) and December 23, 1996 (NJSHPO).

In a letter dated February 4, 1997, the DESHPO provided a review of the DSEIS and concurred with the District's finding of "No Effect" for Delaware project areas at Reedy Point North and South, Buoy 10, Kelly Island, and sand stockpiling locations MS-19 and LC-5. However, the DESHPO expressed the strong opinion that the project will have an adverse effect on archaeological deposits located along the shoreline of Pea Patch Island. In response to the DESHPO's concerns, the Philadelphia District evaluated the potential for increased shoreline erosion on Pea Patch Island resulting from deepening the channel to 45 feet. The results of this additional analysis showed that the project will not increase shoreline erosion, and therefore, will not impact the archaeological deposits on Pea Patch Island (see Appendix C). In a letter dated July 2, 1997, the District submitted to the DESHPO the results of this additional work and was asked to provide a second opinion regarding our "No Effect" finding regarding potential project impacts on Pea Patch Island (see pertinent correspondence). Section 106 coordination is continuing with the Delaware SHPO and will be concluded prior to any project construction activity.

12.0 Oil Spill Coordination/Contingency Planning

The purpose and objective of an oil spill contingency plan is to develop an implementable strategy for a coordinated Federal, state and local response to a discharge or substantial threat of discharge of oil or a release of a hazardous substance from a vessel, offshore facility, or onshore facility operating within the boundaries of a specific port. The adequacy of the existing oil spill contingency plan was assessed for current and projected future vessel movements of crude oil imports through the Delaware River port system. The analysis was done for both the existing channel depth as well as the proposed channel deepening (Greeley-Polhemus Group. 1995).

12.1 Existing Plan

The authority to formulate an oil spill contingency plan is specified in Section 4202 of the Oil Pollution Act of 1990 (OPA'90), and amended subsection (j) of Section 311 of the Federal Water Pollution Control Act (FWPCA), which address the development of a National Planning and Response System. As part of this system, Area Committees, comprised of qualified personnel from Federal, State, and local agencies, are established as spill preparedness and planning bodies and are responsible for developing Area Contingency Plans. The nature of such contingency plans is that they are constantly evolving. New data and technology will be verified and incorporated into the plan, to assure and improve the plan's ability to respond to area spill events.

The Philadelphia Area Oil Spill Contingency Plan (June 1994) is currently undergoing a review process. Area contingency plans are reviewed and will be updated yearly until 1997, after which plans will be updated every five years. Information will be checked to be sure it is current, and in particular, areas will be reviewed concerning response equipment information, emergency notification lists, sensitive areas, hazard/risk assessment of the area, response strategies and dispersant approval. To provide preparation and training for actual clean-up operations, exercises and drills are periodically conducted to assess the effectiveness of area contingency plans and relevant tank vessel and facility response plans.

The Philadelphia Area Oil Spill Contingency Plan addresses three scenarios. A response strategy has been prepared for a most probable discharge, a maximum most probable discharge and a worst case discharge including discharges from fire or explosion. Planning for these three types of events covers the expected range of spills likely to occur in this area. Historical spill data are used in planning the most probable and maximum most probable discharge scenarios. Factors such as the size of the largest spill recorded, traffic flow through the area, hazard and risk assessments, seasonal considerations, and spill histories and operating records of vessels and facilities are also taken into consideration in determining the maximum most probable spill event. The worst case discharge for a vessel is a discharge of its entire cargo in adverse weather conditions.

Prior planning through scenario development is one way to increase effectiveness in response to an oil spill event. Annex I, dated June 1995, deals with scenario development for a range of oil spill events. Three spill scenarios are developed. Each scenario describes in detail an incident, as well as the response to that incident. At present the Area Committee is only required to develop scenarios for oil discharges, but eventually it will address these same three scenarios for hazardous substance releases.

Currently, the three scenarios are described by the Coast Guard as follows:

- Most Probable Discharge: 750 gallons
- Maximum Most Probable Discharge: 483,000 gallons
- Worst Case Discharge: 18.2 million gallons

These amounts are based on historical data (See Table 12-1) and traffic patterns through the area. The worst case scenario involves the loss of an entire ship's cargo, a quantity of 18.2 million gallons. The Coast Guard keeps records on oil spills in the Delaware and has three levels or classifications that can occur. Minor spills involve quantities of oil up to 10,000 gallons. Medium spills range from 10,000 to 100,000 gallons, and a major spill involves over 100,000 gallons of oil released into the river. Historical spill data indicate that from 1986 to 1990, most spills that occurred in the Delaware River were less than 10,000 gallons. Over this same period, over 1,000 minor spills occurred that averaged approximately 150 gallons per spill. Less than 1 percent of all spills in the river are greater than 10,000 gallons. The largest spill occurred in 1986 when the *T/V Grand Eagle* lost 462,000 gallons of crude oil.

Response operations to an oil spill will generally follow a four-phase progression of 1) discovery and notification; 2) preliminary assessment and initiation of action; 3) containment, countermeasures, clean-up and disposal; and 4) documentation and cost recovery. Sections of the Philadelphia Area Oil Spill Contingency Plan address these four areas above, in addition to developing a response strategy for oil, describing actions for removal, waste disposal and remediation, securing operations after an oil spill response, and developing a response strategy for hazardous materials.

The Philadelphia Area Oil Spill Contingency Plan is a voluminous document. The Unified Command System (UCS) is described in detail, as it provides an organization capable of anticipating and responding to pollution response emergencies. The plan is designed to bring together, utilizing an orderly, pre-planned structure, continuous decision-making input from response groups

Table 12-1 - Major Oil Spills in the Delaware River, 1973-1989

Year	Volume (gallons)	Vessel Source	Location	Accident Type
Spills Greater than 100,000 Gallons				
1973	126,000	Tanker	Marcus Hook	Grounding
1974	285,000	Tanker	Philadelphia/Camden	Collision
1975	500,000	Tanker	Marcus Hook	Collision
1976	134,000	Tank Barge	Marcus Hook	Grounding
1978	630,000	Tank Barge	New Castle-Reedy Island	Sinking
1979	189,000	Tank Barge	Marcus Hook	Collision
1985	525,000	Tank Barge	Philadelphia/Camden	Grounding
1989	200,000-300,000	Tanker	Marcus Hook	Grounding
Spills Greater than 10,000 Gallons but less than 100,000				
1973	14,720	Tanker	Ocean Throughway to Delaware Bay	Grounding
1974	13,000	Tanker	Philadelphia/Camden	Fire/Explosion
1975	12,000	Tanker	Marcus Hook	Collision
1975	73,000	Tugboat	Philadelphia/Camden	Capsizing
1976	84,000	Tanker	Philadelphia/Camden	Collision
1979	16,800	Tanker	Philadelphia/Camden	Pipe Rupture

the city, county, state, Federal and the commercial community level. The organization chart (Figure 12-1) shows the chain of command with the U.S. Coast Guard directing the planning and response processes. A summary of area resources is provided along with logistical details associated with providing personnel, equipment and other resources to support a response effort. The proper use of chemical dispersants to respond to oil spills is addressed. Spill histories of the area are given, including locations in the Port of Philadelphia that have had the most spills, the largest spill on record, the most complex spill, high risk areas for spills, and most realistic and maximum feasible potential spill considerations. Health and site safety concerns, including emergency procedures, general safe work practices, and provisions for adequate and appropriate training when on-site, are also provided.

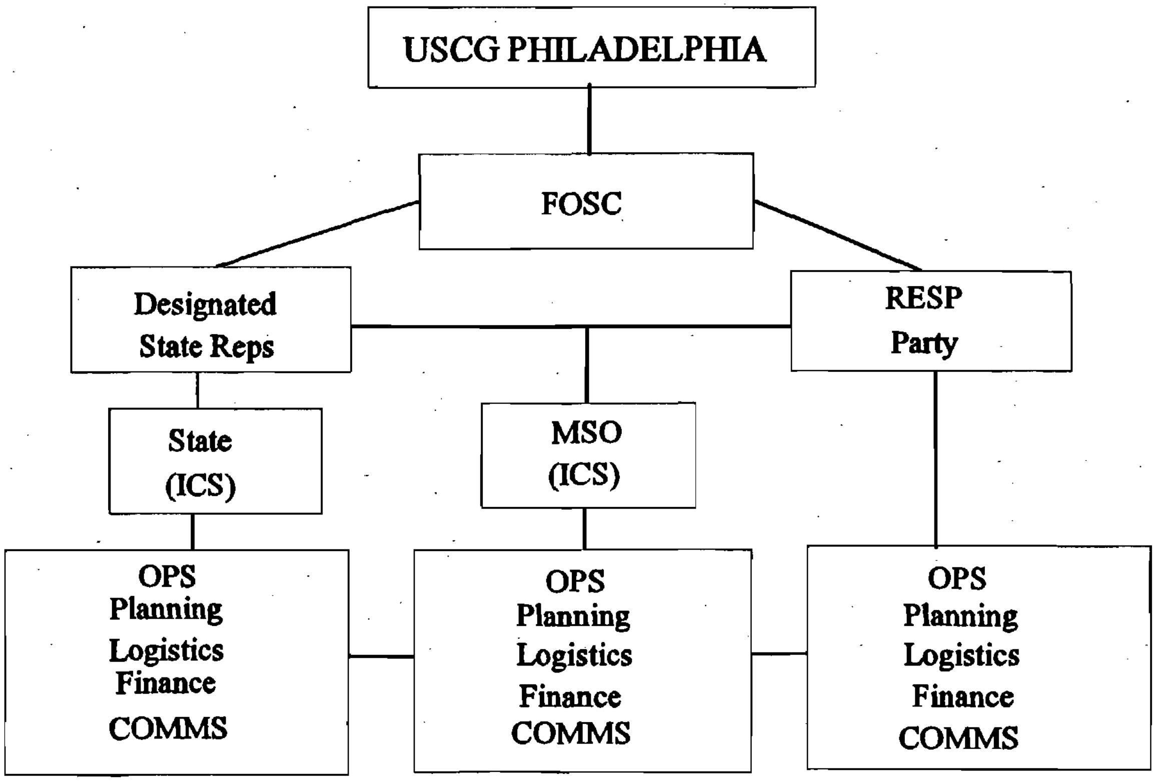
12.2 Adequacy of Current Plan

The Contingency Plan is an evolving, dynamic process that integrates a mix of agency and private sector interests with equipment and strategies. The plan is based on national experience and technologies for confinement, clean-up, treatment and communications. The plan, however, is virtually untested.

Before discussing the plan in terms of the proposed deepening and selective bend widening improvements, a recent oil spill incident permits an examination of the effectiveness of the existing plan. As reported in the July 24, 1995 edition of the *Philadelphia Inquirer*, 40,000 gallons of light crude oil spilled into the Delaware River at 5:00 p.m. on Saturday July 22. A strong wind pushed a docked tanker away from its berth as it was transferring approximately 100,000 gallons of crude oil to a refinery located in Gloucester County, New Jersey. This 40,000 gallon spill was the largest since 1989 when 300,000 gallons of heating oil were spilled near Claymont, Delaware when a tanker ran aground.

According to the newspaper, state and Federal officials were notified within 30 minutes of the spill and were mapping out plans to deal with it within an hour. Within 24 hours of the spill, the refinery had contracted with two cleanup organizations and a wildlife rescue agency to deal with any oil-coated wildlife, especially birds. Water intake facilities located along the Delaware River were notified that there may be oil in the water. Environmentally sensitive areas were identified and booms were deployed to keep oil out of these natural resource habitats. A toll free telephone number was made available to the public to answer any questions that they might have as well as to report any oil slicks or oiled wildlife to the proper authorities. Within three days, newspaper reports indicated that about 80 percent of the spilled oil had been mopped up, sponged or vacuumed.

One newspaper article addressed the complaints of local marina owners and operators, as well as several boating enthusiasts,



Key:

FOSC = Federal On-Scene Coordinator

State Reps = State Representatives

RESP Parsty = Responsible Party

ICS = Incident Command System

MSO = Marine Safety Office (U.S. Coast Guard)

OPS = Operations

COMMS = Communications

DELEWARE RIVER
MAIN CHANNEL
DEEPING PROJECT

Unified Command System Organization

U.S. Army corps of Engineers

Figure 12-1

concerning inadequate equipment to handle such a spill. A representative of the Coast Guard (Greeley-Polhemus. 1995) reported that the responsible party (i.e., the refinery) was primarily concerned with containment of the spill and setting-up booms around the ship, and did not adequately take into account other areas along the river as the oil spill spread. The Coast Guard official said that while 40,000 gallons was the initial figure reported, the actual amount spilled into the Delaware River was probably around 80,000 gallons. Nevertheless, during this latest spill event, the Philadelphia area had enough equipment to handle the spill - no outside resources were needed nor called in to assist with clean-up operations. In this official's opinion, the present oil spill contingency plan is adequate.

Interviews with representatives of the Coast Guard, as well as other experts, also provide some idea of the existing plans' ability to deal with spills. Questions on two issues are relevant: 1) what kinds of spills have occurred in the Delaware River/Bay with respect to the planning scenarios? and 2) Is the planning process adequate to respond to the historic experiences in the River and Bay?

The Coast Guard representative who has been stationed at Philadelphia for the last 11 years, could only recall four medium spill events and five major oil spills occurring in the Philadelphia Port area. There were some years when there were no medium or major spills to report in the Delaware River. He also stated that there are approximately 600 spills reported in the Delaware River annually. This number includes spills from lightering operations as well as smaller incidents such as recreational boaters reporting an oil sheen on the river.

Noting that while various aspects can come into play when cleaning up an oil spill, this Coast Guard official felt that at present, the oil spill plan has adequate resources to respond to a 1.5 million to 2.0 million gallon spill. This would include the most probable and maximum most probable spill events. A point was made, however, that there would be both equipment and personnel shortages in responding to a worst case spill of 18.2 million gallons. It was also stated that it would be prohibitively expensive, in his view, to maintain such levels of readily available materials for such a rare event.

In general, the Delaware Main Shipping Channel is safe. Despite its length, the volume of traffic and the number of turns required, there are few casualties and few oil spills occurring in the waterway. The high degree of skill and training by pilots, navigation aids built and maintained by the U.S. Coast Guard, and an overall sense of cooperation among various waterway interests contribute to the navigation safety of the Delaware River. The channel deepening is expected to reduce lightering operations at the Big Stone Beach Anchorage by 40%. This is expected to reduce barge traffic servicing the benefiting oil refineries located in the Philadelphia/Camden area and therefore the likelihood of oil spills. Based on historical spill data, the existing oil spill contingency plan for the Philadelphia port appears adequate to handle the vast majority (over 99 percent) of oil spills that may occur in the area. An expert panel was assembled to evaluate navigation safety of the Delaware River/Bay. The panel was comprised of seven members of the Delaware River and Bay marine industry including pilots, tug operators, oil interests, and barge companies. Individual interviews were first conducted with each panel member, followed by a plenary session with the set of experts in attendance. From interviews with these experts knowledgeable about the Delaware shipping channel, the channel deepening project, with its selective bend easings, is expected to continue the record of safety in the Delaware River/Bay that has been achieved by the local waterway users, and the present oil spill plan appears to be able to meet the vast majority (over 99 percent) of anticipated future oil spill response needs of the port community. According to the Environmental Protection Agency, the oil spill response network established by the U.S. Coast Guard, Marine Safety Office, Philadelphia is long established and is considered to be as adequately prepared for oil spill response as any in the Nation (Marie Jenet, Personal Communication, U.S. Environmental Protection Agency, Region 2, April 29, 1996).

12.3 The Marine Spill Analysis System (MSAS)

To assist the numerous agencies responsible for the Philadelphia Area Oil Spill Contingency Plan, the Corps of Engineers, Philadelphia District, has looked at various ways of modeling the Delaware Bay in the event of a spill. Although there are several existing models already available, few have a strong focus on environmental resources at risk. Most of these models focus on the trajectory of a spill event, which fundamentally means trying to "forecast" the path based on the initial or present location of the spill. Trajectory modeling is usually the first request of response teams and has proven to be essential throughout a spill event, however may be limited by the availability of "real-time" local weather forecasts. An alternative to trajectory modeling is "resource at risk" analysis which allows a responder to focus on locations in the Delaware River and Bay having high environmental significance and target those areas for protection.

The Florida Marine Research Institute (FMRI) has been working with Environmental Systems Research Institute Inc. (ESRI) to develop a decision support system focusing on natural resource protection. Due to funding limitations, FMRI was not able to fully develop the system. A combined effort between the Corps of Engineers, New Jersey DEP and the US Fish and Wildlife Service, was established to jointly fund additional work efforts by ESRI, resulting in the Marine Spill Analysis System (MSAS) for ArcView2. The MSAS was completed in April 1996 and was designed specifically for the Delaware River and Bay Area. The MSAS is a personal computer based analysis tool that utilizes Geographic

Information Systems (GIS) technologies to support the life cycle of oil spill management; planning, response and damage assessment, to ultimately minimize environmental impacts within the river and bay areas. The MSAS will integrate living resource data with spill information and emergency facility locations, allowing managers to: 1) effectively carry out emergency response operations; 2) prioritize response areas and actions; 3) help produce timely damage assessments.

The MSAS has the capability to import spill trajectory boundaries produced by other spill models allowing for a quick calculation of quantities for those areas in danger, thus providing timely information to help protect natural resources at risk. An Emergency Facilities database is linked to the system helping the user in deciding which Emergency Personnel to contact during a spill event. In addition, a comprehensive database consisting of numerous environmental resource datasets for the river and bay area are available to the user for impact analysis. All output from the system can be used by the Philadelphia Area Committee for practice spill drills and to help emulate various levels of spill scenarios.

13.0 Assessment of Impacts Associated with Rock Blasting

13.1 Description of the Blasting Project

Approximately 229,000 cubic yards of bedrock from the Delaware River near Marcus Hook would be removed to deepen the navigation channel to a depth of 47 ft mean low water. Approximately 70,000 cubic yards, covering 18 acres, will be removed by blasting, with the remainder being removed by mechanical methods. In order to remove the rock by blasting, holes drilled into the rock are packed with explosive to direct the force of the blast into the rock. The depth and placement of the holes and the size of the charges control the amount of rock that is broken. The project would be conducted by repeatedly drilling, blasting, and excavating relatively small areas until the required amount and area of bedrock is removed.

13.2 Fish Communities Near Marcus Hook

The Marcus Hook area is well-studied, although most recent studies have avoided sampling in the winter, the period of greatest relevance for this project. Most of the winter studies were conducted during the 1970s and thus do not represent present conditions. Water quality in the Delaware River improved in the 1980s (Albert 1988), and the species composition and abundance of fish near Marcus Hook has changed dramatically (Weisberg et al. in press).

The most relevant study was conducted by the Atlantic City Electric Company (ACEC) as part of an entrainment and impingement study from December, 1989 until March, 1990 using both pelagic and bottom trawls (ACEC, 1991). Fish were most abundant in deepwater habitats. White perch (Morone americana) and hogchoker (Trinectes maculatus) comprised 57 and 21 percent of the catch, respectively (Table 13-1). Other dominant species captured included channel catfish (Ictalurus punctatus) and silvery minnow (Hybognathus reglus) which, together, comprised an additional 14 percent of the total catch during the study period. Total monthly finfish density in the deepwater habitat for the 4-month study period ranged from 0.021 to 0.047 fish/m^3.

Other winter studies conducted in the Delaware River provide little insight as to whether sampling conducted during the winter of 1990 was representative of most years. Public Service Electric and Gas (PSE&G) conducted winter fish surveys in the Delaware River from 1970 through 1976 (PSE&G 1980), but these studies collected samples near Artificial Island, where salinities are much higher than those at Marcus Hook. Harmon et al. (1975) conducted fish surveys associated with an earlier blasting project at Marcus Hook from March 4 until April 10, 1975 using gillnets. However, because gillnets are typically size selective, they are not the most appropriate gear type for characterizing entire fish communities.

Table 13-1. Species composition and relative abundance near Marcus Hook during winter (data from ACEC [1991] bottom trawl sampling)

Species	# Collected	% of Catch
White perch *Morone americana*	2,066	57.1
Hogchoker *Trinectes maculatus*	772	21.3
Channel catfish *Ictalurus punctatus*	261	7.2
Silvery minnow *Hybognathus reglus*	230	6.3
Blueback herring *Alosa aestivalis*	150	4.1
Striped bass *Morone saxatilis*	65	1.8
Bay anchovy *Anchoa mitchilli*	28	< 1.0
Sea lamprey *Petromyzon marinus*	11	< 1.0
American shad *Alosa sapidissima*	10	< 1.0
Alewife *Alosa pseudoharengus*	9	< 1.0
American eel *Anguilla rostrata*	5	< 1.0
Gizzard shad *Dorosoma cepedianum*	2	< 1.0
Brown bullhead *Ameiurus nebulosus*	2	< 1.0
Tesselated darter *Etheostoma olmstedi*	2	< 1.0
Naked goby *Gobiosoma bosc*	2	< 1.0
Atlantic sturgeon *Acipenser oxyrhynchus*	1	< 1.0
Atlantic menhaden *Brevoortia tyrannus*	1	< 1.0
White crappie *Pomoxis annularis*	1	< 1.0
Total	**3,618**	**100.0**

Other studies of the area serve to confirm which species use this portion of the Delaware River during their life cycles, but do not provide data for the winter period. The most comprehensive fish survey in the Marcus Hook area was conducted by O'Herron et al. (1994). They summarized field data from the spring, summer, and fall of 1992 and 1993. Sampling occurred in shallow (≤ 3.05 meters (m) mean low water (MLW)), intermediate (3.05 to 7.62 m MLW), and deep (≥ 7.62 m MLW) habitat at four stations near Marcus Hook using a variety of gear including beach seines, gillnets, trawls, trotlines, and electrofishing. O'Herron and colleagues collected 31 species in the Marcus Hook vicinity. Nine species made up 92% of the catch (i.e., Atlantic croaker (Micropogonias undulatus), white perch, bay anchovy, hogchoker, channel catfish, mummichog (Fundulus heteroclitus), silvery minnow, banded killifish (Fundulus diaphanus), and striped bass. Fish were most abundant during the fall, when Atlantic croaker represented 45% of the catch. The most abundant species during spring and summer were white perch and hogchoker, respectively. Striped bass were most abundant during the fall, and the largest number of American shad were collected during the summer.

Weisberg et al. (in press) examined beach seine data collected by the New Jersey Department of Environmental Protection (NJDEP) annually during summer and fall from 1980 through 1993. The NJDEP captured 40 species during the surveys, many of which were found in the O'Herron et al. (1994) survey. However, these data are not as useful for characterizing fish communities in deep water habitats near Marcus Hook because they used only beach seines.

Several other recent studies provide comprehensive surveys of ichthyoplankton abundance and density (Burton and Weisberg 1992; Weisberg and Burton 1993; Burton et al. 1994). All three of these studies documented that the Marcus Hook area has high densities of anadromous fish larvae from April through June. The ACEC study, discussed above, documented that larval fish abundance during the anticipated blasting period is likely to be extremely low. No larvae were collected using plankton nets during December, January, or February. Some Atlantic menhaden larvae were captured in March (density 0.36 larvae/m^3); however, the majority of the menhaden stocks along the east coast spawn in off-shore waters (Jones et al. 1978).

13.3 Potential Effects of Blasting Shock Waves

Several studies have demonstrated that underwater blasting can cause fish mortality (Teleki and Chamberlain 1978, Wiley et al. 1981, and Burton 1994). These studies have shown that size of charge and distance from detonation are the two most important factors in determining fish mortality from blasting. Depth of water, type of substrate, and the size and species of fish present also affect the number of fish killed by underwater explosions.

Teleki and Chamberlain (1978) conducted blasting mortality experiments in Long Point Bay, Lake Erie, at depths of 4 to 8 m. Fish were killed in radii ranging from 20 to 50 m for 22.7-kg charges and from 45 to 110 m for 272-kg charges during 28 monitored blasts. Explosives were packed into holes bored into the lake bottom. The kind of substrate determined the decay rate of the pressure wave, and mortality differed by species at identical pressure. Teleki and Chamberlain (1978) presented their results for several species in terms of 10% and 95% mortality radii (i.e., radii at which 10% and 95% of the caged fish were killed).

Wiley et al. (1981) measured the movement of fish swim bladders to estimate blast mortality for fish held in cages at varying depths during midwater detonations of 32-kg explosives in the Chesapeake Bay. Pressure gages were placed in cages that contained spot and white perch. The study was conducted at the mouth of the Patuxent River in depths of about 46 m. Using data collected during 16 blasts, Wiley and colleagues predicted the distances at which 10%, 50%, and 90% mortality of white perch occurred. For 32-kg charges, the pressure wave was propagated horizontally most strongly at the depth at which the explosion occurred.

Burton (1994) conducted experiments on the Delaware River to estimate the effects of blasting to remove approximately 1,600 cubic yards of bedrock during construction of a gas pipeline. Charges of 112 and 957 kg of explosives were detonated in the river bed near Easton, Pennsylvania, during July 1993 in depths ranging between 0.5 and 2.0 m. Smallmouth bass were caged at a range of distances from the blasts. In the larger of the two blasts all fish in cages positioned farther than 24 meters from the blast survived (Table 13-2).

13.4 Methods to Reduce Impacts to Fish From Blasting.

There are three strategies for minimizing impacts to fish from blasting: 1) perform blasting during the winter when the least number of species and individual fish are present, 2) employ fish avoidance devices to reduce fish abundance in the area affected, and 3) conduct blasting in ways that minimize the magnitude of the shock waves produced.

13.4.1 Winter Blasting

Since the density and diversity of fish species are lowest during the winter months (1 December to 15 March), limiting blasting to this time period should minimize impacts to fish. Blasting is prohibited in this reach of the Delaware River from 15 March to 1 December by the Delaware River Basin Fish and Wildlife Management Cooperative to minimize impacts to fish.

Table 13-2. Results of Blasting Mortality Experiments Conducted near Easton, Pennsylvania, July 1993. (Source: Burton 1994)

Test Date	Survival (%)	Distance from Blast (m)
23 July (112.5 kg of explosives)	100.0	48
	100.0	24
	100.0	12
	0.0	6
	0.0	3
30 July (957 kg of explosives)	100.0	48
	100.0	24
	80.0	12
	20.0	6
	0.0	3

13.4.2 Fish Avoidance Techniques

13.4.2.1 Strobe Lights

Many species of fish exhibit strong avoidance responses to underwater strobe lights; however, avoidance is species-specific and varies with other factors, such as current velocity and turbidity (McIninch and Hocutt 1987). Strobe lights were effective at repelling juvenile American shad from intakes at night at the York Haven Hydroelectric Plant on the Susquehanna River (SWES 1990), but were ineffective for American shad during the day at the Roseton Station on the Hudson River (Matousek et al. no date). Combining strobe lights with an air bubble curtain increased effectiveness for white perch, spot, and Atlantic menhaden in a laboratory setting (McIninch and Hocutt 1987) but attracted fish during the day at the Roseton Station (Matousek et al. no date). Sager and Hocutt (1987) found that the effectiveness of strobe lights was less at a current velocity of 0.5 m per second than it was at lower velocities.

13.4.2.2 Low Frequency Sound

Pneumatic poppers project a loud, broadband signal of relatively low frequency (20-1000 Hz) into the water. Most of the sound energy from pneumatic poppers is at approximately 60 Hz. Haymes and Patrick (1986) found that a 12-popper array was up to 99% effective in excluding adult alewife from an experimental area; however, the poppers attracted large numbers of small unidentified fish on at least one occasion. The area of influence of a popper was limited to approximately 10 m, which may make it effective for power plant intakes, but would limit its value for excluding fish from a blast mortality zone. Furthermore, Richard (1968) found that some predatory fish species could be attracted by pulsed low-frequency sound (25-50 Hz), and at the Roseton Station on the Hudson River, the pneumatic popper was ineffective at repelling alewives and blueback herring and attracted American shad (LMS 1988a).

Loeffelman et al. (1991) projected low-frequency sounds at various fish species and repelled 66% to 94% of the fish; however, the authors believe that signals need to be customized to fish species, life stages of fish, and site conditions. This methodology, therefore, would require on-site testing and development, making it less appropriate for the Marcus Hook project.

13.4.2.3 Fishpulser

The fishpulser is a spring-mass impact device that produces a repetitive sharp sound of low fundamental frequency (38 Hz) and high amplitude. A fishpulser was effective in excluding adult alewife at the Pickering Station on Lake Ontario, reducing the number of alewives moving inshore by 85% (Patrick et al. no date). Adult alewives did not habituate to the hammers after six hours of continuous exposure. American shad, however, did not consistently avoid the sound of the fishpulsers at the Annapolis Generating Station on the Bay of Fundy (LMS 1988b).

13.4.2.4 High Frequency Sound

Dunning et al. (1992) examined the response of adult alewife to high frequency sound by exposing fish to continuous-tone, pulsed-tone, and pulsed-broadband sound in a cage suspended in a flooded quarry. The fish habituated to continuous tones; pulsed broadband sound between 117 and 133 kHz at 163 dB//1μPa elicited the most consistent response. Fish were completely excluded from the half of the cage exposed to higher sound levels.

Nestler et al. (1992) produced significant behavioral responses in blueback herring using high frequency sound. In daytime tests, blueback herring responded strongly and consistently to high frequency sound between 110 and 149 kHz at sound pressure levels greater than 190 dB//1μPa. The optimum frequency, in terms of intensity of the immediate avoidance response, appeared to be between 120 and 130 kHz. Hydroacoustic surveys showed a maximum effective distance of 50 to 70 m at a source level of 200 dB//1μPa at 1 m. The fish did not habituate to the sounds during 1-hour test periods. Nestler et al. were also able to overcome an attracting light stimulus using high frequency sound.

Based on unpublished tests of this technology, high frequency sound is likely to be ineffective on non-Alosid species. Some researchers believe that the effectiveness of high frequency sound is limited to the genus Alosa because of cranial structures unique to this taxonomic group (John Nestler, personal communication).

13.4.2.5 Scare Charges

Scare charges are a frequently used, inexpensive, but poorly studied method of moving fish away from an area. Small, nonlethal charges (usually blasting caps) are detonated underwater to produce a pressure wave similar to that produced by larger construction blasts but of smaller magnitude. Because this methodology is not documented, its effectiveness is not known; nevertheless, setting off scare charges before major blasts is inexpensive, easy, and could be effective for at least some species.

13.4.3 Reducing Shock Wave Magnitude

Reducing the magnitude of the pressure wave which fish experience can be accomplished by using bubble curtains and/or specific energy-dispersing blasting techniques. Both of these strategies are reviewed below:

13.4.3.1 Bubble Curtains

Bubble curtains are vertical walls of air bubbles within the water column which are intentionally produced using various types of air diffusers placed on the bottom. They are placed between the blast site and resources requiring protection (e.g., fish, bridges supports, etc.). Bubble curtains are effective at reducing the pressure wave experienced by such resources by essentially creating an energy-absorbing volume of air within the water column. Keevin et al. (in press) have demonstrated the effectiveness of this technology at reducing fish mortality. As discussed in Section 13.3, mortality of fish exposed to blasting is directly and positively correlated with the magnitude of the pressure wave which they experience. In experiments using bluegill (Lepomis macrochirus), peak pressure reductions ranged from 87.5 to 99.4 percent when bubble curtains were employed. Mortality of bluegill, at all distances tested (6.5-14.0 meters from the blast) fell from 100 percent, without the bubble curtain, to zero percent with the bubble curtain in operation.

Bubble curtains appear to be extremely effective at reducing fish mortality. However, deploying and operating a bubble curtain could be costly because the large area of the river where blasting will occur would require that the system be moved several times.

13.4.3.2 Construction Blasting Methods

The following blasting methods were suggested by Keevin and Hempen (1995), to reduce the impacts of blasting on fish. Although the appropriateness of these techniques could vary with site-specific factors, the Wilmington District of the Corps of Engineers (1995) estimated that these techniques could significantly reduce the impact of blasting (Table 13-3).

1) Plan the blasting program to minimize the size of explosive charges per delay (time lag during detonation) and the number of days of explosive exposure;

2) Subdivide the explosives deployment, using electric detonating caps with delays (preferable) or delay connectors for detonating cord (less useful), to reduce total pressure;

3) Use decking (explosives separated by delays) in drill holes to reduce total pressure; and

4) Use angular stemming material (rock piled at an angle on top of drill holes) to reduce energy dispersal.

13.5 Recommended Methods to Minimize Blasting Impacts

Adverse impacts to fish will be minimized by conducting blasting between 1 December and 15 March as recommended by the Delaware River Basin Fish and Wildlife Management Cooperative, and using construction blasting methods described in Section 13.4.3.2 to reduce the amount of energy that would impact fish. In addition, scare charges will also be used. Monitoring of impacts to fish from blasting will also be conducted to verify that impacts are minimal.

TABLE 13-3. Estimated Reduction of Fish Mortality from Blasting Using Construction Techniques

Blasting Impacts Estimated For A General Underwater Blasting Plan (Stemming the Top 1 Foot of Holes and Inserting Delays After Rows)

Fish Weight in Lbs.	LD50* Feet	Acres for LD50	LD1* Feet	Acres for LD1
0.125	1,610	196	2,780	573
1.000	899	63	1,550	181
12.000	446	17	768	47

Blasting Impacts Estimated For A General Underwater Blasting Plan (Stemming The Top 1 Foot of Holes and Inserting a Delay at Each Hole)

Fish Weight In Lbs.	LD50* Feet	Acres for LD50	LD1* Feet	Acres for LD1
0.125	381	12.5	656	34.5
1.000	213	4.5	364	11.5
12.000	105	1.4	180	3.4

The blasting plan consisted of 80 holes in 10 rows of 8 holes, each spaced 8 feet apart. Each hole is 4.5 inches in diameter and contains 98.5 pounds of explosive.

* LD50 (Lethal Distance) Feet is the distance from the blast where 50% of the fish died. LD1 Feet is the distance from the blast where 1% of the fish died.

It is evident from the stemming and inserting delays (a minimum of 25 milliseconds) on each hole reduces the size of the blast impact zone for the worst-case scenario, (i.e., LD1 for a 2-ounce swimbladder fish) by approximately 94 percent (from 573 acres to 34.5 acres).

SOURCE: Wilmington District, U.S. Army Corps of Engineers, 1995.

14.0 List of Preparers

John T. Brady - Biologist

Experience: 16 years environmental impact assessment and impact analysis, St. Louis and Philadelphia Districts; 6 years processing permits for work in waters and wetlands, Philadelphia District.

SEIS Role: Overall preparation of the document, environmental impact analysis, and coordination of project with natural resource agencies.

Anthony J. DePasquale, PE - Civil Engineer

Experience: 11 years geotechnical design and investigations, Philadelphia District.

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Jeffrey A. Gebert - Oceanographer

Experience: 17 years with the Wilmington, NC and Philadelphia Districts; coastal engineering and estuarine hydraulics investigations.

SEIS Role: District coordinator with the Waterways Experiment Station on salinity modeling and with the Coastal Engineering Research Center and Offshore and Coastal Technology, Inc. on Delaware Bay dredged material disposal alternatives.

Robert Griggs - Civil Engineer

Experience: 11 years with Philadelphia District; 5 years with Design Branch.

SEIS Role: Coordinated and directed surveying and mapping of upland dredged material disposal areas, beneficial use areas, and all other required project need areas. Performed quantity computations.

Stan Lulewicz, PE - Civil Engineer

Experience: 23 years with Philadelphia District. Project manager for complex civil works projects.

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Arlene Manqual - Secretary

Experience: 6 years EIS preparation experience.

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SEIS Role: Preparation of all maps.

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Michael Swanda - Archaeologist

<u>Experience</u>: 25 years cultural resource management. 4 years Environmental Resources Branch, Philadelphia District.

<u>SEIS Role</u>: District coordinator for the State Historic Preservation Office (SHPO), Section 106 review.

15.0 Public Involvement

Preparation of this Supplemental Environmental Impact Statement has included numerous coordination/scoping meetings with appropriate Federal and State resource agencies. Table 15-1 is a partial listing of the coordination that has taken place during the PED study. Other coordination included numerous telephone conversations. Table 15-2 is a list of agencies and individuals that are receiving copy (s) of this document. In addition, a public notice has been mailed to everyone who is on the project mailing list notifying them of the document's availability.

Table 15-1. Delaware River Main Channel Deepening Project Planning, Engineering and Design Study Coordination With Resource Agencies

26 September 1994	Field trip to Egg Island Point and Kelly island wetland restoration sites with Federal and State Resource agencies.
19 October 1994	Helicopter reconnaissance trip of the study area with Federal and State Resource agencies
01 November 1994	Site visit to Kelly Island with DDNREC and FWS.
21 November 1994	Meeting with NJDEP to discuss impacts to wetlands/wildlife habitat on upland dredged material disposal sites and Egg Island Point wetland restoration.
14 December 1994	Briefing of FWS on the environmental studies being done during this phase.
10 January 1995	Site visit to Egg Island Point and Kelly Island with Federal and State Resource agencies to coordinate plans.
19 January 1995	Meeting with NJDEP Bureau of Shellfisheries to coordinate plans for Egg Island Point and their concerns of possible impacts to oysters.
13 February 1995	Site visit to Egg Island, Kelly Island, and possible beach nourishment sites with FWS and DDNREC.
06 March 1995	Site visit to proposed confined dredged material disposal areas with FWS and EPA.
09 March 1995	Briefing of EPA on the environmental studies being done during this phase.
28 March 1995	Site visit to Raccoon Island with the NJDEP to discuss wetland delineations of the proposed confined dredged material disposal areas.
12 April 1995	Site visit with the NJDEP, FWS, and EPA to discuss management of confined dredged material disposal areas in New Jersey.

21 April 1995	Workshop with State and Federal Resource agencies to coordinated plans for beneficial use sites.
05 May 1995	Meeting at Bombay Hook National Wildlife Refuge to coordinate plan for Kelly Island wetland restoration.
27 June 1995	Workshop with State and Federal Resource agencies, and interested public to present results of 3-D Salinity Model runs.
10 August 1995	Meeting with NJDEP, DDNREC, and FWS to coordinate plans for Egg Island Point wetland restoration and to discuss the sediment transport and oyster impact models.
11 August 1995	Meeting at Bombay Hook National Wildlife Refuge with FWS and DDNREC to coordinate plan for Kelly Island wetland restoration and to discuss the sediment transport and oyster impact models.
22 August 1995	Site visit to Egg Island Point, King Pond and Straight Creek with NJDEP to determine that the wetland restoration on the east side of Egg Island Point will not adversely impact the mud flats at King Pond.
21 September 1995	Meeting with NJDEP to present a proposed environmental management plan for the new confined dredged material disposal areas.
27 September 1995	Meeting with the Coastal Zone Management personnel from Delaware, New Jersey, and Pennsylvania to discuss environmental studies, including beneficial use sites.
3 November 1995	Meeting with DDNREC to discuss the design of Kelly Island Wetland Restoration site.
17 April 1996	Meeting with DDNREC and Bombay Hook National Wildlife Refuge staffs to discuss the design of Kelly Island Wetland Restoration site.
30 April 1996	Meeting with NJDEP and the Delaware River Port Authority to discuss the upland dredged material disposal sites.
1 May 1996	Meeting with DDNREC to discuss additional testing for PCBs.
11 September 1996	Meeting with the NJDEP and FWS to discuss the upland dredged material disposal sites.

13 November 1996	Meeting with NJDEP, Coastal Zone Management (CZM) staff, to discuss coordination of the CZM process.
22 January 1997	Meeting with DDNREC to revise the design of Kelly Island Wetland Restoration site.
26 June 1997	Meeting with the NJDEP to discuss issues relating to obtaining the CZM consistency certification.

Table 15-2. Agencies/Individuals Receiving This Document.

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APPENDICES

List of Appendices

APPENDIX A

CORRESPONDENCE

APPENDIX A - CORRESPONDENCE

Letters - Federal Agencies

National Marine Fisheries Service, dated 1 March 1995, commenting on the dredged material disposal areas/beneficial use sites.

U.S. Environmental Protection Agency, dated 7 June, 1996 commenting on the dredged material disposal areas/beneficial use sites.

U.S. Environmental Protection Agency, dated 30 May 1995, commenting on the upland dredged material disposal areas.

U.S. Environmental Protection Agency, dated 27 May 1992, commenting on the Final Environmental Impact Statement.

U.S. Fish and Wildlife Service, dated 18 January 1996, commenting on the endangered species biological assessment that was prepared by the Philadelphia District.

U.S. Geological Survey, dated 23 January 1996, stating that there would be no significant impact to aquifers adjacent to the Delaware River as a result of the upstream movement of saltwater as a result of channel deepening, or from infiltration of fluids leaching from the dredged material areas.

State Resource Agencies

Delaware Department of Natural Resources and Environmental Control, Division of Soil and Water Conservation, dated 1 May 1997, providing federal consistency certification.

U.S. Army Corps of Engineers, Programs and Project Management, dated 30 April, 1997, to the Delaware Department of Natural Resources and Environmental Control, Coastal Management Program agreeing to certain items pursant to obtaining federal consistency certification.

Delaware Department of Natural Resources and Environmental Control, Division of Soil and Water Conservation, dated 14 February 1997, requesting information for making a federal consistency determination.

U.S. Army Corps of Engineers, Programs and Project Management, dated 16 July, 1996, responding to the concerns raised by the Delaware Department of Natural Resources and Environmental Control concerning the design and configuration of Kelly Island beneficial use project, possible PCB contamination, and maintenance of the project once completed.

Delaware Department of Natural Resources and Environmental Control, Division of Soil and Water Conservation, dated 17 June 1996, regarding the design of Kelly Island.

Delaware Department of Natural Resources and Environmental Control, Division of Soil and Water Conservation, dated 20 February 1996, comments on the need for a Federal Consistency Determination at the end of the current phase of study, expresses concern about the use of geotextile tubes to contain silt at Kelly Island, and about possible PCB contamination in this silt.

Delaware Department of Natural Resources and Environmental Control, Division of Soil and Water Conservation, dated 22 May 1995, comments on the beneficial use sites, expressing concerns with the composition of dredge material, reuse of stone/rock material, and locations of sand stockpiles in relationship to future use constraints.

Delaware Department of Natural Resources and Environmental Control, Division of Soil and Water Conservation, dated 31 January 1992, stating the Delaware Coastal Management Program conditionally agrees with the Corps' coastal zone consistency determination.

New Jersey Department of Environmental Protection, dated February 3, 1992, states that the Delaware River Main Channel Deepening Project is conditionally consistent with the New Jersey Coastal Zone Management Program.

Commonwealth of Pennsylvania, Department of Environmental Resources, dated February 4, 1997, stating that the project is consistent with the Pennsylvania CZM Program.

Commonwealth of Pennsylvania, Department of Environmental Resources, dated February 21, 1992, stating that the current phase of the project is consistent with the Pennsylvania CZM Program, and that future phases should be submitted for consistency review.

Letters - Cultural Resources

Delaware:

U.S. Army Corps of Engineers, Environmental Resources Branch, dated 2 July 1997, to the Delaware Division of Historical and Cultural Affairs, Bureau of Archaeology and Historic Preservation, requesting their review of the District's finding that the Main Channel Deepening Project will have no effect on the significant archaeological deposits on the shoreline of Pea Patch Island.

U.S. Army Corps of Engineers, Environmental Resources Branch, dated 6 October 1995, requesting review of a draft copy of Submerged and Shoreline Cultural Resources Investigations, Disposal Areas and Selected Target Locations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania by Delaware Division of Historical and Cultural Affairs, Bureau of Archaeology and Historic Preservation.

Delaware Division of Historical and Cultural Affairs, Historic Preservation Office, dated 21 November 1994, states concurrence with investigator's recommendation for additional underwater investigation of 11 "targets", also concurs with finding of four "targets" detected in 1987 do not meet National Register criteria, but the fifth target does meet the criteria, and expresses concerns for the destruction of two targets during maintenance dredging.

Delaware Division of Historical and Cultural Affairs, Historic Preservation Office, dated 2 August 1994, states that they concur with the assessment that the placement of additional fill at Reedy North and South will not effect any significant historical properties.

New Jersey:

U.S. Army Corps of Engineers, Environmental Resources Branch, Dated 28 September 1995, requesting review of a draft copy of Submerged and Shoreline Cultural Resources Investigations, Disposal Areas and Selected Target Locations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania by New Jersey Department of Environmental Protection, Historic Preservation Office.

New Jersey Department of Environmental Protection, Historic Preservation Office, Dated 10 February 1995, states concurrence with investigator's recommendation for additional underwater investigation of 11 "targets"; also concurs with finding that four "targets" detected in 1987 do not meet National Register criteria, but the fifth target does meet the criteria.

New Jersey Department of Environmental Protection, Historic Preservation Office, Dated 28 July, 1994, stating that placing dredged material on the proposed dredged material disposal sites will effect no cultural resources eligible for or listed on the National Register of Historic Places.

Pennsylvania:

Pennsylvania Historical and Museum Commission, Bureau of Historic Preservation, Dated 21 November 1995, states that they agree with the recommendations of this report, and that project activities will have no effect on significant submerged cultural resources in waters of Pennsylvania.

U.S. Army Corps of Engineers, Environmental Resources Branch, dated 6 October 1995, requesting review of a draft copy of Submerged and Shoreline Cultural Resources Investigations, Disposal Areas and Selected Target Locations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania by the Pennsylvania Historical and Museum Commission, Bureau of Historic Preservation.

Pennsylvania Historical and Museum Commission, Bureau of Historic Preservation, Dated 10 July 1995, states that the cultural resources investigation provided important information on submerged cultural resources in the Delaware river.

Pennsylvania Historical and Museum Commission, Bureau of Historic Preservation, Dated 20 July 1994, states concurrence with investigator's recommendation for additional underwater investigation of 11 "targets", also concurs that if Target e-2, 4:16 cannot be avoided then a phase II evaluation and any additional investigation should be conducted; and if Target e-1, 1:15 can not be avoided it should be salvaged.

FEDERAL AGENCIES

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Habitat and Protected Resources Division
James J. Howard Marine Sciences Laboratory
Highlands, New Jersey 07732

March 1, 1995

Mr. John Brady
Planning Division
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Brady:

We have reviewed the Delaware River Main Channel Deepening Conceptual Plans for Beneficial Use of Dredged Material faxed to us on February 14, 1995. Our comments are as follows:

Kelly Island (LC9)
In general, we support the proposed shoreline protection and stabilization using geotubes, in conjunction with creation of low marsh, along the east shore of Kelly Island, Kent County, Delaware. We wish, however, to ensure that adequate tidal exchange be provided to the created marsh. Consequently, we are concerned with the proposed installation of a weir on the Mahon River on the west side of Kelly Island. We discourage the use of weirs, or similar water control structures, that inhibit free tidal exchange. We recommend that the conceptual design for the project incorporate a free-flowing tidal gut that will not only promote uninhibited tidal exchange, but also afford access to fish and invertebrates.

Sand Stockpile
We are concerned with the proposed stockpiling of sand at LC-5. There is no apparent environmental benefits associated with the proposal. Additionally, there are evident ecological detriments associated with suffocating 500-700 acres of benthic fauna. Although environmental benefits have been demonstrated with some submerged berms, the ecological trade-offs associated with benthic faunal losses and habitat modifications must be weighed against any potential benefits. We would like to see this discussed in any updated plans.

Egg Island Point (PN1A)
In general, we also support the proposed shoreline protection using geotubes, in conjunction with the creation of wetlands and sandy beach habitat proposed along the shores of Egg Island Point, Cumberland County, New Jersey. However, as with

Kelly Island, we wish to ensure adequate tidal exchange between the existing marsh at Egg Island Point and Delaware Bay. Consequently, we are concerned that two miles of continuous geotubes along the southeast side, and possibly along the northwest side of Egg Island Point may inhibit free tidal exchange. We recommend that the conceptual design be modified to provide uninhibited tidal flow to the marshes of Egg Island Point, and to afford access to fish and invertebrates.

While the creation of a unconfined sand island off the tip of Egg Island Point may benefit horseshoe crabs, gulls and terns, the benefits of such a project should be weighed against any detrimental effects to benthic fauna. Since the size of the proposed island has not been determined, it is not possible to fully assess the potential impacts of the island creation. Although on a smaller scale, the impacts of island creation are similar to those that may result from stockpiling sand in the bay. Consequently, the ecological trade-offs associated with benthic faunal losses and habitat modifications must also be weighed against any potential benefits as work on the sand island proceeds. We would like to see this trade-off discussed in any updated plans.

Thank you for the opportunity to comment on the conceptual plan. We hope that these comments are helpful to you. If you have any questions or need additional information, please contact either Karen Wurst at (908) 872-3023 for Egg Island Point, or Tim Goodger at (410) 226-5771 for Kelly Island.

Sincerely,

Stanley W. Gorski
Assistant Coordinator
Habitat Program

cc: F/NEO2, T. Goodger

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY - REGION II
290 BROADWAY
NEW YORK, NEW YORK 10007-1866

JUN 07 1995

Mr. Robert L. Callegari
Department of the Army
Corps of Engineers - Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

As requested, the Environmental Protection Agency (EPA) has reviewed the studies on Wetland Restoration, Underwater Features, and Other Beneficial Uses of Dredged Material in the Delaware River Main Channel Deepening Project. EPA also obtained additional information from the U.S. Army Corps of Engineers - Philadelphia District (ACE) at its Beneficial Use Workshop on April 21, 1995. Based on our review, we offer the following comments.

Kelly Island, Delaware - The ACE should ensure that the elevations created by the disposed dredge material at this site are appropriate for the creation of tidal marsh. Furthermore, we recommend that the ACE, during the planning and development stages of the project, include vegetation planting as part of the mitigation plan. We request that copies of the mitigation plan be included in the future NEPA documentation that will be circulated for our review prior to implementation.

Egg Island Point, New Jersey - The ACE should evaluate the possibilities for beneficial use at this site through restoration of the shoreline and the large area of wetlands that has eroded. Moreover, stabilizing the sandy shoreline would improve the conditions for the leased oyster beds in the vicinity, which are currently being impacted by the fine-grained sediments eroding from this area. At a minimum, we recommend that the ACE discuss the possibilities of protecting the oyster beds with Mr. Joseph Dobarro of the New Jersey Department of Environmental Protection (NJDEP); the Delaware Bay Oystermans Association may also have valuable input.

Sand Stockpiling - The ACE proposes to move the northerly site of sand stockpiling to a location about 1.7 miles offshore from Pickering Beach. At the April 21st meeting, the representative from the Delaware Department of Natural Resources and Environmental Control was concerned that an excessive amount of material was being proposed for sand stockpiling in Delaware and in some cases it was being proposed for placement in areas that did not facilitate its use. It is important that sites designated for beneficial use not be used merely as disposal areas. Therefore, we recommend that the ACE modify the beneficial use plan to include consideration of need for the material. We recommend that the analysis of beneficial uses consider placing additional material on Egg Island Point (as discussed above), developing agreements with the States of New Jersey and Delaware to place it in locations where the States can better use it, and developing some other type of habitat in the Bay.

If you have any questions regarding this letter, please contact Ms. Evelyn Tapani-Rosenthal of my staff at (212) 637-3497.

Sincerely yours,

Laura Livingston

Laura J. Livingston, Assistant Chief
Environmental Impacts Branch

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY - REGION II
290 BROADWAY
NEW YORK, NEW YORK 10007-1866

MAY 30 1995

Mr. Robert L. Callegari
Department of the Army
Corps of Engineers - Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

The Environmental Protection Agency (EPA) has reviewed the four draft environmental assessments (EA) prepared by the U.S. Army Corps of Engineers - Philadelphia District (ACE) for the proposed dredged material disposal areas for the Delaware River Deepening Project. This review was conducted in accordance with Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609, PL 91-604 12(a), 84 Stat. 1709), and the National Environmental Policy Act.

The four EAs describe four separate disposal areas located in various townships throughout Gloucester and Salem Counties, New Jersey. They are identified as sites 15D, 15G, 17G, and Raccoon Island. These disposal sites are being evaluated for appropriateness in receiving the 50 million cubic yards of dredged material expected to be generated by the Delaware River deepening project, and the associated maintenance dredging to occur over the subsequent 50 year period. The four sites are all currently diked, or partially diked former disposal areas. Based on our review, we offer the following comments.

According to recent information provided by the ACE, we understand that Raccoon Island is primarily a Phragmites dominated wetland while the remaining sites are currently in cropland. Sites 15G and 15D would be used entirely and impact 5.78 and 40.32 acres of wetlands respectively. The Raccoon Island site and site 17G would be partially utilized and impact 315.00 and 33.60 acres of wetlands respectively. This information should be included in the final EAs.

Additionally, the ACE has indicated that the anticipated dredged material from the initial deepening project has been reduced from the 50 million cubic yards stated in the EAs to a current estimate of 40 million cubic yards. The final EAs should be updated to reflect these revised figures. Of this volume, approximately 10 million cubic yards are to be disposed of via "beneficial use" projects in the Delaware Bay. The four disposal areas are anticipated to eventually accommodate 78.9 million cubic yards over the 50 year life of the project.

To ensure that the wetland impacts associated with the proposed activities are properly minimized and mitigated, a wetlands management plan should be developed for the four proposed dredge disposal sites and included in the final EAs. This plan should include, but not necessarily be limited to, a dredge disposal schedule, a site subdivision plan, creation and enhancement measures, a discussion of plant recolonization, and osprey protection measures. The enclosure to this letter contains additional details.

If you have any questions about this letter, please contact Ms. Evelyn Tapani-Rosenthal of my staff at (212) 637-3497.

Sincerely yours,

Laura Livingston

Laura J. Livingston, Assistant Chief
Environmental Impacts Branch

Enclosure

cc: R. Denmark, Region III

Enclosure

1. A schedule for dredge disposal should be developed with the objective of ensuring that dredged material be deposited in the most environmentally beneficial manner possible while carrying out the project purpose. This schedule should attempt to space out disposal events within each site to the greatest extent possible.

2. The feasibility of dividing the disposal sites into separate cells to improve the management potential of these sites should be evaluated. As we understand, such a partitioning of Site 17G is currently being evaluated by the ACE. Specifically, this site would receive one disposal event prior to the creation of two internal walls. Subsequent filling would proceed sequentially among these cells, with the lowest cell being filled last. We recommend that the plan for Site 17G be incorporated into the management plan.

3. The potential for permanent wetland creation or enhancement should be pursued wherever possible. An evaluation of all potential mitigation sites within property purchased for dredged disposal should be conducted. Such sites should include any property outside of the diked areas which will be retained by the ACE or by the project sponsor. The feasibility of creating freshwater tidal marsh should be given special consideration.

4. As we understand, the ACE is currently evaluating the permanent isolation, via internal walls, of approximately 10-15 acres of mitigation within each site. Consideration in these areas should be given to planting beneficial species which may act as a focal point to potentially colonize recently deposited dredged material. Conversely, all these sites should be protected from being colonized by undesirable species, such as <u>Phragmites</u>, from the disposal sites. These internal sites and any other mitigation areas identified should be included within the management plan.

5. All necessary measures should be taken to reduce potential impacts or disturbance to the osprey nest identified in the vicinity of Raccoon Island.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION II

JACOB K. JAVITS FEDERAL BUILDING

NEW YORK, NEW YORK 10278

From S&A review:
Dir, WLRC
MRD Chief
Review manager
Econ reviewer
WLR-E (2)
WLR official file
CECW-PM (J. Kent)
S&A files
Div POC
Dist POC

MAY 27 1992

Mr. Donald A. Banashek, Director
Washington Level Review Center
ATTN: CEWRC-WLR-E (SA)
Kingman Building
Fort Belvoir, Virginia 22060-5576

Dear Mr. Banashek:

The Environmental Protection Agency (EPA) has reviewed the final environmental impact statement (EIS) for the Delaware River Comprehensive Navigation Study, Main Channel Deepening. This review was conducted in accordance with Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609 12[a] 84 Stat. 1709), and the National Environmental Policy Act. Since the proposed project impacts both EPA Regions II and III, this letter reflects the results of both Regional Offices' reviews of the final EIS.

This project is being proposed in response to Congressional Resolutions; the Army Corps of Engineers (ACE) is seeking an exemption from the Clean Water Act's (CWA) Section 404 permitting requirements pursuant to Section 404(r). Under Section 404(r), the requirement to obtain a Section 404 permit is waived provided information is presented in an EIS to demonstrate that the effects of the discharge of dredge and fill materials, including consideration of the Section 404(b)(1) Guidelines, were evaluated. With this in mind, this comment letter includes EPA's evaluation of the project's consistency with the Section 404(b)(1) Guidelines.

The proposed project involves deepening the Delaware River channel system from 40 to 45 feet below mean low water (MLW), and widening it at bends and other selected locations, from deep water in the Delaware Bay to the Beckett Street Terminal in Philadelphia Harbor, a distance of approximately 102.5 miles. The project also includes the construction of a two space anchorage of compatible depth at the Marcus Hook Anchorage, Pennsylvania.

The ACE is proposing to dredge a total of 50,100,000 cubic yards (CY) of material for the project. The 45-foot channel would require approximately 6,156,000 CY annual maintenance dredging. Five sites have been selected for on-land disposal of the dredged material. Two are existing upland disposal sites near the Chesapeake-Delaware Canal in Delaware (Reedy Point North and South). Three are new upland sites, one near Woodbury, New Jersey (17D), the other two near Bridgeport, New Jersey (15D, and Raccoon Island). Additionally, the EIS proposes to use appropriate dredged material from Delaware Bay for beneficial projects, including marsh/island creation and offshore stockpiling for subsequent beach nourishment.

The final EIS states that the existing channel dimensions reduce the economic efficiency of larger ships transiting the Delaware River main channel. Specifically, under the present channel conditions, larger vessels that carry crude oil, coal, and iron ore periodically must undergo lightering or partial loading due to draft restrictions. The proposed project would reduce the need for these practices and, thereby, encourage the expanded utility of large ships for commercial use on the Delaware River channel system.

As noted in EPA's February 14, 1992 comment letter, the draft EIS provided information on the characteristics of the sediments to be dredged that indicates low concentrations of organics and metals. However, the document did not include information on sediment grain size. These data are important because there is a correlation between a sediment's grain size and its capacity to concentrate contaminants. Moreover, the physical characteristics of sediments influence the choice of appropriate site for dredge disposal and beneficial uses. The final EIS presents the results of grain size analyses on the cores that were collected during the ACE's 1991 sediment sampling program for the proposed project. Based on the sediment data presented, EPA believes that there will be no adverse impacts associated with the disposal of sediments generated by the project.

In a related matter, during the initial planning for this project, the ACE identified Buoy 10 in Delaware Bay as a potential disposal site for coarse grained sediments. In response to EPA's concern about this disposal site, the ACE dropped it from consideration in favor of beneficial uses. Although we believe that this is a better solution, our February 14, 1992 comment letter identified the need for additional information on the sediment stockpiling aspects of the disposal method. The final EIS indicates that approximately 11.5 million CY of sand would be aquatically stock-piled for beneficial uses. Additionally, the final EIS states that studies will be conducted during the preconstruction engineering and design (PED) phase of project development to finalize beneficial use plan alternatives to the Buoy 10 site. In this regard, the ACE commits to coordinate with EPA through the PED phase of project development, and to perform further analyses to determine the impact of open water disposal on aquatic ecosystems. Specifically, these analyses will include a benthic invertebrate sampling program to assess habitat quality at selected sites, bioassay and bioaccumulation studies, and mixing zone studies.

With respect to the beneficial use of fine grained dredge sediments, the ACE proposes the creation of wetlands with approximately 3.2 million CY of silt to be excavated from the Delaware Bay portion of the project area. We recommend that chemical screening analysis of the dredge spoil be performed to ensure that this material does not contain contaminated sediments. Lastly, the final EIS states that the ACE will coordinate with EPA in preparing site-specific environmental assessments for the upland disposal sites.

We commend the ACE on its commitment to prepare supplementary environmental analysis and documentation for the dredged material disposal aspects of the project, and recommend that the project's record of decision (ROD) reflect these commitments. Based upon the information presented, we believe that the EIS provides sufficient technical information and an appropriate evaluation framework to ensure that potential adverse environmental impacts are identified and properly mitigated.

In our draft EIS comment letter, we stated that the analysis of ground water impacts had improved markedly since the original draft EIS. However, we recommended that the ACE provide additional data in the final EIS to support the conclusions in the proposed project's ground water assessment (GA). The final EIS provides the necessary information in an expanded GA. Specifically, the document evaluates existing ground water quality, current pumping rates, sediment structural features, and depth to bedrock. Based on this information, the EIS concludes that the project will not result in significant adverse impacts to ground water quality. Accordingly, we believe the proposed project complies with Section 1424(e) of the Safe Drinking Water Act.

EPA stated in its previous letter that channel improvements will result in an increase in the oil loads of ships that travel the Delaware River. With this in mind, we recommended that the final EIS identify a mechanism for revising the existing Delaware River spill contingency plans to ensure compliance with the mandates of the Oil Pollution Control Act of 1990 and the Spill Prevention Control and Countermeasure (SPCC) requirements of the CWA. The final EIS notes that the ACE plans to coordinate with the regional oil spill response teams (OSRT), a 12 member group that includes EPA, during the PED phase. The OSRT provides a coordinating mechanism through which the Regional Contingency Plan (RCP) can be updated to reflect changes in vessel traffic patterns resulting from the project. We believe that participation by EPA and the ACE in this organization will provide adequate opportunity to address our environmental concerns regarding compliance with SPCC requirements on the Delaware River. We recommend that the ACE's commitments in this regard be reflected in the ROD, and look forward to a cooperative relationship with the ACE and the rest of the OSRT in developing appropriate modifications to the RCP.

With respect to the alternatives analysis, the draft EIS presented a two-way channel at a depth of 45 feet MLW as the preferred alternative. Further, the document indicated that the amount of dredged material generated by the asymmetric one-way channel alternative would be less than with the preferred alternative. With this in mind, our February 14, 1992 letter recommended that the final EIS include additional information to justify the selection of the preferred alternative. The final EIS and feasibility report provide additional information regarding the number of ship movements per year in each direction, and the degree of commerce conducted along the Delaware River. Moreover, the documents sufficiently contrast the benefits and costs of the two-way alternative and the efficient asymmetric one-way channel. Accordingly, we believe the ACE has adequately detailed the selection of the preferred alternative.

Based on our review of the final EIS, we believe that the implementation of the proposed project, which will incorporate the results of the supplementary studies performed and documentation developed during the upcoming PED phase, will not pose significant adverse environmental impacts. Moreover, we believe that the project will be in compliance with the CWA Section 404(b)(1) Guidelines. We recommend that the ROD for the project reflect the EIS's commitments to additional environmental analyses and documentation, and would appreciate receiving a copy of the project's ROD when it is completed.

Once again, I would like to commend the ACE for its extensive effort and cooperative spirit in resolving EPA's environmental concerns about the project. I look forward to EPA's continued coordination with the ACE in the subsequent phases of this project. In the interim, if you have any questions, please feel free to call me at (212) 264-1892.

Sincerely yours,

Robert W. Hargrove

Robert W. Hargrove, Chief
Environmental Impacts Branch

cc: LTC K. Clow, USACE
C. Day, USFWS-Pleasantville

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
927 North Main Street (Bldg. D1)
Pleasantville, New Jersey 08232

Tel: 609-646-9310
FAX: 609-646-0352

IN REPLY REFER TO:

ES-95/183

January 18, 1996

Robert L. Callegari, Chief
Environmental Resources Branch, Planning Division
Department of the Army
Philadelphia District, Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

This responds to the Department of the Army, Corps of Engineers (Corps), Philadelphia District's (District) October 31, 1995 request to the U.S. Fish and Wildlife Service (Service) for formal consultation regarding potential impacts to the federally listed threatened bald eagle (*Haliaeetus leucocephalus*) and endangered peregrine falcon (*Falco peregrinus*) from the proposed Delaware River Main Channel Deepening Project.

This response is provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species and does not address all Service concerns for fish and wildlife resources. These comments do not preclude separate review and comments by the Service as afforded by the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 *et seq.*), if any permits are required from the Corps pursuant to the Clean Water Act of 1977 (33 U.S.C. 1344 *et seq.*), nor do they preclude comments on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

By letter dated February 10, 1992, the Service notified the District that the bald eagle and peregrine falcon are known to nest and forage within the project area and requested that the District prepare a Biological Assessment (BA) to address potential direct, indirect, and cumulative impacts to the bald eagle and peregrine falcon from proposed project activities. Of particular concern was potential exposure to contaminants from dredged materials and disturbance during the nesting period.

In response to the Service's request, the District prepared a BA addressing potential impacts to the bald eagle and peregrine falcon entitled, "Biological Assessment of the Bald Eagle (*Haliaeetus leucocephalus*) and the Peregrine Falcon (*Falco peregrinus*) for the Delaware River Main Channel Deepening Project." The BA included results of sediment testing for contaminants conducted by the District within the project area.

The Service has reviewed the information provided within the BA and concurs with the District's determination that the proposed Delaware River Main Channel Deepening Project is not likely to adversely affect the bald eagle or peregrine falcon. The Service's concurrence with the District's determination is based upon the following information contained within the BA:

- Results of chemical analyses provided within the BA indicate that contaminant loads in the sediments tested are low. The mean and range of contaminant concentrations were provided for each reach of the proposed project area. Mean contaminant concentrations fell within ranges considered to be background for soils and sediments in New Jersey. Maximum concentrations that exceed background appear to be in isolated samples, and are, therefore, limited in spatial distribution. Additionally, no demonstrable acute toxicity or bioaccumulation of sediment-associated contaminants were demonstrated in laboratory tests.

- To avoid disturbance to nesting bald eagles, the District will coordinate with the Service and the New Jersey Department of Environmental Protection (NJDEP), Endangered and Nongame Species Program (ENSP), prior to construction of upland dredged material disposal sites. If active bald eagle nests are found within 0.25 miles or a line of sight distance of 0.5 miles from the disposal area, construction of the site and the use of the site for the disposal of dredged materials will be seasonally restricted to avoid disturbance to nesting eagles.

- To avoid disturbance to nesting peregrine falcons, the District will coordinate with the NJDEP, ENSP prior to initiating any new work at the Raccoon Island upland dredged material disposal site. No new work will be initiated at the Raccoon Island site during the beginning of the nesting period (March 15 to April 15). Prior to restoration of wetlands at Egg Island Point and Kelly Island, the District will coordinate with the NJDEP, ENSP. The District will move an existing peregrine falcon nesting structure located at Egg Island Point to a location as determined in coordination with the NJDEP, ENSP, that will be undisturbed.

The Service concurs with the District's determination that the Delaware River Main Channel Deepening Project is not likely to adversely affect federally listed species under the Service's jurisdiction. Therefore, informal consultation regarding the subject project has been concluded and formal consultation is not required. No further consultation pursuant to Section 7(a)(2) is required by the Service. If additional information on listed and proposed species becomes available or if project plans change, this determination may be reconsidered. It is the Service's understanding that periodic testing of sediments will be conducted throughout the life of the project. Should such sampling reveal the presence of any contaminated sediments within the project area, and at greater concentrations than reported in the BA, an evaluation of potential impacts on federally listed threatened and endangered species must be conducted and consultation with the Service must be re-initiated.

The Service requests that no part of this letter be taken out of context and if reproduced, the letter should appear in its entirety. Please contact Annette Scherer of my staff if you have any questions or require further assistance regarding threatened or endangered species.

Sincerely,

Clifford G. Day

Clifford G. Day
Supervisor

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Division
Mountain View Office Park
810 Bear Tavern Road, Suite 206
West Trenton, New Jersey 08628

January 23, 1996

Mr. Stan Lulewicz
Project Engineer
Corps of Engineers, Philadelphia District
Department of the Army
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3391

Dear Mr. Lulewicz:

The U.S. Army Corps of Engineers, Philadelphia District, is evaluating the feasibility of improvements to the main navigational channel of the Delaware River, which could include deepening the channel from the existing depth of about 40 ft below mean low water (MLW) to about 45 ft below MLW from deep water in Delaware Bay to Philadelphia, Pa. and Camden, N.J. Concerns have been raised that deepening the channel may adversely affect ground-water supplies developed in the adjacent Coastal-Plain aquifers of New Jersey, particularly in the Potomac-Raritan-Magothy aquifer system where many public and private ground-water supplies have been developed adjacent to the Delaware River in the reach where the channel improvements are being evaluated.

The concerns generally focus on the potential for saltwater from the river to infiltrate into the adjacent aquifers. Hypothetically, this could occur in two ways: (1) the dredging operation might uncover a confining bed at the base of the river channel, improving a pathway for saltwater to infiltrate to a freshwater aquifer; and (2) the deepening of the river channel might allow saltwater to encroach upstream in the river to areas where infiltration of the saltwater into the ground-water system would occurs. An additional concern is (3) that fluids leaching from the dredged-material disposal areas could contain contaminants of sufficient concentration that if they were to infiltrate to the aquifer with recharge water in the outcrop areas, they may adversely effect the potability of nearby water-supply wells.

The USGS has investigated the circumstances relating to these concerns in the course of several projects that have been accomplished in cooperation with the Corps of Engineers and the New Jersey Department of Environmental Protection. The results of the USGS will be discussed further from the perspective of the three concerns outlined above.

Concern (1), dredging breaches confining unit: A geophysical survey of the Delaware River bottom material was conducted by Duran (1986) to determine the configuration of aquifers and confining units beneath the river. The results of this study indicate that there are no places between Wilmington, De. and the Philadelphia, Pa./Camden, N.J. area where a breach of a protective confining unit would occur due to the proposed dredging. Generally, upstream of Little Tinicum Island the sands of the Potomac-Raritan-Magothy aquifer system are exposed in the river bottom. Downstream of Little Tinicum Island, clay, thicker than the proposed depth of dredging, predominates in the river-bottom material.

Concern (2), saltwater in river encroaches onto well-recharge areas: Water-supply wells, to be effected by saltwater in the Delaware River, must be located in proximity to the river or its associated tidal tributaries. Furthermore, the rate of pumpage of these wells must be sufficient to draw a substantial portion of their discharge from the river. Navoy and Voronin (*in review*) tabulated wells that are located within 2 miles of existing saltwater wetlands in Gloucester, Salem, and Cumberland Counties. The reach of the river that extends through Gloucester, Salem, and Cumberland Counties is where the transition between potable and nonpotable water occurs, with respect to dissolved chloride. During annual low-flow conditions, Delaware River water with a dissolved-chloride concentration that exceeds drinking-water standards is in the vicinity of Bridgeport, N.J./Chester, Pa (at about river mile 81). In order to ascertain the likely magnitude of upstream saltwater encroachment in the river that is a result of deepening the shipping channel, the Corps of Engineers, Waterway Experiment Station, constructed a three-dimensional salinity model of the Delaware Estuary. The results of the model indicate that salinity conditions for simulated low-flow and drought conditions will be displaced approximately 1 to 2 kilometers further upstream as a result of channel deepening. The movement of a salinity interface, due to tides, wind, and changes in the freshwater discharge of the Delaware River, is on the order of many miles. Therefore, this magnitude of displacement, as simulated, does not represent a significant change and will not likely have a significant effect on ground-water supply withdrawals in the area, under average conditions. This concern then focuses on whether the 1 to 2 kilometer displacement during extreme low-flow events, such as those related to drought, may effect ground-water supplies upstream of the area where saltwater is normally seen.

Significant drawdown of aquifer water levels to below sea level, which may be indicative of conditions that could favor saltwater intrusion, occurs in the Potomac-Raritan-Magothy aquifer system in the Camden metropolitan area (Navoy and Voronin, *in review*, figs. 23, 24, and 25). The most substantial of the ground-water withdrawals in the area of aquifer drawdown, that receive recharge from the river, are located in Pennsauken Township, Camden County (near river mile 105). These areas are identified in Navoy and Carleton (1995, p. 81, fig. 53) as a "river-influenced zone". Under the most severe drought of record, the river water which exceeded drinking water standards encroached upstream to a location in the vicinity of the Ben Franklin Bridge (river mile 100) for about 21 days. Saltwater in the river, however, does not immediately effect nearby wells. The ground-water travel time from the river to the wells of the Camden Area is slow in human terms, proceeding on the order of years or decades. The rate of flow of ground water is dependent on the distance to travel and the water-level gradient, among other things. Because the distance between the wells and the river is variable, the travel time is also variable. Simulations of 6 transects representative of flowpaths in the vicinity of river-proximal wells and well fields indicated the average travel time for flow from the river ranges from slightly more than one year to 15 years (Navoy, 1991, table 6, p. 112). Travel time to wells located farther from the river could be greater that 15 years. During the time the recharge from the river, that may include salty water, travels in the aquifer, substantial dilution takes place with fresh ground water. Based upon simulations of the ground-water system (Navoy, 1991), an intermittent low flow event, such as that due to drought, with a minimum dissolved chloride concentration in the river of between 2,000 and 4,000 mg/l for a duration of 30 days per year with a return period of 5 years is the type of condition that would result in nonpotability at river-proximal wells or well fields. These simulations compare favorably with observed data from November and December, 1964 where the 21-day encroachment of saltwater with a dissolved chloride concentration of 250 mg/l caused a 10 to 28 mg/l rise in chloride concentration at observed wells (Lennon and others, 1986, figure 15, p. 48), but no loss of potability. The conditions necessary to cause nonpotability at the river-proximal wells are in excess of those which could be attributed to the 1 to 2 kilometer displacement.

Concern (3), disposal area effects nearby wells: Along the river in Gloucester and Salem Counties are a number of sites that are presently used, or could be used for the disposal of dredged-material. The National Park and 17G disposal sites are situated within the outcrop of the Potomac-Raritan-Magothy aquifer system in Gloucester County. Based upon simulation of the ground-water system, wells east of the National Park and 17G sites draw recharge from the sites, but at most, one-quarter of the water originates from the sites and the mean travel time of ground-water from the sites to the wells is more than 25 years (Navoy and Rosman, *in review*, p. 15).

Recharge from the Oldmans #1, Pedricktown North, Pedricktown South, and 15G sites to the nearby Goodrich wells is likely, based upon a potentiometric surface analysis. The proximity of the wells to the sites and the steep head gradient indicate that the travel time to the wells could be relatively short, perhaps on the order of several years (Navoy and Rosman, *in review*, p. 26). Disposal of dredged material at the Raccoon Island, 15D, Penns Neck, Killcohook, and Artificial Island sites are not likely to effect existing ground-water withdrawals in the area because the sites are far from wells or the sites are not in good hydraulic contact with the aquifers (Navoy and Rosman, *in review*, p. 35).

In summary, the concerns about increasing the potential for saltwater from the river to infiltrate into the adjacent aquifers, either as a result of dredging through a confining unit or as a result of the upstream movement of saltwater in the deepened channel can be set aside. No significant confining units will be breached and the saltwater will not significantly move upstream to increase the threat of saltwater intrusion.

The concern that fluids leaching from the dredged-material disposal areas could infiltrate to the aquifer with recharge water can also be set aside. A poor connection exists with the aquifer or the contributing volume of recharge is insignificant at most of the disposal sites. For the several instances where the travel time is short and the contributing volume may be higher than insignificant, the risk of contamination can still be considered low. The Corps of Engineers has investigated the potential for the presence of hazardous substances in the dredged material. Their sampling and analyses indicate that the dredged material is not likely to contain hazardous substances that will exceed regulatory levels. Therefore, even though a recharge pathway may exist and travel time may be short, the risk of contamination will be low.

REFERENCES CITED

Duran, P. B., 1986, Distribution of bottom sediments and effects of proposed dredging in the ship channel of the Delaware River between Northeast Philadelphia, Pennsylvania, and Wilmington, Delaware, 1984: U.S. Geological Survey Hydrologic Atlas 697, 1 sheet, scale 1:48,000.

Lennon, G.P., Wisniewski, G.M., and Yashioka, G.A., 1986, Impact of increased river salinity on New Jersey aquifers, in Hull, C.H.J., and Titus, J.G., eds., Greenhouse effect, sea level rise, and salinity in the Delaware Estuary: EPA 230/6-86-001, Washington, D.C., U.S. Environmental Protection Agency, P. 40-54.

Navoy, A.S., and Voronin, L.M., *in review*, Hydrogeologic conditions adjacent tot he Delaware River, Gloucester, Salem, and Cumberland Counties, New Jersey: U.S. Geological Survey Open-File Report, 77 p.

Navoy, A.S. and Rosman, R., *in review*, Evaluation of ground-water flow from dredged-material disposal sites in Gloucester and Salem Counties, New Jersey: U.S. Geological Survey Open-File Report, 39 p.

Navoy, A.S. and Carleton, G.B., 1995, Ground-water flow and future conditions in the Potomac-Raritan-Magothy aquifer system, Camden Area, New Jersey: New Jersey Geological Survey, Geological Survey Report GSR 38, 184 p.

Navoy, A.S., 1991, Aquifer-estuary interaction and vulnerability of ground-water supplies to sea-level-rise driven saltwater intrusion: unpublished doctoral dissertation, Department of Geosciences, The Pennsylvania State University, University Park, Pa., 225 p.

Sincerely,

Anthony S. Navoy, Ph.D.
Supervisory Hydrologist

STATE RESOURCE AGENCIES

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE DIRECTOR

TELEPHONE: (302) 739 - 3451

May 1, 1997

Robert L. Callegari
Chief, Planning Division
Philadelphia District
U. S. Army Corps of Engineers
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

RE: ***Consistency Certification***
Delaware River Main Channel Deepening Project

Dear Mr. Callegari:

The Delaware Coastal Management Program (DCMP) has received and reviewed your consistency determination for the above referenced project. Pursuant to National Oceanic & Atmospheric Administration regulations (15 CFR 930), the DCMP concurs with your consistency determination for the deepening of the Delaware River Federal navigation channel from a depth of 40 feet to 45 feet. The DCMP certifies this project consistent with its program policies after review of the 1997 Draft Environmental Impact Statement, post-informational studies, and conditions agreed to by the Corps of Engineers in their April 30, 1997 letter. Our concurrence will be based upon the restrictions and/or conditions placed on any and all permits issued to you for this project.

This consistency certification in no way guarantees that the State of Delaware will contribute funding to the non-federal sponsorship of this project. Due to the large scale of this project, the DCMP requests that the Corps of Engineers hold an informational public meeting for the citizens of the State of Delaware so that they may be aware of this project and understand its scope.

The DCMP would like to thank the Corps for their coordination and cooperation in the review of this project and we look forward to working with you in the future. If you have any questions regarding this determination please contact me at (302) 739-3451.

Sincerely,

Sarah W. Cooksey

Sarah W. Cooksey, Administrator
Delaware Coastal Management Program

SWC/jll
cc Secretary Christophe A.G. Tulou, DNREC

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING 100 PENN SQUARE EAST
PHILADELPHIA PENNSYLVANIA 19107-3391

Planning Division

30 APR 1997

Sarah W. Cooksey
Delaware Coastal Management Program
89 Kings Highway
P.O. Box 1401
Dover, Delaware 19903

Dear Ms. Cooksey:

Pursuant to the Delaware Coastal Management Program's (DCMP's) federal consistency certification of the Delaware River and Bay Main Channel Deepening Project, the Philadelphia District of the Army Corps of Engineers agrees to the following:

1. To use "best management practices" during construction of the Kelly Island wetland restoration to minimize the chances of additional turbidity in Delaware Bay as a result of fine-grained material that could possibly escape from this site.

2. To include the latest design of the Kelly Island wetland restoration, dated March 1997, and the subsequent maintenance of this site after construction.

3. To assist the State of Delaware in addressing the ongoing erosion problem at Pea Patch Island.

4. To investigate the feasibility of using blasted rock from the channel deepening in the Marcus Hook region for erosion control/shoreline stabilization and habitat enhancement projects.

5. To restrict dredging for either the initial construction or subsequent maintenance of the 45 foot channel within close proximity so that no disturbance occurs to the wading bird colony at Pea Patch Island between 1 April and 30 August.

6. To coordinate with the State of Delaware Department of Natural Resources and Environmental Control during the preparation of Plans and Specifications to attempt to identify specific areas within the area to be dredged that are used by this species for spawning if there is a continuing concern for Atlantic Sturgeon.

7. To address during the Plans and Specifications phase the impacts to benthic resources from the placement of sand stockpiles underwater, specifically at site MS-19 and evaluate the possibility of placing such sand material on the shore for replenishment, protection, and wildlife habitat.

The Army Corps of Engineers understands that the DCMP's federal consistency certification of the Delaware River and Bay Main Channel Deepening project does not in any way guarantee that the State of Delaware will participate in funding the non-federal sponsorship of this project. The Corps looks forward to the federal consistency certification of this project by the Delaware Coastal Management Program based upon the agreements outlined above.

Sincerely,

Robert L. Callegari
Chief, Planning Division

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE DIRECTOR

TELEPHONE: (302) 739 - 3451

February 14, 1997

Mr. Robert L. Callegari
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

RE: ***Federal Consistency Certification***
Delaware River Main Channel Deepening Project

Dear Mr. Callegari:

The Delaware Coastal Management Program (DCMP) has received and reviewed the Army Corps of Engineers' federal consistency determination and the January 1997 Draft Supplemental Environmental Impact Statement for the Delaware River Main Channel Deepening Project. Based upon the DCMP's review of this project and pursuant to National Oceanic and Atmospheric Administration Regulations, 15 CFR 930, the DCMP will be unable at this time to provide the Army Corps of Engineers with final federal consistency concurrence due to additional information requirements outlined in this letter.

In 1992, the DCMP granted conditional federal consistency concurrence to the Army Corps of Engineers for the Draft Environmental Impact Statement and Feasibility Stage of the Delaware River Main Channel Deepening. The conditions of the concurrence were that additional testing, assessments, and impact evaluations be conducted during the Pre-construction, Engineering and Design phase of the project and that at the end of this phase another consistency determination be submitted to the DCMP. In December of 1996, the DCMP received the Draft Supplemental Environmental Impact Statement to the original 1992 Environmental Impact Statement along with the federal consistency determination for this phase.

The information contained within this 1997 Draft Supplemental Environmental Impact Statement is not sufficient for the DCMP to make an informed decision on whether or not this project is consistent with it's program policies. Specifically, the information and data that the DCMP needs to evaluate are:

1. The final design and plans for the Kelly Island beneficial use site;

2. The complete and final summary and analysis of the Mono-ortho, dye-ortho and coplanar congener specific PCB's for the channel sediment samples;

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3. Additional information regarding the potential for increased erosion at Pea Patch Island associated with the deepening of the Main Channel;

4. The methods and specific time of year that dredging is scheduled to occur, in efforts to protect Delaware's wildlife resources; and,

5. The impacts of dredging upon the declining population of Atlantic Sturgeon in the Delaware River.

In light of the information requested above, the DCMP would like to request a meeting with the Corps to discuss the specific needs and informational requirements that need to be met. Prior to such a meeting, more formal, detailed, and specific comments will be forwarded to the Corps.

Since this project is so large in size and that the information in hand is not yet complete, the DCMP will defer it's final consistency concurrence until this critical information is received. At such time that the requested information is received, and adequate review time is provided, the DCMP will make a final concurrence decision.

The DCMP would like to thank the Corps for their cooperation in working with us so far, and we look forward towards achieving this project's success together.

Sincerely,

Sarah W. Cooksey

Sarah W. Cooksey, Administrator
Delaware Coastal Management Program

SWC/jll

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2/14/97

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3391

REPLY TO
ATTENTION OF

JUL 16 1996

Programs & Project Management

Ms. Sarah W. Cooksey, Administrator
Delaware Coastal Management Program
State of Delaware
Department of Natural Resources and
Environmental Control
Division of Soil Water Conservation
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Dear Ms. Cooksey:

Thank you for your letter dated June 17, 1996 with suggestions in refining the design and configuration of the Kelly Island beneficial use project, possible PCB contamination and maintenance of the project once it is completed.

In May 1996, the design report for the Delaware River Main Channel Deepening Project was approved. The plan, which includes use of Kelly Island, has been incorporated into the environmental document. Shortly, the environmental document will be circulated for agency and public comment. Also, this document will be used as the basis for requesting Delaware Coastal Zone consistency approval.

At this time, we have initiated the detailed Plans and Specifications phase of the project development. Your suggestions in the reference letter are being addressed as part of this phase. Any modification to the Kelly Island design as a result of the additional studies or procurement of supplemental sediment chemical data will be incorporated into the Plans and Specifications.

We will be working closely with your office on the ongoing efforts. If you have any questions, please feel free to call Stan Lulewicz (215-656-6586), project engineer, Delaware River Main Channel Deepening Project.

Sincerely,

Richard J. Maraldo, P.E.
Deputy District Engineer
for Programs & Project Management

Copy Furnished:

Mr. John Hughes
State of Delaware
Department of Natural Resources
and Environmental Control
Director, Division of Soil Water Conservation
89 Kings Highway
P.O. Box 1401
Dover, Delaware 19903

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE DIRECTOR

TELEPHONE: (302) 739 - 3451

June 17, 1996

Mr. Stan Lulewicz
CENAP-PL-PS
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Lulewicz:

On May 15, 1996, DNREC held an internal meeting to discuss the options for the design and configuration of the Kelly Island beneficial use project. In attendance at the meeting were representatives from sections within the Division of Water Resources, Division of Soil and Water Conservation and the Division of Fish and Wildlife. This letter reflects the concerns, ideas and suggestions made at the meeting. Issues discussed included design of structures for the containment of silt, erosion and sand transportation rates, deposition of sand, vegetation and stabilization of silt material, possible PCB contamination, and operation and maintenance of the project once it is completed.

It was the consensus of the group present that a substantial sand barrier beach, with or without a geotube layer, was preferred over the original geotube concept for erosion control and containment of the enclosed silty material. It is critical that this silty material remain contained for the purpose of protecting adjacent shellfish beds. The environmental benefits of a sandy beach for horseshoe crab and shorebird populations are clear. The environmental benefit of sand for containment of the silt is dependent upon many factors including sand grain size. Therefore, we would like to see a size distribution analysis of the material that would be used for construction of the beach. If geotubes must be utilized we suggest that they be filled with grout or sand as opposed to silty dredge spoil material.

It is our understanding that your consultant would not be able to model the erosion rates for a sand beach at Kelly Island. Since this is crucial information we recommend that the Corps recruit specialists either from the Coastal Engineering Research Center (CERC) or the University of Delaware's Center for Applied Coastal Research (CACR) to use existing analytical prediction procedures or numerical models to predict sediment transport, direction, and erosion after placement of the sand. It was felt that CERC or CACR should have the expertise to conduct such analysis. We must know the results of such analyses in order to estimate the average annual rate of sand removal, where this sand ultimately will reside and the amount of time that the placed beach will serve its function to protect the silt impoundment. With the potential for erosion of a sand beach at Kelly Island we must know where sand deposition will occur. Deposition into the mouth of the Mahon River or adjacent to the jet fuel unloading facility for the Dover Air Force Base is undesirable and should be avoided. This may be accomplished by the construction of terminal structures at the edges of the created marsh and beach. Also, meeting participants emphasized the need for all tidal exchange to be through the back of the marsh and not via the face of the structure except for the occasional occurrence of storm overwash. The type of data and information that will be produced from the above mentioned analyses will be critical in DNREC's evaluation of this project.

DNREC understands that a process for establishing salt marsh vegetation at Kelly Island is obscure. We are currently forming a group of people to examine this issue and to research which methods may prove to the most effective for stabilization at this site. DNREC is anxious to collaborate with the Corps in the development of such methods.

As previously discussed at the May 1, 1996 meeting between DNREC and the Corps the issue of PCB contamination continued to be an important topic. In order to put this issue to rest the Corps agreed to secure the supplemental data needed to resolve any questions. As a result of DNREC's internal meeting, DNREC would like to reiterate the importance of this data in decision making for this project.

The issue of responsibilities for long term maintenance of the Kelly Island project still must be discussed by DNREC and the Corps. We strongly feel that some type of formal commitment from the Corps regarding long term involvement with the operation and maintenance of this project is necessary. DNREC is ready and to work with the Corps in addressing the issues stated above and upon satisfactory resolution, is committed to this project's success.

Sincerely,

Sarah W. Cooksey

Sarah W. Cooksey, Administrator
Delaware Coastal Management Program

SWC/jll

cc: John Hughes
Gerard Esposito
Andrew Manus

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6/17/96

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE DIRECTOR

TELEPHONE: (302) 739 - 3451

February 20, 1996

Mr. Stan Lulewicz
U.S. Army Corps of Engineers
Philadelphia District
100 Penn Square East
Philadelphia, Pennsylvania 19107

RE: Delaware River Main Channel Deepening Project/Beneficial Reuse

Dear Mr. Lulewicz:

In response to prior meetings between the Philadelphia District of the Army Corps of Engineers and the State of Delaware Department of Natural Resources & Environmental Control (DNREC), regarding the Delaware River Main Channel Deepening project's beneficial reuse, the DNREC would like to reiterate and expand upon its prior comments and concerns.

In accordance with National Oceanic & Atmospheric Administration regulations *15 CFR 930*, and a January 31, 1992 letter from the Secretary of DNREC, Edwin Clark, the Delaware Coastal Management Program (DCMP) which is housed within the DNREC, requires another federal consistency determination from the Corps at the conclusion of the pre-construction, engineering and design phase. A proper federal consistency determination prepared by the Corps should contain; 1) a brief statement that the proposed activities will be undertaken in a manner consistent to the maximum extent practicable with the DCMP and its program policies; 2) a detailed description of the proposed activities, their associated facilities and coastal zone effects; and 3) comprehensive data and information sufficient to support the Corps consistency statement (the amount of supporting information shall be commensurate with the expected effects upon the coastal zone) *15 CFR 930.39.*

Pursuant to prior correspondence regarding comprehensive data and information, the DNREC would like to see the studies regarding the proposed marsh creation at Kelly Island. DNREC has expressed its concerns previously on the stability and design of geotextile tube placement for the marsh creation. The strength of the geotubes is crucial for enabling the silty dredge material to become stabilized for adequate marsh creation. The use of geotubes is still considered to be experimental, DNREC is not convinced that the geotextile material that the tubes are constructed of will be able to withstand the high energy environment of the Delaware Bay, sustained wind and wave action, ice packs, floating debris, general weathering, vandalism, or catastrophic weather events. Current plans for a pilot project to test the stability of the geotubes will not adequately simulate conditions at the Kelly Island site. If the pilot study will be conducted as planned for 1-3 years in a lower energy environment it would lack the ability to clearly demonstrate the geotubes long term projected performance at Kelly Island. In addition to the strength of the geotextile material, another concern is the design and placement of the geotubes upon a sand base. Questions that need to be addressed regarding the design and structure are as follows: How stable will this design be against erosive forces acting upon the shoreline in front of the tubes with the potential for settling and possible collapse of the geotube structure? How well has the continued erosion of the shore bayward of the containment structure been modeled, calculated or predicted? Has a contingency plan been developed in the event of structure failure after construction?

DNREC concerns with the potential impacts of silt during project construction and in the event of project failure are:

1. The scale of the proposed main channel deepening project is unprecedented in recent times in terms of the volume of dredged material to be moved and placed in Delaware waters. Associated with the wetland creation at Kelly Island there will be a considerable amount of silt-clay resuspended into the Bay. These materials have the potential to smother adjacent populations of oysters and oyster habitat.

2. During placement of the silt material within the dike, an unspecified volume of silt will be released with exhaust water through water control structures.

3. Following deposition of the silt within the containment structure, the upper level of geotube will be intentionally breached in order to allow twice daily tidal flooding of the containment area. Again the amount of silt released into the bay through formation of tidal channels is unspecified.

4. The Kelly Island project proposal clearly states that there are no plans to seed, sprig or transplant wetland plants onto the 90 acre silt containment area, indicating that it will produce natural wetland vegetation on its own. The loosely compacted sediments dredged from deep mid-bay waters haven't had a wetland seed bank as part of its natural resource feature since those sediments left the fast land. It is by no means certain that natural seeding will be successful. The growth of wetland plants is imperative in the stabilization of the silt. In addition, even if wetland vegetation is successfully established, only the surface will be stabilized. The marsh will not have the deep peat mat characteristic of natural marshes, thus making it more prone to resuspension, threatening adjacent oyster resources.

There are approximately one thousand acres of commercially and ecologically important oyster seed beds in Delaware, the majority of these beds are located adjacent to Kelly Island. The community is the most productive benthic assemblage in Delaware Bay and it has historically supported a multimillion dollar oyster fishery. Presently depleted by disease, the oyster beds and oyster habitat are especially susceptible to smothering when population levels are low. The Corps consultant, Dr. Eric Powell, in his study did not address our primary concern of smothering of the oysters and their habitat. The study addressed predicted impacts of elevated suspended sediment concentrations, a more chronic effect. While these impacts can be considerable they do not address catastrophic impacts due to geotube containment failure.

In prior correspondence it has been suggested that a sufficient supply of erodible sacrificial sand be deposited in such a way to surround the perimeter of the spoil site. This erodible sand buffer would contain, for example, a 25+ year supply of sand to maintain a protective sand barrier around the disposal site and thus maintain and assure the integrity of the disposal site and provide safe and adequate spoil containment. Surrounding the geotubes with an adequate sand buffer may satisfy DNREC's concerns over the stability of the geotubes to contain the silt. We hope that the Corps is exploring this option. A benefit that the sand buffer would provide is additional breeding habitat (sand beaches) for the Delaware Bay's declining Horseshoe Crab and Diamond Back Terrapin populations.

With regard to the composition of the dredged silt material to be placed for wetland creation, DNREC's additional concerns are related to the minimization of adverse impacts associated with potential PCB concentrations within this material. Under the proper conditions, PCB's can cause a direct toxic effect on sediment-dwelling organisms and can also pose an indirect risk to wildlife and humans that consume fish that have become contaminated via the sediment and food chain transfer. With regard to direct toxic effects to benthic organisms, scientists from NOAA believe that PCB's can begin to cause adverse effect at concentrations as low as 22.7 ppb dry weight. They call this level the "effects range low (ERL)". One approach to developing so-called bioaccumulation-based sediment quality criteria (BBSQC) that shows promise relies upon the equilibrium partition theory. The approach is based on the observation that organic contaminants like PCB's preferentially associate with the organic carbon component of sediments and the lipid fraction of fish. This phenomenon is used to translate an allowable contaminant level in fish flesh to an associated contaminant level in sediment based on simple partitioning. The factor that is used to relate the contaminant level in the organic carbon fraction of the sediment to the contaminant level in the fish lipid is referred to as the biota-to-sediment accumulation factor (BSAF).

DNREC has used the equilibrium partition approach to derive target PCB concentrations for the sediments proposed for placement behind the sand berm at the Kelly Island site. Based on the derivation and calculations in the attachment, the bulk PCB concentration in the surficial sediments should be in the range between 1 and 10 ppb dry weight to keep cancer risk to exposed individuals below a *de minimus* level of 10e-5 (1 in 100,000). The target sediment concentrations are intended to protect fishermen, their families and friends who may consume fish taken in the vicinity of the Kelly Island site. The target sediment concentrations are conservative and reflect standard exposure factors used in human health risk assessment. Fish consumption rates used in deriving the target sediment concentrations are based on a creel study specific to the area of the Delaware Estuary between the PA/DE stateline and Cape Henlopen. One final point worth noting with regard to the target human health sediment levels is that the computed values (1-10 ppb) are of the same order of magnitude as NOAA's ERL of 22.7 ppb. Therefore, if the target of 1-10 ppb to protect humans is met, direct toxic effects to benthic organisms should be prevented as well. It is not for certain that the 1-10 ppb levels will protect certain wildlife species, however the DNREC would like to see levels no higher than 1-10 ppb based upon these calculations.

In comparing the desired PCB concentration range of 1-10 ppb to actual PCB levels for the upper Bay, we note that the actual levels are 10 to 100X greater than the desired levels. In contrast, PCB levels in surficial sediments taken just off of Bowers Beach during the summer of 1995 meet the desired levels. Despite the moderate levels of PCB in the surficial sediments of the upper Bay , it is quite possible that a 5' depth-averaged concentration of PCB from the upper Bay might meet the desired level of 1-10 pbb if the actual contamination is limited to the upper 6 inches or so. In other words, if the deep sediments are clean, they will act to dilute the dirty surficial sediments. The 5' depth-averaged concentration has relevance in this situation since the proposed dredging project would deepen the existing channel by 5 feet. Unfortunately, we do not have any high quality PCB data for 5' cores.

Given the distinct possibility that the deep sediments are clean, two practical strategies come to mind for dealing with the PCB problem. The first strategy would be to make sure the surficial sediments are will-mixed with the deeper, presumably cleaner, bottom sediments upon placement in the Kelly Island wetland. The second strategy would be to place all the surficial sediment on the bottom of the wetland and cover it with the material presumed to be cleaner. This latter strategy may or may not be acceptable from a soil mechanics perspective. Both strategies obviously rely upon the presumption that the deep sediments are clean. There are two ways to deal with this uncertainty, one pre-construction, and one post-construction. The pre-construction option would involve analyzing several five foot deep cores from the area to be dredged for the Kelly Island site. The second option is to hedge a bet that the deep sediments are clean and simply take several sediment samples from the Kelly Island wetland site after construction to verify that the desired PCB levels are met. Regardless of the option, proper analytical methods for PCB's should be used.

The DNREC would like to thank the Corps for meeting with them, the opportunity to comment on the Beneficial Reuse component of the Delaware River Main Channel Deepening project, and looks forward to the Corps response on this subject.

Sincerely,

Sarah W. Cooksey

Sarah W. Cooksey, Administrator
Delaware Coastal Management Program

Enclosure

cc: Christophe A. G. Tulou, Secretary, DNREC
John Hughes, Director, DSWC
Gerard Esposito, Director, DWR

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2/20/96

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
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OFFICE OF THE DIRECTOR

TELEPHONE: (302) 739 - 3451

May 22, 1995

Mr. Stan Lulewicz
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square
Philadelphia, Pennsylvania 19107

RE: Delaware River Channel Deepening Project/ Beneficial Reuse

Dear Mr. Lulewicz:

Pursuant to the workshop held on beneficial reuse of material from the Delaware River Channel Deepening Project, the State of Delaware has gathered comments for your review. The following comments are reflective of several different Divisions within the Delaware Department of Natural Resources and Environmental Control, specifically the Division of Fish & Wildlife and the Division of Soil & Water Conservation.

Regarding the proposed wetlands restoration on Kelly Island via geotextile tube placement, the State is interested in the composition of the dredged material that is to be placed behind the tubes in order to establish an elevation of +4.5 feet MLW. The preliminary design for the Kelly Island project illustrates that this dredged material will be composed of silt and sand. Specifically, the State would like to know the exact ratio of silt to sand and the expected stability of the material . We are concerned about the potential impacts of the material depositing on shellfish beds in the event of a catastrophic weather occurrence.

We are also interested in the Corps evaluation of the potential beneficial reuse of dredged material for shoreline stabilization along road 89 at Port Mahon. It is our understanding that the Corps is willing to evaluate this potential reuse site. We would also like to explore any opportunity to reuse the large stone/rock material that will be generated from the channel deepening in the Marcus Hook area in conjunction with shoreline stabilization at Port Mahon and Delaware's artificial reef program. Another option the State would like to consider is potential oyster bar creation using dredged sand material within the Delaware Bay. The State feels that these options for beneficial reuse are ideas that need to be expanded and looked at more closely.

As discussed in the recent workshop, ideally in the absence of technical, political, and economic constraints placed upon the disposal of the clean sand from this project, the State would prefer to see the material placed directly on the beach at our current nourishment project sites along the Delaware Bayshore (i.e. Lewes, Broadkill, Slaughter, South Bowers, Bowers, Kitts Hummock, and Pickering Beaches) and/or on the beach or in the nearshore zone in 15-20 ft. of water at Dewey and Rehoboth Beach. Recognizing the existence of the above constraints, the proposed nearshore sand stockpile sites designated as MS-19 and L-5 appear to offer a reasonable alternative for the disposal of dredged sand for beneficial reuse.

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Historically, the State (DNREC) and Federal government (USACE) have placed over 761,000 cubic yards of sand at Broadkill Beach (since 1973) and the State alone has placed about 514,000 cubic yards of sand at Slaughter Beach (since 1975). The Northwestern limits of acceptable accessible offshore sand resources for this project are the offshore extensions of Roads 16 and 224. The Northwestern portion of these sand resources have been so heavily utilized in past projects that the northern portion of both project areas can no longer be nourished by our existing equipment due to the increased distance from remaining sand resources to the nourishment site. It is for the above reasons that we would request that every effort be made to locate both MS-19 and L-5 as close to shore and as far Northwest from their current proposed locations as possible given the Corps current restraints.

Thank you for the opportunity to comment on the beneficial reuse project and we look forward to future discussions with the Corps on this project. If we can provide you with any additional information or if you have any questions regarding these comments please feel free to call me at (302) 739-3451.

Sincerely,

Sarah W. Cooksey

Sarah W. Cooksey, Administrator
Delaware Coastal Management Program

SWC/jll

cc: John Hughes, DNREC-DSWC
Bob Henry, DNREC-DSWC
Jeff Tinsman, DNREC-DFW
John Brady, USACE-Philadelphia District

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
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OFFICE OF THE SECRETARY

TELEPHONE: (302) 739 - 4403
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January 31, 1992

Mr. Robert L. Callegari
Chief, Planning Division
Department of the Army
Philadelphia District, Corps of Engineers
Custom House 2nd and Chestnut Streets
Philadelphia, Pennsylvania 19106-2991

Dear Mr. Callegari:

This letter is to notify you that pursuant to 15 CFR Section 930.42, the Delaware Coastal Management Program (DCMP) conditionally agrees with the Army Corps of Engineers' coastal zone consistency determination on the amendment to the Draft Environmental Impact Statement for the Delaware River Comprehensive Navigation Study, Main Channel Deepening project. This finding is the result of a Department review of the draft EIS and meeting with Corps staff to discuss our environmental concerns regarding the proposed project. Since this project and decisions related to its actual implementation will be done in phases, the DCMP pursuant to 15 CFR Section 930.37 (c), will require another consistency determination at the conclusion of the pre-construction engineering and design phase to ensure that the enforceable policies of the DCMP regarding the issues raised in this correspondence are addressed.

The Delaware Coastal Management Program policies related to the pertinent issues of habitat protection, water quality, and water supply are noted below:

HABITAT ISSUES:
<u>Policy 5.C.3.1</u>.

The quantity and quality of fish and wildlife habitat shall be preserved to the maximum extent possible.

Related Policies (Sec. 5.A.1), the wetland policies, **(Sec. 5.A.3)**, the water quality policies, **(Sec. 5.A.4)**, the coastal strip policies, **(Sec. 5.B.2)**, the nature preserves policies, and **(Sec. 5.C.5)** State owned conservation lands policies.

WATER QUALITY ISSUES:
Policy 5.A.3.A.5.

The Quality of State waters shall be maintained at various levels to support pre-designated uses for different segments of these waters. Such uses shall include public water supply; industrial water supply; uses involving prolonged intimate body contact with water in which there is a significant chance of ingestion, such as swimming or waterskiing (primary contact recreation); uses involving water as a pleasurable setting for activities in which there is an insignificant chance of ingestion, such as wading, hiking picnicking, fishing, or boating (secondary contact recreation); maintenance, protection and propagation of fish, shellfish and aquatic life and wildlife preservation; agricultural water supply; navigation; drainage; and passage of anadromous fish.

Policy 5.A.3.A.6.

To ensure that the water quality in the various water segments can support the designated uses, specified water quality standards (criteria) for different pollution indicators shall be maintained in the different water segments.

Policy 5.A.3.A.7.

Short transition zones shall exist between adjacent zones of varying water quality.

Policy 5.A.3.A.10.

At a minimum, coastal waters shall not contain substances attributable to municipal, industrial, agricultural or other discharges in concentrations or amounts sufficient to be adverse or harmful to water uses to be protect, or to human, animal, and plant life. Such waters shall be free from floating solids, sludge deposits, debris, oil and scum.

Policy 5.A.3.B.12.

Discharges into coastal waters shall not contain debris, scum, floating materials, or substances that settle to form sludge deposits. Pollutants in discharges shall be reduced to the extent required to achieve and maintain stream quality criteria.

Policy 5.A.3.C.18.

No person or entity shall, without a permit, undertake any activity in a way which may cause or contribute to the discharge or dredged spoil, solid waste, incinerator residue, sewage, garbage, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, munitions, rock, sand, cellar dirt, or industrial, municipal, or agricultural waste into any surface or groundwater within the State.

Policy 5.A.3.F.32.

No erosion and sediment control plan shall be approved unless it meets conservation standards consistent with the general CMP coastal waters policies and the statewide comprehensive erosion and sediment control program developed by the Delaware Department of Natural Resources and Environmental Control.

WATER SUPPLY ISSUES:
Policy 5.A.3.18

No person or entity shall, without a permit, undertake any activity in a way which may cause or contribute to the discharge or dredge spoil, solid waste, incinerator residue, sewage, garbage, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, munitions, rock, sand, cellar dirt, or industrial, municipal, or agricultural waste into any surface or groundwater within the state.

It is our understanding of the Corps' Civil Works Project process that information on how these policies will be addressed will require additional environmental studies. It is therefore agreed that a conditional consistency determination is granted contingent upon the following studies and information being provided by the Corps to the DCMP during the project process.

The DCMP will review the results of the studies and additional documentation requested and should the information show far reaching deleterious environmental effects, the conditional consistency determination will be revoked. The additional studies and information required of the Corps include the following:

* Bioassay testing of sediments to be dredged.

We appreciate the extensive testing of sediment chemistry that has been done using bulk and elutriate methods. In order to facilitate the evaluation of these data, we require that the COE conduct a comparison of these results with the numeric criteria contained in Delaware's Water Quality Standards (as amended February 2, 1990). A copy of these standards has been provided to your Environmental Resources Branch. This comparison will help to evaluate the impacts of discharges at disposal sites.

The existing criteria and chemical testing do not address the effects of contaminants not tested or the effects of chemicals in combination with other chemicals. We are particularly concerned with the levels of mercury detected and the potential for toxic effects on biological resources. The chemical soup (the whole) may show toxicity even though the individual chemicals (the sum of the parts) do not.

Bioassay and bioaccumulation testing are well established in evaluating the impact of point sources discharges on surface waters. EPA and the COE have developed a testing manual that identifies these types of methods specifically for dredge material, the "Green Book". This document describes a tiered approach to the testing of sediments, and the present EIS has accomplished essentially Tier I. We require that the COE implement the remaining tiers of the manual that includes bioassays and bioaccumulation protocols. We believe that a project of this size warrants the application of "state of the art" methods of testing sediment quality. (See policies 5.C.3.1. and 5.A.3.A.10.)

* Impacts of dredging activities on aquatic resources.

Regarding the impacts on the aquatic resource from the proposed dredging in the Delaware River and Bay we have several concerns. Benthic invertebrates have been shown to be good indicators of environmental quality in estuaries. A recent report prepared by the Maryland Department of Natural Resources ("Long-term Benthic Monitoring and Assessment Program for the Maryland Portion of the Chesapeake Bay:

Interpretative Report", CBRM-LTB/EST-89-2, September 1989) successfully used benthic invertebrates to evaluate the impacts of power plant discharges over the Maryland portion of the Chesapeake Bay. Due to the magnitude of the proposed main channel deepening project we will require an evaluation of the overall impact of dredging on the aquatic resources located within the channel and proposed beneficial use disposal sites of the estuary. Such a study should be coordinated with the activities of the EPA Environmental Monitoring and Assessment Program (EMAP).

* The impacts of marsh creation on existing aquatic resources in the area have not been evaluated.

The DCMP supports the beneficial use concept of using suitable dredge material for the creation of wetlands. But, before such an approach is considered for dredge material disposal, further evaluation of the technical and environmental feasibility of this concept must be demonstrated. Such an evaluation should include two parts. Part one should address site specific losses to existing aquatic resources and indirect impacts to adjacent habitats. Part two should include a technical, operational and engineering feasibility of the concept (i.e. site establishment, stabilization, design, and biological predictability). Monitoring would also be needed to measure the success of any concept implemented. Such monitoring would have to include physical, chemical and biological data collected for several years after the project is completed. (See policy 5.C.3.1.)

* Salinity monitoring before and after the proposed work should be part of this project. This is not mentioned in the EIS.

The Army Corps of Engineers will need to conduct more in-depth research of the modeling of salinity intrusion and flow patterns in the Delaware Bay. Within the EIS, we feel that the following should be considered: (1) Plants that have high value for wildlife and endangered species occur at salinities less than 15 parts per thousand. It is in these areas that biodiversity is the highest. Previous environmental impact statements have tended to under-estimate the salt water intrusion from dredging projects. (2) The dredging project will need to be monitored and more accurate estimations made on the salinity gradings which may adversely impact biodiversity of the upper reaches of the estuary or change the patterns of estuarine vegetation and animal life. (3) With regard to the scoping process and the 3-D model which has been proposed, we should included in the development of this process regarding its impact on State Species of Special Concern, Natural Communities of Special Concern, vegetation, and wildlife resources. (See policy 5.A.3.A.5.)

* The impacts of offshore stockpiling of dredged material for future beach nourishment needs to be evaluated.

The DCMP supports the beneficial use concept of offshore stockpiling of dredged material for future beach nourishment projects. Although this procedure was selected as a feasible option, there was no indication of the impacts that would occur to benthic resources. Before this option can be further considered, these impacts must be evaluated. Final siting of the stockpile areas will be driven by benthic studies that will be scoped with DCMP input and completed during the pre-construction engineering and design phase. (See policies 5.C.3.1. and 5.A.3.A.5.)

In addition to addressing the points raised regarding federal consistency, the Corps of Engineers prior to commencing any work on this project will need to secure all required State permits. Specifically, this will mean that the Corps will have to make application to the State of Delaware for Subaqueous Lands permits and a State discharge permit (7 Del. Code, Section 6003) from the Department of Natural Resources and Environmental Control, Division of Water Resources. Enclosed for your reference are copies of the Delaware Coastal Management Program document (which contains the policies noted above), the Subaqueous Lands Act and Regulations, and the Delaware Environmental Protection Act.

In closing, we look forward to working with the Corps during the scoping process in design of the necessary studies called for in this correspondence as this project moves into the pre-construction engineering and design phase.

Sincerely,

Edwin H. Clark, II

Edwin H. Clark, II
Secretary

EHC/AM/ccb

cc: Trudy Coxe, OCRM

State of New Jersey
Department of Environmental Protection and Energy
Environmental Regulation
CN 401
Trenton, NJ 08625-0401

Scott A. Weiner
Commissioner

John R. Weingart
Assistant Commissioner

February 3, 1992

Robert L. Callegari
Chief, Planning Division
Philadelphia District, Army Corps of Enginneers
Second and Chestnut Streets
Philadeliphia, PA 19106-2991

RE: Federal Consistency for Delaware River Main Channel Deepening
FC File Number: 0000-90-0005.2

Dear Mr Callegari:

The New Jersey Department of Environmental Protection and Energy, Land Use Regulation Program, Acting under Section 307 of the Federal Coastal Zone Management Act (P. L. 92-583) as amended, certifies that the above referenced project is conditionally consistent with the approved New Jersey Coastal Zone Management Program conditioned upon 15 CFR 930.39 requiring "Necessary Data and Information".

<u>Project Description</u>

The proposed project is the deepening of the Delaware Main Channel from Cape May and Cape Lewes to the Ports of Philadelphia and Camden, approximately one hundred river miles. The present channel depth is forty feet with the proposed channel depth to be forty five feet.

<u>Coastal Zone Management Conditions</u>

Pursuant to the <u>Rules on Coastal Zone Management</u> specifically Shellfish Beds(N.J.A.C. 7:7E-3.2) "Any coastal development which would significantly alter the water quality, salinity regime, substrate characteristics, natural water circulation pattern, or natural functioning of the Shellfish Beds during construction or operation of the development is prohibited."

As a condition of this consistency finding, the Army Corp of Engineers is required to provide the necessary data that the deepening will not alter the salinity regime to the extent that the oyster resource would suffer significant negative effects. The data should be derived through "state of the art" modeling techniques that mimic the total dimensional aspect of the channel and river cross section.

The Army Corp of Engineers is also required to show that the deepening will not significantly alter the hydrological and geomorphological features of the project area as to negatively effect the circulation patterns, current velocity, sedimentation rates and erosion rates that could adversely effect oyster larval distribution, seed bed displacement and blue crab distribution.

Upon review of information provided pursuant to the above condition requirements, if the Department of Environmental Protection and Energy determines that there would be adverse effects to New Jersey's Coastal Zone then the Department reserves the right to revoke this conditional consistency determination.

Please be advised that the Army Corp of Engineers is required to obtain Letters of Interpretation for the "upland" dredge spoil disposal sites located in New Jersey pursuant to the Freshwater Wetlands Protection Act N.J.S.A. 13:9B-1 et seq.

Thank you for your continued attention to and cooperation with New Jersey's Coast Management Program.

Sincerely,

Robert A. Tudor
Administrator

c. Lawrence Schmidt, Program Coordination
George Howard, Fish, Game and Wildlife
Bernie Moore, Coastal Engineering
Robert Runyon, Water Resources
Steve Whitney, Regulatory Policy

Pennsylvania Department of Environmental Protection

Rachel Carson State Office Building
P.O. Box 2063
Harrisburg, PA 17105-2063
February 4, 1997

Policy Office

Mr. Robert L. Callegari
Chief, Planning Division
Philadelphia District, Corps of Engineers
Department of the Army
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

The Pennsylvania Department of Environmental Protection (DEP) has reviewed the draft supplemental environmental impact statement (SEIS) regarding the Delaware Main Channel Deepening Project. We have the following comments:

The Department's main concern regarding this project has been the potential for increase in magnitude and upstream migration of salinity that could result, and the possibility of a significant impact on Philadelphia's water supply, the Potomac-Raritan-Magothy aquifer, as well as increased problems to industrial users in Pennsylvania.

Sections of the SEIS that address these concerns include Chapter 5 and Sections 7.1 and 7.2. In order to develop the information of Chapter 5, the Corps has utilized a three-dimensional hydrodynamic model to predict changes in Delaware River and Estuary salinity under various flow scenarios. These scenarios were coordinated with the various water resources agencies of the Delaware River Basin.

The SEIS concludes that "deepening of the Delaware River navigation channel will have a negligible effect on the recharge characteristics of the aquifer" and that "although the proposed channel deepening is predicted by the salinity model to increase [river mile] 98 chlorinity with a recurrence of the drought of record, the resulting 30-day average chlorinity will still be below the present standard of 180 ppm." Moreover, the SEIS points out "Philadelphia's intake at the Samuel Baxter Treatment Plant at river mile 110 is well upstream of [river mile] 98 where the chlorinity standard is set."

In recent discussion with the Delaware River Basin Commission (DRBC) Operations Staff, who have independently modeled salinity changes resulting from the proposed channel deepening using a different model, DEP determined that some discrepancies still exist between modeling results from the DRBC's and Philadelphia District's salinity models. These discrepancies should be resolved. However, it does not appear that the conclusions of the SEIS would be invalidated by minor adjustments in salinity intrusion findings.

Therefore, this Department concurs with your final determination that the proposed Delaware River Main Channel Deepening Project is consistent with Pennsylvania's Coastal Zone Management Program.

If you have any questions, please feel free to contact William A. Gast, Chief of the Division of Water Use Planning, DEP's Bureau of Watershed Conservation at (717) 772-4048.

We appreciate the opportunity to comment on this proposal.

Sincerely,

B. Sexton

Barbara A. Sexton
Director, Policy Office

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES

P.O. Box 2063
Harrisburg, PA 17105-2063
(717) 787-4686

Deputy Secretary for Water Management

February 21, 1992

Lt. Colonel Kenneth H. Clow
District Engineer
Philadelphia District, Corps of Engineers
Custom House - Second and Chestnut Streets
Philadelphia, PA 19106-2991

Dear Colonel Clow:

This response concerns the Division of Coastal Zone Management's (CZM) federal consistency review of the Environmental Impact Statement Amendment for the Delaware River Comprehensive Navigation Study Main Channel Deepening Project (November 1991), received on January 17, 1992. The Division has determined that this phase of the project is consistent with the Pennsylvania CZM Program as provided for under 15 CFR 930.37(c).

The Division of CZM's and the Department's main concern regarding the proposed Channel Deepening Project is the increase in magnitude and upstream migration of salinity that will result, and the possibility of a significant impact on Philadelphia's water supply, the Potomac Raritan Magothy aquifer, as well as increasing problems to industrial users in Pennsylvania.

The Commonwealth and Delaware River Basin Commission have been addressing the salinity intrusion issue by developing upstream reservoirs for increasing water releases to the Delaware River to reduce the threat of salinity intrusion. Because of the impacts of this project, it is important the Corps of Engineers identify similar or other mitigation options in future studies.

We have been informed by John Burnes and Jerry Pasquale of your staff that the development of this project will take several years to complete, requiring additional studies to be performed including mitigation plans and supplemental environmental impact statements to be developed. We have also been assured by Mr. Pasquale that there will be additional opportunities for the CZM Division to make consistency determinations on future phases of this project. With this understanding, we consider this phase of the project to be consistent with the Pennsylvania CZM Program. As you are aware, 15 CFR 930.37(c) requires that where major federal decisions are made in phases based upon developing information, a consistency determination will be required for each major decision.

In conclusion, please send any additional studies or impact statements concerning future phases of this project for our consistency review.

Sincerely,

Caren E. Glotfelty
Deputy Secretary
for Water Management

CULTURAL RESOURCES - DELAWARE

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3390

REPLY TO
ATTENTION OF

JUL 2 1997

Environmental Resources Branch

Ms. Alice Guerrant
Historic Archaeologist
Bureau of Archaeology and Historic Preservation
Division of Historical and Cultural Affairs
#15 The Green, P.O. Box 1401
Dover, Delaware 19901

Dear Ms. Guerrant:

This letter is pursuant to our continuing Section 106 coordination for the proposed Delaware River Main Channel Deepening Project. In a letter dated February 4, 1997, your office provided a review of the *Delaware River Main Channel Deepening Project Draft Supplemental Environmental Impact Statement (DSEIS)* and concurred with the District's finding that the proposed employment of the Reedy Point North and South disposal sites, the Buoy 10 overboard disposal site, the Kelly Island wetland restoration site and the sand stockpiling locations near Slaughter Beach (MS-19) and Broadkill Beach (LC-5) will have no impact on significant cultural resources (Enclosure 1).

However, your office did not concur with the District's "No Effect" finding regarding potential project impacts on significant shoreline archaeological deposits associated with the military occupation of Fort Delaware on Pea Patch Island, a property listed on the National Register of Historic Places.

Following the issuance of the DSEIS and the concerns expressed in your February 4, 1997 letter, the District evaluated the potential for increased shoreline erosion on Pea Patch Island resulting from the proposed deepening of the Delaware River Main Channel to 45 feet (Enclosure 2). This research analyzed various data to determine 1), if deepening the channel would increase current velocities and head values, 2) if vessels using the deepened 45 foot channel would generate larger waves than presently occur with the 40 ft. channel, and 3) if these predicted changes in current velocities, head values and wave heights would increase the shoreline erosion on Pea Patch Island.

This analysis indicates that channel deepening will have a negligible effect on current velocities, water levels, and wave heights at shoreline locations adjacent to the channel on Pea Patch Island and that these changes will not increase shoreline erosion.

A review of existing shoreline profiles and hydrographic data adjacent to Pea Patch Island show the majority of channel depths well below the proposed new dredging depth of 45 feet. Only minimal new dredging in isolated high spots will occur in the vicinity of Pea Patch Island. This proposed work will not significantly effect the existing channel side-slopes and will not result in a movement of the federal channel closer to the island.

It is the Philadelphia District's opinion, based on the information provided in the attached report, that the proposed deepening of the Delaware River Main Channel to a depth of 45 feet will have no impact on the significant archaeological deposits on the shoreline of Pea Patch Island.

Please review the additional information provided in the enclosed report and provide this office with your opinion regarding our "No Effect" finding within 30 days of the date of this letter. If you have any questions regarding this project, please contact Michael Swanda of the Environmental Resources Branch at (215) 656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Enclosure

OCT 17 1995

Environmental Resources Branch

Ms. Faye L. Stocum
Environmental Review Coordinator
Bureau of Archaeology and Historic Preservation
Division of Historical and Cultural Affairs
#15 The Green, P.O. Box 1401
Dover, Delaware 19901

Dear Ms. Stocum:

The U.S. Army Corps of Engineers, Philadelphia District has completed the latest in a series of cultural resources investigations for the Delaware River Comprehensive Navigation Study, Main Channel Deepening Project. A draft report, entitled Submerged and Shoreline Cultural Resources Investigations, Disposal Areas and Selected Target Locations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania (Cox & Hunter, September 1995) is enclosed for your review. This study, partly based on the results and recommendations of the report Submerged Cultural Resources Investigations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania (Dolan Research, Inc., April, 1995), involved four principal work elements at various locations in the Delaware Bay and Delaware River vicinity including remote sensing survey of proposed overboard disposal areas, shoreline survey, underwater target ground truthing and shipwreck investigations. Project areas investigated in Delaware include four potential overboard disposal areas and 11 remote sensing targets.

Remote sensing survey in Delaware was conducted in the Little River (LC-10), Slaughter Beach (MS-19), Roosevelt (L-05) and Port Mahon (LC-09) disposal areas (see report Chapter 6). Targets identified within disposal areas LC-10, MS-19 and LC-05 displayed signature characteristics typically generated by various types of modern debris, or single isolated objects on the bottom. No potentially significant cultural resources were identified in these locations.

Two magnetic anomalies, 9:534 and 9:553, were identified in the Port Mahon (LC-09) disposal area as high probability targets. Underwater ground truthing operations determined both targets as modern debris and not archaeologically significant. Sections of a modern clam dredge and 12" diameter pipe were found at Target 9:534. Target 9:553 exhibited the upper portions of a large 6" diameter, heavy gauge pipe with a welded swivel piece on top and frayed wire rope. It appears to be associated with either a modern navigational or mooring buoy (see report Chapter 7-33).

A low-tide shoreline survey within the boundaries of the Port Mahon (LC-09) disposal area identified the remains of the 1940's New Comb and Hand/Port Mahon Oyster Shucking House and the site of the 1903 Port Mahon Lighthouse, which was lost during the last decade due to severe shoreline erosion (see report Chapter 6-19). These former remains are not considered archaeologically significant.

Underwater ground truthing operations in Delaware waters were also conducted at 11 remote sensing targets identified during the 1993 field season. The results of these investigations are presented in report Chapter 7-1 thru 7-27. In summary, 6 targets exhibited bottom surface debris associated with modern navigation buoys. The remains of a modern fiberglass sailing vessel was identified at Target S-592. Divers found the remains of a wooden hulled barge in poor condition with limited structural integrity on the east channel side-slope off Pea Patch Island at Target S-33. The barge is not considered significant. The last target, S-49, exhibited a pile of partially buried iron I-beams in 57 feet of water. This site will not be impacted by proposed construction due to its location below proposed channel depth of 45 feet.

The District concurs with the report recommendations that no additional archaeological investigations are required at these locations. Based on the results of the cultural resources investigations completed for this project, the Philadelphia District finds that the proposed project will have "No Effect" on significant cultural resources in Delaware. Please review the enclosed and previously submitted documentation and provide us with your opinion concerning our "No Effect" finding within 30 days of receipt of this letter.

You may contact Michael Swanda, Environmental Resources Branch at (215) 656-6556 if you have any questions or need further information.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Enclosure

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STATE OF DELAWARE
DEPARTMENT OF STATE
DIVISION OF HISTORICAL AND CULTURAL AFFAIRS
HISTORIC PRESERVATION OFFICE
15 THE GREEN
DOVER • DE • 19901-3611

TELEPHONE: (302) 739-5685

FAX: (302) 739-5660

November 21, 1994

Mr. Michael Swanda
Archaeologist
Environmental Resources Branch
Philadelphia District, Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mike:

This letter is pursuant to my review of the draft report entitled **Submerged Cultural Resources Investigations, Delaware River Main Channel Deepening Project, Delaware, New Jersey and Pennsylvania,** prepared by Greeley-Polhemus Group, Inc. and Dolan Research Inc. Based on this review, it is our opinion that the consultant has provided your agency with important cultural resource information upon which to make pertinent management decisions for this project. The consultant has identified eleven (11) anomalies within the forty-eight (48) remote sensing survey locations which should be given additional survey consideration. Also, the identification of the Excelsior in one of the five (5) target areas investigated is significant. In all cases, we concur with the consultant that further work is required, assuming that avoidance in the development of this project cannot be achieved. Presently, I'm not sure that Target e-1. 1:5 can be concluded as not eligible. The consultant does not provide sufficient justification.

Pursuant to the consultant discussion on Targets a4:4 and 13:10, there appears that these resources were destroyed as a result of maintenance dredging which occurred after 1987 and before this survey. The Corps should have provided some provisions or mechanisms to protect these targets from ongoing work. Maintenance dredging is an undertaking subject to Section 106. I strongly recommend that something be done to ensure that this does not happen to any of the significant targets which were located or investigated during this survey.

Finally, pursuant to our review of this report against the Secretary of the Interior's **Standards and Guidelines for Archeology** and Historic Preservation: **Preservation Planning** and **Identification** (48 FR 44716 - 44723), there are some concerns. Some adjustments to the text are needed to bring this report into conformance with these **Standards and Guidelines.** Comments have been attached which should be reviewed by the consultant.

If you have any questions, or require any additional assistance, please do not hesitate to contact me at your convenience. Thank you.

Sincerely,

Faye L. Stocum

Faye L. Stocum
Archaeologist

Enclosure

cc: J. Lee Cox

STATE OF DELAWARE
DEPARTMENT OF STATE
DIVISION OF HISTORICAL AND CULTURAL AFFAIRS
HISTORIC PRESERVATION OFFICE
15 THE GREEN
DOVER • DE • 19901-3611
TELEPHONE: (302) 739-5685
FAX: (302) 739-5660

August 2, 1994

Mr. Robert L. Callegari
Chief, Planning Division
Environmental Resources Branch
Philadelphia District, Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107

Attn: Mike Swanda

Dear Mr. Callegari:

I have received you letter wherein you indicate that two (2) Delaware disposal sites have been identified for use in the proposed Delaware River Main Channel Deepening Project. Please be advised that we are of the opinion that since both of these sites have been previously used by the Corps, the placement of additional fill at the Reedy Point North and South disposal sites will not effect any significant historic properties in this area of New Castle County. We concur with you assessment.

Please do not hesitate to contact me if I can be of any further assistance. Thank you.

Sincerely,

Faye L. Stocum

Faye L. Stocum
Archaeologist

cc: Miriam Lynam

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CULTURAL RESOURCES - NEW JERSEY

SEP 2 8 1995

Environmental Resources Branch

Ms. Dorothy P. Guzzo, Administrator
New Jersey Historic Preservation Office
New Jersey Department of Environmental Protection
CN 404
Trenton, New Jersey 08625

Dear Ms. Guzzo:

The U.S. Army Corps of Engineers, Philadelphia District has completed the latest in a series of cultural resources investigations for the Delaware River Comprehensive Navigation Study, Main Channel Deepening Project. A draft report, entitled Submerged and Shoreline Cultural Resources Investigations, Disposal Areas and Selected Target Locations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania (Cox & Hunter, September 1995) is enclosed for your review. This study, partly based on the results and recommendations of the report Submerged Cultural Resources Investigations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania (Dolan Research, Inc., April, 1995), involved four principal work elements at various locations in the Delaware Bay and Delaware River vicinity including remote sensing survey of proposed overboard disposal areas, shoreline survey, underwater target ground truthing and shipwreck investigations. Project areas investigated in New Jersey are Egg Island Point overboard disposal area [PN-1a], Steamboat "Excelsior" Site [E-2, 4:16] and Canal Coal Barge Site [E-2, 4:16].

The proposed 269 acre Egg Island Point overboard disposal area [PN-1a] is located adjacent to the shoreline on the southeastern side of Egg Island Point, Cumberland County. A remote sensing survey of the area did not identify any high probability targets resembling potentially significant submerged cultural resources. A pedestrian survey conducted along the shoreline within disposal area boundaries identified a surface scatter of bricks in the approximate location of the 1878 Egg Island Point Lighthouse. No other cultural material was observed. Phase II underwater investigations at the sites of the steamboat "Excelsior" and the sectional canal coal barge indicate that these vessels are eligible for listing in the National Register of Historic Places under criteria A, C and D.

The Philadelphia District concurs with the report's National Register evaluations and recommendations. The Egg Island Point

Lighthouse Site, "Excelsior" Steamboat Site and Canal Barge Site will be avoided during proposed construction by placing a 200 foot buffer around each site. Please review the enclosed documentation and provide this office with your opinion regarding our finding of "No Effect" within 30 days of the date of this letter. Please do not hesitate to contact Michael Swanda, Environmental Resources Branch at (215) 656-6556 if you have any questions or need further information.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Enclosure

State of New Jersey
Department of Environmental Protection

Christine Todd Whitman
Governor

Robert C. Shinn, Jr.
Commissioner

DIVISION OF PARKS AND FORESTRY
HISTORIC PRESERVATION OFFICE
CN-404
TRENTON, N.J. 08625-0404
TEL: (609) 292-2023
FAX: (609) 984-0578

HPO-L94-45

February 10, 1995

Mr. Robert L. Callegari
Chief, Planning Division
Philadelphia District, Corps of Engineers
Department of the Army
Wanamaker Building
100 Penn Square East
Philadelphia, Pa 19107-3392

Delaware River Comprehensive Navigation Study
Delaware River Main Channel Deepening
Philadelphia District
U. S. Army Corps of Engineers

Dear Mr. Callegari:

I appreciate having been given the opportunity to review a draft version of

[Cox, J. Lee, Jr.]

1994 Submerged Cultural Resources Investigations, Delaware river Main channel Deepening Project. Delaware, New Jersey, and Pennsylvania. Dolan Research, Inc., Philadelphia. April 1994. ["Draft Report: volume 1" (<u>sic</u>)]

I concur with the investigator's recommendations for additional underwater investigation of 11 "targets" (pp. 203-204).

I also concur with his finding that four "targets" detected in 1987 do not meet National Register Criteria of Eligibility as underwater historical resources. The fifth "target", the wreck of the wooden hulled side-wheel steamer Excelsior (1892), does meet the Criteria of Eligibility.

I recommend further investigation of the rock-filled timber crib, Target e-1, 1:5 Section 6.5.2, page 189 bottom-192 top.

This draft versions needs to be emended:

1) Title page must carry author's name.
Date will be day, month, and year of the revision.

2) Throughout, commencing with "Abstract" the terminology needs to be corrected and clarified to distinguish

a. the (width of the) base of the federally dredged navigation channel,
b. the 3:1 side-slope on both sides of a.,
c. the <u>toe of slope</u> of the side-slope,
d. the <u>crest</u> or <u>top of slope</u> of the side-slope.

3) Greater precision in descriptions throughout and employment of acceptable terminology.

4) (<u>Passim</u>) The proper Coast Guard Aids-to-Navigation and Pilot's terminology is: **ranges** <u>intersect</u> at <u>bends</u> in the river; the **vessel** changes course by executing a <u>turn</u> at the <u>intersection</u> of two **ranges**; **bends** are found in <u>rivers</u> and in <u>navigation channels</u>. It will be seen that by their nature ranges cannot "bend".

5) All maps and charts need a graphical scale and north arrow. All Map (boxed) detail rectangles must be oriented as the indexing rectangle on the whole-project locator maps.

6) The report omits mention of aboriginal navigation, Basque whaling in the 13th and 14th centuries, New England whaling in the 17th and 18th centuries, the possible invention of a kind of two-masted schooner by late 17th century Swedes, and the possible Swedish boat building tradition exemplified in the Delaware River (and South Jersey) Durham flatboat.

In view of the inappropriately large number of pages devoted to political, military, and naval history as background or "context", it would reasonably be expected that rare or unique "contexts" would be included.

7) Figures depicting Sonar targets need legends explaining what the strip charts show that may be culturally significant and why.

8) Add , Jr. to all entries for Cox, J. Lee in Section 80.0 (pages 206 and 207), and at other entries in which cox is a junior author.

9) When coordinates for shipwrecks are known, these should be added to Appendix I in a sole copy to be marked and retained as "Confidential" by the Philadelphia District.

10) The writing and organization of the report is inferior, even to the extent of misnaming one of the two "remote sensing" apparatuses. Sharper editing would be desirable; however, it will not essentially meliorate the report.

The project reviewer is Mr. Jonathan Gell; he can be reached at (609) 984-0140.

Sincerely,

James F. Hall
Deputy State Historic
Preservation Officer

JFH:vp

Code#94-1080

C:\WDATA\L94-45

Christine Todd Whitman
Governor

State of New Jersey
Department of Environmental Protection
DIVISION OF PARKS AND FORESTRY
HISTORIC PRESERVATION OFFICE
CN-404
TRENTON, N.J. 08625-0404
TEL: (609) 292-2023
FAX: (609) 984-0578

Robert C. Shinn, Jr.
Commissioner

HPO-G94-118

July 28, 1994

Lt. Colonel R. F. Sliwoski
District Engineer
U. S. Army Corps of Engineers
Wanamaker Building - 100 Penn Square East
Philadelphia, PA 19107-3390

Dear Colonel Sliwoski:

As Deputy State Historic Preservation Officer for New Jersey, in accordance with 36 C.F.R. Part 800: Protection of Historic Properties, as published in the Federal Register, 2 September 1986 (Volume 51, Number 169, pages 31115-31125), I am commenting officially upon the project designated below:

NATIONAL HISTORIC PRESERVATION ACT OF 1966 as amended

SECTION 106: SHPO Consultation and Comments (36 CFR Part 800)

PROJECT TITLE: Delaware River Comprehensive Navigation
Delaware River Main Channel Deepening
Dredged Spoils Disposal- Raccoon Island, 15D, 15G, and 17G
Gloucester County, New Jersey
Pre-construction, Engineering, and Design Study

FEDERAL AGENCY: Philadelphia District
U. S. Army Corps of Engineers

I. 800.4 Identifying Historic Properties

In my opinion the proposed dredged spoils disposal sites entail no cultural resource factors.

II. 800.5 Assessing Effects

Adding dredged spoils to Disposal Sites Raccoon Island, 15D, 15G, and 17G will affect no cultural resources eligible for or listed on the National Register of Historic Places.

Additional Comments:

I would be interested to learn what records the Philadelphia District possesses concerning the creation of these four disposal sites.

If you have any questions, you may contact the project reviewer, Mr. Jonathan Gell, at (609) 984-0140.

Sincerely,

James F. Hall
Deputy State Historic
Preservation Officer

JFH/vs

c: Advisory Council on Historic Preservation
Mr. Michael Swanda, Environmental Corps
Mr. Robert L. Callegari, Planning Corps
Mr. Lawrence C. Schmidt

Code#94-1521

Disk#11A:\G94-118

CULTURAL RESOURCES - PENNSYLVANIA

Commonwealth of Pennsylvania
Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Post Office Box 1026
Harrisburg, Pennsylvania 17108-1026

November 21, 1995

Department of the Army
Philadelphia District, Corps of Engineers
Attn: Robert L. Callegari, Chief, Planning Division
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3390

Re: ER# 84-1708-042-O
Submerged Cultural Resources
Investigations: Delaware River Main
Channel Deepening Project,
Philadelphia & Delaware Counties

TO EXPEDITE REVIEW USE
BHP REFERENCE NUMBER

Dear Mr. Callegari:

The Bureau for Historic Preservation (the State Historic Preservation Office) has reviewed the above named report in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended in 1980 and 1992, and the regulations (36 CFR Part 800) of the Advisory Council on Historic Preservation. Our comments are as follows:

This investigation was well done and we agree with the recommendations of this report. Based on the results of this investigation, in our opinion, project activities will have no effect on significant submerged cultural resources in waters of Pennsylvania.

Although Site E-1, 1:5 lies in waters of New Jersey, this submerged canal coal barge would appear to be directly related to Pennsylvania's nineteenth century coal industry and related transportation network. We agree with the recommendation that the canal coal barge should be completely avoided by project activities and preserved in place. We also agree that the wreck should not be removed from its submerged state without the appropriate provisions for full data recovery, conservation, display and interpretation, and preservation in perpetuity.

Please send three copies of the final report (one unbound) for our files and distribution to the various repositories. Your cooperation in this matter is very much appreciated.

If you have any questions or comments regarding our review of this report please contact Mark Shaffer at (717) 772-0924.

Sincerely,

Kurt W. Carr, Chief
Division of Archaeology &
Protection

KWC/ms

OCT 6 1995

Environmental Resources Branch

Mr. Kurt Carr, Chief
Division of Archaeology & Protection
Bureau for Historic Preservation
Pennsylvania Historical and Museum Commission
Box 1026
Harrisburg, PA 17108-1026

RE: ER# 84-1708-042-L
Submerged Cultural Resources
Investigations: Delaware River
Main Channel Deepening Project,
Philadelphia & Delaware Counties

Dear Mr. Carr:

The U.S. Army Corps of Engineers, Philadelphia District has completed the last in a series of cultural resources investigations for the Delaware River Comprehensive Navigation Study, Main Channel Deepening Project. A draft report, entitled Submerged and Shoreline Cultural Resources Investigations, Disposal Areas and Selected Target Locations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania (Cox & Hunter, September 1995) is enclosed for your review. This study, partly based on the results and recommendations of the report Submerged Cultural Resources Investigations, Delaware River Main Channel Deepening Project, Delaware, New Jersey, and Pennsylvania (Dolan Research, Inc., April, 1995), involved four principal work elements at various locations in the Delaware Bay and Delaware River vicinity including remote sensing survey of proposed overboard disposal areas, shoreline survey, underwater target ground truthing and shipwreck investigations. Project areas investigated in Pennsylvania are located in Tinicum Range and include Targets S 13 and S 49a (page 7-28 in report).

Underwater investigations determined that these two targets contain various modern debris and do not represent significant cultural resources. The District concurs with the report recommendations that no additional archaeological investigations are required at these locations. Based on the results of the cultural resources investigations completed for this project, the Philadelphia District finds that the proposed project will have "No Effect" on significant cultural resources in Pennsylvania. Please review the enclosed and previously submitted documentation and provide us with your opinion concerning our "No Effect" finding within 30 days of receipt of this letter.

Please do not hesitate to contact Michael Swanda, Environmental Resources Branch at (215) 656-6556 if you have any questions or need further information.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Commonwealth of Pennsylvania
Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Post Office Box 1026
Harrisburg, Pennsylvania 17108-1026

July 10, 1995

Department of the Army
Philadelphia District, Corps of Engineers
Environmental Resources Branch
Attn: Robert L. Callegari, Chief, Planning Division
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3390

Re: ER# 84-1708-042-N
Final Report, Submerged Cultural Resources Investigations: Delaware River Main Channel Deepening Project, Philadelphia & Delaware Counties

Dear Mr. Callegari:

The Bureau for Historic Preservation (the State Historic Preservation Office) has reviewed the above named report in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended in 1980 and 1992, and the regulations (36 CFR Part 800) of the Advisory Council on Historic Preservation. These requirements include consideration of the project's potential effect upon both historic and archaeological resources. Our comments are as follows:

Thank you for sending the additional copies of the above referenced report. This investigation has provided important information on submerged cultural resources in the Delaware River and the copies of the report will be sent to the appropriate report repositories. Your cooperation in dealing with this matter is appreciated.

If you have any questions or comments regarding our review of this report please contact Mark Shaffer at (717) 772-0924.

Sincerely,

Kurt W. Carr, Chief
Division of Archaeology & Protection

KWC/ms

Commonwealth of Pennsylvania
Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Post Office Box 1026
Harrisburg, Pennsylvania 17108-1026

July 20, 1994

Department of the Army
Philadelphia District, Corps of Engineers
Attn: Robert L. Callegari
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3391

Re: ER# 84-1708-042-M
Submerged Cultural Resources
Investigations, Delaware River Main
Channel Deepening Project,
Philadelphia & Delaware Counties

TO EXPEDITE REVIEW USE
BHP REFERENCE NUMBER

Dear Mr. Callegari:

The above named report has been reviewed by the Bureau for Historic Preservation (the State Historic Preservation Office) in accordance with Section 106 of the National Historic Preservation Act of 1966, as amended in 1980, and the regulations (36 CFR Part 800) of the Advisory Council on Historic Preservation. Our comments are as follows:

This investigation was well done. We agree with the recommendation that additional archaeological investigation of the eleven high probability targets identified through this survey be conducted to assess their National Register eligibility.

If Target e-2, 4:16, the Excelsior, cannot be avoided by project impacts, we agree that a Phase II evaluation and any additional investigations should be conducted as appropriate. If Target e-1, 1:15, the Revolutionary War-era timber crib, cannot be avoided, in our opinion, it should be salvaged and conserved because it has interpretive value and a museum or historic site in the Delaware Valley may be interested in curating it.

In accordance with our state guidelines, please provide three copies of this report, one of which should be unbound. If you have any questions or comments regarding our review of this report, please contact Mark Shaffer at (717) 772-0924.

Sincerely,

Brenda Barrett
Director

APPENDIX B

ENVIRONMENTAL REPORTS

APPENDIX B - ENVIRONMENTAL REPORTS

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SECTION B-1

INTRODUCTION

Included in the following sections are some of the reports that were done to gather information for the preparation of this document. The first report (Section B-2) is an environmental assessment that was prepared to evaluate possible impacts that may occur to endangered species under the jurisdiction of the U.S. Fish and Wildlife Service (FWS). The next two reports (Sections B-4 and B-5) are planning aid reports prepared by the FWS that provide information on the relationship of the beneficial use of dredged material in the aquatic disposal sites and the management of confined upland dredged material disposal sites to fish and wildlife resources.

SECTION B-2

BIOLOGICAL ASSESSMENT OF THE BALD EAGLE (*Haliaeetus leucocephalus*) AND THE PEREGRINE FALCON (*Falco peregrinus*) FOR THE DELAWARE RIVER, MAIN CHANNEL DEEPENING PROJECT, PHILADELPHIA DISTRICT, U.S. ARMY CORPS OF ENGINEERS, OCTOBER, 1995

BIOLOGICAL ASSESSMENT OF THE BALD EAGLE (HALIAEETUS LEUCOCEPHALUS) AND THE PEREGRINE FALCON (FALCO PEREGRINUS)

FOR

THE DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Prepared By:

U.S. ARMY
CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

OCTOBER, 1995

BIOLOGICAL ASSESSMENT FOR THE BALD EAGLE (*Haliaeetus leucocephalus*) AND THE PEREGRINE FALCON (*Falco peregrinus*) FOR THE DELAWARE RIVER COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT

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INTRODUCTION

Based on the findings of the February, 1992 Delaware River Comprehensive Navigation Study Main Channel Deepening Interim Feasibility Report and Environmental Impact Statement, the proposed channel deepening of the Delaware River was authorized by Congress in October, 1992 as part of the Water Resources Development Act of 1992. Preconstruction Engineering and Design (PED) Study efforts were initiated in April, 1992. In compliance with Section 7 (c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), this biological assessment evaluates the potential effects of the Channel Deepening Project on the threatened bald eagle (Haliaeetus leucocephalus) and the endangered peregrine falcon (Falcon peregrinus). This assessment was prepared in accordance with the Joint Regulations on Endangered Species (50 CFR Section 402.12). A separate biological assessment is being coordinated with the National Marine Fisheries Service addressing those species that occur in the project area that are within their jurisdiction.

PROJECT DESCRIPTION

The proposed plan of improvement calls for modifying the existing Federal Navigation channel from 40 feet at mean low water to 45 feet. The proposed project provides for a full width channel that would follow the existing channel alignment from the Delaware Bay to the Philadelphia/Camden waterfront, a distance of about 102.5 miles (Figure 1). The proposed project includes all appropriate bend widenings as well as provision of a two space anchorage at Marcus Hook. Approximately 36 million cubic yards of dredged material would be removed for initial construction over a four year period. Dredged material from the river would be placed in confined upland disposal areas. Material excavated from the Delaware Bay would be primarily sand and would be considered for various beneficial purposes including wetland creation/restoration at Egg Island Point, NJ and Kelly Island, DE, and underwater sand stockpiling for future beach nourishment. Construction of the upland disposal areas is scheduled to begin about the year 2000 and take 1 year to complete. The dredging for the channel deepening is expected to take about 4 years to complete. The upland disposal areas will be used for 50 year maintenance of the proposed project.

Dredging Approximately 36 million cubic yards of material would be dredged from the navigation channel using hydraulic dredging. Approximately 26 million yards from the river portion, upstream of Artificial Island, would be placed in confined, upland disposal areas; 10 million cubic yards from the Bay would be used for beneficial uses.

Upland Disposal Sites Dredged material from the river portion of the project area will be placed in new and existing Federal confined disposal facilities (CDFs). The four new disposal areas are located in New Jersey (17G, 15D, 15G, and Raccoon Island) and were formerly used for dredged disposal about 25 years ago. All these sites are also shown on Figure 1. Figures 2 thru 5 show the habitat types that presently occur on the 4 new sites and Table 1 shows a compilation of the vegetation/habitats that exist on these sites. Sites 17G, 15D, and 15G are primarily used for row crop agriculture, while Raccoon Island is primarily covered by common reed (Phragmites australis). Under the project, the new CDFs will be managed to maximize wildlife/wetland values as much as is practicable while serving the need to confine dredged material (Table 2).

Beneficial Use Sites The following beneficial uses of the 10 million cubic yards of dredged material from Delaware Bay are being considered:

1. Egg Island Point, NJ, Wetland Restoration Site (See Figures 6 and 7).

a. Objective: To provide protection for existing wetlands and allow for restoration of wetlands.

b. Proposed Design

EAST SIDE

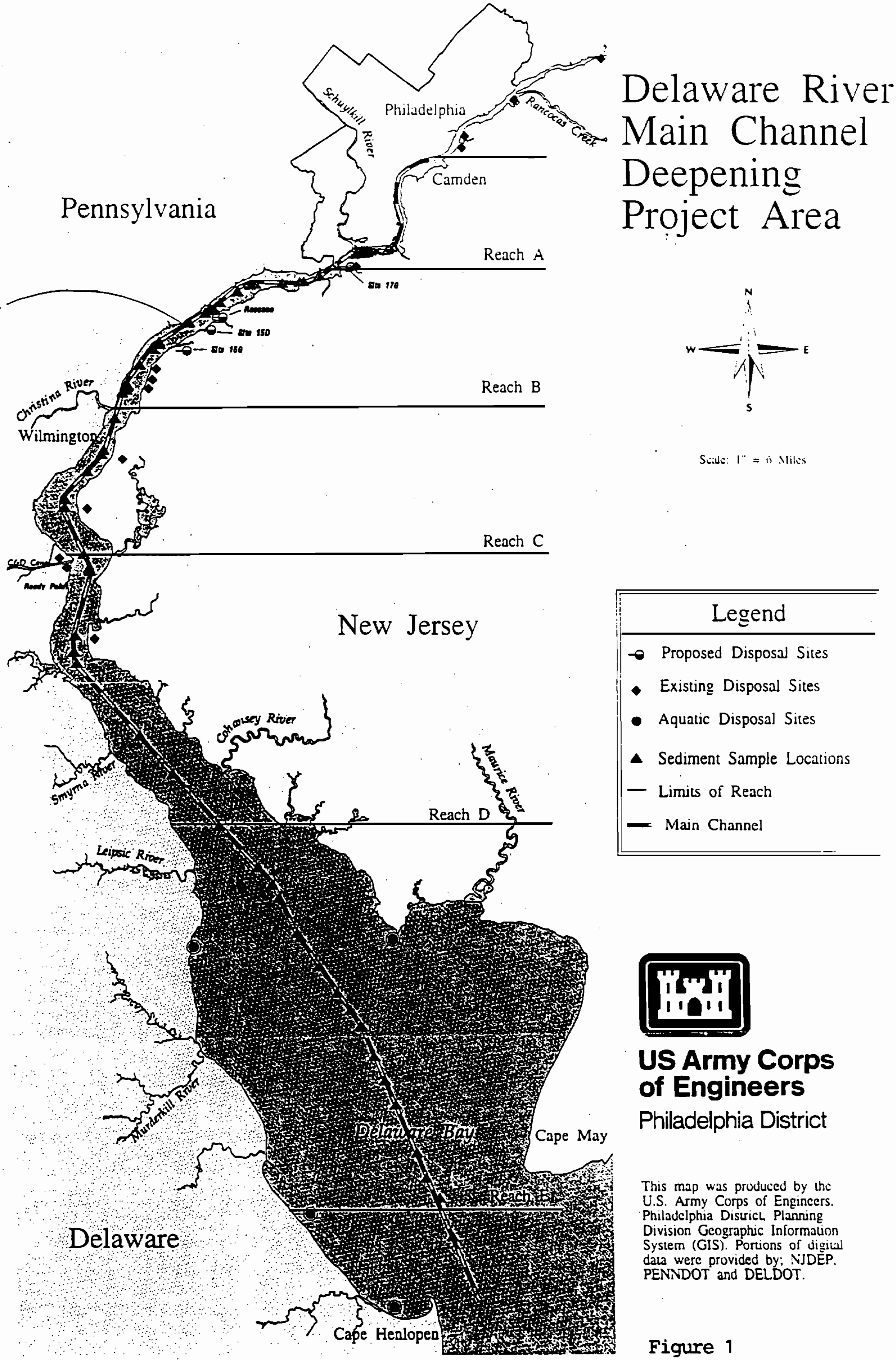
. Hydraulically place a sand foundation to elevation of 0 foot MLW along the alignment of the geotextile tube. The foundation will have a 80 to 100 foot top width and 1V to 15H sideslopes.

. Place a scour apron on top of the sand foundation extending 15 feet beyond the seaward edge of the proposed location of the tube. The apron will protect the tube from undermining scour.

. Place and fill 200' tubes, butted end to end on top of the scour blanket and foundation. The final tube elevation will be between elevation +5.0 and+6.0 MLW. Tidal exchange will occur through the open end of the area and over the top of the tubes. If necessary, additional openings will be provided during construction after natural exchange mechanisms have had time to develop. The entire area will be divided into compartments to reduce potential cumulative erosion problems. Interior geotextile tube groins will be placed to mitigate damaging tidal channels that will develop just inside of the tube alignment.

. Pump approximately 2.4 million cubic yards of sand behind the tubes to an elevation of +5.0 MLW. The project will restore approximately 145 acres of wetlands.

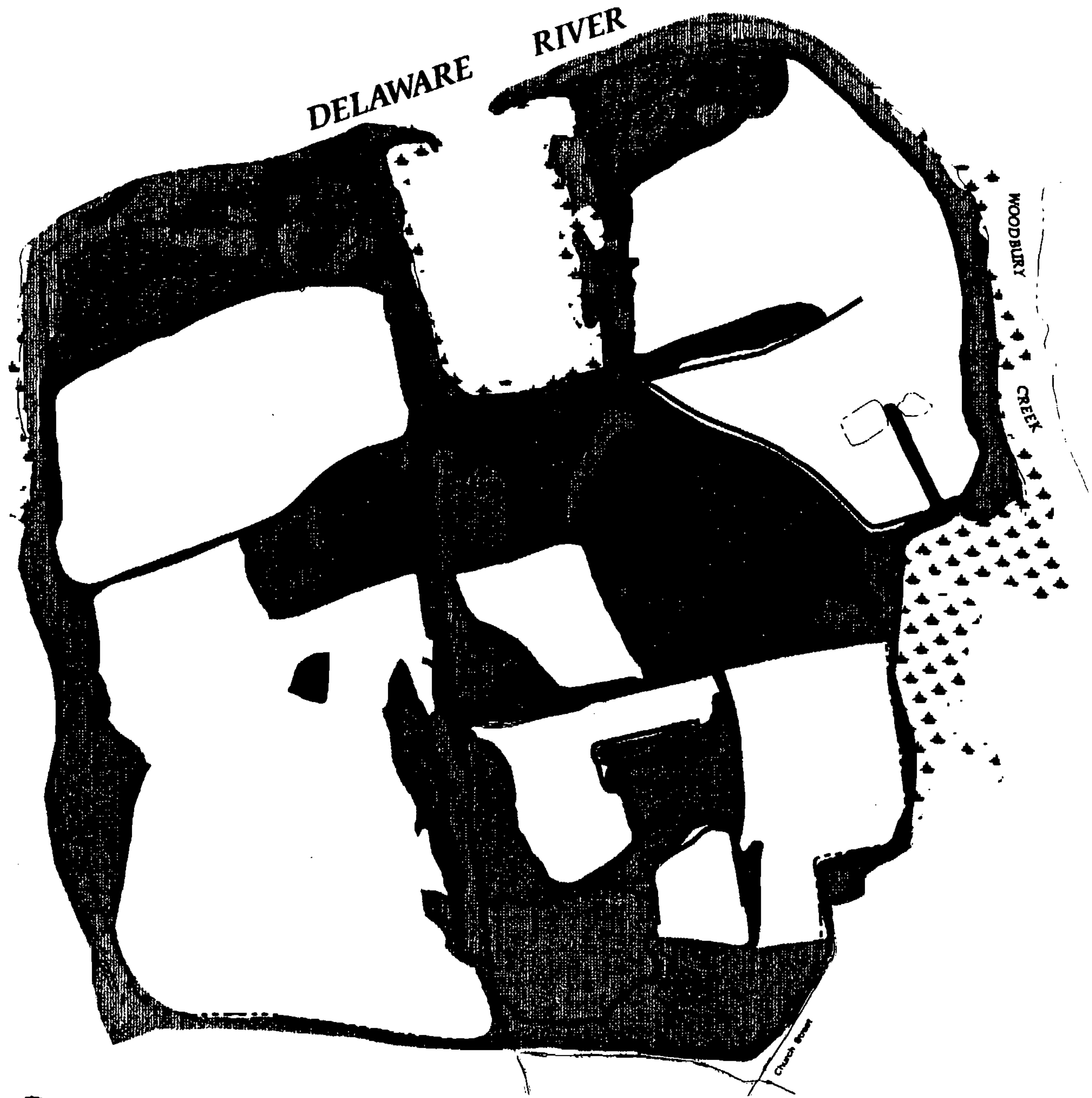
Delaware River Main Channel Deepening Project Area



US Army Corps of Engineers
Philadelphia District

This map was produced by the U.S. Army Corps of Engineers, Philadelphia District, Planning Division Geographic Information System (GIS). Portions of digital data were provided by; NJDEP, PENNDOT and DELDOT.

Figure 1



LEGEND

- Woodlands
- Shrubs
- Common Reed
- Tidal Marsh
- Non-Tidal Marsh
- Agriculture
- Ruderal Area
- Apparent Primary Berm Line
- Drainage
- Gas Transmission Line
- Highway
- Secondary Road
- Railroad
- Trail

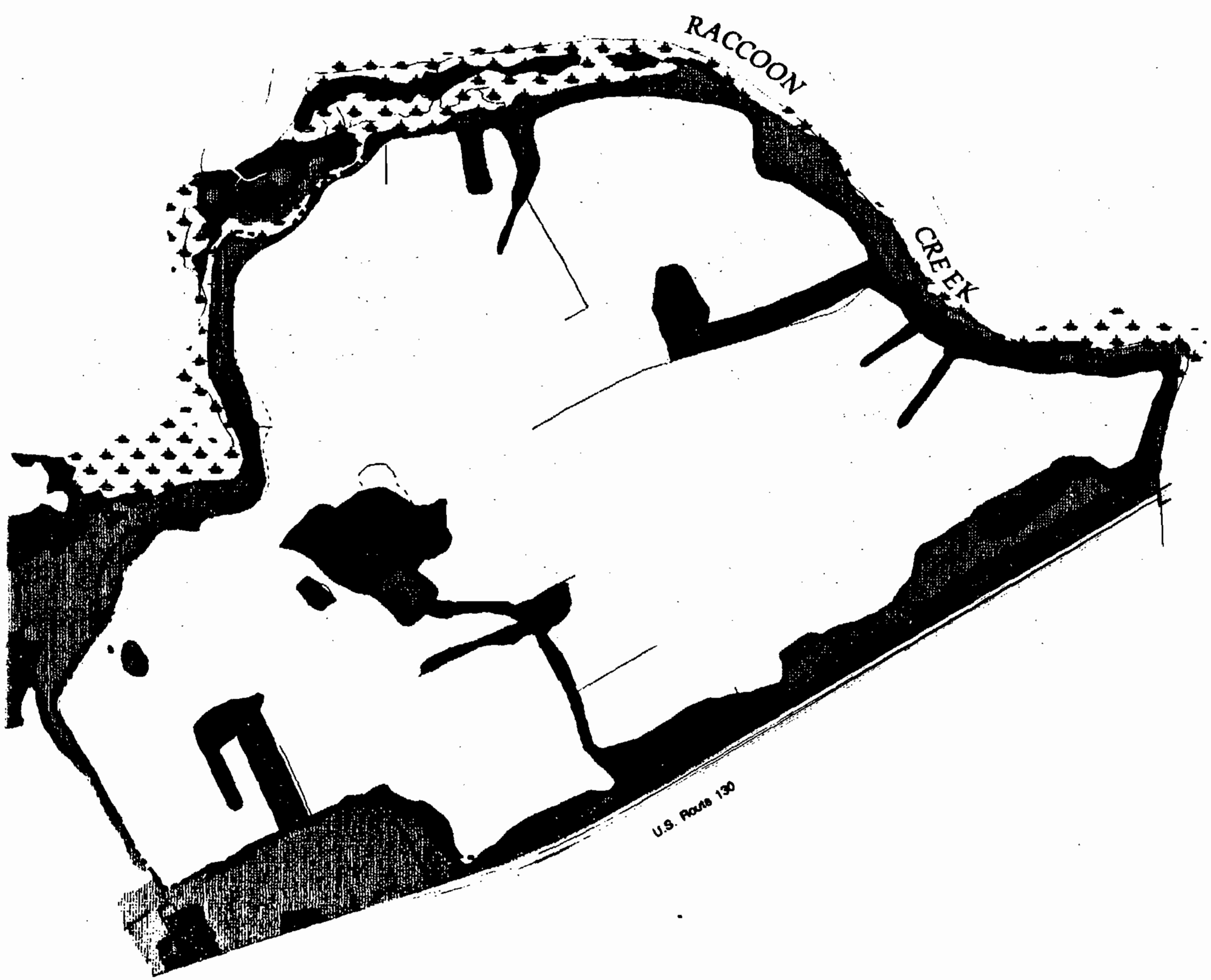
Scale: 1" = 600 Feet

DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT

Existing Wildlife Habitats at Upland, Confined Dredged Material Disposal Site 17G

Figure 2

U.S. Army Corps of Engineers, Philadelphia District



LEGEND

- Woodlands
- Shrubs
- Common Reed
- Tidal Marsh
- Non-Tidal Marsh
- Agriculture
- Ruderal Area
- Apparent Primary Berm Line
- Drainage
- Gas Transmission Line
- Highway
- Secondary Road
- Railroad
- Trail

N
W
E
S

Scale: 1" = 600 Feet

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Existing Wildlife Habitats at Upland, Confined Dredged Material Disposal Site 15D

Figure 3
U.S. Army Corps of Engineers, Philadelphia District

LEGEND

- Woodlands
- Shrubs
- Common Reed
- Tidal Marsh
- Non-Tidal Marsh
- Agriculture
- Ruderal Area
- Apparent Primary Berm Line
- Drainage
- Gas Transmission Line
- Highway
- Secondary Road
- Railroad
- Trail

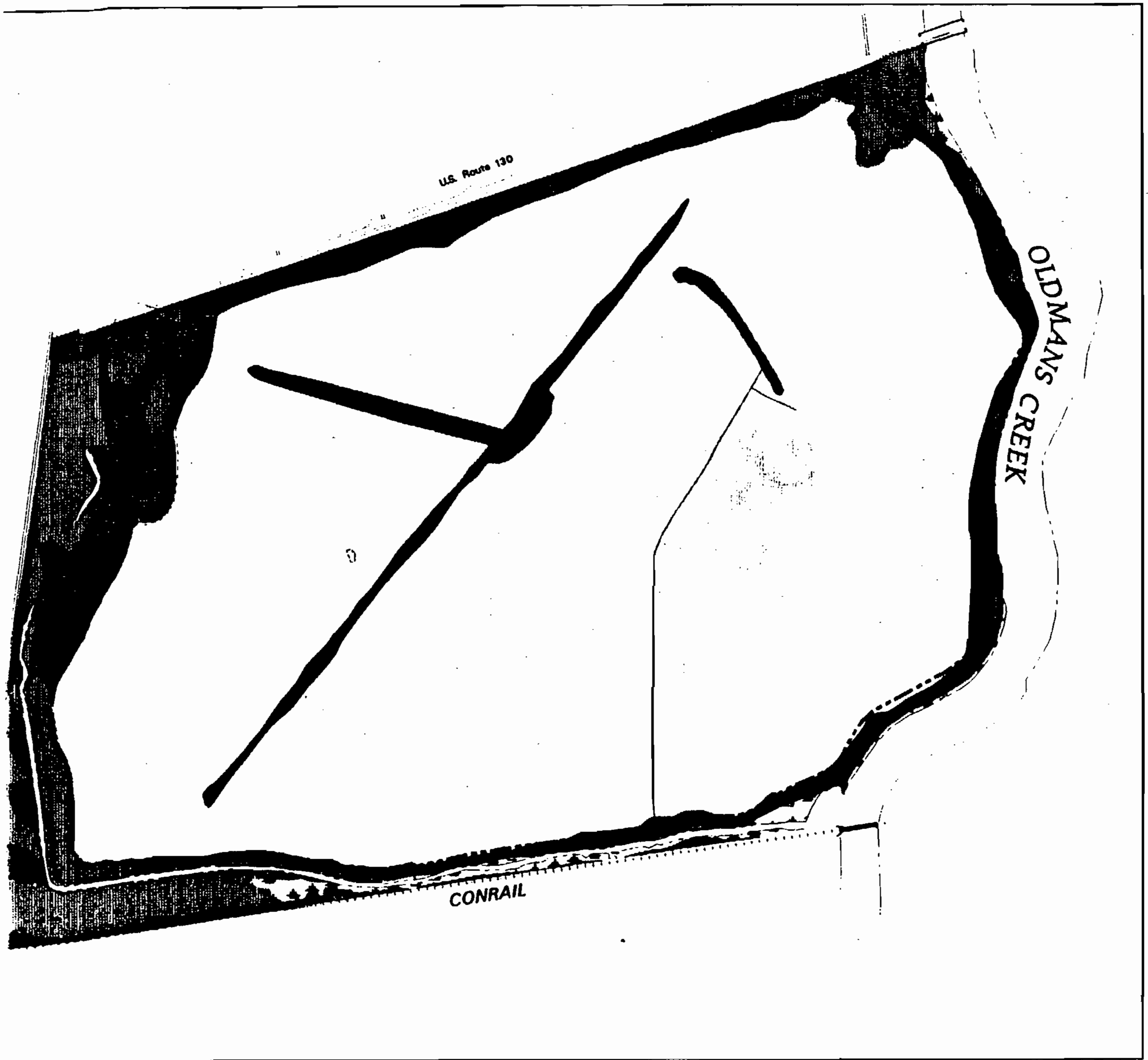
N
W
E
S

Scale: 1" = 800 Feet

DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT

Existing Wildlife Habitats at Upland, Confined Dredged Material Disposal Site Raccoon Island

Figure 5
U.S. Army Corps of Engineers, Philadelphia District



LEGEND

- Woodlands
- Shrubs
- Common Reed
- Tidal Marsh
- Non-Tidal Marsh
- Agriculture
- Ruderal Area
- Apparent Primary Berm Line
- Drainage
- Gas Transmission Line
- Highway
- Secondary Road
- Railroad
- Trail

Scale: 1" = 500 Feet

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Existing Wildlife Habitats at Upland, Confined Dredged Material Disposal Site 15G

Figure 4

U.S. Army Corps of Engineers, Philadelphia District

TABLE 1. DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
UPLAND DISPOSAL AREAS
WILDLIFE HABITAT/VEGETATION IMPACTS

	DISPOSAL SITES AREA				
Habitat Types	15G	17G	Raccoon Island	15D	Totals
Row Crops	246	191	-	248	685
Common Reed	24	65	320	60	469
Woodlands	-	21	20	7	48
Ruderal	5	18	6	5	34
Non-Tidal Marsh	-	-	4	-	4
Totals	275	295	350	320	1240

TABLE 2. DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
ENVIRONMENTAL MANAGEMENT/ENHANCEMENT
OF UPLAND DISPOSAL AREAS

- Existing forest and scrub-shrub habitat will be avoided to the greatest extent practicable.

- The placement of dredged material will be rotated between either diked subdivisions within each of the 4 new CDFs, and/or among the 4 new CDFs and 4 other existing CDFs in the vicinity, over a 6 - 8 year cycle.

- Dredged material would be left in a wet or ponded condition for 3 - 4 years before draining would occur.

- Approximately 50% of the area within the 4 new CDFs (550 to 600 acres) would be in a wet or ponded condition at any given time.

- Wetlands created within the CDFs would be primarily palustrine emergent.

- Wetlands in the CDFs would primarily benefit waterfowl, wading birds, and shorebirds.

- Land within the purchase boundary, including wetlands, that is not used for as a CDF (approximately 469 acres) will be preserved as wildlife habitat/wetlands.

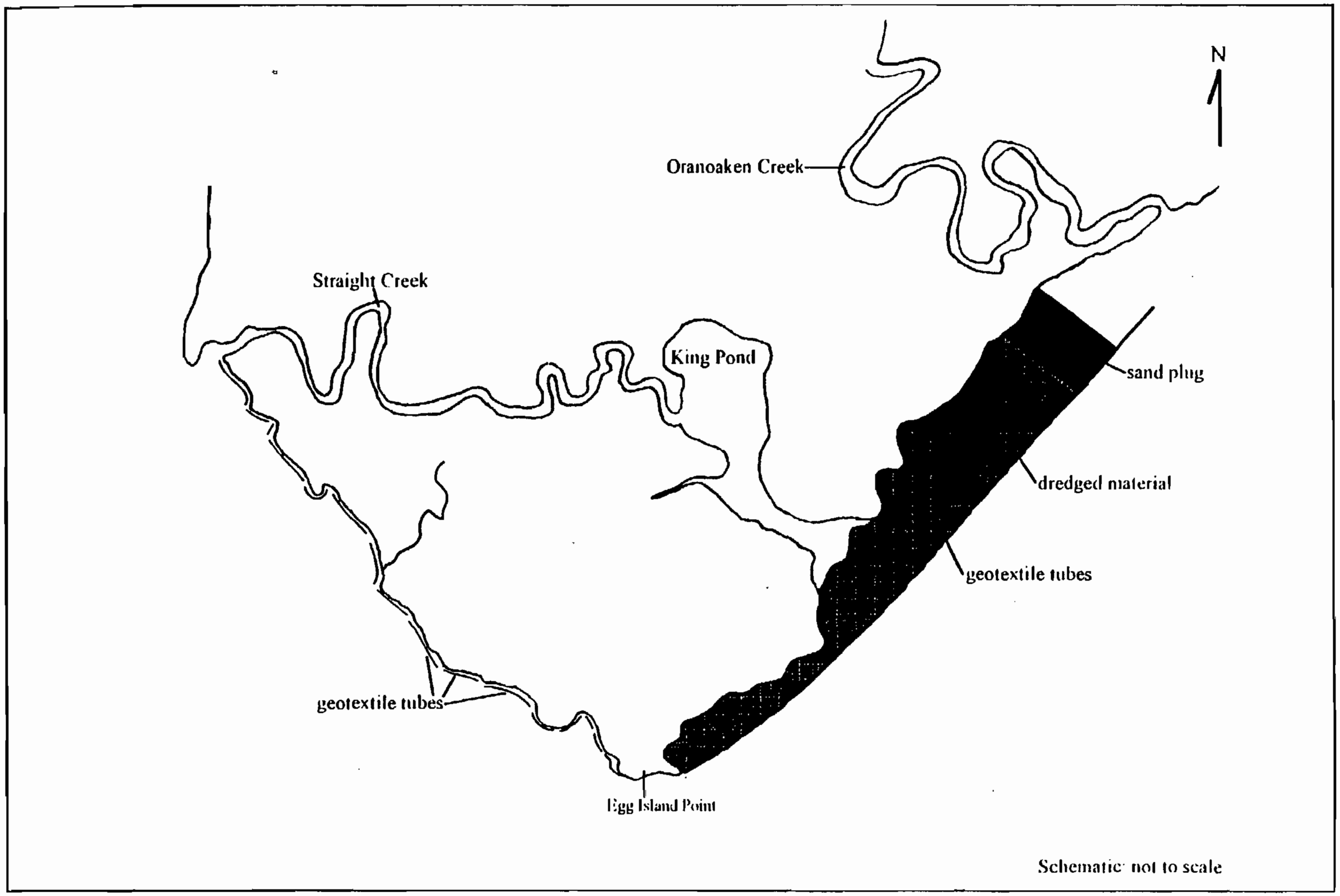


Figure 6. Preliminary shoreline stabilization and marsh restoration plan for Egg Island Point, New Jersey (overhead view).

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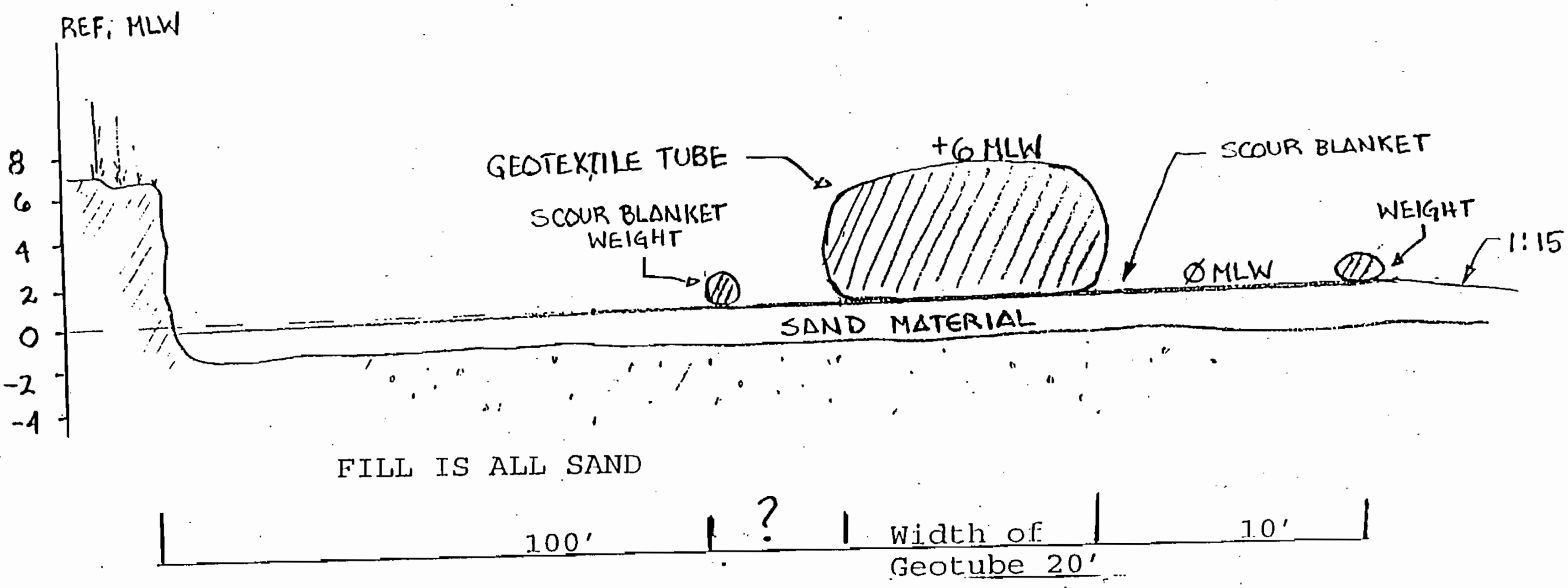
Figure 7

Delaware River Main Channel Deepening

Preliminary Design

Egg Island Point, New Jersey



<u>Elevations Referenced to MLW</u>

. The tube and pumped fill areas will allow for some wave transmission at high tide; however the effect of the project will greatly reduce the wave energy on the existing marsh.

WEST SIDE

. Hydraulically place a sand foundation where required to elevation of 0 foot MLW along the alignment of the geotextile tube. The foundation will extend from the existing shoreline 100 foot top width and 1V to 15H sideslopes.

. Place a scour apron on top of the sand foundation extending 15 feet beyond the seaward edge of the proposed location of the tube. The apron will protect the tube from undermining scour.

. Place staggered line of 200' geotextile tubes from Egg Island Point to a location approximately 10,000 feet north of the point. The project will protect almost 2 miles of coastline and hundreds of acres of wetland from future erosion.

. The alignment will protect the existing marsh from further erosion while allowing horseshoe crabs and other organisms access to the coast.

2. Kelly Island,DE, Wetland Restoration Site (See Figures 8 and 9)

a. Objective: To restore wetlands with dredged material, and confinement of fine grained material.

b. Proposed Design

. Place a sand foundation to elevation of 0.0 feet MLW along the alignment of the geotextile tube.

. Place a scour blanket on top of the sand foundation extending 15 feet beyond the seaward edge of the tube.

. Place 200 foot geotextile tubes side by side on the sand foundation along the alignment shown on the drawing, approximately 1000 feet from the existing marsh scarp, 5600 feet in length. Fill the tubes to elevation +5 feet MLW.

. Place a third tube on the top of the previous two to form a pyramid shape and fill the top tube to elevation +10 feet MLW.

. Place a single line of tubes bayside along the existing peninsula approximately 800 feet in length to prevent additional erosion and possible breaching of the peninsula by the Mahon river. A single line of tube will also be installed along the center line of the proposed sand plugs

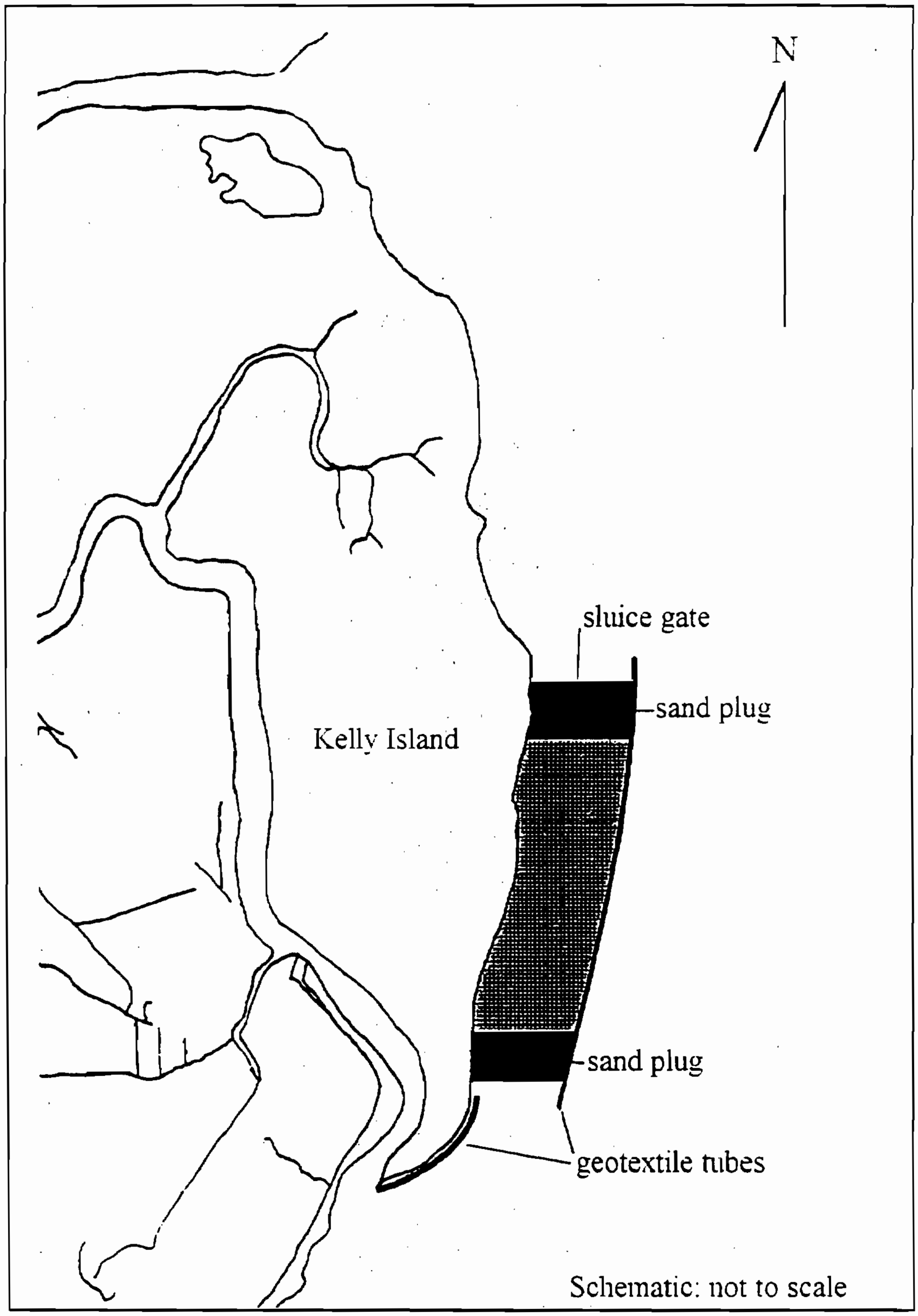


Figure 8 Preliminary shoreline stabilization and marsh restoration plan for Kelly Island, Delaware (overhead view).

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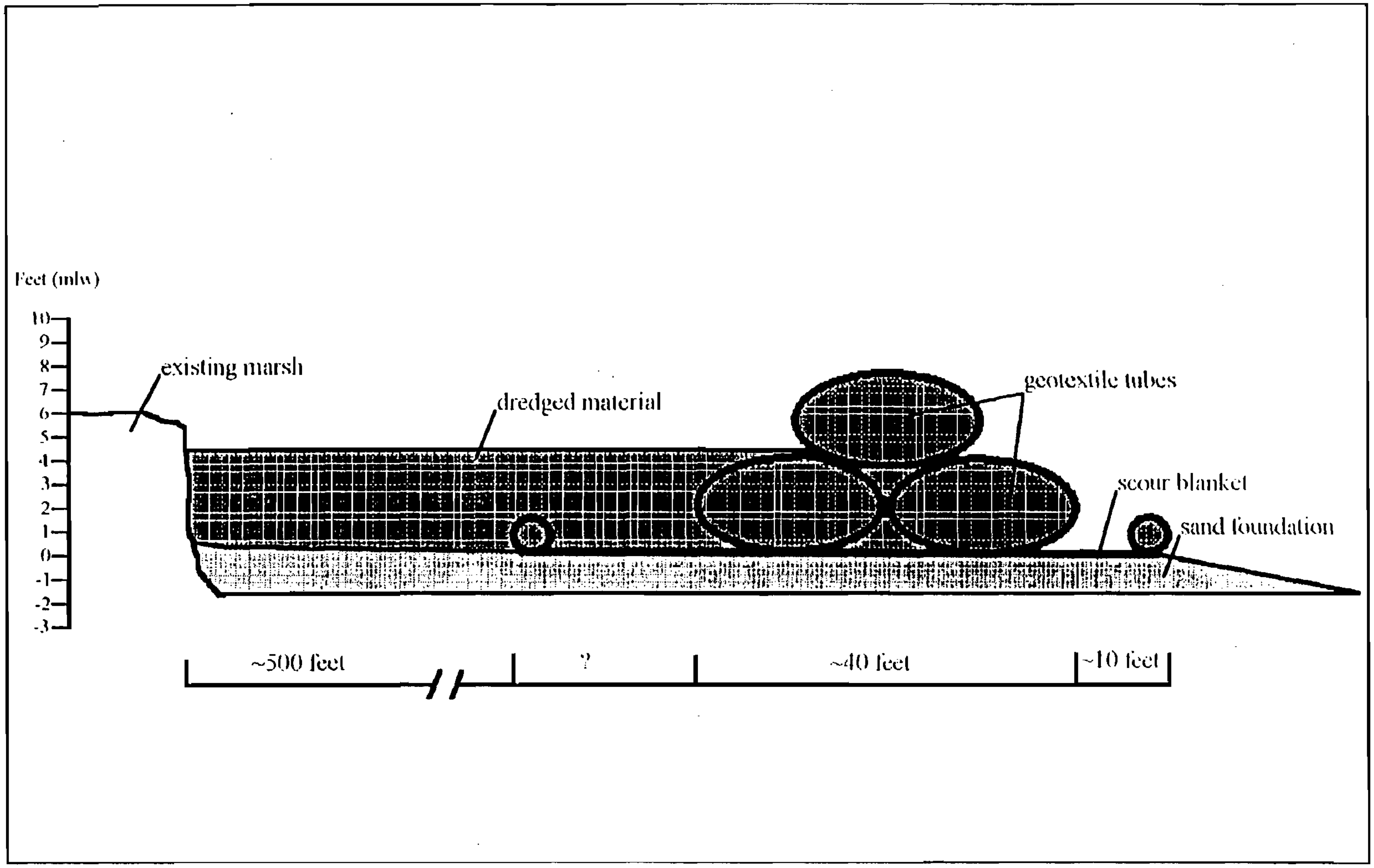

Figure 9 Preliminary shoreline stabilization and marsh restoration plan for Kelly Island, Delaware (cross-sectional view).

to prevent future deep cutting of the sand plugs.

. Pump sand plugs at the northern and southern ends of the project to complete the confined disposal area. The plugs will provide 1500 feet of beach for horseshoe crab access. Install a sluice for drainage of ponding water from the disposal operation.

. Place dredged material behind the tubes to a final elevation of approximately +4.5 feet MLW. The final project will restore 90 -100 acres of wetland.

. Tidal exchange will be provided by either removing several 200' top tubes along the alignment as required or cutting channels between the Mahon river and the project site.

3. Sand Stockpiles

a. LC-5. Approximately 2.1 million cubic yards of sand would be placed at this location. The sand stockpile would cover approximately 150 acres. The bottom depths would be decreased approximately 8 feet to a maximum elevation of 0 feet MLW. It would be located about 0.33 miles offshore of Broadkill Beach, Delaware.

o MS-19. Approximately 3.6 million cubic yards of sand would be placed at this location. This stockpile would cover about 250 acres. The bottom depths would be decreased approximately 8 feet to a maximum elevation of 0 feet MLW. It would be located about 0.5 miles offshore of Slaughter Beach, Delaware.

Sediment Testing

Introduction: Concerns were expressed during the Feasibility Study regarding the chemical quality of sediments that would be disturbed during project construction, and the potential adverse effects on aquatic resources. In the riverine section of the project area, from Philadelphia to Artificial Island, channel sediments would be dredged and placed in several confined, upland dredged material disposal sites. Sediment quality concerns in this portion of the project regard turbidity generated at the point of dredging, and the turbidity associated with the discharge of effluent from the disposal areas. In Delaware Bay, channel sediments comprised primarily of sand would be used for various beneficial uses that involve placement of sediments in open water. Sediment quality concerns in this area include turbidity generated at the point of dredging and impacts associated with open water placement.

Two types of chemical quality concerns can be raised with regard to dredging and dredged material disposal activities. The first is potential short-term water quality degradation arising from disturbance of bottom sediments, and ensuing impacts to aquatic biota. Aquatic ecosystems concentrate biological and chemical substances such as organic matter, nutrients, heavy metals and toxic chemical compounds in bottom sediments. When introduced to the water column, these substances tend to bind with suspended particulate matter and eventually settle to the bottom. Dredging operations typically elevate levels of suspended particulates in the water column through agitation of the sediment. Suspension of sediment exposes associated biological and chemical constituents to dissolved oxygen, which can result in a variety of chemical reactions. Adverse impacts to water quality may include oxygen depletion and the release of chemical substances, making them biologically available to aquatic organisms through ingestion or respiration. It is generally believed that carefully designed and conducted dredging operations do not pose a significant adverse environmental threat, primarily because dredging is a temporary localized phenomenon that does not supply a persistent load of suspended sediment. The turbidity associated with temporary dredging activities is usually less than the turbidity associated with natural flooding. In addition, most rivers that are used for navigation, including the Delaware River, are naturally turbid.

The second type of concern is long-term contamination problems associated with the dredged material disposal site. Generally, the greatest potential for environmental effects from dredged material discharge to open water lies in the benthic environment. Deposited dredged material is not mixed and dispersed as rapidly or as greatly as the portion of the material that may remain in the water column. Bottom dwelling animals living and feeding on deposited material for extended periods represent the most likely pathways by which adverse effects to aquatic biota can occur. Placement of contaminated sediment at upland disposal sites can also result in long-term impacts such as groundwater contamination and direct uptake of contaminants by plants and animals.

To address these concerns the Corps has conducted various sediment quality studies as outlined in the national comprehensive testing strategy, developed jointly by the Corps and the U.S. Environmental Protection Agency. This tiered testing approach provides for successive levels of investigation to be implemented on a "reason to believe" that there is potential for unacceptable adverse effects.The following provides a summary of the work efforts and an overview of the findings. A summary of the data collected by these tests is attached as Appendix A.

Sediment Testing (Bulk Analysis)

Work Effort: If there is reason to believe that contaminants are present, which was the case with the main channel deepening project, the first level of evaluation consists of bulk sediment analysis. This is essentially an inventory of contaminants to identify those that could potentially have an impact on the environment during dredging and dredged material disposal activities. A series of 97 sediment cores have been collected within channel and bend widening locations that would be dredged during project construction (Figure 1). Bend widening locations provide a "worst case" picture of contaminant concentrations that would potentially be in the dredged material. These areas are not currently dredged, as such contaminants could accumulate over a long period of time. Within the channel, accumulated sediment is quickly removed to maintain project dimensions, thus precluding contaminant accumulation over time. Sample locations were determined with the assistance of the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service.

Sediment cores were collected with vibracoring equipment that employed a collection tube approximately three inches in diameter. Sediment cores were collected to proposed project depths and divided into 153 distinct sediment strata. Each sediment strata greater than six inches constituted a separate sample. Strata were then individually evaluated through grain size and chemical analyses. Sediment was removed from the interior portion of the core to minimize chemical contamination associated with the core tube. If a core consisted of a single, homogenous unit, the interior portion of the core was removed over the entire length of the core, thoroughly homogenized, and sub-sampled. Sediment from the exterior portion of the core was used for grain size analyses. Bulk chemical analyses were conducted on each strata to determine the range of contaminants and their total concentrations. The chemical parameter list included a host of heavy metals, pesticides, PCBs, PAHs and a variety of volatile and semi-volatile organics. All results were reported on a dry weight basis.

<u>Findings</u>: Bulk analysis of sediments did not identify high concentrations of organic contaminants within the channel or bend widening locations. PCBs were detected in two samples. One sample was collected in the Bellevue Range, and the other was collected in the upper portion of Liston Range. The Bellevue sample contained PCB arochlors 1248 and 1254 at concentrations of 0.53 and 1.19 parts per million (ppm), respectively. The Liston sample contained PCB arochlors 1248 and 1260 at concentrations of 0.12 and 0.19 ppm, respectively. DDE, DDD, endosulfan and heptachlor epoxide were the only pesticides detected. Endosulfan was detected once in the Bellevue Range sample; DDE and DDD were detected once in the Liston Range sample; and heptachlor epoxide was detected once in a sample collected from Mifflin Range. Concentrations of these pesticides were below 0.1 ppm. Polynuclear aromatic hydrocarbons (PAHs) were detected in several channel bends between Philadelphia Harbor and Artificial Island. PAHs are primarily formed through combustion of fossil fuels, and are expected to be found in highly industrialized and populated regions. PAHs were not detected in the Delaware Bay portion of the project area. PAH concentrations were generally below 2 ppm. The only exception was fluoranthene, which was detected in one sample collected in the vicinity of Tinicum Island at a concentration of 2.25 ppm. The U.S. Environmental Protection Agency has proposed sediment quality criteria (SQC) for

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fluoranthene, which are intended to predict toxicological effects of fluoranthene on organisms living in sediment. The freshwater criteria include a median concentration of 620 ppm, with a lower level 95 percent confidence interval of 290 ppm. These concentrations are orders of magnitude above levels found in the Delaware River navigation channel.

Of the remaining volatile and semi-volatile organic contaminants evaluated, only methylene chloride, acetone, 2-butanone, styrene and phthalates were detected at quantifiable levels. Styrene was detected in one sample and 2-butanone was detected in two samples. Concentrations of these chemicals were below 0.1 ppm. Methylene chloride was detected in several samples. Methylene chloride is mainly used as a low-temperature extractant of substances which are adversely affected by high temperature. It is also used as a solvent and as a paint remover. Because of its utility as a chemical extractant, methylene chloride is commonly used in laboratory analyses. It is likely that detection of methylene chloride was a byproduct of laboratory testing. Acetone was also detected in several samples. Acetone is also a common laboratory solvent, which was used to clean glassware and sampling implements for sample collection. Detection of acetone is also attributed to laboratory procedures.

Phthalates were also detected at more than one location. Phthalates are used in large quantities as plasticizers to improve the quality of plastics. A plasticizer is a substance added to plastics to keep them pliable or soft. Phthalates may also be used as starting or intermediate materials for a variety of industrial processes. The highest concentration was 2.67 ppm, which was reported for di-n-butyl phthalate from one sample collected in the vicinity of the Philadelphia Naval Base.

Heavy metals were found to be widely distributed throughout the project area, which was to be expected. Metal concentrations were generally highest at the surface, with lower concentrations found below the top strata. Concentrations of metals in the predominantly sandy Delaware Bay sediments were generally lower than up-river areas. Other than that, there were no apparent contamination trends. The presence of heavy metals in channel sediments is attributed to the urban and industrialized nature of the river basin.

To evaluate potential human health impacts associated with disposal of channel sediments, bulk data were compared to New Jersey Department of Environmental Protection (NJDEP) Residential, Non-Residential and Impact to Groundwater Soil Cleanup Criteria (NJAC 7:26D). Compliance with the Residential Standards allows maximum unrestricted future use of property, including residential use. Compliance with Non-Residential Standards is also acceptable provided the property owner agrees to limit future uses to non-residential activities. The Non-Residential Standards are most applicable to material that would be placed in confined, upland dredged material disposal sites. These areas would remain undeveloped as a result of disposal activities. Material dredged from Delaware Bay would be used for beneficial uses, primarily beach nourishment. The Residential Standards are more applicable here as people visiting the beaches would come in contact with the sand. A total of 91 chemical parameters were evaluated.

To facilitate this evaluation, the main channel project area was divided into five reaches (Reaches A through E; see Figure 1), which correspond to disposal area locations. Material from Reaches A through D would be placed in several upland disposal sites. Reach A extends from the upstream project limit in Philadelphia Harbor to the Billingsport Range. Reach B extends from the Tinicum Range to the Cherry Island Range. Reach C extends from Deepwater Point Range to the New Castle Range. Reach D extends from Reedy Island Range to Ship John Light (Liston Range). Reach E is located in Delaware Bay, this material would be used for beneficial uses, such as sand stockpiling for beach nourishment and wetland creation.

To evaluate the sediment quality data relative to the NJDEP criteria, samples collected within each reach were grouped and the mean concentration of each chemical parameter was calculated. In many cases a chemical parameter was not detected in a sediment sample, and the laboratory reported a result that represented the lowest quantifiable concentration that could be achieved with the test procedure. To include these data points in the analysis, the reported quantification limit was calculated into the mean, as if the chemical parameter had actually been present in the sediment at that concentration. This made the evaluation very conservative, because it is unlikely that the contaminant would be present at that concentration in all cases.

All 91 parameters in all five reaches met the NJDEP Impact to Ground Water Soil Cleanup Criteria, without exception. All 91 parameters in all five reaches met the NJDEP Residential and Non-Residential standards, with the exception of the pesticide toxaphene and the heavy metals thallium and cadmium. Toxaphene has Residential and Non-Residential standards of 0.10 and 0.20 ppm, respectively. While toxaphene was not detected in any of the 153 sediment samples tested, the laboratory detection levels were consistently above NJDEP standards. As such, a definitive conclusion with regard to toxaphene is not possible. Worst case concentrations of toxaphene in channel sediments, calculated solely on laboratory detection levels, range from 0.26 ppm in Reach E to 0.56 ppm in Reach A. There is no reason to believe that toxaphene is a contaminant of concern in the Delaware Estuary. Therefore, the risk that actual concentrations of toxaphene in channel sediments are above NJDEP standards is considered low.

Both the Residential and Non-Residential standards for thallium are two ppm. Mean concentrations of thallium were above the standard in Reaches A and B. Mean concentrations were 3.76 and 2.48 ppm, respectively. Thallium and its compounds are used as rodenticides, fungicides, and insecticides; as catalysts in certain organic reactions; in the manufacture of optical lenses, plates and prisms; in photoelectric cells; in dyes and pigments; in fireworks; and imitation precious jewelry.

A total of 82 separate sediment samples were collected from Reaches A and B over three sampling events. All of these samples were analyzed for thallium. The initial event in 1991 collected 42 samples. Thirty of these samples had laboratory detection levels greater than two ppm. Four samples had actual thallium detections greater than two ppm (5.5-9.0 ppm). Twenty additional sediment samples were collected in 1992, and the final 20 samples were collected in 1994. These 40 samples showed thallium concentrations in channel sediments to be less than two ppm. All 40 samples had laboratory detection levels or actual detections of thallium below 0.4 ppm. While mean thallium concentrations for channel sediments in Reaches A and B are above the NJDEP standard, it appears that high detection levels from the 1991 sampling event is responsible for skewing the means. Two subsequent sampling events failed to reproduce the earlier results. Like toxaphene, there is no reason to believe that thallium is a contaminant of concern in the Delaware Estuary. Based on the above information, it is concluded that the calculated mean concentrations are high, and that the true mean thallium concentration in channel sediments is actually below two ppm.

The mean cadmium concentration of channel sediment samples collected from Reach A was 1.66 ppm. This is above the NJDEP Residential standard of one ppm, but well below the Non-Residential standard of 100 ppm. Cadmium was detected in a number of samples at concentrations above one ppm, so there is no reason to suspect that the calculated mean is high. Since the material dredged from Reach A would be placed in an upland, dredged material disposal site that would not be used for residential development, and since the mean concentration of cadmium is so far below the NJDEP Non-Residential sediment standard of 100 ppm, it is concluded that the concentration of cadmium in sediments from Reach A would not pose any human health concerns.

Overall, concentrations of contaminants in channel sediments are considered low. Channel sediments to be dredged from Reaches A through D are sufficiently clean for placement in confined, upland sites. In the Delaware Bay portion of the project area, where material would be used for beneficial uses such as beach nourishment, comparison of data to NJDEP Residential criteria suggests that the proposed plan is also acceptable.

Sediment Testing (Elutriate Analysis)

Work Effort: While bulk analysis provides an accurate characterization of contaminants associated with the sediments, it does not provide insight into the potential impacts on water quality and aquatic resources associated with sediment disturbance. To predict contaminant levels that would be liberated from sediment during dredging and disposal activities, which would then be biologically available to impact aquatic resources, 109 individual sediment strata were also evaluated through an elutriate analysis. This test mimics the sediment disturbance that would occur, and determines contaminant levels that would be released. The elutriate test provides the second tier of testing in the national comprehensive testing strategy. The results of this test can be compared to water quality standards after consideration of mixing, as described in the Clean Water Act 404(b)(1) Guidelines. This analysis is currently under way. We are considering water quality standards adopted by the States of New Jersey, Pennsylvania and Delaware, as well as those developed by the U.S. Environmental Protection Agency and the Delaware River Basin Commission. This comprehensive review of criteria will insure that the most stringent standards that apply to a particular section of the river are used in the evaluation. The results of this analysis will be used to design the confined disposal facilities, such that all water quality standards are met.

Biological Effects Based Testing

Introduction: Bulk and elutriate tests provide valuable data regarding the nature of sediment contamination within the project area, and the concentration of contaminants that could be expected with dredging. In a letter of comment on the draft Environmental Impact Statement, the USEPA stated: "Overall, the levels of organics and metals in bulk sediment analyses and elutriate tests are low. As such, disturbance or disposal of the sediments from the project would not cause a significant adverse environmental impact." In a letter of comment on the final EIS, USEPA reiterated: "Based on the sediment data presented, EPA believes that there will be no adverse impacts associated with the disposal of sediments generated by the project."

In the Record of Decision, which was prepared at the end of the Environmental Impact Statement process, the Corps committed to conducting biological effects based testing to more fully evaluate sediment quality concerns. These tests provide the third tier of sediment investigations. A water column, or suspended solid particulate phase bioassay can be run to evaluate water quality concerns associated with the release of contaminants from sediment into dredging or disposal site water. A whole sediment, or benthic bioassay can be run to evaluate impacts to benthic organisms residing at open water disposal sites. These bioassays are used to provide information on the toxicity of individual contaminants, and also to indicate possible interactive effects of multiple contaminants. Lastly, if there is reason to believe that bioaccumulation is of concern, the potential uptake of contaminants by aquatic organisms at an open water disposal site can be evaluated with a bioaccumulation test. Unless there is continuous dredging/discharge, bioaccumulation from the material remaining in the water column is considered to be of minor concern due to the short exposure time and low exposure concentrations resulting from rapid dispersion and dilution.

Bioassays and bioaccumulation tests have been run to directly test the toxic effects of Delaware River channel sediments on aquatic organisms. The water column and whole sediment bioassays exposed living organisms to sediments, to evaluate any differences in mortality between Delaware River channel sediments and clean laboratory sediments used as a control. Early life stages of fish, crustaceans, molluscs, zooplankton and polychaete worms were tested. Young organisms are more sensitive than adults to the effects of sediment contamination, and are considered to be better indicators of problems.

Water Column and Whole sediment Bioassays

Work Effort: In the riverine portion of the project area, which is defined as the navigation channel from Beckett Street Terminal, Camden, New Jersey to Artificial Island, New Jersey, dredged material would be placed in several confined upland dredged material disposal sites. Water quality concerns in this portion of the project regard turbidity generated at the point of dredging, and turbidity associated with the discharge of effluent from upland disposal sites. In Delaware Bay, dredged sediments would be used for various beneficial uses, such as sand stockpiling for beach nourishment purposes, and wetland restoration. Water quality concerns in this area include turbidity at the point of dredging and at open water placement sites. To assess the potential effects of dredging and disposal activities on water quality, acute water column bioassays were run on the elutriate of sediment samples and unfiltered Delaware River water. Procedures followed those outlined in the draft USACE/USEPA Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (EPA-823-B-94-002).

A total of 38 water column bioassays were run. In the riverine portion of the project area, 28 sediment samples were collected. One sample was collected from each channel range and each channel bend from Beckett Street Terminal to Artificial Island. In Delaware Bay, an additional 10 sediment samples were collected from the channel in areas that would require dredging. Each sediment sample was combined with unfiltered Delaware River water in a sediment - to - water ratio of 1:4 on a volume basis. The mixture was thoroughly agitated, allowed to settle for one hour, and the supernatant was removed. This solution was then used to run the bioassays. The larval stages of three aquatic species were exposed to the 100 percent sediment elutriate for each of the 38 bioassays. For the 28 riverine samples, test species were the fathead minnow (Pimephales promelas), a water flea (Ceriodaphnia sp.) and an amphipod (Hyalella azteca). For the 10 Delaware Bay samples, test species were the sheepshead minnow (Cyprinodon variegatus), the American oyster (Crassostrea virginica) and a mysid shrimp (Mysidopsis sp.). Five replicate samples were run for each species per test; 10 organisms were tested in each replicate sample. Each test was run for a duration of 48 hours.

In Delaware Bay, dredged material would be placed in open water for beneficial uses, as previously discussed. Acute whole sediment bioassays were run to assess the potential sediment quality impacts to benthic organisms that would reside at the site after placement. The 10 Delaware Bay sediment samples were tested. Procedures again followed those outlined in the USACE/USEPA testing manuals. Sediments were placed in containers, and test organisms were exposed to the sediment for a period of 10 days. Test species included an infaunal amphipod (Ampelisca sp.), a burrowing polychaete (Nereis virens) and a bivalve mollusc (Mercenaria mercenaria). Immature individuals of each species were tested. Five replicate samples were run for each species per test; 20 amphipods and polychaetes, and 10 molluscs were tested in each replicate sample.

Bioaccumulation Testing

Work Effort: Bioaccumulation tests were run with Delaware Bay sediment to evaluate the potential for bioaccumulation of contaminants by aquatic organisms that would reside in the sediment after placement in the beneficial use sites. Two separate bioaccumulation tests were run. In 1993, five of the 10 Delaware Bay sediment samples collected for bioassays were tested. The five Delaware Bay samples with the highest percentage of fine grain silts and clays were used as, fine grain sediment has a greater potential to retain contaminants than coarse grain sands. The bivalve mollusc Mercenaria mercenaria was used as the test organism. In 1994, two additional samples of channel sediment were collected from areas containing fine grained material. The burrowing polychaete Nereis virens was used as the test organism. In both cases individuals were exposed to the sediment for 28 days. After the exposure period, the soft body tissues were chemically analyzed and compared to data obtained from individuals exposed to clean laboratory sediment. Chemical parameters included heavy metals, pesticides, PCBs and PAHs.

Findings: All water column and whole sediment bioassays resulted in 100 percent survival of all test species. The results of the water column bioassays suggest that sediment disturbance, and associated water column turbidity, at the point of dredging and at dredged material disposal locations would not result in mortality of aquatic organisms in the vicinity. Likewise, the results of the whole sediment bioassays suggest that aquatic organisms that colonize sediment placed for beneficial uses in Delaware Bay would also be unaffected by sediment contaminants. With regard to bioaccumulation, there was no evidence that contaminants accumulated in clam tissue exposed to Delaware Bay sediment at greater concentrations than clam tissue exposed to clean laboratory sediment. All of the tissue residues were representative of what one would expect in organisms exposed to uncontaminated material. With regard to bioaccumulation and the polychaete Nereis virens, there were no statistical differences between contaminants in worms exposed to channel sediments and worms exposed to reference sediments, with the exception of the heavy metal arsenic. The mean arsenic concentration in worms exposed to one channel sediment sample (0.700 ppm) was statistically higher than concentrations in worms exposed to reference sediment samples (0.360 and 0.460 ppm). The measured tissue concentration of arsenic in worms exposed to the channel sediment did not appear to be deleterious. No more mortality was observed in the channel sediment test worms than in worms exposed to other sediments. Furthermore, a mean tissue concentration of arsenic in worms exposed to the control sediment (0.680 ppm), which was obtained in Maine where the worms were collected, was virtually identical to that measured for the channel sediment worms (0.700 ppm). Both of these values are well below the range of acceptable background tissue arsenic concentrations for test organisms from East Coast sites, which is reported to be 1.5 to 3.9 ppm in the USEPA Guidance Manual for Bedded Sediment Bioaccumulation Tests (EPA-600-R-93-183). Overall, test results suggest that open water placement of Bay sediment is acceptable with regard to bioaccumulation concerns.

CONSULTATION HISTORY

In a planning aid report (Plage. 1989), the U.S. Fish and Wildlife Service (FWS) stated that the endangered peregrine falcon has nested or attempted to nest on Delaware River bridges within the project area, and that aside from occasional transient individuals, no other federally listed or proposed threatened or endangered species under FWS jurisdiction are known to occur within the project area. The report further states that it is unlikely that the areas potentially impacted by the proposed project provide essential habitat for peregrines.

In a letter forwarding the Draft Fish and Wildlife Coordination Act Report, Section 2(b) (Day. 1992), the FWS stated that both the peregrine falcon and the bald eagle nested within the project area and requested that the Corps prepare a biological assessment to address potential project related adverse impacts to these species. The letter further stated that aside from occasional transient individuals, no other federally listed or proposed threatened or endangered species under FWS jurisdiction are known to occur within the project area.

A meeting was held in the Philadelphia District office on December 14, 1994 with representatives from the FWS. Ms Dana Peters, FWS, stated that the species of concern are the bald eagle and the peregrine falcon. For the bald eagle, the concerns are possible exposure to contaminants from the additional dredging, and disturbance during nesting. A pair of eagles has nested in various locations near the upland disposal areas in recent years. The FWS requires a buffer zone of 0.25 miles or a line of site buffer of 0.5 miles from the nest from January to July to avoid disturbance. At this time we can not tell if an eagle nest will be located near an upland disposal area in the year 2000. Ms Peters recommended that a contingency plan be developed based on FWS recommendations. It is believed that construction could be staged to avoid disturbance impacts. The FWS recommended that the following potential impacts be addressed in a biological assessment: disturbance, increased development, contaminants, and increased oil spills. FWS recommended that the assessment be coordinated with Larry Niles of the NJDEP. For the peregrine falcon, FWS recommended that disturbance at their nest/roosting sites at the Walt Whitman and Commodore Barry bridges, as well as contaminants, would need to be addressed in the biological assessment. There are presently no restrictions for dredging in the Delaware River for the peregrine falcon.

BIOLOGY, DISTRIBUTION AND STATUS RELATED TO THE PROJECT

BALD EAGLE

The bald eagle was listed as an endangered or threatened species throughout the United States in 1978; the Chesapeake Bay Region (CBR) bald eagle population was determined to be threatened in 1995. The bald eagles in the project area are covered under the Chesapeake Bay Region Bald Eagle Recovery Plan: First Revision (USFWS. 1990).

The CBR bald eagle occupies shoreline habitat of the Chesapeake and Delaware Bays and their tributaries. The eagle requires large blocks of undisturbed mature forested habitat in proximity to aquatic foraging areas. The principal threat to its continued recovery is habitat loss due to shoreline development and other land use changes. The CBR eagle is also threatened by acute toxicity caused by continued use of certain contaminants, shooting, accidents, and natural environmental events (USFWS. 1990).

Bald eagles have been documented to be sensitive to human activity and disturbance, particularly during the breeding season, although sensitivity varies greatly between individuals (Mathisen, 1968; Stalmaster and Newman, 1978; USFWS, 1990; Grubb and King, 1991). The breeding cycle of CBR bald eagles can generally be divided into four phases with each phase having an associated level of sensitivity to human disturbance (Cline, 1990; Figure 10). Eagles are most sensitive early in the nesting cycle when nest selection,

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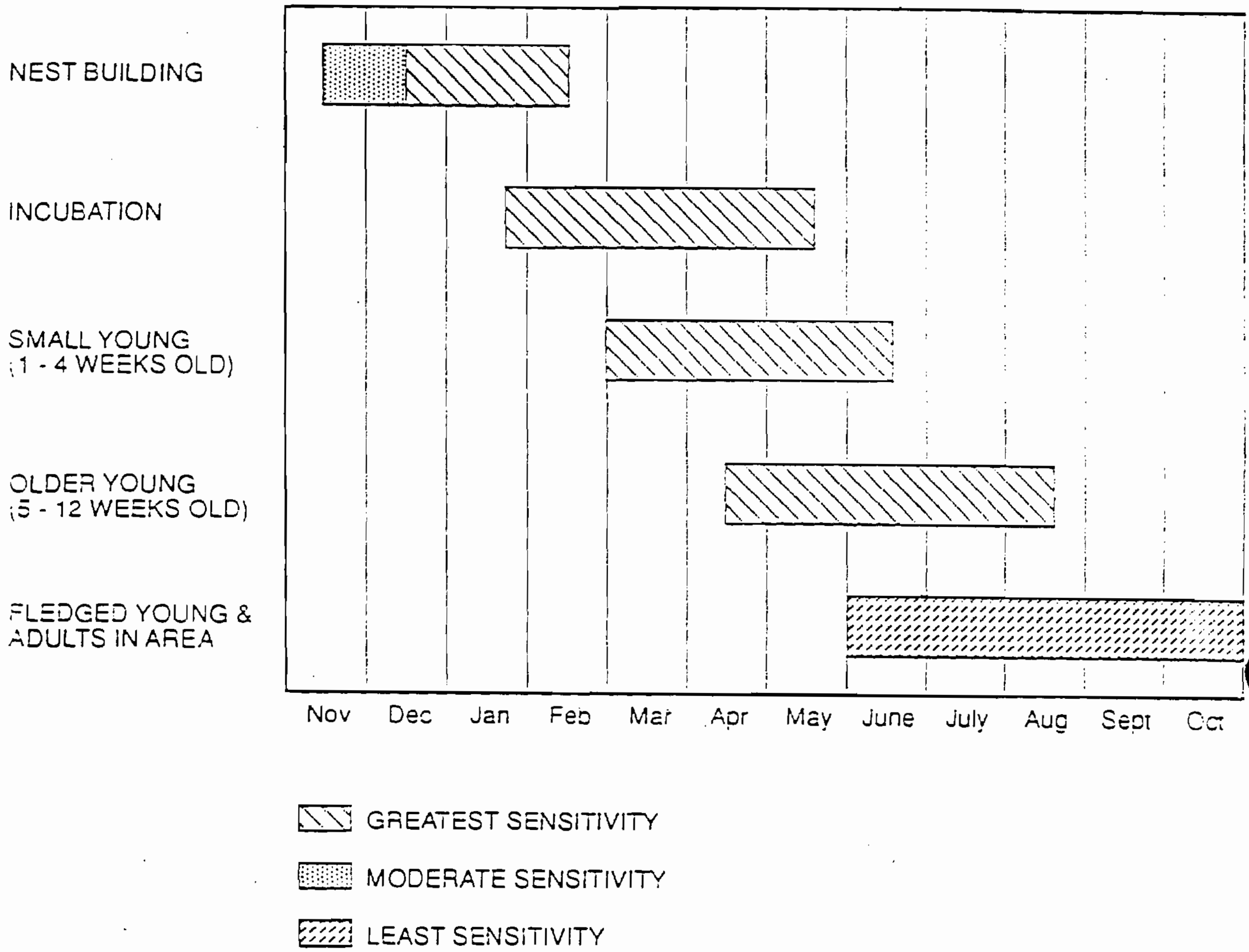

SOURCE: Cline, 1990

Figure 10. Bald Eagle Sensitivity to Human Disturbance

nest building, incubation and brooding occur (Mathisen, 1968). Bald eagles are moderately sensitive to disturbance when young are older and preparing to fledge. After young are fledged and before nest selection begins, the bald eagles are least sensitive to disturbance. Most bald eagle nests are located in large wooded areas associated with marshes and other water bodies. Sometimes nests are built in isolated trees located in marshes, farmland or clear cuts. Nest sites are typically remote from areas of intense human activity, although some have been observed near railroad tracks, highways, airfield runways and human residences (USFWS, 1990). Primary factors contributing to breeding habitat suitability are distance from human activity, availability of suitable nest trees, and an adequate forage base (USFWS, 1986).

In the CBR, the bald eagle is found feeding most often along river, lake, and bay shoreline, or perched in the trees bordering them; and in extensive freshwater marshes on hillocks, muskrat houses, bare sand or mud bars, and isolated trees. Since they typically snatch fish from the water's surface, shallow water is an important component of live fish availability to eagles. Most bald eagle nests are less than 1.6 km from feeding areas, although some nests are up to 3.2 km from their primary food source (USFWS. 1990).

The CBR bald eagle population was listed as endangered in 1978 (43 CFR 6233) and, at that time, the major limiting factor for the population was identified as lowered productivity resulting from pesticide contamination (USFWS, 1990). Secondary limiting factors included shooting, disturbance, and habitat destruction. A recovery plan for the CBR bald eagle population was released in 1982. The original plan was revised in 1990 (USFWS, 1990). The draft version of the revised recovery plan lists 11 known major bald eagle concentration areas in the CBR, including one in southern New Jersey (USFWS. 1990).

The CBR bald eagle population has exponentially increased from 1962 to 1992, as evidenced by increases in the number of active nests (an index of nesting pairs) (Figure 11). In part, this has been a result of improved population recruitment, indexed by young/nest/year, since 1985 (Figure 12). The population growth curve (Figure 12) exhibits an instantaneous rate of increase of 0.0541 (N = 46.39e; where t = number of years since 1961). This translates into a 5.6% average increase in the number of active nests per year, although from 1991-1992 the number of active nests increased by nearly 20%. These rates compare favorably with the maximum growth rate of 11% predicted by the USFWS for the Northern States bald eagle population (USFWS, 1983). The population would double to roughly 600 nests by the year 2007, based on these population data and growth rates and in absence of increased environmental resistance (i.e., density dependent factors such as limited available habitat) (NASA. 1993).

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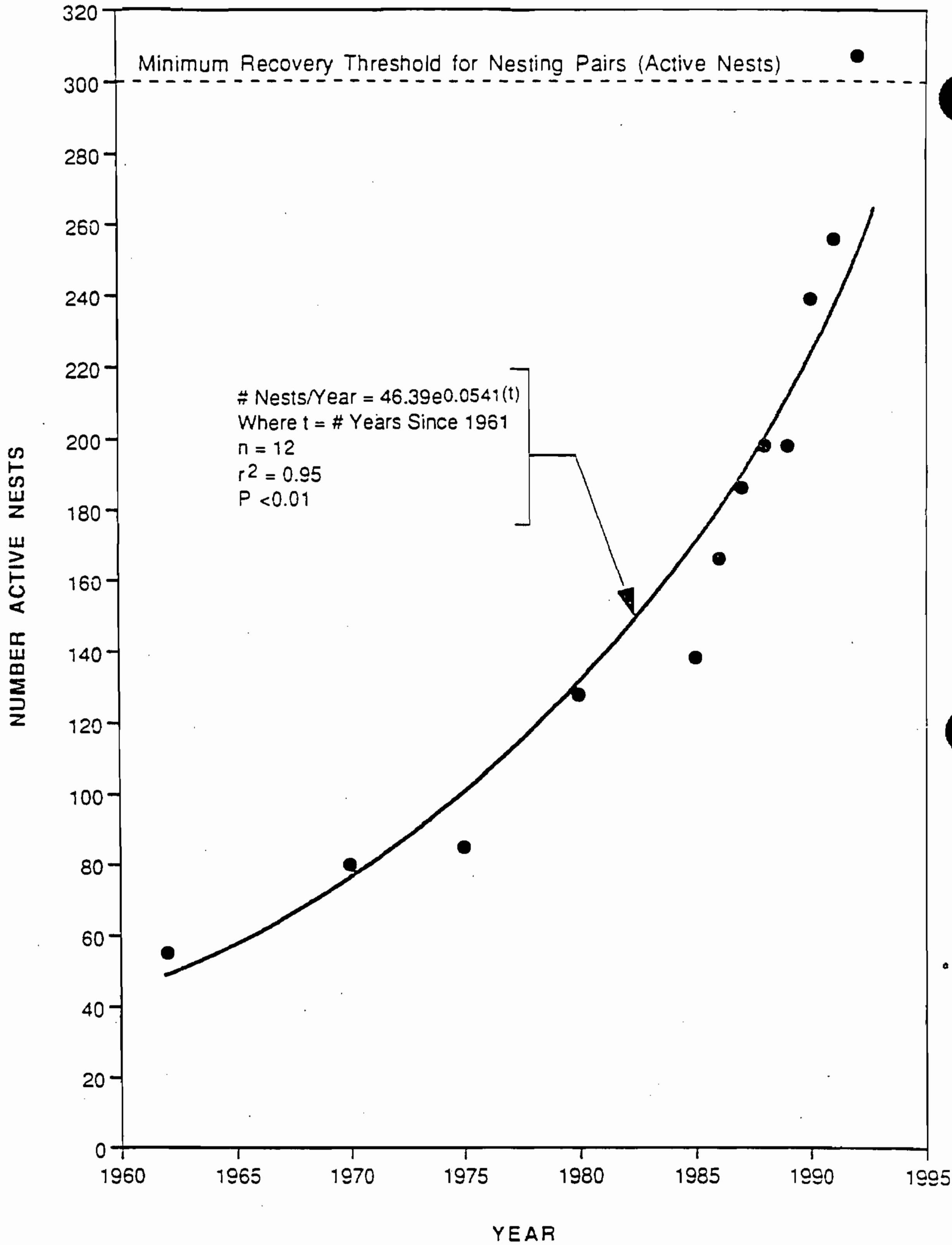
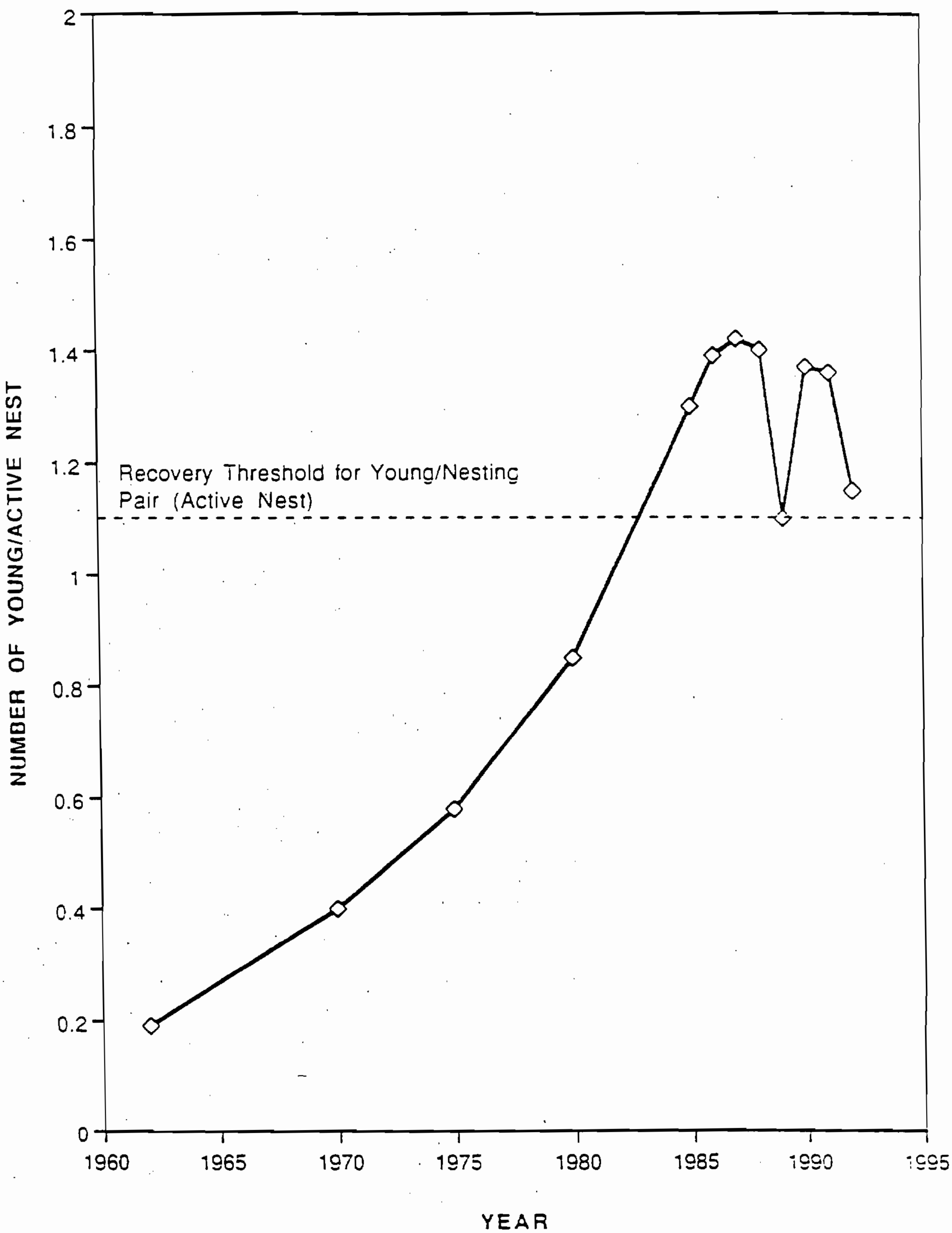


SOURCE: USFWS, 1990; USFWS, 1993b

FIGURE 11 NUMBER OF ACTIVE BALD EAGLE NESTS IN THE CHESAPEAKE BAY REGION FOR SELECTED YEARS FROM 1962 TO 1992



SOURCE: USFWS, 1990; USFWS, 1993b

FIGURE 12 BALD EAGLE YOUNG/NEST IN THE CHESAPEAKE BAY REGION FOR SELECTED YEARS FROM 1962 TO 1992

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The CBR bald eagle population is approaching thresholds judged to indicate full recovery. For full recovery, the CBR must contain 300 to 400 nesting pairs with a productivity level of 1.1 eaglets per active nest sustained over 5 years (USFWS, 1990). The current documented population of 307 nesting pairs already exceeds the lower range of the goal. Based upon the population data discussed above and in absence of increased environmental resistance, the CBR bald eagle population would exceed 400 nesting pairs around 2001. The goal of producing 1.1 or more eaglets per active nest per year has been sustained from 1985 to 1992 (1993 data were not available), exceeding the 5 year requirement (NASA. 1993).

Nesting habitat availability has recently replaced pesticide contamination as the major limiting factor on the CBR bald eagle population (USFWS, 1990). Density dependent influences will limit the availability of unoccupied nesting habitat and will ultimately slow the population growth as the number of nesting pairs increases. One result of the increased competition for nesting areas will be greater use of suboptimum nest areas.

Additional factors limiting population growth include habitat destruction and disturbance, shooting, continued use of certain environmental contaminants, natural phenomena, and accidents. Although all limiting factors are addressed to the extent possible, current recovery efforts are particularly focused on improving habitat availability, protecting existing habitat, and eliminating mortality due to shooting (USFWS. 1990).

Bald Eagle Populations in the Project Area

1. New Jersey. Clark et. al. (1994) reports that there were six (6) active bald eagle nests in the project area. Four (4) of these nests produced 8 young in 1994 while two (2) of the nests failed to produce young that year. One pair of eagles that nested near Raccoon Creek (designated as the Raccoon Creek site) is suspected to be the same pair that nested near Gibbstown in the past. The nest is located less than 2 miles from one of the proposed dredged material upland disposal sites (15D). This site and one near Welchville (the Home Run site) have not produced young in the last 2 years and are believed to have contaminant problems. Infertile eggs collected from the Home Run site had a high enough level of PCBs to cause death (Clark. 1995. Personal Communication). None of the other nests are located within 4 miles of either the navigation channel, upland disposal areas, or beneficial use sites; however, eagles from all the nests would be expected to forage along the Delaware Bay.

Thirty-one bald eagles were counted in the 1994 bald eagle winter survey along the Delaware Bay coastline. The Maurice and Cohansey River drainages held the highest concentrations, while the Maurice River watershed continued to support the greatest number of wintering bald eagles in southern New Jersey (Clark et. al. 1994).

2. Delaware. Gelvin-Innvaer (1994) reports that there were 10 active bald eagle nests in Delaware in 1994. Six of these nests produced 7 chicks to banding age, yielding a productivity of 0.7 chicks per occupied nest. In 1995 there are about 10 past or present eagle nest locations where the birds would be expected to forage along the Delaware Bay (Gelvin-Innvaer. Personal Communication). Trends in the numbers of banding-aged chicks, occupied nests, and successful nests have increased in the past 17 years, especially since the mid-1980's (Gelvin-Innvaer. 1994). One nest that is located in the Bombay Hook National Wildlife Refuge is about 6 miles from the Kelly Island beneficial use site (Smith. Personal Communication). Another eagle nest is located in the Prime Hook National Wildlife Refuge about 0.5 miles from the shore of Delaware Bay (O'Shea Personal Communication). As in New Jersey, contaminants are suspected to be a factor in nest failures at three nest sites including the one at Bombay Hook. Disturbance, habitat loss and habitat degradation increasingly threaten the long-term maintenance and expansion of eagle numbers in Delaware (Gelvin-Innvaer. 1994).

Eighteen bald eagles were reported to have wintered in Delaware in 1994; however, no significant concentrations of wintering eagles occur in Delaware (Gelvin-Innvaer. 1994).

3. Pennsylvania. In the Pennsylvania portion of the study area, the bald eagle is a transient; there are no nests or wintering concentrations (Brauning. 1995. Personal Communication).

<u>Environmental Contaminants</u> (USFWS. 1990)

Organochlorine pesticides, primarily DDT (especially its metabolite DDE) and dieldrin, were a significant reason for the past decline of the CBR bald eagle population, causing major reductions in reproductive success and direct mortality of eagles during the 1950s and 1960s. Although DDE concentrations have decreased markedly, other contaminants continue to have a negative impact on the population.

The historical effects of DDT and current threats from other environmental contaminants on bald eagles are discussed below.

1. Organochlorines. It was first reported in 1957 that the Chesapeake Bay bald eagle population appeared to be declining. It was hypothesized that the cause of the population decline and reproductive failure in Florida at that time might be DDT contamination of the environment. The extremely low rate of production by the Chesapeake Bay population in 1962 provided additional support to this hypothesis, as did a decline in reproduction for the New Jersey bald eagle population observed in the late 1950s.

Residues in eggs: The residue levels of several organochlorines found in CBR bald eagle eggs that failed to hatch for the years 1973-79 were among the highest for any bald eagle population in the United States. DDE, shown to cause eggshell thinning in several species of birds in experimental studies occurred at especially high levels. It was found that DDE in bald eagle eggs was much more closely associated with eggshell thickness and production of young than other toxicants.

A DDE concentration of 1.3 ppm in eggs was associated with a production level of 1 young per active breeding pair, whereas a concentration of 3.5 ppm was associated with a mean production of 0.7 young per pair. When DDE levels reached 15 ppm, production of young was reduced to 0.25 young per active breeding area. The geometric mean DDE concentration for Maryland and Virginia bald eagle eggs collected in 1973-79 was 9.6 ppm. Concentrations of DDE declined to 4.7 ppm for the years 1980-85.

The mean PCB concentration for these years declined from 27 to 15 ppm, whereas the mean dieldrin concentration declined from 1.0 to 0.3 ppm. Concentrations of other contaminants also declined. These declining concentrations of contaminants correlate with improvements in reproductive success that were reported during the years of sterile egg collection, although mean shell thickness has not significantly improved (see Table 3). The mean shell thickness of bald eagle eggs from Delaware, Maryland, and Virginia for the years 1975-79 was significantly thinner than the pre-DDT norm. No consistent or major improvement in shell thickness was noted for the area in the years 1980-85, and shell thinning exceeded 15% for the nest in New Jersey for the years 1982-86. This trend, however, may be biased by the fact that only eggs that did not hatch were collected and submitted for analysis. Young production in sample breeding areas was somewhat lower than in the overall population, confirming the bias in sampling.

Residues in tissues: Formerly, all bald eagles found dead or dying in the wild were submitted to the National Wildlife Health Research Center (NWHR) and PWRC for necropsy and chemical analysis. A number of the adult bald eagles acquired in the Mid-Atlantic region showed residue concentrations of organochlorines in their brains and carcasses. The concentrations in these bald eagles indicated that this population was one of the more highly contaminated populations in the United States. Current levels of reproductive success suggest that this is no longer the case, and tissue analysis is no longer conducted on a routine basis.

Elimination of DDT, aldrin (which is metabolized to dieldrin), and dieldrin since the early 1970s has been the major reason for the steadily increasing numbers and productivity rates in the CBR bald eagle population. However, although organochlorines are no longer a major threat to the CBR bald eagle population overall,

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TABLE 3. SHELL THICKNESS OF BALD EAGLE EGGS COLLECTED FROM 1973 TO 1986.

	Years	N	Mean thickness (mm)	% changed from pre-1946 norm
New Jersey	1982-86	1	0.481	-22
Delaware	1977-78 1982-85	1 3	0.473 0.523	-23 -15
Maryland	1977-78 1982-85	7 8	0.548 0.530	-11 -14
Virginia	1975-79 1980-85	5 11	0.506 0.539	-18 -13

N = Number of breeding territories represented

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their persistence may still impair the reproduction of a few pairs, especially in more contaminated areas such as Delaware Bay. DE Department of Natural Resources has noted that recurrence of contamination is a serious problem around the Delaware Bay. Their work on peregrine falcons and ospreys indicates increasing contaminant loads and corresponding shell thinning in both species that may be related to the age of the population; reproductive declines in bald eagles due to the continued presence of DDE and shell thinning in CBR bald eagles may not yet be apparent only because the population is young.

Preliminary results of contaminant testing by the New Jersey Department of Environmental Protection of blood and feather samples from eaglets along the New Jersey side of the Delaware Bayshore indicate that eaglets have moderate to high levels of DDT compounds compared to eaglets from the Great Lakes (Clark et. al. 1994). Studies by Steidl et. al. (1991 a and c) compared reproductive success in Delaware Bay and Atlantic coast osprey populations in New Jersey. The Delaware Bay population had lower reproductive success and the eggs from this population contained significantly higher levels of DDE, DDD, PCB's, dieldrin, and heptachlor epoxide than Atlantic coast eggs. This suggests that contaminants from within the Bay contributed to reduced hatching success in this population.

2. Organophosphorus and Carbamate Pesticides. Use of organophosphorus and carbamate compounds continue to pose threats to bald eagles in the region. The type and magnitude of threat differ from that formerly posed by DDT: the newer contaminants cause localized effects from acute toxicity.

These pesticides have been associated with the lethal poisonings of both bald and golden eagles in the United States. Since there is no national system for monitoring and reporting wildlife poisonings related to pesticides, records of eagles poisoned by pesticides are only an indication that such poisonings have occurred and continue to occur. There is no accounting of the total number of eagles in the CBR and elsewhere that are affected by pesticides.

Still, NWHR records show that the CBR has the most concentrated clustering of organophosphate/carbamate poisonings of bald eagles in the country. Their records also indicate that carbofuran was the major factor in the death of bald eagles from the Chesapeake Bay area in 1988.

Other pesticides also continued to affect bald eagles survivorship in the CBR, although to a lesser extent than carbofuran.

3. Oil. With increased petrochemical transport activities in the Chesapeake Bay region, the potential exists for eagles to come into contact with oil. Oil on their breast feathers could be transferred to their eggs. Small quantities of oil (as little as

one microliter of No. 2 fuel oil) on the surface of duck eggs have been showed to cause a significant reduction in ability to hatch. At least 146 bald eagles are known to have died in association with the 1989 oil spill in Prince William Sound, Alaska. Furthermore, reproductive success was depressed among eagles nesting in that area.

4. Other contaminants. Mercury has not been a threat to the CBR bald eagle population. However, other sources of contamination such as sedimentation and excessive nutrients have the potential to adversely affect Chesapeake Bay and Delaware Bay water quality, prey populations secondarily, and ultimately the CBR bald eagles.

PEREGRINE FALCON

The peregrine falcon was placed on the Federally Protected Migratory Bird List in March, 1972. In 1970, the U.S. Fish and Wildlife Service listed the American peregrine falcon under the Endangered Species Conservation Act of 1969, and in 1984, all peregrines in the lower 48 states were listed under the Endangered Species Act of 1973 as endangered by similarity of appearance. The peregrine falcons in the project area are covered under the Peregrine Falcon (Falco peregrinus), Eastern Population Recovery Plan - 1991 Update (USFWS. 1991).

The peregrine falcon nests on high cliffs, tall buildings, and bridges. It requires an uncontaminated avian prey base and undisturbed nest sties. The primary threats to the eastern population at the present time are disturbance of habitat by humans at existing sites and predation by great horned owls, which may limit population expansion in the southern Appalachians, Great Lakes, and southern New England/Central Appalachians recovery regions, except at urban sites.

Prey for the peregrine consists primarily of common passerine bird species such as bluejays, flickers, meadowlarks and pigeons. During migration and on the wintering grounds, passerines, shorebirds and waterfowl are taken while starlings, other passerines, and pigeons serve as the principal source of food for falcons occupying metropolitan areas.

Population trends of peregrines can be monitored with greater reliability than with many other birds because these falcons exhibit a high degree of nest site fidelity. An inventory of eastern peregrine eyries conducted in the late 1930s and early 1940s showed 408 eyries in the eastern United States, Canada, Labrador, and Greenland. Of these sites, 275 were located in the eastern United States and at least 210 were active eyries.

Former breeding distribution of the eastern population extended from northern New England through the Adirondacks and along the Appalachian Range to Georgia and Alabama. Populations also existed in the upper Mississippi River area of Wisconsin and Minnesota. Tree nesting populations were also present in Tennessee and Kentucky.

Falcons generally reach sexual maturity at age three. Usually, the male arrives first at a cliff site and performs a series of aerial acrobatic displays to attract a mate. Historically in the eastern region, peregrine pairs were usually on their breeding grounds and had re-established territories by March. Their eggs, usually four in a clutch, were laid in late March and April; if this clutch was lost early in the laying period, a second clutch was laid. Reintroduced birds are following this pattern. Peregrines vigorously defend the immediate area surrounding their nesting ledge, but are more tolerant to human intrusion into their hunting territory.

Incubation lasts 32-34 days. The female does most of the incubating and brooding while the male hunts. The juvenile peregrines are most vulnerable during their first year when they are still developing their flying skills and learning to hunt. This is the period when the birds are especially vulnerable to shooting or predation, and the first year mortality from all causes is much higher than in subsequent years.

In the early 1960s the number of peregrine falcons nesting in the United States declined rapidly, with extensive use of organochlorine pesticides considered to be the primary cause. High levels of organochlorines, particularly the widely used insecticide DDT, proved lethal to birds, and sublethal doses induced reproductive failure. DDE, a metabolite of DDT, disrupted calcium metabolism so that peregrine falcons accumulating sufficient DDE residues produced abnormally thin-shelled eggs, which often broke before hatching. Eggshell thinning in combination with other effects of organochlorines upon reproduction greatly reduced the nesting success of peregrine falcons, and the recruitment rate of young peregrine falcons fell below the number necessary to replace natural and pesticide-caused mortalities. Subsequently, peregrine falcon numbers dwindled to the point where, by the mid-1960s, the breeding population of the peregrine falcon in the eastern United States was extirpated. Due to successful efforts to captively breed and reintroduce peregrine falcons into areas where they once bred, as well as new areas, the peregrine again breeds in many regions of the Northeast, and have steadily increased in numbers (Steidl et. al. 1991).

Protection of peregrines from the effects of pesticides has been indirectly enhanced through the Federal Pesticide Control Act and similar state laws. These acts led to restricted use of chlorinated hyrodcarbons in the United States. As a result, the mean DDT and dieldrin levels in indicator species such as starlings have declined significantly since 1967. During the past few years, there have been eggs recovered from coastal sites in the mid-

Atlantic region that contained relatively high residues of DDE. The source of the material is uncertain, but migrating prey is suspected. Although the worst offenders have been banned, environmental contamination persists as a localized threat to the full recovery of these raptors.

Direct human disturbance of nesting birds is the primary threat to the eastern peregrine population at this point. In combination with this, great horned owls prey on young (and occasionally adult) peregrines.

Alteration of peregrine falcon nesting and migrating/wintering habitat is occurring at a low to moderate level, particularly in the coastal reaches of the eastern population's range. Many nests have been established within publicly owned areas; protection of this habitat is secured. Migratory and wintering peregrine habitat is more at risk, although protection of this habitat is also proceeding in many areas concomitant to protection of shorebird habitat. In addition, illegal shooting of peregrine falcons in the eastern United States remains a sporadic cause of bird mortality.

Natural increases in peregrine population levels are anticipated over the long run, given sufficient protection of the species' habitat. If implementation of recovery activities continues, reclassification of this population of the peregrine falcon should be possible when the number of nesting pairs reaches approximately one-fourth to one-third of the historical population level. As the population continues to grow, full recovery will be achieved when approximately one-half the historical number of 350 nesting pairs is shown to be self-sustaining and distributed across the falcon's former range (USFWS. 1991).

Peregrine Falcon Populations in the Project Area

1. New Jersey. Within the study area in New Jersey there are 5 nest locations. Three of the locations are on bridges over the Delaware River between New Jersey and Pennsylvania (Benjamin Franklin, Walt Whitman, and Commodore Barry). The other locations are at the Heislerville Wildlife Management Area and near Egg Island Point, both in Cumberland County. The same pair may be using the last two locations in different years (Clark. 1994 and Clark. Personal Communication). Production of young at New Jersey sites near the Delaware River and Bay has been lower than those from other parts of the state. Eggshell thinning due to contaminants continues to be a problem. Eggshell thickness reported from eggs collected from 1985-88 in New Jersey averaged 16.4% below pre-DDT levels and apparently has decreased steadily since 1979. This decrease in eggshell thickness suggests that falcons continue to be exposed to environmental contaminants. All peregrine populations where egg thinning exceeded 17% were either declining or became extirpated (Steidl, et. al. 1991). In addition, total PCBs and chlordane in New Jersey and other eastern peregrine falcon eggs continue to be

higher than those from other parts of the country, while total DDT remains high (Clark. 1994).

2. Delaware. Peregrine falcons have nested on the Delaware Memorial Bridge that connects Delaware to New Jersey. They have also attempted to nest on high buildings in Wilmington. There is no recent data on peregrine falcons in Delaware (Gelvin-Innvaer. Personal Communication).

3. Pennsylvania. Peregrine falcons have nested on two bridges in the project area (Walt Whitman and Commodore Barry) that have been cooperatively monitored by the Pennsylvania Game Commission and the New Jersey Department of Environmental Protection. Eggs from the first clutch from these two nests were removed and hacked in urban locations in Pennsylvania and New Jersey. The two pairs of falcons failed to renest (Clark. 1994). Productivity in captive-rearing facilities was higher than historically has been experienced with bridge-nesting peregrines (Brauning. 1994).

4. Migratory. In addition to the peregrine falcons that nest within the project area, many migrate through with up to 800 passing by Cape May, New Jersey in the fall, as well as a few birds that winter in the area (Herpetological Associates, Inc. 1992).

ASSESSMENT OF POTENTIAL IMPACTS

BALD EAGLE

Disturbance of Nest Sites

1. Construction and use of Upland Dredged Material Disposal Areas. One pair of eagles that nested near Raccoon Creek (designated as the Raccoon Creek site) is suspected to be the same pair that nested near Gibbstown in the past. The nest is located between 1.5 and 2 miles from one of the proposed dredged material upland disposal sites (15D). The FWS requires a buffer zone of 0.25 miles or a line of site buffer of 0.5 miles from the nest from January to July to avoid disturbance (Peters. Personal Communication). There would be no adverse impact provided that the eagles continue to nest in the locations that have been used in the past. At this time we can not tell if an eagle nest will be located near an upland disposal area in the year 2000 when the upland sites would be constructed. A contingency plan will be developed based on FWS recommendations. Construction of the site and use of the site for disposal of dredged material could be staged to avoid disturbance impacts where work would be performed within the dates recommended by Cline (1985).

2. Construction of Kelly Island and Egg Island Point Wetland Restoration Sites. The Kelly Island beneficial use site is about 6 miles from an eagle nest in the Bombay Hook National Wildlife Refuge, and there would be no impacts to the nesting bald eagles

from construction of the site. There are no suitable bald eagle nesting trees near either the Kelly Island wetland restoration site or the Egg Island Point wetland restoration site.

Potential for Increased Development

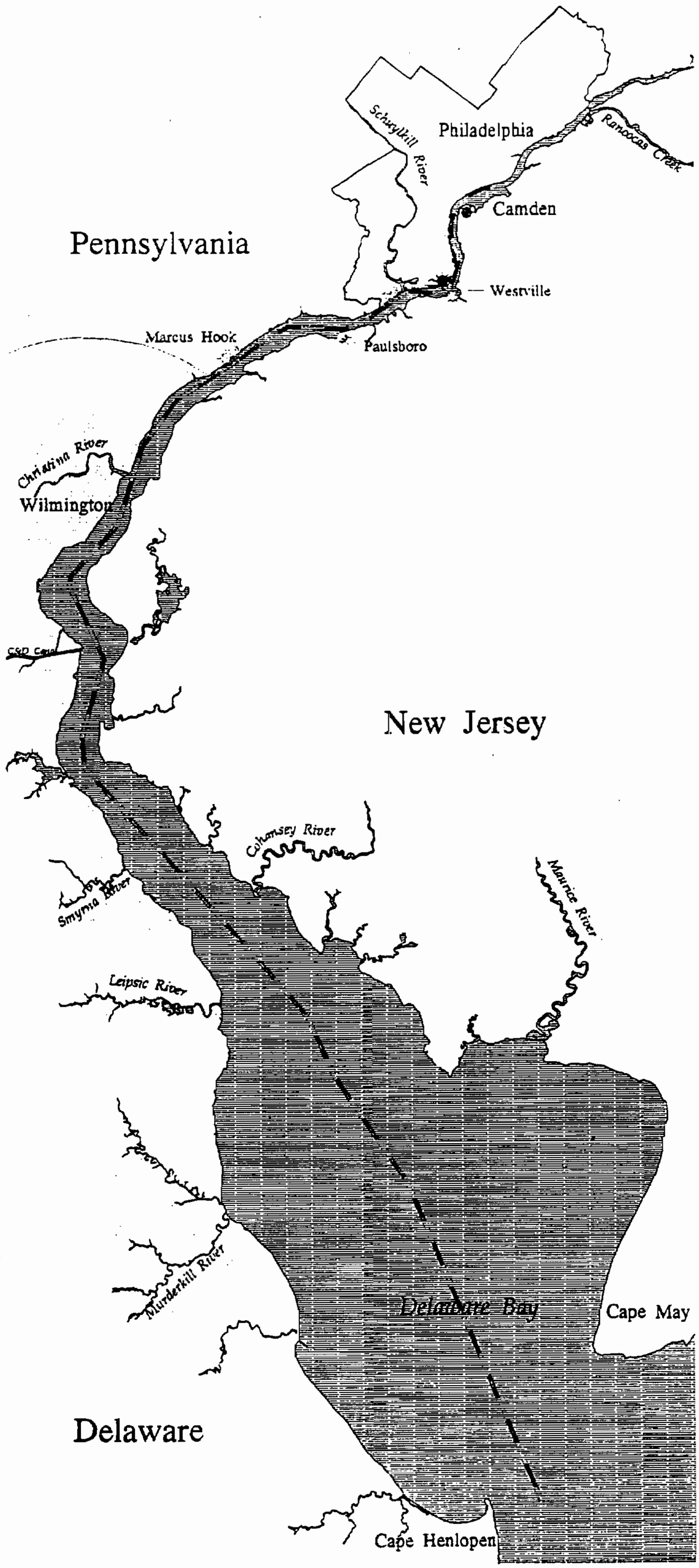
There should be no impacts to bald eagles from increased development due to the channel deepening project. Although the greatest economic benefit for the channel deepening project is to the petroleum industry, the oil refining facilities in the project area are not expected to increase as a result of this project. The import level for crude oil is forecasted to be 79 million tons in 2055 without the channel deepening project. The refineries will need to expand their current 60 million ton capacity in order to process the projected tonnage. The refinery capacity is expected to increase in the future through technology changes, upgrading facilities, expansion, and new development in order to accommodate projected commodity flow. However, the economic benefits of this project will result from increased efficiency of oil transportation due to decreased lightering, and there is no additional increased development projected due to this project. The locations of the six oil refineries that will benefit from this project are shown in Figure 13 and consist of the following facilities: Sun Oil, Marcus Hook, PA; BP Oil, Marcus Hook, PA; Mobil Oil, Paulsboro, NJ; Sum Oil, Ft. Mifflin, PA; Sun Pipeline, Ft. Mifflin, PA; and Coastal Eagle Point Oil, Westville, NJ. None of the known current locations of eagle nests are near these refineries.

Potential for Increased Oil Spills

There should be no impacts to bald eagles from increased oil spills due to the channel deepening project. Although the channel deepening project will enable oil tankers to bring larger quantities of oil directly to the oil refineries, this will be done more safely than it is under present conditions. Under present conditions, large oil tankers with full cargos need to transfer a portion of their cargos to smaller tankers in the lower, deeper portion of Delaware Bay so that they can negotiate the 40 foot channel upriver. This process is called "lightering", and it is in this operation that there is a greater possibility for oil being spilled. With the new, deepened channel, lightering will be reduced 40% for benefitting facilities. In addition, the navigation channel will be widened at certain bends such as the bend at Marcus Hook, PA. This is the only location in the estuary where bedrock is exposed, and over 37% of the major oil spills that have occurred since 1973 have taken place at this location by groundings (see Table 4). The widening and deepening of the navigation channel at Marcus Hook should reduce the possibility of oil spills in the Delaware Estuary.

The input of oil into the Delaware River results from several activities, including refinery and other industrial operations,

Delaware River Main Channel Deepening Project Area



Legend

- Oil
- Iron Ore (Conrail)
- Container (Packer Ave)
- Scrap/Bulk (Beckett)
- Main Channel

Benefitting Terminals

US Army Corps of Engineers
Philadelphia District

This map was produced by the U.S. Army Corps of Engineers, Philadelphia District, Planning Division Geographic Information System (GIS). Portions of digital data were provided by: NJDEP, PENNDOT and DELDOT.

Figure 13

urban runoff, municipal waste, and tanker traffic. In 1975, the input of oil from onshore operations (not including that resulting from tanker operations) was estimated at 59,000 gallons per day or about 21.5 million gallons per year. Following enactment of the Clean Water Act in 1977, this oil discharge decreased by over one-half (COE. 1992).

The potential for oil spills and concern over the negative environmental impacts involved is very much a public concern. Any oil spill event in the Delaware River must be reported to the National Response Center. Under the National Oil Spill Contingency Plan (NCP), there are National, Regional, and Local Response Teams. The Region III and Region II Emergency Response Teams have jurisdiction in the Delaware River Comprehensive Navigation Study area. The Region III Response Team consists of representatives of the following:

- Environmental Protection Agency
- U.S. Coast Guard
- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Energy
- Department of Health and Human Services
- Department of the Interior
- Department of Labor
- Federal Emergency Management Agency
- Commonwealths of Pennsylvania, Virginia, and District of Columbia
- States of Delaware, Maryland, and West Virginia

The Region II Response Team is composed of the same Federal agencies plus the States of New Jersey and New York. Under the Regional Contingency Plan (RCP) in the Delaware River Comprehensive Navigation Study Area the U.S. Coast Guard Captain of the Port, Philadelphia (COTP) is designated as the on scene cleanup coordinator (OSC). The OSC can call upon support for spill clean up from the Atlantic Strike Team (located at Fort Dix, NJ), a specially trained and equipped contingent of NCP's National Strike Team; the Delaware Bay and River Cooperative (DB&RC), a consortium of oil, chemical, and petroleum transportation companies which operate two cleanup vessels and have an assortment of other kinds of cleanup equipment at their disposal; members of the Regional Response Team; and representatives of the Local Response Team such as the New Jersey State Police and the Philadelphia Fire Department. The Regional Contingency Plan is updated on a continual basis and would be updated to reflect any changes in current vessel traffic patterns due to a modified project.

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Table 4 - Major Oil Spills in the Delaware River, 1973-1989

Year	Volume (gallons)	Vessel Source	Location	Accident Type
Spills Greater than 100,000 Gallons				
1973	126,000	Tanker	Marcus Hook	Grounding
1974	285,000	Tanker	Philadelphia/Camden	Collision
1975	500,000	Tanker	Marcus Hook	Collision
1976	134,000	Tank Barge	Marcus Hook	Grounding
1978	630,000	Tank Barge	New Castle-Reedy Island	Sinking
1979	189,000	Tank Barge	Marcus Hook	Collision
1985	525,000	Tank Barge	Philadelphia/Camden	Grounding
1989	200,000-300,000	Tanker	Marcus Hook	Grounding
Spills Greater than 10,000 Gallons but less than 100,000				
1973	14,720	Tanker	Ocean Throughway to Delaware Bay	Grounding
1974	13,000	Tanker	Philadelphia/Camden	Fire/Explosion
1975	12,000	Tanker	Marcus Hook	Collision
1975	73,000	Tugboat	Philadelphia/Camden	Capsizing
1976	84,000	Tanker	Philadelphia/Camden	Collision
1979	16,800	Tanker	Philadelphia/Camden	Pipe Rupture

U.S. Coast Guard data from 1973 to 1989 on vessel-related oil spills in the Delaware River revealed a gradual decline in both the number of spill incidents and the volume. Much of it can be attributed to the increase in tanker vessel size and the use of larger tank barges for lightering. Twenty-five percent of the spills analyzed involved residual fuel oil, 20 percent involved crude oil, and another 20 percent involved diesel fuel. Additional petroleum-related materials spilled in the river were gasoline, other distillate fuel oils, and waste oil. On a volume basis, crude oil comprised 44 percent of material spilled followed by residual fuel oil with 26 percent.

Lightering operations have occurred at the Big Stone Beach Anchorage since the 1960's. Transfer accidents in the Delaware River occur at a rate one-half that of the national average of 8 accidents per 1000 transfers. The average national lightering spill is about 32 gallons. For the Delaware such spills are immediately cleaned up using an oil skimmer which is permanently stationed at Lewes, Delaware and operated by the Delaware Bay and River Cooperative.

Most of the oil spilled into the Delaware River has been the result of tanker and barge accidents. Refer to Table 4 for a listing of the major oil spills which have occurred in the Delaware River from 1973 to 1989. Major incidents such as these are usually the result of human error and structural or mechanical failures. After an oil spill event, a prompt and efficient oil spill cleanup can reduce many adverse impacts. The amount of oil that is recovered after an oil spill can vary from 5% to 80% depending on the weather conditions, location, tidal condition, and type of oil spilled. The conditions are worse when the spill occurs in the open Bay where it is difficult to contain and when the oil is light and disperses quickly. In these conditions recovery will fall below 50% (Dillon. 1995. Personal Communication). In the aftermath of the catastrophic Exxon Valdez oil spill in Prince William Sound Alaska, several actions have been taken to lessen the chances and reduce the impacts from similar spills that may occur in the future. Since the enactment of the Oil Pollution Act of 1990, all vessels must have spill response plans to deal with the worst case oil spill that could occur.

These plans were in place on February 18, 1993. Also, the Marine Spill Response Corporation (MSRC) was created and incorporated in 1989. This not-for-profit corporation was created to assist in the cleanup of large oil spills using state of the art technology. Lastly, there is increasing public pressure to require vessels that transport oil to have double hulls, back-up steering and emergency back-up propulsion systems.

If an oil spill occurs, the oil Pollution Act of 1990 (OPA) requires that the impacts be documented and the area restored. The Oil Spill Liability Trust Fund is money set aside by oil companies. Money from this fund can be accessed by either the Department of the Interior or the National Oceanographic and Atmospheric Administration, the Federal Trustees, and can be used to restore damaged resources and lost services. The responsible party is identified and must replace the money that was used.

Although spills also occur periodically, the Delaware River has functioned safely considering the huge volume of oil that is transported on the river. Channel dimensions have not been identified as a contributing factor to the previous accidents or oil spills on the Delaware River. Through proper planning and design of waterway improvements and navigation aids, the potential for accidents can be minimized. There is potential to reduce oil pollution due to lightering operations by main channel deepening. This would alleviate the need for lightering vessels in the 40' to 45' sailing draft range.

PEREGRINE FALCON

Disturbance of Nest Sites

1. Construction and Use of Upland Dredged Material Disposal Areas. A pair of peregrine falcons has nested on the Commodore Barry bridge which crosses the Delaware River between Pennsylvania and New Jersey. The bridge is adjacent to the proposed Raccoon Island upland dredged material disposal site. The time when nesting peregrines are the most sensitive to disturbance is at the beginning of the nesting period (15 March to 15 April). During this period no work should be initiated; however, it may be possible to continue ongoing work without disturbing the falcons (Clark. 1995. Personal Communication). The Philadelphia District will coordinate closely with the NJDEP before work would be performed during this critical period.

2. Restoration of Wetlands at Egg Island Point and Kelly Island. Another pair of peregrine falcons has nested on a structure near Egg Island Point where the Philadelphia District plans to restore a wetland that is eroding at a rate of up to 30 feet per year. Conversations with the NJDEP (Clark. 1995. Personal Communication) indicate that the nest structure is in danger of being destroyed by the continuing erosion. The Philadelphia District would move the nest structure to a safer location as determined in coordination with the NJDEP. The restoration of wetlands at Egg Island Point and Kelly Island should have a beneficial impact by restoring and protecting tidal wetlands that provide habitat for waterfowl and shorebirds which are prey species for peregrine falcons.

CONTAMINANTS

After review of available data for dredged material derived from the Delaware River Main Channel Deepening Project, it would appear that the relative risk of contaminants in the dredged material to wildlife and especially endangered species such as the bald eagle and peregrine falcons should be very low and consequently, should not be a significant concern. The frequency of detection of contamination in sediment samples collected throughout the project was low and therefore any detected contamination when placed in the designated disposal sites will be mixed to such a large extent that contaminant concentrations will end up very low.

PCBs. The highest concentrations of PCB-1254 and PCB-1248 observed in one out of 49 samples from Reach B of the project were 1.19 and 0.53ppm, respectively. After dredging and placement in a disposal site, the overall final PCB concentration will be no doubt be below 0.25 ppm. Bioaccumulation of PCBs in wetland and upland soil dwelling animals have been observed to be less than one half the concentration measured in the dredged material. For example, at the Corps of Engineers' Field Verification Program field sites, both earthworms in the upland site and sandworms in the wetland site bioaccumulated approximately 3 ppm PCBs from dredged material containing 6.7 ppm PCBs (Lee et al. 1995). FDA action levels for human consumable food have been set at 2 ppm PCBs. While there are no set action levels for wildlife food, it is reasonable to assume that foodchain components that contain above 2 ppm could represent significant risk to wildlife. It would appear that reduced concentrations of sediment PCBs, such as 0.25 ppm, should not be a significant risk to wildlife exposed to an ecosystem developed on the proposed disposal sites for dredged material from Delaware Estuary.

Pesticides. Few sediment samples showed detected pesticides. One sediment sample out of 33 showed 0.060 ppm heptachlor epoxide (Reach A), while another sample out of 49 showed 0.06 ppm Endosulfan (Reach B) and finally a third sample out of 19 showed 0.026 and 0.045 ppm of DDD and DDE, respectively. Dredging and placement of sediments in the disposal sites will result in reduced concentrations of these pesticides. The reduced concentrations should not represent a significant risk to wildlife.

PAHs. Sediment samples did show detectable amounts of PAHs. The highest concentrations of PAHs were observed in 2 out of 49 samples in Reach B. One sample approached a total PAH concentration of 10 ppm. Concern for exposure of foodchain components to sediments containing 10 ppm or more of PAHs could be warranted. However, when this sediment is dredged and placed in a disposal site with the other 48 sampled sediments within the

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Reach, the resultant reduced concentration of PAHs should be approximately 0.2 ppm and of little concern or risk.

<u>Metals</u>. Most sediment samples showed detectable metals. Metals that were detected at levels that might be of concern were cadmium (1.66 ppm, mean concentration for Reach A) and thallium (3.76 and 2.48 ppm mean concentration for Reaches A and B, respectively). These concentrations were above NJ DEP Residential Direct Contact Soil Cleanup Criteria, which can give some perspective of sediment chemical data, but may not relate well at all to the risk to wildlife. All other metals were low and should not be a significant risk.

1. Cadmium. Up to 1994, 2.7 ppm cadmium was the soil concentration allowed for land receiving sewage sludge and used in crop production for human and animal food (Lee et al. 1991). Newly established EPA 503 regulations for land application of sewage sludge raised the soil levels to 34 ppm cadmium for unrestricted use of land. It would appear that dredged material containing an average concentration of 1.66 ppm cadmium should be of low risk in light of the 503 limitations. Bioaccumulation of cadmium in foodchains has been observed on dredge material containing 11 ppm cadmium (Stafford et al. 1987). Cottonwood trees that colonized the Times Beach Confined Disposal Facility at Buffalo, NY took up cadmium from the dredged material into their leaves. The leaf litter on the soil surface was inhabited by earthworms which bioaccumulated cadmium up to 100 ppm, resulting in a significant potential risk to wildlife foodchains on the disposal site. This example is an order of magnitude more sediment cadmium than that observed in Delaware River sediments and illustrates that bioaccumulation can occur at higher soil cadmium concentrations.

2. Thallium. The risk of thallium to foodchains is unknown. While there are water quality criteria for thallium for human risk assessment, there are no FDA action levels for thallium in human or animal food. The concentration of thallium observed 2.48 and 3.76 ppm appears to be above the NJDEP Residential Direct Contact Soil Cleanup Criteria of 2.00 ppm, however, the magnitude above the criteria is below 2X times. Concern for concentrations of potential contaminants usually becomes warranted when magnitudes above criteria approach 5X times. Until a more applicable criterion is established for the risk of thallium to wildlife foodchains, the risk to wildlife should be considered low.

<u>Water Column Impacts</u> The discussion above is related to disposal site impacts. The potential for impacts and risk to wildlife and especially the bald eagle and peregrine falcon is minimal from the dredging of sediments in the Delaware River, based on the collected data. Elutriate test show very little release of contaminants of concern to the water column. Dredging will

temporarily suspend sediments, but the duration and exposure will be temporary and should not result in significant risk to fish or wildlife. Bioassay tests with suspended sediments showed no toxicity or bioaccumulation of any significance. Therefore, the risk to fish and ultimately the bald eagle or peregrine falcon should be insignificant.

Bioassay and Bioaccumlation Testing

All water column and whole sediment bioassays resulted in 100 percent survival of all test species. The results of the water column bioassays suggest that sediment disturbance, and associated water column turbidity, at the point of dredging and at dredged material disposal locations would not result in mortality of aquatic organisms in the vicinity. Likewise, the results of the whole sediment bioassays suggest that aquatic organisms that colonize sediment placed for beneficial uses in Delaware Bay would also be unaffected by sediment contaminants.

With regard to bioaccumulation, there was no evidence that contaminants accumulated in clam tissue exposed to Delaware Bay sediment at greater concentrations than clam tissue exposed to clean laboratory sediment. All of the tissue residues were representative of what one would expect in organisms exposed to uncontaminated material. With regard to bioaccumulation and the polychaete Nereis virens, there were no statistical differences between contaminants in worms exposed to channel sediments and worms exposed to reference sediments, with the exception of the heavy metal arsenic. The mean arsenic concentration in worms exposed to one channel sediment sample (0.700 ppm) was statistically higher than concentrations in worms exposed to reference sediment samples (0.360 and 0.460 ppm). The measured tissue concentration of arsenic in worms exposed to the channel sediment did not appear to be deleterious. No more mortality was observed in the channel sediment test worms than in worms exposed to other sediments. Furthermore, a mean tissue concentration of arsenic in worms exposed to the control sediment (0.680 ppm), which was obtained in Maine where the worms were collected, was virtually identical to that measured for the channel sediment worms (0.700 ppm). Both of these values are well below the range of acceptable background tissue arsenic concentrations for test organisms from East Coast sites, which is reported to be 1.5 to 3.9 ppm in the USEPA Guidance Manual for Bedded Sediment Bioaccumulation Tests (EPA-600-R-93-183). Overall, test results suggest that open water placement of Bay sediment is acceptable with regard to bioaccumulation concerns.

ALTERNATIVES CONSIDERED

A number of alternatives to the selected plan were considered by the Philadelphia District. In addition, a number of dredged material disposal alternatives and sites, and a number of beneficial uses of dredged material were evaluated using economic, engineering and environmental criteria and are discussed in detail in the Final Interim Feasibility Report and Environmental Impact Statement (COE. 1992).

CONCLUSIONS

No significant adverse impacts will occur to either the bald eagle or the peregrine falcon provided the following measures are done:

BALD EAGLE

Prior to construction of the upland dredged material disposal areas, the Philadelphia District will coordinate with the USFWS and the NJDEP to determine if there are any bald eagle nests within 0.25 miles or a line of site distance of 0.5 miles from the dredged material disposal area. If there is an active nest within these distances, construction of the site and the use of the site for the disposal of dredged material will be staged to avoid disturbance impacts.

PEREGRINE FALCON

1. Coordinate with the NJDEP before initiating any new work at the Raccoon Island upland dredged material disposal site between 15 March and 15 April.

2. The Philadelphia District will move the nest structure located at Egg Island Point to a safer location as determined in coordination with the NJDEP.

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SECTION B-3

PLANNING AID REPORT, COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT, DELAWARE RIVER FROM PHILADELPHIA TO THE SEA, BENEFICIAL USE OF DREDGED MATERIAL
U.S. FISH AND WILDLIFE SERVICE
AUGUST, 1995

PLANNING AID REPORT

COMPREHENSIVE NAVIGATION STUDY
MAIN CHANNEL DEEPENING PROJECT
DELAWARE RIVER FROM PHILADELPHIA TO THE SEA

BENEFICIAL USE OF DREDGED MATERIAL

U.S. FISH & WILDLIFE SERVICE

DEPARTMENT OF THE INTERIOR

Prepared by:

U.S. Fish and Wildlife Service
Region 5
Delaware River / Delmarva Coastal Ecosystem Team

August 1995

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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Tel: 609-646-9310
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IN REPLY REFER TO:

FP-95/25

August 18, 1995

Lt. Colonel Robert P. Magnifico
District Engineer, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Lt. Colonel Magnifico:

Enclosed is the U.S. Fish and Wildlife Service (Service) planning aid report on the Philadelphia District Corps of Engineers' (District) Comprehensive Navigation Study, Main Channel Deepening Project, Delaware River from Philadelphia to the Sea (Beneficial Use of Dredged Material). This report has been prepared pursuant to a Fiscal Year-1995 interagency agreement between the District and the Service.

This planning aid report is provided as technical assistance and does not constitute the report of the Secretary of Interior pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 *et seq.*). Planning aid is valid only for the described conditions and must be revised if changes to the proposed project take place prior to initiation.

This report is also provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species and does not address all Service concerns for fish and wildlife resources. Therefore, these comments do not preclude separate review and comments by the Service on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

Federally-listed Species

The federally-listed endangered bald eagle (*Haliaeetus leucocephalus*) nests near the Delaware Bay, and feeds throughout the project area. Additionally, the federally-listed endangered peregrine falcon (*Falco peregrinus*) also nests on Egg Island Point in the vicinity of the proposed project. Peregrine falcons may be expected to forage for prey throughout the project area and generally feed on songbirds, gulls, terns, shorebirds, and wading birds. Additionally, peregrine falcons use the Delaware Bay shoreline during migration, especially in the fall.

It is the Service's understanding that the District is preparing a Biological Assessment to address potential project-related adverse impacts to the bald eagle, and peregrine falcon. Other than the aforementioned species, no other federally-listed or proposed endangered or threatened flora or fauna under Service jurisdiction are known to occur within the project area. It is also our understanding that the District is coordinating with the National Marine Fisheries Service regarding the federally-listed shortnose sturgeon (*Acipenser brevirostrum*) (endangered), Atlantic Ridley turtle (*Lepidochelys kempii*) (endangered), and loggerhead turtle (*Caretta caretta*) (threatened). Appendix A provides lists of federally-listed endangered and threatened species and federal candidate species in New Jersey and Delaware.

Any questions regarding this report or federally-listed endangered or threatened species should be directed to John Staples or Peter Benjamin of my staff. The Service looks forward to continued cooperation with the District in the planning stages of the proposed project.

Sincerely,

Clifford G. Day
Supervisor

Enclosure

PLANNING AID REPORT

COMPREHENSIVE NAVIGATION STUDY
MAIN CHANNEL DEEPENING PROJECT
DELAWARE RIVER FROM PHILADELPHIA TO THE SEA

BENEFICIAL USE OF DREDGED MATERIAL

Prepared for:

U.S. Army Corps of Engineers
Philadelphia District
Philadelphia, Pennsylvania 19107

Prepared by:

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August 1995

EXECUTIVE SUMMARY

In accordance with a Philadelphia District, U.S. Army Corps of Engineers (Corps) Fiscal Year - 1995 scope-of-work agreement, the U.S. Fish and Wildlife Service (Service) has prepared this planning aid report for the Corps' Delaware River Comprehensive Navigation Study, Main Channel Deepening Project. The material presented in this planning aid report summarizes available data and information on the fish and wildlife resources of Delaware Bay, with an emphasis on those resources that would be most affected by plans currently under consideration by the Corps for the disposal of material dredged from the Delaware Bay portion of the Main Channel.

The proposed Main Channel Deepening Project, authorized by Congress in October 1992 as part of the Water Resources Development Act of 1992, would involve the deepening of the existing federal navigation channel for the Delaware River and Delaware Bay from 40 feet below mean-low-water (mlw) to 45 feet below mlw. The proposed project provides for a full width channel that would follow the existing channel alignment from the Delaware Bay to the Philadelphia / Camden waterfront, a distance of approximately 102.5 miles. Approximately 50 million cubic yards of dredged material would be removed for initial construction over a five year period. Approximately 40 million cubic yards of material to be dredged from the Delaware River would be placed in confined upland disposal areas. An estimated 10 million cubic yards of dredged material, which would be generated by the Delaware Bay portion of the Main Channel Deepening project, is available to be used beneficially to help combat the severe erosion that is threatening bayshore wetlands and properties. Potential beneficial uses evaluated for this report include the use of geotextile tubes for wetland restoration and shoreline stabilization at Egg Island Point, New Jersey, and Kelly Island, Delaware; beach nourishment along the Delaware shoreline; and, the formation of sand stockpiles in Delaware Bay. Such stockpiles would provide a readily available source of sand for future beach nourishment projects.

Information presented in this report includes an assessment of the effects of various dredged material disposal scenarios on fish and wildlife resources and provides Service recommendations regarding the preferred locations and designs for projects that would provide beneficial uses of dredged material, in terms of improving fish and wildlife habitat. Additionally, this planning aid report presents identified data gaps and additional information needed to fully evaluate the effects of the various disposal scenarios, and includes recommendations for future studies.

Based upon review of available information, numerous site visits, and coordination with local sources of expertise, the Service has concluded that the proposed wetland restoration projects at Egg Island Point, New Jersey, and Kelly Island, Delaware, would provide positive benefits to fish and wildlife resources. The Service further concludes that beach nourishment would have the greatest positive effects on beaches between Port Mahon and South Bowers Beach, Delaware, while nourishment of beaches in the more southern sections of the Delaware shoreline would be less beneficial, although still worthwhile. Additionally, the Service concludes that the proposed disposal of dredged material in sand stockpiles would adversely affect fish and wildlife resources and that the use of sand stockpiles should be minimized or eliminated as an alternative.

While the Service supports the proposed wetland restoration and beach nourishment plans, in concept, substantial additional coordination and planning are necessary to ensure maximum project benefits with minimal adverse effects on fish and wildlife. The Service is particularly concerned that the proposed wetland restoration projects at Kelly Island and Egg Island Point may adversely impact oyster beds through increased turbidity and sedimentation. The Service recommends that the Corps continue to coordinate project planning with the Service, the New Jersey Division of Fish, Game and Wildlife (NJDFGW), and the Delware Department of Natural Resources and Environmental Control (DNREC).

The Service recommends that the Corps proceed with plans to conduct a pilot project to study the effectiveness of geotextile tubes in Delaware Bay. Such a pilot project would greatly improve the prospects for successful implementation of the proposed Egg Island Point and Kelly Island wetland restoration projects. Such a pilot project should also include expanded horseshoe crab and shorebird surveys, and assessments of horseshoe crab spawning habitat requirements. The Service recommends that the Corps coordinate with the Service, DNREC, and NJDFGW regarding the design of the pilot project, and related monitoring studies.

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I. INTRODUCTION

This U.S. Fish and Wildlife Service (Service) planning aid report has been prepared in conjunction with a Philadelphia District, U.S. Army Corps of Engineers (Corps) Fiscal Year - 1995 scope-of-work agreement, and is submitted for the Corps' Delaware River Comprehensive Navigation Study, Main Channel Deepening Project. The material presented in this planning aid report summarizes available data and information on the fish and wildlife resources of Delaware Bay, with an emphasis on those resources that would be most affected by plans currently under consideration by the Corps for the disposal of material dredged from the Delaware Bay portion of the Main Channel. Previous Service reports have documented the effects of the proposed dredging on fish and wildlife resources (U.S. Fish and Wildlife Service, 1985, 1989, 1992). Information presented in this report includes an assessment of the effects of various dredged material disposal scenarios on fish and wildlife resources and provides Service recommendations regarding the preferred locations and designs for projects that would provide beneficial uses of dredged material, in terms of improving fish and wildlife habitat. Finally, this planning aid report presents identified data gaps and additional information needed to fully evaluate the effects of the various disposal scenarios, and includes recommendations for future studies.

II. PROJECT DESCRIPTION

The Feasibility Study for the Main Channel Deepening Project was completed in 1992. The proposed Main Channel Deepening Project was authorized by Congress in October 1992 as part of the Water Resources Development Act of 1992, based on the findings of the Feasibility Study. The authorized project would involve modification of the existing federal navigation channel from 40 feet below mean-low-water (mlw) to 45 feet below mlw. The proposed project provides for a full width channel that would follow the existing channel alignment from the Delaware Bay to the Philadelphia / Camden waterfront, a distance of approximately 102.5 miles. The proposed project includes all appropriate bend widenings as well as provision of a two-space anchorage at Marcus Hook.

Approximately 50 million cubic yards of dredged material would be removed for initial construction over a five year period. The approximately 40 million cubic yards of material dredged from the Delaware River would be placed in confined upland disposal areas. The environmental effects of the use of these proposed upland disposal areas are discussed in a separate planning aid report (U.S. Fish and Wildlife Service, 1995a). Various disposal options, including beneficial uses for dredged material, are currently being considered for the approximately 10 million cubic yards of material to be dredged from the Delaware Bay.

The Delaware Bay shoreline is experiencing severe erosion, subjecting shoreline properties to storm damage from waves and tidal inundations. Continual erosion of the Delaware Bay shoreline over the past century has also resulted in substantial wetland losses. These wetlands provide not only valuable habitat for fish and wildlife, but also protect bayside properties and structures from storms (U.S. Fish and Wildlife Service, 1994a). The estimated 10 million cubic yards of dredged material that would be generated by the Delaware Bay portion of the Main Channel Deepening project could be used beneficially to help combat the severe erosion that is threatening bayshore wetlands and properties. Potential beneficial uses include wetland restoration, shoreline stabilization, beach nourishment, and the formation of sand stockpiles in Delaware Bay. Such stockpiles would provide a readily available source of sand for future beach nourishment projects.

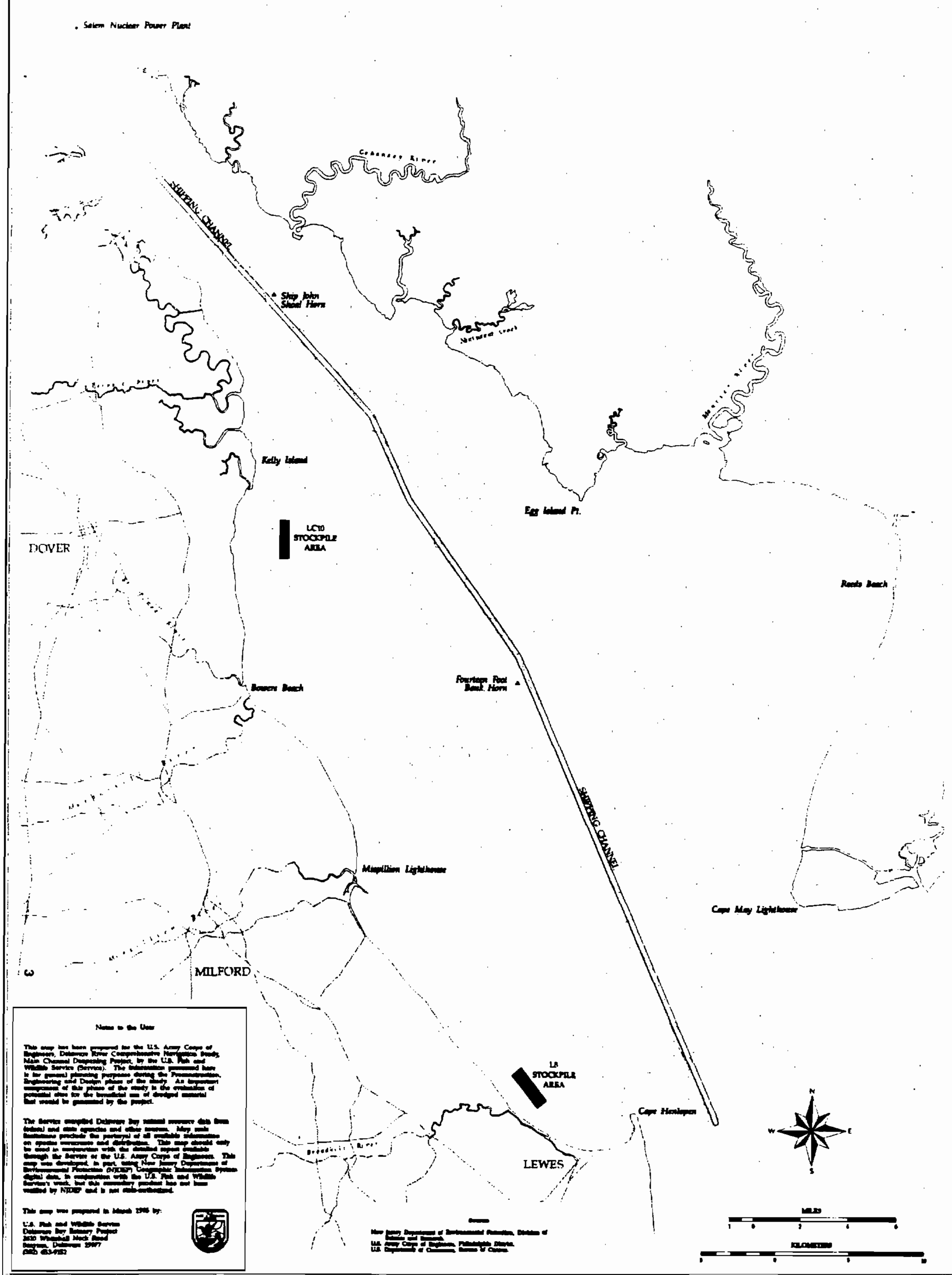
The Corps is currently engaged in the Preconstruction, Engineering and Design phase of the study. The purposes of this phase are to: re-affirm and refine the authorized plan; respond to comments received on the Feasibility Study; establish the final design of the project features; and, finalize the project cooperative agreement with the Delaware River Port Authority, the non-federal project sponsor. A critical component of this phase of the study is to identify and design disposal areas for dredged material from the Delaware Bay portion of the Main Channel. Because the costs of dredged material disposal increases as the distance from the Main Channel to the disposal site increases, the sites evaluated in this report are only those sites closest to the Main Channel, that have the highest potential for providing economically feasible alternatives, as identified by the Corps. These sites include the following: Kelly Island, Delaware, and Egg Island Point, New Jersey, wetland restoration / shoreline protection sites; possible beach nourishment sites along the Delaware shore of the Bay; and, possible sand stockpile sites in Delaware Bay (Figure 1) (J. Brady, pers. comm., 1995). It is recognized that many other areas of Delaware Bay could be suitable sites for beneficial use projects.

The Corps has prepared preliminary designs for the Kelly Island and Egg Island Point wetland restoration / shoreline protection sites. The existing conditions of these sites are described in Section IV below. In summary, the shoreline in both of these areas consists of rapidly eroding tidal marsh. The preliminary plan for both of these sites is to use geotextile tubes and material dredged from the Main Channel to restore wetlands and to stabilize the shoreline.

On the Kelly Island site, the goal is to protect the southern tip of Kelly Island and to restore a portion of the historic shoreline to tidal marsh. The preliminary plan (Figure 2a) includes the placement of a single geotextile tube filled with dredged material 50 to 100 feet seaward of the existing shoreline from the southern tip of Kelly Island to approximately 500 feet north of the tip. The tube would be placed on a layer of sand and a geotextile scour blanket for support.

From a point approximately 500 feet north of the southern tip of Kelly Island to Deepwater Point (a distance of 5,000 to 8,000 feet), a second geotextile tube structure would be constructed approximately 500 to 800 feet seaward of the existing shoreline. The structure would consist of a stack of three geotextile tubes filled with dredged material and supported by a layer of sand and a geotextile scour blanket placed on top of the existing substrate (Figure 2b).

Figure 1. Delaware Bay Reference Map
for the Delaware River Beneficial Use Plan



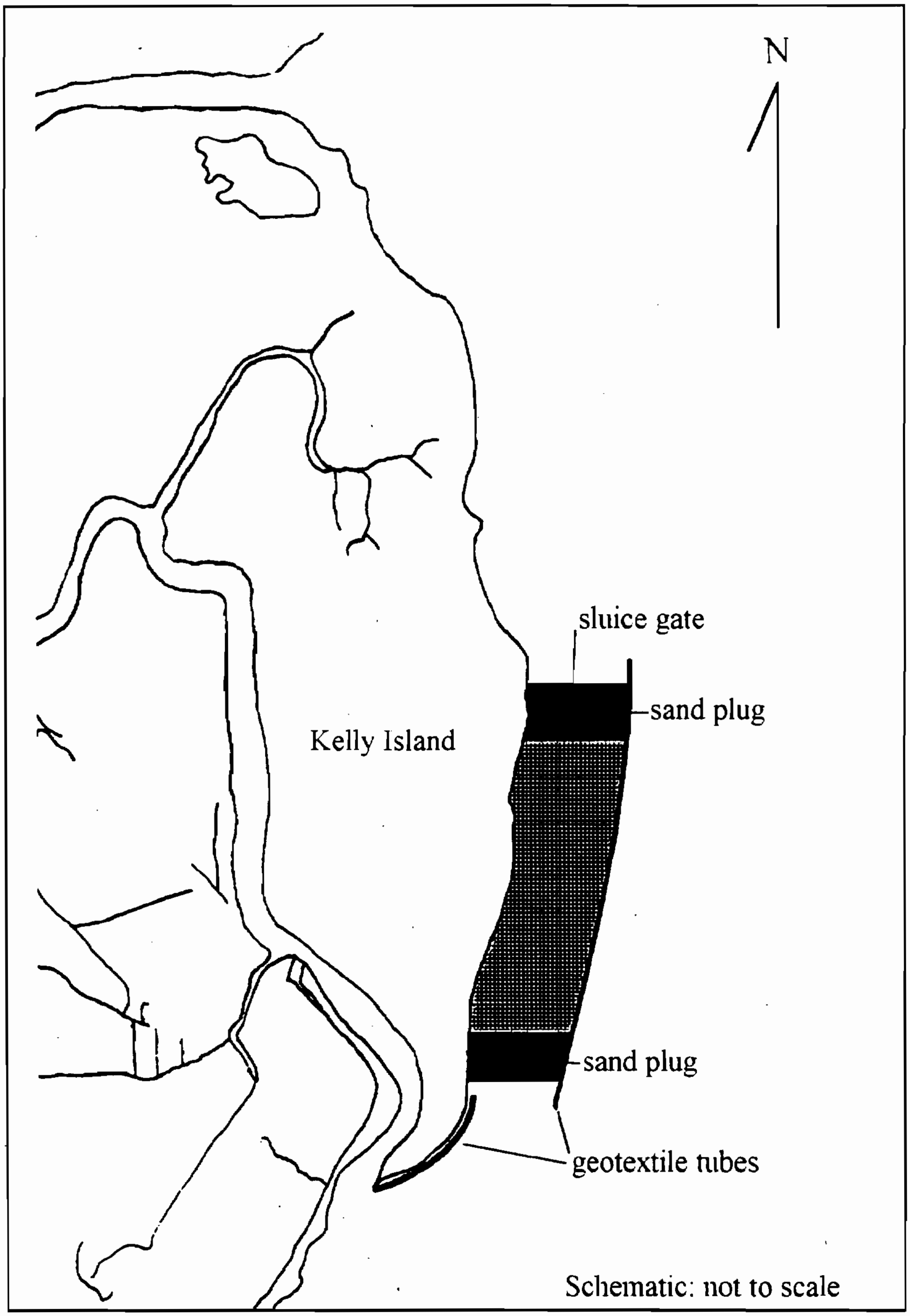


Figure 2a. Preliminary shoreline stabilization and marsh restoration plan for Kelly Island, Delaware (overhead view).

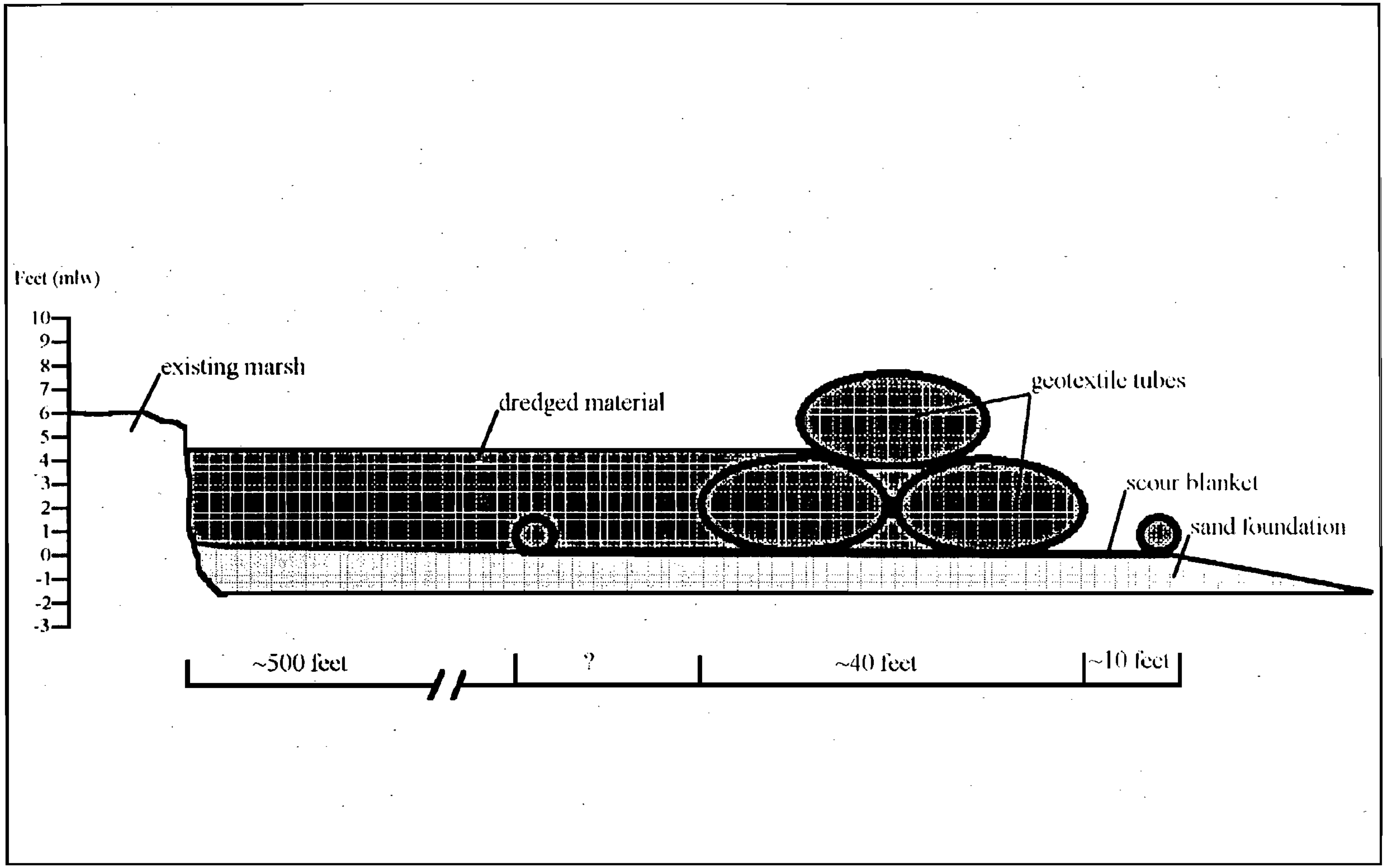


Figure 2b. Preliminary shoreline stabilization and marsh restoration plan for Kelly Island, Delaware (cross-sectional view).

The top elevation of the sand foundation would be approximately mean low water (mlw). The top elevation of the top tube would be approximately 10 feet above mlw. The areas between the shoreline and the northern and southern ends of the geotextile tube structure would be plugged with sand berms to create a confined compartment for the placement of dredged material.

Once the geotextile structure is in place, approximately one million cubic yards of silt and fine-grained material from the Main Channel would be deposited within the compartment. The site would be designed such that the dredged material would settle to the approximate elevation of the adjacent low marsh (4.5 to 5 feet above mlw). The drainage of slurry water from the site would be controlled by one or more sluice gates installed in the sand plugs. The filled area would then be planted or allowed to naturally vegetate with salt marsh cordgrass (*Spartina alterniflora*) and other native salt marsh vegetation. Approximately 80 to 125 acres of wetland would be restored, depending on the location of the geotextile tube structure.

The preliminary plan for the Egg Island Point site is similar to the Kelly Island plan in that geotextile tubes would be used to provide wetland restoration and shoreline protection (Figure 3). The structure would extend approximately two miles in each direction from Egg Island Point; northwest to Straight Creek, and northeast to Oranoaken Creek. The Corps is considering a number of design options for the proposed structure, including whether or not to place dredged material landward of the geotextile tubes. If dredged material is placed behind the structure it would be designed to stabilize at the approximate level of the adjacent low marsh, similar to the Kelly Island site. If dredged material is not placed landward of the structure, it is expected that the existing marsh would gradually advance to seaward toward the structure via sedimentation. These and other specific design options are discussed in Section VI below.

The Corps is also considering plans to nourish beaches along the Delaware shoreline using sand dredged from the Main Channel. Sites currently under consideration include the entire shoreline from Port Mahon to Lewes Beach, Delaware. The Corps is currently assessing whether beach nourishment is economically feasible.

The Corps is currently proposing to use the sand dredged from the Main Channel that is not used for either wetlands restoration or beach nourishment to create two or more sand stockpiles near the Delaware shoreline. Depending on the volume of sand used for other projects, the sand stockpiles could contain up to 9.5 million cubic yards of sand. The stockpiled sand would be available for use by the State of Delaware for erosion control, shoreline stabilization and beach nourishment (U.S. Army Corps of Engineers, 1994). The proposed stockpile sites were chosen based upon the economics of future use by the State of Delaware and environmental considerations (J. Brady, pers. comm., 1995).

Sand stockpile Site L-5 is approximately 500 acres, and is located approximately 1,000 yards offshore from Broadkill Beach, Delaware (Figure 1).

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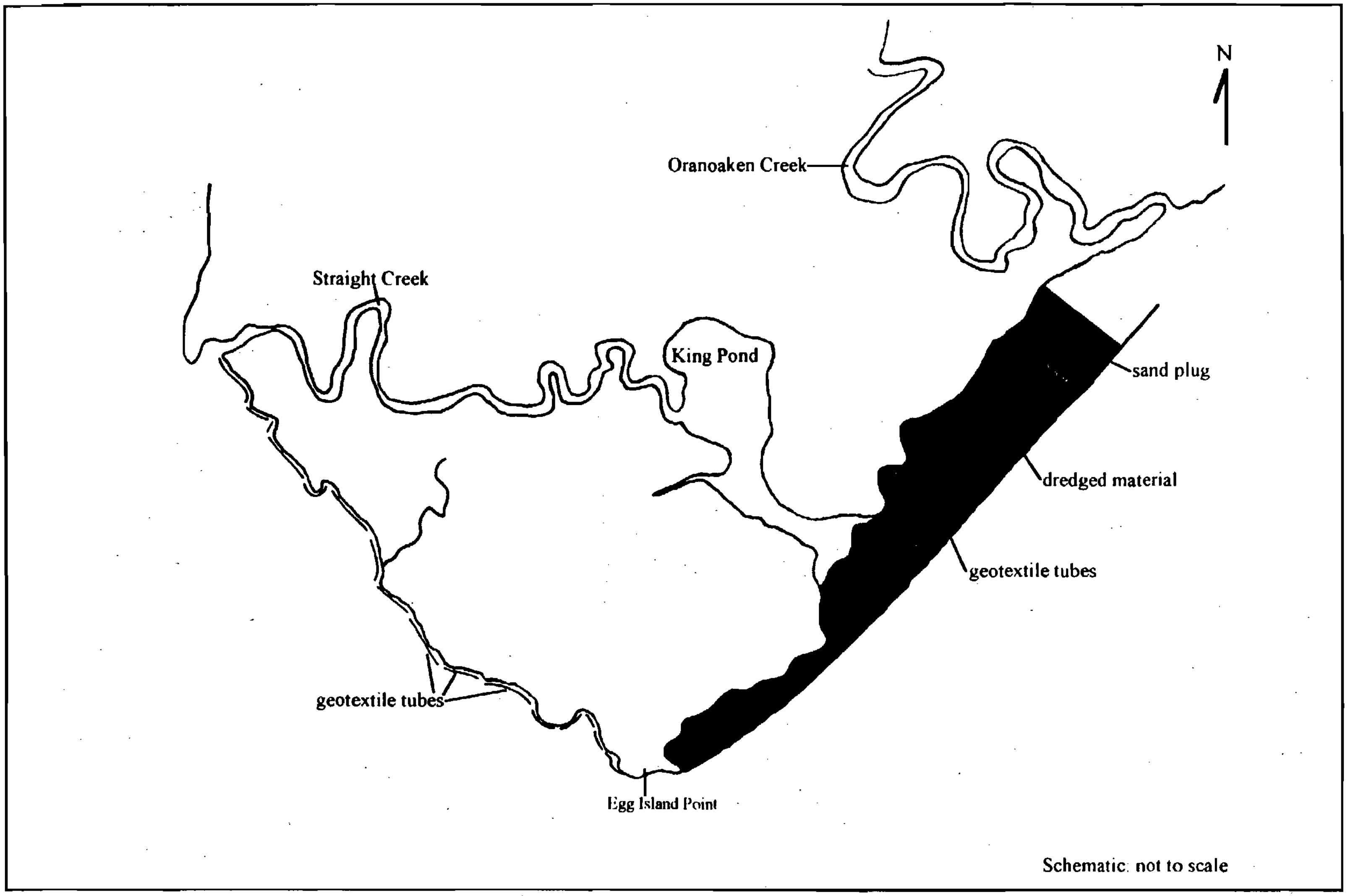

Figure 3. Preliminary shoreline stabilization and marsh restoration plan for Egg Island Point, New Jersey (overhead view).

The Corps had previously identified Site LC-10 (also 500 acres) as a second site for sand stockpiling; however, further coordination with the Service and the Delaware Department of Natural Resources and Environmental Control (DNREC) indicated that deposition of dredged material in this area would have serious environmental consequences, as discussed below. Therefore, Site LC-10 has been eliminated from further consideration (J. Brady, pers. comm., 1995). The Corps is presently considering an alternative site in the vicinity of Big Stone Beach, Delaware. No information is currently available regarding the exact location or areal extent of the proposed alternative sand stockpile site; however, the site would most likely be located in the vicinity Site MS-19, which was previously investigated by the Corps. The top elevation of the proposed stockpiles would be approximately 5 feet below mlw.

III. METHODOLOGY

The information for this planning aid report was compiled from reports provided by the Corps, searches of Service field office files and libraries, meetings and telephone conversations with local sources of expertise and representatives from DNREC and the New Jersey Department of Environmental Protection, Division of Fish, Game and Wildlife (NJDFGW). Several site visits were conducted by Service biologists to the following beaches in Delaware during February 1995: Kelly Island; Port Mahon; Pickering Beach; Kitts Hummock; South Bowers; Bennetts Pier; Big Stone Beach; Cedar Beach; Mispillion Jetty; Slaughter Beach; Fowler Beach; Roosevelt Inlet (Beach Plum Island); Lewes Beach; and, Cape Henlopen Breakwater Harbor. Additionally, Egg Island Point, New Jersey, was visited in January 1995. Two helicopter trips in February 1995 allowed for aerial observation of the area between Egg Island Point and the mouth of the Maurice River; and, from Kelly Island to Cape Henlopen.

Beach nourishment using sand dredged from the Main Channel could potentially improve spawning habitat for horseshoe crabs (*Limulus polyphemus*). Therefore, a major focus of this report is to identify those areas that are currently providing below optimal spawning habitat for horseshoe crabs as potential sites for beneficial use projects. As discussed in detail below, horseshoe crabs are habitat generalists and will spawn in a wide variety of shoreline conditions; as such, the presence of large numbers of horseshoe crabs on a given beach is not necessarily an indication of habitat quality (Shuster, 1994). However, spawning success is highest on gently sloping beaches consisting of sand at least 8 inches deep.

To assess the current suitability of individual beaches as horseshoe crab spawning habitat, field observations were recorded during the February site visits. Specifically, beach characteristics, including beach slope, sand depth, and sediment composition were recorded. Because beach conditions may vary substantially between winter and summer, the field observations discussed below may not necessarily reflect beach conditions during the horseshoe crab spawning season; however, these observations should be useful in assessing the relative suitability of individual beaches for horseshoe crabs.

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Measurements for beach slope were taken with a Staedtler Mars 964 51-10 split protractor wired with a spirit level and placed on a board. Readings in degrees were taken every two meters from the highest Spring tide wrack line to the waterline. Observations were also recorded regarding the nature of the beach substrate in the area of each beach estimated to be the center of horseshoe crab spawning activity. This area is generally several meters below the wrack line, and is the area that would be uncovered between the Spring high tide and one to two hours after high tide, when horseshoe crab spawning is likely to be most intense. Sediment was sieved to ascertain suitability for spawning by horseshoe crabs. Sieve sizes of 0.425 mm and 4.25 mm were used to obtain percentages by weight of fine sand, medium and coarse sand, and gravel. Samples have been retained at the Service's Delaware Bay Estuary Project for further analysis by the Corps if desired. In sandy areas, the approximate depth of sand was also recorded.

Maps produced in a Geographic Information System have been included in this report to aid the reader in visualizing biologically sensitive areas and species distributions along the Delaware shoreline of the Bay. These maps are graphical representations of electronic data obtained by the Service from a variety of sources (listed on the maps). Only the Delaware shoreline area was mapped for this report because of the wide range of disposal scenarios currently under consideration by the Corps along the Delaware shoreline.

IV. STUDY AREA DESCRIPTION

A. DELAWARE BAY

The Delaware Bay covers a 782 square-mile area from the point at which the Delaware River widens at Liston Point, Delaware, to the mouth of the Bay between Cape Henlopen, Delaware, and Cape May, New Jersey. The general orientation of the Delaware shoreline is from the northwest to the southeast, except for Cape Henlopen, which turns north. The lower Delaware Bay is semicircular, with minimal shoreline topographic development. This flat shoreline topography has resulted in the long contiguous sandy beaches that are typical of the Delaware Bay. In fact, the Delaware Bay contains the longest contiguous sandy beaches of any estuary on the mid-Atlantic coast (C. Shuster, pers. comm., 1995).

The open mouth of the Delaware Bay exposes much of the shoreline to the open ocean. The fetch (distance across open water to shore) is large, and the shoreline can experience fully developed seas even when they are created within the bay under local wind conditions. Much of the wave energy responsible for the constant, incremental (non-storm) erosion is thought to be developed from local wind patterns (Kraft *et al.*, 1976). However, severe tropical and extra-tropical storms are responsible for the most damaging events (French, 1990). A long history of erosion, subsidence, and sea level rise continues to result in dynamic, unstable shoreline conditions in many

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areas. Tidal amplitude is high; from 4 to 7 feet compared to the Chesapeake Bay, which averages about 1.5 feet. There are also strong currents in Delaware Bay; up to 4 knots (Kraft *et al.*, 1976).

The average net change for the Delaware shoreline from Kelly Island to Lewes, Delaware, between the years 1882 and 1977 was 419.3 feet to landward or approximately 2.6 feet per year (French, 1990). Average net change for the more highly erosive northern portion of the shoreline, north of the Mispillion River Inlet, between 1842 and 1977 was 978.9 feet to landward (French, 1990). This translates to an average rate of erosion of 7.2 feet per year (French, 1990). Unlike the southern and central sections of the Delaware shoreline, the pattern of erosion in the northern areas does not appear to be storm-driven. Instead the shoreline appears to be retreating at a relatively regular rate (French, 1990). The reasons for these differences in erosion rates in various sections of the Bay are not clear, but erosion is expected to continue or possibly accelerate (French, 1990).

The pattern of shoreline change along the New Jersey shoreline of the Bay is less well documented than on the Delaware side. The shoreline in the vicinity of Fortescue, New Jersey, which is approximately two miles northwest of the Egg Island Point project site, experienced average erosion of approximately one foot per year between 1940 and 1978. However, the area around Maurice River Cove, immediately to the east of Egg Island Point, had erosion rates between 3 and 12 feet per year over the same period (U.S. Army Corps of Engineers, 1991). Egg Island Point itself appears to be eroding more rapidly, and the Corps estimates the shoreline at Egg Island Point to be eroding at a rate of between 15 and 30 feet per year (J. Brady, pers. comm., 1995).

B. DESCRIPTION OF SITES UNDER CONSIDERATION FOR DREDGED MATERIAL DISPOSAL

For the purposes of this report the Delaware shoreline of Delaware Bay has been divided into four segments: (1) Kent Island and Kelly Island; (2) Port Mahon to South Bowers Beach; (3) Bennetts Pier to Big Stone Beach; and, (4) Mispillion Jetty to Lewes Beach. While this division is somewhat arbitrary, and considerable variation occurs among the beaches within each segment, the beaches within each of these segments share certain properties that make this grouping useful for discussion.

Additional information regarding beach characteristics and historic shoreline changes along the Delaware shoreline can be obtained from the following sources:

Robert Henry
Division of Soil and Water
Delaware Department of Natural Resources
and Environmental Control
89 Kings Highway
P.O Box 1401
Dover, Delaware 19903
(302) 739-4411

Jonathan Sharp
University of Delaware
College of Marine Studies
700 Pilottown Road
Lewes, Delaware 19958
(302) 645-4259

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Robert Jordan
Delaware Geological Survey
University of Delaware
Delaware Geological Survey Building
Newark, Delaware 19716
(302) 831-2833

1. Egg Island Point

This section of the New Jersey shoreline is characterized by eroding salt marsh, with limited areas of sandy beach. Most of the shoreline consists of steep scarps of eroded peat four to six feet tall interfacing directly with open water of Delaware Bay. Some areas, particularly along the southwestern shoreline, have small sandy beaches consisting of thin layers of sand over eroded peat. These areas and the tip of Egg Island Point are the only areas of the site with substantial sandy beaches. Scattered small dunes immediately landward of the shoreline are vegetated primarily by common reed (*Phragmites australis*) and high-tide bush (*Iva frutescens*). The salt marsh in this area is typical of Delaware Bay salt marshes with the dominant vegetation being salt marsh cordgrass. There are also numerous shallow tidal and non-tidal ponds and tidal creeks scattered across the surface of the salt marsh.

2. Kent Island and Kelly Island

This section of the Delaware shoreline is part of the Bombay Hook National Wildlife Refuge. The shoreline in this area can be characterized as eroding salt marsh, with limited areas of sandy beach. The shoreline of Kent Island consists of approximately 1.5 miles of salt marsh interfacing directly with open water of Delaware Bay. The erosional rate in this portion of the Bay is extremely high. Recession averaged nearly 20 feet per year between 1848 and 1972 (Kraft *et al.*, 1976). The marsh substrate is a thick layer of peat; 18 to 30 feet deep (Kraft *et al.*, 1976). The dominant vegetation is a mixture of salt marsh cordgrass and common reed.

Kelly Island has approximately 2.5 miles of shoreline consisting of sheltered tidal flats, small mixed sand and gravel beaches, and outcrops of salt marsh in erosional areas. The small beaches in this area consist of thin layers of sand and gravel over exposed peat. Service biologists visited the southern tip of Kelly Island on February 13, 1995. The substrate consists of compacted peat with vertical scarps 3 to 5 feet high at the waterline. Large sections of the marsh mat at the island's southern tip have been broken off by recent wave action. The southern tip of the island is eroding rapidly, and has migrated northward more than 5,000 feet since 1842; an average of over 37 feet per year (French, 1990). The marsh substrate in this area exceeds 30 feet in depth (Kraft *et al.*, 1976). Sand taken from a small beach face in front of Bombay Hook Marsh just north of Kent Island in 1978 had a mean sediment size of 0.339mm (French, 1990).

According to a map of percent silt / clay in Delaware Bay sediments (Maurer *et al.*, 1978), sediments in Kelly Island area were between 70 and 100 percent silt / clay. Similarly, the Greeley-Polhemus Group (1994) found that substrates at this site included sandy areas and areas consisting of silt / clay.

In the event of an oil or hazardous materials spill, three Boom Deployment sites have been identified in the Delaware Bay and River Cooperative's Oil Spill Response Plan Appendices (Delaware Bay and River Cooperative, Inc., 1991) along the Kent Island shoreline, along a 1.5-mile-long section between the Leipsic River and the Simons River, indicating the sensitivity of this area to disturbance and pollution.

3. Port Mahon to South Bowers Beach

This section of the Delaware Bay shoreline can be characterized as experiencing moderate to severe erosion. The individual beaches in this section vary in their physical characteristics depending upon whether beach nourishment or other shoreline stabilization mechanisms have been employed. There is little to no longshore sediment transport in the area between Port Mahon and Pickering Beach (French, 1990).

The Port Mahon site extends approximately one mile from the mouth of the Mahon River to the mouth of Little Creek. The shoreline is rip-rapped and bulkheaded for most of this length; however, small beaches of sand and crushed oyster shell occur in areas where the bulkhead has collapsed or at the ends of the bulkhead, and salt marsh has filled in some areas behind the bulkhead. Numerous pilings and remnant piers are scattered along the shoreline. Rip-rapped sections of the Port Mahon site are washed over in some areas by spring tides and storm tides. There is a fishing fleet at the road's northern terminus, and the boat ramp is heavily used by small-boat traffic. Hundreds of bird watchers come to Port Mahon in May and conflicts often arise because too many cars block the narrow, washed out road that runs parallel to the beach.

The most suitable horseshoe crab spawning habitat at Port Mahon is the approximately 660-foot-long section of shoreline just north of the Dover Air Force Base Aviation Gas pipeline / barge unloading pier. Field observations of beach conditions in this area collected during a February 1995 Service site inspection indicated that the sand was fairly uniform in grain size from the surface to a depth of about 8 inches. Buried rip-rap was encountered at two sample spots, and a layer of gravel and oyster shells was found at a depth of approximately 10 inches along the mid-tide line. Sediment samples taken at the southern end of Port Mahon, near the mouth of Little Creek were composed almost entirely of unconsolidated peat.

The thickness of the coastal mud offshore of Port Mahon ranges from 30 feet or less near the mouth of the Mahon River at the north end of the site to greater than 30 feet along the remainder of shoreline. These deep mud deposits extend south most of the way to Kitts Hummock (Kraft *et al.*, 1976).

Pickering Beach is a small summer resort community, with approximately 40 summer cottages located about 20 feet behind the landward edge of the barrier dune. Pickering Beach consists of approximately 0.75 mile of mixed sand and gravel beach, grading into exposed marsh substrate covered with a thin layer of sand at the northern and southern ends of the site. An extensive mud flat occurs in the offshore area.

Pickering Beach has experienced an average, long-term erosion rate of 5.6 feet per year (French, 1990). This rate is higher than Kitts Hummock, but lower than Port Mahon. The Pickering Beach community is extremely vulnerable to storm damage, and has experienced severe erosion following storms events.

Pickering Beach is part of the State's beach replenishment program, and was also one of six sites selected for a demonstration project of low-cost shoreline protection (U.S. Army Corps of Engineers, 1981). The scrap-tire breakwater structure located about 300 feet off the mid-southern portion of the beach was installed in 1978, and aerial observation indicates some accretion of sediment around it. Sand taken from Pickering Beach in 1978 had a mean sediment size of 0.724mm (French, 1990).

Kitts Hummock consists of approximately 0.5 mile of mixed sand and gravel beaches surrounded by extensive tidal mud flats and marshes. Sand taken from Kitts Hummock in 1978 had a mean sediment size of 0.550mm (French, 1990). Long-term erosion rates for Kitts Hummock average approximately 4.2 feet per year (French, 1990).

The normal tidal range at Kitts Hummock is approximately 5 feet, and nearly tops the barrier dunes at high tide (National Oceanic and Atmospheric Administration, 1995). This renders the small coastal community of Kitts Hummock vulnerable to storm damage. While beach nourishment has slowed the rate of erosion somewhat, the area is still undergoing landward recession. Three breakwaters were installed by the Corps in 1978 and 1979 as part of the above-mentioned demonstration project (U.S. Army Corps of Engineers, 1981). Each breakwater was constructed of different materials. The northernmost breakwater is approximately 300 feet in length and was constructed of pre-cast concrete boxes; the center breakwater is also approximately 300 feet in length and was constructed of nylon sandbags, which have apparently failed; and the southernmost breakwater is a 300-foot-long mound of rubble. The breakwaters are separated by gaps of about 300 feet. Conversations with a local resident suggested that extensive buildup of mud in front of the beach has accelerated since the breakwaters were built.

Bowers Beach consists of approximately 2,400 feet of medium sand and gravel beaches. The average grain size of sand taken from Bowers Beach in 1978 was 0.586mm (French, 1990). Analysis of Corps data indicates that shoreline erosion in the Bowers Beach area averaged slightly over 4 feet per year between 1843 and 1954 (Kraft *et al.*, 1976). Bowers Beach is periodically renourished by the State of Delaware, and the mouth of the Murderkill River is stabilized on both sides by large sand-filled bags. The combination of sandbag groins and beach nourishment has performed reasonably well in reducing beach loss (U.S. Army Corps of Engineers, 1981); although the net erosion over the long term has still averaged 5.4 feet per year (French, 1990). While littoral sediment transport in this area is weak and erratic (French, 1990), wave heights averaging 1-2 feet with a maximum of 4 feet have the potential to move significant amounts of sediment (U.S. Army Corps of Engineers, 1981).

The beaches of South Bowers Beach are mixed sand and gravel. The area of the beach near the waterline consist of a thin layer of sand and gravel over peat, whereas the upper portions of the beach have thicker layers of sand and gravel. There are extensive mud flats offshore. The distance from the wrack line to the beginning of the mud flats (with 0 degrees slope) was approximately 55 feet during February 1995 site investigations.

Field observations of beach conditions collected during a February 1995 Service site inspection indicated that the sand depths on South Bowers Beach are somewhat variable, ranging from less that 2 inches in depth near the mean low water line to in excess of 15 inches near the high tide line.

In the event of an oil or hazardous materials spill, two boom deployment sites have been identified in the Delaware Bay and River Cooperative's Oil Spill Response Plan Appendices (Delaware Bay and River Coopratives, Inc., 1992) at Port Mahon; they are at the mouths of Little Creek and the Mahon River. Additionally, there are boom placement sites at the mouth of the Little River, along the marshes off the Little Creek Wildlife Management Area, and at the mouth of Lewis Ditch.

4. Bennetts Pier to Big Stone Beach

This section of the Delaware shoreline consists of relatively stable to slightly accreting beaches; in part due to the more erosion-resistant Pleistocene neck formations in this area. The shoreline on either side of the Murderkill River has oscillated between periods of erosion and periods of accretion. These beaches eroded substantially between 1842 and 1943 (French, 1990), followed by slight accretion during the period between 1943 and 1954, and again by erosion between 1954 and 1969. From 1969 to 1977 the area experienced the highest average annual accretion rate in recorded history (French, 1990).

Nothing remains of the pier that once stood at Bennetts Pier except for a few rotted pilings. Sand taken from Bennetts Pier in 1978 had a mean sediment size of 0.587mm (French, 1990). Field observations taken during the Service's February 1995 site inspection indicate that large segments of the beach between Bennetts Pier and Big Stone Beach can be characterized as either predominantly sand or sand-covered peat outcrops ranging in height from 1 to 3 feet. Mud flats occur adjacent to the beach in some areas, particularly near Clark Point. In this area, 3.2 miles south of Bennetts Pier, the beach is very narrow with steeper slope and peat scarps at the waterline; high tide completely inundates this beach up to the dune.

The Big Stone Beach portion of the Delaware shoreline appears to be experiencing relatively little erosion. Sand taken from Big Stone Beach in 1978 had a mean sediment size of 1.117mm (French, 1990). The Nature Conservancy and Delaware Wildlands own a significant portion of Big Stone Beach in the Milford Neck area.

5. Mispillion Jetty to Lewes Beach

Cedar Beach (at the Mispillion Jetty) consist of approximately 0.6 mile of unconsolidated peat, eroded marsh embankments and a thin layer of mixed sand and gravel. Most of Cedar Beach (the undeveloped portion) is in the shadow of the large jetty at the mouth of the Mispillion River. The jetty extends more than 1.1 miles from the shore toward the southeast. There is no sand on the northern portion of Cedar Beach except for a small pocket near the foot of the large jetty and a small sand island about halfway out from the jetty. Sand taken from Cedar Beach at the Mispillion River in 1978 had a mean sediment size of 0.708mm (French, 1990). The entire northern half of the beach is composed of unconsolidated peat with shell fragments and common reed stem fragments in three or more large scarps beginning at the waterline and ending near the edge of detrital marsh grass, an average distance of 50 feet. Peat outcrops from relict marshes are also present. Unconsolidated peat is at least 25 inches deep at a point 20 feet below the highest wrack line. Bordering the peat beach is a dense stand of common reed. The southern portion of Cedar Beach, most of which is inhabited, is a layer of mixed sand and gravel of variable thickness overlying densely packed peat.

Extensive mud flats lie offshore from Cedar Beach. The thickness of the mud exceeds 30 feet (Kraft *et al.*, 1976). The silt dredged out of the Mispillion River by the Corps has been historically deposited in the area immediately to the south of the jetty (J. Brady, pers. comm., 1995), but will in future operations be placed on the Bay side of the rubble breakwater along the north shore of the inlet (T. Mercer, pers. comm., 1995).

The sand island about halfway out from the jetty measures approximately 150 feet wide by 800 feet long, and is surrounded by mud flats. The sand along the mid-tide line was at least 12 inches deep during the February 1995 site inspection. The distance from the waterline at low tide to the vegetation near the jetty was approximately 100 feet.

Slaughter Beach consists of approximately 2.8 miles of mixed sand and gravel beach interspersed with peat outcrops and offshore mud flats. No tidal creeks intersect this segment of beach, but several are located just behind the dunes. Sand taken from Slaughter Beach in 1978 had a mean sediment size of 1.125mm (French, 1990).

Slaughter Beach has experienced an oscillatory pattern of low accretion or limited erosion, followed by periods of substantial accretion (French, 1990). Long-term analysis shows an average annual accretion rate of +1.0 foot per year (French, 1990). These relatively stable shoreline conditions are due, in part, to shoreline stabilization efforts in this area.

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Approximately one mile south of the southernmost house on Slaughter Beach is a large washover or dune blowout. During February 1995 site inspections, the opening in the dune was approximately 250 feet wide at the top of the dune, and sand extended into flats over the marsh, covering it for a distance of approximately 1,000 feet. Large numbers of horseshoe crab remains were observed, especially in a low muddy spot just inside the opening. The beach to seaward of the washover consists of a thin layer of sand overlying peat outcrops near the water's edge.

Fowler Beach is primarily mixed sand with some gravel. From the wrack line to 75 feet down slope, the beach is primarily sand and gravel. The sand is fairly deep (greater than 15 inches) in the upper portion of the intertidal zone. Sand taken from Fowler Beach in 1978 had a mean sediment size of 0.739mm (French, 1990). The sand is eroded near the waterline, exposing peat in hard, rib-like formations about 4 inches wide oriented perpendicular to the shoreline.

Broadkill Beach was not visited during field investigations for this project. However, information on this area is available from a previous Service Planning Aid Report (U.S. Fish and Wildlife Service, 1994a). A Service biologist inspected the Broadkill Beach shoreline on November 11, 1994, just after a beach replenishment effort by the State of Delaware. The existing beach is exposed to a fetch of 12 miles or more across Delaware Bay. Houses along Broadkill Beach are linearly distributed in a narrow zone between the beach and an extensive salt marsh. There is only a narrow low vegetated dune between the back of the beach and the houses. The vegetation is primarily beach grass (*Ammophila breviligulata*). Sand taken from Broadkill Beach in 1978 had a mean sediment size of 0.669mm (French, 1990).

The beach north of the jetty at Roosevelt Inlet is mixed sand and gravel, thinning out to the north. Immediately inside the inlet at the foot of the jetty are large peat outcrops covered with a thin layer of sand that appears to have been blown or washed over the jetty from the north side.

Lewes Beach consists of approximately 2 miles of mixed sand and gravel from Roosevelt Inlet to the ferry terminal. The site was recently nourished by the State of Delaware as part of an ongoing program of beach maintenance. Lewes Beach is lined with houses for the entire distance from the ferry terminal to the breakwater at Roosevelt Inlet.

The DNREC, Division of Soil and Water, has identified the northern 1,000 to 2,000 feet of Lewes Beach as an area in continual need of replenishment because the sand from this location is carried by water currents and deposited beside the jetty at the ferry terminal (R. Henry and T. Pratt, pers. comm., 1995).

6. Sand Stockpiles

The Corps evaluated a number of aquatic sites for potential use as locations for sand stockpiles. Preliminary assessments conducted by the Corps and the Greeley-Polhemus Group (1994) identified two sites (L-5 and LC-10) as the most

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practicable sites for sand stockpiles (Figure 1). Based on additional information and interagency coordination during the preparation of this report, the LC-10 site was eliminated from consideration due, in part, to the environmental constraints discussed below. The Corps is currently considering an alternative sand stockpile site to be located in the vicinity of Big Stone Beach. The nearest site for which data are available is the previously evaluated Site MS-19, located near Slaughter Beach. Information on Site MS-19 is summarized below because it is expected that the offshore area in the vicinity of Big Stone Beach is similar in nature to Site MS-19; although, once a site is selected for the proposed sand stockpile, site specific conditions should be verified.

Site L-5 is 500 acres located approximately 1,000 yards offshore of Broadkill Beach, Delaware. Water depths in this area range from 10 to 17 feet at mlw. The Greeley-Polhemus Group (1994) characterized the sediments at this site as mostly sand, with some areas of silt / clay. Site LC-10 is a 500-acre site located approximately one mile offshore of Kelly Island in approximately 9 to 12 feet of water. Maurer *et al.* (1978), characterized the LC-10 area as mostly composed of 70 to 100 percent silt / clay sediments, with slightly sandier (40 to 70 percent silt / clay) sediments to the immediate north. This concurs with the Greeley-Polhemus Group (1994) who characterized the sediments at Site LC-10 as mostly fine sand and silt / clay. Site MS-19 is a 500-acre site located approximately 1,000 feet offshore of Slaughter Beach, Delaware, in approximately 8 to 10 feet of water. Maurer *et al.* (1978) characterized the area around the MS-19 site as having sediments ranging from 0 to 40 percent silt / clay (i.e., consisting mostly of sand or other hard substrate). The Greeley-Polhemus Group (1994) characterized the substrate at this site as consisting of sand and silt / clay.

V. FISH AND WILDLIFE RESOURCES

A. GENERAL

The Delaware Bay supports diverse and abundant fisheries and shellfisheries resources of high ecological, commercial and recreational value. Additionally, the extensive tidal marshes and shallow water areas bordering most of the Delaware Bay receives heavy use throughout the year by migratory shorebirds, waterfowl, raptors, and passerines. The interspersion of beach and marsh cover types annually hosts the second largest concentration of migrating shorebirds in the Western Hemisphere, including 80 percent of the hemispheric population of red knots (*Calidris canutus*) (Myers *et al.*, 1987; Clark *et al.*, 1993).

09

1. Macroinvertebrates

a. <u>Horseshoe crabs</u>

The largest population of spawning horseshoe crabs in the world is found in Delaware Bay (C. Shuster, pers. comm., 1995). Each spring, adult horseshoe crabs migrate from deep water in the Delaware Bay and the Atlantic continental shelf to spawn on Delaware Bay beaches. The minimal geologic shoreline development and smooth morphology of Delaware Bay's lower shoreline facilitates movement of horseshoe crabs and enables them to find suitable spawning beaches in large numbers. Spawning generally occurs from April to July, with the peak spawning activity occurring on full moon high tides in May and June. The average width of the intertidal area used by horseshoe crabs for spawning is about 45 feet on Delaware Bay beaches (C. Shuster, pers. comm., 1995). Eggs are deposited in the upper portion of the intertidal zone in clusters approximately 6 to 8 inches below the surface. The average cluster contains between 3,000 and 4,000 eggs.

Horseshoe crab reproductive success is greatest under the following conditions: (1) the egg clusters are moistened by water with salinity of at least 8 parts per thousand; (2) the substrate around the egg clusters is well oxygenated; (3) the beach surface is exposed to direct sunlight to provide sufficient incubation; and, (4) the slope of the beach is adequate for larvae to orient and travel downslope to the water upon hatching (Shuster, 1994). These conditions are found on sandy beaches along the lower portion of Delaware Bay.

The mechanism by which horseshoe crabs locate preferred spawning habitat is not completely understood. While horseshoe crabs spawn in greater numbers and with greater fecundity along sandy beaches, horseshoe crabs can tolerate a wide range of physical and chemical environmental conditions, and will spawn in less suitable habitats if ideal conditions are not encountered. Therefore, the presence of large numbers of horseshoe crabs on a beach is not necessarily an indicator of habitat suitability (Shuster, 1994). It is known that shoreline areas with high concentrations of silt or peat are less favorable to horseshoe crabs, because the anaerobic conditions reduce egg survivability. It also appears that horseshoe crabs can detect hydrogen sulfide, which is produced in the anaerobic conditions of peat substrates, and that horseshoe crabs actively avoid such areas (Shuster, 1994).

Beach slope is also thought to play an important role in determining the suitability of beaches for horseshoe crab spawning (C. Shuster, pers. comm., 1995). Horseshoe crabs generally travel downslope after spawning and appear to become disoriented on flat areas (T. Jacobsen, pers. comm., 1995). Although the optimal beach slope is unknown, beaches visited by the Service during February 1995 had slopes of between 3 and 7 degrees to seaward. As previously noted, beach conditions vary substantially from season to season, and these observations may not reflect beach conditions during the horseshoe crab spawning season.

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In addition to the intertidal zone used for spawning, horseshoe crabs also use shallow water areas (less than two fathom depths) such as intertidal flats and shoal water as nursery habitat for juvenile life stages. Adult horseshoe crabs forage in deep water habitat during most of the year, except during the breeding season when they move into shallow and intertidal water.

The presence of offshore mud flats may also influence the use of certain beaches by spawning horseshoe crabs. Horseshoe crabs may congregate on mud flats to wait for full moon high tides, because these areas provide protection from wave energy. Female horseshoe crabs can carry over 88,000 eggs per animal (Shuster and Botton, 1985). Therefore, several tidal cycles are required to complete spawning. Offshore mud flats may provide safe areas to rest between tide cycles.

Under normal conditions spawning mortality on beaches averages approximately 10 percent of the spawning individuals. Factors contributing to normal mortality include age, excessive energy expenditure during spawning, stranding, desiccation, or predation by gulls. Entrapment in man-made structures such as rip-rap, bulkheads, and jetties, and commercial harvest also account for significant additional mortality.

Annual beach surveys of Delaware Bay horseshoe crab spawning activity conducted by volunteers since 1990 appear to indicate an overall decline in the horseshoe crab population in recent years (Swan *et al.*, 1994). Preliminary results from the 1995 beach surveys appear to further support the conclusion that horseshoe crab numbers are declining (B. Swan, pers. comm., 1995). Additionally, trawl surveys conducted by DNREC appear to corroborate the findings of the beach surveys (S. Michels, pers. comm., 1995). Weather and other factors influence the timing and intensity of spawning; therefore, additional data are needed before valid conclusions can be drawn regarding population trends. Nonetheless, the observed downward trend in the existing data is reason for concern.

The beach surveys are also useful in documenting relative use of various shoreline segments by spawning horseshoe crabs. For example, the survey data indicate declining numbers of spawning horseshoe crabs on beaches experiencing the highest erosion; Kelly Island and Port Mahon, in particular. The most consistent spawning beaches in Delaware appear to be those between Kelly Island and South Bowers Beach, which have extensive mud flats offshore.

While horseshoe crabs have some commercial value, the primary importance of this species is food chain support, particularly for migratory shorebirds. Shorebirds congregate along the Delaware Bay shoreline during their northward migration each spring because the massive amounts of horseshoe crab eggs provide a food source unlike that in any other site in the Western Hemisphere. Shorebirds passing through Delaware Bay spend, on average, 15 days replenishing body fat reserves before continuing their migration to nesting areas in the Arctic. During that period, these shorebirds consume massive quantities of horseshoe crab eggs. For example, sanderling (*Calidris alba*) have been estimated to eat 9,000 eggs per individual per day (Castro *et al.*, 1989).

The bills of most shorebirds are too short to allow them to dig up horseshoe crab egg clusters (C. Shuster, pers. comm., 1995). Most, shorebirds rely on successive waves of horseshoe crabs to come ashore and inadvertently dig up previously deposited egg clusters while attempting to deposit new egg clusters. Therefore, a large population of horseshoe crabs, laying many more eggs than are needed to maintain the population, is necessary to provide a sufficient food supply for migrating shorebirds. However, the minimum size of the population needed to sustain shorebird populations is unknown.

b. <u>Other macroinvertebrates</u>

Commercially and recreationally important macroinvertebrate species found in Delaware Bay include Blue crab (*Callinectes sapidus*), American oyster (*Crassostrea virginica*) and hard clam (*Mercenaria mercenaria*). Blue crabs are abundant throughout the area, foraging in tidally influenced waters and wetlands from May through November. During the Winter (December through April) blue crabs stay in water greater than 15 feet deep.

In waters within the State of Delaware, oysters occur in naturally reproducing seed beds offshore and north of Kelly Island and in leased bed areas south of Kelly Island down to the Mispillion River area. In New Jersey waters, oyster seed beds occur from south of Artificial Island to Fortescue; lease beds occur from southwest of Egg Island Point throughout much of the lower Bay. Hard clams occur throughout the area, on soft sandy bottoms in water with salinity greater than 12 ppt (J. Dobarro, pers. comm., 1995).

Maurer *et al*. (1978) found a total of 169 species of benthic macroinvertebrates in the Delaware Bay over two summers of sampling (1972 and 1973). Maurer *et al*. (1978) noted that there are marked seasonal and annual fluctuations in the distributions of animal assemblages. The number of species and number of individuals increased with increasing salinity and increasing median sediment grain size.

The general composition of the benthic invertebrate community is similar to that of other temperate estuaries in the Northern Hemisphere (Maurer *et al*., 1978). Dominant species include the polychaetes *Glycera dibranchiata*, *Heteromastus filiformis*, and *Scoloplos fragilis*; and mollusks such as *Tellina agilis*, *Ensis directus*, *Nucula proxima*, *Gemma gemma*, *Mulinia lateralis*, *and Mytilus edulis*. These species are found in community assemblages throughout the Mid-Atlantic Bight (Pratt, 1973).

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2. Finfish

The Delaware Bay supports substantial recreational and commercial fisheries. Weakfish (*Cynoscion regalis*), summer flounder (*Paralichthys dentatus*), and bluefish (*Pomatomus saltatrix*) are the most popular recreational species, but the recreational catch also includes striped bass (*Morone saxatilis*), scup (*Stenotomus chrysops*), tautog (*Tautoga onitis*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), red hake (*Urophycis chuss*), black sea bass (*Centropristis striata*), skates, and sharks (Seagraves, 1988). The Delaware Bay also supports important anadromous fish species including American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*). Stocks of several of these species, most notably weakfish, have declined in recent years due largely to over-fishing (R. Miller, pers. comm., 1995).

Weakfish are one of the most important species in Delaware Bay in terms of abundance and value to the recreational and commercial fisheries. Weakfish are seasonal residents of Delaware Bay from April through October and spawn throughout the project area. Spawning occurs throughout the summer, but peaks in June and July. The larvae are transported by currents to the middle and upper portions of the Bay where they develop into juveniles. During the fall, after juveniles have attained a length of 4 to 6 inches, weakfish migrate to wintering areas off Virginia and North Carolina (Mercer and Moran, 1989).

Striped bass occur in all seasons, throughout the project area; although young-of-the-year use the project area only sporadically, concentrating primarily in the spawning area, which is in the Wilmington / Philadelphia area of the Delaware River.

Black sea bass, scup, and tautog stay in close proximity to reefs or other hard irregular structures. These species can be found throughout the project area, during any time of the year.

American shad use the project area during two time periods. In the spring and early summer (April through July) the channel and other deep areas of the bay serve as a "multi-stock" staging area for adults as they wait for water temperatures to warm upstream in the Delaware River and further up the Atlantic coast. Fish from the north Atlantic then move back out to the coast, while the Susquehanna and Delaware River stocks migrate upstream to spawn. In the fall (September through November) the "young-of-the-year" move down into the Bay as the water temperatures decrease, and then leave the Bay for the open ocean (MacKenzie *et al.*, 1985).

3. Reptiles

The northern diamondback terrapin (*Malaclemys t. terrapin*) is relatively common throughout the study area. Estuarine emergent marshes and associated creeks and near shore waters are used for foraging (April through December) (Palmer and Cordes, 1988). Salt marsh snails and fiddler crabs form the bulk of the diamondback terrapin diet. Egg laying occurs from early June through mid-July on sandy beaches with little or no vegetation, as well as on bayshore beaches surrounding the mouth of tidal marsh creeks. Hibernation occurs in mud banks and creek bottoms within the foraging areas, as well as within the nests themselves.

The northern diamondback terrapin is a candidate for inclusion on the federal List of Endangered and Threatened Wildlife and Plants, pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.). Candidate species receive no protection under the Endangered Species Act; however, the Service encourages federal agencies and other planners to consider candidate species in project planning. Additional information on federally-listed species is provided in section V.A.5 below.

4. Avifauna

a. Waterfowl

Waterfowl are abundant in tidally influenced wetlands and shallow water areas throughout the study area, reaching peak numbers in the fall and winter months. The Little Creek Management Area south of Kelly Island and the Bombay Hook National Wildlife Refuge area are important concentration areas for snow goose (*Chen caerulescens*), Canada goose (*Branta canadensis*) and dabbling ducks such as mallard (*Anas platyrhynchos*), American black duck (*Anas rubripes*), northern pintail (*Anas acuta*), and green-winged teal (*Anas crecca*). Black ducks are known to concentrate in the scalloped, cut-out areas along Kelly Island, created as the shoreline erodes (E. Smith, pers. comm., 1995). In addition, diving ducks such as scaup (*Aythya sp.*) and canvasback (*Aythya valisineria*) use the Little Creek area of the Bay itself (generally within the oyster leasing area).

b. Shorebirds

As many as 1.5 million shorebirds may pass through the Delaware Bay each spring (Niles *et al.*, 1994); the largest concentration of shorebirds on the east coast. As previously mentioned, the shorebird stopover coincides with the spawning period of horseshoe crabs. The most commonly occurring shorebird species that migrate through Delaware Bay are the red knot, ruddy turnstone (*Arenaria interpres*), semipalmated sandpiper (*Calidris pusilla*), sanderling, dunlin (*Calidris alpina*), and dowitchers (*Limnodromus* spp.). The first four species listed comprise 97 percent of all shorebirds observed in aerial surveys conducted since 1986 (Clark *et al.*, 1993).

Shorebirds are dependent on a mosaic of beach and salt marsh cover types to meet their requirements for foraging, roosting, and resting (Burger *et al.*, in press; Niles *et al.*, 1994). While the horseshoe crab eggs found on Delaware Bay beaches are an essential food source for migrating shorebirds, other cover types are also used extensively by shorebirds. Shorebirds feed in salt marsh ponds and creeks during high tide when bayshore beaches are inaccessible, and shorebirds roost in protected areas of the salt marsh.

Little information exists on the historical use of the Delaware Bay by migrating shorebirds. Since 1985, the NJDFGW, Endangered and Nongame Species Program, and the DNREC, Endangered and Nongame Species Program, have conducted annual shorebird surveys along Delaware Bay. Aerial surveys of approximately 50 miles of shoreline in both Delaware and New Jersey are conducted once per week for six weeks each May and June. The Delaware portion of the survey extends from Woodland Beach south to Cape Henlopen. The New Jersey portion of the survey extends from the Cohansey River to Cape May Canal. Estimates are made of total bird numbers, by species. Clark *et al.* (1993) summarize 7 years of data (1986-1992) by upper and lower portions of the Bay. Niles *et al.* (1994) summarize data for the same period, using 18 shoreline segments to cover the Delaware and New Jersey shorelines. Clark (1991) summarizes five years of data (1986-1990), using individual beaches as organizing units.

The survey data indicate that the beach areas from the Mispillion River north to Simons River are the most heavily used by shorebirds (Clark, 1991). In 1990, this area accounted for over 80 percent of all the shorebirds observed in the Delaware portion of the survey (Gelvin-Innvaer, 1991). The Mispillion River area, including the mud flats of the Mispillion jetty, experience the heaviest use, both in terms of total numbers of birds and species density. Survey data also indicate heavy shorebird use along the entire New Jersey shoreline, particularly near Dennis Creek, Moores Beach, Thompson Beach, Egg Island Point, and Fortescue.

Two trends in shorebird abundance are important to note from the surveys. First, the number of sanderlings using the Delaware Bay has apparently declined markedly (Howe *et al.*, 1989; Clark *et al.*, 1993). In 1990, sanderling were observed at only four Delaware beaches, all south of Big Stone Beach (Gelvin-Innvaer, 1991). Second, there is also evidence that semipalmated sandpipers are declining significantly (Clark *et al.*, 1993).

5. Federally-listed and State-listed Threatened and Endangered Species

The federally-listed endangered bald eagle (*Haliaeetus leucocephalus*) is known to nest near the Delaware River and Delaware Bay in New Jersey and Delaware, and also winters in, and migrates through, the area. There are currently 11 active eagle nests in New Jersey, most of which are located within 10 miles of the Delaware Estuary. Additionally, adult eagles from many of these nests appear to be year-around residents of the Delaware Estuary area (K. Clark, pers. comm., 1995).

The federally-listed endangered peregrine falcon (*Falco peregrinus*) is known to feed on waterfowl and shorebirds in the vicinity of Kent Island in spring and fall. Additionally, the NJDFGW, Endangered and Nongame Species Program, maintains a peregrine falcon nesting tower on Egg Island Point. This tower is currently used by nesting peregrine falcons (K. Clark, pers. comm., 1995).

The active peregrine falcon nesting tower on Egg Island Point is located near the existing shoreline in an area that is eroding rapidly. If steps are not taken in the near future to either relocate the tower or halt the shoreline erosion, this tower will be lost. Additionally, if the tower is still functional when the proposed project is implemented it is likely that project construction activities would disturb nesting peregrine falcons. The Endangered and Nongame Species Program has expressed interest in having a new tower constructed in an area that is less susceptible to erosion. The Service recommends that the Corps coordinate with the Endangered and Nongame Species Program and the Service to incorporate relocation of the peregrine tower into the current project plans.

The National Marine Fisheries Service (NMFS) has jurisdiction over the federally-listed endangered shortnose sturgeon (*Acipenser brevirostrum*), the endangered Atlantic Ridley turtle (*Lepidochelys kempii*) and leatherback turtle (*Dermochelys coriacea*), and federally-listed threatened loggerhead turtle (*Caretta caretta*), and green turtle (*Chelonia mydas*).

The shortnose sturgeon has been found throughout the Delaware Bay study area, though spawning is limited to areas upstream of the study area. Little information is available regarding shortnose sturgeon use of Delaware Bay, but it is believed that this area is used by all age classes to some extent, except young-of-the-year. Shortnose sturgeon orient to the channel and channel-like linear depressions or troughs. The Main Channel may provide localized areas where shortnose sturgeon currently concentrate or may concentrate as the population recovers (J. O'Herron, pers. comm., 1995).

Sea turtles, especially the loggerhead turtle, but also the Atlantic Ridley turtle, green turtle, and leatherback turtle, may occur in the lower Delaware Bay from June to November. Current lists of federally listed, proposed, and candidate species in New Jersey and Delaware, are provided in Appendix A.

Project-related activities could adversely affect the above-mentioned species. The lead federal agency for a project has the responsibility under Section 7(c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to prepare a Biological Assessment if the project is a construction project that requires an Environmental Impact Statement and the project may affect federally-listed species. The Service is aware that the Corps is currently preparing a Biological Assessment to address potential project-related adverse impacts to the above-mentioned species. The Service recommends that the Corps continue to consult with the Service and the NMFS during preparation of the Biological Assessment.

A list of State-listed threatened and endangered species in New Jersey is provided in Appendix B. For additional information on State-listed species, the Service recommends that the Corps contact the NJDFGW, Endangered and Nongame Species Program at the following address:

Mr. Larry Niles
Endangered and Nongame Species Program
Division of Fish, Game and Wildlife
CN 400
Trenton, New Jersey 08625
(609) 292-9101

B. SITE SPECIFIC FISH AND WILDLIFE RESOURCES

1. Egg Island Point

Information regarding fish and wildlife resources of the Maurice River Cove area, immediately east of the proposed Egg Island Point project site, has been summarized in previous Service reports (U.S. Fish and Wildlife Service, 1994b, 1995b).

Based on survey information collected at Fortescue to the northwest and East Point to the east of the project site, Egg Island Point receives moderate to heavy use by horseshoe crabs. However, the shoreline conditions are generally not conducive to high spawning success, except at the tip of Egg Island Point and along the small sandy beach segments on the southwestern shoreline.

Commercially important oyster lease beds are located throughout the offshore area around Egg Island Point. Most of these lease beds are located 500 to 800 feet offshore; but in some cases lease beds are located within close proximity to the shoreline (J. Dobarro, pers. comm., 1995). Oyster seed beds occur to the northwest of Straight Creek and this area also supports a commercially important blue crab fishery.

The Egg Island Point area receives heavy use each spring by migratory shorebirds. Shorebirds feed in large numbers along the shoreline and along the sandy deltas at creek mouths. Additionally, the numerous small tidal and non-tidal ponds on the adjacent salt marsh provide valuable shorebird feeding and roosting habitat. The most common species using this area include ruddy turnstone, red knot, and semipalmated sandpiper.

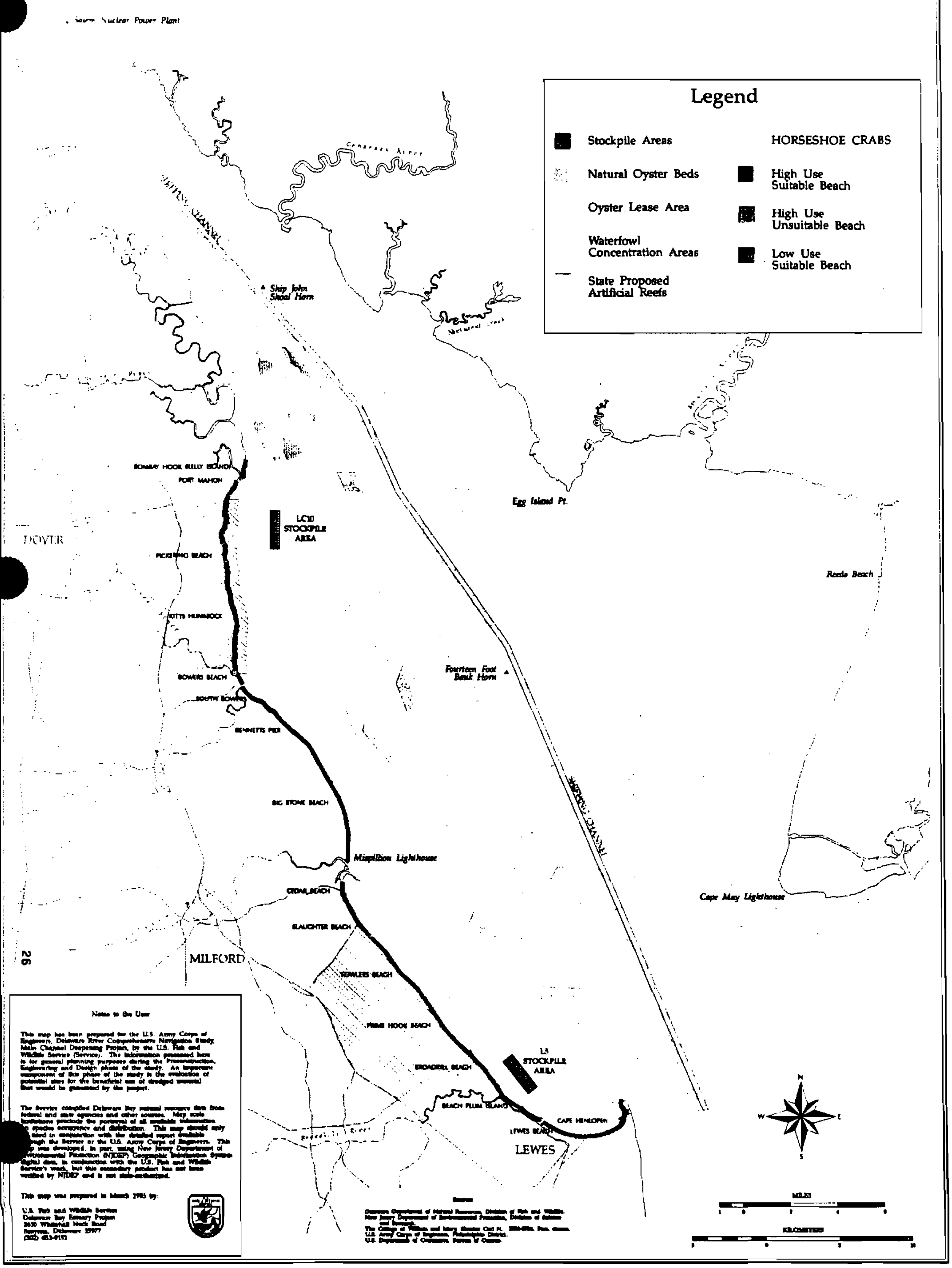
The wetlands and nearshore shallows of Egg Island Point also provide valuable habitat for a large number of migratory waterfowl. Species identified during mid-winter waterfowl surveys conducted between 1985 and 1989 include mallard, American black duck, green-winged teal, scaup, merganser (*Mergus sp.*), gadwall (*Anas strepera*), bufflehead (*Bucephala albeola*), American widgeon (*Anas americana*), Northern shoveler (*Anas clypeata*), Canada goose, and snow goose (New Jersey Division of Fish, Game and Wildlife, 1990).

2. Kent Island and Kelly Island

While horseshoe crabs spawn in the Kent Island area, conditions are generally not conducive to egg development, and reproductive success is probably low (Figure 4a). The value of horseshoe crab eggs at this site may be more as a food source for migrating shorebirds, than as a source for sustaining horseshoe crab populations.

Preliminary Delaware Bayshore Ecological Analysis

for the Delaware River Beneficial Use Plan



Commercially important oyster seed beds exist in the area offshore of Kent Island and Kelly Island (Figure 4b). There are also oyster beds inside the mouth of the Leipsic River. Additionally, hard clams and blue crabs are distributed throughout the Kelly Island area. Blue crabs in this area are commercially important.

The most frequently occurring species of benthic macroinvertebrates in samples taken in the vicinity of Kelly Island area by Maurer *et al.* (1978) in 1972 and 1973 included polychaetes such as *Nephtys picta*, *Glycera capitata*, *Glycera dibranchiata*, and *Heteromastus filiformis*; mollusks such as *Tellina agilis*, *Nassarius trivittatus*, *Ensis directus*, *Mulinia lateralis*, and *Nucula proxima*; and, crustaceans including *Cancer irroratus*, *Paraphoxus spinosus*, *Protohaustorius wigleyi*, and *Pagurus longicarpus*.

The Greeley-Polhemus Group (1994) found 23 macroinvertebrate species at the Kelly site in 1993. Crustaceans (11 species) and polychaetes (5 species) dominated the samples. Dominant species included mollusks such as *Mulinia lateralis*, and polychaetes including *Glycera dibranchiata*. Small horseshoe crabs were also collected. The Greeley-Polhemus Group (1994) reported sampling problems associated with the thick cohesive silt / clay substrate, which made it difficult to dredge for commercially or recreationally important species.

Striped bass use the mouth of the Leipsic River in all seasons. This area is also a spawning area in spring and summer for riverine and anadromous fish such as American shad, river herring, and white perch (*Morone americana*) (R. Miller, pers. comm., 1995).

Kent Island marshes provide significant shelter, wintering and breeding habitat for American black duck and other waterfowl species (E. Smith, pers. comm., 1995). Gulls, terns, and large numbers of wading birds such as glossy ibis (*Plegadis falcinellus*) use the Kent Island and Kelly Island areas, especially in spring.

The beach on the southern tip of Kelly Island historically supported large numbers of spawning horseshoe crabs, with corresponding heavy use by shorebirds, particularly ruddy turnstones and semipalmated sandpipers. As the beach at the southern tip of Kelly Island has eroded, horseshoe crab spawning activity has declined. While horseshoe crabs still spawn here in large numbers, conditions are generally no longer suitable for egg survival. Although horseshoe crab spawning activity has declined, shorebird use of this area has remained high. In fact, the area between Kelly Island and South Bowers Beach still supports one of the largest springtime concentrations of shorebirds in the entire Delaware Bay (Niles *et al.*, 1994). This large shorebird concentration could be due in part to the inaccessibility of this area to humans.

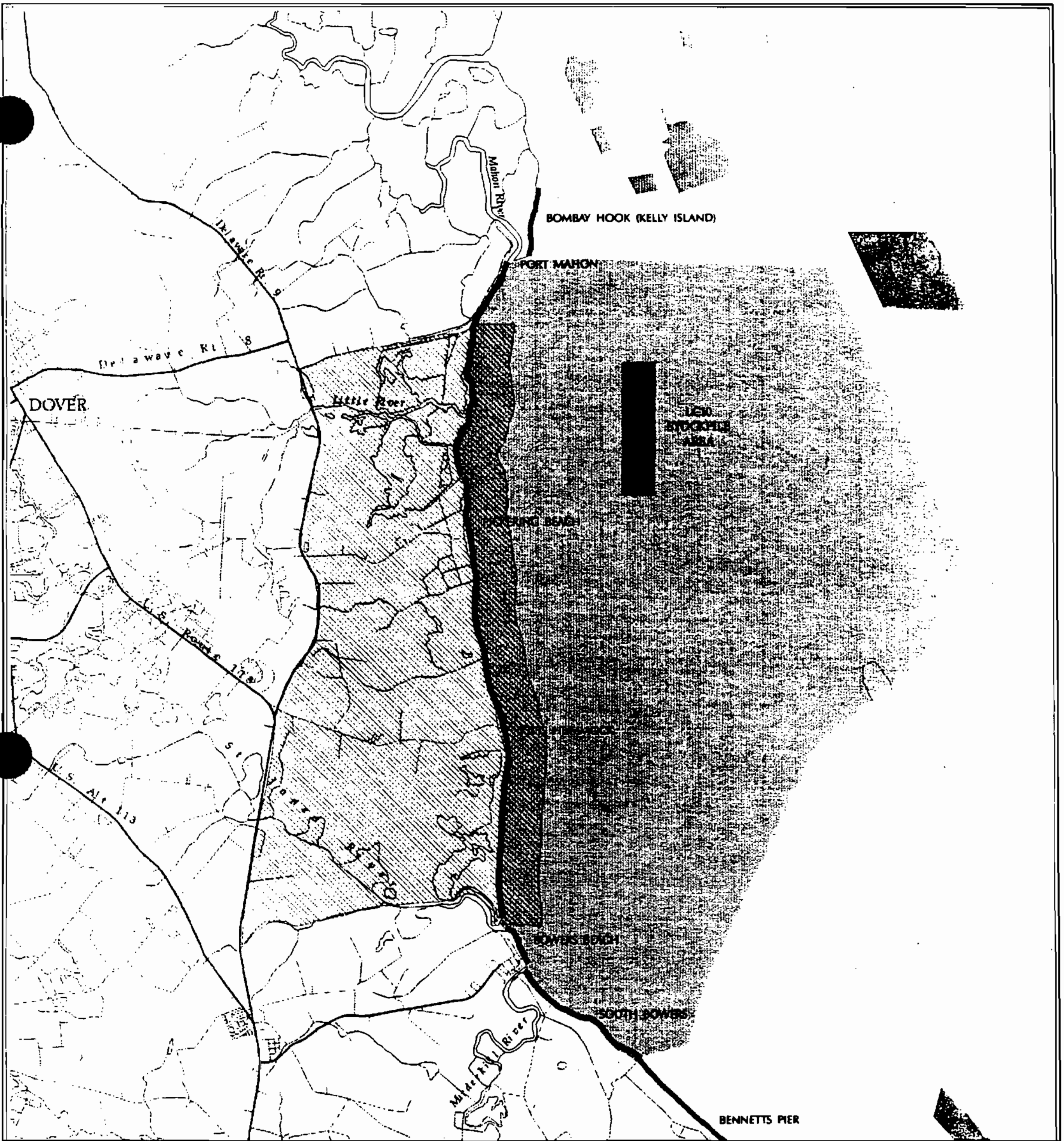


Figure 4b. Kelly Island Vicinity

Notes to the User

This map has been prepared for the U.S. Army Corps of Engineers, Delaware River Comprehensive Navigation Study, Main Channel Deepening Project, by the U.S. Fish and Wildlife Service (Service). The information presented here is for general planning purposes during the Preconstruction, Engineering and Design phase of the study. An important component of this phase of the study is the evaluation of potential sites for the beneficial use of dredged material that would be generated by the project.

The Service compiled Delaware Bay natural resource data from federal and state agencies and other sources. Map scale limitations preclude the portrayal of all available information on species occurrence and distribution. This map should only be used in conjunction with the detailed report available through the Service or the U.S. Army Corps of Engineers. This map was developed, in part, using New Jersey Department of Environmental Protection (NJDEP) Geographic Information System digital data, in conjunction with the U.S. Fish and Wildlife Service's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

This map was prepared in March [illegible] by:

U.S. Fish and Wildlife Service
Delaware Bay Estuary Project
2610 Whitehall Neck Road
Smyrna, Delaware 19977
(302) 653-9152

MILES

KILOMETERS

Sources

Delaware Department of Natural Resources, Division of Fish and Wildlife.
New Jersey Department of Environmental Protection, Division of Science and Research.
The College of William and Mary, [illegible] Carl N. [illegible]
U.S. Army Corps of Engineers, Philadelphia District.
U.S. Department of Commerce, Bureau of Census.

Legend

- Stockpile Areas
- Natural Oyster Beds
- Oyster Lease Area
- Waterfowl Concentration Areas
- State Proposed Artificial Reefs

HORSESHOE CRABS

- High Use Suitable Beach
- High Use Unsuitable Beach

3. Port Mahon to South Bowers Beach

Port Mahon receives heavy use by horseshoe crabs and shorebirds (Figure 4b). However, the high level of human disturbance and continued erosion threaten the area's continued suitability for horseshoe crabs and shorebirds. The sand strip to seaward of the rip-rap has been eroding noticeably each year, and the shorebirds and horseshoe crabs using this area are being forced closer to, and often onto, the road. Additionally, horseshoe crabs may be legally harvested by permit at Port Mahon.

The narrow (less than 30 feet wide) strip of sandy beach just north of the Dover Air Force Base Aviation Gas pipeline / barge unloading pier comprises the best spawning area for horseshoe crabs at Port Mahon. Although the sand along this 600-foot-long section of shoreline is covered by water at high tide, horseshoe crabs have been observed spawning on falling tides in this area. The viability of horseshoe crab eggs is probably minimal on beaches that are covered by high tides such as this area, but the value of eggs as food for shorebirds and juvenile fish remains high. Other small sections of shoreline, totalling approximately 300 feet in length are scattered among the rip-rap and bulkheads. These areas generally do not support favorable spawning conditions. Service field observations revealed that large numbers of horseshoe crabs become trapped in the rip-rap, and the normal 10 percent mortality from spawning activities on more natural beaches is probably exceeded substantially at this site.

Extensive oyster lease beds occupy the offshore area from Port Mahon to South Bowers Beach. Additionally, many species of marine fish, particularly weakfish, spawn in the offshore area from approximately 600 feet to 3,600 feet offshore of Port Mahon to the mouth of the Little River near Pickering Beach. Juvenile fish, particularly weakfish, also concentrate just offshore of Port Mahon in spring (R. Miller, pers. comm., 1995).

Port Mahon, especially near the mouth of Little Creek, supports large numbers of birds during all seasons. Numerous species of waterfowl and shorebirds use the area in fall, winter and spring (Clark *et al.*, 1993). Many species of gulls and terns use the area during the spring, summer and fall, and numerous wading birds are found here all year. Shorebirds have been observed feeding on inviable horseshoe crab eggs in the thick, unconsolidated peat deposits at the mouth of Little Creek in all seasons.

Pickering Beach receives high use by spawning horseshoe crabs, and migratory shorebirds. Site visits revealed that Kitts Hummock also supports large number of spawning horseshoe crabs and migrating shorebirds; however, the only suitable spawning habitat for horseshoe crabs at Kitts Hummock is the 0.5-mile-long sand and gravel beach.

The mud flats offshore of Kitts Hummock have accumulated since the three breakwaters were constructed. These mud flats contain benthic invertebrates that support large numbers of shorebirds in the spring. Blue crabs and hard clams are distributed throughout this area. Winter flounder *(Pleuronectes americanus)* and summer flounder are distributed throughout the area, along with numerous species of finfish (R. Miller, pers. comm., 1995).

Spawning horseshoe crabs and migrating shorebirds also occur in large numbers at Bowers Beach and South Bowers Beach. Additionally, blue crabs, hard clams, and oysters are distributed throughout the area, and numerous species of riverine, anadromous, and marine fish also use this area. Riverine and anadromous fish spawn in the Murderkill and Saint Jones Rivers.

4. Bennetts Pier to Big Stone Beach

Big Stone Beach experienced extraordinarily high horseshoe crab spawning in 1993, with light spawning activity in other years (Swan *et al.*, 1994). It appears that this area is not extensively used by spawning horseshoe crabs in most years, despite the presence of apparently suitable spawning habitat. Similarly, the area from Bennetts Pier to Big Stone Beach does not appear to be heavily used by shorebirds. Additionally, there are no oyster lease beds offshore of Bennetts Pier and Big Stone Beach (J. Tinsman, pers. comm., 1995).

5. Mispillion Jetty to Lewes Beach

Horseshoe crabs attempt to spawn at Cedar Beach in large numbers. However, due to the relatively flat beach slope, thousands of horseshoe crabs become stranded on the intertidal mud flats and die. The small sand deposit halfway along the south jetty is surrounded by soft mud, and is probably only marginally suitable for spawning horseshoe crabs; however, this area is heavily used by shorebirds. More than 50,000 shorebirds concentrate in the immediate vicinity of this sandy area (Niles *et al.*, 1994).

Hard clams and blue crabs are distributed throughout the offshore area in the vicinity of Cedar Beach. Additionally, marine, anadromous and riverine fish spawn in the Mispillion River. Fish species found here include striped bass, American shad, tautog, bluefish, black sea bass, spot, Atlantic croaker, weakfish, red hake, and white perch (R. Miller, pers. comm., 1995).

Numerous species of waterfowl, wading birds, and gulls and terns are distributed throughout the Cedar Beach area. Osprey *(Pandion haliaetus)* are also found here in spring, summer, and fall.

Slaughter Beach supports a moderate shorebird population during the spring and early summer. Historically, Slaughter Beach experienced heavy spawning by horseshoe crabs, and harvesting these animals here was a healthy industry during the 1800s (Shuster and Botton, 1985). Current use by horseshoe crabs is sporadic and unpredictable; although the large dune washover south of slaughter beach appears to receive heavy use by spawning horseshoe crabs, based on the large number of molts observed in this area during Service site inspections. Numerous species of gulls and terns, as well as waterfowl, wading birds, and raptors frequent the area. Similarly, Fowler beach currently supports low numbers of spawning horseshoe crabs and migratory shorebirds.

Broadkill beach appears to receive higher use by spawning horseshoe crabs and migratory shorebirds than other beaches in this section of the shoreline; although, the numbers of horseshoe crabs and shorebirds seen here are substantially lower than in the Port Mahon to South Bowers Beach section (L. Gelvin-Innvaer, pers. comm., 1995). Semipalmated sandpiper and red knot are the most common species of shorebirds at Broadkill Beach.

The peat area inside the mouth of the Roosevelt Inlet, although experiencing rapid erosion, is the only part of Roosevelt Inlet beach where horseshoe crabs have spawned recently in substantial numbers, according to the annual volunteer horseshoe crab survey (W. Hall, pers. comm., 1995). In 1990, 1,000 horseshoe crabs were counted during the annual survey. In 1991, 60,800 crabs were counted. Since 1991, spawning activity has been light.

Some riverine and anadromous fish may spawn in the mouth of the Broadkill River at Roosevelt Inlet. Distributed throughout are summer and winter flounder, bluefish, black sea bass, Atlantic menhaden (*Brevoortia tyrannus*), spot, Atlantic croaker, weakfish, scup, and northern kingfish (*Menticirrhus saxatilis*).

6. Sand Stockpile Areas

The most frequently occurring species of benthic macroinvertebrates in samples taken in the vicinity of Site L-5 area by Maurer *et al.* (1978) in 1972 and 1973 included polychaetes such as *Nephtys picta*, *Scoloplos fragilis*, *Glycera americana*, *Glycera capitata*, *Glycera dibranchiata*, *Aricidea cerruti*, and *Heteromastus filiformis*; mollusks such as *Tellina agilis*, *Nassarius trivittatus*, *Ensis directus*, and *Nucula proxima*; and, crustaceans including *Cancer irroratus*, *Paraphoxus spinosus*, *Protohaustorius wigleyi*, and *Pagurus longicarpus*.

The Greeley-Polhemus Group (1994) found 51 macroinvertebrate species at Site L-5 in 1993. Crustaceans (19 species) and polychaetes (18 species) dominated the samples. Dominant species included crustaceans such as *Ampelisca sp.*, and *Cerapus tubularis*; mollusks such as *Mulinia lateralis*, and *Nucula proxima*; and, polychaetes including *Glycera americana* and *Nephtys incisa*.

The most frequently occurring species of benthic macroinvertebrates found in samples taken in the vicinity of Site LC-10 by Maurer *et al.* (1978) in 1972 and 1973 included polychaetes such as *Heteromastus filiformis*, *Glycera dibranchiata*, *Glycera capitata*, and *Nephtys picta*; crustaceans including *Melita nitida*, *and Protohaustorius wigleyi*; and mollusks such as *Mulinia lateralis*, and *Tellina agilis*.

The Greeley-Polhemus Group (1994) found a total of 50 species, including 20 crustaceans and 16 polychaetes, at Site LC-10. Dominant species included the polychaetes, *Scoloplos sp.*; crustaceans such as *Ampelisca sp.*, and *Neomysis americana;* mollusks *Mulinia lateralis*, and *Ensis directus*; and, the nemertean *Cerebratulus lacteus*. This site contained more commercially or recreationally important species than other sites sampled, including the knobbed whelk (*Busycon carica*), the channeled whelk (*Busycon canaliculatum*), hard clams, blue crab, and horseshoe crab.

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Site LC-10 is within an American oyster lease area. Sampling in this area by the Greeley-Polhemus Group (1994) did not detect oysters; however, this was likely due to the sampling techniques used in that study.

The area in the vicinity of Site MS-19 was sampled by Maurer *et al.* (1978) in 1972 and 1973. The dominant species included mollusks such as *Ensis directus*, *Tellina agilis*, and *Nucula proxima*; polychaetes including *Glycera americana*, *Glycera capitata*, *Glycera dibranchiata*, *Nereis succinea*, *Nephtys picta*, *Capitella capitata*, *Aricidea cerruti*, *Polydora ligni*, *Sabellaria vulgaris*, and *Heteromastus filiformis*; and, crustaceans including *Protohaustorius wigleyi*, *Paraphoxus spinosus*, *Pagurus longicarpus*, *Cancer irroratus*, *Melita nitida*, *Neopanope sayi*, *Corophium simile*, *Paracaprella tenuis*, and *Eurypanopeus depressus*.

The Greeley-Polhemus Group (1994) found a total of 62 species at Site MS-19 in samples collected in 1993. The mean density of individuals collected at this site (26,562.5 individuals per square meter) was much higher than that of any other proposed sand stockpile site. Most species were crustaceans (24 species) and polychaetes (20 species). Dominant species included crustaceans such as *Ampelisca sp.*, *Corophium sp.*, *Cerapus tubularis*, and *Eurypanopeus depressus*; and, mollusks such as *Crepidula fornicata*, and *Ensis directus*. Commercially and recreationally important species included knobbed whelk, horseshoe crab, blue crab, and hard clam.

The offshore areas in the vicinity of all three proposed stockpile sites support important fisheries for weakfish. Additionally, the offshore areas in the vicinity of Sites L-5 and MS-19 support summer flounder, black sea bass, and drum (Figley and McCloy, 1988).

VI. EFFECTS TO FISH AND WILDLIFE AND SUGGESTED MITIGATIVE MEASURES

A. SHORELINE PROTECTION / WETLAND RESTORATION

Estuarine emergent wetlands such as those on Egg Island Point and Kelly Island are among the most productive natural systems on earth. The detritus produced by the annual death and decay of saltmarsh vegetation and other wetland vegetation contributes to estuarine productivity and the aquatic food web. In some estuaries, the detrital material exported from salt marshes is more important than the phytoplankton-based production in the estuary (Mitsch and Gosselink, 1986). Additionally, salt marshes provide important spawning and nursery habitat for many species of marine and estuarine fish, shellfish and crustaceans, and provide feeding, resting and breeding habitat for a wide variety of migratory waterfowl, shorebirds, wading birds, raptors, and passerine birds.

The continual loss of estuarine wetlands through shoreline erosion not only eliminates habitat for marsh-dwelling organisms; but also reduces the productivity of the entire estuary. Therefore, measures designed to slow or reverse the erosion of Delaware Bay salt marshes, if successful, would be expected to produce many positive benefits for the Delaware Bay ecosystem as a whole.

Although erosion control has many desirable benefits, shoreline stabilization measures such as beach nourishment and the use of hard structures such as geotextile tubes may also have a number of site-specific adverse impacts that must be carefully weighed against the expected project benefits in order to determine the net effect. In particular, the effects of the proposed geotextile tube structures on spawning horseshoe crabs is unknown. While the Egg Island Point and Kelly Island sites do not currently support high quality breeding habitat, as discussed above, significant numbers of horseshoe crabs still spawn in these areas. Although most eggs deposited in these areas may be inviable, the eggs still provide a valuable food source for migratory shorebirds and other organisms.

It is almost certain that the geotextile tube structures would not provide suitable spawning habitat for horseshoe crabs, given the lack of open sandy area above mean low water. It is uncertain whether horseshoe crabs would continue to attempt to spawn along these structures. Additionally, horseshoe crabs may become trapped behind these structures, which could result in increased mortality.

1. Egg Island Point

The estuarine wetlands on Egg Island Point provide valuable habitat for a wide variety of fish and wildlife, particularly species of migratory shorebirds and waterfowl; therefore, carefully designed measures that slow or reverse erosional wetland loss would benefit these species. However, careful planning will be necessary to ensure that these shoreline protection measures are effective in controlling erosion without adversely affecting important fish and wildlife resources.

The initial construction of the proposed project, particularly the deposition of the sand foundation, would most likely create a temporary increase in turbidity in the vicinity of the oyster lease beds. Additionally, the initial construction of the proposed project could adversely effect spawning horseshoe crabs and migrating shorebirds, if construction occurred between April 15 and June 30. To avoid impacts to spawning horseshoe crabs and shorebirds, the Service recommends that no construction activities be scheduled to occur between April 15 and June 30.

The potential exists for substantial quantities of dredged material to migrate out of the project area, and smother nearby oyster beds; however, the completed project would likely reduce shoreline erosion and sediment transport onto the oyster beds. Insufficient information exists regarding sediment transport in the Egg Island Point area to accurately predict the movement of

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deposited dredged material. The Corps is currently conducting modeling studies to assess sediment transport. The Service recommends that a meeting be held among interested parties upon completion of these modeling studies to review and discuss the results.

Depending on design, the proposed geotextile tube structure at Egg Island Point may alter the tidal flow over the adjacent salt marsh. Altered tidal flow may interrupt nutrient transport over the marsh; thereby decreasing the value of the tidal ponds to migratory shorebirds and potentially encouraging the spread of common reed. The Corps has stated that the proposed structure would be designed to maintain 100 percent of the current tidal flow over the salt marshes (J. Brady, pers. comm., 1995). The Service supports this design specification and recommends that the Corps take all necessary steps to ensure that tidal flow over the marsh is maintained.

The proposed shoreline protection at Egg Island Point would result in the elimination of all subtidal benthic habitat directly under the footprint of the proposed geotextile tubes, supporting scour blanket, and areas of dredged material placement for wetland restoration. The current plan to deposit up to 2.6 million cubic yards of dredged material landward of the geotextile tube structure along the southeastern shoreline would restore between 150 and 200 acres of estuarine emergent wetlands, while eliminating the same amount of open water and benthic habitat. The area in the proposed footprint of the structure does not appear to support a particularly diverse or unusual benthic community; however, care must be taken to avoid nearshore areas that support oyster lease beds. It should be noted that geotextile tubes used for similar projects in other parts of the country frequently become colonized by a variety of benthic invertebrates (M. Landin, pers. comm., 1995).

The proposed geotextile tube structure could also block access to the beach for spawning horseshoe crabs. This is a concern along the southwestern shoreline and at the tip of Egg Island Point, where the most productive horseshoe crab spawning habitat exists. A possible design under consideration by the Corps would provide spaces between sections of geotextile tube placed along the southwestern shoreline. Such spaces would provide access points to the beaches for spawning horseshoe crabs, while still providing protection of the shoreline. Specific design features, such as the exact configuration of the geotextile tubes or the width of the spaces between tubes have not yet been determined (J. Brady, pers. comm., 1995). The Service recommends that the Corps continue to coordinate with the Service and the NJDFGW to develop site plans that would provide shoreline protection while allowing beach access for spawning horseshoe crabs along the tip of Egg Island Point and along the southwestern shoreline.

2. Kelly Island

The environmental consequences resulting from the proposed Kelly Island project are in many respects similar to those mentioned above regarding Egg Island Point. The proposed wetland restoration at Kelly Island would use up to one million cubic yards of dredged material to convert approximately 80 to 125 acres of nearshore shallow water habitat to estuarine intertidal wetlands.

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This conversion would result in a permanent loss of the benthic community in this area; however, the only commercially important species known to occur at this site is the horseshoe crab. It is also important to note that the project purpose is wetland restoration, and that the proposed project area was historically an emergent marsh.

The primary concerns regarding the proposed Kelly Island project are the avoidance of the ecologically sensitive area on the northern end of Kelly Island and the avoidance of potential effects on the oyster seed beds located offshore of Kelly Island. The wetlands on the northern end of Kelly Island, north of Deepwater Point, provide valuable waterfowl habitat. Additionally, the northern end of the island does not appear to be eroding as rapidly as the southern portion of Kelly Island. Therefore, the Service recommends that the proposed wetlands restoration project be limited to the area south of Deepwater Point.

The footprint of the proposed wetland restoration at Kelly Island would not directly affect oyster beds; however, increased sedimentation and turbidity resulting from the initial construction of the project could adversely affect oysters. Additionally, the movement of large volumes of dredged material from the proposed project site to the oyster beds due to storm events or structural failure of the geotextile tubes poses a significant threat to oyster seed beds. Adverse impacts to oysters through increased sedimentation is a greater threat at Kelly Island than at Egg Island Point due to the proposed deposition of fine-grained silt and clay material at the Kelly Island site.

Any benefits to fish and wildlife derived from the proposed wetland restoration at Kelly Island would be insufficient to offset the loss of oyster seed beds due to excessive sedimentation. As such, the over-riding design consideration for the Kelly Island site must be to minimize the risks of sediment transport from the project site to the oyster beds, both in terms of construction-related sedimentation and long-term sedimentation.

The concerns regarding sedimentation from the Kelly Island site would be substantially reduced or eliminated if the material deposited at the site were sand instead of silt and clay. Therefore, the Corps should carefully consider alternative disposal options for the fine-grained material, including upland disposal at one of the existing disposal sites along the Delaware River. If upland disposal of the fine-grained dredged material is not practicable, the Corps should investigate the feasibility of mixing or capping the fine-grained sediments with coarser-grained material.

It is important that the site be designed such that the dredged slurry is retained on site for sufficient time to allow suspended sediments to settle before water is discharged from the site. Additionally, the Service recommends water quality monitoring of the effluent from the site and the development of contingency plans to be implemented should monitoring indicate adverse impacts during site construction. Once the sediment deposited within the geotextile tube barrier settles and becomes vegetated, it is expected that less material would erode from the area than is currently eroding from the existing exposed marsh. Periodic water quality monitoring in the three to five year period following construction should be conducted to confirm that the site performs as expected.

Overall, it is the Service's view that wetland restoration / shoreline protection projects at Egg Island Point and Kelly Island, similar to those currently proposed, would have a net positive effect on fish and wildlife resources. However, considerable additional planning will be necessary to ensure maximum project benefits with minimal adverse effects. Therefore, the Service recommends that the Corps continue to work with the Service, DNREC, and NJDFGW to evaluate and refine project plans for these two areas.

As previously stated, Kelly Island is part of the Bombay Hook National Wildlife Refuge. As such, the Corps' use of the Kelly Island site for dredged material disposal will require a Special Use Permit from the Service, pursuant to the National Wildlife Refuge System Administration Act of 1966 (80 Stat. 927, 16 U.S.C. 668dd-668ee). Application for the Special Use Permit should be made to the Refuge Manager at the following address:

Paul Daly
Bombay Hook National Wildlife Refuge
R.D. 1, Box 147
Smyrna, Delaware 19977
(302) 653-0684

B. BEACH NOURISHMENT

In the absence of continued beach nourishment, the current shoreline recession that is already severely affecting the beach systems and adjacent salt marshes along the Delaware shoreline is expected to continue. The rate and degree of adverse impact on surrounding beaches and their biological processes is difficult to assess, but it is clear that without intervention some beaches will be lost and wetlands will be converted from vegetated to open water conditions.

Few studies have examined the effects of beach nourishment on beach infaunal communities (Reilly and Bellis, 1978; Naqvi and Pullen, 1982; Fenchel, 1969; Martore *et al.*, 1991). The results of these studies have indicated various effects depending on the compatibility of the beach substrate and replenishment material, time of year, magnitude of the project, and the benthic community composition. One Corps study (Reilly and Bellis, 1978) found that beach infauna was completely eliminated by beach nourishment in North Carolina, and that after 20 months, the infaunal community had still not recovered in any significant degree to its pre-disturbance composition or biomass. Naqvi and Pullen (1982) found that in most cases, initial infaunal recruitment was primarily by opportunistic species and that these species prevented the re-establishment of the original community. Additionally, because beach infaunal organisms are sensitive to even slight changes in sand grain-size distribution and substrate porosity, the species composition of the infaunal community prior to beach nourishment could differ from the post-project community (Fenchel, 1969; Martore *et al.*, 1991).

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Beach nourishment conducted between mid-April and mid-July would adversely impact spawning horseshoe crabs, both through the potential disturbance or burial of spawning adults and through the burial of eggs and larvae. It is unlikely that eggs and larvae buried during beach nourishment activities would survive. Beach nourishment activity during this period would also disturb migrating shorebirds.

Aside from the above-mentioned dependency of migratory shorebirds on horseshoe crab eggs, the biomass and species composition of the infaunal community are also important for supplying the nutritional needs of shorebirds. Therefore, significant effects to spawning horseshoe crabs and / or the infaunal community would have congruent effects on migratory shorebirds.

There is little published information regarding the effects of beach nourishment on nearshore benthic and fish communities. A Florida study (Holland *et al.*, 1980) examined the effects of beach nourishment on nearshore species. This before-and-after-impact study found a temporary increase in fish abundance along the newly created beach, possibly due to the sudden and large-scale die-off of infaunal organisms resulting from the beach nourishment. However, long-term information is lacking. Beach nourishment activities could adversely effect offshore oyster beds through reduced water quality (i.e., higher turbidity and lower dissolved oxygen concentrations), and the deposition of fine-grained material.

The reduction in water quality that would likely occur adjacent to and down current from beach nourishment activities could also adversely effect anadromous fish. If water quality were reduced during the period in which anadromous fish make their spawning runs into inlets and up the Delaware River, their migration could be inhibited and their reproductive success compromised.

Not withstanding the above-mentioned potential adverse effects, properly conducted beach nourishment projects could produce a number of positive environmental effects, particularly in terms of retarding the above-mentioned adverse effects of shoreline erosion. The specific recommendations that follow should help the Corps select beach nourishment projects that would result in maximum benefits with minimum adverse effects.

1. Port Mahon to South Bowers Beach

This section of the Delaware shoreline is experiencing severe erosion that threatens existing wetlands and bayshore communities. The area between Port Mahon and South Bowers Beach is also an area of high biological sensitivity in terms of its value to spawning horseshoe crabs, migratory shorebirds, fish and shellfish. All beaches in this section of the shoreline receive high use by spawning horseshoe crabs; however, reproductive success is probably low at some of these beaches, particularly Port Mahon and Pickering Beach, due to unsuitable habitat conditions. Additionally, the offshore area of this section of shoreline supports commercially valuable oyster beds as well as important spawning areas for commercially and recreationally important fish species.

This section of the Delaware shoreline has the highest ecological value and the most severe erosion of the three sections analyzed for possible beach nourishment projects. Accordingly, the Service recommends that beaches in this section receive priority consideration for beach nourishment. Beach nourishment would have the greatest ecological benefits at Port Mahon and Pickering Beach; although all beaches in this section would benefit from nourishment. Beach nourishment projects should not be conducted between April 15 and June 30 in order to avoid potential adverse impacts to spawning horseshoe crabs, and migratory shorebirds.

2. Bennetts Pier to Big Stone Beach

This section of shoreline appears to have fewer biological constraints than the northern portion of the study area. Although high numbers of spawning horseshoe crabs have been observed in this section in some years, these beaches do not appear to receive consistently high use by horseshoe crabs. The reason for the lower use of this area by horseshoe crabs is not understood, because many of the beaches in this section appear to provide suitable spawning habitat. Factors other than beach habitat characteristics may limit the use of this section of the shoreline by spawning horseshoe crabs.

Significant numbers of shorebirds use the area in the spring, particularly Conch Bar Inlet; therefore, beach nourishment projects should not be conducted along this section of the shoreline during the spring migration period, April 15 through June 30. There are no significant American oyster lease or seed beds in the offshore area, with the exception of the offshore area north of Bennetts Pier; therefore, potential adverse impacts related to any beach nourishment project conducted outside the spring shorebird migration would be limited to temporary disturbances of the benthic infaunal community.

The Service recommends that beaches in this area be given lower priority for consideration as potential disposal sites. The rate of erosion in this section of shoreline is also slower than in the section between Port Mahon and South Bowers Beach. In addition, the potential ecological benefits of beach nourishment projects along the section of shoreline between Bennetts Pier and Big Stone Beach are generally less than could be realized from projects conducted between Port Mahon and South Bowers Beach.

3. Mispillion Jetty to Lewes Beach

This area receives the lowest use by spawning horseshoe crabs, despite the presence of apparently suitable spawning beaches. This area also receives proportionately less use by migratory shorebirds, with the exception of the mud flats adjacent to Cedar Beach. There are also no commercial oyster beds between Mispillion Jetty and Lewes Beach.

Nourishment of this section of the Delaware shoreline should receive the lowest priority in terms of providing beneficial uses for dredged material.

The anticipated effects of beach nourishment activities in this area would be short-term disturbance of the beach infaunal community. While beach nourishment projects would have positive economic benefits for local communities in terms of property protection, it is unlikely that beach nourishment in this area would greatly enhance habitat values for spawning horseshoe crabs or migratory shorebirds.

C. SAND STOCKPILES

It is unlikely that the habitat and aquatic resources in the vicinity of sites L-5, LC-10, and MS-19 would change significantly over time if sand deposition does not take place. Conversely, the use of these areas as dredged material disposal sites would have a number of environmental effects.

The environmental impacts of dredged material disposal in open water are similar in some ways to impacts resulting from sand dredging. Direct impacts include water quality degradation and temporary loss of the benthic community. Benthic community loss will in turn impact finfish species that feed on benthic organisms. Temporary water quality degradation is expected due to elevation of suspended sediments. Brief periods of elevated turbidity will occur as a result of sand placement. Extended periods of elevated turbidity would occur if wind or water currents cause sediments to remain in suspension. Water quality degradation would be more severe and widespread with unconfined open water disposal than if the sand were deposited behind containment devices such as geotextile tubes.

Placement of up to 9.5 million cubic yards of dredged material at the proposed sand stockpile sites would result in burial of the existing benthic community. Benthic recolonization depends upon a number of factors, which include substrate type, distance from similar habitat, and water currents. Recovery of the benthic community would be further hindered by future disturbance as the material is taken from the stockpiles for beach nourishment projects. Site LC-10, while not under consideration at this time, would have been placed directly on top of an economically important oyster lease bed. The Service supports the Corps decision to eliminate the Site LC-10 from further consideration as a sand stockpile area.

Deposition of large quantities of dredge spoil in sand stockpiles would decrease water depth at the sites from current depths to approximately 5 feet below mlw. This depth reduction could result in changes in the tidal regime and current patterns, which in turn could impact biological resources. Changes in the tidal regime may have some impact on biological resources associated with nearby rivers as well as resources associated with adjacent beaches.

Benthic recolonization is dependent upon recruitment from plankton dispersed by water currents. Changes in current patterns and velocities may alter dispersal of benthic larvae. The District is investigating the potential impacts to current patterns and velocities (J. Brady, pers. comm., 1995). When this information is available, the Service requests that it be provided for review.

Except for oysters, the loss of the benthic community due to dredged material disposal would be expected to be a short-term adverse impact. The Corps has constructed twenty-three underwater berms for storm attenuation or beach nourishment throughout the United States (Landin, 1992). For example, results of detailed studies of benthic recovery and fish use on a berm constructed at Dauphin Island, Alabama, indicated rapid benthic recovery. Fish use of the area also was reported as greater than in surrounding waters. The benthic recovery and greater fish use are related to slope, configuration, and orientation of the berm in the current (Landin, 1992).

Long-term impacts would likely result from the use of the sites as sand sources for future beach nourishment projects if the area is subjected to repeated disturbances. A regularly disturbed bottom would not necessarily provide the same abundance or species composition as the present site condition.

Placement of dredged material would result in some loss of finfish nursery and feeding areas. The loss of the food source would be expected to result in a temporary and localized reduction in recreationally and commercially important finfish species. As with effects to the benthic community, the repeated disturbance of the sand stockpile sites for future beach nourishment projects would likely result in long-term adverse impacts to local fisheries.

The above-described adverse impacts of the sand stockpiles would not be offset by any appreciable environmental benefits, as would be the case with the other projects under consideration. Therefore, the use of sand stockpiles for the disposal of dredged material cannot be considered "beneficial" in terms of its effects on fish and wildlife resources.

The Service recommends that the disposal of dredged material in sand stockpiles be considered the disposal option of last resort, and that dredged material be used for wetland restoration and direct beach nourishment to the maximum extent possible. Current plans for Egg Island Point and Kelly Island may accommodate over 3.5 million cubic yards of the estimated 10 million cubic yards of material to be generated by the Delaware Bay portion of the Main Channel Deepening Project. Beach nourishment projects in the above-recommended areas along the Delaware shoreline could accommodate substantial additional quantities of dredged sand; thereby minimizing or eliminating the need for sand stockpiles.

The Service recommends that the Corps coordinate with the State of Delaware to schedule dredging activities to coincide with State-sponsored beach nourishment efforts in order to minimize the costs of conducting beach nourishment as part of the Main Channel Deepening Project. Additionally, the Corps should re-evaluate the economic feasibility of using the dredged material for projects outside the area evaluated for the current study, such as the Maurice River Cove area and beaches in Cape May County, New Jersey.

VII. DATA GAPS AND RECOMMENDATIONS FOR FURTHER STUDIES

Significant concerns remain regarding the potential erosion of large quantities of dredged material from the Kelly Island and Egg Island Point wetland restoration sites, and the effects of such erosion on commercially important shellfish resources. Additionally, there are similar concerns regarding the movement of dredged material placed in sand stockpiles. As previously mentioned, the Service is aware that the Corps is currently conducting modeling studies of sediment transport patterns in these areas. The Service recommends that meetings be held between the Corps, Service, DNREC and NJDFGW upon the completion of these studies to review the results.

There is currently little information regarding the performance or effectiveness of geotextile tubes in areas with tidal regimes and wave patterns similar to Delaware Bay. It is also uncertain whether the peat substrate surrounding Kelly Island and Egg Island Point would support such structures or how much settling would likely occur. Additionally, the effect of shoreline hardening structures such as geotextile tubes on beach access to spawning horseshoe crabs is unknown. The Corps has discussed the possibility of conducting a pilot project for the use of geotextile tubes in Delaware Bay (J. Brady, pers comm., 1995). Such a pilot project would allow an assessment of the effectiveness of geotextile tubes in the Delaware Bay environment. The Service supports the proposal to conduct a pilot project using geotextile tubes, and recommends that the Corps coordinate with the Service, DNREC, and NJDFGW regarding the design of such a project, and related monitoring studies.

A direct correlation appears to exist between the area of sand available on a given beach and the number of horseshoe crabs that will spawn there; however, this remains to be quantified (C. Shuster, pers. comm., 1995). Additionally, it is believed that beach slope plays an important role in determining horseshoe crab spawning success. In order to better design beach nourishment projects to benefit spawning horseshoe crabs, additional information is needed regarding the relationships between these habitat parameters and horseshoe crab beach utilization and spawning success. The Service recommends that the Corps coordinate with the Service and other sources of expertise to design and implement a study of horseshoe crab spawning habitat requirements as a component of the above-mentioned pilot project.

Migratory shorebirds are one of the main species groups intended to benefit from the proposed beach nourishment and wetland restoration projects, yet information regarding shorebird use of Delaware Bay beaches and wetlands is incomplete. The lack of complete information makes a thorough assessment of the effects of the various proposed projects on migratory shorebirds difficult. Additionally, without sufficient baseline data, it will not be possible to determine whether the projects achieve the goal of improving shorebird habitat. The Service recommends that the Corps coordinate with the NJDFGW, Endangered and Nongame Species Program, to continue and expand the annual shorebird surveys. Additional studies should focus on the use of specific project sites by migratory shorebirds, before and after project construction.

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VIII. CONCLUSIONS

Shoreline erosion poses a continuing threat to the diverse and abundant fish and wildlife resources of the Delaware Bay. The Service has evaluated three types of proposals by the Corps to use dredged material to combat shoreline erosion: wetland restoration using geotextile tubes, beach nourishment, and sand stockpiles. The Service concludes that the proposed wetland restoration projects at Egg Island Point and Kelly Island would provide positive benefits to fish and wildlife resources. The Service further concludes that beach nourishment would have the greatest positive effects on beaches between Port Mahon and South Bowers Beach, while nourishment of beaches in the more southern sections of the Delaware shoreline would be less beneficial, although still worthwhile. Finally, the Service concludes that the proposed disposal of dredged material in sand stockpiles would adversely affect fish and wildlife resources and that the use of sand stockpiles should be minimized or eliminated.

While the Service supports the proposed wetland restoration and beach nourishment plans, in concept, substantial additional coordination and planning are necessary to ensure maximum project benefits with minimal adverse effects. Therefore, the Service offers the following recommendations to assist the Corps in refining project plans.

In regard to protection of federally-listed threatened and endangered species, the Service recommends that the Corps:

1. coordinate with the NJDFGW, Endangered and Nongame Species Program, and the Service to incorporate relocation of the peregrine falcon nesting tower on Egg Island Point into the current project plans;

2. continue to consult with the Service and the NMFS in the preparation of the Biological Assessment necessary to address potential project-related effects to federally-listed species; and,

3. contact the NJDFGW, Endangered and Nongame Species Program for additional information regarding State-listed threatened and endangered species.

In regard to the proposed wetland restoration plans for Egg Island Point, New Jersey, and Kelly Island, Delaware, the Service recommends that the Corps:

1. avoid construction between April 15 and June 30 in order to minimize potential adverse impacts to spawning horseshoe crabs and migrating shorebirds;

2. continue modeling studies to determine the sediment transport patterns around Egg Island Point and Kelly Island, and coordinate with the Service, NJDFGW and DNREC to discuss the results of these studies;

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3. design the proposed geotextile tube structure to ensure maintenance of existing tidal flow over adjacent salt marshes;

4. avoid impacts to oyster lease and seed beds adjacent to the proposed project sites by locating project features outside of areas known to support oysters;

5. design the Egg Island Point site to allow beach access for horseshoe crabs along the southwestern shoreline and the tip of Egg Island Point;

6. limit the proposed Kelly Island project to the area south of Deepwater Point, in order to avoid the ecologically sensitive area of northern Kelly Island;

7. evaluate alternative disposal options for the fine-grain dredged material, including upland disposal, in order to avoid adverse impacts to oyster beds;

8. investigate the feasibility of mixing or capping fine-grained material with coarser-grained material, in order to minimize adverse impacts to oyster beds;

9. retain dredged slurry on site long enough to allow sediments to settle before discharging water, in order to further minimize potential sedimentation impacts to oyster beds;

10. conduct water quality monitoring of effluent from the Kelly Island wetland restoration sites, and develop a contingency plan to be implemented should monitoring indicate adverse impacts during construction;

11. conduct periodic water quality monitoring for three to five years following construction to ensure that the wetland restoration projects are performing as planned;

12. continue to coordinate project planning with the Service, NJDFGW and DNREC; and,

13. coordinate with the refuge manager of the Bombay Hook National Wildlife Refuge regarding the need for a Special Use Permit for the Kelly Island project.

In regard to proposed beach nourishment projects along the Delaware shoreline, the Service recommends that the Corps:

1. give highest priority for beach nourishment to the beaches between Port Mahon and South Bowers Beach, followed next by the beaches between Bennetts Pier and Big Stone Beach, and last by the beaches between the Mispillion Jetty and Lewes Beach; and,

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2. avoid beach nourishment between April 15 and June 30 in order to minimize potential adverse impacts to spawning horseshoe crabs and migrating shorebirds.

In regard to the proposed disposal of dredged material in sand stockpiles near the Delaware shoreline, the Service supports the Corps decision to eliminate Site LC-10 from further consideration as a dredged material disposal site. Additionally, the Service recommends that the Corps:

1. verify site conditions once a specific location is identified for a sand stockpile in the vicinity of Big Stone Beach;

2. minimize or eliminate the use of sand stockpiles for the disposal of dredged material by maximizing use of dredged material for beach nourishment and wetland restoration;

3. coordinate with the State of Delaware to identify cost-effective measures to use as much sand as possible to direct nourishment of Delaware beaches;

4. re-evaluate the potential for additional beach nourishment and wetland restoration projects outside the area evaluated for the current study including the Maurice River Cove area and beaches in Cape May County; and,

5. coordinate with the Service, NJDFGW, and DNREC regarding the results of the sediment transport modeling studies.

Finally, the Service recommends that the Corps proceed with plans to conduct a pilot project to study the effectiveness of geotextile tubes in Delaware Bay. Such a pilot project would greatly improve the prospects for successful implementation of the proposed Egg Island Point and Kelly Island wetland restoration projects. Such a pilot project should also include expanded horseshoe crab and shorebird surveys, and assessments of horseshoe crab spawning habitat requirements. The Service recommends that the Corps coordinate with the Service, DNREC, and NJDFGW regarding the design of the pilot project, and related monitoring studies.

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Revised 5/95

FEDERALLY-LISTED ENDANGERED AND THREATENED SPECIES IN NEW JERSEY

An **ENDANGERED SPECIES** is any species that is in danger of extinction throughout all or a significant portion of its range.

A **THREATENED SPECIES** is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

FISHES

Sturgeon, shortnose*	Acipenser brevirostrum	E

REPTILES

Turtle, Atl. Ridley*	Lepidochelys kempii	E
Turtle, green*	Chelonia mydas	T
Turtle, hawksbill*	Eretmochelys imbricata	E
Turtle, leatherback*	Dermochelys coriacea	E
Turtle, loggerhead*	Caretta caretta	T

BIRDS

Eagle, bald	Haliaeetus leucocephalus	PT
Falcon, Am. peregrine	Falco peregrinus anatum	E
Plover, piping	Charadrius melodus	T
Tern, roseate	Sterna dougallii dougallii	E

MAMMALS

Bat, Indiana	Myotis sodalis	E
Cougar, eastern	Felis concolor couguar	E+
Whale, blue*	Balaenoptera musculus	E
Whale, finback*	Balaenoptera physalus	E
Whale, humpback*	Megaptera novaeangliae	E
Whale, right*	Balaena glacialis	E
Whale, sei*	Balaenoptera borealis	E
Whale, sperm*	Physeter catodon	E
Wolf, gray	Canis lupus	E+

INVERTEBRATES

Dwarf wedge mussel	Alasmidonta heterodon	E+
Beetle, northeastern beach tiger	Cicindela dorsalis dorsalis	T
Butterfly, Mitchell satyr	Neonympha m. mitchellii	E+
American burying beetle	Nicrophorus americanus	E+

PLANTS

Pogonia, small whorled	Isotria medeoloides	E
Swamp pink	Helonias bullata	T
Orchid, eastern prairie fringed	Platanthera leucophaea	T+
Knieskern's beaked-rush	Rhynchospora knieskernii	T
American chaffseed	Schwalbea americana	E
Joint-vetch, sensitive	Aeschynomene virginica	T
Pigweed, sea-beach	Amaranthus pumilus	T+

STATUS:

E: endangered species
T: threatened species
+: presumed extirpated
PE: proposed endangered
PT: proposed threatened

* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

Note: for a complete listing of Endangered and Threatened Wildlife and Plants refer to 50 CFR 17.11 & 17.12, August 20, 1994

FEDERAL CANDIDATE SPECIES IN NEW JERSEY

CANDIDATE SPECIES in categories 1 and 2 are species that appear to warrant consideration for addition to the federal List of Endangered and Threatened Wildlife and Plants. Although these species receive no substantive or procedural protection under the Endangered Species Act, the U.S. Fish and Wildlife Service encourages federal agencies and other planners to give consideration to these species in the environmental planning process.

VERTEBRATES

Turtle, bog	Clemmys muhlenbergii	1
Terrapin, northern diamondback	Malaclemys terrapin terrapin	2
Snake, northern pine	Pituophis melanoleucus melanoleucus	2
Duck, harlequin	Histrionicus histrionicus	2
Goshawk, northern	Accipiter gentilis	2
Rail, Black	Laterallus jamaicensis	2
Shrike, migrant loggerhead	Lanius ludovicianus migrans	2
Sparrow, Henslow's	Ammodramus henslowii	2
Warbler, cerulean	Dendroica cerulea	2
Bat, eastern small-footed	Myotis leibii	2
Rabbit, New England cottontail	Sylvilagus transitionalis	2
Shrew, Tuckahoe masked	Sorex cinereus nigriculus	2
Woodrat, Alleghany	Neotoma magister	2

INVERTEBRATES

Mussel, brook floater	Alasmidonta varicosa	2
Mussel, yellow lamp	Lampsilis cariosa	2
Mussel, green floater	Lasmigona subviridis	2
Damselfly, lateral bluet	Enallagma laterale	2
Dragonfly, extra-striped snaketail	Ophiogomphus anomalus	2*
Dragonfly, banded bog skimmer	Williamsonia lintneri	2*
Beetle, cobblestone tiger	Cicindela marginipennis	2
Moth, Albarufan dagger	Acronicta albarufa	2
Moth, Buchholz' dart	Agrotis buchholzi	2
Skipper, eastern beard grass	Atrytone arogos arogos	2
Moth, precious underwing	Catocala pretiosa pretiosa	2
Moth, Daecke's pyralid	Crambus daeckeellus	2
Moth, Hebard's noctuid	Erythroecia hebardi	2
Moth, buck	Hemileuca sp.	2
Moth, Lemmer's pinion	Lithophane lemmeri	3C
Moth, Doll's merolonche	Merolonche dolli	2
Moth, noctuid	Papaipema aerata	2
Butterfly, tawny crescent	Phyciodes batesi	2*
Skipper, rare	Problema bulenta	2
Moth, annointed sallow	Pyreferra ceromatica	2*
Skipper, grizzled	Pyrgus wyandot	2*
Moth, Carter's noctuid	Spartiniphaga carterae	2
Butterfly, regal fritillary	Speyeria idalia	2*

PLANTS

Lakecress	Armoracia lacustris	3C
Bur-marigold	Bidens bidentoides var. bidentoides	2
Sedge, handsome	Carex formosa	2
Sedge, variable	Carex polymorpha	2
Sedge, Schweinitz's	Carex schweinitzii	2
Spring beauty yellow	Claytonia virginica var. hammondiae	2
Tick-trefoil, ground-spreading	Desmodium humifusum	2
Boneset, pine barrens	Eupatorium resinosum	2
Spurge, Darlington's	Euphorbia purpurea	2
Everlasting, clammy	Gnaphalium macounii	3B
St. Johnswort, Barton's	Hypericum adpressum	2
Butternut	Juglans cinerea	2
Rush, New Jersey	Juncus caesariensis	2
Blazingstar	Liatris borealis	2
Lobelia, Boykin's	Lobelia boykinii	2
Micranthemum, Nuttall's	Micranthemum micranthemoides	2*
Bog asphodel	Narthecium americanum	1
Panic grass, Hirst's	Panicum hirstii	2
Pondweed, algae-like	Potamogeton confervoides	2
Plum, Alleghany	Prunus alleghaniensis	2
Meadowbeauty, awned	Rhexia aristosa	2
Bulrush, Long's	Scirpus longii	2
Morning-glory, Pickering's	Stylisma pickeringii	2
Sea blite	Suaeda rolandii	2
False-foxglove, auriculate	Tomanthera auriculata	2*
Verbena	Verbena riparia	2*

Categories:

1: Taxa for which the U.S. Fish and Wildlife Service (Service) currently has substantial information to support the appropriateness of proposing to list the species as threatened or endangered. Development and publication of proposed rules on these species is anticipated.

2: Taxa for which information now in possession of the Service indicates that proposing to list the species as threatened or endangered is possibly appropriate, but for which conclusive data are not available to support proposed rules at this time.

3B: Names that, on the basis of current taxonomic understanding, do not represent distinct taxa meeting the Act's definition of "species." Such supposed taxa could be reevaluated in the future on the basis of new information.

3C: Taxa that have proven to be more abundant than previously believed and/or those that are not subject to any identifiable threat. If further research or changes in habitat indicate a significant decline in any of these taxa, they may be reevaluated for possible inclusion in categories 1 or 2.

PE: Proposed Endangered species

PT: Proposed Threatened species

* Signifies a lack of sightings, to the Service's knowledge, since 1963 for New Jersey.

Note: For complete listings of taxa under review, refer to Federal Register Vol. 59, No. 219, Nov. 15, 1994 (Animal) and Vol. 58, No. 188, September 30, 1993 (Plants).

FEDERALLY-LISTED ENDANGERED AND THREATENED SPECIES IN DELAWARE

FISHES

Sturgeon, shortnose*	Acipenser brevirostrum	E

REPTILES

Turtle, Alt. Ridley*	Lepidochelys kempii	E
Turtle, green*	Chelonia mydas	T
Turtle, hawksbill*	Eretmochelys imbricata	E
Turtle, leatherback	Dermochelys coriacea	E
Turtle, loggerhead*	Caretta caretta	T

BIRDS

Eagle, bald	Haliaeetus leucocephalus	T
Falcon, Am. peregrine	Falco peregrinus anatum	E
Plover, piping	Charadrius melodus	T
Tern, roseate	Sterna dougallii dougallii	E

MAMMALS

Squirrel, Delmarva peninsula fox	Sciurus niger cinereus	+
Whale, blue*	Balaenoptera musculus	E+
Whale, finback*	Balaenoptera physalus	E
Whale, humpback*	Megaptera novaeangliae	E
Whale, right*	Balaena glacialis	E
Whale, sperm*	Physeter catodon	E

FEDERAL CANDIDATE SPECIES IN DELAWARE

VERTEBRATES

Turtle, bog	Clemmys muhlenbergii	1
Terrapin, northern diamondback	Malaclemys terrapin terrapin	2
Duck, fulvous whistling	Dendrocygna bicolor	2
Duck, harlequin	Histrionicus histrionicus	2
Goshawk, northern	Accipiter gentilis	2
Rail, black	Laterallus jamaicensis	2
Tern, black	Chlidonias niger	2
Shrike, loggerhead	Lanius ludovicianus	2
Warbler, cerulean	Dendroica cerulea	2

INVERTEBRATES

Skipper, rare	Problema bulenta	2
Butterfly, regal fritillary	Speyeria idalia	2+
Floater, brook	Alasmidonta varicosa	2+

APPENDIX B

State-listed endangered and threatened species in New Jersey

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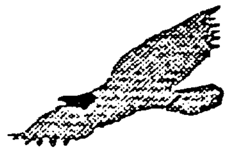

ENDANGERED AND THREATENED WILDLIFE OF NEW JERSEY

Endangered Species are those whose prospects for survival in New Jersey are in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, disease, disturbance or contamination. Assistance is needed to prevent future extinction in New Jersey.

Threatened Species are those who may become endangered if conditions surrounding them begin to or continue to deteriorate.

BIRDS

Endangered

- Pied-billed Grebe,* *Podilymbus podiceps*
- Bald Eagle, *Haliaeetus leucocephalus***
- Northern Harrier,* *Circus cyaneus*
- Cooper's Hawk, *Accipiter cooperii*
- Red-shouldered Hawk, *Buteo lineatus* (Breeding)
- Peregrine Falcon, *Falco peregrinus***
- Piping Plover, *Charadrius melodus***
- Upland Sandpiper, *Bartramia longicauda*
- Roseate Tern, *Sterna dougallii*
- Least Tern, *Sterna antillarum*
- Black Skimmer, *Rynchops niger*
- Short-eared Owl,* *Asio flammeus*
- Sedge Wren, *Cistothorus platensis*
- Loggerhead Shrike, *Lanius ludovicianus*
- Vesper Sparrow, *Pooecetes gramineus*
- Henslow's Sparrow, *Ammodramus henslowii*

Threatened

- American Bittern*, *Botaurus lentiginosus*
- Great Blue Heron*, *Ardea herodias*
- Little Blue Heron, *Egretta caerulea**
- Yellow-crowned Night Heron, *Nyctanassa violacea*
- Osprey, *Pandion haliaetus*
- Northern Goshawk, *Accipiter gentilis*
- Red-shouldered Hawk, *Buteo lineatus* (Non-breeding)
- Black Rail, *Laterallus jamaicensis*
- Long-eared Owl, *Asio otus*
- Barred Owl, *Strix varia*
- Red-headed Woodpecker, *Melanerpes erythrocephalus*
- Cliff Swallow,* *Hirundo pyrrhonota*
- Savannah Sparrow, *Passerculus sandwichensis*
- Ipswich Sparrow, *Passerculus sandwichensis princeps*
- Grasshopper Sparrow, *Ammodramus savannarum*
- Bobolink, *Dolichonyx oryzivorus*

*Only breeding population considered endangered or threatened
**Federally endangered or threatened

REPTILES

Endangered

- Bog Turtle, *Clemmys muhlenbergi*
- Atlantic Hawksbill, *Eretmochelys imbricata***
- Atlantic Loggerhead, *Caretta caretta***
- Atlantic Ridley, *Lepidochelys kempi***
- Atlantic Leatherback, *Dermochelys coriacea***
- Corn Snake, *Elaphe g. guttata*
- Timber Rattlesnake, *Crotalus h. horridus*

Threatened

- Wood Turtle, *Clemmys insculpta*
- Atlantic Green Turtle, *Chelonia mydas***
- Northern Pine Snake, *Pituophis m. melanoleucus*

**Federally endangered or threatened

ENDANGERED AND NONGAME SPECIES PROGRAM

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
DIVISION OF FISH, GAME AND WILDLIFE

AMPHIBIANS

Endangered

Tremblay's Salamander, *Ambystoma tremblayi*
Blue-spotted Salamander, *Ambystoma laterale*
Eastern Tiger Salamander, *Ambystoma t. tigrinum*
Pine Barrens Treefrog, *Hyla andersonii*
Southern Gray Treefrog, *Hyla chrysoscelis*

Threatened

Long-tailed Salamander, *Eurycea longicauda*
Eastern Mud Salamander, *Pseudotriton montanus*

MAMMALS

Endangered

Bobcat, *Lynx rufus*
Eastern Woodrat, *Neotoma floridana*
Sperm Whale *Physeter, macrocephalus***
Fin Whale, *Balaenoptera physalus***
Sei Whale, *Balaenoptera borealis***
Blue Whale, *Balaenoptera musculus***
Humpback Whale, *Megaptera novaeangliae***
Black Right Whale, *Balaena glacialis***

INVERTEBRATES

Endangered

Mitchell's Satyr (butterfly), *Neonympha m. mitchellii***
Northeastern Beach Tiger Beetle, *Cicindela d. dorsalis*
American Burying Beetle, *Nicrophorus americanus***
Dwarf Wedge Mussel, *Alasmidonta heterodon***

**Federally endangered

FISH

Endangered

Shortnose Sturgeon, *Acipenser brevirostrum***

List revisions: March 29, 1979
January 17, 1984
May 6, 1985
July 20, 1987
June 3, 1991

The lists of New Jersey's endangered and nongame wildlife species are maintained by the DEP&E's Division of Fish, Game and Wildlife's, Endangered and Nongame Species Program. These lists are used to determine protection and management actions necessary to insure the survival of the State's endangered and nongame wildlife. This work is made possible only through voluntary contributions received through the Wildlife Check-off on the New Jersey State Tax Form. The Wildlife Check-off is the only major funding source for the protection and management of the State's endangered and nongame wildlife resource. For more information about the Endangered and Nongame Species Program or to report a sighting of endangered or threatened wildlife contact: Endangered and Nongame Species Program, Northern District Office, Box 383 R.D. 1, Hampton, NJ 08827 or call (908) 735-8975.

SECTION B-4

PLANNING AID REPORT, COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT, DELAWARE RIVER FROM PHILADELPHIA TO THE SEA, UPLAND DISPOSAL SITES

U.S. FISH AND WILDLIFE SERVICE

JULY, 1995

PLANNING AID REPORT

COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT DELAWARE RIVER FROM PHILADELPHIA TO THE SEA

UPLAND DISPOSAL SITES

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services, Region 5
New Jersey Field Office
Pleasantville, New Jersey 08232

July 1995

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
927 North Main Street (Bldg. D1)
Pleasantville, New Jersey 08232

Tel: 609-646-9310
FAX: 609-646-0352

IN REPLY REFER TO:

FP-95/25

July 13, 1995

Lt. Colonel Robert P. Magnifico
District Engineer, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Lt. Colonel Magnifico:

Enclosed is the U.S. Fish and Wildlife Service (Service) planning aid report on the Philadelphia District Corps of Engineers' (District) Comprehensive Navigation Study, Main Channel Deepening Project, Delaware River from Philadelphia to the Sea (Upland Disposal Sites). This report has been prepared pursuant to a Fiscal Year-1995 interagency agreement between the District and the Service.

This planning aid report is provided as technical assistance and does not constitute the report of the Secretary of Interior pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 *et seq.*). Planning aid is valid only for the described conditions and must be revised if changes to the proposed project take place prior to initiation.

This report is also provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species and does not address all Service concerns for fish and wildlife resources. These comments do not preclude separate review and comments by the Service on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

Federally-listed Species

The federally-listed endangered bald eagle (*Haliaeetus leucocephalus*) nests inland from the mouth of Raccoon Creek, but feeds extensively in riverine marshes. Bald eagles also roost in forested areas in the vicinity of the project area. Bald eagle use of these marshes reaches a peak in winter.

The federally-listed endangered peregrine falcon (*Falco peregrinus*) also nests on Delaware River bridges in the immediate vicinity of the proposed disposal areas. Peregrine falcons may be expected to forage for prey throughout the project area and generally feed on songbirds, gulls, terns, shorebirds, and wading birds. Additionally, peregrine falcons use the Delaware Bay shoreline during migration, especially in the fall.

It is our understanding that the Corps is preparing a Biological Assessment to address potential project-related adverse impacts to the bald eagle, and peregrine falcon. Other than the aforementioned species, no other federally-listed or proposed endangered or threatened flora or fauna under Service jurisdiction are known to occur within the project area. It is also our understanding that the Corps is coordinating with the National Marine Fisheries Service regarding the federally-listed shortnose sturgeon (*Acipenser brevirostrum*) (endangered), Atlantic Ridley turtle (*Lepidochelys kempii*) (endangered), and loggerhead turtle (*Caretta caretta*) (threatened). Appendix A provides lists of federally-listed endangered and threatened species and federal candidate species in New Jersey.

Any questions regarding this report or federally-listed endangered or threatened species should be directed to Eric Schrading of my staff. The Service looks forward to continued cooperation with the District in the planning stages of the proposed project.

Sincerely,

Clifford G. Day

Clifford G. Day
Supervisor

Enclosure

PLANNING AID REPORT

COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT DELAWARE RIVER FROM PHILADELPHIA TO THE SEA

UPLAND DISPOSAL SITES

Prepared for:

U.S. Army, Corps of Engineers
Philadelphia District
Philadelphia, Pennsylvania 19107

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services, Region 5
New Jersey Field Office
Pleasantville, New Jersey 08232

Preparers: Eric P. Schrading and Peter M. Benjamin
Assistant Project Leader: John C. Staples
Project Leader: Clifford G. Day

July 1995

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I. INTRODUCTION

The Delaware River provides an important avenue for waterborne commerce. However, the existing Delaware River navigation channel is of insufficient depth to accommodate bulk commodity vessels at design drafts. These commodities, which include crude oil, coal, and iron ore, are currently shipped in partially loaded vessels due to draft restrictions.

The U.S. Army Corps of Engineers, Philadelphia District (Corps) is currently studying feasible modifications to the Delaware River that would increase the efficiency of the Delaware River navigation channel. Alternatives have been evaluated based on their potential effects on natural and social environments and impacts on fish and wildlife resources within the study area.

This U.S. Fish and Wildlife Service (Service) planning aid report includes: an identification of fish and wildlife resources on the existing and proposed upland dredged material disposal sites; a discussion of the potential impacts on those resources from disposal activities; a preliminary discussion of possible mitigative measures; and, recommendations for fish and wildlife habitat improvements. The objective of this report is to provide the Corps with specific recommendations on mitigative measures and fish and wildlife habitat improvements for the Corps' proposed upland disposal sites. The report is based on project plans provided in the Delaware River Comprehensive Navigation Study, Main Channel Deepening Project, Final Draft Interim Feasibility Report and Final Environmental Impact Statement (FEIS) (U.S. Army Corps of Engineers, 1992). A previous planning aid report addressing fish and wildlife resources in three of the four proposed disposal sites was completed by the Service in November 1989 (U.S. Fish and Wildlife Service, 1989). In addition, the Service completed a Fish and Wildlife Coordination Act Section 2(b) Report on the proposed project in June 1992 (U.S. Fish and Wildlife Service, 1992).

The Service requests that no part of this report be used out of context and, if the report is reproduced, it should appear in its entirety. Any information excerpted from this report should be properly cited and include the page number from which the material was taken.

II. PROJECT DESCRIPTION

In the Delaware River Comprehensive Navigation Study, the Corps is evaluating existing conditions affecting waterborne commerce on the Delaware River and Delaware Bay and is recommending a plan of improvement to meet the current and future needs of users of Delaware River ports. For purposes of the Corps' feasibility study, the project area was divided into five reaches (Figure 1). The Corps' tentatively-selected plan calls for a navigation project extending from the deep water in Delaware Bay to the Beckett Street terminal in Philadelphia Harbor, a distance of 102.5 miles (Figure 2). The Corps selected a two-way, full-width channel with a maximum depth of 45 feet at mean low water (plus two feet of allowable overdraft) as the recommended plan of improvement.

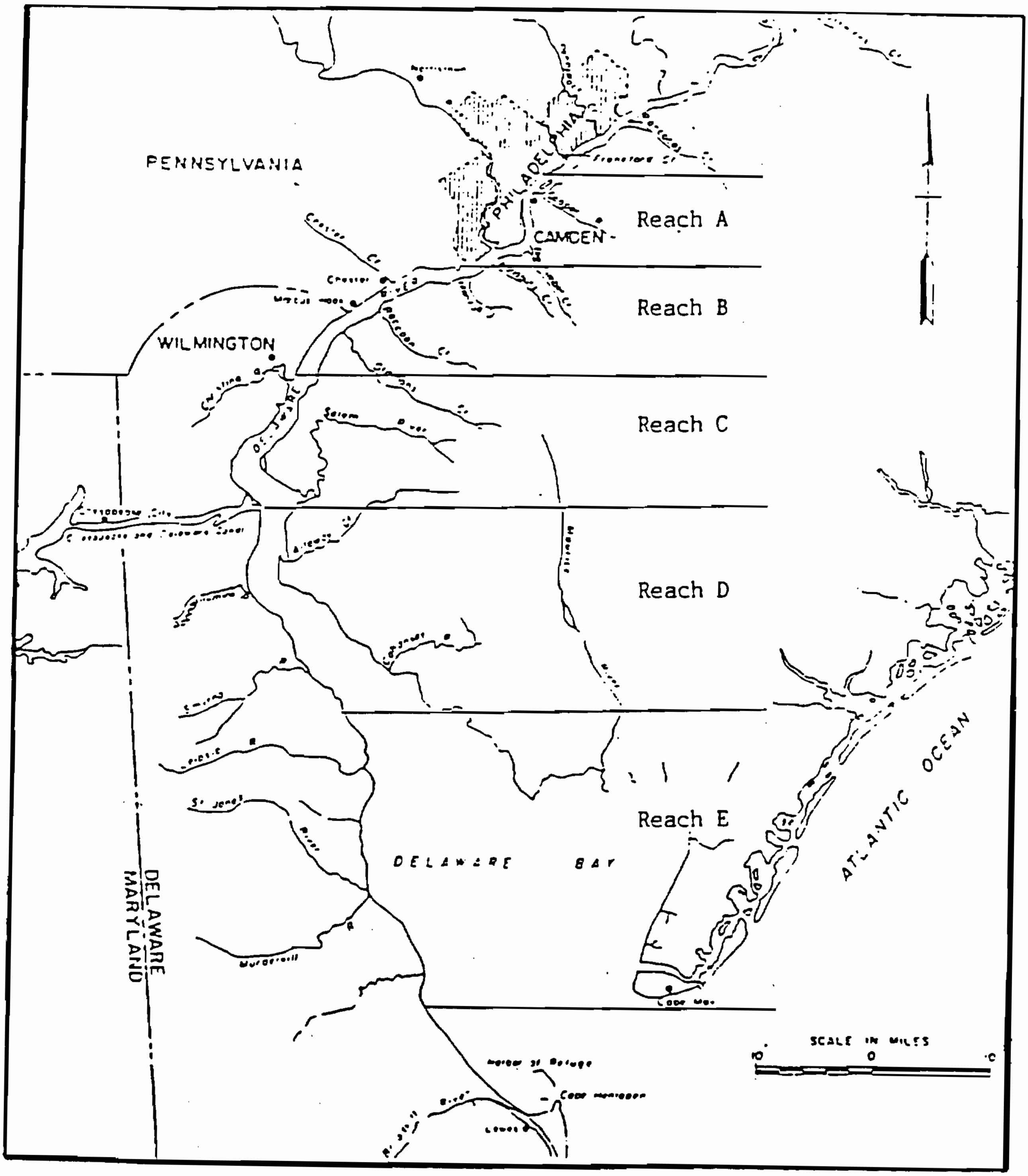

Figure 1. Study area for the Delaware River Comprehensive Navigation Study, Main Channel Deepening, showing the limits of study reaches A through E. Source: U.S. Army Corps of Engineers, 1990.

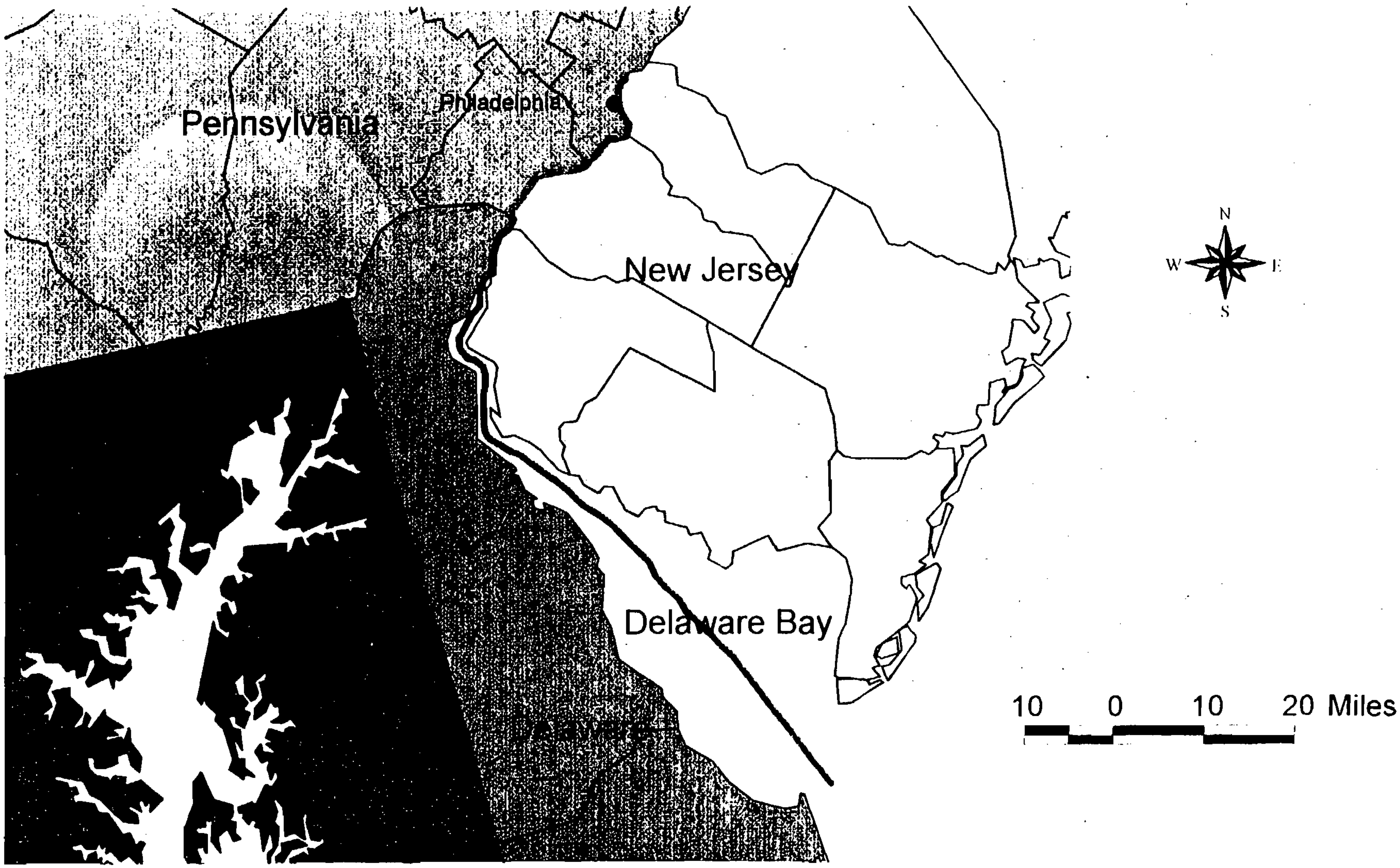

Figure 2. Delaware River, Comprehensive Navigation Study, Main Channel Deepening, showing the location of the main channel and channel bends.

From the Beckett Street Terminal in Camden, New Jersey through Philadelphia Harbor, the 400- to 500-foot-wide west side channel, now at a 40-foot depth relative to mean low water, would be deepened to 45 feet, while the east side channel would remain at the 37-foot depth. Between the Philadelphia Navy Yard and the Delaware Bay, the existing channel would be deepened to 45 feet for its entire 800-foot width. In the Bay, the full 1,000-foot-wide channel would be deepened to 45 feet. Other aspects of the selected plan include widening of 16 channel bends, partial deepening of the Marcus Hook Anchorage, and deepening of access to the bulk berths at Beckett Street Terminal. When required, advanced maintenance dredging of the channel to 47 or 49 feet below mean low water would occur depending on rate of shoaling. High shoaling areas would be dredged at a minimum of every year, while areas of less shoaling would be dredged at intervals of several years. Upon project completion, the channel would have three horizontal to one vertical side slope ratio.

The initial dredging quantity necessary to increase channel depths from the currently authorized 40 feet includes 50,100,000 cubic yards from the federal project (channel and anchorage) and 2,423,300 cubic yards from the non-federal project (berth areas). Maintenance dredging would increase by an estimated 756,000 cubic yards per year. Construction of the proposed project would also entail removal of approximately 420,000 cubic yards of rock in the vicinity of Marcus Hook, Pennsylvania.

For the initial construction, the selected dredged material disposal plan includes the use of Site 17G in Reach A; sites 15D and 15G for Reach B; the Raccoon Island disposal area for Reach C; and, Reedy Point North, Reedy Point South, and Raccoon Island for Reach D. Reedy Point North and Reedy Point South are existing federal disposal sites, whereas sites 17G, 15D, 15G, and Raccoon Island are proposed new upland disposal sites. The Corps is currently examining beneficial uses of Delaware Bay channel materials including wetland restoration / shoreline protection and offshore stockpiling for subsequent beach nourishment. Dredged material from maintenance dredging would be placed at currently used federal and non-federal disposal sites.

III. METHODS AND PROCEDURES

This planning aid report incorporates information compiled from searches of the Service's New Jersey Field Office library and files, personal interviews, and other sources. Additionally, two New Jersey Department of Environmental Protection databases (Notable Information on New Jersey Animals and the Biological and Conservation Database) were reviewed for information on federally-listed and State-listed species and on other fish and wildlife use in the vicinity of the upland disposal sites. The Service's November 1989 planning aid report on the proposed upland disposal sites was also reviewed with regard to fish and wildlife resources that occur on the proposed upland disposal sites (U.S. Fish and Wildlife Service, 1989). In addition, reports compiled for the Corps by Dames & Moore, Inc. (1994a; 1994b; 1994c; and 1994d) on each proposed new disposal site (i.e., Raccoon Island, 15D, 15G, and 17G) were reviewed and relevant information was incorporated into this planning aid report. Representatives of the Service have made numerous site visits (including one aerial overflight) of the proposed upland disposal sites between July 13, 1989 and October 23, 1989. More recently, all proposed new upland disposal sites were investigated in the field by a Service biologist on March 6, 1995 for preparation of this report. Information collected by the Service during the site visits was compared with information collected by Dames and Moore, Inc. to verify site conditions. Existing upland disposal sites Penns Grove, Pedricktown North, Pedricktown South, Oldmans site, and National Park were visited by a Service representative on April 12, 1995. Service site visits of existing upland disposal sites were beneficial toward visualizing future conditions on proposed new upland disposal sites and toward developing management recommendations. The active federal disposal sites, Reedy Point North and Reedy Point South, were not visited by the Service.

IV. EXISTING ENVIRONMENT

A. DELAWARE RIVER AND DELAWARE BAY

The Delaware Estuary drains 12,765 square miles and includes 782 square miles of water surface. Overviews of the project area and fish and wildlife resources present in the Delaware River and Delaware Bay are available in previous Service planning aid reports (see U.S. Fish and Wildlife Service, 1983; U.S. Fish and Wildlife Service, 1985).

The Delaware Estuary has higher water quality today than at any other time during this century (Albert, 1988). Water quality improvements are reflected in the great diversity and abundance of fish in portions of the river that until recently, were considered heavily polluted. However, studies in the upper reaches of the Delaware River associated with the proposed project revealed heavy metal concentrations in sediments (e.g., antimony, arsenic, beryllium, cadmium, chromium, mercury, selenium, thallium, and zinc) in excess of NJDEP Interim Soil Action Level criteria (U.S. Army Corps of Engineers, 1991). Sampling within the lower Delaware River and Delaware Bay revealed only trace levels of heavy metals and the Corps has concluded that sediments are clean within the area of the Delaware Bay where dredging is proposed (U.S. Army Corps of Engineers, 1991).

The Delaware Estuary supports many federal trust resources of interest to the Service. Anadromous fish such as American shad (*Alosa sapadissima*), blueback herring (*A. aestivalis*), and alewife (*A. pseudoharengus*), and semi-anadromous fish such as striped bass (*Morone saxatilis*), pass through or spawn within the project area. The Delaware Estuary also supports diverse and abundant waterfowl populations during migration and in winter. During a 1990 annual midwinter survey, the New Jersey Division of Fish, Game and Wildlife (NJDFGW) counted 174,600 migrating waterfowl within the Delaware Bay coastline (New Jersey Division of Fish, Game and Wildlife, 1990).

The Delaware Estuary also supports the largest staging area for shorebirds in the Atlantic Flyway (New Jersey Division of Fish, Game and Wildlife, 1994). The NJDFGW (1994) documented peak counts of 200,000 to over 400,000 shorebirds in surveys conducted from May to June 1986 through 1992. Semipalmated sandpipers (*Calidris pusilla*), ruddy turnstones (*Arenaria interpres*), sanderlings (*Calidris alba*), and red knots (*Calidris canutus*) made up the majority of the shorebirds observed in the surveys. Dunlin (*Calidris alpina*) and dowitchers (*Limnodromus* spp.) also were commonly observed in the surveys.

B. FEDERALLY-LISTED AND STATE-LISTED ENDANGERED AND THREATENED SPECIES

1. Federally-Listed Species

The project site is within the breeding range of two federally-listed endangered species under Service jurisdiction: the peregrine falcon (*Falco peregrinus*) and the bald eagle (*Haliaeetus leucocephalus*). In recent years, peregrine falcons have nested or attempted to nest on various Delaware River bridges. One peregrine pair nested in 1992 on the Commodore Barry bridge immediately adjacent to the Raccoon Island disposal site. Peregrine falcons feed mostly on shorebirds, waterfowl, and passerines. Peregrines may travel 10 to 18 miles in search of prey and seek feeding opportunities in marshes and riparian areas where these prey concentrate.

The bald eagle is known to nest near the Delaware River and Delaware Bay in New Jersey and Delaware, and also winters in, and migrates through, the area. There are currently 11 active eagle nests in New Jersey, including one within five miles of Site 17G. Most of these nests are located within 10 miles of the Delaware Estuary. A currently-occupied nest is located near Gibbstown, New Jersey, less than 0.5 mile from the Delaware River. The eagles using this nest are known to feed along the river (Clark, pers. comm., 1995). Additionally, the adult eagles from many of these nests appear to be year-around residents of the Delaware Estuary area (Clark, pers. comm., 1995). No other federally-listed or proposed species under Service jurisdiction are known to regularly occur within the project boundary.

The National Marine Fisheries Service (NMFS) has jurisdiction over the federally-listed endangered shortnose sturgeon (*Acipenser brevirostrum*), the endangered Atlantic Ridley turtle (*Lepidochelys kempii*), and federally-listed threatened loggerhead turtle (*Caretta caretta*). The shortnose sturgeon has been found throughout the project area, though spawning is thought to be limited to areas upstream from the project area. Importance of the area to juveniles and post-spawning adults is not certain. Lists of federally-listed, proposed, and candidate species in New Jersey are provided in Appendix A.

Project-related activities could adversely affect the bald eagle and peregrine falcon. The lead federal agency for a project has the responsibility under Section 7(c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to prepare a Biological Assessment if the project is a construction project that requires an Environmental Impact Statement and the project may affect federally-listed species. The District is currently preparing a Biological Assessment to address potential project-related adverse

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impacts to the above-mentioned species. The Service recommends that the Corps continue to consult with the Service and the NMFS during preparation of the Biological Assessment.

2. State-Listed Species

A pair of osprey (*Pandion haliaetus*) nest on a transmission line tower immediately adjacent to the proposed Raccoon Island disposal site. This species is listed by the State of New Jersey as threatened. An American bittern (*Botaurus lentiginosus*) and seven great blue herons (*Ardea herodias*), both of whose breeding populations are listed as threatened by the State of New Jersey, were also observed on the proposed Raccoon Creek disposal area (Dames & Moore, Inc., 1994a). One great blue heron was also observed on the proposed Site 15D disposal area. However, no heron rookeries are known to occur within the vicinity of either Site 15D or Raccoon Creek proposed dredge disposal sites. A list of species considered endangered or threatened by the State of New Jersey is presented in Appendix B.

For additional information on State-listed species, the Service recommends that the Corps contact the NJDFGW, Endangered and Nongame Species Program at the following address:

Mr. Larry Niles
Endangered and Nongame Species Program
Division of Fish, Game and Wildlife
CN 400
Trenton, New Jersey 08625
(609) 292-9101

C. UPLAND DISPOSAL SITES

New sites proposed for the disposal of dredged material for this project are Raccoon Island, sites 15D, 15G, and 17G (Figure 3). Existing federal sites currently used for maintenance dredging and proposed for use for initial project construction are Reedy Point North and Reedy Point South.

All four of the proposed new sites are located in New Jersey adjacent to the Delaware River and have been used for dredged material disposal in the past. Cover types present range from agricultural fields and monotypic fields of common reed (*Phragmites australis*), to mature forest dominated by black willow (*Salix nigra*), black cherry (*Prunus serotina*), and other tree species. Wetlands are present on or adjacent to all four sites.

A diversity of wildlife species occur on the four proposed disposal sites including species of resident and migrating birds, mammals, reptiles, and fish (Dames & Moore, Inc., 1994a; 1994b; 1994c; and 1994d). In general, the species identified reflect the extensive open habitat present on the sites and their proximity to the Delaware River, various tidal creeks, and associate marshes.

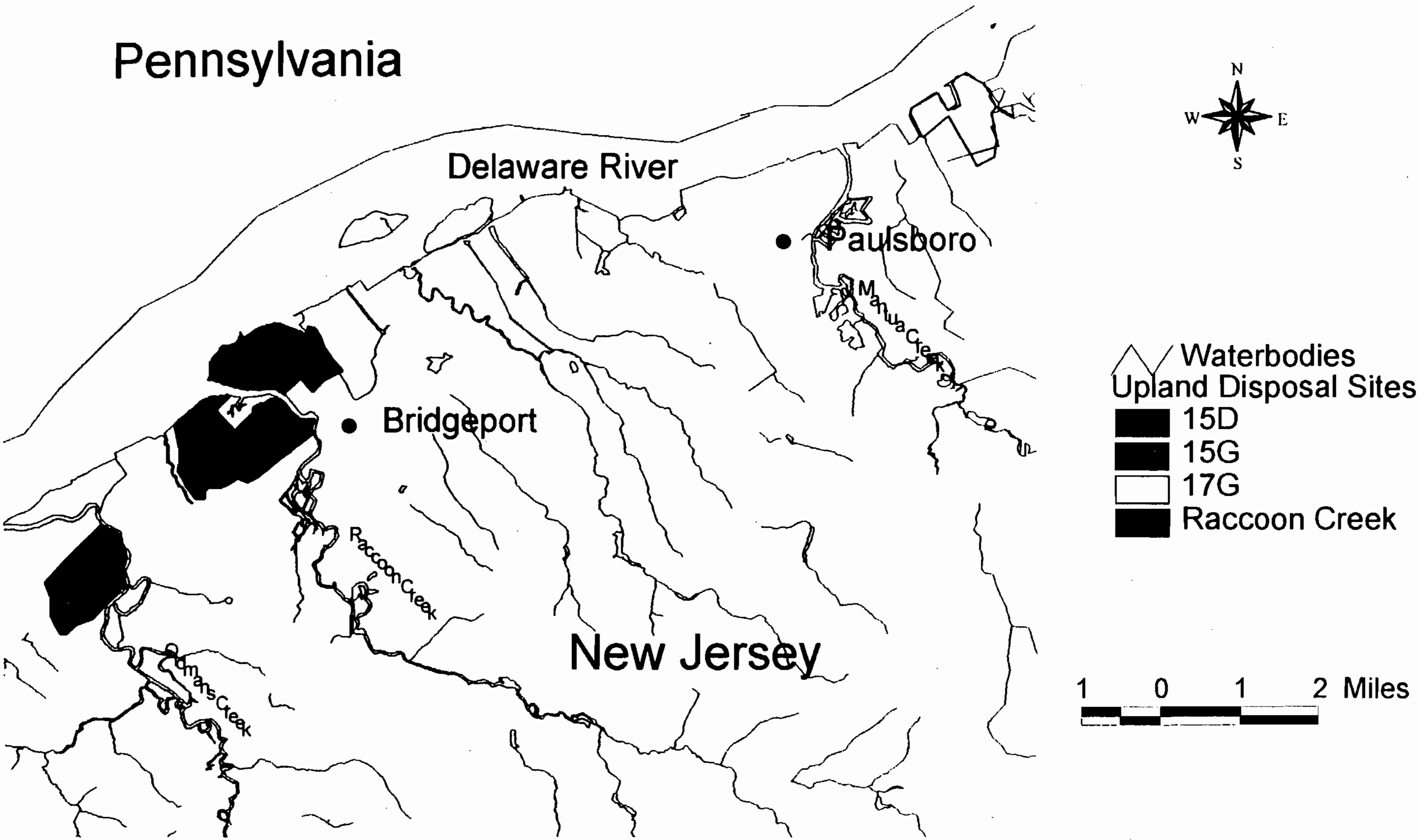

Figure 3: Proposed Upland Disposal Sites for the Delaware River Comprehensive Navigation Project

1. Raccoon Island

Raccoon Island is an approximately 640-acre site in Logan Township, Gloucester County, New Jersey, bordered by State Route 130 to the south, the Delaware River to the north, Raccoon Creek to the west, and private property to the east. Raccoon Island is currently a partially-active Delaware River dredged material disposal site. Approximately 15 to 20 feet of dredged material cover the original ground surface (Dames & Moore, 1994a). A number of dikes divide the proposed site into several raised units, which are approximately 20 feet above the elevation of the Delaware River. The Commodore Barry Bridge, a fixed span bridge that crosses the Delaware River, traverses the northeast portion of the site. Raccoon Island is relatively flat except for the dikes and berms.

Approximately 501 acres of wetlands occur on Raccoon Island. Most of these wetlands are classified as palustrine emergent wetland and are dominated by common reed (Figure 4) (Dames & Moore, 1994a). Several palustrine open water areas occur on the site and are surrounded by emergent vegetation such as spike rush (*Eleocharis obtusa*), shallow sedge (*Carex lurida*), arrowwood (*Viburnum recognitum*), and switch grass (*Panicum virgatum*). In addition, approximately 34 acres of forested wetlands occur on Raccoon Island and are dominated by black willow with a shrub understory of coastal plain willow (*Salix caroliniana*). One forested wetland unit (one acre) is dominated by green ash (*Fraxinus pennsylvanica*). The area surrounding Raccoon Island includes residential and agricultural land.

Approximately 139 acres of upland occur on Raccoon Island, which is typically dominated by tree-of-heaven (*Ailanthus altissima*), princess tree (*Paulownia tomentosa*), white mulberry (*Morus alba*), black cherry, and staghorn sumac (*Rhus typhina*). Raccoon Island supports 277 species of plants; however, the most abundant species are alien herbs (Dames & Moore, 1994a). Areas on the perimeter of Raccoon Island and along the berms and dikes in the interior of the site provide the most diverse habitat for wildlife species (Figure 4) when compared to monotypic stands of common reed in the center of the site.

Areas dominated by common reed cover 472 acres of the Raccoon Island site. Contrary to the popular view that common reed provides low value habitat, many areas dominated by common reed support a wide variety of wildlife species. This is particularly true in areas where common reed is interspersed with shallow water and/or areas of tidal influence, and when other species (particularly food plants such as duckweed) are present. However, most of the common reed areas on Raccoon Island consist of monotypic stands with little or no standing water and as such currently provide lower value habitat than other areas of the site. Overall, 7 species of mammals and 48 species of birds were observed on the site (Dames & Moore, 1994a). Species observed during the Service's March 6, 1995 site visit included white-throated sparrow (*Zonotrichia albicollis*) and northern harrier (*Circus cyaneus*). Wildlife on Raccoon Island is generally more abundant and diverse in woodland (102 acres) and tidal marsh (29 acres) areas as a result of the ability of these areas to meet the food, cover, and reproductive needs of more individuals and species. For this reason, the woodland and tidal marsh areas are generally classified as moderate to high value to wildlife.

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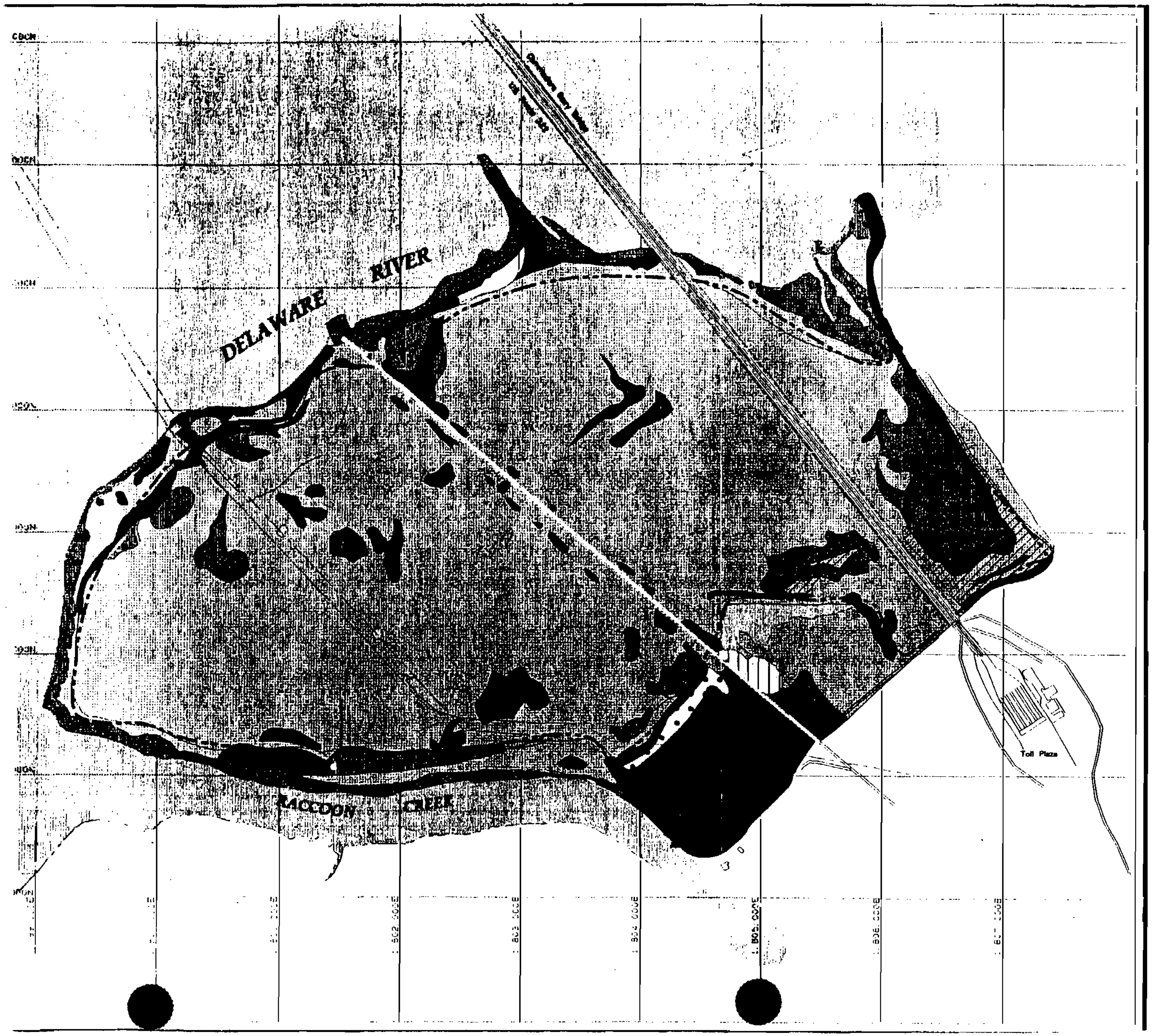

Figure 4:

VEGETATION/ LAND COVER TYPES
RACCOON ISLAND

Delaware River Comprehensive Navigation Study Main Channel Deepening Project

Legend:	Acreage:
Black Locust Dominated	2
Black Willow Dominated	49
Mixed Lowland Hardwoods	21
Mixed Upland Hardwoods	24
Arrowwood Dominated Thicket	2
Blueberry Dominated Shrublands	2
Shoreline Shrubs	2
Common Reed Dominated	458
Common Reed/Mixed Herb	8
Non-tidal Marsh	4
Switchgrass	2
Tidal Marsh	29
Ruderal Area	33
Water Body	6
Apparent Primary Berm Line	
Electrical Transmission Line	
Pipeline	
Highway	
Secondary Road	
Trail	

New Jersey High-Interest Specie Locations:

Rumex hastatulus

1:9600

800 0 1600

feet

September 15, 1994

Notes:

1. Initial habitat delineations made via interpretations from 1990 aerial photography. Interpretations were field checked and boundary adjustments made where needed.

2. Data used in creating base maps for habitat delineation were digitized from the Philadelphia Corps of Engineers blue line maps, referenced to the New Jersey State Plane coordinate system.

Source: Dames & [illegible] Inc. 1994

2. Site 15D

Site 15D is located in Logan Township, Gloucester County, New Jersey and is approximately 470 acres (Dames & Moore, 1994b). The site is bounded by Raccoon Creek to the north and east, Route 130 to the south, and farmland and Birch Creek to the west. Site 15D is currently used for rotational agriculture, primarily soybean and corn cropping. However, most of the site was used for dredged material disposal between approximately 1955 and 1965. The thickness of dredged materials ranges from 10 to 20 feet over both uplands and wetlands (Dames & Moore, 1994b). Land use prior to the dredged material disposal activities was agricultural.

Site 15D is relatively flat except for numerous dikes and ditches that subdivide the site into ten compartments. Each compartment was used for dredged material deposition (Dames & Moore, 1994b). The land surrounding Site 15D consists of undeveloped land (primarily freshwater tidal marsh), residential, and heavy industry.

Wetlands occur on the north, east, and south edges of the Site 15D and in several pockets in the center of the site (Figure 5). Dames and Moore (1994b) identified fifteen wetland units on Site 15D totaling 51 acres. However, Dames and Moore (1994b) did not delineate the size of two tidal marshes along Raccoon Creek within the site. All of the wetlands on Site 15D are palustrine emergent and are dominated by common reed, reed meadowgrass (*Glyceria maxima*), Pennsylvania smartweed (*Polygonum pensylvanicum*), and soft rush (*Juncus effusus*). However, several units are also dominated by black willow, black gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), box elder (*Acer negundo*), and white mulberry. One unit (identified as "BL") is approximately 12 acres and includes a particularly diverse plant community dominated by spotted touch-me-not (*Impatiens capensis*), Japanese honeysuckle (*Lonicera japonica*), royal fern (*Osmunda regalis*), sensitive fern (*Onoclea cylindrica*), skunk cabbage (*Symplocarpus foetidus*), soft rush, black gum, red maple, black willow, sweetgum (*Liquidambar styraciflua*), and duckweed (*Lemna* spp.) (Dames & Moore, 1994b). Many of the wetlands on the periphery of the site are tidally influenced (29 acres) and are dominated by arrowwood, spatter dock (*Nuphar luteum*), and pickerelweed (*Pontederia cordata*) (Dames & Moore, 1994b).

The majority (419 acres) of Site 15D is upland and much of the upland (299 acres) is under rotational row-crop agriculture (Figure 5). Mixed lowland hardwoods (18 acres) occur along the border of Raccoon Creek and are dominated by green ash, red maple, and black willow (Dames & Moore, 1994b). Mixed upland hardwoods (28 acres) are restricted primarily to berms. The canopy of this community is dominated by black cherry, white mulberry, tree-of-heaven, and princess tree. Mixed oak (4 acres), ruderal areas (6 acres), and black willow dominated communities (14 acres) also occur on Site 15D. Ruderal areas are disturbed areas such as roadsides and waste places that are often colonized by weedy herbaceous species. Site 15D supports 264 species of plants; however, the most diverse communities occur on the periphery of the site (Dames & Moore, 1994b).

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The agricultural areas, which comprise the largest cover type on the site, offer low to moderate habitat value. Ruderal areas (i.e., disturbed areas such as roadsides and waste places that are often colonized by weedy herbaceous species) and common reed communities also provide limited value to wildlife due to their low structural diversity. Woodlands and tidal marsh areas are generally more diverse, providing habitat for a variety of wildlife species and are classified as moderate to high value for wildlife. Thirteen species of mammals and 39 species of birds were observed on Site 15D (Dames & Moore, 1994b). Due to their high value to waterfowl, marshes of Raccoon Creek have been designated by the Service as focus areas for needed protection under the Atlantic Coast Joint Venture, an effort being undertaken pursuant to the North American Waterfowl Management Plan (NAWMP). Site 15D is also adjacent to a priority wetland as designated by the Department of the Interior (DOI) under the Emergency Wetlands Resources Act (EWRA) (P.L. 99-645; 100 Stat. 3582). Raccoon Creek and adjacent marshes are of exceptional value to fish and wildlife resources.

3. Site 15G

Site 15G is an approximately 380-acre site located in Oldmans Township, Salem County, New Jersey. The site is bounded by Route 130 to the north, Oldmans Creek to the east, Conrail railroad tracks to the south, and Railroad Avenue to the west (Dames & Moore, 1994c). The site has been farmed since approximately 1980 (primarily rotational corn and soybean cropping). Site 15G has been completely bermed and partially filled with dredged material since at least 1959 (Dames & Moore, 1994c). Site 15G is relatively flat except for a perimeter dike and interior berm. The site has approximately 15 to 20 feet of deposited dredged material inside the dike. Surrounding land use includes a mixture of agriculture, residential development, and heavy industry (Dames & Moore, 1994c).

Seven wetland units, totaling approximately 6.5 acres occur on Site 15G. However, Dames & Moore (1994c) did not delineate one tidal marsh along Oldmans Creek within Site 15G. All of the wetland units within the site are palustrine emergent wetlands (Figure 6). The largest wetland unit (5 acres) is dominated by common reed and duckweed. The remaining smaller (<1 acre) wetland units are dominated by spatterdock, purple loosestrife (*Lythrum salicaria*), arrow arum (*Peltandra virginica*), common reed, jewelweed (*Impatiens capensis*), sensitive fern, and Pennsylvania smartweed (Dames & Moore, 1994c). Two very small (<0.1 acre) units are dominated by the above mentioned herbaceous vegetation and coastal-plain willow (*Salix caroliniana*), American elderberry (*Sambucus canadensis*), and black willow. Two of the seven wetlands are tidal marshes (approximately 5 acres) and occur immediately adjacent to Oldmans Creek.

Approximately 370 acres of upland occur on Site 15G. Much of this area (286 acres) is subject to rotational row-crop agriculture (Dames & Moore, 1994c) (Figure 6). Ruderal areas occupy approximately 15 acres. Site 15G has a thin band of mixed lowland hardwoods (13 acres) along Railroad Avenue on the western side of the site. This area is dominated by green ash, red maple, and black willow. Mixed upland hardwoods (20 acres) occur primarily on the berms

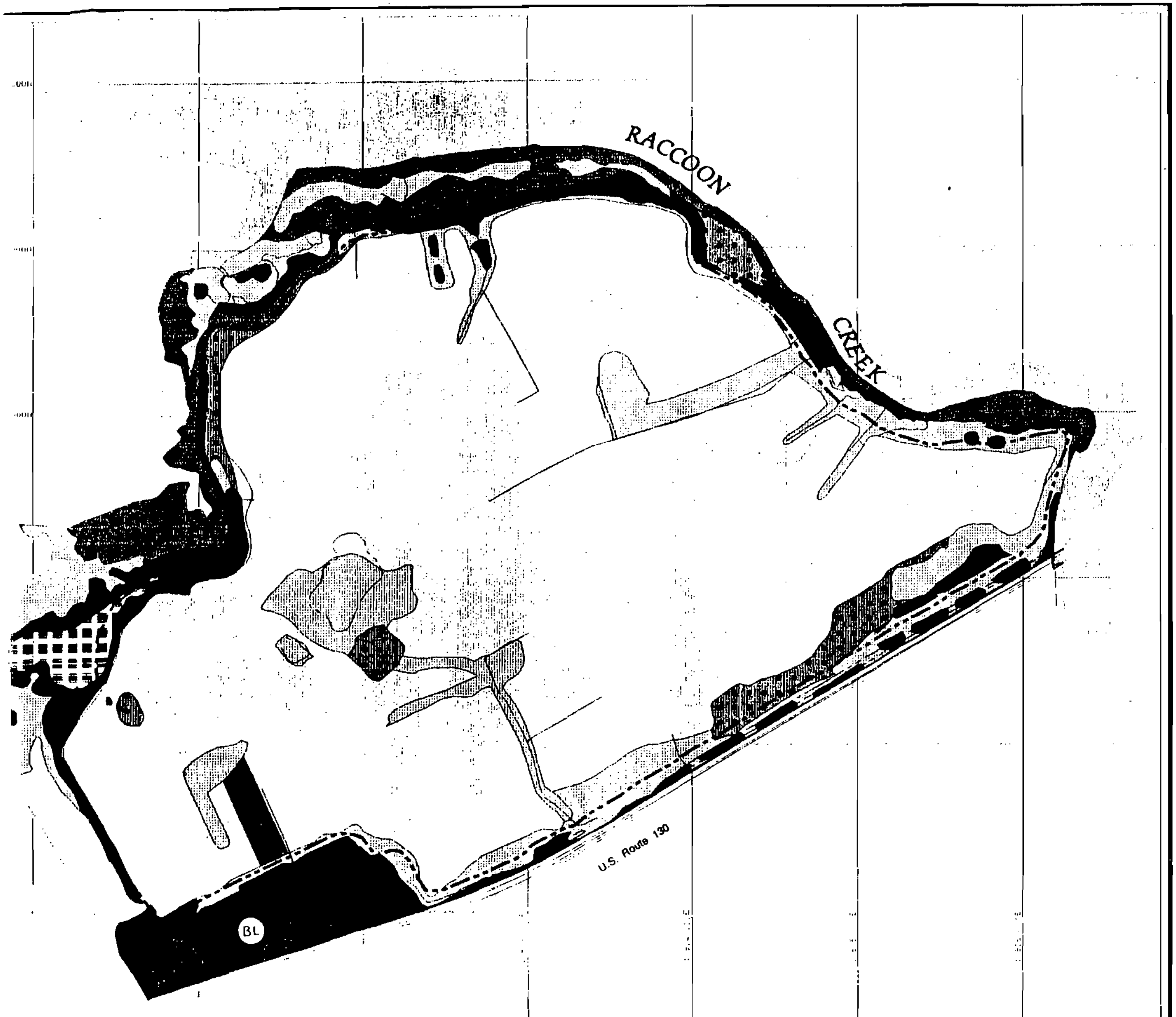

Figure 5:

VEGETATION/ LAND COVER TYPES
SITE 15D

Delaware River
Comprehensive Navigation Study
Main Channel Deepening Project

Legend:	Acreage:
Black Willow Dominated	14
Mixed Lowland Hardwood	18
Mixed Oaks	4
Mixed Upland Hardwood	28
Common Reed Dominated	69
Tidal Marsh	29
Rotational Row crop Agriculture	299
Ruderal Area	6
Apparent Primary Berm Line	
Drainage Ditch	
Highway	
Secondary Road	
Trail	

1:7200

600 0 1200

feet

September 15, 1994

Notes

1. Initial habitat delineations made via interpretations from 1990 aerial photography. Interpretations were field checked and boundary adjustments made where needed

2. Data used in creating base maps for habitat delineation were obtained from the Philadelphia Corps of Engineers in the form of digital exchange files (dxf), referenced to the New Jersey State Plane coordinate system

Source: Dames & Moore, Inc. 1994

Figure 6:

VEGETATION/ LAND COVER TYPES
SITE 15G

Delaware River
Comprehensive Navigation Study
Main Channel Deepening Project

Legend:	Acreage:
Mixed Lowland Hardwoods	13
Mixed Upland Hardwoods	20
Common Reed Dominated	42
Tidal Marsh	5
Rotational Row Crop Agriculture	286
Ruderal Area	15
Apparent Primary Berm Line	
Drainage	
Gas Transmission Line	
Highway	
Secondary Road	
Railroad	
Trail	

1:6000

500 0 1000

feet

September 15, 1994

Notes.

1. Initial habitat delineations made via interpretations from 1990 aerial photography. Interpretations were field checked and boundary adjustments made where needed.

2. Data used in creating base maps for habitat delineation were obtained from the Philadelphia Corps of Engineers in the form of digital exchange files (dxf), referenced to the New Jersey State Plane coordinate system.

Source: Dames & Mo[illegible], Inc. 1994 and are dominated by black cherry, white mulberry, tree-of-heaven, and princess tree. Site 15G supports 217 species of plants; however, the most abundant species are agricultural crops and alien herbs (Dames & Moore, 1994c).

The largest cover type on Site 15G, agricultural areas, offer low to moderate habitat value. Cropped areas provide inadvertent food source for many wildlife species throughout the growing season (Dames & Moore, 1994c). Over 100 Canada geese (*Branta canadensis*) were observed in these fields during the March 6, 1995 site visit. Ruderal areas provide little to no wildlife habitat. Most of the areas dominated by common reed provide limited value for most wildlife species; however, the common reed area, which also supports duckweed, may provide higher value wildlife habitat. Woodland areas and tidal marshes, which occur on the periphery of the site, are the most diverse communities on Site 15G and provide moderate to high habitat value for wildlife species. Twelve species of mammals and 37 species of birds were observed on Site 15G (Dames & Moore, 1994c). Due to their high value to waterfowl, marshes of Oldmans Creek have been designated by the Service as focus areas for needed protection under the NAWMP. In addition, Site 15G and the adjacent wetlands are designated as a priority wetland by the DOI under the EWRA because of the national ecological significance of this wetland complex. Site 15G is also a priority wetland as designated by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency, 1994) under the Clean Water Act (62 Stat. 1155, as amended; 33 U.S.C. 1251 *et seq.*). Oldmans Creek and adjacent marshes are of exceptional value to fish and wildlife resources.

4. Site 17G

Site 17G is located in West Deptford, Gloucester County, New Jersey and is approximately 560 acres. The approximate area within the berms is 465 acres (Dames & Moore, 1994d). Only the northern two-thirds of this site is currently proposed for use as a dredged material disposal site. The lower one-third of this site is currently proposed for use as a wetland mitigation bank by the New Jersey Department of Environmental Protection (Brady, pers. comm., 1995). Site 17G is relatively flat except for the perimeter dike and interior berms. The site is bounded by the Delaware River on the north, active agricultural land to the west, Woodbury Creek to the east, and agricultural and residential land to the south. Site 17G has been used for agriculture, primarily corn and soybean cropping, since 1980. The site was previously used as a dredge disposal site. The land use in surrounding areas is primarily agricultural with some undeveloped fields and woodlands (Dames & Moore, 1994d).

Forty-one non-tidal wetland units comprising 35 acres occur on Site 17G. However, one tidal wetland along Woodbury Creek within site 17G was not delineated by Dames and Moore (1994d). The majority of wetlands within the site are palustrine emergent (Figure 7). Dominant vegetation consists of

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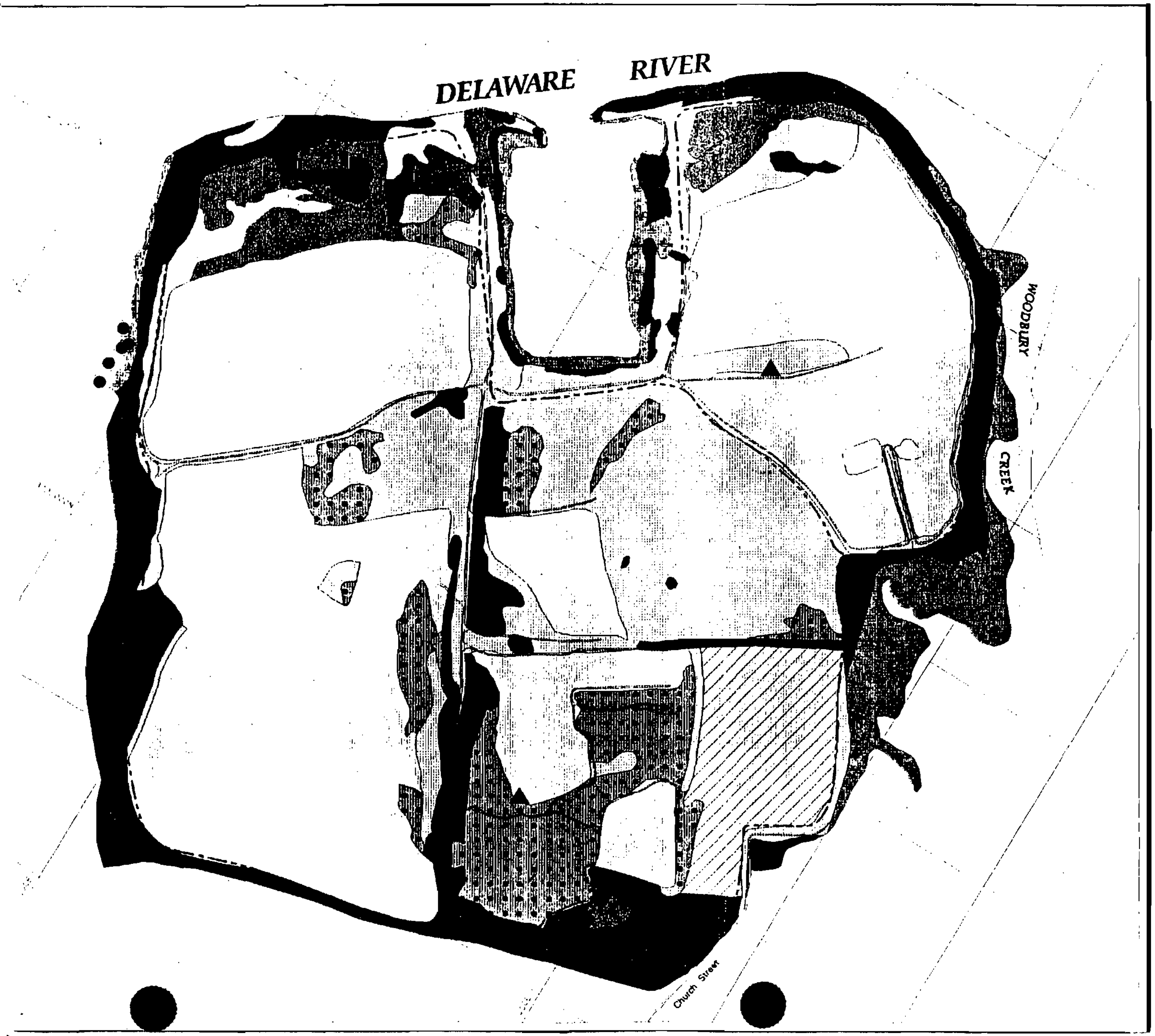


Figure 7:

VEGETATION/ LAND COVER TYPES
SITE 17G

**Delaware River
Comprehensive Navigation Study
Main Channel Deepening Project**

Legend:	Acreage:
Black Locust Dominated	18
Black Willow Dominated	42
Mixed Lowland Hardwoods	27
Mixed Upland Hardwoods	46
Shoreline Shrub	4
Common Reed Dominated	112
Tidal Marsh	27
Pasture	25
Rotational Row Crop Agriculture	237
Ruderal Area	22
Apparent Primary Berm Line	
Secondary Road	
Trail	

New Jersey High-Interest Species Locations:

● *Zannichellia palustris* ▲ *Carex frankii*

1:7200

600 0 1200

feet

September 16, 1994

Notes:

1. Initial habitat delineations made via interpretations from 1990 aerial photography. Interpretations were field checked and boundary adjustments made where needed.

2. Data used in creating base maps for habitat delineation were digitized from the Philadelphia Corps of Engineers blue line maps, referenced to the New Jersey State Plane coordinate system.

Source: Dames & [illegible] Inc. 1994

common reed with some interspersed black willow trees and saplings. One palustrine forested wetland (1 acre) is dominated by black willow, false indigo-bush (*Amorpha fruticosa*), purple loosestrife, and soft rush (Dames & Moore, 1994d). Several emergent wetlands that occur in actively farmed areas include vegetation such as celery-leaf butter-cup (*Ranunculus sceleratus*), blunt spike rush, clammy hedgehyssop (*Gratiola neglecta*), fall panic grass (*Panicum dichotomiflorum*), straw-color flatsedge (*Cyperus strigosus*), and Virginia bugleweed (*Lycopus virginicus*) when the areas are not plowed for corn cultivation. One tidal marsh along Woodbury Creek (approximately 15 acres) consists of black willow and silky dogwood (*Cornus amomum*) along the landward edge of the wetland and yellow cow-lily (*Nuphar luteum*), pickerelweed, and three-square bulrush (*Scirpus americanus*) along the tidal flats and shores of the wetland.

Approximately 510 acres of upland occur on Site 17G, much of which (237 acres) is subject to rotational row-crop agriculture (Dames & Moore, 1994d) (Figure 7). Mixed upland hardwoods (46 acres) are primarily restricted to berms and are dominated by black cherry, white mulberry, tree-of-heaven, and black locust (*Robinia pseudo-acacia*). Several forested areas (42 acres) are dominated by black willow, which has colonized wetlands created by dredge spoil deposition. These areas have since dried via drainage, evaporation, and transpiration. Mixed lowland hardwoods (27 acres) occur along the border of Woodbury Creek, the central tidal basin, and the Delaware River and are dominated by green ash, red maple, and black willow (Figure 7). Pasture areas (25 acres), which support cattle grazing for part of the year, and ruderal areas (22 acres) also occur on Site 17G. Black locust-dominated woodlands (18 acres) occur in well-drained disturbed areas of Site 17G. Site 17G supports 301 species of plants; however, the most abundant species are agricultural crops and alien herbs (Dames & Moore, 1994d).

The agricultural land, which is the largest cover type on the site, offers low to moderate habitat value. Ruderal areas and common reed communities on the site also provide limited value to wildlife due to their low structural diversity. Woodland areas on the perimeter of the site and along interior berms are generally more diverse, providing habitat for a variety of wildlife species. These wetlands may be classified as having moderate to high value for wildlife. Tidal marsh areas also occur on the perimeter of Site 17G and have moderate to high habitat value due to the vegetational diversity of these communities and their proximity to water. Six species of mammals and 50 species of birds were observed on Site 17G (Dames & Moore, 1994d). Species observed during the March 6, 1995 site visit included red-winged blackbird (*Agelaius phoeniceus*), white-throated sparrow, mourning dove (*Zenaida macroura*), northern harrier, and numerous Canada geese in the farm fields. Additionally, numerous waterfowl were observed in the tidal basin including common merganser (*Mergus merganser*), ruddy duck (*Oxyura jamaicensis*), mallard (*Anas platyrhynchos*), scaup (*Aythya* spp.), and pintail (*Anas acuta*). The Delaware River, Woodbury Creek, and adjacent marshes are of exceptional value to fish and wildlife resources.

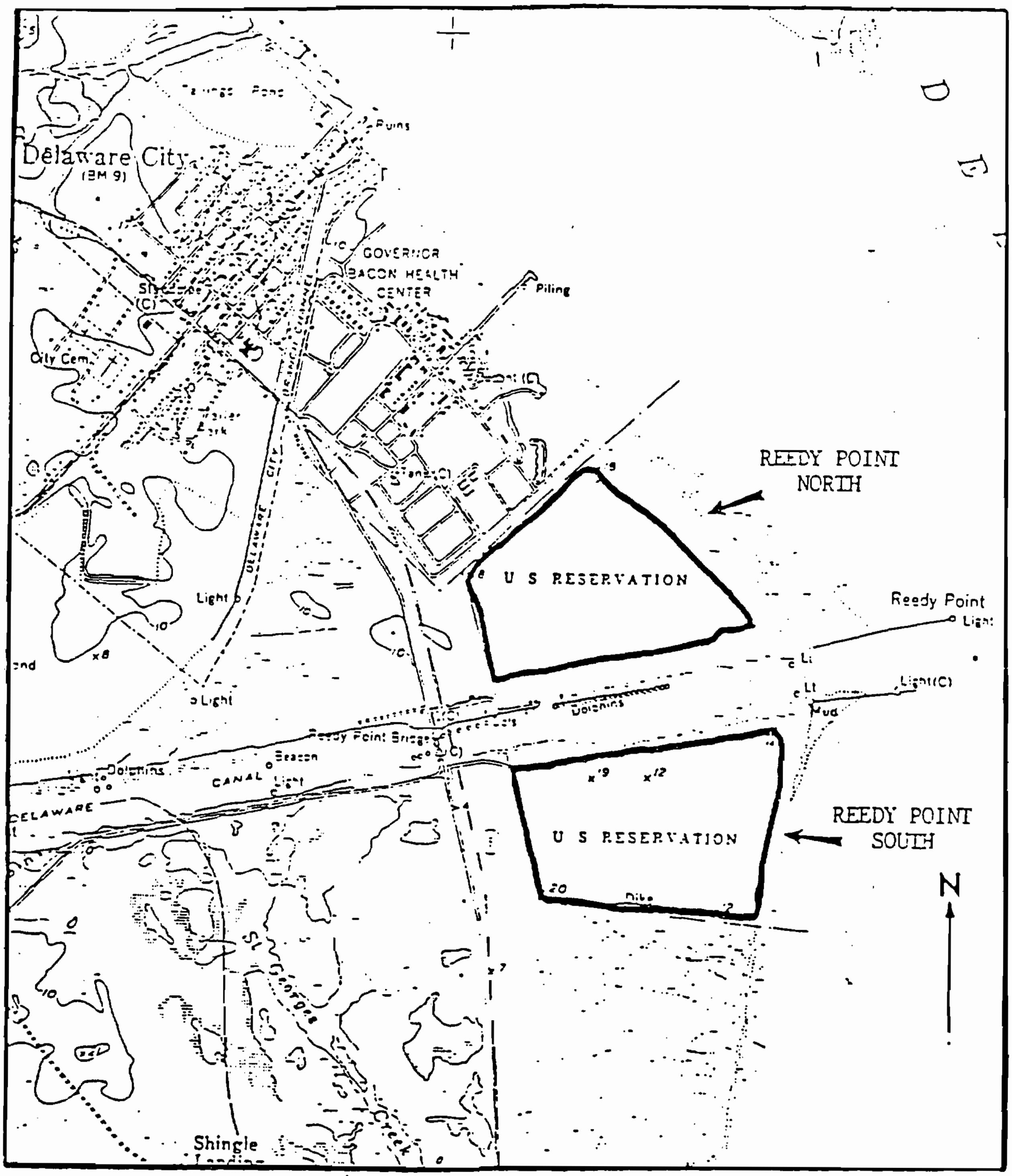
5. Federal Sites Currently in Use

Federal sites currently used for maintenance dredging, and proposed for deposition of material from channel deepening and maintenance dredging, include the following upland sites: Reedy Point North and Reedy Point South in Newcastle County, Delaware (Figure 8), and existing federally-owned disposal sites in New Jersey, including National Park (Reach A), Pedricktown North, Pedricktown South, and Oldmans site (Reach B), Penns Neck and Killcohook (Reach C), and, Artificial Island (Reach D). Reedy Point North and Reedy Point South are reportedly dominated by common reed (Brady, pers. comm., 1995), although the Service has not visited these sites.

The Service visited the National Park, Oldmans, Pedricktown North, Pedricktown South, and Penns Grove disposal sites on April 12, 1995. The predominant cover type on all of these sites is common reed. However, water collects in low-lying portions of these sites, providing valuable habitat for a variety of wetland-associated wildlife species. A large portion of the National Park site supports shallow water interspersed with common reed and duck weed. Many species of birds were observed in this area including American coot (*Fulica americana*), scaup, bufflehead (*Bucephala albeola*), common merganser, mallard, Canada goose, great egret (*Casmerodius albus*), and red-winged blackbird.

Several species were observed on a large shallow water area on the Oldmans site including northern shoveler (*Anas clypeata*), approximately 100 scaup, ruddy duck, northern pintail, Canada goose, greater yellowlegs (*Tringa melanoleuca*), and lesser yellowlegs (*Tringa flavipes*). Additionally, the following species were observed at a shallow ponded area adjacent to the Pedricktown North site: blue-winged teal (*Anas discors*), bufflehead, mallard, scaup, black-crowned night heron (*Nycticorax nycticorax*), green heron (*Butorides striatus*), and bank swallow (*Riparia riparia*). The Pedricktown South site was predominantly common reed with some small areas of black willow. Red-winged blackbird and ring-necked pheasant (*Phasianus colchicus*) were observed at this site.

The Penns Grove site is comprised of a large lake ranging in depth up to 30 feet. Species observed at this site during the Service's April 12, 1995 site visit included Canada goose, ring-necked pheasant, bank swallow, yellow-rumped warbler (*Dendroica coronata*), white-throated sparrow, and bank swallows. Additionally, mallards were observed nesting in the reed canary grass along the shore of the lake.



Scale = 1 : 24,000

Figure 8. Location of federally owned upland disposal sites, Reedy Point North, and Reedy Point South, in Newcastle County, Delaware. Source: U.S. Army Corps of Engineers, 1990.

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V. DISCUSSION OF POTENTIAL IMPACTS FROM ALTERNATIVE UPLAND DISPOSAL SITES

The majority of the four selected new upland disposal sites are of low to medium value for wildlife and typically support monotypic stands of vegetation (e.g., common reed, corn, or soybean). However, areas along interior berms, and particularly along the perimeter of the sites, provide medium to high quality habitat for various species of wildlife. Additionally, the tidal river shallows and vegetated wetlands adjacent to the proposed upland sites provide exceptionally valuable habitat for a variety of fish and wildlife species.

It is the Service's understanding that all new berm construction and subsequent dredged material disposal would occur within the existing berms on these sites (as indicated by the dashed lines labeled "Apparent Primary Berm Line" on Figures 4 through 7). Therefore, the majority of the impacts from the proposed project would be limited to areas of low to medium habitat value (i.e., agricultural fields, ruderal areas, and wetlands dominated by common reed). Additionally, it is likely that cover types similar in habitat value to those that currently exist on the proposed new disposal sites would quickly establish following disposal operations, based on the condition of the existing disposal sites visited by the Service.

The most substantive impacts on wildlife species would occur in the wooded portions of the sites. Some wooded areas of moderate habitat value would be adversely affected by the initial site preparation and subsequent disposal operations. Additionally, although most of the areas that would be affected contain cover types of relatively low habitat value, the large size of the affected areas indicates that considerable numbers of fish and wildlife would be adversely impacted by the proposed project. In order to minimize impacts on fish and wildlife, the Service recommends that the Corps avoid direct impacts on moderate to high value habitats, such as tidal wetlands adjacent to the proposed sites and mature forest along the perimeter of the sites, by focusing dike construction and disposal operations toward the interior of the sites to the extent possible.

Clearing of existing vegetation, and other construction-related activities required prior to use of the upland disposal sites, and inundation of remaining habitat on disposal sites with dredged material may cause direct mortality to wildlife present on the sites, including nesting migratory birds. Adverse impacts to nesting birds could be minimized by conducting site preparation activities outside of the primary migratory bird nesting season: April 1 through July 15.

In reference to new dredged material disposal sites, the Corps states in the DEIS that "construction of replacement habitats is not required to mitigate with-project losses" (U.S. Army Corps of Engineers, 1990). In contrast, the Service recommended full mitigation of all habitats adversely impacted by dredged material disposal (U.S. Fish and Wildlife Service, 1989). Mitigation for adverse impacts on wetland and upland sites should be addressed. The

Service's definition of mitigation is the same used by The Council on Environmental Quality, in which compensation is the least preferred approach. Mitigation may include (in order of preference): (1) avoidance of impacts; (2) minimization of impacts; (3) rectification by repairing, rehabilitating or restoring the effected environment; (4) elimination or reduction of impacts over time; and, (5) compensation through replacement. The Service only endorses mitigation plans that demonstrate compliance with the sequential mitigation process and that ensure the achievement of effective mitigation.

The NAWMP, an international cooperative agreement between the United States and Canada, is being implemented to restore, protect, and enhance aquatic habitats and increase waterfowl populations. The proposed project is within the Middle-Upper Atlantic Coast Habitat Area, one of five Priority Habitat Ranges in the United States. A January 1989 joint agreement between the Department of the Interior and the Department of the Army is designed to further the goals of the NAWMP. Under this agreement, consideration of NAWMP goals should be incorporated into the planning, engineering and design, and construction phases of Corps projects.

VI. OPPORTUNITIES FOR HABITAT ENHANCEMENT

The amount of habitat enhancement that could be accomplished on the disposal sites is constrained by the need to maintain the utility of the sites for future dredged material disposal. Any habitat enhanced following a disposal episode would be subject to elimination by future disposal episodes. In addition, disposal sites must be completely drained for one to two years prior to a disposal episode to allow the dredged material to dry and consolidate. There are also limits on the amount of water that can be retained on disposal sites without compromising the structural integrity of the containment dikes.

In spite of the above constraints, there are numerous opportunities for habitat enhancement on the four proposed upland disposal sites (Raccoon Island, Site 15D, Site 15G, and Site 17G) and on the existing upland disposal sites (National Park, Pedricktown North, Pedricktown South, Oldmans site, Penns Neck, Killcohook, Artificial Island, Reedy Point North, and Reedy Point South). Under the current management strategy for the existing disposal sites, water is drained from the sites as quickly as possible to allow the dredged material to dry and consolidate. This strategy encourages rapid colonization of the sites by common reed. As observed during the April 12, 1995 site visit of existing upland disposal sites, habitat value is much higher in areas with shallow standing water. Therefore, the Service recommends changing the water management strategy of each disposal site to allow the retention of standing water from 18 inches to three feet deep over as large an area as possible and for as long as possible between disposal episodes to enhance the habitat value.

Development of a management plan for the coordinated use of all of the disposal sites would also promote habitat enhancements. Using the sites in a coordinated sequential manner would maximize the amount of time between disposal episodes on each of the sites; thereby, extending the period during which each site could be managed for productive wildlife habitat. For example, if all the disposal sites in Reach B of the River (i.e., Site 15D, Site 15G, Pedricktown North, Pedricktown South, and Oldmans) were managed as one unit, such that a different site were used each year, there would be at least five years between the use of each site. Assuming a two-year drying period prior to re-use, each site would be capable of providing three years of productive shallow water habitat.

Many of the sites (e.g., Pedricktown North and Pedricktown South) appear to be large enough to sub-divide without compromising their effectiveness as disposal sites. Subdivision of these sites would increase the number of compartments available for sequential use; thereby, allowing greater flexibility in site management. Using the sites in Reach B again as an example, if Pedricktown North and Pedricktown South were sub-divided into two compartments each, there would be a total of seven compartments available for use in Reach B. Therefore, each compartment would be used for dredged material disposal only once every seven years, and each compartment would be capable of providing at least five years of productive habitat, assuming a two-year dewatering period.

The existing sites already have sluice gates and other structures for controlling water levels. Therefore, the implementation of a water management plan, in its simplest form, would not require any additional structures. The above-described management scenario is essentially a "passive" management option in that water levels would be maintained solely through control of the sluice gates, and there would be no manipulation of water levels once the desired depth is achieved following a disposal event.

There are a number of options for more "active" management of the disposal sites between disposal events. For example, pumps could be used in conjunction with the sluice gates to seasonally manipulate water levels in each compartment. Compartments could be flooded with one to three feet of water in the fall through winter to benefit migratory waterfowl, and drained in the spring to provide mudflats for migratory shorebirds. Additionally, active manipulation of water levels could facilitate the maintenance of a variety of water regimes on each site, with some compartments providing shallow water habitat and others providing mudflat or emergent wetland habitat. The periodic flooding of compartments would also help control common reed.

The management scenarios outlined above are essentially similar to the "moist soil management" strategies used to manage impoundments on many of the Service's National Wildlife Refuges, and on other wildlife management areas throughout the country. A number of sources of information are available regarding this type of water level management. The following are notable sources of information regarding moist soil management:

Hale Laskowski
South Zone Biologist
Blackwater National Wildlife Refuge
U.S. Fish and Wildlife Service
2145 Key Wallace Drive
Cambridge, Maryland 21613
(410) 221-1836

Leigh Fredrickson
Gaylord Memorial Laboratory
Route 1, Box 185
Puxico, Missouri 63960
(314) 222-3531

Joseph DeMartino
Ducks Unlimited, Inc. (New Jersey)
133 Fox Hollow Drive
Lanoka Harbor, New Jersey 08734
(609) 971-5845

Ray Whittemore, Regional Director
Ducks Unlimited, Inc.
219 Country Road
Bedford, New Hampshire 03110
(603) 626-7706

Other management options to enhance wildlife habitat on the proposed upland disposal areas include pond creation by mechanical excavation, shaping topography by manipulating the location of spoil deposition, and seeding or disking to establish desirable vegetation. Planting vegetation in inundated compartments may be costly considering that the area would be re-disturbed during the next disposal episode. Therefore, the Service recommends that only the interior berms and exterior dikes be seeded with vegetation that establishes quickly (e.g., perennial ryegrass). Seeding would assist in stabilization of such structures and may assist in controlling common reed via competition. Planning of any such management should be closely coordinated with the Service and the NJDFGW.

Finally, once disposal capacity is reached, the external and internal features of the disposal area (e.g., internal berms, sluice gates, water control structures, exterior dikes) should be made permanent. In addition, all disposal sites should be placed under conservation easement, possibly with the NJDFGW or a conservation organization, to protect the areas in perpetuity. If active management is pursued on the disposal sites (e.g., water pumps, adjustable water control structures) a fund should be set up to finance the continued management and operation of the disposal sites in perpetuity. Other agreements with the State or conservation organizations can be made to ensure the continued management of upland disposal sites as wildlife habitat.

VII. CONCLUSIONS AND RECOMMENDATIONS

The Service concludes that the conversion of Site 15D, Site 15G, Site 17G and Raccoon Island to dredged material disposal sites would cause significant adverse impacts to fish and wildlife resources. Therefore, in order to minimize adverse impacts to fish and wildlife, the Service recommends the following measures.

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1. Continue to consult with the Service and NMFS in the preparation of a Biological Assessment to address potential project-related adverse impacts to federally-listed threatened and endangered species.

2. Contact the NJDFGW, Endangered and Nongame Species Program, for updated information regarding State-listed species.

3. Avoid direct impacts on moderate to high value habitats, such as tidal wetlands adjacent to the proposed sites and mature forest along the perimeter of the sites, by focusing dike construction and disposal operations toward the interior of the sites to the extent possible.

4. Avoid the clearing of vegetation and other site preparation activities between April 1 and July 15, in order to minimize adverse effects on nesting migratory birds.

5. Address mitigation for adverse impacts on wetland and upland cover types from dredged-material disposal activities at each of the proposed upland disposal sites.

6. Incorporate objectives of the NAWMP in the planning, engineering, design, and implementation of the proposed upland disposal sites.

The Service has further concluded that there are numerous opportunities to improve wildlife habitat on the proposed disposal sites (Raccoon Island, Site 15D, Site 15G, and Site 17G) and on the existing upland disposal sites (National Park, Pedricktown North, Pedricktown South, Oldmans site, Penns Grove, Penns Neck, Killcohook, Artificial Island, Reedy Point North, and Reedy Point South) that, if implemented, could adequately offset the adverse impacts resulting from the construction of the proposed disposal sites. The Service recommends that the Corps investigate the following measures to enhance wildlife habitat on these disposal sites.

1. Develop water management plans for each of the disposal sites with the goal of maintaining shallow water over as large an area as possible and for as long as possible between disposal episodes on each site.

2. Incorporate the water management plans for each site into a coordinated plan for the sequential use of disposal sites within each reach of the river.

3. Investigate the feasibility of sub-dividing each disposal site into compartments, in order to increase management options and flexibility.

4. Investigate the feasibility of using pumps in association with the sluice gates to more actively control water levels on the disposal sites.

5. Coordinate closely with the Service, the NJDFGW and other sources of expertise regarding opportunities for moist soil management and creation and maintenance of habitat for waterfowl and other wildlife on the proposed disposal areas.

6. Investigate other management options to enhance wildlife habitat on the proposed upland disposal areas including pond creation by mechanical excavation, shaping topography by manipulating the location of spoil deposition, and seeding or disking to establish desirable vegetation. Planning should be coordinated with the Service and the NJDFGW.

7. Once disposal capacity is reached at the current and proposed disposal sites, the Corps should make all external and internal features of the disposal area (e.g., internal berms, sluice gates, water control structures, exterior dikes) permanent, and place the disposal site under conservation easement in perpetuity. Conservation easements might be established with the New Jersey Division of Fish, Game and Wildlife or with a conservation organization (e.g., The Nature Conservancy). In addition, the Corps could negotiate an agreement or establish a fund with such organizations to maintain the continued management and operation of the disposal sites in perpetuity.

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VIII. REFERENCES

A. LITERATURE CITED

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B. PERSONAL COMMUNICATIONS

Brady, J. 1995. Biologist. Philadelphia District, Corps of Engineers. Philadelphia, Pennsylvania.

Clark, K. 1995. Biologist. New Jersey Division of Fish, Game and Wildlife, Endangered and Nongame Species Program. Tuckahoe, New Jersey.

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APPENDIX A

Federally-listed endangered and threatened species
and candidate species in New Jersey

Revised 3/95

FEDERALLY-LISTED ENDANGERED AND THREATENED SPECIES IN NEW JERSEY

An ENDANGERED SPECIES is any species that is in danger of extinction throughout all or a significant portion of its range.

A THREATENED SPECIES is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

FISHES

Sturgeon, shortnose*	Acipenser brevirostrum	E

REPTILES

Turtle, Atl. Ridley*	Lepidochelys kempii	E
Turtle, green*	Chelonia mydas	T
Turtle, hawksbill*	Eretmochelys imbricata	E
Turtle, leatherback*	Dermochelys coriacea	E
Turtle, loggerhead*	Caretta caretta	T

BIRDS

Eagle, bald	Haliaeetus leucocephalus	PT
Falcon, Am. peregrine	Falco peregrinus anatum	E
Plover, piping	Charadrius melodus	T
Tern, roseate	Sterna dougallii dougallii	E

MAMMALS

Bat, Indiana	Myotis sodalis	E
Cougar, eastern	Felis concolor couguar	E+
Whale, blue*	Balaenoptera musculus	E
Whale, finback*	Balaenoptera physalus	E
Whale, humpback*	Megaptera novaeangliae	E
Whale, right*	Balaena glacialis	E
Whale, sei*	Balaenoptera borealis	E
Whale, sperm*	Physeter catodon	E
Wolf, gray	Canis lupus	E+

APPENDIX B

State-listed endangered and threatened species in New Jersey

INVERTEBRATES

Dwarf wedge mussel	Alasmidonta heterodon	E+
Beetle, northeastern beach tiger	Cicindela dorsalis dorsalis	T
Butterfly, Mitchell satyr	Neonympha m. mitchellii	E+
American burying beetle	Nicrophorus americanus	E+

PLANTS

Pogonia, small whorled	Isotria medeoloides	E
Swamp pink	Helonias bullata	T
Orchid, eastern prairie fringed	Platanthera leucophaea	T+
Knieskern's beaked-rush	Rhynchospora knieskernii	T
American chaffseed	Schwalbea americana	E
Joint-vetch, sensitive	Aeschynomene virginica	T
Pigweed, sea-beach	Amaranthus pumilus	T+

STATUS:

E: endangered species
T: threatened species
+: presumed extirpated
PE: proposed endangered
PT: proposed threatened

* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

Note: for a complete listing of Endangered and Threatened Wildlife and Plants refer to 50 CFR 17.11 & 17.12, August 20, 1994

ENDANGERED AND THREATENED WILDLIFE OF NEW JERSEY

Endangered Species are those whose prospects for survival in New Jersey are in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, disease, disturbance or contamination. Assistance is needed to prevent future extinction in New Jersey.

Threatened Species are those who may become endangered if conditions surrounding them begin to or continue to deteriorate.

BIRDS

Endangered

Pied-billed Grebe,* *Podilymbus podiceps*
Bald Eagle, *Haliaeetus leucocephalus***
Northern Harrier,* *Circus cyaneus*
Cooper's Hawk, *Accipiter cooperii*
Red-shouldered Hawk, *Buteo lineatus* (Breeding)
Peregrine Falcon, *Falco peregrinus***
Piping Plover, *Charadrius melodus***
Upland Sandpiper, *Bartramia longicauda*
Roseate Tern, *Sterna dougallii*
Least Tern, *Sterna antillarum*
Black Skimmer, *Rynchops niger*
Short-eared Owl,* *Asio flammeus*
Sedge Wren, *Cistothorus platensis*
Loggerhead Shrike, *Lanius ludovicianus*
Vesper Sparrow, *Pooecetes gramineus*
Henslow's Sparrow, *Ammodramus henslowii*

Threatened

American Bittern*, *Botaurus lentiginosos*
Great Blue Heron*, *Ardea herodias*
Little Blue Heron, *Egretta caerulea**
Yellow-crowned Night Heron, *Nyctanassa violaceus*
Osprey, *Pandion haliaetus*
Northern Goshawk, *Accipiter gentilis*
Red-shouldered Hawk, *Buteo lineatus* (Non-breeding)
Black Rail, *Laterallus jamaicensis*
Long-eared Owl, *Asio otus*
Barred Owl, *Strix varia*
Red-headed Woodpecker, *Melanerpes erythrocephalus*
Cliff Swallow,* *Hirundo pyrrhonota*
Savannah Sparrow, *Passerculus sandwichensis*
Ipswich Sparrow, *Passerculus sandwichensis princeps*
Grasshopper Sparrow, *Ammodramus savannarum*
Bobolink, *Dolichonyx oryzivorus*

*Only breeding population considered endangered or threatened
**Federally endangered or threatened

REPTILES

Endangered

Bog Turtle, *Clemmys muhlenbergi*
Atlantic Hawksbill, *Eretmochelys imbricata***
Atlantic Loggerhead, *Caretta caretta***
Atlantic Ridley, *Lepidochelys kempi***
Atlantic Leatherback, *Dermochelys coriacea***
Corn Snake, *Elaphe g. guttata*
Timber Rattlesnake, *Crotalus h. horridus*

Threatened

Wood Turtle, *Clemmys insculpta*
Atlantic Green Turtle, *Chelonia mydas***
Northern Pine Snake, *Pituophis m. melanoleucus*

**Federally endangered or threatened

ENDANGERED AND NONGAME SPECIES PROGRAM

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
DIVISION OF FISH, GAME AND WILDLIFE

AMPHIBIANS

Endangered

Tremblay's Salamander, *Ambystoma tremblayi*
Blue-spotted Salamander, *Ambystoma laterale*
Eastern Tiger Salamander, *Ambystoma t. tigrinum*
Pine Barrens Treefrog, *Hyla andersonii*
Southern Gray Treefrog, *Hyla chrysoscelis*

Threatened

Long-tailed Salamander, *Eurycea longicauda*
Eastern Mud Salamander, *Pseudotriton montanus*

MAMMALS

Endangered

Bobcat, *Lynx rufus*
Eastern Woodrat, *Neotoma floridana*
Sperm Whale *Physeter, macrocephalus***
Fin Whale, *Baleenoptera physalus***
Sei Whale, *Balaenoptera borealis***
Blue Whale, *Balaenoptera musculus***
Humpback Whale, *Megaptera novaeangliae***
Black Right Whale, *Balaena glacialis***

INVERTEBRATES

Endangered

Mitchell's Satyr (butterfly), *Neonympha m. mitchellii***
Northeastern Beach Tiger Beetle, *Cicindela d. dorsalis*
American Burying Beetle, *Nicrophorus americanus***
Dwarf Wedge Mussel, *Alasmidonta heterodon***

**Federally endangered

FISH

Endangered

Shortnose Sturgeon, *Acipenser brevirostrum***

List revisions: March 29, 1979
January 17, 1984
May 6, 1985
July 20, 1987
June 3, 1991

The lists of New Jersey's endangered and nongame wildlife species are maintained by the DEP&E's Division of Fish, Game and Wildlife's, Endangered and Nongame Species Program. These lists are used to determine protection and management actions necessary to insure the survival of the State's endangered and nongame wildlife. This work is made possible only through voluntary contributions received through the Wildlife Check-off on the New Jersey State Tax Form. The Wildlife Check-off is the only major funding source for the protection and management of the State's endangered and nongame wildlife resource. For more information about the Endangered and Nongame Species Program or to report a sighting of endangered or threatened wildlife contact: Endangered and Nongame Species Program, Northern District Office, Box 383 R.D. 1, Hampton, N.J. 08827 or call (908) 735-8975.
or (908) 735-5450.

APPENDIX C

APPENDIX C

SHORELINE EROSION INVESTIGATION

The following discussion on shoreline erosion and its effect on Pea Patch Island was taken directly from the January 1996 report entitled "Delaware River Main Channel Deepening Project, Design Memorandum Report and Supplemental Environmental Impact Statement, Appendix B, Modeling Efforts/ Hydraulic Analyses" (U.S. Army Corps of Engineers, 1996). The ship generated wave analysis was completed in the Spring, 1997.

Potential shoreline erosion due to the proposed deepening of the Delaware River Main Channel was evaluated in the PED study phase. The purpose of the work was to determine if the channel deepening would induce erosion in areas which presently experience none, or increase shoreline erosion in areas where it is already a problem. The problem was addressed through the application of a 2-dimensional hydrodynamic model of the entire Delaware estuary, with emphasis on the portion of the estuary with several historic shoreline erosion areas.

The shoreline erosion analysis was conducted using RMA-2V, a module of the TABS-2 numerical modeling system. RMA-2V is a two-dimensional finite element hydrodynamic model which has been applied in a wide range of estuarine and fluvial hydraulic investigations within the Corps of Engineers and by others. A complete description of the development and verification of the model of the Delaware Estuary is provided in Appendix B-1C in the above referenced report. The original purpose of the 2-D model development was to provide boundary condition currents for the ship simulation model. However, the model grid scale and coverage, combined with model geometrics representing the existing 40 ft and proposed 45 ft deep channels, made the model ideal for determining if the channel deepening led to current velocity changes, and thus to increased shoreline erosion potential.

Five shoreline locations within Delaware Estuary were evaluated in this analysis. Two of the sites, Pea Patch Island and Oakwood Beach, have existing or historic erosion problems. The other three sites have relatively stable shorelines and were selected to determine if the proposed channel deepening would cause current velocity changes which could lead to erosion. The five sites are indicated on Figure 1. Pea Patch Island is located at River Mile 61, and its eastern shoreline ranges from as little as 200 feet up to about 1200 feet from the west edge of the existing navigation channel. The island is utilized as a historic site by the State of Delaware for the Fort Delaware State Park. The eastern shoreline adjacent to the navigation channel has been the site of persistent erosion over the past several decades, and is unprotected by erosion control works.

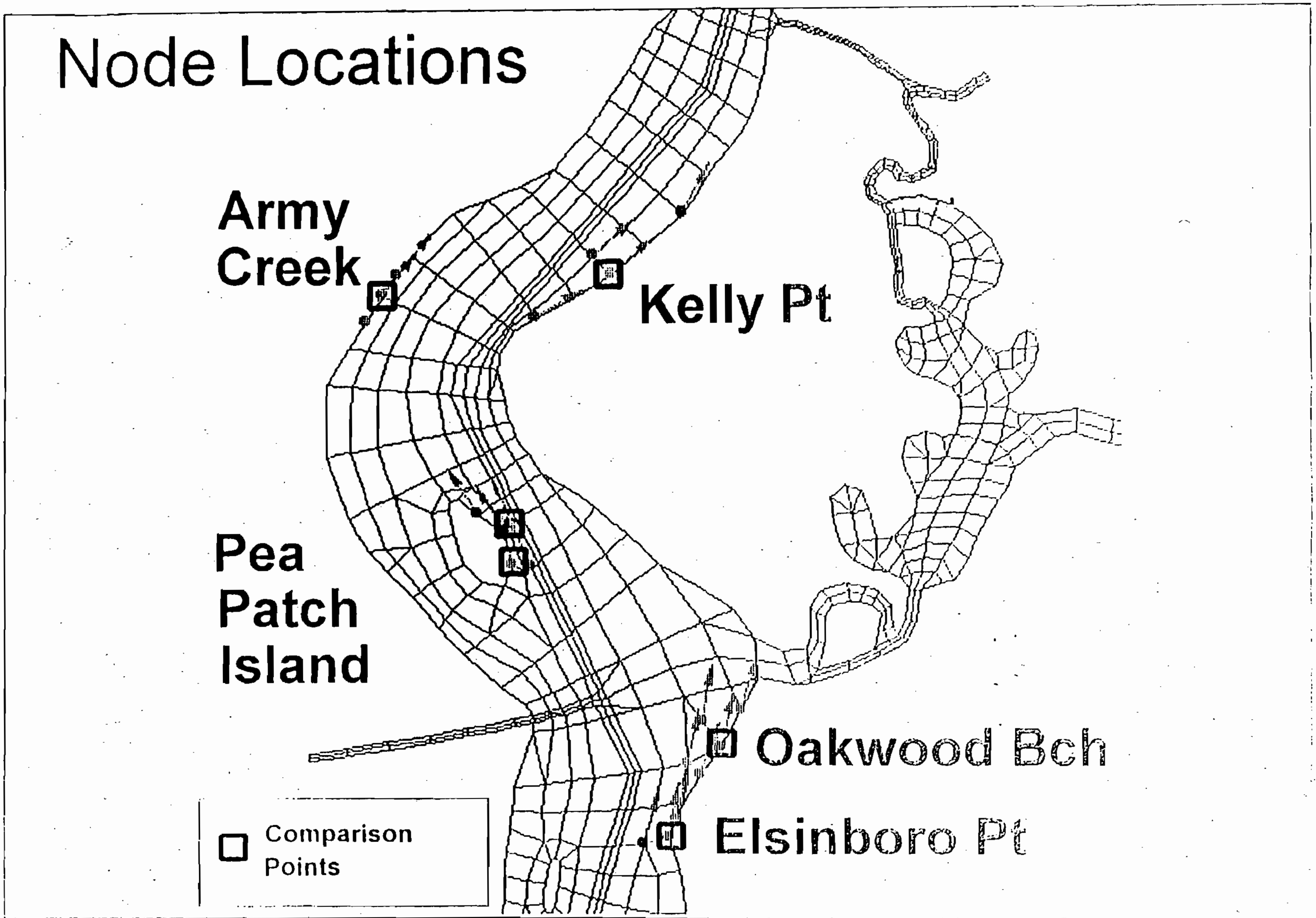

Node Locations
Army Creek
Kelly Pt
Pea Patch Island
Oakwood Bch
Elsinboro Pt
Comparison Points

Figure 1

The Oakwood Beach site is located on the New Jersey shoreline at approximately RM 58. The shoreline at this site ranges between 3000 and 8000 feet from the east edge of the navigation channel, due to changes in the alignment of the channel and shoreline. Oakwood Beach has also suffered from shoreline erosion for at least several decades, but most of its bay frontage has been stabilized in position by a patchwork of locally constructed bulkheads and seawalls. Army Creek, Kelly Point, and Elsinboro Point were the three non-eroding control sites selected in the vicinity of the known erosion problem areas.

The analysis was conducted by selecting several model nodes at each of the five sites. The first model run (Base) utilized a 60-hour (5 tide cycle) spring tide boundary condition data set with the existing 40 ft channel in place. Model-predicted velocity and head values were saved at each of the selected nodes, and incorporated into a spreadsheet. A second model run (Plan) was made, with the only change being the deepening of the navigation channel from 40 to 45 feet. Velocity and head data were saved at the same nodes as in the Base run, and also incorporated into the spreadsheet. Sample model output in spreadsheet format is included in Table 1 for the 40 ft channel at Node 1325, Pea Patch Island. Table 2 contains the model output for Node 1325 for the 45 ft channel alternative. Data from the Plan condition (45 ft channel) were subtracted at each time step from the corresponding values for the Base condition, and tabulated and plotted.

The comparison of Base and Plan velocities showed that the largest predicted changes at any of the five sites were on the order of 0.1 ft/sec, with most of the differences computed to be closer to "zero" ft/sec. Figures 2 and 3 present plots of model-predicted velocities at Pea Patch Island for the 40 ft and 45 ft channel geometrics. Figure 2 shows the velocity comparison at the shoreline (Node 1325), and Figure 3 shows the velocity comparison at model node adjacent to the navigation channel. The close correspondence of the velocity plots for the 40 ft and 45 ft channels is evident. Figure 4 is a plot showing the difference in velocities at Node 1325 at Pea Patch Island, with difference values consistently less than 0.1 ft/sec. Figures 5 through 8 present velocity plots for the 40 ft and 45 ft channel alternatives respectively at Oakwood Beach, Elsinboro Point, Army Creek, and Kelly Point. Comparison of the predicted velocities for the 40 ft and 45 ft channel geometrics at these locations shows negligible velocity differences attributable to the deepened channel. Based on a review of velocity and head comparisons at the five sites investigated, it was concluded that the channel deepening will have a negligible effect on current velocities and water levels at shoreline locations adjacent to the channel, and there will be no shoreline erosion induced or exacerbated by the channel deepening.

VESSEL GENERATED WAVES.

The potential role of ship generated waves on shoreline erosion was also evaluated specifically for the problem area at Pea Patch Island. As described above, the curved eastern shoreline of the island ranges from as little as 200 feet up to about 1200 feet from the west edge of the existing navigation channel. The objective of this investigation was to determine if vessels using the deepened (i.e. , 45 ft) channel would generate larger waves than presently occur with the existing 40 ft channel. Procedures and equations presented in "Bank Protection for Vessel Generated Waves" (Robert Sorensen, 1986, Lehigh University Imbt Hydraulics Laboratory Report IHL-117-86) were utilized for this evaluation.

The principal variables considered in this analysis include vessel shape characteristics, vessel draft, vessel speed, sailing direction, and distance from the shoreline. The analysis assumed that tankers, due to their size, speed, and number of transits, constituted the critical class of vessels for this analysis. Further, based on data developed for the economic analysis of the proposed deepening project, it was assumed that the critical vessel was the same ship for the 40 and the 45 ft channels, with the vessel simply loaded to a five-foot deeper draft in the case of the 45 ft channel.

The results of the this analysis indicated that maximum wave heights at the shoreline of Pea Patch Island would increase only 4% for the case of the design vessel loaded to a five foot greater depth, with the other variables (speed, distance from shore, and sailing direction) held constant. It is concluded here, in the absence of a full understanding of all the physical factors which contribute to the shoreline erosion problem of Pea Patch Island, including naturally high tidal current velocities and existing ship waves, that the predicted vessel generated wave height increase of 4% associated with vessels loaded to five-foot greater draft is negligible with respect to overall Pea Patch Island shoreline erosion problem.

TABLE 1
NODE 1325 (PEA PATCH ISLAND) MODEL OUTPUT
40 FT CHANNEL

Time history node data generated by FastTABS.
geometry file name == untitled.geo
solution file name == delextdy.sol
number of time history nodes == 20

Node ID	timestep	vel x	vel y	vel mag	vel flood	head	depth
1325	0	0	0	0	0	204.71	8.21
	0.5	0	0	0	0	204.71	8.21
	1	0	0	0	0	204.71	8.21
	1.5	0	-0.001	0.001	-0.001	204.71	8.209
	2	0	-0.004	0.004	-0.004	204.707	8.206
	2.5	0	-0.018	0.018	-0.018	204.694	8.193
	3	0.002	-0.063	0.063	-0.063	204.654	8.151
	3.5	0.004	-0.166	0.166	-0.166	204.555	8.047
	4	0.009	-0.346	0.346	-0.346	204.363	7.848
	4.5	0.016	-0.583	0.583	-0.583	204.06	7.538
	5	0.022	-0.817	0.817	-0.817	203.658	7.131
	5.5	0.027	-0.991	0.991	-0.991	203.192	6.662
	6	0.029	-1.086	1.087	-1.087	202.698	6.168
	6.5	0.03	-1.12	1.12	-1.12	202.2	5.671
	7	0.03	-1.116	1.116	-1.116	201.706	5.179
	7.5	0.029	-1.09	1.09	-1.09	201.223	4.696
	8	0.028	-1.048	1.049	-1.049	200.753	4.225
	8.5	0.027	-0.994	0.994	-0.994	200.303	3.775
	9	0.025	-0.928	0.928	-0.928	199.881	3.352
	9.5	0.023	-0.851	0.852	-0.852	199.502	2.975
	10	0.02	-0.76	0.76	-0.76	199.196	2.674
	10.5	0.017	-0.632	0.633	-0.633	199.032	2.525
	11	0.01	-0.374	0.374	-0.374	199.149	2.671
	11.5	-0.008	0.294	0.294	0.294	199.682	3.237
	12	-0.028	1.036	1.036	1.036	200.507	4.088
	12.5	-0.043	1.584	1.584	1.584	201.341	4.959
	13	-0.053	1.981	1.982	1.982	202.089	5.745
	13.5	-0.061	2.278	2.279	2.279	202.81	6.498
	14	-0.067	2.474	2.475	2.475	203.532	7.242
	14.5	-0.069	2.549	2.55	2.55	204.22	7.935
	15	-0.067	2.489	2.49	2.49	204.814	8.517
	15.5	-0.062	2.29	2.291	2.291	205.262	8.93
	16	-0.052	1.944	1.945	1.945	205.506	9.119
	16.5	-0.039	1.433	1.434	1.434	205.489	9.035
	17	-0.02	0.747	0.748	0.748	205.174	8.657
	17.5	0.003	-0.107	0.107	-0.107	204.61	8.057
	18	0.023	-0.87	0.87	-0.87	203.946	7.386
	18.5	0.034	-1.251	1.251	-1.251	203.304	6.75

TABLE I

(continued)

TIMESTEP	VELX	VEL Y	VEL MAG	VEL FLUID	HEAD	DEPTH
19	0.036	-1.335	1.336	-1.336	202.72	6.177
19.5	0.035	-1.315	1.315	-1.315	202.181	5.647
20	0.034	-1.27	1.27	-1.27	201.67	5.14
20.5	0.033	-1.216	1.217	-1.217	201.181	4.651
21	0.031	-1.153	1.153	-1.153	200.713	4.183
21.5	0.029	-1.079	1.079	-1.079	200.27	3.739
22	0.027	-0.993	0.994	-0.994	199.86	3.329
22.5	0.024	-0.895	0.895	-0.895	199.504	2.977
23	0.021	-0.772	0.772	-0.772	199.26	2.743
23.5	0.015	-0.572	0.572	-0.572	199.251	2.761
24	0.002	-0.06	0.06	-0.06	199.663	3.212
24.5	-0.021	0.784	0.784	0.784	200.487	4.06
25	-0.039	1.457	1.457	1.457	201.401	5.005
25.5	-0.051	1.905	1.905	1.905	202.192	5.836
26	-0.06	2.229	2.229	2.229	202.91	6.588
26.5	-0.066	2.446	2.446	2.446	203.619	7.322
27	-0.068	2.536	2.537	2.537	204.294	8.005
27.5	-0.067	2.481	2.482	2.482	204.875	8.574
28	-0.061	2.281	2.282	2.282	205.303	8.968
28.5	-0.052	1.927	1.927	1.927	205.521	9.131
29	-0.038	1.401	1.401	1.401	205.472	9.014
29.5	-0.019	0.695	0.695	0.695	205.124	8.603
30	0.005	-0.18	0.18	-0.18	204.536	7.982
30.5	0.025	-0.922	0.923	-0.923	203.864	7.304
31	0.034	-1.268	1.269	-1.269	203.223	6.669
31.5	0.036	-1.335	1.335	-1.335	202.64	6.098
32	0.035	-1.308	1.309	-1.309	202.103	5.569
32.5	0.034	-1.262	1.263	-1.263	201.592	5.061
33	0.032	-1.207	1.208	-1.208	201.103	4.573
33.5	0.031	-1.143	1.143	-1.143	200.638	4.106
34	0.029	-1.067	1.068	-1.068	200.199	3.667
34.5	0.026	-0.98	0.98	-0.98	199.798	3.267
35	0.024	-0.877	0.877	-0.877	199.462	2.937
35.5	0.02	-0.741	0.742	-0.742	199.264	2.753
36	0.013	-0.488	0.488	-0.488	199.359	2.879
36.5	-0.005	0.194	0.194	0.194	199.923	3.483
37	-0.028	1.034	1.034	1.034	200.841	4.424
37.5	-0.044	1.649	1.65	1.65	201.76	5.38
38	-0.056	2.072	2.073	2.073	202.552	6.214
38.5	-0.064	2.381	2.382	2.382	203.299	6.996
39	-0.069	2.575	2.576	2.576	204.042	7.764
39.5	-0.071	2.63	2.631	2.631	204.739	8.465
40	-0.068	2.534	2.535	2.535	205.322	9.03
40.5	-0.062	2.289	2.29	2.29	205.731	9.397
41	-0.051	1.883	1.883	1.883	205.904	9.507
41.5	-0.035	1.297	1.297	1.297	205.785	9.314

TABLE I
(concluded)

TIMESTEP	VEL X	VEL Y	VEL MAG	VEL FLOOD	HEAD	DEPTH
42	-0.014	0.526	0.529	0.529	205.354	8.821
42.5	0.01	-0.389	0.389	-0.389	204.705	8.145
43	0.029	-1.073	1.074	-1.074	204.002	7.442
43.5	0.036	-1.343	1.343	-1.343	203.348	6.796
44	0.037	-1.377	1.378	-1.378	202.755	6.216
44.5	0.036	-1.341	1.342	-1.342	202.205	5.673
45	0.035	-1.292	1.292	-1.292	201.68	5.15
45.5	0.033	-1.234	1.235	-1.235	201.177	4.647
46	0.031	-1.166	1.167	-1.167	200.696	4.165
46.5	0.029	-1.088	1.088	-1.088	200.24	3.708
47	0.027	-0.998	0.998	-0.998	199.816	3.284
47.5	0.024	-0.895	0.896	-0.896	199.448	2.92
48	0.021	-0.77	0.77	-0.77	199.196	2.679
48.5	0.015	-0.564	0.564	-0.564	199.194	2.704
49	0.001	-0.021	0.021	-0.021	199.637	3.199
49.5	-0.023	0.84	0.84	0.84	200.505	4.082
50	-0.041	1.516	1.516	1.516	201.449	5.059
50.5	-0.053	1.963	1.964	1.964	202.255	5.906
51	-0.061	2.282	2.283	2.283	202.986	6.67
51.5	-0.067	2.49	2.491	2.491	203.703	7.413
52	-0.069	2.564	2.565	2.565	204.377	8.092
52.5	-0.067	2.484	2.485	2.485	204.943	8.641
53	-0.061	2.254	2.255	2.255	205.338	8.997
53.5	-0.05	1.861	1.862	1.862	205.503	9.102
54	-0.035	1.288	1.288	1.288	205.384	8.913
54.5	-0.014	0.532	0.532	0.532	204.962	8.43
55	0.01	-0.373	0.373	-0.373	204.328	7.769
55.5	0.028	-1.042	1.043	-1.043	203.644	7.084
56	0.035	-1.301	1.302	-1.302	203.009	6.458
56.5	0.036	-1.332	1.332	-1.332	202.434	5.894
57	0.035	-1.294	1.295	-1.295	201.9	5.367
57.5	0.033	-1.243	1.244	-1.244	201.392	4.861
58	0.032	-1.185	1.186	-1.186	200.906	4.375
58.5	0.03	-1.117	1.117	-1.117	200.446	3.914
59	0.028	-1.038	1.038	-1.038	200.016	3.483
59.5	0.025	-0.946	0.947	-0.947	199.629	3.098
60	0.022	-0.836	0.836	-0.836	199.326	2.802

TABLE 2

NODE 1325 (PEA PATCH ISLAND) MODEL OUTPUT

45 FT CHANNEL

Time history node data generated by FastTABS.
geometry file name == untitled.geo
solution file name == delplan1dyn.sol
number of time history nodes == 20

Node ID	timestep	vel x	vel y	vel mag	vel flood	head	depth
1325	0	0	0	0	0	204.71	8.21
	0.5	0	0	0	0	204.71	8.21
	1	0	0	0	0	204.71	8.21
	1.5	0	-0.001	0.001	-0.001	204.709	8.209
	2	0	-0.004	0.004	-0.004	204.706	8.206
	2.5	0.001	-0.019	0.019	-0.019	204.694	8.193
	3	0.002	-0.065	0.065	-0.065	204.653	8.149
	3.5	0.005	-0.17	0.17	-0.17	204.553	8.044
	4	0.01	-0.354	0.355	-0.355	204.358	7.843
	4.5	0.016	-0.596	0.596	-0.596	204.051	7.529
	5	0.022	-0.834	0.834	-0.834	203.645	7.117
	5.5	0.027	-1.01	1.01	-1.01	203.174	6.643
	6	0.03	-1.107	1.107	-1.107	202.675	6.143
	6.5	0.031	-1.141	1.141	-1.141	202.17	5.639
	7	0.031	-1.136	1.137	-1.137	201.671	5.141
	7.5	0.03	-1.109	1.109	-1.109	201.182	4.651
	8	0.029	-1.064	1.065	-1.065	200.707	4.176
	8.5	0.027	-1.006	1.007	-1.007	200.253	3.72
	9	0.025	-0.937	0.937	-0.937	199.827	3.295
	9.5	0.023	-0.856	0.856	-0.856	199.447	2.916
	10	0.02	-0.759	0.759	-0.759	199.143	2.619
	10.5	0.017	-0.624	0.624	-0.624	198.989	2.48
	11	0.009	-0.344	0.344	-0.344	199.124	2.648
	11.5	-0.009	0.352	0.352	0.352	199.678	3.235
	12	-0.029	1.085	1.085	1.085	200.513	4.097
	12.5	-0.044	1.626	1.627	1.627	201.35	4.971
	13	-0.055	2.03	2.031	2.031	202.105	5.763
	13.5	-0.063	2.331	2.331	2.331	202.837	6.526
	14	-0.068	2.526	2.527	2.527	203.567	7.278
	14.5	-0.07	2.596	2.597	2.597	204.258	7.975
	15	-0.068	2.528	2.529	2.529	204.854	8.557
	15.5	-0.062	2.318	2.319	2.319	205.301	8.968
	16	-0.053	1.957	1.958	1.958	205.541	9.152
	16.5	-0.038	1.43	1.431	1.431	205.515	9.058
	17	-0.02	0.727	0.727	0.727	205.188	8.668
	17.5	0.004	-0.146	0.146	-0.146	204.612	8.058
	18	0.024	-0.907	0.908	-0.908	203.94	7.379
	18.5	0.034	-1.282	1.283	-1.283	203.293	6.737
	19	0.037	-1.366	1.366	-1.366	202.703	6.157
	19.5	0.036	-1.344	1.345	-1.345	202.157	[illegible]

TABLE 2

(continued)

TIMESTEP	VEL X	VEL Y	VEL MAG	VEL FLOOD	HEAD	DEPTH
20	0.035	-1.298	1.298	-1.298	201.639	5.104
20.5	0.033	-1.241	1.242	-1.242	201.142	4.607
21	0.032	-1.173	1.174	-1.174	200.667	4.132
21.5	0.029	-1.094	1.094	-1.094	200.219	3.682
22	0.027	-1.003	1.003	-1.003	199.804	3.268
22.5	0.024	-0.898	0.898	-0.898	199.447	2.916
23	0.021	-0.768	0.768	-0.768	199.207	2.688
23.5	0.015	-0.553	0.554	-0.554	199.213	2.723
24	0	0	0	0	199.648	3.199
24.5	-0.023	0.841	0.842	0.842	200.487	4.062
25	-0.04	1.5	1.501	1.501	201.406	5.012
25.5	-0.052	1.951	1.952	1.952	202.202	5.848
26	-0.061	2.281	2.281	2.281	202.931	6.611
26.5	-0.067	2.498	2.499	2.499	203.649	7.354
27	-0.069	2.584	2.585	2.585	204.328	8.041
27.5	-0.068	2.521	2.522	2.522	204.911	8.61
28	-0.062	2.31	2.311	2.311	205.336	9.002
28.5	-0.052	1.941	1.942	1.942	205.552	9.16
29	-0.038	1.399	1.4	1.4	205.495	9.034
29.5	-0.018	0.675	0.675	0.675	205.135	8.611
30	0.006	-0.216	0.216	-0.216	204.537	7.981
30.5	0.026	-0.957	0.957	-0.957	203.857	7.295
31	0.035	-1.298	1.299	-1.299	203.21	6.654
31.5	0.037	-1.365	1.365	-1.365	202.622	6.076
32	0.036	-1.338	1.338	-1.338	202.077	5.54
32.5	0.035	-1.289	1.29	-1.29	201.558	5.023
33	0.033	-1.232	1.232	-1.232	201.062	4.527
33.5	0.031	-1.162	1.163	-1.163	200.59	4.054
34	0.029	-1.081	1.082	-1.082	200.146	3.61
34.5	0.027	-0.988	0.989	-0.989	199.742	3.206
35	0.024	-0.879	0.879	-0.879	199.406	2.876
35.5	0.02	-0.735	0.735	-0.735	199.215	2.701
36	0.012	-0.462	0.462	-0.462	199.327	2.848
36.5	-0.007	0.258	0.258	0.258	199.915	3.476
37	-0.029	1.088	1.088	1.088	200.844	4.429
37.5	-0.046	1.693	1.694	1.694	201.766	5.389
38	-0.057	2.122	2.123	2.123	202.566	6.231
38.5	-0.065	2.435	2.436	2.436	203.324	7.024
39	-0.071	2.628	2.629	2.629	204.076	7.799
39.5	-0.072	2.677	2.678	2.678	204.776	8.503
40	-0.069	2.573	2.574	2.574	205.36	9.068
40.5	-0.062	2.316	2.316	2.316	205.767	9.432
41	-0.051	1.894	1.895	1.895	205.935	9.535
41.5	-0.035	1.291	1.291	1.291	205.806	9.332
42	-0.014	0.504	0.505	0.505	205.363	8.828
42.5	0.011	-0.425	0.425	-0.425	204.703	8.142

TABLE 2
(concluded)

TIMESTEP	VEL X	VEL Y	VEL MAG	VEL FLOOD	HEAD	DEPTH
43	0.03	-1.107	1.108	-1.108	203.993	7.431
43.5	0.037	-1.374	1.375	-1.375	203.333	6.779
44	0.038	-1.409	1.409	-1.409	202.734	6.192
44.5	0.037	-1.372	1.372	-1.372	202.176	5.641
45	0.036	-1.32	1.321	-1.321	201.643	5.109
45.5	0.034	-1.259	1.26	-1.26	201.132	4.598
46	0.032	-1.186	1.187	-1.187	200.645	4.109
46.5	0.03	-1.102	1.103	-1.103	200.183	3.646
47	0.027	-1.006	1.007	-1.007	199.755	3.219
47.5	0.024	-0.897	0.898	-0.898	199.386	2.854
48	0.021	-0.764	0.765	-0.765	199.139	2.619
48.5	0.015	-0.543	0.543	-0.543	199.153	2.664
49	-0.001	0.043	0.043	0.043	199.622	3.176
49.5	-0.024	0.9	0.9	0.9	200.505	4.084
50	-0.042	1.561	1.561	1.561	201.453	5.065
50.5	-0.054	2.011	2.012	2.012	202.265	5.918
51	-0.063	2.336	2.337	2.337	203.007	6.694
51.5	-0.068	2.543	2.544	2.544	203.734	7.445
52	-0.07	2.612	2.613	2.613	204.412	8.128
52.5	-0.068	2.524	2.525	2.525	204.978	8.677
53	-0.061	2.281	2.282	2.282	205.372	9.03
53.5	-0.05	1.874	1.874	1.874	205.533	9.13
54	-0.034	1.283	1.284	1.284	205.405	8.93
54.5	-0.014	0.51	0.51	0.51	204.971	8.436
55	0.011	-0.407	0.408	-0.408	204.325	7.766
55.5	0.029	-1.075	1.075	-1.075	203.635	7.073
56	0.036	-1.331	1.332	-1.332	202.995	6.44
56.5	0.037	-1.362	1.362	-1.362	202.413	5.87
57	0.036	-1.323	1.323	-1.323	201.872	5.335
57.5	0.034	-1.27	1.27	-1.27	201.355	4.82
58	0.032	-1.208	1.208	-1.208	200.863	4.327
58.5	0.031	-1.135	1.135	-1.135	200.396	3.859
59	0.028	-1.05	1.051	-1.051	199.961	3.423
59.5	0.026	-0.953	0.953	-0.953	199.572	3.036
60	0.022	-0.836	0.836	-0.836	199.27	2.743

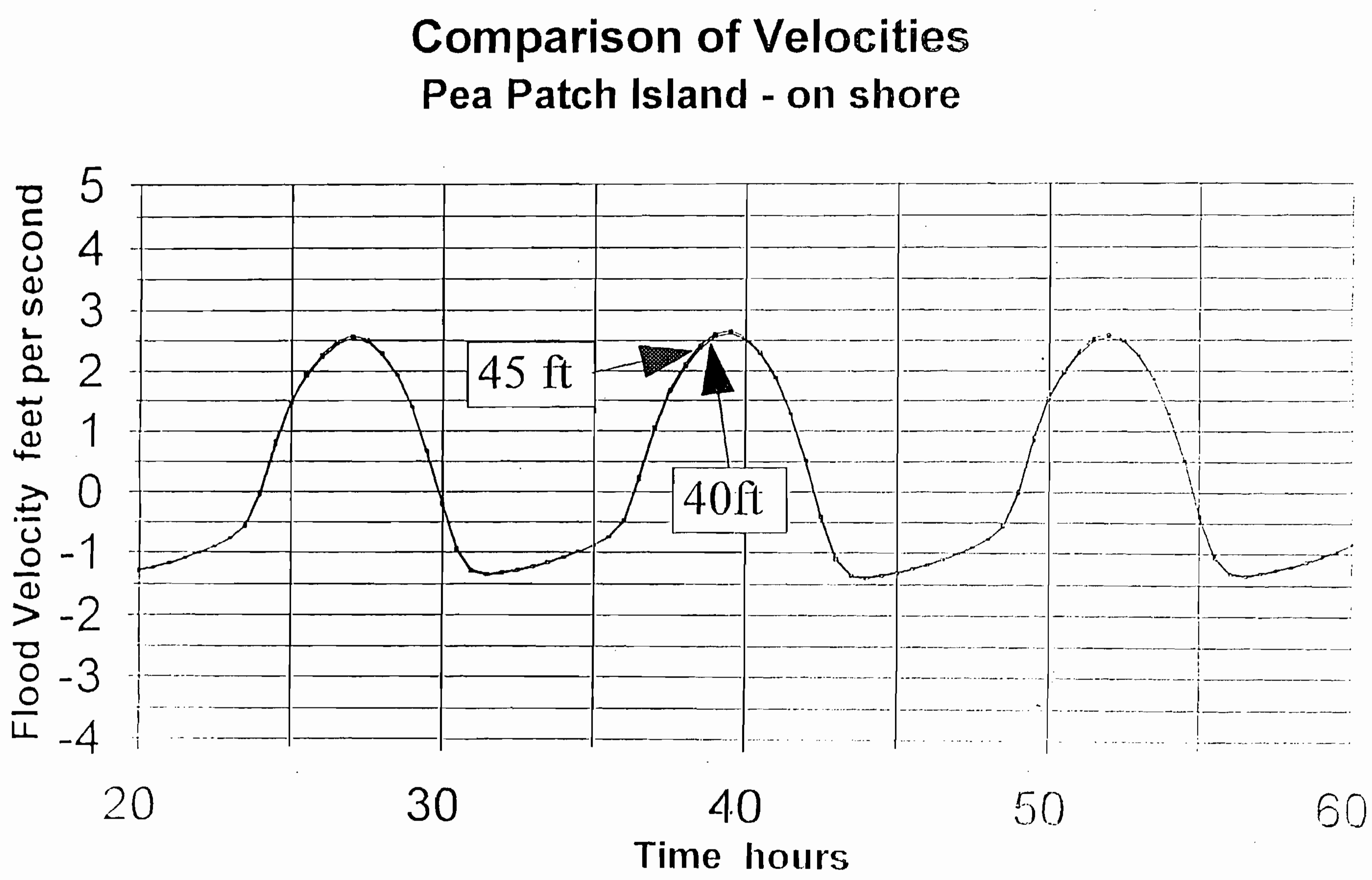

Comparison of Velocities
Pea Patch Island - on shore
Flood Velocity feet per second
5
4
3
2
1
0
-1
-2
-3
-4
45 ft
40ft
20
30
40
50
60
Time hours

Figure 2.

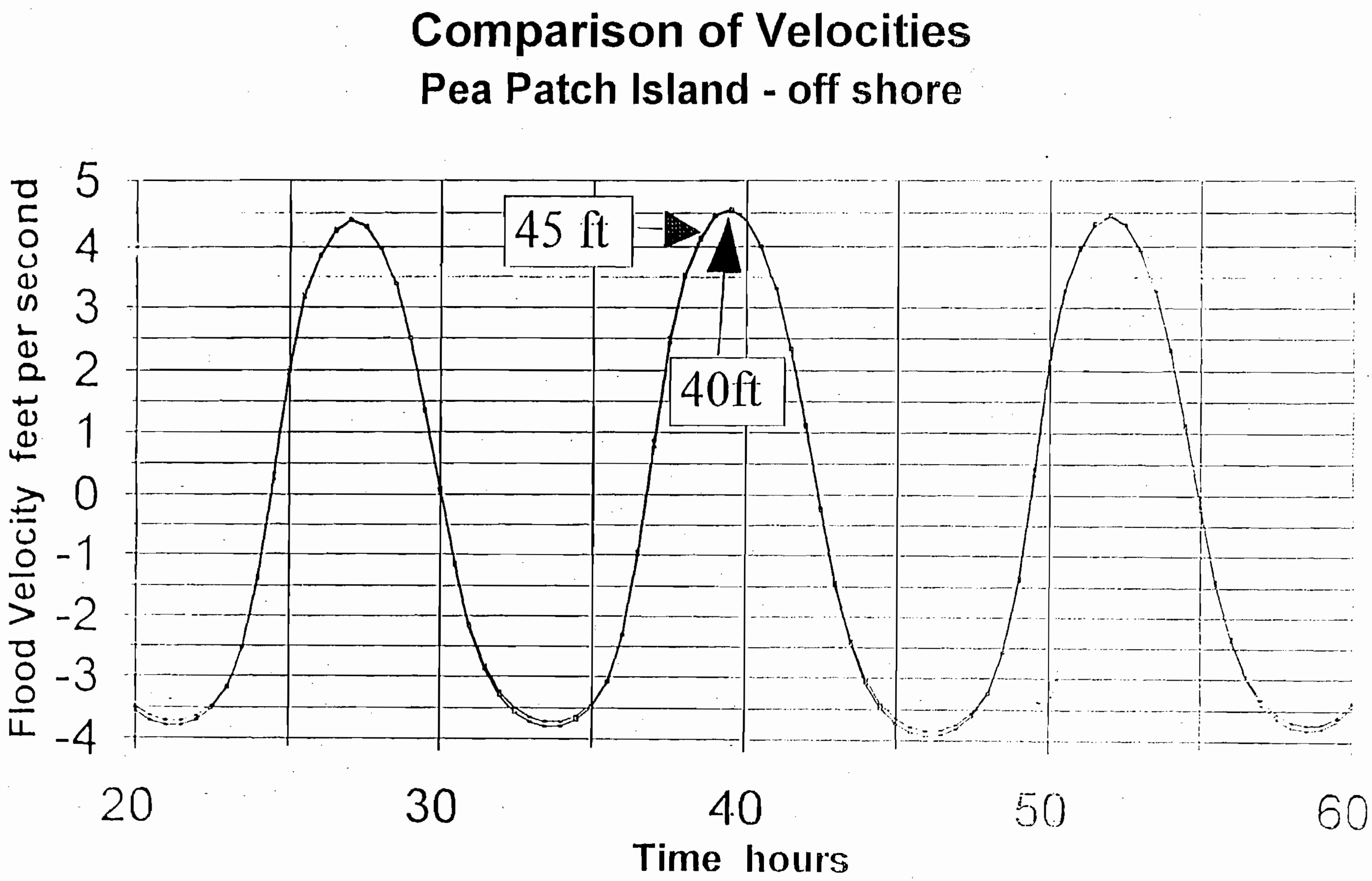

Comparison of Velocities
Pea Patch Island - off shore
45 ft
40ft
Flood Velocity feet per second
5
4
3
2
1
0
-1
-2
-3
-4
20
30
40
50
60
Time hours

Figure 3

NODE 1325

VELOCITY DIFF, 40 VS 45 FT CHAN

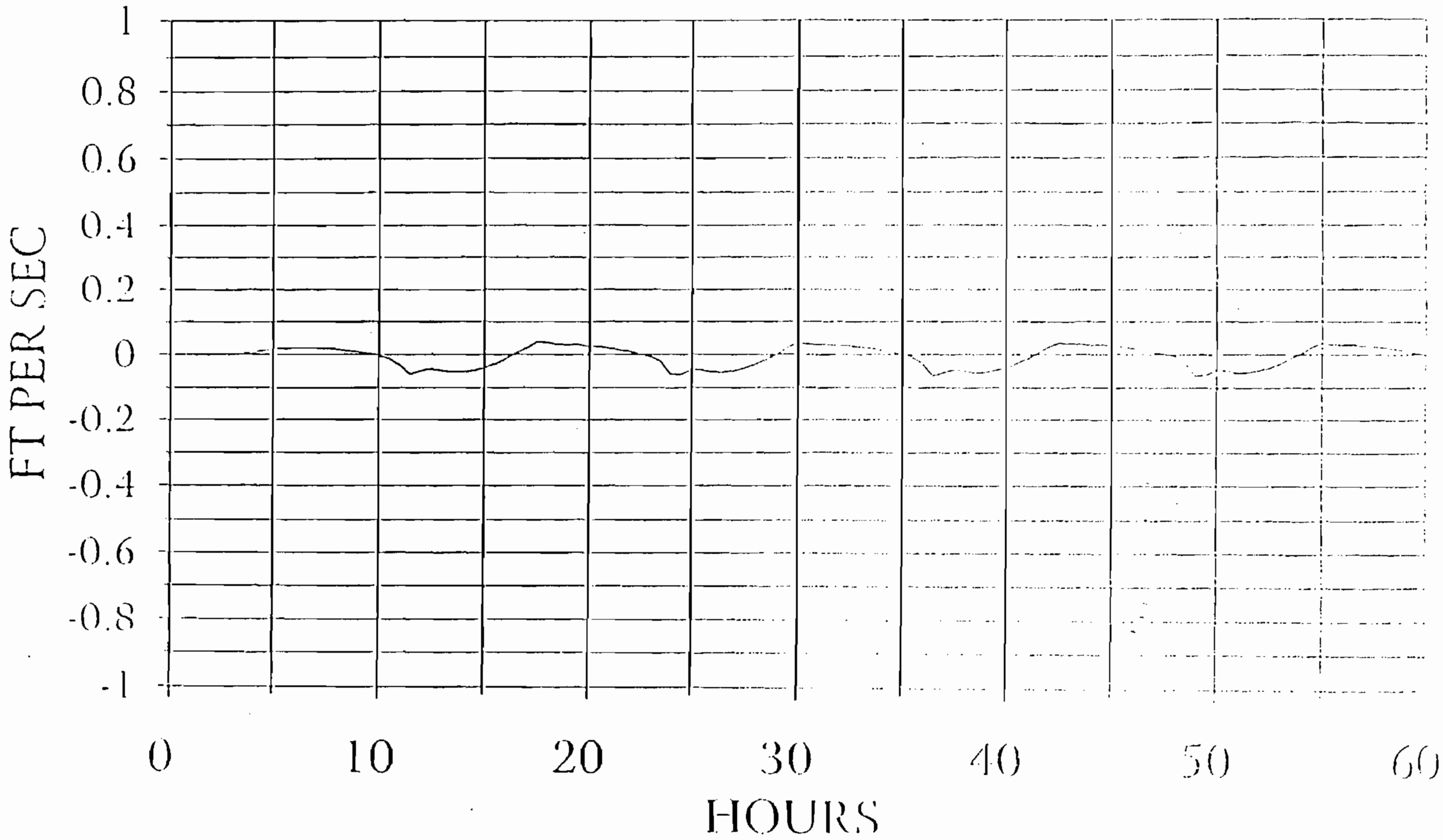


Figure 4.

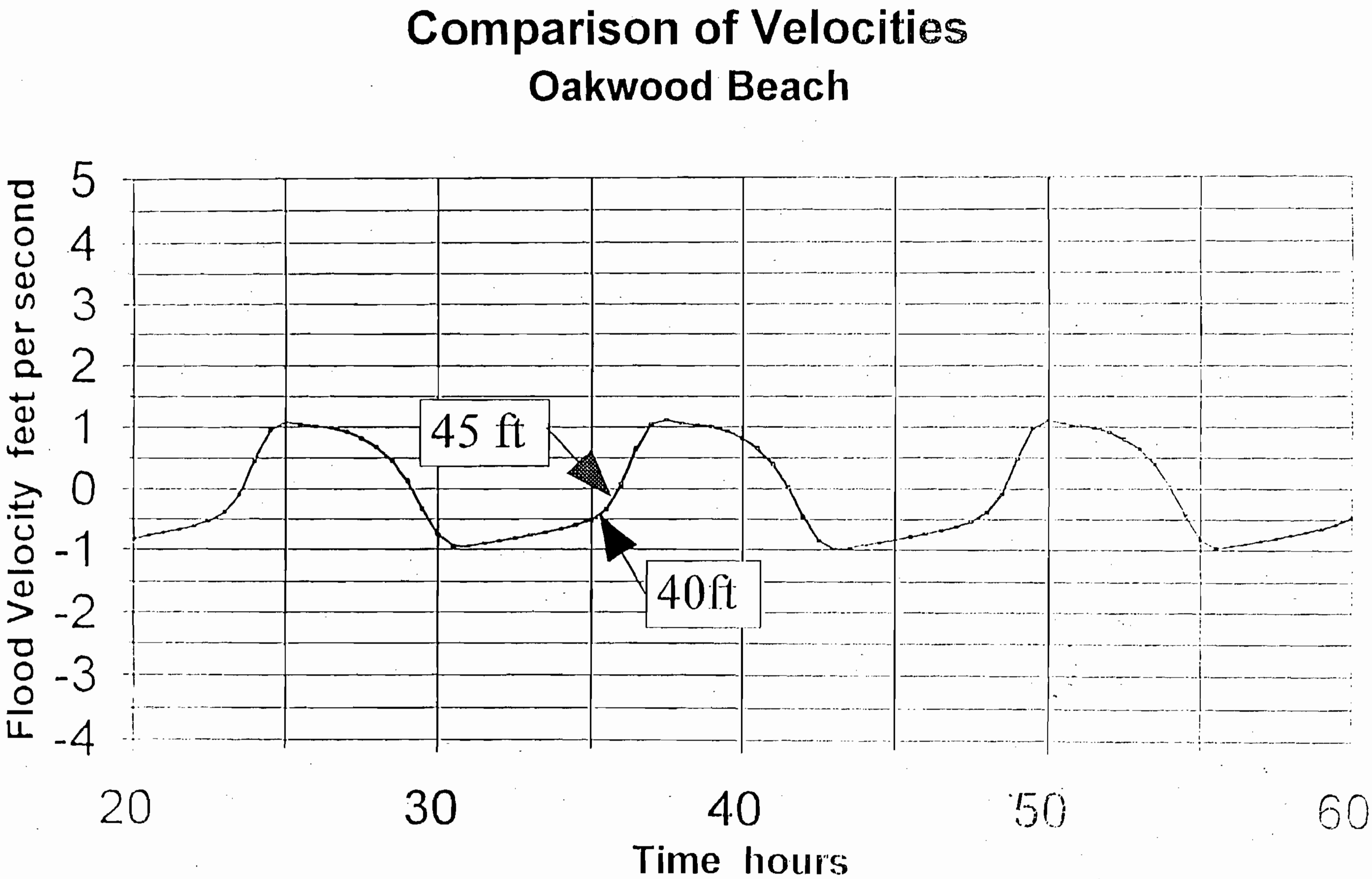

Comparison of Velocities
Oakwood Beach
Flood Velocity feet per second
5
4
3
2
1
0
-1
-2
-3
-4
45 ft
40ft
20
30
40
50
60
Time hours

Figure 5

Comparison of Velocities
Elsinboro Point

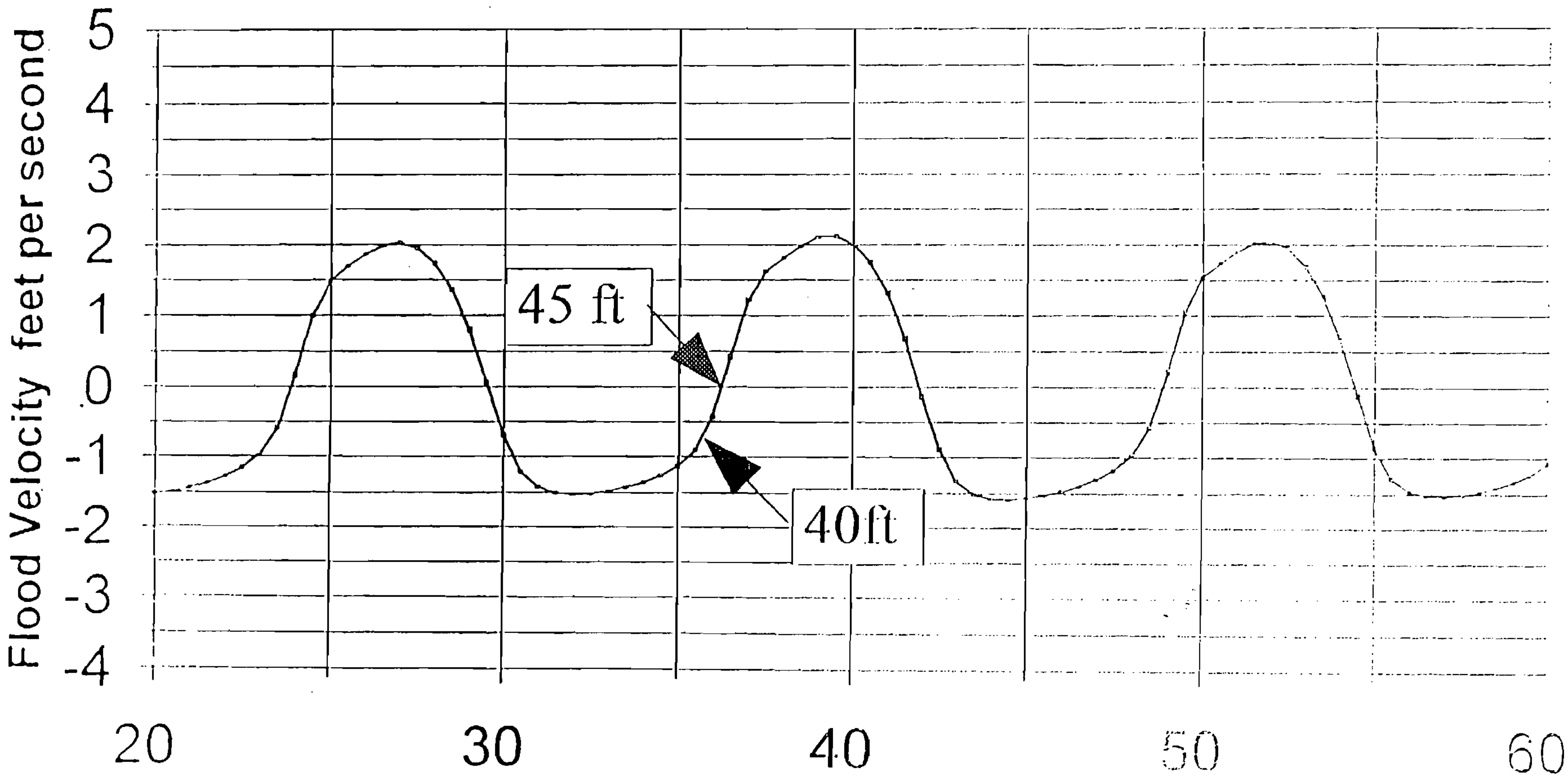


Figure 6

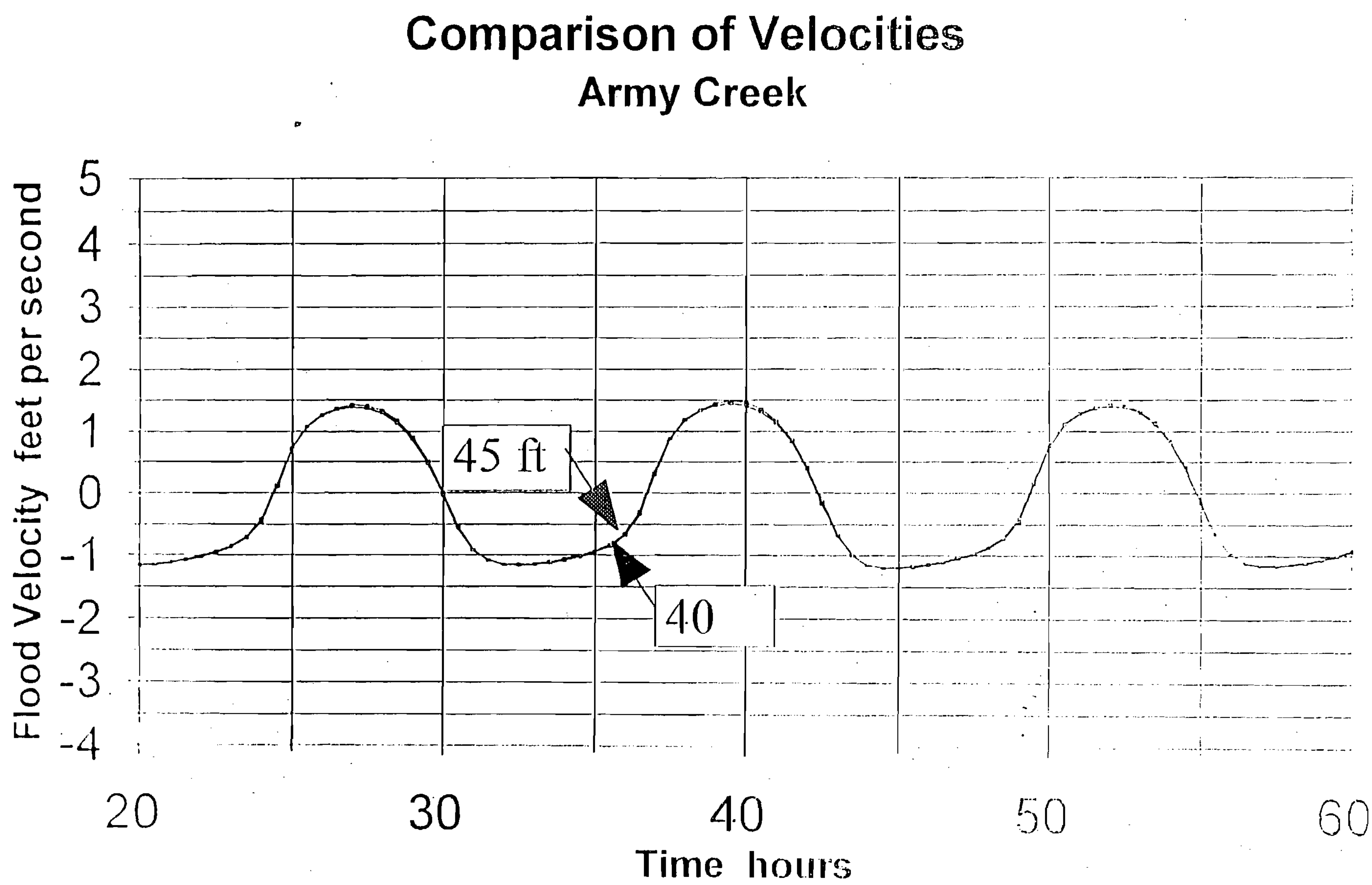
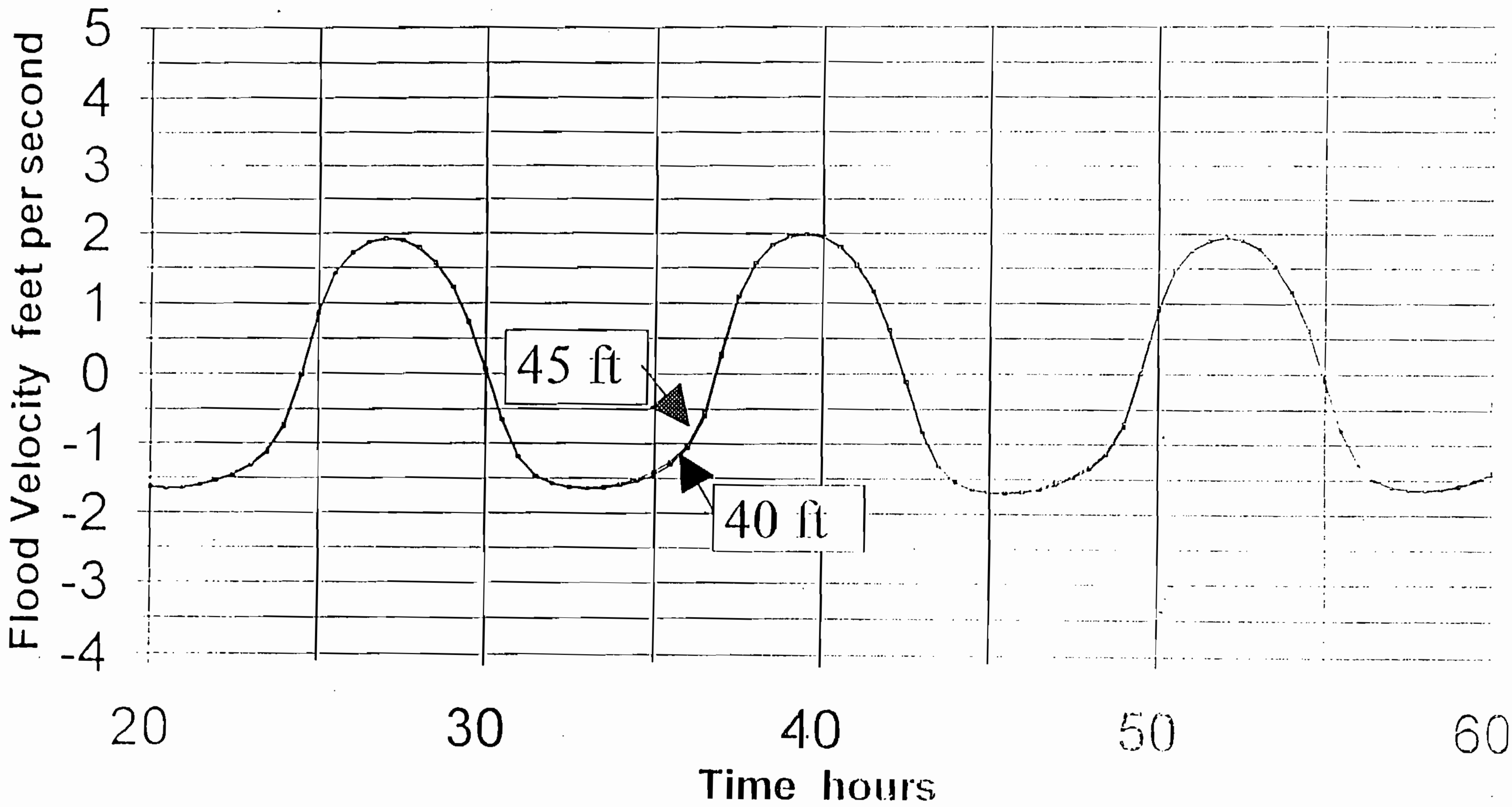

Comparison of Velocities
Army Creek
Flood Velocity feet per second
5
4
3
2
1
0
-1
-2
-3
-4
45 ft
40
20
30
40
50
60
Time hours

Figure 7.

Comparison of Velocities
Kelly Point



DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Corps of Engineers Responses
To
Letters Received
On
Final Supplemental Environmental Impact Statement
Dated July 1997

U.S. Army Corps of Engineers, Philadelphia District

CENAP-PL-E
6554/am
25 FEBRUARY 1998
BRADY
PASQUALE
LULEWICZ
KAMPER
GUARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Michael E. Riska
Executive Director
Delaware Nature Society
Ashland Nature Center
P.O. Box 700
Hockessin, Delaware 19707

Dear Mr. Riska:

This is in reply to your letter dated August 29, 1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997. The concerns stated in your letter are addressed in this report. Specifically, impacts of dredged material disposal on horseshoe crabs is discussed in Sections 3.3.2.7 and 9.1.5; on sport fisheries in Sections 9.1.5 and 9.2.4; on shellfish beds in Sections 8.3 and 9.3; and on groundwater supplies in Section 7.0. Impacts to shortnose sturgeon are discussed in Section 10.4.2 and 10.5.2. An evaluation of the project under the Clean Water Act is presented in Section 1.2. The impacts of blasting to remove bedrock is discussed in Section 13.0. An evaluation of sediment quality of the dredged material is presented in Section 4.0.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

The project will benefit the State of Delaware by providing clean sand material from the Delaware Bay portion of the project to be used for nourishing of nearby beaches. Also, using dredged material a wetland restoration project will be constructed at Kelly Island in vicinity of Port Mahon. A plan has been developed to contain the erosion process and to create intertidal habitat. The deepened channel will reduce the magnitude of lightering operations that normally occur on a regular basis in the Delaware Bay and the related environmental risks that accompany this operation. Indirect economic benefits in terms of jobs, wages and revenues will also accrue during construction of the project.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and interest in this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

DELAWARE NATURE SOCIETY

ASHLAND NATURE CENTER
(HEADQUARTERS)
P. O. BOX 700, HOCKESSIN, DE 19707
(302) 239-2334
(302) 239-2473 FAX

ABBOTTS MILL NATURE CENTER
R.D. 4, BOX 207, MILFORD, DE 19963
(302) 422-0847
(302) 422-1849 FAX

August 29, 1997

John Brady
Planning Division, Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Brady:

The Delaware Nature Society respectfully requests that a public hearing be held on the proposed Delaware River Main Channel Deepening Project by the Army Corps of Engineers before huge sums of public monies are spent on the project. As you know, the project proposes to dredge the main channel of the Delaware River from the Camden/Philadelphia area to Cape May. The concerns of the Delaware Nature Society are as follows:

- Disposal of dredge spoils both underwater and on land may threaten, horseshoe crabs, sport fisheries, shellfish beds, and groundwater supplies.
- Issues affecting the federally endangered Short-nosed Sturgeon have not been adequately addressed.
- The project does not meet the standards of the Clean Water Act.
- The project will require blasting of subaqueous bedrock off Claymont with deleterious effects on fish, shellfish, benthic organisms, waterfowl, and wading birds.
- Dredging will redistribute bottom sediments, including PCBs and heavy metals, and resuspend silt and toxic substances in the water column.
- The project will cost $300 million with little economic benefit to Delaware.

Thank you for the opportunity to comment on this project. Please do not hesitate to call at (302) 239-2334 if you have any questions.

Sincerely,

Michael E. Riska

Michael E. Riska
Executive Director

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. George S. Roof, Secretary/Treasurer
Delaware Taxidermist Association
359 Cypress Branch Road
Magnolia, Delaware 19962

Dear Mr. Roof:

Thank you for your letter dated September 29,1997 concerning comments on the Delaware River Main Channel Deepening Project.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and interest in this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Delaware Taxidermists Association

359 Cypress B... oad
Magnolia D... 962

George Donahue, President
John Mizic, Vice President
George Roof, Sec./Treasurer

September 29, 1997

US Army Corps of Engineer, District- Philadelphia
Attn: Mr. John Brady
100 Penn Square East
Philadelphia, PA 19107-3390

Mr. Brady,

Re the Dredging Project scheduled to remove sediment from the headwaters of the Delaware Bay and dump them along the Delaware Coast at Slaughter Beach. Our organization is deeply concerned and vehemently opposed to such actions. This is absolutely a case of a dog not soiling its bed, but unconcerned on soiling someone elses.

About 25% of our taxidermy business directly relates to the bays and estuaries of this state. The striped bass populations are just beginning to recover and the sea trout have again reappeared in numbers equalling those of the early 1970's. Slaughter Beach and the Broadkill slough, areas your office intends to use as a dump, are especially fertile fishing grounds for the lower Delaware peninsula.

If an environmental impact study was ever given anything other than a bureaucratic waiver, it would surprise me. It is especially galling for only avenue of political relief to be negated by such nefarious actions. If, but for a moment, you remove your business hat, would you feel any different were this situation reversed?

This decisions impact will have a devastating impact on commercial and recreational fishing, waterfowl, and recreational watercraft. In our strongest plea, we ask for public hearings on the issue. One day, you will retire. What do you intend to do if the individual who replaces you, decides to dump his refuse in the lot next to your house?

Sincerely

Gene Roof

George S. Roof, Secretary/Treasurer, DTA
359 Cypress Branch Road
Magnolia DE, 19962
(302) 697-9606

CENAP-PL-E
6554/am
25 FEBRUARY 1998
BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Peter S. Martin
Delaware Wildlands, Incorporated
315 Main Street
P.O. Box 505
Odessa, Delaware 19730-0505

Dear Mr. Martin:

This is in response to your letter dated September 25, 1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

As part of the existing Federal Navigation Channel Project, the District is consulting with Delaware on measures to combat erosion of Pea Patch Island.

Regarding the Kelly Island project, it is correct that, to our knowledge, projects of this nature have not been attempted in an environment such as the Delaware Bay. In particular, wetland restoration projects have not been constructed using the proposed volume of dredged material in an environment with the wave energy and water level fluctuations of the Delaware Bay.

Your comment on the Corps' statement about the geotextile tube groins is correct. However, the success of the Kelly Island project does not depend on the performance of the geotextile tubes. The recommendation to use the geotextile tube groins was based on our uncertainty in the prediction of longshore sand transport. We estimated that about 35,000 cubic yards of sand could potentially be transported from the Kelly Island site without groins and the design is based on that value. In case the transport is significantly higher than predicted after construction, the groins would be initially present to prevent sand from leaving the area too rapidly. The groins would provide sufficient time to take appropriate actions for modifications to the project or alterations in maintenance plans. If the transport is at or below 35,000 cubic yards per year, then the groins are just an extra element in the project design.

We expect sand that is transported away from the project to remain close to the shoreline based on the fact that natural pockets of sand can be found along the shoreline. That is, the sand does not appear to move into deeper water. This would limit its effect on the benthic communities except in the areas very near the shoreline. If our estimates of bank erosion are accurate, then the bay bottom near the shoreline is relatively new considering that erosion is causing the bank line to recede at an estimated 20 feet per year, so that many of the benthic communities that would be impacted are relatively recent in origin. Another consideration is that if one mile of shoreline erodes 20 feet and the bank is five feet high, a total of 19,000 cubic yards of material will be released into the bay per year. This sediment is finer than sand and will stay suspended longer creating higher turbidity over a larger region. If one considers the many miles of eroding shoreline in the Delaware Bay and the total volume of sediment contributed from normal erosion into bay waters, the potential input of material from the Kelly Island project is minor.

The Port Mahon Feasibility Study is independent of the Delaware River Main Channel Deepening Project and must be justified independently, or on its own merits (i.e. benefits must outweigh costs) as required by Corps of Engineers regulations. The Port Mahon plan would utilize sandy material from selected portions of the existing 40-foot Delaware River channel as a sand borrow source. The proposed use of the existing Delaware River Navigation Channel as a sand borrow source was selected to minimize disturbance to undisturbed potential sand sources in the Bay. The Final Port Mahon Feasibility Report further clarifies that the Kelly Island feature proposed as part of the Delaware River Main Channel Deepening Project would have no adverse or beneficial effects on the Port Mahon shoreline regardless of whether or not the Kelly Island site is constructed. The selected plan at Port Mahon follows the Council on Environmental Quality guidelines for the National Environmental Policy Act (NEPA) as they relate to plan formulation and development.

It is correct that the Port Mahon and the Kelly Island projects will introduce sediment "beyond the present input" to the system, because there is essentially no input of sandy sediment to the system at present. This deficit of sediment contributes to the existence of the highest rate of shoreline and wetland erosion of any location in Delaware Bay. Kelly Island and Port Mahon have experienced shoreline retreat rates over at least the past century which average between 15 and 20 feet per year. Along 5,000 lineal feet of Port Mahon shoreline, a retreat rate conservatively averaged as 15 feet per year results in the loss of 3.44 acres of wetlands per year, or approximately 344 acres of wetlands in the past century. Thus the 300 plus acres of shallow estuarine habitat adjacent to the Kelly Island and Port Mahon project areas have been created over 100 years at the expense of 300 plus acres of wetlands. If no action is taken, at Kelly Island in particular, this conversion of wetlands to shallow estuarine habitat will continue into the future. There are many other locations within Delaware Bay where erosion is presently causing shoreline retreat and loss of wetlands, and creating new shallow estuarine habitat. However, there are no locations where wetlands are experiencing a natural net gain. Therefore, the combined impacts of the Port Mahon Project and the Kelly Island Wetland Restoration Project will not have a significant adverse impact on the shallow water habitat of Delaware Bay.

It is not correct to say that there was no quantitative analysis used to evaluate the benthic communities. Twelve potential sites were compared to background conditions in the Delaware Bay to determine any particular attributes that would assist in the beneficial use site selection process. The candidate sites were evaluated on the basis of four attributes: (1) physical characteristics, (2) presence of "unique" species, i.e., species which were not collected at other sites or in the surrounding Delaware Bay, (3) presence of commercially or recreationally important species, and (4) condition of the benthic macroinvertebrate community. This data is presented in Section 8 of the FSEIS. Based on field testing, no significant differences were found between any candidate site and background conditions in Delaware Bay that would preclude its selection as a beneficial use site. As a result, it was concluded that no significant impact will occur to either the diversity or overall populations of benthic resources due to the use of any of these sites as either wetland restorations or sand stockpiles.

The resource agencies mandated the dredged material from the Delaware Bay portion of the channel deepening project be used for beneficial use purposes such as wetland creation/protection, beach nourishment, etc. Typically the normal least cost disposal option would be for the dredged material be disposed adjacent to the navigation channel. Obviously, this option does not meet the objectives of the beneficial use of dredged material. Various areas were screened for beneficial use of dredged material considering economic and environmental data. Our economic analysis concluded that the least costly beneficial use option would be to protect the wetlands at Kelly Island and Egg Island Point and sand stockpile material in the vicinity of Broadkill and Slaughter Beaches in the State of Delaware.

Concerning Pea Patch Island, the Philadelphia District evaluated the potential for increased shoreline erosion. Although the hydraulic analyses predict a slight increase of approximately 4% in wave height as a result of deepening the channel from 40 to 45 feet, the resulting impact on the present erosion rate would not be significant. A review of hydrographic data adjacent to Pea Patch Island show that the majority of channel depths are well below the depth of 45 feet. Consequently, the improved channel will not significantly affect the existing channel side-slope profiles and will not result in a movement of the Federal navigation channel closer to the island.

Nonetheless, in an attempt to avoid the potential for an adverse effect on Pea Patch Island, and to ensure the integrity of the resource, the District will be sending a Notification of Adverse Effect and requesting the comments of the Advisory Council on Historic Preservation. The District anticipates that completion of shoreline stabilization prior to the proposed Delaware River Main Channel Deepening activities will avoid or mitigate erosion impacts.

The current operation and maintenance of the existing 40 foot navigation channel, in conjunction with the failure of the shoreline seawall on Federal property, is having an adverse effect. To that end, the District is conducting an evaluation of alternatives for shoreline stabilization at Pea Patch Island in connection with the ongoing operation and maintenance of the Delaware River, 40 foot Federal Navigation Project and has met with the State of Delaware and their consulting firm to review alternative plans. The Corps has requested funds to perform this remedial work as part of the operation and maintenance of the existing 40 foot project. At this point, no funding has been appropriated to perform the necessary repairs.

Costs for development of the Kelly Island wetland restoration using dredged material are beyond the normal disposal costs. First, the dredged material from the channel is transported over a longer distance than placement adjacent to the navigation channel. Secondly, due to the wetland restoration nature of the project, the design features must take into account ecological concerns, containment and management of dredged material, and shoreline protection in order to achieve the beneficial use purposes. This requires placement of geotextile tubes, pumping of sand into tubes and construction of interior and exterior sand dikes, groins, outlet works, etc. which also adds to the project cost.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

As part of final project design, numerous meetings were held with Federal and State resource agencies and interested groups. Their input and review of completed work efforts were used in the refinement of the various features of the recommended project. A Draft Supplemental Environmental Impact Statement was prepared in January 1997. This document was made available to all resource agencies, interested groups and individuals for comment. Responses to all comments were incorporated in the July 1997 Final Supplemental Environmental Impact Statement. As a result, I believe that adequate coordination was undertaken to involve the environmental groups, while following the NEPA process.

The "incidental take statement" for the endangered shortnose sturgeon was developed by the National Marine Fisheries Service (NMFS) as part of their biological opinion for Philadelphia District dredging projects. It limits the number of sturgeon that can be "incidentally taken" to three individuals before further consultation would have to occur with NMFS.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

September 25, 1997

VIA FACSIMILE
(215) 656-6543

Mr. Robert Callegari
Environmental Resources Branch
U. S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This letter contains comments regarding the report titled **Delaware River Main Channel Deepening Project; Supplemental Impact Statement, July, 1997.**

Thank you for the extension of the commenting period. I found the review task extremely cumbersome due to the difficulty in locating changes from the previous document (Draft SEIS dated January, 1997). The PCOE could facilitate future endeavors of this type by identifying all changes and/or additions from previous documents of the same title.

I will direct my comments to the same concerns and your responses to those concerns that I expressed in my letter of March 11, 1997 (included in Appendix D of the subject report).

Request for Public Hearing

Your comment regarding a request for a Public Hearing directed me to your responses to Representative Shirley A. Price. In light of the current (September, 1997) situation, your response is misleading and not accurate and certainly not objective (a NEPA requirement). Indeed substantial interest has been expressed in holding Public Hearings. Delaware Mobile Surf Fishermen, Inc. are forwarding a petition for a Public Hearing with an excess of 1,800 signatures (personal communication). Senator Roth of the Delaware Congressional delegation has requested a Public Hearing. In addition, both Senator Bunting and Representative Shirley A. Price of the State of Delaware

315 MAIN STREET • P.O. BOX 505 • ODESSA, DELAWARE 19730-0505 • TEL: (302) 378-2736 • FAX: (302) 378-3629

Legislature have requested Public Hearings. In addition, I believe the U. S. Congress maintains final jurisdiction over this project since they must authorize release of the $200 million Federal share for this project. Senator Roth is Chairman of the Senate Finance Committee.

You also state that you met with "a number of fishing groups to discuss their concerns". I am not aware of the meetings you reference. The only meeting in Delaware was held on July 10 at the University of Delaware College of Marine Studies, Lewes, Delaware. As far as I am aware only two fishing groups received Army Corps invitation to this meeting, and your invitation requested that these two groups "limit" attendance. A notice of this meeting provided by DNREC appeared in the Wilmington News Journal on the morning of July 10 (Wilmington is over 90 miles from Lewes, Delaware) and in a Lewes newspaper (Cape Gazette) on July 11, 1997---one day after the meeting. It should be noted that the PCOE and DNREC participants in this meeting contributed to around one-third of the attendees. A considerable portion of the meeting was concerned with the significance of the meeting. <u>None</u> of the attendees, including DNREC, were satisfied with the PCOE explanations. This meeting had <u>no legal standing within the NEPA procedures.</u> It was at this meeting that Senator Bunting requested a Public Hearing and an administrative assistant to Senator Roth announced that Senator Roth would request a Public Hearing.

You also state "The purpose of this Supplemental EIS is to reaffirm conclusions...". NEPA 1502.2, however, states, "Environmental impact statements shall serve as the means of assessing the environmental impact of proposed agency actions, **RATHER THAN JUSTIFYING DECISIONS ALREADY MADE."**

Once again, I request a Public Hearing.

<u>Pea Patch Island</u>

My personal communication with the Delaware SHPO indicates conflicting viewpoints. It is the SHPO contention that ship wake <u>is making a significant impact</u> on the Fort Delaware historical site. A promise to resolve this conflict at a future date does not seem appropriate.

Kelly Island

On May 21-24, 1997, a Shorebird Management Workshop was conducted at Bombay Hook National Wildlife Refuge. Representatives of the PCOE and Army Corps Design Branch were present and provided a briefing of the Kelly Island project as updated in the July, 1997 SEIS. Some of my present comments reflect information presented at that meeting.

The beach created by the project greatly exceeds the beach as it appears in historical photographs. This beach will require periodic replenishment on a 7 to 10 year cycle or less if impacted by severe storms. The representative of the Army Corps Design Branch indicated the following:

1. Projects of this nature have not been attempted in environments such as the Delaware Bay. In particular, the large range of tides presents a unique design challenge.

2. The geotextile groins were at the least desirable orientation in terms of exposure to potential damage. This potential design flaw (geotextile groins) could result in failure at the least desirable time--during severe winter nor'easter storms and could result in massive loss of the created beach. This design requires re-examination and should be changed to a more structurally sound groin design.

The Kelly Island created beach will result in an estimated annual input of 35,000 cubic yards of material into the aquatic system and benthic community. Another project proposed by the PCOE involves the creation of beach at Port Mahon, an area adjacent to and south of Kelly Island. This project would result in an estimated annual input of 21,428 cubic yards of material. Cumulative annual input of material is 56,428 cubic yards. Obviously, these projects are linked ecologically in terms of impact on the adjacent benthic community. The combination of these projects represents a significant input of materials beyond the present input to the benthic/aquatic system. Failure to link the Port Mahon project and the Kelly Island project is not in conformity with NEPA as it is piecemealing of known or foreseeable projects. Neither project presents a quantitative analysis of the benthic community but rather contends that the benthic community is an abundant resource that is expanding due to rise in sea level. A DNREC benthic specialist, during the July 10 meeting at the College of Marine Studies, indicated that the benthic sampling method used in the PCOE study—bottom grabs—was inadequate to quantify benthic communities, especially in "patchy" biotic distributions. In addition, the "no significant impact" conclusion assumes that all benthic communities are nearly equal in quality and function. The "no significant impact" conclusion is not supported by any quantitative investigations.

I am somewhat perplexed by your cost benefit analysis. During the Shorebird Management Workshop, May 21-24, 1997, Mr. Brady indicated that the Kelly Island project would cost $15 million beyond normal disposal costs of the spoils utilized in the project. Copies of Section 204, Water Resources Development Act of 1992 were passed out. The implication was that the $15 million project cost would be generated under this provision of PL 102-580. Our experience in purchase of tidal wetlands along the Delaware Coast yields an average price of $500 per acre. $15 million would purchase approximately 30,000 acres of tidal wetlands. This project generates only 60 acres of wetlands and 5,000 feet of beach. This is not a wise expenditure of taxpayer dollars. Your cost benefit ratio is way out of line.

Sand Stockpiles

The proposed sand stockpiles have drawn numerous adverse comments from the EPA, NOAA, and USF&WS. Recently the DCMP has withdrawn support for sand stockpiles (personal communication by letter copy). Concerns ranged from the excessive amount of material (in relation to potential beneficial use requirements) to concerns regarding adverse impact to benthic community. Neither issue has been adequately addressed by the PCOE. Further, PCOE representatives during the July 10, 1997 meeting at the College of Marine Studies in Lewes, Delaware indicated that as much as 50% of the material would migrate from the stockpile sites in a 10-year period resulting in additional destruction of adjacent benthic habitat. My previous comments regarding lack of quantitative supportive data for "no significant impact" apply.

My comment regarding the stockpiles action as a potential impediment to shoreward horseshoe crab migration was a result of personal communication with Dr. Carl Shuster, also an expert on horseshoe crabs.

Mr. Robert Callegari
Page Five
September 25, 1997

NEPA

I have received a copy of: NEPA, THE U.S. ARMY CORPS OF ENGINEERS AND DEEPENING THE MAIN SHIPPING CHANNEL OF THE DELAWARE RIVER AND BAY by James I. Dennis, III and his cover letter to the PCOE dated July 8, 1997. The document was submitted to the faculty of the University of Delaware to meet requirements for the degree Master of Marine Policy. His conclusion that the "Corps is not doing a very good job of involving environmental interest groups (NGO's) in the process" seems to ring true in light of the recent increase in adverse public comment regarding the project. I can't help but to believe that a more pro-active and timely involvement of the public and NGO's (i.e., prior to Congressional authorization) would result in a much more viable project. This is constructive criticism and should be included in "lessons learned" for development of future projects. Unfortunately, I see the PCOE committing the same errors with the Port Mahon project proposal.

Shortnose Sturgeon

How will classification of the Shortnose Sturgeon as an endangered species affect the "Incidental Take Statement" (10.5.2.4)?

Sincerely,

Peter S Martin

Peter S. Martin

PSM/ssc

CENAP-PL-E
6554/am
25 FEBRUARY 1998
BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Richard S. Fischer
President
Homeowners Association
400 East Cape Shores
Lewes, Delaware 19958

Dear Mr. Fischer:

Thank you for letters dated July 30, and September 26, 1997 on the *Delaware River Main Channel Deepening Project, Final Supplemental Impact Statement (FSEIS)*, dated July, 1997.

The Cape Shores and Port Lewes beaches are located to the east of the Delaware River and Bay Authority's Cape May-Lewes Ferry Terminal breakwater and is outside the area identified in the Roosevelt Inlet-Lewes Beach, Delaware Interim Feasibility Study. However, a technical analysis conducted at the end of the study concluded that no Federal project in the area, including the Inner and Outer Harbor of Refuge Breakwaters and the Roosevelt Inlet jetties, has caused adverse impacts (ie. erosion) to the beaches in the Breakwater Harbor area.

With regard to the proposed Delaware River Main Channel Deepening Project, the placement of sand material to a specific area is primarily driven by the availability of an adequate sand source located within a close proximity of a given beach community. Considering the transport distance and associated environmental impacts, our economic analysis indicated that the least cost option is to place sand material at the two selected sand stockpile areas (Broadkill and Slaughter) for subsequent use in beach nourishment.

However, during the review of the draft Supplemental Environmental Impact Statement for the Delaware River Main Channel Deepening Project, concerns were raised about potential impacts to bottom dwelling organisms at the sand stockpile locations. As a result a re-evaluation of this project feature to place the sand directly on Delaware Bay beaches without sacrificing the economic or environmental integrity of the project was made. Indications are that with a cost increase, the sand material designated for the stockpiles can be placed directly on Delaware Bay beaches with no significant environmental impact. The beach placement plan would be finalized as part of the Plans and Specifications for this channel segment of the Deepening Project, and we can review your request for beach placement at that time.

Thank you for your comments and interest in this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Homeowners Association

400 East Cape Shores • Lewes, DE 19958
(302) 645-1992 • Fax 302-645-9761

September 26, 1997

Mr. Robert L. Callegari, Chief, Planning Division
Environmental Resources Branch
Department of the Army
Corps of Engineers-Philadelphin District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

RE: Omission of the public beach at Cape Shores and Port Lewes from the Corps' Bay Dredging EIS and Feasibility Study of erosion cause by federal breakwaters

Dear Mr. Callegari:

This letter is a follow-up to my July 30 correspondence on behalf of the Cape Shores Homeowners Association and Port Lewes Association of Condominium Owners regarding the Delaware River Main Channel Deepening Project Draft and Supplemental Environmental Impact Statement for the Delaware River, dated January 1997 and July 1997 respectively.

In that letter we requested you consider the public beach in front of our communities (located in the Breakwater Harbor between the Cape May- Lewes Ferry and the Delaware State Park) as a "beneficial use area" for the initial project and the maintenance dredging. As part of the justification of that request, I noted that the sand starved condition of the public beach bordering our property is caused by the interruption of the southward littoral flow of sand resulting from the Ferry breakwater. This is only partially correct.

Now an August 15, 1997-report in the ***Cape Gazette*** regarding the Corps' feasibility study to reverse the erosion of Lewes' Delaware Bay beaches appears to corroborate our own findings which reveals that federally constructed breakwaters are major factors responsible for the erosion and sand starved condition of our beaches.

While we are pleased that the dredging project will create an opportunity for beach nourishment, and that the Corps' study has identified that Federal navigation projects at Lewes are the primary cause of the shore problems on Lewes' beaches, we are extremely concerned that the mile long stretch of public beach next to Cape Shores and Port Lewes has been ignored in both Corps studies as a potential beneficiary. Moreover, neither study appears to provide any justification for such discrimination against this section of beach. The purpose of this letter is to bring this omission to your attention, ask for the inclusion of the public beach at Cape Shores and Port Lewes in any beach nourishment and remedial activities undertaken by the Corps, and encourage you to treat this beach in the same manner as the other beaches which Federal navigation projects have adversely affected.

As you consider our concerns, we ask that you keep the following factors in mind:

- The mile long beach is a public resource near two private developments that have an estimated $90 million property value.
- The beach is strategically situate, bordering Cape Henlopen State Park and providing direct beach access to the magnificent junction of the Delaware Bay and the Atlantic Ocean.
- It is an important breeding ground for horseshoe crabs and therefore a critically important location for migratory birds that feed on them and their eggs.
- Perhaps what is most important, the beach is eroding at an alarming rate because Federal navigation projects are obstructing the natural flow of sand.

Again, we would appreciate your consideration of the omission of the public beach at Cape Shores and Port Lewes from two recent federal studies and ask that you treat them in the same manner as other affected beaches as potential beneficiaries. If we can be of any help, or you need further information, please do not hesitate to call us at (302)645-1992.

Respectfully yours:

Richard S. Fischer, President
Cape Shores Homeowners Assn.

cc: Governor Thomas R. Carper
Lt. Governor Ruth Ann Minner
Senator William V. Roth, Jr.
Senator Joseph R. Biden
Congressman Michael N. Castle
Senator Robert J. Voshell
Representative John R. Schroeder
Mayor George H.P. Smith
T. Pratt, DNREC
D. Lemmon, Port Lewes

Homeowners Association

400 East Cape Shores • Lewes, DE 19958
(302) 645-9751 • Fax 302-645-9761

July 30, 1997

Mr. Robert L. Callegari, Chief, Planning Division
Environmental Resources Branch
Department of the Army
Corps of Engineers - Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

Thank you for sending us the Draft and Final Supplemental Environmental Impact Statement for the Delaware River Main Channel Deepening Project dated July 1997. We have read both voluminous reports completely. It seems to us that the Statement has been well prepared and presented leaving no addressable questions unanswered.

I am President of the Cape Shores Homeowners Association and have been asked by the Port Lewes Association of Condominium Owners to reply to the Statement. Cape Shores is a single family residential community of two hundred and twenty-two (222) lots and Port Lewes is an adjoining condominium community, on our western property line, consisting of one hundred and twenty units (120) units. We are beachfront communities on Delaware Bay situated between the Cape May Lewes Ferry and Cape Henlopen State Park in Lewes Delaware. The combined property values including the improvements are more than ninety million dollars ($90,000,000.). Our beach frontage is more than one mile.

The public beach in front of our communities is eroding at an alarming rate, so much that we are in fear of losing our property. The sand starved beach condition is caused by the interruption of the southward littoral flow of sand by the jetty of the Cape May Lewes Ferry. The accretion of sand on the north side of the jetty attests to this problem and is evidenced by aerial photographs.

The Delaware State Legislature has identified its bay and ocean beaches as one of the State's most important natural resources and should be protected by sand nourishment. We are located south five and one-half (5-1/2) miles from the proposed two hundred and thirty (230) acre Broadkill Beach L-5 disposal site.

We would like you to designate our location a "beneficial use area" similar to Slaughter Beach and Broadkill Beach for both the initial Project and the required maintenance dredging.

The dredged material is suitable, the beach is in dire need of nourishment, we are close to the Project, and why not put the disposal material where it is really needed? It seems to us that you will have an excess of material and it would be a win situation for our communities, the State of Delaware, and the U.S. Army Corps of Engineers.

Please telephone us at (302)645-1992 if we can be of any help, if you have any questions, or write us at 400 East Cape Shores Drive, Lewes, DE 19958.

Respectfully yours:

Richard S. Fischer
President
Cape Shores Homeowners
Association

cc: D. Lemmon, Port Lewes Association

DEC 1 8 1997

Planning Division

Honorable Michael N. Castle
Representative in Congress
J. Allen Frear Federal Building
300 S. New Street
Dover, Delaware 19904

Dear Mr. Castle:

This is in reference to your letter dated December BYSCAVAGE on behalf of Mr. Richard Fischer concerning beach erosion and placement of sand near the Cape Shores and Port Lewes beach KEYSER communities in Delaware.

Mr. Fischer's property is located to the east of the Delaware River and Bay Authority's Cape May-Lewes Ferry Terminal breakwater and is outside the study area identified in the Roosevelt Inlet-Lewes Beach, Delaware Interim Feasibility Study. However, a technical analysis conducted at the end of the study concluded that no Federal project in the area, including the Inner and Outer Harbor of Refuge Breakwaters and the Roosevelt Inlet jetties, has caused adverse impacts (i.e. erosion) to the beach in the Breakwater Harbor area.

With regard to the proposed Delaware River Main Channel Deepening Project, the placement of sand material to a specific area is primarily driven by the availability of an adequate sand source located within close proximity of a given beach community. Considering the transport distance and associated environmental impacts, our economic analysis indicated that the least cost option is to place sand material at two selected sand stockpile areas (Broadkill and Slaughter) for subsequent use in beach nourishment.

However, during the review of the draft Supplemental Environmental Impact Statement for the Delaware River Main Channel Deepening Project, concerns were raised about potential impacts to bottom dwelling organisms at the sand stockpile locations. As a result, a re-evaluation of this project feature, to place the sand directly on Delaware Bay beaches without sacrificing the economic or environmental integrity of the project, was made. Indications are that, with a cost increase, the sand material designated for the stockpiles can be placed directly on Delaware Bay beaches with no significant environmental impact. The beach placement plan will be finalized during Plans and Specifications for this channel segment of the

Deepening Project and we can review your request for beach placement then.

I hope this information is helpful for your needs. Should you have any additional questions, please do not hesitate to contact me.

Sincerely,

Robert B. Keyser
Lieutenant Colonel, Corps of Engineers
District Engineer

Copy Furnished:

Honorable Michael N. Castle
House of Representatives
1227 Longsworth House Office Building
Washington, DC 20515-0801

CENAD-PA
CENAP-DE
CENAP-PAO
CENAD-ET-P
DAEN-CWZ

MICHAEL N. CASTLE
DELAWARE, AT-LARGE

COMMITTEES:
BANKING AND FINANCIAL SERVICES
CHAIRMAN:
SUBCOMMITTEE ON DOMESTIC AND INTERNATIONAL MONETARY POLICY
EDUCATION AND THE WORKFORCE
VICE CHAIRMAN:
SUBCOMMITTEE ON EARLY CHILDHOOD, YOUTH, AND FAMILIES
SELECT COMMITTEE ON INTELLIGENCE

Congress of the United States
House of Representatives
Washington, DC 20515–0801

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DOVER, DE 19904
(302) 736–1666 (KENT)
(302) 856–3334 (SUSSEX)

delaware@hr.house.gov
www.house.gov/castle/

December 5, 1997

Lt. Colonel Robert B. Keyser
Commander, Philadelphia District
United States Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Colonel Keyser:

Recently, I was contacted by a constituent Richard S. Fischer, President of the Cape Shores Homeowners Association regarding his concern about beach erosion along the public beaches in Breakwater Harbor at the Cape Shores and Port Lewes beachfront communities.

According to Mr. Fischer, the beach erosion along Cape Shores and Port Lewes is the result of two federally funded breakwaters located at the mouth of the Delaware Bay. I understand the Army Corps of Engineers(ACOE) has done a feasibility study to reverse beach erosion on western Lewes beaches, but nothing has been studied concerning Cape Shores and Port Lewes beaches. Can you please inform me of any measures the ACOE is currently reviewing to decide whether Cape Shores and Port Lewes beaches are being considered for sand nourishment or other remedial activities as part of the Delaware River Main Channel Deepening project?

As you know, several other issues have the potential to be negatively impacted by beach erosion in this area. The Cape Henlopen area has been a longtime breeding ground for horseshoe crabs and serves as a feeding stop for migratory birds. Without the appropriate amount of sand along the beachfront, the horseshoe crabs may have some difficulty in breeding and in turn impact the migratory bird population. Many other areas are impacted by this issue as well, including tourism, housing and recreation.

I would appreciate your reviewing this situation and letting me know whether the Cape Shores and Port Lewes beachfront areas are being considered for beach nourishment along with other areas in the Breakwater Harbor. Please forward all correspondence on this issue directly to Kate Johnson of my staff at 300 S. New Street, Dover, DE 19901.

Thank you in advance for your help and cooperation with this request. I look forward to hearing from you in the near future.

Sincerely,

Mike Castle

Michael N. Castle

cc: Mr. Richard S. Fischer, President, Cape Shores Homeowners Association, 400 East Cape Shores, Lewes, DE 19958

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Don Kirchhoffer
New Jersey Conservation Foundation
Project Manager
Bamboo Brook
170 Longview Road
Far Hills, New Jersey 07931

Dear Mr. Kirchhoffer:

Thank you for your letter dated August 28,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

A management system will be developed that will provide wetland habitat on portions of all of the four new disposal areas (including 15D and 15G), and is described in detail in Section 3.2.3 of the SEIS. An additional 372 acres of adjacent undeveloped area that includes some high quality fresh water tidal marsh (including portions the nationally and state significant areas) will be purchased and maintained in its natural state. These actions will enhance the nationally and state significant tidal wetlands adjacent to disposal areas 15D and 15G.

Concerning runoff from site 15G to Oldmans Creek, the sediment load will be monitored and controlled in order to meet all State of New Jersey effluent standards. Sediment load will be controlled by elevating the ponding level within the disposal area during disposal of dredged material. The elevated water levels create an increased retention time for the slurry, allowing sediment to settle to the bottom and remain within the confined disposal facility (CDF). Excessive silt laden discharges into Oldmans Creek is not allowed by New Jersey Department of Environmental Protection regulations, nor is it the practice of the Philadelphia District to operate the CDFs in this manner.

Pertaining to the toxicity of the dredged material and its effect on plant and animal species, the District concurs with your recommendation for monitoring of the dredged material as they are discharged into sites 15G and 15D. Specifically, the Philadelphia District of the U.S. Army Corps of Engineers and the

New Jersey Department of Environmental Protection will form a working group to develop appropriate coordinated sediment sampling and testing programs, surface water discharge monitoring plans and ground water monitoring wells.

Thank you for your comments and continuing participation in the review of this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

NEW JERSEY
CONSERVATION
FOUNDATION

August 28, 1997

Mr. Robert Callegari
Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building, 11 Penn Square East
Philadelphia, PA, 19107-3390

Dear Mr. Callegari,

The New Jersey Conservation Foundation has the following comments on the Delaware River Main Channel Deepening Project Final Supplemental Environmental Impact Statement dated 25 July 1997. Our comments are limited to the sites at the mouth of the Raccoon and Oldmans creeks.

We are concerned that the ACOE still has not adequately addressed the effect of sites 15 D and 15 G on the tidal habitat upstream of these two sites. As is documented in the ACOE and other reports these two sites are of state and national importance as resting and migratory stops for waterfowl, shore birds and raptors.

Of specific concern is the stated plan to have the runoff of site 15 G (Oldmans Creek) directed into Oldmans Creek. We propose that the runoff be redirected back into the Delaware rather than into Oldmans Creek. The effect of long term silt laden discharge into the tidal portion of the creek is unknown.

We are still not satisfied that you have addressed the toxicity of the spoils and their effect on the plant and animal species in the vicinity. We propose a periodic monitoring of the spoils as they are discharged to the site. This would allow corrective action be taken if your assumptions about the levels of contaminants in the dredged material are incorrect.

Because of the proximity of two outstanding habitats so close to proposed sites 15 D and G, it is extremely important that the construction of the sites be done according to specifications. We propose the employment of an independent environmental firm to monitor all construction while in progress.

We appreciate the opportunity to comment on this project.

Sincerely,

Don Kirchhoffer
Project Manager

Bamboo Brook, 170 Longview Road, Far Hills, New Jersey 07931 908-234-1225 Fax 908-234-1189

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6554/am
25 FEBRUARY 1998
BRADY JP
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BURNES JAB
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Maya K. Van Rossum
Delaware Riverkeeper Network
P.O. Box 326
Washington Crossing, PA 18977-0326

Dear Ms. Van Rossum:

Thank you for your letters dated August 21, September 5, and September 8,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

As part of the hydrodynamic and salinity model development, workshop meetings were held to scope out the work efforts and to solicit input and review of completed efforts. Agencies and experts in salinity modelling were invited to participate throughout the model development and review of results. At the completion of this effort, model results were made available to all participants at the workshop meetings and a summary of the results was documented in the SEIS in Section 5.0. The SEIS was distributed to all Federal agencies and to all individuals that attended our workshop meetings. As a result, through the workshop meetings and coordination of the SEIS, the data was made available for review and comment by others.

All of the four "new" upland disposal areas are former confined dredged material disposal facilities (CDF). The management and development of the new upland disposal areas which will result in portions being wetlands has been coordinated with the U.S. Fish and Wildlife Service, the Environmental Protection Agency, and New Jersey Department of Environmental Protection (NJDEP), and is supported by these agencies. The NJDEP has approved this project feature as part of their coastal zone consistency determination. The habitat that will be used for dredged material disposal has been described as "mostly poor quality wildlife habitat and that once the construction process is over habitat will be enhanced through wetlands creation in the

CDFs..." (Kerlinger, Paul. *Review of Delaware River Main Channel Deepening Project (Pennsylvania, New Jersey, Delaware), Draft Supplemental Impact Statement*. February 8, 1997). The nationally significant resources are the wetland/upland complexes that surround these areas, 372 acres of which will be protected by this project.

It is true that these proposed disposal areas provide considerable habitat value as they are, as described in Section 6.3 of the FSEIS; however, these areas are needed to construct and maintain the project. By implementing the management system that will provide wetland habitat on portions of the disposal areas, by purchasing an additional 372 acres of adjacent undeveloped area that includes some high quality fresh water tidal marsh, and maintaining this area in its natural state, and by restoring 135 acres of intertidal wetlands at Egg Island Point, the overall wetland/wildlife value in New Jersey will be improved.

During discharges of effluent into Oldmans and Raccoon Creeks, the sediment load will be monitored and controlled in order to meet all State of New Jersey effluent standards. Sediment load is simply controlled by elevating the ponding level within the disposal area during disposal of dredged material. The elevated water levels will create an increased retention time for the slurry, allowing sediment to settle to the bottom and remain within the confined disposal facility.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

August 21, 1997

Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari,

I am writing with a preliminary set of comments from the Delaware Riverkeeper Network on the Delaware River Main Channel Deepening Project Supplemental Environmental Impact Statement dated July 1997.

Once again the Army Corps of Engineers has released a massive document, inches thick, and is expecting individuals, organizations and agencies to read, comprehend, digest and respond to the document with comments in only 30 days. This is unacceptable and rises to the level of denying public comment by making the task an almost impossible one. We request that the Corps extend the comment period regarding this very important and controversial project.

We also, again, request that the Corps hold a public hearing to discuss the project and the most recent SEIS. The Corps claims that because this project is not "controversial" a hearing is not warranted. This is clearly a faulty conclusion and characterization. The Main Channel Deepening project is highly controversial. Individuals throughout the watershed are concerned about the ramifications of this project on the River, water quality, the salt line, wetlands, uplands, aquatic species to name a few. The Corps claims that only 1 state representative, 7 organizations and 3 individuals requested a public hearing.

- The Corps fails to recognize that organizations such as Riverkeeper should not be considered as single entities – they represent whole, and large, constituencies. Riverkeeper alone has well over 2,000 members, a large number of which have expressed concern about the proposed dredging project and relief that we have been involved in the comment process.

- The Corp fails to note that the Delaware Department of Natural Resources and Environmental Control requested a hearing.

Tel: 215-369-1188 **Fax:** 215-369-1181 **E-mail:** drkn@libertynet.org **WWW:** http://www.libertynet.org/~drkn
DELAWARE RIVERKEEPER NETWORK, P.O. BOX 326, WASHINGTON CROSSING, PA 18977-0326
An American Littoral Society Project

- The Corps fails to note that each of the comment periods for the recent SEIS' have been so short that they have discouraged the public from actually attempting to participate in the process and issue comment (Riverkeeper only heard about the extension of the last comment period when it was ¼ to ½ over – hardly providing us the ability to take advantage of extra time given.)

Hearings held in 1993 and/or more recently with local organizations but without widespread notice of the meetings do not rise to the level of providing adequate opportunity for public input on the recent Corps findings and proposals regarding the project and found in the latest SEIS documents.

Once again, we demand that the Corps hold a public hearing regarding this matter providing enough time for interested individuals to properly review and consider the SEIS that has been issued.

At this time we also want to point out that Corps responses to comments given to the previous SEIS are sorely inadequate and unresponsive. By way of example:

- Riverkeeper's expressed concern that the Corps has failed to make the data used to support the argument that the proposed dredging activities will not impact the River's salt line available to others (including other experts and agencies) for review, consideration and comment.

- The Corps' response fails to acknowledge this point. It simply states that its present model is more accurate that other models used in the past (a point disputed by other experts) and that the SEIS presents a summary of what they believe to be the model's most significant findings. They do not offer to make the underlying data actually available to others for review and analysis. The Corps has clearly ignored the comment and failed to respond appropriately – i.e. to make the underlying data available for review, consideration and comment by others.

Riverkeeper hopes to be able to provide additional comment on this SEIS. Unfortunately, the short comment period is greatly inhibiting our ability to properly and honestly do so.

Respectfully submitted,

Maya K. van Rossum
Delaware Riverkeeper

RIVER KEEPER

September 5, 1997

Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari,

I am writing with some additional comments from the Delaware Riverkeeper Network on the Delaware River Main Channel Deepening Project Supplemental Environmental Impact Statement dated July 1997.

While we appreciate the Corps extending the comment period an additional 30 days we still demand that a public hearing be held on the proposed project – a hearing where full and comprehensive presentations, including recorded testimony, are given to an audience of <u>all</u> the stakeholders and affected community. Hearings held to date have been limited to specific communities with testimony on a limited number of issues, depriving all participants information about the varying public perspectives, findings, questions and information. It is important that hearings be held where all interested parties are able to attend, speak and listen.

In this set of comments we would like to discuss some of the wetlands issues raised by the project. The Corps response to previous comments made regarding to the wetlands issues from Riverkeeper and others have been either unresponsive or dismissive.

Our laws are written to protect wetlands for a reason, because they are essential for a healthy environment. Our laws, environmental health, and communities all demand that our country's wetlands be protected – this protection takes precedence over an environmentally unsound and economically indefensible project. Corps arguments to the contrary remain unpersuasive.

According to the SEIS the project is going to disturb and destroy valuable wetlands habitat in the Delaware River watershed. The Corps justifies this wetlands destruction by stating that "these areas are needed to construct and maintain the project." (response to Oldmans Creek Watershed Assn comments.) What the Corps is arguing is "we need to do it therefore you have to let us do it.". This kind of rationale is meaningless and totally unacceptable.

Tel: 215-369-1188 Fax: 215-369-1181 E-mail: drkn@libertynet.org WWW: http://www.libertynet.org/~drkn
DELAWARE RIVERKEEPER NETWORK, P.O. BOX 326, WASHINGTON CROSSING, PA 18977-0326
An American Littoral Society Project

The Corps also justifies destruction of some of the wetlands by characterizing them as "poor quality". Wetlands have value for water quality and wildlife; they exist in locations where the environment deems they are needed; once damaged or altered their future is uncertain. Wetlands, regardless of our characterization, must be protected in their natural state. What criteria lead the Corps to the characterization of "poor quality"? For the environment, water quality and wildlife any wetlands is better than no wetlands.

The Corps discusses creating wetlands to mitigate for the ones that will be destroyed. The jury is still out on whether or not wetlands creation really works. Until we know for sure that wetlands restoration projects are successful, we cannot risk destroying the few wetlands that remain on this gamble.

On a number of occasions, a number of organizations and individuals have questioned the Corps about how and why wetlands of national and international significance can be (and are being) destroyed by this project. The Corps response is always the same: we will be mitigating the destruction with creation elsewhere, we are not really destroying those wetlands, we will actually be enhancing the wetlands, in total there will be a wetlands quality gain in the watershed. After reading all of the comments, the SEIS's, and the Corps' responses, we still do not feel the Corps is being truly responsive to the wetlands issues and concerns being raised. The fact of the matter is that the SEIS itself states that hundreds of acres of wetlands will be destroyed and/or impacted by this project. The fact is that many of these have received national and international recognition. In one place we would like to see a comprehensive explanation for why the Corps feels this wetlands destruction is acceptable, appropriate and legal (and simply saying that other agencies are generally supportive is not going to cut it) and why destruction of these wetlands will not adversely and irreversibly impact water quality, wildlife and habitat along the Delaware River.

Respectfully submitted,

Maya K. van Rossum
Delaware Riverkeeper

RIVER KEEPER

September 8, 1997

Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari,

I am writing with some additional comments from the Delaware Riverkeeper Network on the Delaware River Main Channel Deepening Project Supplemental Environmental Impact Statement dated July 1997.

The Corps has not been clear about the sediment controls to be used during the dredge spoil dewatering process.

We are concerned about how the Corps plans to ensure that excessive sediment loads are not discharged into Oldmans Creek as the result of the dewatering process.

Excess sediment loadings and associated water quality issues are already a large problem for the Delaware River and its tributary streams.

If excessive sediment is discharged during (or as the result of) dewatering on an incoming tide the sediment will be pushed up Oldmans Creek clouding the waters, impacting aquatic habitats, carrying associated toxics, and generally adversely impacting the Creek's water quality.

The SEIS does not adequately address this issue or explain the strategy for dealing with it.

Respectfully submitted,

Maya K. van Rossum
Delaware Riverkeeper

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An American Littoral Society Project

CENAP-PL-E
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25 FEBRUARY 1998

BRADY
PASQUALE
LULEWICZ
KAMPER
NARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Leah L. Roedel
DR&BS Council
1212 Foulk Road, Apt. 1D
Wilmington, Delaware 19803

Dear Ms. Roedel:

Thank you for your letter dated August 25,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Section 404(r) is a portion of the Clean Water Act, 33 USC 466 et seq. It exempts Federal projects from obtaining a water quality certification if the project has been authorized by Congress, and an environmental impact statement, that includes an evaluation of the Section 404(b)(1) guidelines, has been submitted to Congress before the actual discharge of dredged or fill material in connection with the construction of the project and prior to either authorization or appropriation of funds for the project. These conditions were met with the submission of the final EIS in February, 1992 and subsequent authorization in October, 1992 as part of the Water Resources Development Act of 1992. The Section 404(r) waiver was concurred in by the U.S. Environmental Protection Agency in their comment letter dated March 17, 1997. A copy of this letter is attached.

The Final SEIS also documents that (Section 4.0), based on field sampling and subsequent data analysis, no significant impacts to the aquatic ecosystem are expected from dredging and the disposal of dredged material. None of the sediment samples taken revealed significant levels of contaminants. The fine-grained material from the industrial northern portion of the project area will be placed in upland, confined dredged material disposal facilities, away from the river. The sediment toxicity data from this project was reviewed by the Corps of Engineers' Waterway Experiment Station, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine

Fisheries Service, the New Jersey Department of Environmental Protection, the Delaware Department of Natural Resources and Environmental Control, and the Pennsylvania Department of Environmental Protection. The U.S. Environmental Protection Agency in a letter dated 17 March 1997 stated that "....EPA continues to believe that there will be no adverse impacts associated with the disposal of sediments generated by the project". In addition, in their letter of 12 September 1997, the U.S. Environmental Protection Agency stated that "... we have concluded that the proposed project would not result in significant adverse environmental impacts; EPA has no objection to the implementation of the proposed project." Neither the U.S. Department of the Interior (parent agency of the U.S. Fish and Wildlife Service) in their letter of September 11, 1997, nor the U.S. Department of Commerce (parent agency of the National Marine Fisheries Service) in their letter of September 29, 1997, have expressed any concern about contaminants in the dredged material. Furthermore, the Commonwealth of Pennsylvania and the states of Delaware and New Jersey have reviewed the sediment data as part of their coastal zone management consistency review. Each concluded that this project was consistent with the Coastal Zone Management Act.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Attachment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

MAR 17 1997

Robert L. Callegari, Chief
Planning Division
U.S. Army Corps of Engineers
Wanamaker Builder
100 Penn Square East
Philadelphia, PA 19107-3390

Class: EC-2

Dear Mr. Callegari:

The Environmental Protection Agency (EPA) has reviewed the draft supplemental environmental impact statement (SEIS) for the Delaware River main channel deepening project. This review was conducted in accordance with Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609 12 [a] 84 Stat. 1709), and the National Environmental Policy Act. Since the proposed project would affect both EPA Regions II and III, this letter incorporates the results of both Regional Offices' reviews of the draft SEIS.

This project is being proposed in response to Congressional Resolutions; the Army Corps of Engineers (ACE) is seeking an exemption from the Section 404 permitting requirements, pursuant to Section 404(r) of the Clean Water Act. Under Section 404(r), the requirement to obtain a Section 404 permit is waived provided information is presented in an EIS to demonstrate that the effects of the discharge of dredge and fill materials, including consideration of the Section 404(b)(1) Guidelines, were evaluated. With this in mind, this comment letter includes EPA's evaluation of the project's consistency with the Section 404(b)(1) Guidelines.

In 1990, the ACE proposed to widen and deepen the existing Delaware River shipping channel. Under that proposal, the ACE would have dredged a total of 50.1 million cubic yards (CY) of material, with the channel requiring 6,156,000 CY annual maintenance dredging. Based on a review of the project's draft EIS, EPA raised environmental concerns regarding incomplete sediment analysis, designation of several environmentally sensitive disposal sites, and inadequate information on public water supply wells. The ACE coordinated closely with EPA to correct these deficiencies and to ensure that our concerns were addressed in the final EIS. As a result, a comment letter on the final EIS withdrew our objections, based on the ACE commitment to comprehensively evaluate a variety of environmental issues and prepare site-specific environmental assessments for the upland disposal sites, as part of the preconstruction, engineering, and design (PED) phase of the project. The draft SEIS discusses the results of the completed PED studies.

The current federal channel depths restrict efficient use of both present and future tankers, dry bulk carriers, and container vessels. The recommended plan of improvement involves deepening the existing navigation channel from 40 to 45 feet below mean low water (MLW), with an allowable dredging over-depth of one foot. The modified channel would follow the existing channel alignment from Delaware Bay to Philadelphia Harbor and Beckett Street Terminal, Camden, New Jersey, with no change in channel widths. The plan also includes channel bend widenings, as well as partial deepening of the Marcus Hook Anchorage to 45 feet.

The ACE now proposes to dredge 33.4 million CY of material, plus 229,000 CY of rock, a reduction from the original proposal. The 45-foot channel would require approximately 6,007,000 CY annual maintenance dredging. In the riverine portion of the project area, dredged material would be placed in upland disposal sites. A portion of the dredged material from the Delaware Bay section of the project has been designated for beneficial use purposes; the rest of the material would go to the existing open water site, Buoy 10, near the mouth of the Bay.

An interagency meeting was held by the ACE on February 7, 1997, to answer outstanding questions about the project, and to present additional information. Based on our review of the document and the information obtained at this meeting, we offer the following comments.

Much of the dredged material from the Delaware Bay portion of the project area was designated for beneficial use purposes. In particular, wetland restoration sites have been proposed at Kelly Island, Port Mahon, Delaware, and at Egg Island Point, New Jersey. The tidal marshes in these areas had been impacted by severe erosion. The proposed plan would dispose of the dredged material behind a berm to allow the re-establishment of the salt marsh (Egg Island Point) or to manage the area as an impoundment for waterfowl (Kelly Island). Approximately 225 acres of mostly subtidal habitat would be restored to intertidal habitat.

Since the release of the draft SEIS, additional sampling of channel sediments reveal a significant decrease in the amount of silt that would be available for the Kelly Island restoration site. Specifically, the quantity of silt has been reduced from approximately 1 million cubic yards (CY) to 200,000 CY, with a concomitant increase in the amount of sand. Based on this change in available material, the ACE designed a new site plan which was presented at the aforementioned interagency meeting. The design plan creates a sand berm using one geotextile tube to enclose the site. The sand berm will provide more horseshoe crab habitat than the original design.

Based on our review of this plan, it is unclear if the Kelly Island site is to be managed as an impoundment or tidal marsh. We would prefer that it be managed for salt marsh restoration, as that would provide more valuable wetlands and coastal aquatic functions and values. It is also not clear if the ACE, the U.S. Fish & Wildlife Service (USF&WS), or the Delaware Department of Natural Resources and Environmental Control will be managing water levels. The final SEIS should include a management plan for the new site design clarifying the environmental resource management objectives for the site, identifying the responsible agency, and containing a project schedule to achieve the stated goals.

Results of modeling show that there are no expected impacts on oyster survivability or growth during normal or storm conditions except possibly at Kelly Island during the month of August. The final SEIS should include a contingency plan that will address repairs to any breach or potential breach at the Kelly Island site. With regard to the Egg Island Point site, we have no concerns regarding its use as a wetlands restoration site. It is understood that the ACE will implement a monitoring plan for both sites to prevent impacts to nearby seed and leased oyster beds. EPA requests the opportunity to review the operation and maintenance manuals, which will include the monitoring plans.

The other beneficial use of the dredged material would be the nourishment of Slaughter and Broadkill Beaches in Delaware. The material would be placed in stockpiles less than 0.5 miles from shore. This stockpiled sand will be made available for beach nourishment purposes when the situation permits. Sand that migrates from the stockpile sites will move predominantly shoreward, providing nourishment for the beaches.

The draft SEIS contains a thorough analysis of the benthic assemblages and the impacts of the project on these resources. Both the Slaughter Beach and Broadkill Beach benthic communities would be affected in the short- and long-term by use as sand stockpile sites. The area of bay bottom and its benthic communities that will be impacted is approximately 730 acres. The Broadkill Beach site will change from a muddy sediment habitat to a coarse sand habitat. At both sites, benthic assemblages will be buried from emplacement of dredged material. If the areas are used for future beach nourishment projects, the repeated disturbances could result in long-term impacts. The ACE prepared a feasibility plan in September 1996 for shore protection for Broadkill Beach that included beach fill. The final SEIS should address the placement of dredged material directly on Broadkill Beach. This would reduce the amount of material to be stockpiled, and eliminate the need for the double handling of material and its associated environmental impacts. If this is not feasible, other opportunities for beneficial uses should be explored, including direct placement of sand on beaches for shore protection, or placing more sand at the wetland restoration sites.

The draft SEIS states that dredged material from the Delaware River would be disposed of in existing federal disposal areas, along with four proposed disposal sites, all of which are located in New Jersey. Approximately 396 acres of wetland, dominated by Phragmites australis, will be impacted on the four sites by the disposal of dredged material. In order to minimize impacts to wetlands/wildlife habitat in the upland dredged material disposal areas, the ACE has developed a management plan, in conjunction with the New Jersey Department of Environmental Protection (NJDEP). Part of the plan entails dividing each of the four new disposal sites into cells and, through the use of water control structures and contouring, manipulating the variety and type of habitat that will occur. The ACE estimates a net increase from this project of 200 acres of wetlands over the life of the project as a result of the management plan. The ACE will also purchase 372 acres of high quality wildlife habitat, including some tidal marshes, which will be maintained as undeveloped land. We concur with the ACE plan for the use of the upland dredged material disposal sites.

The PED studies included follow-up sediment sampling that indicates the sediments that would be disposed of at the upland sites were compared to the NJDEP Residential, Non-Residential and Impacts to Groundwater Soil Cleanup Criteria; additional bioassay tests were performed on sediments that would be disposed of at the beneficial use sites. These tests showed no toxicity or bioaccumulation of any significance; therefore, EPA continues to believe that there will be no adverse impacts associated with the disposal of sediments generated by the project.

At the time of the draft EIS, we expressed concerns about salt water intrusion and possible impacts on drinking water quality and aquatic ecosystems. One of the PED studies was a three-dimensional hydrodynamic modeling of the Delaware Estuary to evaluate potential changes in salinity and circulation patterns. The study uses the CH3D-WES hydrodynamic model to investigate the impacts of the deepening of the navigation channel on water uses and living resources. The model was verified with one year of field data and data from the June-November 1965 portion of the drought of record. The model successfully reproduced the drought event and predicted that a maximum penetration of the salt line of from 1.4 to 4.0 miles would result from the deepened channel and a recurrence of the drought of record.

Our review indicates that the predictive capability of the model is very good. With the new channel in place, the EPA criteria for chlorides and the New Jersey standards for sodium in drinking water will not be violated in the areas of water withdrawals for municipal needs. The computed chlorinity under most adverse conditions will remain well below the current and projected Delaware River Basin Commission (DRBC) water quality standards for designated locations for natural and regulated flow patterns. Therefore, it appears that the water supply in Philadelphia, among other uses, will not be adversely affected. Also, the chlorinity standard established by the DRBC to protect the Potomac-Raritan-Magothy aquifer will not be exceeded.

Based on the model results, we concur that the predicted increases in salinity/chlorinity attributable to the channel deepening will probably have insignificant impacts to drinking water, ground water, and environmental resources.

In a related matter, the proposed project is located within the New Jersey Coastal Plain Aquifer System, which has been designated as a sole source aquifer (SSA), pursuant to the Safe Drinking Water Act (SDWA). Based on our review, we do not anticipate that this project will result in significant adverse impacts to ground water quality. Accordingly, the project satisfies the requirements of Section 1424(e) of the SDWA.

In our comment letter on the final EIS, we requested that a commitment regarding oil spill response be reflected in the Record of Decision. The draft SEIS states that a Marine Spill Analysis System has been developed by the ACE, NJDEP, USF&WS, and the Environmental Systems Research Institute. We concur that this system, and the response network in place, is adequate.

In conclusion, based on our review and in accordance with EPA policy, we have rated this draft SEIS as EC-2, indicating that we have environmental concerns (EC) about the design and monitoring plan for Kelly Island, and the stockpiling of sand at Slaughter and Broadkill Beaches. Accordingly, additional information (2), as outlined in this letter, should be presented in the final SEIS to address these issues. We concur with the Section 404(b)(1)

Guidelines analysis which states that the proposed project is consistent with the Guidelines.

I would like to commend the ACE for its extensive effort and cooperative spirit in resolving EPA's environmental concerns about the project. I look forward to our continued coordination in the subsequent phases of this project. In the interim, if you have any questions, please call Deborah Freeman, of my staff, at (212) 637-3730.

Sincerely yours,

Grace Musumeci for

Robert W. Hargrove, Chief
Strategic Planning and Multi-Media Programs Branch

cc: J. Brady, ACE

Mr Robert L Callegari
ATTN: Environmental Resources Branch
US Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

AUG 25, 1997

Dear Mr Callegari,

Thank you for sending the Final Supplemental Environmental Impact Statement for the Delaware River Main Channel Deepening Project. We regret the short time allowed for response and do wish to request a public hearing in which the public may receive an explanation of the need for the project as well as possible public benefits. We enclose preliminary comments.

The scale of the Main Channel Deepening Project is unprecedented in terms of volume of dredge material to be removed. In our opinion this constitutes a burdensome impact on the Delaware River Basin; it's waters, it's shorelines, it's historical and natural resources.

We are dismayed that the US Army Corps of Engineers was granted an exemption on water quality certification for this project. How could this be possible? Why should federal law be set aside in this particular case? Our immediate concern is the impending redistribution of bottom sediments including PCB's and heavy metals. This disturbance will recirculate dangerous chemicals and elements throughout the Delaware River Basin; it's natural environment, it's water, it's fish, and it's wildlife.

The Delaware Estuary has shown an outstanding recovery under the implementation of the Federal Clean Water Act. This remarkable progress has been most encouraging to residents, businesses regional and local governments who have contributed substantial public and private investments. We believe the time has come to protect and enhance our quality of life in the Delaware River Basin. We do not agree that we should declare deleterious effects to be acceptable.

We look forward toward an open public hearing within the near future where ther can be full discussion of pertinent issues.

Most sincerely yours,

Leah L Roedel

Leah L Roedel
DR&BS Council
1212 Foulk Rd Apt 1D
Wilm. De 19803

CENAP-PL-E
6554/am
25 FEBRUARY 1998

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LULEWICZ

KAMPER

MARALDO

BURNES

CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Joseph W. Turner, Co/Chair
Pennsylvania Sierra Club
Water Resources Committee
P.O. Box 723
Langhorne, PA 19047-0723

Dear Mr. Turner:

Thank you for your letters dated August 24 and 28,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

Sediment cores were collected from the seven industrial facilities and port terminals that would benefit from the Delaware River Main Channel Deepening Project. These cores were subjected to bulk sediment analyses to quantify chemical contaminant concentrations in berthing area sediments. A total of 35 sediment samples were analyzed. The results of this investigation are presented in Section 4.5 of the FSEIS. The sediment tests indicated that berthing area sediments were similar to navigation channel sediments with respect to contaminant levels. Overall, test results suggest that sediments within the seven industrial and port facility berthing areas are sufficiently clean to conclude that dredging and upland dredged material disposal operations would not result in any significant environmental impacts.

As for all Corps of Engineers projects, the 45-foot channel deepening has been subject to a very rigorous technical, economic, and environmental review. The Corps' cost-benefit analysis in the feasibility report was reviewed and approved by the Secretary of the Army and the Office of Management and Budget prior to authorization by Congress. This procedure reflects the longstanding detailed approach which characterizes Corps' studies and the standard independent review process. The benefit-cost ratio for the project is 1.4 to 1.

Each foot of additional depth adds to the competitiveness of the Delaware River ports. The Corps applied a stringent optimization approach to determine that net benefits are maximized at the 45 foot depth. Incremental benefits would continue to accrue at depths beyond 45 feet but at a lower magnitude than incremental costs.

As described in Section 3.3.3.2 of the FSEIS, the Kelly Island wetland restoration site has been re-designed, which greatly reduces the possibility of silt escaping and reaching the oyster bed areas. The amount of silt being placed in Kelly Island has been reduced from over 900,000 cubic yards to under 200,000 cubic yards. The silt will be enclosed in a containment area by a sand berm with a geotextile tube core for extra protection. The berm will not be overtopped except by the most severe storms that are only expected to occur once in 100 years. Tidal inundation will be controlled by outlet structures. The entire Kelly Island structure will be monitored, repaired and maintained, as necessary. The silt within the containment structure will be mixed with and covered by an additional 500,000 cubic yards of sand which will become vegetated and will provide an extra measure of protection. Because of all of the measures that are mentioned above, it is extremely unlikely that nearby oyster beds and lease areas in Delaware would be adversely impacted by silt escaping from the Kelly Island wetland restoration; and even more unlikely that the oyster areas in New Jersey, which are more than 4 miles away, will be impacted. Section 9.0 of the FSEIS documents the analyses performed to address impacts associated with proposed beneficial use sites. Specifically with regard to oyster resources, our analyses indicate that the predominant direction of sediment transport (essentially 100% sand) from the wetland restoration and sand stockpile sites will be landward and alongshore, away from the nearest oyster habitats.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

As part of the hydrodynamic and salinity model development, workshop meetings were held to scope out the work efforts and to solicit input and review of completed efforts. Agencies and experts in salinity modelling were invited to participate throughout the model development and review of results. At the completion of this effort, model results were made available to all participants at the workshop meetings and a summary was provided in the FSEIS. The FSEIS was distributed to all Federal agencies and to all individuals that attended our workshop meeting. As a result, through the workshop meetings and coordination of the FSEIS, the data was made available for review and comment by others.

The hydrodynamic/salinity modeling performed as part of the final project design, to date demonstrated that the predicted salinity impacts of the deepened channel are small enough to be considered negligible with respect to water quality and living resources. The FSEIS, Section 5.0, presents a summary of the findings of the hydrodynamic/salinity modeling. The modeling was performed over a period of about two years during which periodic open-invitation workshops were held in order to guide the focus of the modeling and to present results.

In addition, there is evidence from recent investigations by the U.S. Geological Survey that the present Delaware River Basin Commission chlorinity standards for River Mile 98 are overly conservative with respect to possible impacts on ground water quality in the Camden County area recharged by Delaware River groundwater. Further, there are many possible alternate drought management strategies which could be implemented to conserve basin storage for optimal repulsion of salinity/chlorinity in the vicinity of River Mile 98 during drought conditions.

The hydrodynamic/salinity modeling demonstrated the range of potential salinity impacts due to the proposed deepening under a range of conditions, including a recurrence of the drought of record, the typical "transition" period at the end of the spring high-flow period, and also "average" inflow conditions. The use of the model to address concerns regarding salinity distribution was viewed as the most appropriate approach to apply in this matter. This approach was confirmed through coordination workshops held prior to and during the conduct of the modeling. In fact, modeling is the only valid approach which permits a direct and objective assessment of salinity impacts attributable to changes such as channel deepening. Even the most ambitious pre- to post-deepening monitoring effort would not be able to unambiguously determine if observed salinity differences or oyster population changes were the result of channel deepening, or as a result of some other cause. This is in part due to the dynamic natural range in salinity at most locations throughout the estuary, and in part due to the many variables other than salinity which affect the distribution and health of the oyster population.

The knowledgeable scientific community recognizes that the existing circulation and salinity regimes of the Delaware Estuary are highly dynamic, with large changes in flow velocity, flow direction, and salinity occurring naturally in response to variations in fresh water inflow distribution, both in time and space, wind, tides, and adjacent ocean boundary salinity. These changes occur over periods as short as several hours, such as during storm events, over periods of 12.4 hours, the duration of the average tidal cycle, and over periods of seasons and years. The modeling has demonstrated over a wide range of hydrological conditions that the changes induced by channel deepening are a small fraction of the natural dynamic variability in flow and salinity for the estuary, and that no detectable adverse impacts will be associated with the proposed deepening.

The District coordinated findings from the salinity model with Rutgers University oyster researcher Dr. Eric Powell. Dr. Powell is a nationally recognized expert on oyster ecology, and concluded that the range of salinity changes predicted by the model would pose no adverse impact on oyster resources. It is our view that Dr. Powell's findings are valid and should be accepted as a reliable indicator of "no significant impact" on oysters in the Delaware Estuary. In addition, in their letter of March 17, 1997, the Environmental Protection Agency stated that their review of the model indicates that its predictive capability was very good; and that, based on the model results, concurred that the predicted increases in salinity/chlorinity attributable to the project will probably have insignificant impacts to drinking water, ground water, and environmental resources. In summary, we believe that the model is the best available tool to predict salinity changes, and additional testing/monitoring, solely for salinity, is not necessary or practicable.

Nevertheless, the Corps in cooperation with the state of New Jersey and the Haskins Shellfish Research Laboratory will develop and implement a monitoring plan to commence when construction begins, designed to examine the health and productivity of oyster populations on the natural seed beds in the Delaware Bay to confirm that the project would not significantly impact the oyster resource.

The Philadelphia District is using dredged material for beneficial uses wherever possible. Consideration of beneficial uses has been investigated by the Corps. Beneficial uses of dredged material has been recommended in the Delaware bay where most of the dredged material is sand. In the upper portion of the project area (i.e. Wilmington to Philadelphia), the dredged material contains a higher proportion of fine grained material and must be confined to prevent water quality degradation. The District is exploring alternatives to the upland disposal sites, and in some cases has been successful. For example, dredged material is being used to build a new runway at the Philadelphia International Airport. However, not all dredged material is suitable for construction because of differing physical properties.

All of the four "new" upland disposal areas are former confined dredged material disposal facilities (CDF), as described in Section 6..3 of the FSEIS. The management and development of the new upland disposal areas (See Section 3.2 of the FSEIS) which will result in portions being wetlands was coordinated with the U.S. Fish and Wildlife Service, Environmental Protection Agency, and New Jersey Department of Environmental Protection (NJDEP), and is generally supported by these agencies. The NJDEP has approved this project feature as part of their coastal zone consistency determination. The habitat that will be used for dredged material disposal has been described as "mostly poor quality wildlife habitat and that once the construction process is over habitat will be enhanced through wetlands creation in the CDFs..." (Kerlinger, Paul. *Review of Delaware River Main Channel Deepening Project (Pennsylvania, New Jersey, Delaware), Draft Supplemental Impact Statement*. February 8, 1997). The nationally significant resources are the wetland/upland complexes that surround these areas, 372 acres of which will be protected by this project.

It is true that these proposed disposal areas provide considerable habitat value as they are; however, by implementing the management system that will provide wetland habitat on portions of the disposal areas, by purchasing an additional 372 acres of adjacent undeveloped area that includes some high quality fresh water tidal marsh, and maintaining this area in its natural state, and by restoring 135 acres of intertidal wetlands at Egg Island Point, the overall wetland/wildlife value in New Jersey will be improved.

The FSEIS acknowledged that there are still contaminant problems with bald eagles and peregrine falcons in Sections 10.1.1.1 and 10.1.1.2, respectively. The USFWS has stated in their Biological Opinion that this project is not likely to adversely effect federally listed species under their jurisdiction, including the bald eagle.

The proposed project is not expected to cause additional adverse impacts to the heronry at Pea Patch Island. This is discussed in Section 10.4.3.6 of the FSEIS.

In summary, all of the issues that are mentioned in your letter have been addressed in the FSEIS, and have been considered by the states of New Jersey, Delaware, and Pennsylvania in their coastal zone management consistency determinations. Coastal zone management consistency was granted by each of the three states.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

24 August 1997

Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari,

I am writing on behalf of the Pennsylvania Sierra Club, Water Resources Committee concerning the Delaware River Main Channel Deepening Project Supplemental Environmental Impact Statement dated July 1997. Pennsylvania Sierra Club represents approximately 20,000 members in the commonwealth.

We object to the rather short time,(30 days) being given by the Army Corps of Engineers, for the review and comment period of the rather massive document produced in connection with the Delaware River Dredge Project.

We request the comment period be extended for at least an additional thirty days. You expect citizens to read, understand, and then respond within this rather short time frame. Your imposed time limit is nothing short of an attempt to limit citizen involvement.

Pennsylvania Sierra Club is concerned over the lack of public hearings to discuss the dredging and the most recent SEIS. The Main Channel Deepening project is highly controversial and, at a minimum should have hearings in each of the affected states. Citizens throughout the watershed are concerned with the ramifications of this project on the River, water quality, the salt line, wetlands, uplands, aquatic species to name a few.

Sincerely,

Joseph W. Turner, Co/Chair
Pennsylvania Sierra Club
Water Resources Committee
P.O. Box 723
Langhorne, Pa. 19047-0723
215-945-1329
jturner@voicenet.com

28 August 1997

Robert L. Callegari
ATTN: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari,

The Pennsylvania Chapter of Sierra Club, Water Resources Committee is concerned about the lack of a public hearing and the short time period given for commenting on the Delaware River Main Channel Deepening Project supplemental EIS. Your imposed time limitation is not sufficent to allow the public to review, digest and prepare useful comments on this very dense, technical and complicated document. Providing a time frame which is inadequate for allowing the public to consider and comment on the proposal at hand, here the SEIS, is essentially the same as denying the opportunity altogether. This fact is reinforced by the Delaware Estuary Program's CCMP (Action W7, page 139) wherein it states that one measure of success of dredging in the Delaware River is to have "an informed public on the continued maintenance and proposed dredging process in the Estuary." The Pa. Sierra Club believes it is imperative that the comment period be extended and public briefings and hearings be held on the SEIS. The public must have a true opportunity to participate in this public process.

At this time, we would also like to submit some preliminary comments on the SEIS.

1. Private docks and berths along the Delaware are a potential haven for toxics. Once the main channel of the Delaware River is dredged, channels to the private docks and berths will have to be dredged to accommodate the larger ships. Such action is an unavoidable consequence of the main channel deepening. Therefore the associated environmental impacts must also be studied, considered and reviewed. Without this review, the EIS and SEIS cannot be said to have fully considered all associated environmental impacts and consequences of the project.

2. The basic premise that the dredge is necessary to ensure that the Delaware River ports stay competitive with other ports on the east coast has not been adequately analyzed or supported. It seems to be a generally accepted premise, but one that is not documented. For example, what about the fact that other nearby rivers have 50 foot channels; if competitiveness is the rationale, how can we remain competitive with a 45 foot channel when other nearby ports are already at 50 feet?

3. We continue to be concerned about potential impacts to oyster beds' particularly the acknowledged possibility of impacts resulting from sand stockpiling and restoration work conducted on and around Kelly Island and Egg Island Point. While the SEIS acknowledges the possibility of long-term, adverse impacts there is not a concrete plan in place for preventing these impacts, only a promise of future monitoring and some unspecified contingency plan. we feel the Corps response to these potential impacts is unacceptable.

4. The Corps proposes to stockpile sand off shore for later reuse in beach renourishment projects. The SEIS does not adequately justify the need for stockpiling and later reuse, double-handling, which will result in repeated disturbance of local benthic communities and fisheries.

5. Pa Sierra WRC, is particularly concerned about proposed beneficial use site MS-19B to be used for sand stockpiling. The SEIS describes site MS-19B as having "one of the highest quality benthic community among the 12 potential beneficial use sites and would be expected to sustain greater impacts due to the lower recovery potential of its benthic community." The SEIS then states that in spite of this site's "species richness," and high "abundance of equilibrium species à indicative of a stable, diverse, mature community," because the background conditions of the site are not significantly different from the rest of the Bay it may still be used for sand stockpiling. Clearly this site is different from the rest of the Bay, that is why its benthic community thrives. The Corps' justification for using this site is not supportable by the evidence provided nor does it make any sense. The site is home to a healthy benthic community with a high frequency of equilibrium species. The site's benthic community would suffer long-term, perhaps irreparable, impacts if the site is disturbed for the proposed use. The site should therefore be removed from the list of beneficial use sites.

6. A significant number of agencies, individuals and organizations raised concerns during the FEIS comment period regarding the potential for alteration of the River's salt line and intrusion into upriver drinking water supplies. Through modeling the Corps has determined that there will not be any impacts to drinking water aquifers from the movement of the salt line. According to experts, the SEIS fails to provide the data which would allow others to verify the Corps' findings and conclusions. As a result, the public is unable to properly comment on this finding. Additionally, what if the Corps is wrong? The SEIS fails to provide a plan for dealing with this very real possibility.

7. Dredging the shipping channel another five feet is going to impact the circulation patterns and salinity line of the River. The SEIS indicates that these alterations will not be significant enough to impact benthic invertebrates and fish. While other agencies, that lack the expertise to make such analyses, are willing to defer to the Corps on this point with the stipulation that the Corps monitor the actual impacts in the future, we do not agree that we should be taking such a risk. We need to ensure that the data is correct before we act. Once the patterns have changed and the benthic and fish populations have reacted, fulfilling agency requests that maintenance dredging be halted and the channel be allowed to return to 40 feet will not be so easy, and it will necessarily result in another habitat alteration that will once again impact our benthic and fish populations.

11

8. Residents along the River are already subject to massive dredge spoil piles which have become home to large phragmites populations. Pedrickstown is a prime example; dredge spoils piled up 50 feet from previous dredging efforts block the town's historic view of the River. The SEIS discusses spoil piles 100 feet high. A better plan has to be laid for the dredge spoils before this project goes forward.

9. Site 15G has been designated as priority wetlands pursuant to the Emergency Wetlands Resource Act, and sites 15G, 15D and Raccoon Island have received wetlands recognition under other laws including the Clean Water Act and the NAWMP. It is wholly inappropriate, and in contradiction with our nation's environmental protection laws, to allow these sites to be used as disposal sites for dredge spoils. How can the Corps justify such action?

10. There is a contradiction between the SEIS conclusion regarding the health of bald eagle populations in the estuary as compared to the Delaware Estuary CCMP. The SEIS says the populations are doing well, while the CCMP indicates they are still being impacted by toxics, along with other important bird populations including osprey and peregrine falcons.

11. What will the impacts of the project be on Pea Patch Island and its heronry? The SEIS does not appear to address this question except indirectly by stating that no breeding areas are located in the project. The Pennsylvania Chapter of Sierra Club representing approximately 20,000 members request that the Army Corps of Engineers extend the comment period on the SEIS and hold a public hearings to allow all the residents of the watershed the time and attention needed to thoroughly review and understand the proposed project, its impacts and the SEIS.

Sincerely,

Joseph W. Turner, Co/Chair
Water Resources Committee
Pennsylvania Sierra Club
P.O. Box - 723
Langhorne, Pa. 19047-0723
215-945-1329
jturner@voicenet.com

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY

PASQUALE

LULEWICZ

KAMPER

MARALDO

BURNES

CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Vivian Newman, Chair
National Marine Wildlife & Habitat Committee
Sierra Club
11194 Douglas Avenue
Marriottsville, Maryland 21104

Dear Ms. Newman:

Thank you for your letters dated September 30,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated, July, 1997.

Section 404(r) is a portion of the Clean Water Act, 33 USC 466 et seq. It exempts Federal projects from obtaining a water quality certification if the project has been authorized by Congress, and an environmental impact statement, that includes an evaluation of the Section 404(b)(1) guidelines, has been submitted to Congress before the actual discharge of dredged or fill material in connection with the construction of the project and prior to either authorization or appropriation of funds for the project. These conditions were met with the submission of the final EIS in February, 1992 and subsequent authorization in October, 1992 as part of the Water Resources Development Act of 1992. The Section 404(r) waiver was concurred in by the U.S. Environmental Protection Agency in their comment letter dated March 17, 1997. A copy of this letter is attached.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

The FSEIS documents in detail the impacts of the specific project proposed for construction, i.e., deepening the main navigation channel of the Delaware River from its present authorized depth of 40 feet to 45 feet. The FSEIS provides a comprehensive review of all aspects of the project, including dredging and dredged sediment disposal plans, salinity and circulation changes, water quality, sediment quality, natural resources, and Endangered Species. The assessment of past and current dredging of the Delaware River and Bay has been addressed in environmental documents that were prepared for the operation and maintenance of the existing Delaware River Federal Navigation 40-foot Channel Project; the foreseeable impacts have been addressed in the Final Environmental Impact Statement (1992) and the FSEIS document. We believe that these environmental documents fulfill the requirements of the National Environmental Policy Act.

There is an existing shoreline erosion problem at Pea Patch Island which is the cumulative result of a number of causes, including sea level rise, tidal currents, wind and storm waves, ship wakes, and lack of maintenance to the seawall. It is not possible to accurately quantify the relative role of these, and perhaps other, factors in causing shoreline erosion on Pea Patch Island. We evaluated the potential increase in vessel wake heights due to deeper draft ships using the navigation channel, and found that vessel wake heights would increase on the order of 4% for design vessels operating with a five foot increase in draft, reflecting the increase in project depth from 40 to 45 feet. We do not view the impacts of increased vessel wake heights to represent a significant change compared to existing conditions, given that vessel wake is only one of many factors which contribute to the problem. However, as part of the existing Delaware River Federal Navigation 40-foot Channel Project, the District is consulting with Delaware on measures to combat erosion of Pea Patch Island.

It is true that Pea Patch Island is a Ramsar Convention site, as are many of the private and publicly owned wetlands adjacent to Delaware Bay. The sites where wetland restoration will occur, Kelly Island (Bombay Hook National Wildlife Refuge) and Egg Island Point State (New Jersey) Wildlife Management Area are both Ramsar sites. The beneficial use of dredged material will benefit these sites, as has been recognized by the states of Delaware and New Jersey, and is reflected in their issuing a coastal zone consistency determination for this project.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Attachment

SIERRA CLUB

~~730 Polk Street San Francisco, CA 94109 415 776 2211 Fax: 415 776 0350~~

Mr. John Brady, Project Manager
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

September 30, 1997

Dear Mr. Brady, Re: Delaware River Main Channel Deepening Project
Supplemental Environmental Impact Statement, July, 1997

The following comments are submitted on behalf of the Sierra Club's National Marine Wildlife and Habitat Committee and reflect our concerns about both regional and national environmental policy in relation to public participation in decisions affecting aquatic ecosystems.

We specifically call for public hearings to be held in Pennsylvania, New Jersey, and Delaware. References in the SEIS and the press point to a growing controversy over this project that can best be addressed by adhering to requirements of the National Environmental Policy Act. We would also draw your attention to recent analyses of the NEPA process by the Council on Environmental Quality that stress the importance of public involvement opportunities that go beyond the standard public hearing format and exceed legal requirements in order to improve the quality of projects and reduce impacts to the environment.

We are especially disturbed by the letter from the Environmental Protection Agency (Callegari, COE, from Hargrove, EPA, 3/17/97) that appears to waive all Section 404 reviews for this project. If our interpretation of this is correct, we protest it and request a retraction in writing.

The SEIS document fails to assess direct, secondary, and cumulative impacts from past, current, and foreseeable hydromodification projects affecting this portion of the mid-Atlantic seaboard. The impacts to fisheries, in both environmental and economic contexts, warrant considerably more attention and the use of the best science and technical tools to accomplish this assessment.

The Delaware River and Bay have a critical ecological function for our fisheries. Because the National Marine Fisheries Service has yet to publish final regulations for Essential Fish Habitat (EFH) as required under the Magnuson/Stevens Fisheries Conservation & Management Act of 1996, we request that the Corps consider these regulations as "new information" to be addressed in the public hearings.

We request that you provide due consideration to problems of shoreline erosion caused by ship wakes and sealevel rise, particularly as they would affect the historic preservation of Fort Delaware, located on Pea Patch Island in the Delaware Bay.

We also request that you explicitly recognize that Pea Patch Island and other sites in the Delaware Bay are designated Wetlands of International Significance under the Ramsar Convention. The United States Government became a signatory to the Convention in 1987, and at the Conference of Parties in Brisbane, Australia in 1996 reiterated its commitment to national action to further the Convention's mission. Moreover, the Brisbane Conference adopted new guidelines for interpreting change in the ecological character of Ramsar sites and on the importance of wetlands to fish. Yet we find no mention of Ramsar in this document

We look forward to expanded discussion of these and other topics at the public hearings.

Sincerely,

Vivian Newman

Vivian Newman, Chair
National Marine Wildlife and Habitat Committee

Reply to:
11194 Douglas Avenue
Marriottsville MD 21104

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25 FEBRUARY 1998

BRADY
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CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. William E. Craven
Chairman of the Board, Fort Delaware Society
P.O. Box 553
Delaware City, Delaware 19706

Dear Mr. Craven:

This is in reply to your letter dated August 26,1997 regarding the concern for Pea Patch Island from the proposed Delaware River Main Channel Deepening Project.

Our current design of the deepened channel in the vicinity of Pea Patch Island should not impact the Civil War era dock that is located on the east side of the island. As part of Plans and Specifications, we will further address this concern and if needed make the necessary design refinements.

The current operation and maintenance of the existing 40 foot navigation channel, in conjunction with the failure of the shoreline seawall on Federal property, is having an adverse effect on the shoreline erosion on Pea Patch Island. To that end, the District is conducting an evaluation of alternatives for shoreline stabilization at Pea Patch Island in connection with the ongoing operation and maintenance of the Delaware River 40 foot Federal Navigation Project and has met with the State of Delaware and their consulting firm to review alternative plans. The Corps has requested funds to initiate the repairs as part of the operation and maintenance of the existing 40 foot project; funding has not been made available.

I hope that this information has addressed your concerns. Please do not hesitate to contact Mr. Michael Swanda, Environmental Branch at (215) 656-6556, if you have any further questions.

Sincerely,

Robert L. Callegari
Chief, Planning Division

FORT DELAWARE SOCIETY
Founded 1950
P.O. Box 553 • Delaware City, DE 19706 • (302) 834-1630

August 26, 1997

Mr. Robert L. Callegari
Environmental Resources Branch
U. S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Ref: Delaware River Main Channel Deepening Project Final Supplemental Environmental Impact Statement, July, 1997

Dear Mr. Callegari,

On behalf of the Fort Delaware Society, I thank you for placing the Society on the mailing list to receive the subject EIS.

We are pleased to see sections of the EIS which address our concerns that were described in our comment letter of Feb. 13, 1997.

We note that the EIS acknowledges that Pea Patch Island is suffering from continuing erosion which has exposed, and continues to expose, archaeological material and foundations related to the historic military occupation of Fort Delaware. Also, the Philadelphia District is working closely with the Delaware State Parks and their contractor, S. T. Hudson Engineers, Inc., to review plans and specifications for the placement of shoreline protection and to secure funding for the work under the existing federal project. In another paragraph, it is acknowledged that higher ship generated waves resulting from deeper draft vessels could increase shoreline erosion of historic archaeological deposits.

The report states that the ship generated waves would be four percent higher than at present and this would have no significant impact on Pea Patch Island erosion. We assume that this is correct only if the shoreline of Pea Patch Island has had the present sea wall gap repaired.

We also note that the EIS states that the majority of existing channel depths adjacent to Pea Patch Island are well below the proposed new dredging depth of 45 feet, meaning only minimal new dredging in isolated high spots will occur in the vicinity of Pea Patch Island. Also, the existing channel side-slope profiles would not be significantly affected and would not result in a movement of the federal channel closer to the island. Are we correct in assuming that the remains of the Civil War era dock on the east side of Pea Patch Island will not be disturbed?

We appreciate your expansion of the EIS to include possible affects on all of Pea Patch Island, including the historic areas and the herony on the north end of the island.

The Fort Delaware Society is still concerned that a project for the placement of shoreline protection on Pea Patch Island has not yet been funded and approved. We believe the shoreline should be protected prior to the Channel Deepening Project.

Very truly yours,
for the Officers and Directors of the Fort Delaware Society

William E. Craven

William E. Craven
Chairman of the Board
Fort Delaware Society

cc: The Hon. Joseph R. Biden, Jr., United States Senator
The Hon. William V. Roth, Jr., United States Senator
The Hon. Michael N. Castle, United States Congressman
Christophe A. G. Tulou, Secretary, D. E. N. R. E. C.

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CALLEGARI

MAR 0 9 1998

Planning Division

Mr. John C. Newcomb
Maritrans, Inc.
One Logan Square
Philadelphia, Pennsylvania 19103

Dear Mr. Newcomb:

This is in reply to letter dated September 30, 1997 concerning your comments on the Final Supplemental Environmental Impact Statement for the proposed Delaware River Main Channel Deepening Project, dated July 1997.

Two documents accompanied your letter. Responses to your two documents: namely, "Comments to the Delaware River Main Channel Deepening Project-Final Supplemental Environmental Impact Statement" and the "Critique of the U.S. Army Corps of Engineers Business Plan for the Delaware River Port Authority's Ownership and Operation Of Dredge Spoils Sites-Business Plan-Environmental Issues" are attached.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Attachment

MFR: Input to responses were provided by Economics Br., Environmental Br. Civil and Structural and Geotechnical Sections. District Counsel (Barry Gale)reviewed the attached responses.

S. Lulewicz

Stan Lulewicz
CENAP-DM

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

RESPONSES

TO

COMMENTS

OF

MARITRANS, INC.

" DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT "

ATTACHMENT

1. COMMENT SECTION II. A. PAGE 3

The Corps Failed to Consider All Alternatives to the Disposal of Dredged Spoils in Wetlands Located in Southern, New Jersey Within Its Section 404(b) Evaluation for the Project.

The *Final Interim Feasibility Report*, dated February, 1992 contains a discussion of alternatives, including the "no build" alternative, as well as a Clean Water Act Section 404 (b)(1) analysis, as required. Also, alternatives to disposal of dredged material were evaluated as part of this report. The report concluded that the most viable 50-year disposal plan for the river portion of the project is to place material at upland disposal sites. Concerning disposal of dredged material in Pennsylvania abandoned coal mines, this option would be more costly over the long term 50-year period then the recommended disposal plan.

2. COMMENT SECTION II. B. PAGE 4

The Corps Overstates the Positions of the Purported Beneficiaries of the Project.

Based on interviews conducted with potential beneficiaries, it was determined that six refineries will accrue benefits if the refinery berths are deepened commensurate with the main channel. This determination involved a combination of discussions with the refineries and consideration of present and future tanker characteristics and operations for both with and without the deepened channel. The refinery, which Tosco re-opened in May 1997, is included as part of the six refineries to benefit. Tosco's discussion with the project sponsor indicated the presence of a mix of vessel sizes that currently operate at the facility. As stated in the comment, smaller vessels in its fleet will not lighter, or benefit from the channel deepening project. However, Tosco indicated that larger vessels in its fleet mix, carrying crude oil up to 1 million barrels each, will benefit from reduced lightering with the main channel deepened. Thus, Tosco will accrue benefits from the project.

3. COMMENT SECTION II. C. PAGE 6

The Corps Has Improperly Excluded Actions Which Are Part of the Project From Environmental Review in the FEIS and FSEIS.

By law, Corps of Engineers projects require a non-Federal sponsor. The Corps does not undertake studies or investigations without the request of the sponsor and the appropriation of study funds by Congress. The Delaware River Port Authority (DRPA) is the sponsor of the 45-foot Delaware River deepening project. DRPA has expressed continued interest and support for the project. The sponsor is responsible for procuring funding sources for the non-Federal share of project cost.

For many Corps projects, the sponsor coordinates with the Corps for advice on how to raise their share of the project costs. This is a normal activity that the Corps provides to the sponsor. As a result, a business plan was prepared to illustrate revenue sources that could potentially be pursued by the project sponsor, if it chose to do so. The business plan offered various options and

6. COMMENT SECTION II. F. PAGE 11

The Project Will Displace an Existing Private Wetlands Mitigation Bank and Reduce Wetland Creation in Southern New Jersey.

Regarding the private wetland banking, the proposed business plan calls for use of areas adjacent to the four proposed upland disposal sites. The private wetland banking is not included in the areas proposed for wetland banking in the business plan. Consequently, the proposed plan would not destroy or impact the existing wetland banking plan that is being developed by a private company adjacent to the proposed Site 17G. Wetland banking ventures in the State of New Jersey have been subject to a very rigorous review process that has been established by the New Jersey Mitigation Council. For the most part, wetland banking involves creation of new wetlands or restoration/enhancement of existing wetlands to be used as credits for mitigation purposes for various development projects, such as highways, etc. The business plan presents various wetland banking options and revenues that could be realized adjacent to the proposed disposal areas. All proposed mitigation plans are subject to the approval by the New Jersey Mitigation Council and may be subject to Federal and State regulatory approval. Again, this is a possible revenue source, subject to DRPA's assessment of its potential and the limitations of their compact.

7. COMMENT SECTION II. G. PAGE 13

In Analyzing Sediment Quality, the FSEIS Minimizes the Risks Posed by the Contaminants in the Dredged Spoils by Using Mean Concentrations Rather Than Actual Concentrations.

There is no mandatory protocol for evaluating sediment quality data with regard to dredging projects. There are no sediment quality criteria that must be met by Federal or State regulation. The NJDEP has been using the Residential and Non-Residential Surface Soil Standards as guidelines when evaluating bulk sediment data collected in conjunction with dredging activities. These criteria provide a point of comparison, but do not carry any regulatory weight. The Surface Soil Standards are not referenced in the NJDEP 1996 draft technical manual "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters". In addition, the 1996 manual does not outline any required procedure for evaluating sediment quality data.

The analysis presented in the FSEIS was intended to reduce a very large data set down to something that could be easily reviewed, while providing sufficient data for the reviewer to see the full picture. Means are appropriate because material dredged from a waterway is well mixed in an upland dredged material disposal site. However, means were not the only values presented. The analysis also provided the number of samples, the number of detections of each contaminant, and the concentration range of the actual detections. The Surface Soil Standards were used to provide the reviewer with a point of comparison, and because NJDEP had indicated that they used these criteria as a guide. We were not required by regulation to use these criteria, or to meet them.

8. COMMENT SECTION II. G. PAGE 13, Sub-Section 1.

The Sediment Quality Data Collected by the Corps Are Not Suitable for Compliance Averaging Under the NJDEP Guidance.

The procedure described in this section does not apply to the evaluation of sediment quality data associated with dredging activities. Dredging activities are not regulated by NJDEP Technical Requirements for Site Remediation. The procedure is not discussed in the NJDEP 1996 draft technical manual "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters".

9. COMMENT SECTION II. G. PAGE 15, Sub-Section 2

The Corps Cannot Use Compliance Averaging to Demonstrate Compliance With NJDEP Soil Cleanup Standards for Arsenic, Beryllium, Thallium, and Benzo(a)pyrene.

Again, this requirement does not apply to the evaluation of sediment quality data associated with dredging activities. Exceedances of the NJDEP Surface Soil Standards were not masked in the FSEIS. Maximum detected concentrations were presented in the bulk sediment tables.

10. COMMENT SECTION II. H. PAGE 16.

The Corps Has Agreed to Perform Additional Environmental Analysis Which Will Not Be Subject to the Required Public Review and Comment.

As previously stated, the requirements identified by Maritrans for evaluating sediment quality data associated with dredging activities are not included in the referenced draft guidance manual. The sediment quality analysis presented in the FSEIS was completed prior to the availability of the manual. It was not possible to redo the complete analysis because of a new draft guidance document. The additional sampling articulated in the Corps/NJDEP agreement is for the purpose of monitoring sediment quality and the impact of actual dredging operations associated with the existing project, and the deepening project. If the monitoring identified a problem, it would be addressed through modification of the operation. The Corps has monitored many dredging projects, and intends to continue collecting data on the Philadelphia to the Sea Delaware River (40 foot) navigation channel and its dredging operation to insure that conditions do not change in the future, which could result in unacceptable environmental impacts. This type of data collection would not be subject to NEPA review requirements.

11. COMMENT SECTION II. G. PAGE 18

The Corps Did Not Adequately Consider the Impact That Heavy Metals Present in the Delaware River Sediments Will Have on Groundwater When the Sediments Are Disposed of in a Dredged Material Disposal Facility.

Section 7 of the final SEIS indicates that the U.S. Geological Survey was tasked with performing an evaluation of potential contaminant travel times from the proposed project disposal sites to nearby drinking water and industrial production wells. The report entitled "Evaluation of Groundwater Flow from Dredged Material Disposal Sites in Gloucester and Salem Counties, New Jersey" (USGS, 1995), determined that the disposal sites would not impact local wells as the sites provide a very small percentage of well recharge and potential contaminant travel times were on the order of fifty to one hundred years.

12. COMMENT SECTION II. H. PAGE 19

The Corps Ignores Recent Data Which Demonstrates That the Delaware River Sediments Contain Significant Levels of Contaminants.

The Corps' conclusions with regard to sediment contamination and potential environmental impacts associated with dredging are based on sampling of locations within the project area. The A.D. Little study sampled locations outside of the project area. The high resolution PCB analyses conducted by Versar are a good example of the differences that can exist between the two areas (i.e., locations that are periodically dredged can be cleaner than undisturbed areas). The Versar study collected data on PCB congeners because there was no congener data for the navigation channel. The Versar study did not collect data on heavy metals, polyaromatic hydrocarbons, pesticides and their metabolites because sufficient information had already been collected to draw conclusions regarding these parameters. The FSEIS does include sediment quality data collected from channel bends and private berthing areas. These data were similar to that collected in the navigation channel. While no PCB congener data were collected, all samples were tested for heavy metals, polyaromatic hydrocarbons, pesticides and PCB arochlors.

13. COMMENT SECTION II. I. PAGE 21

The Corps Improperly Failed to Perform a Bioaccumulation Study for Sediments Dredged From Reaches A, B, C, and D.

Bioaccumulation testing is a tool that can be used to evaluate potential adverse effects of sediment contamination. This tool is not required by any regulation. The testing that was conducted, which did include bioassays throughout the project area and bioaccumulation testing in Delaware Bay, was developed based on concerns expressed by Federal and State resource agencies. Section 7 coordination, as required by the Endangered Species Act, was conducted with the U.S. Fish and Wildlife Service relative to threatened and endangered species under their jurisdiction. Based on a review of the sediment quality data, the U.S. Fish and Wildlife Service was able to conclude that the project would not likely impact the bald eagle or peregrine falcon. As such, bioaccumulation testing was not necessary.

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

RESPONSES

TO

COMMENTS

OF

MARITRANS, INC.

"CRITIQUE OF THE U.S. ARMY CORPS OF ENGINEERS BUSINESS PLAN FOR THE DELAWARE RIVER PORT AUTHORITY'S OWNERSHIP AND OPERATION OF DREDGE SPOILS SITES BUSINESS PLAN-ENVIRONMENTAL ISSUES"

1. COMMENT SECTION I PAGE 4

There Will Be A Net Loss of Wetlands In New Jersey From The Dredging Project.

As stated in our response to your comment on the draft SEIS, the management of the proposed confined upland sites has been supported by the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, and the New Jersey Department of Environmental Protection (NJDEP). Furthermore, NJDEP has indicated that this project, including the management of the new upland dredged material disposal facilities, is consistent with the Coastal Zone Management Act. Most of the existing wetlands in the proposed confined upland sites are poor quality Phragmites marsh. By implementing the management system that will provide wetland habitat on portions of the disposal areas, by purchasing an additional 372 acres of adjacent undeveloped area that includes some high quality fresh water tidal marsh, and maintaining this area in its natural state or developing it as a wetland bank, and by restoring 135 acres of intertidal wetlands at Egg Island Point, the overall wetland/ wildlife value in New Jersey will be improved.

2. COMMENT SECTION II PAGE 6

The Dredging Project Would Reduce Wetlands Creation in Southern New Jersey.

In regard to mitigation banking, the Corps is not building any mitigation banks as part of this project. The sponsor is investigating the possible use of mitigation banking on land adjacent to the proposed upland disposal sites that they will own. Before these banks are constructed, they would need to receive approval from the NJDEP, and would need to demonstrate that it is beneficial to the wetland/wildlife habitat of the area.

The proposed upland site designated as 17G is displayed on Plate 20 of the FSEIS. The site is located adjacent and riverward of the mitigation bank. This site will not reduce wetland creation in Southern New Jersey since mitigation will be done at other locations as required by state and Federal law. As mentioned above, this project will actually create a net increase in the overall wetland/wildlife value in the area.

3. COMMENT SECTION III PAGE 8

The Business Plan Proposes That Contaminated Dredged Material From The Port of New York and New Jersey Be Disposed Of In Southern New Jersey.

The Delaware River Port Authority has evaluated the viability of this option. As a result of their evaluation, they are not considering disposing out-of-region dredged material in Southern New Jersey. The disposal plan presented in the Final Supplemental Environmental Impact Statement does not recommend the use of the dredged material disposal areas for disposal of dredged material from places other than the Delaware River.

4. COMMENT SECTION IV PAGE 11

The Business Plan Improperly Relies On Revenues Associated With The Disposal Of Dredged Spoils From The Port of Maryland.

The Delaware River Port Authority is not considering this option. The tipping fee was based on disposing of clean material. The disposal plan presented in the Final Supplemental Environmental Impact Statement does not recommend the use of the dredged material disposal areas for disposal of dredged material from places other than the Delaware River.

5. COMMENT SECTION V PAGE 13

The ACOE Has Incorrectly Concluded That The Contaminants In The Delaware River Sediments Do Not Pose Any Environmental Risks.

There is no mandatory protocol for evaluating sediment quality data with regard to dredging projects. No specific data evaluation procedures are outlined in the NJDEP 1996 draft technical manual " The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters". The analysis presented in the FSEIS was intended to reduce a very large data set down to something that could be easily reviewed, while providing sufficient data for the reviewer to see the full picture. Means were not the only values presented. The analysis also provided the number of samples, the number of detections of each contaminant, and the concentration range of the actual detections. Maximum detected concentrations were presented in the bulk sediment tables. As such, the presentation did not mask these concentrations.

Section 7 of the final SEIS indicates that the U.S. Geological Survey was tasked with performing an evaluation of potential contaminant travel times from the proposed project disposal sites to nearby drinking water and industrial production wells. The report entitled "Evaluation of Groundwater Flow from Dredged Material Disposal Sites in Gloucester and Salem Counties, New Jersey" (USGS, 1995), determined that the disposal sites would not impact local wells as the sites provide a very small percentage of well recharge and potential contaminant travel times were on the order of fifty to one hundred years.

Consideration of environmental effects of the activities related to the business plan were not included as part of the FSEIS, as the business plan **is not** a component of the proposed Federal project. The FSEIS has evaluated environmental impacts of Federal channel dredging activities, the dredging of the benefitting berthing areas, and subsequent disposal. As a result, the FSEIS has considered corresponding impacts of the activities along with the channel.

The additional sampling articulated in the Corps/NJDEP agreement is for the purpose of monitoring sediment quality and the impact of actual dredging operations associated with the existing project, and the deepening project. If the monitoring identified a problem, it would be addressed through modification of the operation. The Corps has monitored many dredging projects, and intends to continue collecting data on the Philadelphia to the Sea Delaware River navigation channel and its dredging operation to insure that conditions do not change in the future, which could result in unacceptable environmental impacts. This type of data collection would not be subject to NEPA review requirements.

6. COMMENT SECTION VI Page 15

A recent Study of Delaware River Sediments Demonstrates That Contaminants Are Widely Distributed And Can Get Into The Food Chain.

The Corps' conclusions with regard to sediment contamination and potential environmental impacts associated with dredging are based on sampling of locations within the project area, including the navigation channel, bend widening locations, and berthing areas associated with various port facilities. Chemical analyses of sediments included PCBs, pesticides, polyaromatic hydrocarbons, heavy metals, and a number of other volatile and semi-volatile organic parameters. It is incorrect to say that the Corps did not address the presence of a complete set of chemical contaminants in the SEIS. The conclusion drawn from the sediment analyses is that sediments in the project area do not contain chemical contaminants at a level that warrant the concerns expressed in the comment. The sediment data was coordinated with the appropriate Federal and State resource agencies. These agencies included the U.S. Fish and Wildlife Service which reviewed the data in conjunction with Section 7 consultation, as required by the Endangered Species Act, with regard to threatened and endangered species under their jurisdiction. The U.S. Fish and Wildlife Service concurred with the Corps' conclusion.

7. COMMENT SECTION VII PAGE 18

Dredged Spoil Stockpiling At Locations Offshore Of Delaware Beaches May Cause Adverse Environmental Impacts.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction. The initial assessment indicates this modification is both economically and environmentally feasible.

Delaware Bay sediments proposed for sand stockpiling and habitat creation were tested using bulk sediment and biological effects based testing. The bulk sediment data were compared to guidelines developed to assess the potential for sediment contaminants to adversely effect benthic communities. This comparison suggested a low possibility of Delaware Bay sediments having an adverse effect. The biological effects based testing included water column bioassays, whole sediment bioassays, and bioaccumulation tests. Again, these tests did not identify any environmental concerns. This information is presented in Section 4 of the final SEIS.

The District has evaluated the potential for groundwater contamination from the disposal areas along the Delaware River and found the impact to be negligible. The material to be disposed is not "highly contaminated". In fact the material is essentially considered "clean". This determination is supported by the U.S. Environmental Protection Agency in their letter dated March 17, 1997. To further assure the local community that the groundwater will not be impacted from the disposal operations, monitoring wells will be installed at the proposed upland sites.

COMMENT SECTION VIII-PAGE 19

The Dredging Project Creates Additional Environmental Concerns.

We disagree with your statement that "the change in the hydraulics of the Delaware Bay resulting from the proposed project has not been adequately addressed". Virtually the entire hydrodynamic/salinity modeling effort, including the one-year prototype monitoring program from October, 1992 to October, 1993, was structured to do this. The salinity modeling studies and the results are discussed in Section 5 of the Final Supplemental Environmental Impact Statement.

The Star Enterprise refinery has not expressed interest in benefiting from the project and, thus, was not included in the benefit analysis.

MARITRANS
One Logan Square
Philadelphia, PA 19103
215-864-1200
800-523-4511

September 30, 1997

Via Hand Delivery

Mr. Robert L. Callegari
Attn: Environmental Resources Branch
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3397

Re: Delaware River Main Channel Deepening Project

Dear Mr. Callegari:

Maritrans Inc. transmits herewith the attached comments on the Final Supplemental Environmental Impact Statement prepared by the U.S. Army Corps of Engineers - Philadelphia District for the proposed Delaware River Main Channel Deepening Project. Our comments are submitted in the two documents that are enclosed; namely, "Comments to the Delaware River Main Channel Deepening Project-Final Supplemental Environmental Impact Statement" and the "Critique of the U.S. Army Corps of Engineers Business Plan for the Delaware River Port Authority's Ownership And Operation Of Dredge Spoils Disposal Sites - Business Plan - Environmental Issues." We request that both documents, along with the comments to the Draft Supplemental Environmental Statement transmitted to you via cover letter February 18, 1997, be included in the administrative record developed for the project.

Our outside counsel is still waiting for a final response from the Corps' Office of the General Counsel to an administrative appeal of several Freedom of Information Act requests. We reserve the right to supplement these comments with any information that will be provided to us by the Corps in the future.

Thank you for the opportunity to submit these comments.

Very truly yours,

John C. Newcomb

John C. Newcomb

Enclosures
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Organizations

11..	DE Audubon	8-26-97	Groundwater Impacts at CDFs, Public Hearing
12.	Cape May Boat	8-28-97	Contaminated Dredged Material, DE Bay Disposal.
13.	Green DE	9-30-97	Water Quality, Sediment Quality, Oil Spills, Pea Patch, De Bay Disposal, Public Hearing
14.	De Mobile Surf-Fishermen	9-25-97	DE Bay Disposal, Sediment Quality, Oil Spills, Economics, Business Plan, Public Hearing
15.	DE Nature Soc.	8-29-97	Horseshoe Crabs, Sport Fish, Shellfish, Groundwater, Shortnose Sturgeon, Clean Water Act, Blasting, Sediment Quality, DE Bay Disposal, Economics, Public Hearing
16	DE Taxidermists	9-29-97	DE Bay Disposal, Public Hearing
17.	DE Wildlands	9-25-97	Public Hearing, Pea Patch Is., Kelly Is., Cumulative Impacts of Port Mahon and DE Deep., DE Bay Disposal, Public Invol., Shortnose Sturgeon,
18.	Homeowners	4-30-97 9-26-97	Impacts of Federal projects on beach erosion at Breakwater Harbor, Request of sand for beach nourishment
19.	NJ Cons. Found.	8-28-97	Management and Monitoring of CDFs.
20.	Riverkeeper	8-21-97 9-5-97 9-8-97	Public Hearing, Public review of Salinity Model, Management and Monitoring of CDFs., Public Invol,
21.	DR&BS Council	8-25-97	Public Hearing, 404 [R], Sediment Quality
22	PA Sierra Club	8-24-97 8-28-97	Berthing Areas, Economics, Design of Kelly Is, Salinity Impacts to oysters, DE Bay Disposal, Salinity impacts, Pea Patch Is., Public Hearing
23.	Sierra Club, Nat. Marine& Wildlife Comm.	9-30-97	404 [R], DE Bay Disposal, Hydromodification, Sea Level Rise, Pea Patch Is. Public Hearing
24.	Maritrans	9-30-97	Alternatives, Impacts of Business Plan, Economics, Wetland Impacts, Sediment Quality, DE Bay Disposal, Salinity
25	Fort DE Society	8-26-97	Pea Patch Island

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KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Leslie G. Savage
Board of Directors
Delaware Audubon Society
Chapter of National Audubon
Box 1713
Wilmington, Delaware 19899

Dear Ms. Savage:

Thank you for your letter dated August 26,1997 on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The proposed upland disposal Site 15G was originally tidal wetlands but was used for the disposal of dredged material from maintenance of the existing Delaware River Federal 40 foot navigation channel for many years, until about 20 years ago. As stated in the SEIS, the site has 20 to 40 feet of fine -grained material from past dredging, and this material will greatly impede the flow of water from this area and significantly increase the travel time between site 15G and the wells.

As stated in response to your letter of February 11, 1997, sediments from Reach B were analyzed for all of the contaminants provided in your list, but the majority of these contaminants were either not found or found in only one or two of the samples. Heavy metals were frequently detected in Reach B sediments. Except for thallium, all of the metals were below New Jersey Department of Environmental Protection (NJDEP) Residential Surface Soil Standards. This means that the material is suitable for use as "clean fill" for residential development. With regard to thallium, as discussed in the FSEIS, the mean concentration is elevated because of the high detection levels achieved in the first round of sampling. In two subsequent rounds of sampling, 40 additional sediment samples show that the actual concentration of thallium in channel sediments is less than 0.4 ppm, which is well below the NJDEP Residential Standard of 2.0 ppm. The only pesticide detected in Reach B sediments was endosulfan. This contaminant was only detected in one of 49 samples. Likewise, PCB-1254 and PCB-1248 were the only PCB's detected. These were again only detected in one of the 49 samples. Several PAH's were detected in Reach B, but in only two of the 49 samples. There were similar results for phthalates, except for di-n-butyl phthalate, which was detected in 20 of 28 samples. The highest concentration of di-n-butyl phthalate detected in Reach B sediments was 1.51 ppm, which is well below the NJDEP Residential surface Soil Standard of 5,700 ppm. The remaining groups of volatile and semi-volatile organic contaminants were primarily undetected in the entire river. This information is presented in Section 4.0 of the FSEIS. Based on the data it is concluded that Reach B sediments are clean, and would not have an adverse impact on water quality in the area.

Although the FSEIS states that the placement of contaminated dredged material at upland disposal areas can result in long-term impacts such as groundwater contamination and direct uptake of contaminants by plants and animals, this would not occur from the material that will be dredged to deepen the Delaware River main channel. The sediment toxicity data from this project was reviewed by the Corps of Engineers' Waterway Experiment Station, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the New Jersey Department of Environmental Protection, the Delaware Department of Natural Resources and Environmental Control, and the Pennsylvania Department of Environmental Protection. The U.S. Environmental Protection Agency in a letter dated 17 March 1997 stated that "....EPA continues to believe that there will be no adverse impacts associated with the disposal of sediments generated by the project". In addition, in their letter of 12 September 1997, the U.S. Environmental Protection Agency stated that "... we have concluded that the proposed project would not result in significant adverse environmental impacts; EPA has no objection to the implementation of the proposed project." Neither the U.S. Department of the Interior (parent agency of the U.S. Fish and Wildlife Service)in their letter of September 11, 1997, nor the U.S. Department of Commerce (parent agency of the National Marine Fisheries Service) in their letter of September 29, 1997, have expressed any concern about contaminants in the dredged material. Furthermore, the Commonwealth of Pennsylvania and the states of Delaware and New Jersey have reviewed the sediment data as part of their coastal zone management consistency review. Each concluded that this project was consistent with the Coastal Zone Management Act.

To provide an extra level of assurance that no significant amounts of contaminants are entering the Delaware River or ground water from the proposed Site 15G, the Philadelphia District of the U.S. Army Corps of Engineers and the New Jersey Department of Environmental Protection will form a working group to develop appropriate coordinated sediment sampling and testing programs, surface water discharge monitoring plans, and ground water monitoring wells.

Site 15G is presently used for agricultural production of crops such as corn, wheat, and soybeans for human or livestock consumption. The proposed use of Site 15G will not include agriculture, but will include management as wetland/wildlife habitat between dredging cycles. The details of this plan is presented in Section 3.2.3 of the FSEIS.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

DELAWARE AUDUBON SOCIETY
Chapter of National Audubon
Box 1713, Wilmington, Delaware 19899
302-428-3959

August 26, 1997

Mr. Robert L. Callagari
Chief, Planning Division
U.S. Army Engineer District, Philadelphia
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

RE: STATEMENT OF THE DELAWARE AUDUBON SOCIETY PERTAINING TO THE FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Dear Mr. Callagari:

The Delaware Audubon Society is a statewide citizen organization whose mission is to promote an appreciation and understanding of nature; to preserve and protect our environment; and to affirm the necessity for clean air and water and the stewardship of our natural resources. We submit herewith, our concerns, comments and questions on the Final Supplemental Environmental Impact Statement on the Delaware River Main Channel Deepening Project.

Our examination of the Final Supplemental Environmental Impact Statement on the Delaware River Main Channel Deepening Project reveals several areas of concern we feel have not been fully addressed to our satisfaction.

<u>P. 1-4, Groundwater, section 1.1.1.3.</u> This section discusses the evaluation of potential contaminate travel times from the proposed project disposal sites to nearby drinking water by the United States Geological Survey. Their report determined the mean travel times for groundwater, from the new proposed disposal areas, to reach any potential water supply well is in excess of 50 years, except for a cluster of wells near area 15G where the report states that "travel times to these wells could be relatively short, perhaps on the order of several years". The Corp's conclusion to this reported concern states, "It is important to consider all of the contributing factors when evaluating the potential negative impact of the travel times from all disposal areas. First, the existence of 20-40 feet of fine-grained material from past dredging within the disposal areas greatly impedes the flow of water from the areas and increases the travel times substantially. In addition, the new dredged sediments from the 45

foot project contain no harmful levels of contamination; so in the event that the water were to reach the well from the disposal area, it would have no impact on water quality".

The Corp's first assertion regarding previously dredged materials increasing travel times does not apply to disposal site 15G as 15G is a new site, previously unused for the dumping of dredge spoils. The assertion that new dredged sediments contain no harmful levels of contamination and therefore, pose no threat to the quality of groundwater in nearby wells is refuted even by the data the Army Corp of Engineers has put forth in this Final Supplemental Environmental Impact Statement. Dredged materials from Reach B will be deposited at site 15G as well as several other sites. P.4-21 - 4-31, Bulk Sediment Analyses, section 4.1. The following is a list of all contaminates found in bulk sediment samples within Reach B: Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, Vanadium, Zinc, Aldrin, Dieldrin, Chlordane, Toxaphene, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, Endosulfan, DDT, DDD, DDE, Mirex, Methoxychlor, Parathion, Malathion, Hexachlorocyclohexane (Alpha, Beta, Delta, Gamma (Lindane)), Guthion, Demeton, PCB-1242, PCB-1254, PCB-1221, PCB-1232, PCB-1248, PCB-1260, PCB-1016, Acenapthene, Naphthalene, Acenaphthylene, Anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Phenanthrene, Fluorene, Fluoranthene, Benzo(a)anthracene, Benzo(ghi)perylene, Dibenzo(ah)anthracenem, Ideno(123-cd)pyrene, Pyrene, Bis(2ethylhexyl) phthalate, Butyl benzyl phthalate, Di-n-butyl phthalate, Di-n-octyl phthalate, Diethyl phthalate, Dimethyl phthalate, Volatile Halogenated Alkanes, Volatile Halogenated Alkenes, Volatile Aromatic Hydrocarbons, Volatile Chlorinated Aromatic Hydrocarbons, Volatile Unsaturated Carbonyl Compounds, Volatile Ethers, Phenols, Substituted Phenols, Organonitrogen Compounds, Chlorinated Aromatic Hydrocarbons, Chlorinated Aliphatic Hydrocarbons, Halogenated Ethers, and Miscellaneous Oxygenated Compounds.

Delaware Audubon believes that the sum total of contaminates from the dredged sediment would most certainly have an adverse impact on the quality of water found in the cluster of wells near disposal site 15G. These wells would be subjected to leaching of water from dredged sediments, even though all the mean channel sediment concentrations were below the NJDEP residential standards, except for the heavy metal thallium and the pesticide toxaphene. The Army Corp of Engineers proves this in the statement found on P.4-19, section 4.1. "Depending on the contaminate, the human health criteria are based on an additional lifetime cancer risk of 1of 1,000,000 or 1 of 100,000". If each of the above listed chemicals pose an additional lifetime risk of cancer then the additional lifetime risk of cancer to those drinking water from wells contaminated from site 15G is the sum of each additional risk.

P.4-5, section 4.1. To summarize the large volume of data, samples collected within each reach were grouped and the mean concentration of each chemical parameter was calculated. P.4-6 - 4-31. Tables 4-2 through 4-8 shows the mean concentration of each contaminate in Reaches A through E as well as the detection range. By calculating the mean concentration and then using that calculation against the NJDEP standards gives a false appearance of falling within these standards. In addition, the Army Corp of Engineers often applied two different standards to the same data. When a sample exceeded the NJDEP residential standard, it was then compared to the NJDEP non-residential standard even though a residential standard was used for all other contaminates found in that reach. Upon examination of Tables 4-2 through 4-8 compared against Tables 4-9 through 4-19, we found that the detection range of the samples offered a better indicator of contaminate levels within each reach. For example, in Reach B where the Corp has only indicated two contaminates as being over NJDEP residential standards, the detection range shows that 6 of the 130 contaminates falls outside the NJDEP residential standard.

Parameters	Reach B	NJDEP Residential Standards
Number of Samples	49	
Antimony		
Mean Conc.	9.93	
# of Detections	24	
Detection Range	1.7-32.0	
Range exceeds NJDEP by	18	14
Beryllium		
Mean Conc.	0.82	
# of Detections	38	
Detection Range	0.31-1.5	
Range exceeds NJDEP by	0.5	1.0
Cadmium		
Mean Conc.	0.94	
# of Detections	19	
Detection Range	0.11-4.0	
Range exceeds NJDEP by	3.0	1.0
Lead		
Mean Conc.	19.09	
# of Detections	44	
Detection Range	4.7-120	
Range exceeds NJDEP by	20	100
Selenium		
Mean Conc.	16.53	
# of Detections	28	
Detection Range	0.21-119	
Range exceeds NJDEP by	56	63
Thallium		
Mean Conc.	2.48	
# of Detections	13	
Detection Range	0.17-9.0	
Range exceeds NJDEP by	7	2.0

All concentrations presented in parts per million (mg/kg), dry weight.

P.4-2, section 4.0. The Army Corp of Engineers states that the placement of contaminated sediment at upland disposal sites can also result in long-term impacts such as groundwater contamination and direct uptake of contaminants by plants and animals.
On page1-1 it is indicated that disposal areas 15D, 15G and 17G are currently being used mostly for the production of row crops such as corn and soybeans. Will these areas continue to be used for growing crops and if so who consumes these crops?

In conclusion, the Delaware Audubon Society feels the Army Corp of Engineers has not provided proof that the concentration levels of contaminates from the dredged sediment will not pose a hazard to the health and well-being of humans whose groundwater and soil may become contaminated by leachate from nearby disposal sites. In light of irreparable damage to nearby drinking water supplies, we request that site 15G be abandoned and an alternate site be found. Given the above discrepancies in data found in the Final Supplemental Environmental Impact Statement for the Delaware River Main Channel Deepening Project, the Delaware Audubon Society requests a public hearing to more fully address our health and environmental concerns.

Sincerely,

Leslie G. Savage
Board of Directors

Cc: Senator Joseph Biden
Senator William Roth
Congressman Michael Castle
Christophe Tulou
Sarah W. Cooksey

CENAP-PL-E
6554/am
25 FEBRUARY 1998
BRADY
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PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Captain Joseph Galese
Secretary
Cape May County Party Charter Boat Association
P.O. Box 1065
Cape May, New Jersey 08204

Dear Captain Galese:

Thank you for your letter dated August 28,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

Based on field sampling and subsequent data analysis, no significant impacts to the aquatic ecosystem are expected from dredging and the disposal of dredged material for this project. None of the sediment samples taken revealed significant levels of contaminants. The fine-grained material from the industrial northern portion of the project area will be placed in upland confined dredged material disposal facilities (CDFs), away from the river. The sediment toxicity data from this project was reviewed by the Corps of Engineers' Waterway Experiment Station, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the New Jersey Department of Environmental Protection, the Delaware Department of Natural Resources and Environmental Control, and the Pennsylvania Department of Environmental Protection. The U.S. Environmental Protection Agency in a letter dated 17 March 1997 stated that "....EPA continues to believe that there will be no adverse impacts associated with the disposal of sediments generated by the project". In addition, in their letter of 12 September 1997, the U.S. Environmental Protection Agency stated that "... we have concluded that the proposed project would not result in significant adverse environmental impacts; EPA has no objection to the implementation of the proposed project." Neither the U.S. Department of the Interior (parent agency of the U.S. Fish and Wildlife Service)in their letter of September 11, 1997, nor the U.S. Department of Commerce (parent agency of the National Marine Fisheries Service) in their letter of September 29, 1997, have expressed any concern about contaminants in the dredged material. Furthermore, the Commonwealth of Pennsylvania and the states of Delaware and New Jersey have reviewed the sediment data as part of their coastal zone management consistency review. Each concluded that this project was consistent with the Coastal Zone Management Act.

The wetland restoration plan for Egg Island Point was coordinated with the New Jersey Department of Environmental Protection, the National Marine Fisheries Service, and the Mid-Atlantic Fishery Management Council. None of these agencies indicated that this proposed project would have significant impacts to fishery resources. The Egg Island Point area is experiencing erosion rates of 15 to 30 feet per year of the tidal marshes that support many of the aquatic resources in the Delaware Bay. The proposed Egg Island Point wetland restoration will protect hundreds of acres of this valuable tidal marsh.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

Thank you for your comments and continuing participation in the review of this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Cape May County, N.J. Party & Charter Boat Association
SAFETY INTEGRITY

P.O. BOX 1065 • CAPE MAY • NEW JERSEY • 08204

Mr. Robert L. Callegari, Chief
Environmental Resource Branch
US Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

August 28, 1997

Dear Mr. Callegari:

The Cape May County Party and Charter Boat Association, with over 230 members, wish to express its grave concern with the plans published in "Public Notice, No. CENAP-PL-E-97-06" Dated 25 July 1997: *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement.*

The following expresses our immediate urgency:

1. What will the effects that dredging materials from Northern areas, some of which contain toxicity and which inevitably will be carried downstream during the project, have on the beaches, fish spawning areas and the fishery at large for the lower Delaware Bay?

2. Similarly, but even of greater concern, how will the dredge materials planned for the "Beneficial Use Sites" effect the spawning areas and the natural bottom which supports the Delaware Bay fishery? Specifically, the site of *Egg Island Point* is currently a prime location for spawning weakfish, and schooling striped bass (just to note two of the many species located in these waters). What has the research shown on the short and long range effects for these species, if anything? Also, with the inclusion of Slaughter and Broadkill Beaches as "Beneficial Use Sites", two locations which support the Spring migration of black drum fish, as well as flounder, will the natural shell bottom of these locations be effected by the dumping of dredge materials and thus alter the natural fishing environment for these species as well as the feeding chain of other species of the lower Delaware Bay?

It appears to the membership of CMCPCBA, most of whom are professional fishing captains having decades of boating and angling experience in the lower Delaware Bay, that the fishing environment will be adversely effected by these activities.

Cape May County, New Jersey alone has sustained over a $1,000,000,000. tourist business with most dependent on Delaware Bay and Ocean water conditions and with a large percentage of the tourist dollar drawn directly and indirectly from the recreation/sportfishing industry.

We hope and will lobby for a prudent approach to this project with, above all, a caring and accurate eye on maintaining the health of the lower Delaware Bay fishery, the quality of our waters, the pristine beaches and the economics of our area.

Respectfully submitted,

Capt. Joseph Galese
Secretary

cc: Governor C. Whitman
New Jersey State, Game and Fishing Commission
National Marine Fisheries Service

CENAP-PL-E
6554/am
25 FEBRUARY 1998
BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Alan Muller
Green Delaware
Box 194
Port Penn, Delaware 19731

Dear Mr. Muller:

This is in reply to your letter dated September 30, 1997 concerning comments on the Delaware River Main Channel Deepening Project. I am enclosing a copy of the Final Supplemental Environmental Impact Statement (FSEIS), dated July, 1997, where you should find the answers to your concerns. Specifically, water quality impacts are discussed in Sections 4.0, 5.0, 7.0, and 9.1.2; impacts of dredged material on aquatic species are discussed in Sections 4.4, 5.11, 8.3, 9.0, and 10.4; impact of sediment quality are discussed in Sections 4.0 and 10.4; impacts of oil spills are discussed in Section 12.0; and impacts to Pea Patch Island are discussed in Sections 10.4.3.6 and 11.3.9.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and interest in this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Enclosure

Green Delaware

Alan Muller
Box 194
Port Penn DE 19731
(302)834-3466
fax (302)836-3005
amuller@dca.net

September 30, 1997

Mr. Frank Cianfrani
Chief, Regulatory Branch, Philadelphia District
U. S. Army Corp. Of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390
FAX: 215.656.6724

RE: Comment on Proposed deepening of Delaware River Main Channel

Dear Mr. Cianfrani:

Green Delaware has several concerns regarding this project, which we oppose in its present form.

Procedural Concerns:

This project has been the focus of considerable public concern among non-governmental organizations and government agencies in Delaware. Opposition to the project has been voiced on various grounds. Nevertheless, the Corps is reportedly refusing to hold public hearing(s) on the proposed activity and has apparently claimed that it is "non-controversial." This doesn't ring true to us.

Green Delaware hereby requests that the Corp. Hold a formal public hearing, for the reasons listed below. We understand that several parties have requested such a hearing. We think that refusal to hold a hearing(s) would cast into doubt any decisions the Corp. might make regarding this matter.

Substantive Concerns

Massive disturbance of sediments associated with such a project might have sever consequences for water quality in the Delaware River and Estuary.

Habitat of aquatic species might be damaged by intentional or incidental deposition of sediments.

Disposal of possibly contaminated dredge spoil in a harmless manner may not be possible.

Transit of more heavily loaded vessels containing hydrocarbons may pose an increased risk from spills and collisions.

Direct and indirect effects of the project might increase erosion losses to vulnerable locations such as Pea Patch Island, a place of great historical and ecological significance, already suffering serious erosion losses.

(We understand that the Corps has already concluded that these are not problems. We are unconvinced.)

I will conclude by noting that for many decades industrial use of the Delaware has been given priority over other uses, leading to massive destruction of fisheries, depletion of populations, and discouragement of recreational activities. In recent years some improvements in water quality have enabled a potential revival of some of these uses. In our opinion continued improvement in water quality and habitat should, at this stage, take precedence over other usages of the Delaware.

Yours very truly,

CENAP-PL-E
6554/am
25 FEBRUARY 1998

~~BRADY~~

PASQUALE

LULEWICZ

KAMPER

MARALDO

BURNES

CALLEGARI

Environmental Resources Branch

MAR 05 1998

Robert V. Martin, Captain
Delaware Mobile Surf-fishermen, Inc.
201 Wilson Street
Georgetown, Delaware 19947

Dear Captain Martin:

This is in response to your letter dated 25 September, 1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

Since the dredged material from the Delaware Bay portion of the channel deepening project is 98 percent sand and 2 per cent fine-grained material, the resource agencies requested that the excavated dredged material be used for beneficial purposes. The Kelly Island wetland restoration project has been designed as a confined area that will hold the fine-grained material from the Delaware Bay and provide erosion protection for existing wetlands. At the request of the Delaware Department of Natural Resources and Environmental Control the wetland restoration project at Kelly Island was re-designed to increase the size of the sand berm that would confine the fine-grained material. The additional sand source for the increased berm was obtained from the sand that was designated for placement at the sand stockpile MS-19, thereby reducing the sand quantities to be placed at MS-19 or the sand quantities that would be placed directly on nearby beaches.

Regarding your concern about sediment quality, mean concentrations were presented in the FSEIS because of the large volume of data collected over the course of the study. In Delaware Bay, 23 samples of channel sediment were tested for the heavy metal selenium. Selenium was detected in 11 of the 23 samples. Ten of these samples had selenium concentrations that were below the New Jersey Residential Surface Soil Standard of 63 ppm. As such, 95.6 percent of the samples tested (22 of 23) had selenium concentrations below the New Jersey Residential Standard. One sample did have a selenium concentration of 121 ppm. It is incorrect to characterize all Delaware Bay channel sediment as having this concentration of selenium. This concentration is not considered significant, as the New Jersey Non-residential Surface Soil Standard for Selenium is 3,100 ppm. A concentration of 121 ppm is only 3.9 percent of the New Jersey Non-residential standard.

The September 18, 1997 oil spill occurred during the lightering operation of the oil tanker (Mystras) at Big Stone Beach Anchorage to a barge. This lightering operation was required due to the current channel depth of 40 feet. It appears that if lightering was not required this spill could have been prevented. The deepened channel will reduce the magnitude of lightering operations that normally occur on a regular basis in the Delaware Bay and the related environmental risks that accompany this operation. With the reduction of lightering, there will be less barges moving on the river, while the number of oil tankers will remain the same, with the larger tankers in the fleet carrying more oil directly to the refinery docks due to the deeper channel. The reduction in overall barge traffic will reduce the risk of collisions. In addition, as part of the proposed deepening project, the channel bends will be widened and rock at Marcus Hook will be removed. These actions will result in a safer navigation channel. Finally, according to the U.S. Environmental Protection Agency, the oil spill responses network established by the U. S. Coast Guard, Marine Safety Office, Philadelphia is considered to be as adequately prepared to handle oil spills as any in the Nation. This is explained in Section 12.2 of the FSEIS.

As for all Corps projects, the 45-foot channel deepening project has been subject to a vigorous technical review of the economic analysis. The Corps cost benefit analysis followed required regulations and was reviewed and approved by the Secretary of the Army and the Office of Management and Budget prior to authorization by Congress.

The existing Delaware River 40-foot deep project restricts efficient movement of both present and future tankers, dry bulk carriers and container vessels. The 45-foot channel improvement will provide sufficient transportation cost savings through increased efficiency of transporting commodities.

The new large container vessels of post-Panamax size do not use the Panama Canal since they exceeded the dimensions of the canal. These vessels travel via the Suez Canal in their service from the Pacific to the Atlantic Ocean.

For many Corps projects, the local sponsor coordinates with the Corps for advice on how to raise their share of the project costs. This is a normal activity that the Corps provides to the sponsor. As a result, a business plan was prepared to illustrate new revenue sources that could potentially be pursued by the project sponsor, Delaware River Port Authority (DRPA), if it chose to do so. The business plan offered various options and opportunities that upon further analysis by the sponsor could potentially be used to generate revenues for the non-Federal share for the proposed 45 foot project. The business plan does not represent "the financial plan" for the project. It is a possible way for the DRPA to raise revenues. In fact, it could be developed if DRPA chose to without the 45 foot project. It is the ultimate responsibility of the local sponsor, not the Corps , to develop a financing plan for its cost-share. Once the financing plan is developed by the sponsor, the Corps will make its review to ensure it adequately meets our requirements.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

DELAWARE Mobile Surf-fishermen, Inc.
3 October, 1997

MR John BRADY
Environmental Resources Branch
U.S. Army Engineer DIST. Philadelphia
100 Penn Square East
Philadelphia, PA 19107-3390

DEAR MR. BRADY;

I must ask for your indulgence and for your patience.

Arlene indicated to me that she saw no problem in replacing the letter section of my Sept. 25, '97 response to the July, 1997 FSEIS with a better copy corrected for spelling, punctuation, and readability.

The typist of the corrected letter mailed an unsigned copy and without the complete addenda in error. There is no change in the 70 signature pages (1894 signatures). These are to be retained as part of the DMS response.

Please discard the 6 pages of the original letter response section and the addenda cover letter, which was handwritten, and replace the letter and addenda section of the DMS response with this copy which word for word is exactly the same as the original sent on 25 September, 1997

Unfortunately I am not the beneficiary of professional and regular clerical assistance.

I ask your forbearance in this matter and thank you for your attention.

Sincerely,

Bob Martin

201 Wilson St.
Georgetown DE 19947 (302) 856-6742

Delaware Mobile Surfishermen, Inc.
Robert V. Martin, Capt. US Navy-RRetired
DMS Project Liaison
201 Wilson Street, Georgetown, DE 19943
September 25, 1997

Mr. John Brady
Environmental Resources Branch
U.S. Army Engineer District, Philadelphia
100 Penn Square East
Philadelphia, PA 19107-3390

RE: Final Supplemental Environmental Impact Statement
Delaware River Comprehensive Navigation Study
Main Channel Deepening Project, July 1997
Attachment: 70 pages of signatures requesting a Public Hearing as well as well as eliminating stockpiling.
Addenda: Response to Mr. Callegari's memorandum to files.

Dear Mr. Brady:

The Delaware Mobile Surfishermen, Inc. hereby request that the Army Corps Engineers (ACE) hold Public Hearings related to the above named FSEIS.

This letter is written in protest to the ACE proposal to dispose of 3.3 million cubic yards of dredged material from the deepening of the main river channel on the Coral Beds off of Slaughter and Broadkill Beaches, sites MS-19 and L-5.

The January, 1997 SEIS proposed to dump 4.7 million cu.yds.of dredged materials on sites MS-19 and L-5. The July 1997 FSEIS still plans to use these same sites for that purpose. The ACE continues to ignore or to minimize the unique make-up of these fishery areas. The ACE spokesman for Lt. Col. Keyser, District Engineer, and Robert Callegari, Chief of Planning, Mr. John Brady, stated in a TV interview on July 10th, 1997 that he guessed the fishermen would have to find someplace else to fish. He completely missed the point. Please note that the areas we are talking about, all 480 acres (previously 730 acres--same benthic community), are very specialized and unique. These are truly most significant fin and shellfish spawning and nursery areas and are not duplicated in the Delaware Bay. These nursery/spawning areas will have no difficulty qualifying as Essential Fish Habitat (EFH) under the Magnuson-Stevens Act.

Generalizations by the ACE as to the effect of stockpiling are inappropriate and inadequate. There is no way that any benthic community is going to re-colonize from being smothered under a five foot blanket of dredged spoils. Any comment that this benthic community is an insignificant one and will regenerate in a short time is an uninformed and unscientific one. The area off of Broadkill and Slaughter Beach has been identified as "Coral Beds" for years on USNOAA navigation charts. A scientist representative of the DNREC Division of Fish and Wildlife during an untitled meeting held at the University of Delaware College of Marine Studies on July 10, 1997, stated that the ACE method of sampling in the MS-19 and L-5 sites was improper and faulted. The procedure used, bottom grabs, was entirely inadequate and would not properly identify the benthic community. There is a tape recording of this meeting of 1 hour and 45 minute duration.

If stockpiled, the 1.4 million cu.yds.of dredged material at Slaughter Beach (MS-19), and the 1.9 million cu yds at Broadkill (L-5) will be subject to wave driven transport as declared by the ACE In the July '97 FSEIS. This FSEIS further states that the transport potential is calculated to be "about" 260,000 cubic yards per year at MS-19, and 230,000 cu yds at L-5. The direction of this transport will be northwest. In addition, a single event major storm of 3 days could move an additional 40,000 cu yds of dredged material from each site. Those transports will extend the foot of the material stockpiled year by year and will eventually cover additional spawning and nursery areas in acreages that will in a short time exceed the original stockpiled area. For the ACE to suggest that the impact of spoils stockpiling will be of little consequence is the nadir of hypotheses. The EPA, as well as the U. S. Dept. of Interior, in the July 1997 FSEIS stated that other areas should be considered for the disposal of dredged materials. There was no suggestion that stockpiling is a beneficial resource. The U. S. Dept. of Interior stated in their letter to ACE that "they did not consider sub-tidal sand stockpiles an environmentally beneficial use of dredged material". Should the ACE change its approach by justifying dredged material for stockpiling as not disturbing the average representation of the Delaware Bay, it cannot change the real impact on MS-19 and L-5. This approach will be further evidence of the Corp's use of "means" type qualification as used in minimizing contaminant contents of dredged materials. Stockpiling in itself is not a beneficial use, no matter what the intent. Included in EPA and Dept. of Interior Statements are references that, in addition to the original disturbance to MS-19 and L-5, repeated visitation to these sites for beach replenishment purposes will further disturb any resurgence of a benthic community. The position of the ACE, repeated time and time again, is a reflection of the limited and singularity exclusive opinion of the ACE. The ACE is in a perpetual "Denial" state.

During the July 10th meeting referred to earlier, Mr. John Brady said that material taken from the MS-19 was to be used for recreating Kelly Island. The purpose of which is really not clear and is over simplified. In another SEIS, Port Mahon, a statement is made that Port Mahon will not be affected one way or another whether or not Kelly Island is "Re-created". If Kelly Island is evaporating as rapidly as the ACE says it is, there is not going to be a recreation of any duration no matter how much continued replenishment goes on.

The material to be taken from MS-19 <u>must</u> be considered excessive contrary to Mr. Lulewicz's and Mr. Brady's observations during the July 10th meeting that there were no excesses, otherwise, MS-19 could not afford to lose 1.4 million cu.yds.of material. This implies that not only is all the stockpiled material in excess of that needed, but that these sites are being used as expedients to dispose of, get rid of, dredged material. Of course, spoils have to go someplace.

There is serious question as to whether or not this material meets acceptable contamination standards. The N. J. clean-up requirements for the heavy metal Selenium, for example is 63 parts per million. The range of contamination in material dredged from Reach E destined for use at MS-19 and L-5 is from 23 ppm to 121 ppm. The "mean" contamination is 20.08 ppm. (Please note the previous use of the word "mean" in this response related to the benthic community and the Delaware Bay). 20.08 ppm is a very good average. The ACE uses this "mean" as the basis for saying the material is acceptable. These figures are taken from tables included in the July FSEIS.

I suppose that the residents of Slaughter and Broadkill beach communities will be happy to have 121 ppm of heavy metal dumped on their beaches. Not! The ACE will have to use a rather large cocktail shaker to get the sediment from Reach E mixed to a 20.08 ppm mean. I personally would not want any of that 121 ppm "good stuff" (a reference made about this material by a DNREC Div. Of Soil and Water Representative) dumped in my child's sand box. The "mean" is not an appropriate measure or standard for the use of these materials. There should be a determination of the exact contamination of what is dredged, when it is dredged, when it is stockpiled, and when it is placed on the beach.

Stockpiling of dredged material is a bad idea. We need a Public Hearing, not to hear more "information" from the ACE, but for the ACE to hear from us. People must be heard, not suppressed. I fail to understand why the ACE denies the light of a Public Hearing. The meeting at the U of D July 10th in no way could replace a Public Hearing. The group in attendance was far too small.

The U. S. Coast Guard at Philadelphia states that oil spills of consequence have occurred because of vessels grounding, collisions, and port accidents. Added to that list are faulty valves aboard tankers and improperly maintained equipment aboard these same tankers. Faulty equipment aboard the Mystras was the cause of the Sept. 18, 1997 spill at Big Stone Beach Anchorage.

The deepening of the main river channel obviously is not to accommodate deeper draft vessel, as none are in sight for Philadelphia ports. Operators of crude oil vessels do not intend and have not incorporated any potential shift in their fleet even though the channel may be deepened. These operators have made an economic decision to lighter tonnage at Big Stone Beach Anchorage onto barges until the sailing draft is sufficiently reduced to allow vessels to travel upriver to the pertinent activity. Even if the channel is deepened to 45 feet they are expected to make the same economic decision and will carry the equivalent amount of tonnage in the same vessels. This information is from the May, 1996 DRMCDP Design memorandum. In other words, lightering will still be a necessary procedure. Again, lightering is not the danger. A tanker carrying more crude oil upriver will present a greater risk for a large spill because of grounding or collision.

The need for a deeper channel attracts greater scrutinity and study as cost benefits are elusive. Cost benefits will tend to benefit the vessel operators and their country of origin and apparently will not reflect any benefit to the American economy. Please refer to Maritrans response in the July '97 FSEIS appendix.

All inter-ocean commerce vessels, Atlantic to Pacific must be built to accommodate the Panama Canal depth of 38 feet. Obviously container vessels to and from the Pacific via the Panama Canal will not be influenced one way or another by a Delaware Deepening Project.

The Army Corps has undertaken a self-imposed assignment to develop a business plan so that the non-federal partner in the deepening project can pay for its share. This appears to be a misuse of tax dollars, although I'm sure the ACE is in compliance with all laws. The ACE has contracted the Greely-Polhemus Group, Inc. Of West Chester, PA to develop a business plan to provide income to the Delaware River Port Authority (DRPA) so that they can meet their $100,000,000 share of the cost of the deepening project. This business plan is a detailed document putting the DRPA into the dredged spoils site business. It appears that the ACE is, in a way, guaranteeing income by suggesting that contracted dredging companies for the deepening project use the sites to be purchased by the DRPA and for which use these companies pay a "tipping fee". Not only does the ACE research how the DRPA should go into business but they suggest that dredging companies under contract for the deepening project will use these sites. Refer to the Greely-Polhemus working draft titles "DRPA Business Plan for Local Sponsor" prepared for the non-federal partner of the deepening project. There may be questions that this procedure attracts. Does the ACE exceed their responsibility and authority? At the least, this enterprise deserves the light of a Public Hearing or at least an enlightenment.

There is some evidence that other Delaware Estuary projects not mentioned in the FSEIS are to become beneficiaries of dredged material. Specifically, Port Mahon. It suggests that NEPA regulations are not met as not only is the Port Mahon destination for spoils not included in an impact study but alternatives to the restoration of Port Mahon are not included.

The following is an incomplete list of individuals and large organizations which have requested a Public Hearing to discuss various controversial aspects of the FSEIS:

U. S. Senator Wm. V. Roth
State Senator George Bunting
State Representative Shirley Price
Delaware Parks and Recreation Council
Oldmans Creek Watershed Association (several letters), N.J.
Delaware Mobile surfishermen (over 3,000 membership)
River Keepers (Pennsylvania)
Delaware Nature Society
Delaware Audubon Society
Delaware Wildlands, Inc.
New Jersey conservation Foundation
Partnership for the Delaware Estuary
Delaware River and Bay Council, Wilmington, DE
Individual citizen letters and supporting signatures
Plus numerous letters of controversy which did not include specific requests for a public hearing.

The criteria quoted by Mr. Robert Callegari in his "Memorandum to Files" follows:
Action: According to the *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR 1506.6 (c)) there are two criteria to use when deciding whether or not to hold a public hearing:

1. Substantial environmental controversy concerning the proposed action or substantial interest in holding the action.

2. A request for a hearing by another agency with jurisdiction over the action supported by reasons why a hearing will be helpful.

These criteria are more than adequately met.

Senator Fritz Hollings, D-South Carolina, stated to the Senate body on Thursday morning, Sept. 18, 1997, that "the very function of government is to protect". He also referred to the Executive, Legislative and Judicial branches of government and that each had a relationship to the other. It is a government of the separation of powers. He made a reference to the "Arrogance of Power" and that arrogance suppresses. "People cannot be heard". He strongly stated the "Arrogance of Power" is an endangerment to our country.

The ACE has refused a request from two state legislators, Senator Bunting (made during the July 10th meeting, and Representative Price. To my knowledge you have yet to respond to a request from U. S. Senator Roth to hold a Public Hearing.

The DMS is requesting a Public Hearing, not a "meeting", a "public meeting", a "discussion", or an "informational meeting" but a bona fide "Public Hearing" with properly advertised announcements.

As part of public input, we repeat our request for a Public Hearing. We've read and listened to the ACE's information programs. Now, as part of the process of democracy, we want to be heard.

Enclosed find 70 pages containing 1,894 signatures requesting a Public Hearing in addition to a request that dredged material stockpiling be eliminated from your plans. The specific request comes from a DMS membership of over 3,000 souls. The NEPA criteria does not prevent a Public Hearing. The above list of addressees and the attached 1,894 signatures more than meet the criteria used to deny a Public Hearing.

We look forward to hearing in a reasonable time your plans for a Public Hearing.

Sincerely, yours,

Robert Martin

Robert V. Martin, Capt. US Navy-RRetired
DMS Project Liaison

cc: Governor Thomas Carper
Lt. Gov. Ruth Ann Minner
Senator William V. Roth, Jr.
Senator Joseph R. Biden, Jr.
Representative Michael Castle
State Senator George Bunting
State Representative Shirley Price
Senator Fritz Hollings, D-South Carolina
Robert Stickles, Sussex County Administrator
Ken Dodd, Pres., DMS
Delaware Wildlands
Delaware Audubon Society
Delaware Nature Society
Sierra Club

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3391

REPLY TO
ATTENTION OF

Environmental Resources Branch

AUG 11 1997

Mr. Robert V. Martin
201 Wilson Street
Georgetown, Delaware 19947

Dear Mr. Martin:

As you requested, I am transmitting to you a Memorandum to Files for a meeting held at the University of Delaware, College of Marine Studies in Lewes, Delaware on July 10, 1997 to discuss the Delaware River Main Channel Deepening Project with fishing interests. If you have any questions, please contact John Brady of my staff at 215-656-6554.

Sincerely,

for John A. Burnes

Robert L. Callegari
Chief, Planning Division

Encls

#1 ADDENDA:
Cover letter

ADDENDA

This Memorandum to Files is not an accurate representation of what took place during the July 10, 1997 gathering at the University of Delaware, College of Marine Studies, Lewes, DE.

According to John Brady, this discussion was not a meeting of record. Therefore, this Memorandum to Files has no significance. It is not attributed to any author, therefore its credibility is in question. Mr. Callegari did not attend this meeting.

Addenda No. 1:
Army Engineer Corps "Memorandum to Files" in re: July 10, 1997 meeting at U.D. - CMS.

Addenda No. 2:
DMS response to "Memorandum"

MEMORANDUM TO FILES

SUBJECT : Delaware River Main Channel Deepening Project-Meeting with Fishing Interests

LOCATION. A meeting was held with fishing interests on July 10, 1997 at University of Delaware, College of Marine Studies.

PURPOSE. The purpose of the meeting was to go over the proposed plan of placing sand material offshore at two sand stockpile sites (MS-19 and LC-5), to summarize the field sampling, sediment quality evaluation, and engineering studies, and to address concerns to " Coral Beds" raised by fishing interests.

ATTENDEES.

. Corps of Engineers

John Brady	-Environmental Resources
Stan Lulewicz	-Project Manager
Jeff Gebert	-Oceanographer
Ed Voight	-Public Affairs

Approximately 25 people attended the meeting. A partial list is attached as ENCLOSURE 1 and includes those people who wish to receive a copy of the Final Supplemental Environmental Impact Statement.

Attendees representing the public included:

Robert Book	-Staff Assistant to Senator William Roth
Shirley Price	-Delaware State Representative
George Bunting	-Delaware State Senator
John Hughes	-DNREC, Division of Soil and Water
Sarah Cookesy	-DNREC, Division of Soil and Water
Jennifer Lukens	-DNREC, Division of Soil and Water
Jeff Tinsman	-DNREC, Division of Fish and Wildlife

#1. ADDENDA
Mem. To Files 1.

PRESENTATION. A brief overview of the project was given by Mr. Lulewicz. Mr. Brady went over the conducted benthic sampling that was undertaken at the two proposed sites and conclusions reached. A summary of this effort was handed out and is attached as ENCLOSURE 2. Also, the sediment testing efforts were discussed. This effort was summarized via a handout. This handout is attached as ENCLOSURE 3. Lastly, Mr. Gebert went over the sediment transport investigations that were undertaken regarding the sediment pathways at the two sites. A description of this effort and results are attached as ENCLOSURE 4.

1 DISCUSSION. Upon completion of the formal presentation, the meeting was opened for questions. The following issues were discussed:

- 2. Need for a Public Hearing. Most of the people at this meeting wanted to have another meeting that would have general notification so that all of the interested public could attend. There were specific requests from Mr. Book, Representative Price, and Senator Bunting.

3. Action: According to the *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR 1506.6 (c)) there are two criteria to use when deciding whether or not to hold a public hearing:

1. Substantial environmental controversy concerning the proposed action or substantial interest in holding the action.

2. A request for a hearing by another agency with jurisdiction over the action supported by reasons why a hearing will be helpful. //

4. During this current phase of study, the Corps met with conservation organizations in New Jersey, Pennsylvania, and Delaware, including a public meeting at the Camden Aquarium on November 4, 1993, where both economic and environmental interests expressed their concerns so that the Corps could consider them during this phase of study. The Corps expects to continue to meet with other groups and individuals to discuss specific issues in workshops.

5. Based on a decade-long study record, the Corps of Engineers does not consider that this project is controversial. Over 325 copies of the SEIS were distributed, including copies to 36 libraries in the area. In addition, over 2000 public notices were mailed, to make people aware of the availability of the SEIS. Only 1 state representative, 7 organizations, and 3 individuals requested a public hearing. No agency with jurisdiction over the project requested a public hearing. Delaware

#1 ADDENDA
MEMO TO FILES 2.

requested an informational public meeting. As a result, the Corps has met with a number of fishing groups to discuss their concerns, and will continue to coordinate with this group to insure that no significant construction impact will occur to Delaware's aquatic resources.

6. The purpose of the current Supplemental Environmental Impact Statement is to re-affirm the conclusions that were drawn from the Final EIS in 1992 with additional testing, analysis etc. and to respond to resources agency and public interest comments. The Corps believes that the topics that were left over from the 1992 EIS have been answered both in study newsletters and in this document, and that a public hearing would not provide additional substantial information.

- 7. In general the group did not want sand placed at the sand stockpile areas. They are concerned about the quality of the benthic communities and the possibility that the sand may migrate to other areas.

  Action: The Corps continues to believe that the sand stockpiles will not significantly impact the overall benthic resources of Delaware Bay, based on the sampling that was done. However, the District will further address these concerns during the preparation of the Plans and Specifications. This additional work effort is scheduled to be initiated in early 1999.

- 8. Although the sampling that was done by the Corps found very few areas of sand coral (Sabellaria vulgaris) in MS-19 and none in LC-5, Mr. Tinsman said that this species is difficult to find with the technique used, i.e., grab sampling. He stated that this species occurs in "patchy" distribution and would be more likely found using a dragging technique such as a clam dredge.

9. Action: As part of the Channel Deepening Project, the Corps of Engineers proposes to place approximately 1.9 million cubic yards of clean sand approximately 0.33 miles offshore of Broadkill Beach (Site LC-5), and approximately 1.4 million cubic yards approximately 0.5 miles offshore of Slaughter Beach (Site MS-19). It was pointed out that due to the re-design of Kelly Island wetland restoration site, the quantity of sand that will be placed on sand stockpile site MS-19 has been reduced from 2.8 million cubic yards to 1.4 million cubic yards. This will reduce the area of MS-19 from 500 acres to 250 acres. The total quantity of sand for both sand stockpiles (MS-19 and L-5) will be reduced from 4.7 million cubic yards to 3.3 million cubic yards, and the total area for both sand stockpiles has been reduced from 730 acres to 480 acres.

#1 ADDENDA; memo 20 files 7.

10. The purpose of these sand stockpiles is to provide a source of clean sand for future beach nourishment. The sites were chosen by examining their biological characteristics, as well as economic and engineering constraints. Each of these sites was sampled twice, in different years, to characterize their benthic communities. Although impacts will occur to the local populations of benthic resources, as described in Section 8.3 of the SEIS, no significant differences were found between any candidate site and background conditions in Delaware Bay that would preclude its selection as a beneficial use site. Therefore, no significant impact will occur to either the diversity or overall populations of benthic resources in Delaware Bay due to the use of any of the candidate sites as either wetland restorations or sand stockpiles.

11. The sand builder worms, Sabellaria vulgaris, often referred to as "coral", are relatives of the bloodworms often used for bait; they are not reef-forming corals. Reef-forming corals all live in warm, shallow, tropical marine environments. Sabellaria are members of the Class Polychaeta in the animal Phylum Annelida, while reef corals are members of the different Phylum, Cnidaria.

12. The star coral, Astrangia danae occurs in Delaware Bay, and is found from Cape Cod to Florida. It is our only shallow water, northern coral and is found on pilings, rocks, and shells. It is subtidal, occurring from shallow depths to 36 meters. Limited tolerance for brackish water and turbidity, plus lack of suitable attachments inshore, may account for its scarcity along most of the coast. The star coral occurs in colonies that consist of low cuplike corallites, 5-6 mm in diameter, united by a thin crust, or sometimes forming low branching groups several inches across (Gosner, K. 1978. A Field Guide to the Atlantic Seashore, Houghton Mifflin Co.). No star coral was found at either Site MS-19 or LC-5.

13. Sabellaria are found from Cape Cod to Georgia, and are easily mistaken for corals. They live in tubes constructed out of sand grains; these tubes often occur together in large enough numbers to form reefs. Sabellaria also have a crown of threadlike structures which protrude from the open end of the tube similar in appearance to the tentacles of reef corals(Burton, W. 1997. Versar, Inc. Personal Communication). They grow to a length of one to two inches, usually on hard substratum. They occur from lower intertidal to subtidal at shallow depths, including estuaries in salinities above 15 ppt (Gosner.1978). They form productive aquatic habitats which provide food for fish, which are attracted to the Sabellaria colonies (Tinsman, J. 1997. DNREC. Personal Communication).

14. Effects on Sabellaria populations by the proposed sand stockpiling of dredged material, will likely be very localized. Sabellaria are common in many areas of the east coast of the United States and produce large numbers of planktonic larvae which will soon

recolonize any affected areas with suitable habitat.

15. It is also unlikely that any significant populations of Sabellaria occur within the MS-19 sand stockpile area. Of the 80 locations sampled, Sabellaria was collected at one site at rather low concentrations. In addition, the substrates encountered at MS-19 were sands rather than the hard substrates necessary for Sabellaria to establish themselves. The populations in Delaware Bay would be expected to be located in water containing rocks, boulders, shell, or stones in a sand substrate. It is less likely that the sand worms would occur on site LC-5, which has more silt and clay content in its substrate, and none were found during benthic sampling.

16. Even though few (Site MS-19) or no (Site LC-5) Sabellaria were found at the sand stockpile sites, they may still occur in these locations, since their distribution is "patchy". Local fisherpersons report that sand worms occur either in or near the sand stockpile areas. The Corps of Engineers shares the concerns of the fishing public that no adverse impacts occur to important aquatic resources and will further address this concern in the next study phase, Plans and Specifications. This additional work is scheduled to be initiated in early 1999. As part of these efforts a meeting will be held to set a course of action and determine if a hearing is appropriate.

- Keep sand as far as possible from the Mispillion Jetties.

17. Action: The sand would be placed at least 2 miles from the south jetty and should not cause significant additional amounts of sediment to be deposited there.

- 18. It was suggested that as much sand as is needed for beach nourishment at Slaughter and Broadkill beaches be placed on these beaches and the rest be put at Buoy 10.

WHAT AGENCIES?

19. Action: The resource agencies have requested that all the dredged material in the Bay be used for beneficial uses and not placed at Buoy 10.

- 20. What would be the cost to the fishing industry if the sand was placed at the stockpiles?

21 Action: As stated in the FSEIS, placing sand at the stockpile areas is not expected to have an overall significant impact on the benthic resources of Delaware Bay, as supported by the sampling data.

22 • Some of the charter fishing boats draw more than 3 feet and will run aground at the sand stockpiles.

Action: Most large boats have depth sounding equipment to identify shallow areas.

#1 ADDENDA
memo to file 6

ADDENDA 2

DMS RESPONSE TO
R.L. Callegari MEMORANDUM
To Files Re: meeting on July
10, 1997 AT U.D.-CMS, LEWES, DE

ADDENDA:

1 A 1 ½ hour tape of this meeting is available

2 Without exception all in attendance not representing ACE, DNREC or the news media requested a public hearing. Mr. Brady responded to a question raised by State Senator Bunting that a request from a U. S. Senator should be sufficient, but that was not his decision to make.

3 No comment was made during this meeting related to this paragraph. This paragraph not presented.

4 No comment was made during this meeting related to this paragraph. This paragraph not presented.

5 No comment as this paragraph was not presented.

6 This paragraph was not presented.

7 This was not a general statement. A review of the tape of this meeting indicates that a considerable amount of time was spent on the wave transport of this material. This "Action" statement is a reflection of the Corp's "denial" state and does not address the questions raised during this discussion.

8 There was very little discussion of the sabelleria vulgaris during this meeting. There was a live display of bottom life of the habitat at location MS-19 and L-5. The comment was that if a charter boat captain could find these aquatic life, so could the ACE.

9 The re-direction of 1.4 million cu yds of dredged material from the planned stockpiling at MS-19 to Kelly Island is evidence that MS-19 originally had an excess of material stockpiled for future use. This fact also suggests that MS-19 is being used principally as a disposal site.
A long discussion followed regards costs and the use of the Buoy 10 disposal site, and the multiple handling of dredged material. Comment was made as well as supportive calculations that 3.3 million cu yds of dredged material would cover beach and roof tops of dwellings on both communities.

10 Not discussed. However Mr. Callegari's comment that stockpiling will have no impact on the benthic community is not in any way support]able. All evidence in the FSEIS which includes statements from the EPA and the Dept.of the Int. contradict Mr. Callegari's comment emphatically.

11 There are studies conducted by a previous professor at the U of D College of Marine Studies concerned with the reefs of the Delaware. Dr. Larry Curtis, previously conducted a study of the distribution Sabelleria Larvae. The large numbers of these larvae implied that the source was not only a prolific one but these larvae were produced by large colonies

ADDENDA: NO 2
DMS RESPONSE TO
MEMO TO FILES 1.

Addenda 2

DMS Response To R.L. Callegari Memorandum To Files Re: Meeting on July 10, 1997 held at UD-CMS Lewes, DE

Pg 2 of 2

of the Sabelleria structures.

12 No comment

13 Not discussed, but agree

14 Not discussed

15 Not discussed. This is conjecture

16 Not discussed. The relevance to this meeting is obscure.

17 No comment

18 Agree. If material not contaminated. See DMS letter related to contaminants.

19 What agencies ? EPA suggested a beneficial use of materials but did not direct that the buoy 10 site not be used. DNREC asked for clean sand with no comment about not using buoy 10 site. This comment "action" not qualified.

20 This question was not asked. It was stated that the fishing industry contributed millions of dollars to the Delaware economy and also provided the livelihood of many small businesses.

21 Fail to see the relevance of this "action". This is another example of the ACE using a "mean" to answer the specific. Not an acceptable comment.

22 Frankly, this is a meaningless response to a non-question.

The enclosures to Mr. Callegari's "Memorandum to Files" were not part of the discussion. It appears that these enclosures are an inadequate attempt to justify the ACE "denial" position.

As this was not a meeting of record according to Mr. Brady, Mr. Callegari's "Memorandum to Files" has no significance.

RLMartin

ADDENDA: No. 2
DMS Response to
memo to Files 2.

CENAP-PL-E
6554/am
30 MARCH 1998
BRADY
PASQUALE
LULEWICZ
BURNES
CALLEGARI

Environmental Resources Branch MAR 30 1998

Ms. Belva-Ann Prycl
President, Board of Directors
EAGLE
Post Office Box 347
Greenwich, New Jersey 08323

Dear Ms. Prycl:

Thank you for your letter dated March 9, 1998, concerning comments on the Delaware River Main Channel Deepening Project. I am enclosing a copy of the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997 (Enclosure 1), which should provide answers to many of your concerns.

Impacts of dredged material disposal on horseshoe crabs is discussed in Sections 3.3.2.7 and 9.1.5. Dredging has been conducted in the Delaware Bay for many years. During this period of time, horseshoe crab populations have gone through increases and decreases. These population changes have not been correlated to dredging. This project has a number of features that will benefit the spawning habitat of the horseshoe crab by providing additional spawning habitat through the beneficial use of dredged material as described in Sections 3.3.3.2 and 9.1.5 of the FSEIS.

Concerning the risk of oil spills, the deepened channel will reduce the magnitude of lightering operations that normally occur on a regular basis in the Delaware Bay and the related environmental risks that accompany this operation. With the reduction of lightering, there will be less barges moving on the river, while the number of oil tankers will remain the same, with the larger tankers in the fleet carrying more oil directly to the refinery docks due to the deeper channel. The reduction in overall barge traffic will reduce the risk of collisions. In addition, as part of the proposed deepening project, the channel bends will be widened and rock at Marcus Hook will be removed. These actions will result in a safer navigation channel. Finally, according to the U.S. Environmental Protection Agency, the oil spill responses network established by the U.S. Coast Guard, Marine Safety Office, Philadelphia is considered to be as adequately prepared to handle oil spills as any in the Nation. This is explained in Section 12.2 of the FSEIS.

In regard to your concerns about the new dredged material disposal areas, a management system will be developed that will provide wetland habitat on portions of all of the four new disposal areas, and is described in detail in Section 3.2.3 of the SEIS. An additional 372 acres of adjacent undeveloped area that includes some high quality fresh water tidal marsh (including portions of the nationally and state significant areas) will be purchased and maintained in its natural state. Section 6.5 describes how the areas will look and possible management practices after they are no longer used for dredged material disposal.

Impacts to bald eagles are described in Sections 10.1.1.1, 10.4.1.1, and 10.5.1.1 of the FSEIS. A Biological Opinion has been received from the U.S. Fish and Wildlife Service which concluded that the project will not have significant adverse impacts on the bald eagle.

As part of final project design, numerous meetings were held with Federal and State resource agencies and interested groups. Their input and review of completed work efforts were used in the refinement of the various features of the recommended project. A Draft Supplemental Environmental Impact Statement was prepared in January 1997. This document was made available to all resource agencies, interested groups and individuals for comment. Responses to all comments were incorporated in the July 1997 Final Supplemental Environmental Impact Statement. Public notices announcing the availability of both the draft and final report were mailed to over 2,000 entities throughout the estuary, and the report was made available at many public libraries. As a result, the Corps believes that adequate coordination was undertaken to involve the public in the review of this project.

As for all Corps projects, the 45-foot channel deepening project has been subject to a rigorous technical review of the economic analysis. The Corps cost-benefit analysis was reviewed and approved by the Secretary of the Army and the Office of Management and Budget prior to authorization by Congress. The project is not expected to adversely impact ecotourism in southern New Jersey, since no significant adverse impacts are expected to occur. To insure that there will not be significant impacts the Corps of Engineers has incorporated a number of environmental features into this project. Many of these are described in the FSEIS, and include managing portions of the new upland dredged material disposal areas as wetlands during the life of the project (Section 3.2), monitoring groundwater and surface water adjacent to new and existing upland disposal areas, employing environmental windows to avoid impacts to environmental resources during dredging operations (Table 1-1), using dredged material for wetland restorations (Section 3.3.3.2), beach nourishment at Delaware Bay beaches, and monitoring of oyster resources before, during, and after construction.

The Corps of Engineers has used a number of "state of the art" techniques to evaluate potential environmental impacts of this project. These include the hydrodynamic/salinity modeling that is described in Section 5 of the FSEIS, and sediment transport/oyster impact modeling that is described in Section 9.3. The project has been reviewed by the United States Environmental Protection Agency who stated in their letter of September 12, 1997 (Enclosure 2) "...we have concluded that the proposed project would not result in significant adverse environmental impacts...". Furthermore, the Commonwealth of Pennsylvania and the states of Delaware and New Jersey have reviewed the project as part of their coastal zone management consistency review. Each concluded that this project was consistent with the Coastal Zone Management Act.

Concerning your request for a public hearing, we intend to do this in the spring of this year. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss specific areas of concern in a less formal setting. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Enclosures

MFR: This letter responds to comments on the Main Channel Deepening Project. It was coordinated with CENAP-PL-PS (Lulewicz).

EAGLE
P.O. Box 347
Greenwich, NJ 08323

U.S.Army Engineer District, Philadelphia
100 Penn Square East
Philadelphia, Pa. 19107-3390
March 9, 1998

RE: DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Dear Sirs:

Estuary Action Group for a Lasting Environment (EAGLE) is a non-profit citizen's organization founded in 1996 for the purpose of education and preservation of the bayshores, species and tidal habitats of southern New Jersey. Our organization is comprised of over 300 members and sponsors, people who value the natural attributes that make this area such a unique and irreplaceable resource. Because the channel deepening project is a massive undertaking with far-reaching effects to the entire bay ecosystem, and because those potential effects are on both animal and human populations, we are writing to request a formal public hearing on this project.

We believe this is needed for the following reasons:

(1)-Negative impacts of longterm dredging on the declining population of Delaware Bay horseshoe crabs;

(2)-Safety concerns involving the handling of oil spills and effects of an accident event on horseshoe crab spawning activity and the hemispheric shorebird migration;

(3)-Number of new spoil sites, and the practicability and effects of traditional reclamation practices, as well as attendant impacts to wildlife;

(4)-Disturbance of nesting eagle sites and disturbance of potential optimum habitat sites for bald eagles;

(5)-Lack of sufficient opportunity for public comment among affected communities and groups within the estuary.

(6)-Questionable regional economic benefits and impacts to ecotourism, an growing industry intimately linked to maintaining a healthy environment and a focus of much of the tourism enterprise in southern New Jersey.

We note that there has been no project proposed in recent years within the estuary which has the potential to so radically alter the region. Concerns are justified: the history of containing oil spills has not been a particularly promising one; predictions and models about dredging impacts have often resulted in outcomes that required radical hydrologic changes or outright reversals of previous policy in order to mitigate; and the cumulative impacts of many small changes within the estuary can have longterm results for the resource as a whole, as has been observed in the unforeseen demise of Chesapeake Bay seagrass beds due to nutrient-loading and turbidity. The potential natural and human impacts of this project, we believe, demand a public hearing process in order that all concerns may be raised and evaluated in an open forum.

We thank you for the opportunity to comment in this process which has important consequences for all the citizens of the region.

Belva-Ann Prycl

Belva-Ann Prycl President
Board of Directors, EAGLE

Individuals

Ref. No.	Source	Date	Comment Topics
26.	Bossert	8-20-97	Erosion at Broadkill Beach, DE Bay Disposal
27.	Conte	8-25-97 9-29-97	Broadkill Beach, DE Bay Disposal
28.	Dressler	9-30-97	Public Hearing, Economics, Public Invol.
29.	French	9-29-97	Economics, Oil Spills
30.	Malkiewicz	9-30-97	CDFs, DE Bay Disposal, Impacts to Fin Fish and Shellfish, Sediment Quality, Oil Spills, Public Hearing
31.	Nygood	8-8-97	Impacts of Dredging, DE Bay Disposal, Economics, Impacts on fishery
32.	O'Herron	8-30-97	Shortnose Sturgeon
33.	Plantan	9-30-97	Aquatic Resources, DE Bay Disposal, Water Quality, Salinity, Public Hearing
34.	Thompson	8-15-97	Pea Patch Island

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Joan Bossert
8 N. Carolina Avenue
Broadkill Beach, Delaware 19968

Dear Ms. Bossert:

Thank you for your letter dated August 20,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The structure located at North Carolina Avenue in Broadkill Beach is a shore perpendicular groin and was constructed in 1954 to alleviate a progressive erosion problem in the area. It is a timber crib-stone filled type groin. During the recent Corps Broadkill Beach feasibility study, this groin was inspected and found to be in extremely poor condition. The groin was buried beyond the high water line, the wood rotted, the steel rusted and corroded, and there was almost no stone left in the cribbing structure. The groin in this condition is not effectively functioning to trap any significant amount of littoral transport (sand).

North Carolina Avenue is within the region of Broadkill Beach that historically experienced the largest shoreline recession rates of 8 to 10 feet per year taking into account the numerous beachfills that have been placed in this area. Since 1957 this area has required and received the largest amount of fill within Broadkill Beach in order to maintain the shoreline. Approximately 160,000 cubic yards of sand per linear foot of shoreline has been placed between Main and Florida Streets during the past 40 years.

The *Final Feasibility Report and Environmental Impact Statement* for Broadkill Beach was completed in September 1996. The proposed plan was found to be technically sound, economically justified, and socially and environmentally acceptable. However, the current Administration's budgetary policy precludes further Federal participation in the design and construction of hurricane and storm damage reduction projects. This means that the feasibility phase of study was completed, but Federal funds will not be budgeted for future construction of this project.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

The proposed project will not increase the risk of oil spills in the Delaware Bay. The deepened channel will reduce the magnitude of lightering operations that normally occur on a regular basis in the Delaware Bay and the related environmental risks that accompany this operation. With the reduction of lightering, there will be less barges moving on the river, while the number of oil tankers will remain the same, with the larger tankers in the fleet carrying more oil directly to the refinery docks due to the deeper channel. The reduction in overall barge traffic will reduce the risk of collisions. In addition, as part of the proposed deepening project, the channel bends will be widened and rock at Marcus Hook will be removed. These actions will result in a safer navigation channel. Finally, according to the U.S. Environmental Protection Agency, the oil spill responses network established by the U.S. Coast Guard, Marine Safety Office, Philadelphia is considered to be as adequately prepared to handle oil spills as any in the Nation. This is explained in Section 12.2 of the FSEIS.

Thank you for your comments and interest in this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

1-20-11

Dear Mr. Brady -

I live a 8 N. Carolina Ave., Broadkill Beach, Milton, DE. 19968 in the summer.

Our jetty at our street was put in Backwards many, many years ago. It was never changed, and as a consequence our beach is gone. All our sand is in front of North Shores in Broadkill.

We have been promised beach replenishment for years, but they never, ever completed the job. Now the sand from the dredging of the bay, some of which was to be headed our way has been shelved, because it will cost about $1.00 a cubic yard more to put it on the beaches.

Well, isn't that just about the straw that broke the camel's back.

All I can say is a promise doesn't mean much anymore. We were willing to risk the obvious (oil spills) for the sake of beach replenishment. Now we're supposed to believe dumping 4 feet of sand on the coral beds in the bay won't change the environment. That's the biggest joke yet.

Would you like to be lied to over and over? Well neither do I. Just sign me disgusted with Politics and politicians

Sincerely
Joan Bossert

CENAP-PL-E
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25 FEBRUARY 1998
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CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Robert A. Conte
406 Maple Avenue
Wilmington, Delaware 19809

Dear Mr. Conte:

Thank you for your letters dated August 25, and September 29,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement*, (FSEIS), dated July, 1997.

The *Final Feasibility Report and Environmental Impact Statement* for Broadkill Beach was completed in September 1996. The proposed plan was found to be technically sound, economically justified, and socially and environmentally acceptable. However, the current Administration's budgetary policy precludes further Federal participation in the design and construction of hurricane and storm damage reduction projects. This means that the feasibility phase of study was completed, but Federal funds will not be budgeted for future construction of this project.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

Thank you for your comments and interest in this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

406 Maple Ave.
Wilmington, DE 19809

August 25, 1997

District Engineer
U.S. Army Engineer District, Philadelphia
100 Penn Square East
Philadelphia, PA 19107-3390

re: Delaware River Main Channel Deepening Project
Final Supplemental Environmental Impact Statement, July, 1997

re: Broadkill Beach, DE, Interim Feasibility Study, Final Feasibility Report and Environmental Impact Statement, September, 1996

Engineers,

In the referenced Channel Deepening Project, two beneficial use sand stockpile sites, MS-19 and L-5, lie wonderfully close inshore to Slaughter Beach, DE and to Broadkill Beach, DE respectively.

The referenced Broadkill Beach, DE Study calls out a large scale sand nourishment project to stabilize and protect Broadkill Beach.

Because the two Corps' studies seem to complement each other in design and relative time frame, marry them to take the dredged channel sand directly onto the beaches as nourishment.

Such an effort could be more cost efficient than the two done separately, and may also spare the burial of Bay floor biosystems, e.g. the area commonly known as the coral beds.

Thank you for your consideration.

Sincerely,

Robert A. Conte

Robert A. Conte

406 Maple Ave.
Wilmington, DE 19809

September 29, 1997

Mr. John Brady
U. S. Army Corps of Engineers
U. S. Army Engineer District-Philadelphia
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Brady,

I support the Corps' project to deepen the Delaware River and Bay channel to 45 feet. Allowing deeper draft ships to go to the upriver ports without pumping a portion of their cargo into barges will reduce the threat of an oil spill in the Delaware Bay.

I have read the Corps' "Delaware River Main Channel Deepening Project Supplemental Environmental Impact Statement" dated July, 1997, and found it to be comprehensive in its scope and I agree with its conclusions.

Sincerely,

Robert A. Conte

Robert A. Conte

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY

PASQUALE

LULEWICZ

KAMPER

MARALDO

BURNES

CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Erik R. Dressler
108 N. Main Street
St. Georges, Delaware 19733-0348

Dear Mr. Dressler:

Thank you for your letter dated September 30, 1997 concerning comments on the Delaware River Main Channel Deepening Project.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

The 45 foot channel deepening project has been subject to a rigorous independent technical, economic and environmental review process. The Corps economic analysis was reviewed and approved by the Secretary of the Army and the Office of Management and Budget prior to authorization by Congress. Once constructed, the 45 foot channel will benefit the local community through transportation cost savings. Deeper draft vessels, which can hold more cargo, will now be able to navigate the 45 foot channel. The increased efficiency of transporting commodities (by allowing more fully laden ships to transit the waterway and by reducing lightering operations in the Delaware Bay) will result in annual cost savings of about $40 million.

In addition, the project sponsor, the Delaware River Port Authority, has expressed continued interest in the project and [redacted] is preparing a financial plan for non-Federal share of project costs.

The working group for the C&D Canal project is composed of 17 members, including 5 public citizens, as well as others from Federal and state agencies and other private organizations. The group decided when they would like to meet; the time was mutually established, and not decided solely by the Corps of Engineers.

Thank you for your comments and interest in this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Erik R. Dressler
108 N. Main Street
St. Georges, DE., 19733-0348

30 September, 1997

John Brady
District Engineering Headquarters
U.S. Army Corps of Engineers
Philadelphia District
The Wanamaker Building
100 Penn Square East
Philadelphia, PA., 19107-3390

Dear Mr. Brady,

I would like to express my disappointment at what seems to be the standard manner in which the Corps integrates the public into its' projects. Regarding the Delaware River dredging project, it seems that once again avoidance of direct public involvement is the rule.

It is my impression that the Army Corps of Engineers is facing a one billion dollar shortfall this fiscal year. Why is the Corps pursing both the Delaware River and C. & D. Canal dredging projects when such a large amount of red ink is on the page? I believe these two projects represent an amount equivalent to roughly one quarter of that shortfall. I also believe that the purposefulness of both projects is questionable.

As for workshops, when asked to participate in the working group for the C. & D. Canal dredging project, I discovered that because most members of the group were on company time to be there, the meetings were being held at 9:00 am on Tuesdays. Why not simply say "we intend to exclude the public".

At this point in time it is my belief that the Corps should line up behind the IRS for a major review and overhaul.

Respectfully,

Erik R. Dressler

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY

PASQUALE

LULEWICZ

KAMPER

MARALDO

BURNES

CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Robert P. French
7 Liszar Drive
Lewes, Delaware 19958-1252

Dear Mr. French:

This is in response to your letter dated 29 September, 1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The deepening of the Delaware Bay and River shipping channel was economically justified solely on benefits that would be derived from reduced transportation costs from the more efficient movement of commodities. The reduction of oil spills was not used in the economic justification of the project.

The deepened channel will reduce the magnitude of lightering operations that normally occur on a regular basis in the Delaware Bay and the related environmental risks that accompany this operation. With the reduction of lightering, there will be less barges moving on the river, while the number of oil tankers will remain the same, with the larger tankers in the fleet carrying more oil directly to the refinery docks due to the deeper channel. The reduction in overall barge traffic will reduce the risk of collisions. In addition, as part of the proposed deepening project, the channel bends will be widened and rock at Marcus Hook will be removed. These actions will result in a safer navigation channel. Finally, according to the U.S. Environmental Protection Agency, the oil spill responses network established by the U.S. Coast Guard, Marine Safety Office, Philadelphia is considered to be as adequately prepared to handle oil spills as any in the Nation. This is explained in Section 12.2 of the FSEIS.

As for all Corps projects, the 45-foot channel deepening project has been subject to a rigorous technical review of the economic analysis. The Corps cost-benefit analysis was reviewed and approved by the Secretary of the Army and the Office of Management and Budget prior to authorization by Congress.

Thank you for your comments and interest in this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

September 29,1997

7 Liszar Drive
Lewes, DE 19958-1252

302-644-2067

John Brady
Army Corps of Engineers
U.S. Army Engineer District-Philadelphia
100 Penn Square east
Philadelphia, PA 19107-3390

Dear Mr. Brady,

I oppose the Army Corps of Engineers proposal to deepen the shipping channel in the Delaware Bay and Delaware River. Your justification for this major project is that there will be fewer oil spills because tankers will not have to transfer as much of their oil onto barges. In a September 19 article in the Wilmington News Journal your spokesman , Richard Chlan , was quoted " Fewer barges will be needed to take the oil from the ship, so you'll have fewer vessels on the water and fewer transfer operations. Therefore, it would reduce the amount of oil spills in the area". Further in this article Chlan expanded the concept by stating barge transfers would be reduced from three to two for a 150,000 ton tanker.

Using spill data in this same article, it appears that over the last 22 years some 50000 gallons of oil were spilled during lightering operations . This is less than 3% of the 1.8 to 2.0 million gallons of total oil released. Therefore a 1/3 reduction in lightering would possibly reduce spills by 1%.

The major source of oil spills is due to tanker incidents ... 1.7 to 1.9 million gallons or 95% of the total spillage. Using your 150000 ton tanker example, the tanker volume would increase by 27% and therefore it would appear that heavier loaded tankers would increase total spills by over 25%!

In summary the reduced risk of oil spills due to less lightering would be greatly offset by an increased risk of heavier loaded tankers . This combined with the possibility , even though unprovable, of environmental damage clearly dictate that this project should be abandoned.

Sincerely,

Robert P. French

Robert P. French

CENAP-PL-E
6554/am
25 FEBRUARY 1998
BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Michael J. Malkiewicz
Loockerman and State Streets
P.O. Box 1298
Dover, Delaware 19903

Dear Mr. Malkiewicz:

This is in response to your letter dated 30 September, 1997 concerning comments on the Delaware River Main Channel Deepening Project.

In 1992, Congress authorized construction of the Delaware River Main Channel 45-foot Deepening Project based on Corps study findings. The findings addressed comments from the resource agencies and interested parties on the Final Environmental Impact Statement (FEIS). During the current post-authorization work, the Preconstruction Engineering and Design, the design features of the authorized project were refined. This refinement was based on additional engineering detail required by this phase and completion of environmental studies as dictated by the Record of Decision for the Final Environmental Impact Statement that was completed in 1992.

The concerns that are raised in your letter have been addressed in the Final Supplemental Environmental Impact Statement (FSEIS) that was distributed in July, 1997, a copy of which is enclosed for your information. That document reaffirmed the conclusions from the 1992 Final Environmental Impact Statement.

Specifically, impacts of the disposal of dredged material for upland disposal areas has been addressed in Section 6.0 of the FSEIS, and the impacts of the beneficial use sites (ie. wetland restorations and sand stockpiles) in Section 9.0. The impacts to fin fish are discussed in Section 9.2.4, and the impact to shell fish are discussed in Sections 8.0, 9.1.5, 9.2.3, and 9.3.

The Final SEIS also documents that (Section 4.0), based on field sampling and subsequent data analysis, no significant impacts to the aquatic ecosystem are expected from dredging and the disposal of dredged material. None of the sediment samples taken revealed significant levels of contaminants. The fine-grained material from the industrial northern portion of the project area will be placed in upland, confined dredged material disposal facilities, away from the river. The sediment toxicity data from this project was reviewed by the Corps of Engineers' Waterway Experiment Station, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the New Jersey Department of Environmental Protection, the Delaware Department of Natural Resources and Environmental Control, and the Pennsylvania Department of Environmental Protection. The U.S. Environmental Protection Agency in a letter dated 17 March 1997 stated that "...EPA continues to believe that there will be no adverse impacts associated with the disposal of sediments generated by the project". In addition, in their letter of 12 September 1997, the U.S. Environmental Protection Agency stated that "... we have concluded that the proposed project would not result in significant adverse environmental impacts; EPA has no objection to the implementation of the proposed project." Neither the U.S. Department of the Interior (parent agency of the U.S. Fish and Wildlife Service) in their letter of September 11, 1997, nor the U.S. Department of Commerce (parent agency of the National Marine Fishery Service) in their letter of September 29, 1997, have expressed any concern about contaminants in the dredged material. Furthermore, the Commonwealth of Pennsylvania and the states of Delaware and New Jersey have reviewed the sediment data as part of their coastal zone management consistency review. Each concluded that this project was consistent with the Coastal Zone Management Act.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

As stated in Section 12.0, we do not believe that this project will increase the potential for oil spills. In addition to the reduction in lightering that would result from this project, bends will be widened and dangerous rock near Marcus

Hook will be removed. These actions should result in a safer navigation channel which should result in less oil entering the water. According to the Environmental Protection Agency, the oil spill response network established by the U.S. Coast Guard, Marine Safety Office, Philadelphia is long established and is considered to be as adequately prepared for oil spill response as any in the Nation.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and interest in this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Enclosure

LAW OFFICES OF
BARROS, McNAMARA, SCANLON, MALKIEWICZ & TAYLOR, P.A.
LOOCKERMAN AND STATE STREETS
P.O. BOX 1298
DOVER, DELAWARE 19903

TELEPHONE
(302) 734-8400
TELEFAX
(302) 734-4349

A. RICHARD BARROS
EDWARD R. McNAMARA
PATRICK SCANLON
MICHAEL J. MALKIEWICZ
ROBERT J. TAYLOR
J. JAY LAZZERI
BRADLEY S. EABY
ELIZABETH Y. OLSEN

September 30, 1997

VIA FACSIMILE (215)-656-6820

Mr. John Brady
Army Corps of Engineers
U.S. Army Engineer District-Philadelphia
100 Penn Square East
Philadelphia, PA 19107-3390

RE: Army Corps of Engineers' Plan to Deepen the Delaware River Channel
Public Comment and Request

Dear Mr. Brady:

I am a recreational fisherman in the State of Delaware. My family and I fish in the Delaware Bay and believe that we would be negatively impacted by the Army Corps of Engineers' plan to deepen the Delaware River shipping channel, and dispose of the dredge material at various locations in and around the Delaware Bay.

I ask that this letter be made part of the record in the above proceeding.

My first request is that there be a public hearing on the Army Corps of Engineers' plan. My second request is that more than one public hearing be held, and that the hearings be held in all of the relevant counties in both the State of Delaware and New Jersey. I also ask that the hearings be held at a time where members of the public will not have to take off of work to attend the hearings.

I also ask that the Army Corps of Engineers prepare a complete Environmental Impact Statement relating to the project. If the Environmental Impact Statement has been prepared, I request that the contents of the document be updated to the time the dredging is to begin. In other words, the information contained in the Environmental Impact Statement could be based on the irrelevant or untimely information at the time the document was prepared.

Furthermore, the contents of the Environmental Impact Statement do not adequately address the issue of what will happen to the areas where the dredge spills will be disposed of in and around the Delaware Bay. There has been insufficient study on the potential impact on fin fish and shell fish in these disposal areas.

In addition, there has been insufficient study on the potential impact that an oil spill or petroleum spill would have on the fisheries in the Delaware Bay, and on the wetland environment that boarders the

Delaware and New Jersey coast lines. In addition, there needs to be a study about the potential financial impact a petroleum spill would have on residents living on the Delaware and New Jersey coast lines, the commercial and recreational fisheries operating in the Delaware Bay, and the wetlands that boarder the Delaware Bay on the New Jersey and Delaware coastlines.

Sincerely,

BARROS, MCNAMARA, SCANLON,
MALKIEWICZ & TAYLOR, P.A.

Michael J Malkiewicz/jld

DICTATED BUT NOT ...

Michael J. Malkiewicz

MJM/jld

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY
PASQUALE
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KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Howard Nygood
Howard & Blackie Nygood
R.D. 2, Box 217
Georgetown, Delaware 19947

Dear Mr. Nygood:

Thank you for your letter dated August 8,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The dredging of the main navigation channel of the Delaware River/Bay to an additional 5 feet is not expected to have any significant adverse impacts to the aquatic resources of Delaware Bay. The channel is currently dredged to maintain a 40 foot channel, and the aquatic environment in the channel is generally impoverished. Coordination under Section 7 of the Endangered Species Act was conducted with both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service as described in Section 10 of the (FSEIS). Both agencies reported that there should be no significant adverse impacts to species under their authority. The project has also been coordinated with the Mid-Atlantic Fisheries Management Council, and they have not objected to the proposed dredging activities.

The present beneficial use dredged material disposal plan includes both direct placement of sand at the shoreline, and at other locations, placement of sand nearshore in the form of submerged sand stockpiles. The sites with direct placement of sand at the shoreline include the wetland restoration/protection projects at Kelly Island, Delaware, and Egg Island Point, New Jersey. There is no site proposed in this project which includes placement of silt which will be directly exposed to the coastal estuarine environment.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

Rather than a "costly folly", beach nourishment, or "replenishment," is one engineering solution to the widespread problems of shoreline erosion and coastal storm damage potential. Beach nourishment projects constructed by the Corps of Engineers, at the direction of the United States Congress and with funds provided at least in part by non-Federal sponsors, have been subject to rigorous evaluation for costs and benefits before authorization and construction. These projects are typically constructed at coastal locations which have an underlying deficit of sandy sediment. Beach nourishment is simply the replacement of eroded beach sediment with sand obtained from a "borrow" source and transported to the affected beach. Several bay beaches in Delaware have experienced beach erosion which has been addressed historically through both Federal and State beach erosion control projects. The Delaware River Deepening project presents an opportunity for the State of Delaware to obtain a large quantity of beach-quality sand at a significantly reduced cost compared to the cost of locating and dredging from adequate borrow sources.

As stated in the previous paragraphs, no significant adverse impacts are expected to occur to aquatic resources of Delaware as a result of this project, and therefore there should be not significant adverse impacts to Delaware's recreational fishing industry.

Thank you for your comments and interest in this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Howard & Blackie Nygood
R.D. 2, Box 217 • Georgetown, DE 19947
Phone/Fax 302-856-2199

RIVERLANE DACHSHUNDS

RIVERLANE BASSETS

8 August 1997

Department of the Army
Philadelphia District Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19102-3370

Gentlemen:

Regarding the "Delaware River Main Channel Deepening Project", having attended the meeting a month ago at the College of Marine Studies in Lewes, DE and having reviewed the supplemental environmental impact study, I wish to go on record as being opposed to any dredging of the main Delaware Bay channel and the dumping of any spoil.

As an environmentalist and recreational fisherman who fishes in Delaware Bay 60-80 times a year I question whether or not dredging and disturbing the inshore bottoms and the edges of the main channel violates sections of the Magnuson Act and the Endangered Species Protection Act by destroying essential habitat and certainly dumping any spoil on the proposed locations, i.e, the coral beds and anywhere in the Broadkill sloughs endangers many species of aquatic life and threatens bottom structures that are home to same and destroys a necessary feeding chain.

Prime recreational fishing areas are along the edges of channels and dropoffs where predator/game fish feed. The coral beds is probably the best bottom for black drum fishing on the East Coast of the US. In fact, Delaware Bay produced an IGFA all-tackle record for this species. The coral beds and Broadkill sloughs are also prime fishing area for fluke, gray trout, bluefish and striped bass as well as other species. The mussel beds, grass bottoms and coral bottoms found in many deep water areas of the Bay are home to aquatic species on which black sea bass, porgies, croaker, kingfish and tautog feed. Dredging any of this bottom or dumping spoils on it can be considered downright destruction.

As for the proposal for dumping spoil on beaches for replenishment, we are looking at costly folly. Beaches from Ocean City to Cape Henlopen have been recipients of past replenishment efforts only to have storms destroy again and again the results of these costly projects. Redistribution and buildup of silt is likely to have more detrimental than beneficial impact than the more slowly-evolving natural changes on coastline.

My concerns as a Delaware resident and taxpayer re this project focus on the substantial revenue that businesses in this state receive from recreational fishermen who ply the few miles of the Delaware coastline in pursuit of their hobby. A cost benefit analysis impact study will show that several million dollars is spent annually by out-of-state sportsmen as well as Delaware residents on accomodations, meals, tackle, bait, ice, fuel, boats and equipment, launching fees, docking accomodations and charter and headboat fees. By destroying fish habitat, a significant portion of this revenue can very easily be transferred to adjacent and nearby states, namely NJ, MD, VA and NC.

The health of Delaware's economy is crucial to Delaware residents and should not be sacrificed for the profits of international and Philadelphia shipping interests.

Sincerely yours,

Howard Nygood

Howard Nygood

HN:bhn

cc: Senator Biden
Senator Roth
Representative Castle
Governor Carper
Secretary Tulou
Mike D'Amico
The Fisherman

CENAP-PL-E
6554/am
20 JANUARY 1998

BRADY JP

PASQUALE JP

LULEWICZ

~~KAMPER~~

~~MARALDO~~

BURNES

CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. John C. O'Herron, II
O'Herron Biological & Environmental Consulting
220 Washington Street
Mount Holly, New Jersey 08060-1646

Dear Mr. O'Herron:

Thank you for your letters dated August 30,1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The endangered shortnose sturgeon (*Acipenser brevirostrum*) is under the authority of the National Marine Fisheries Service (NMFS), under Section 7 of the Endangered Species Act. As stated in the FSEIS, the Philadelphia District prepared a biological assessment for the District's dredging activities and submitted it to the NMFS. On November 26, 1996 the National Marine Fisheries Service (NMFS) issued a "Biological Opinion" for all dredging projects permitted, funded, or conducted by the District, including the channel deepening project. The Opinion stated that dredging projects within the Philadelphia District may adversely affect sea turtles and shortnose sturgeon, but are not likely to jeopardize the continued existence of any threatened or endangered species under the jurisdiction of the NMFS for dredging activities within the District.

Your concerns, that were stated in your comment letter to the draft SEIS, were transmitted to the NMFS. NMFS responded (Karen Green, Personal Communication, February 24, 1997) that:

1. The Delaware Basin Fish and Wildlife Management Cooperative's restrictions on dredging were sufficient to protect the shortnose sturgeon.

2. The behavior of juvenile shortnose sturgeon is still not known.

3. The findings of the "Biological Opinion" are valid. If their recommendations are followed, there will be no jeopardy to this species. However, consultation may be reinitiated if conditions change, or the take authorized by the Incidental Take Statement is exceeded.

4. Additional studies of the age structure and sex ratios of shortnose sturgeon populations in the Delaware River, feeding habits, and areas of significant habitat would provide insight into the behavior of this species in the Delaware River, especially the juveniles. However, these studies are not required under the terms of the Biological Opinion; they are considered conservation recommendations.

NMFS has been involved throughout the conduct of our final project design. Our findings were based on recommendations of the NMFS, and subsequent conclusions reached by NMFS. Since NMFS has the legal authority over this endangered species, we must defer to their expertise and findings.

Thank you for your comments and continuing participation in the review of this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

O'HERRON BIOLOGICAL AND ENVIRONMENTAL CONSULTING
220 Washington Street
Mount Holly, New Jersey 08060-1646
Voice and facsimile (609) 261-0711; e-mail JOHERRON@VOICENET.COM

August 30, 1997

Attention: Environmental Resources Branch

U.S. Department of the Army
Philadelphia District, Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Re: Final Supplemental Environmental Impact Statement, Delaware River Comprehensive Navigation Study, Main Channel Deepening Project. July, 1997. U.S. Army Corps of Engineers, Philadelphia District.

Dear Sirs/Madams:

The responses to my comments to the Draft Supplemental Environmental Impact Statement (January, 1997) for the above-referenced project were inappropriate to the issues raised because both of the references cited (the November 26, 1996, Biological Opinion conducted by National Marine Fisheries Service, Northeast Regional Office and a personal communication with Ms. Karen Green, NMFS) by U.S.A.C.O.E. expose reasons for concluding that there is high potential for negative impact to the Delaware River shortnose sturgeon (*Acipenser brevirostrum*) population, yet conclude otherwise. As an example, from a purely logical standpoint consider this - no one knows quite where the juvenile population occurs. Studies elsewhere have found high concentrations of juveniles immediately upstream of the salt line in channel depth waters. This is a widely fluctuating location in the Delaware Estuary due to the effects of the tides played against the daily and seasonal meteorological regimes. Hence, the juvenile population may at any one given time be somewhere between Chester, Pennsylvania and Artificial Island, New Jersey (higher or lower in the estuary than that during severe meteorological extremes). Now here we are willing to dredge where there are small, juvenile fish that lack the motility of their adults and we know that the adults can be entrained by dredges. Furthermore, the juveniles are typically in concentrated aggregations where found. The juveniles of any species are what continue the species' existence; a sort of legacy for the future. Like many fish, shortnose sturgeon do not have stable year classes. In fact, those of the Delaware River are severely limited by the character of each year's late winter and spring season meteorology. It is plainly irresponsible to contemplate channel dredging when the juvenile population is knowingly at risk. It is true that juveniles of the Delaware Estuary shortnose sturgeon population have been subject to channel maintenance dredging of some sort for over 150 years and the population still survives. What also may be true is that the juvenile shortnose sturgeon population has been under duress during that entire period and will continue to suffer aperiodic negative dredging impacts that relate negatively to the overall survivability of the population until such time as dredging activities are knowingly conducted away from aggregations of juveniles and are considerate of their habitat.

The recent dredging restrictions developed by the Delaware Basin Fish and Wildlife Management Cooperative are frequently held out as a guard against dredging impacts to shortnose sturgeon. I have had opportunity to evaluate them when they were in draft and concluded that they are not protective of shortnose sturgeon. The problem is the very circumstances of the occurrence of shortnose sturgeon in the Delaware Estuary. Additionally, any monitoring of negative impact is ineffectual and post-active which means that considerable mortality can occur and the observation of any at all will only be done serendipitously.

I ask that U.S.A.C.O.E. reread my comments with some open-mindedness. To forge ahead with this project in the face of unknowns regarding an endangered species is foolish at best and probably otherwise an action of poor intent. As well, I am available to discuss much more than this in detail.

Sincerely yours,

John C. O'Herron, II

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Margarate Plantan
135 Delaware Avenue
Woodland Beach
Smyrna, Delaware 19977

Dear Ms. Plantan:

Thank you for your letter dated September 30,1997 concerning comments on the Delaware River Main Channel Deepening Project.

We do not believe that your livelihood will be impacted by this project. As explained in the Final Supplemental Environmental Impact Statement (FSEIS), no aspect of the project is expected to have a significant impact on aquatic resources. The project will restore over 200 acres of tidal marsh which provides habitat for many aquatic species.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

We are not aware of dredging related water quality problems at Woodland Beach. The water in this reach of the Delaware Bay is naturally brackish and can range up to 18 parts per thousand (ppt) of salt, depending on the time of year, recent freshwater inflows, and the tidal cycle. The mouth of the Smyrna River is located at about River Mile (RM)45 of the Delaware River. RM43 is the data save location in the modeling closest to the mouth of the Smyrna River for the Delaware River Main Channel Deepening Project. The simulations of the drought of record, from June through November 1965, indicate that salinity over this period ranged from a low of 13 ppt to a high of 26 ppt, compared to open-ocean salinity in the range of 30 to 34 ppt. Simulations of the June to November period with average monthly inflows indicate a salinity range from a low of 7 ppt to a high of 21 ppt at RM43. The modeling of the deepened channel compared to the existing channel indicates that salinity changes at RM43 will typically be on the order of 0.1 to 0.2 ppt. This is viewed as an insignificant change to a very dynamic natural salinity regime, and will have no perceptible change on any living resources in the vicinity of Smyrna River.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and interest in this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Mr Brady -

My husband's livelyhood de-pends on the Delaware Bay area, he is a waterman and this dredging will end our way of life. It is imperative that there be hearings on this issue, the oil companies have plenty of money we have Social Security. You know as well as we do that all the little people on both sides of the river will go under. We already have brackish water because of dredging. I and my husband wants hearings for the little people. Oil companies be damned!

Marguerite Easter
135 Delaware Ave
Woodland Beach
Smyrna Del 19977-9757

Here's a project for your engineers, get us fresh water.

CENAP-PL-E
6554/am
20 JANUARY 1998
BRADY JR
PASQUALE JR
S.L.
LULEWICZ
~~KAMPER~~
MARALDO
BURNES JMB
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Sue Thompson
1930 Thomas Road
Wilmington, Delaware 19803

Dear Ms. Thompson:

This is in response to your August 15, 1997 letter regarding the shoreline erosion problem on Pea Patch Island and the proposed Delaware River Main Channel Deepening Project.

The Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement dated July, 1997 includes sections on the history of Fort Delaware, Pea Patch Island and on the potential impacts the proposed project may have on the island's historic archaeological shoreline deposits. These sections can be found in Chapter 11, Sections 11.1.6 and 11.3.9. A copy of this report is attached for your information.

The Philadelphia District evaluated the potential for increased shoreline erosion on Pea Patch Island. Although the hydraulic analyses predict a slight increase of approximately 4% in wave height as a result of deepening the channel from 40 to 45 feet, the resulting impact on the present erosion rate would not be significantly increased. A review of hydrographic data adjacent to Pea Patch Island show that the majority of channel depths are well below the depth of 45 feet. Consequently, the improved channel will not significantly affect the existing channel side-slope profiles and will not result in a movement of the Federal channel closer to the island.

Nonetheless, in an attempt to avoid the potential for an adverse effect on Pea Patch Island and to ensure the integrity of the resource, the District will be sending a notification of adverse effect and requesting a copy of the comments of the Advisory Council on Historic Preservation. The District anticipates that completion of shoreline stabilization prior to the proposed Delaware River Main Channel Deepening activities will avoid or mitigate erosion impacts.

The current operation and maintenance of the existing 40 foot navigation channel, in conjunction with the failure of the shoreline seawall on Federal property, is having an adverse effect on the shoreline erosion on Pea Patch Island. To that end, the District is conducting an evaluation of alternatives for shoreline stabilization at Pea Patch Island in connection with the ongoing operation and maintenance of the Delaware River 40 foot Federal Navigation Project and has met with the State of Delaware and their consulting firm to review alternative plans. The Corps has requested funds to initiate the repairs as part of the operation and maintenance of the existing 40 foot project; funding has not been made available.

I hope that this information has addressed your questions and concerns. Please do not hesitate to contact Mr. Michael Swanda, Environmental Resources Branch at (215) 656-6556 if you have further questions or require additional information.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Enclosure

MFR: Coordinated with CENAP-DP-M.

August 15, 1997

Mr. Robert L. Callegari
US Army Corps of Engineers, Philadelphia District
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

I have just read of the Philadelphia District Corps of Engineers' plan to dredge and deepen the main shipping canal of the Delaware River–a plan that will have great impact upon Pea Patch Island which, amazingly, is not included in the Environmental Impact Study the Engineers have conducted.

The Corps of Engineers has apparently openly neglected the part of the island for which they are responsible, refusing to repair a seawall breach that occurred over 30 years ago. The resulting erosion to the island, truly a Delaware historical treasure, is just unconscionable.

I have only recently moved to Wilmington from Los Angeles, where I learned well the sad result of a lack of forethought for the preservation of historical space. I do not understand the dull neglect of something as historically rich as Pea Patch Island. To destroy a site that has strong reverberations of the Civil War is . . . I cannot think of a word strong enough. "Stupid" will do. Delaware is a tiny little state, certainly without the resources of far-thinking preservationists such as those who care for Philadelphia history. Can history be preserved just because it's the right thing to do? Can the Corps of Engineers care a little bit? Can you at least include the island in the EIS?

Please do not destroy the island because of shortsightedness and ignorance. Please repair the seawall and allow the island to be preserved. I do not understand the clear neglect and lack of concern evidenced here. I ask you to do the right thing. I have also written Delaware Congressman Mike Castle and Senator Joseph Biden.

Sincerely,

Sue Thompson

Sue Thompson
1930 Thomas Road
Wilmington, DE 19803

CENAP-PL-E
6554/am
25 FEBRUARY 1998

BRADY
PASQUALE
LULEWICZ
KAMPER
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CALLEGARI

Environmental Resources Branch

Mr. Robert W. Hargrove, Chief
Strategic Planning and Multi-Media programs Branch
United States Environmental Protection Agency
Region 2
290 Broadway
New York, New York 10007-1866

Dear Mr. Hargrove:

This is in reply to your letter dated 12 September, 1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement (FSEIS),* dated July, 1997.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

Thank you for your comments and continuing participation in the review of this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

INDEX OF COMMENT LETTERS RECEIVED ON FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Government Agencies (Federal, State, and Local)

Ref. No.	Source	Date	Comment Topics
1.	USEPA	9-12-97	Environmental Monitoring, DE Bay Disposal
2.	USFWS	9-11-97	Management of Existing CDFs, DE Bay Disposal, Tidal flow at Kelly Is., Salinity impacts on oysters
3.	NOAA	9-29-97	DE Bay Disposal, Tidal flow at Kelly Is., Shortnose Sturgeon
4.	Mid-Atlantic Fishery Mngt Co	8-27-97 9-30-97	DE Bay Disposal, Tidal flow at Kelly Is., Sediment Quality, Public Hearing
5.	DRBC	8-26-97	Salinity Model and Impacts
6.	DCMP	8-29-97	DE Bay Disposal, Public Hearing
7.	DE Wetlands	9-12-97	404 [R], State Permits
8.	DE Geo. Survey	8-26-97	DE Bay Disposal
9.	DE SHPO	8-21-97	Pea Patch Island
10.	Salem Co., NJ	8-15-97	Request for sand for beach nourishment.

SEP 12 1997

Robert L. Callegari, Chief
Planning Division
U.S. Army Corps of Engineers
Wanamaker Builder
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Callegari:

The Environmental Protection Agency (EPA) has reviewed the final supplemental environmental impact statement (SEIS) for the Delaware River main channel deepening project. This review was conducted in accordance with Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609 12 (a) 84 Stat. 1709), and the National Environmental Policy Act. The proposed project would affect EPA Regions II and III; therefore, this letter incorporates the results of both Regional Offices' reviews of the final SEIS.

The purpose of the project is to modify the depth of the existing federal navigation channel from 40 to 45 feet mean low water. Approximately 33 million cubic yards (CY) of material would be dredged for initial project construction; the channel would require approximately 6 million CY of annual maintenance dredging. The purpose of the final SEIS is to provide additional information to address environmental concerns raised during review of the 1992 Feasibility Report and EIS.

In our March 17, 1997 comment letter on the draft SEIS, EPA expressed concerns regarding the design and monitoring plan for Kelly Island, where a wetland restoration site was proposed. We indicated that the final SEIS should include a management plan for the new site design clarifying the environmental resource management objectives, and identifying the agency responsible for site management. We are pleased to note that the re-design of the Kelly Island site incorporates construction of a 60 acre tidal marsh impoundment that will be managed by the Delaware Department of Natural Resources. The Army Corps of Engineers (ACE) is to be commended on this design, which now incorporates both wetlands and small areas of shallow open water habitat to provide for greater habitat diversity. The document indicates that the ACE intends to develop a detailed monitoring plan during the design phase of the project; both Regions II and III request the opportunity to review this plan when it becomes available.

TOTAL P.02

Please note that the first paragraph on page 3-24 of the document includes the specifications of the previous Kelly Island site design; it should be corrected to reflect the aforementioned re-design.

With regard to the stockpiling of sand at Slaughter and Broadkill Beaches, our comment letter requested that the project reduce the need for the double handling of dredged material and its associated environmental impacts. The final SEIS indicates that the volume of material that will be deposited offshore has been reduced by 1.4 million cubic yards; this partially addresses our concern by lessening the aquatic impacts. In addition, the document indicates that the ACE will consider eliminating the need for double handling entirely by evaluating the economic viability of direct placement of dredged material during the design phase of the project. Both Regions II and III request the opportunity to review this evaluation when it becomes available.

SAND stock-piles

Based on our review of the final SEIS, our concerns have been adequately addressed. Accordingly, we have concluded that the proposed project would not result in significant adverse environmental impacts; EPA has no objections to the implementation of the proposed project.

Should you have any questions concerning this letter, please contact Deborah Freeman of my staff at (212) 637-3730.

Sincerely yours,

Robert W. Hargrove, Chief
Strategic Planning and Multi-Media Programs Branch

cc: J. Brady, ACE

bcc: R. Denmark, EPA-Region 3
M. Walsh, EPA-Region 3
M. Del Vicario, DEPP-PBPB
W. Andrews, DEPP-WPB

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Environmental Resources Branch

Mr. Don Henne, Regional Environmental Officer
United States Department of the Interior
Office of Environmental Policy and Compliance
Custom House, Room 244
200 Chestnut Street
Philadelphia, PA 19106-2904

MAR 05 1998

Dear Mr. Henne:

This is in reply to your letter dated 11 September, 1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The nine existing Corps disposal areas are used for disposal of dredged material from maintenance of the existing 40 foot Delaware River Federal navigation project. These sites are vital for continued maintenance of the 40 foot project and any long term use restrictions would jeopardize the maintenance of that project due to loss of disposal capacity. One existing disposal site, the Kilcohook disposal area, is already being managed for wildlife habitat by the U.S. Fish and Wildlife Service. To enhance wildlife habitat within remaining existing disposal sites, Section 1135 (b) of WRDA 1986 would be more applicable than Section 204 of the WRDA 1992.

In order to conduct an investigation under Section 1135 authority, a non-Federal sponsor would be required who is willing to provide 25% of the costs of implementation and assume full maintenance responsibility. Any habitat improvements at existing disposal areas would require development of a Memorandum of Understanding, as suggested. The District is willing to explore the possibility of a partnership with a non-Federal sponsor for management of existing upland disposal areas for wildlife habitat, in a manner that would not jeopardize their continued use for the disposal of dredged material. The District would need the Service's assistance in developing viable plans and identifying possible sponsors. At this time, conservation easements or deed restrictions on existing or proposed sites cannot be imposed due to our real estate regulations. This could possibly be considered in the future when the sites are reaching their ultimate capacity.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

In regard to the wetland restoration sites at Kelly Island, Delaware and Egg Island Point, New Jersey, the Corps of Engineers will coordinate with the U.S. Fish and Wildlife Service, as well as other appropriate state and federal resource agencies, prior to construction, to finalize the details of managing these two sites, and obtaining the Special Use permit for Kelly Island.

The Corps in cooperation with the state of New Jersey and the Haskins Shellfish Research Laboratory will develop and implement a monitoring plan to commence when construction begins, designed to examine the health and productivity of oyster populations on the natural seed beds in the Delaware Bay to confirm that the project would not significantly impact the oyster resource.

Thank you for your comments and continuing participation in the review of this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

United States Department of the Interior

OFFICE OF THE SECRETARY

Office of Environmental Policy and Compliance
Custom House, Room 244
200 Chestnut Street
Philadelphia, Pennsylvania 19106-2904

IN REPLY REFER TO:

September 11, 1997

ER-96/0816

Lieutenant Colonel Robert B. Keyser
District Engineer, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Lieutenant Colonel Keyser:

The Department of the Interior has reviewed the Delaware River Main Channel Deepening Project Final Supplemental Environmental Impact Statement. The subject FSEIS addresses modifications to the existing Delaware River federal navigation channel between the Philadelphia/Camden waterfront and southern extent of Delaware Bay. The project involves activities in the tri-State area of New Jersey, Pennsylvania, and Delaware.

Many of the Department's concerns regarding the Draft Supplemental Environmental Impact Statement have been adequately addressed by the U.S. Army Corps of Engineers, Philadelphia District. However, the Department continues to have the following outstanding concerns relating to the project that have not been completely addressed.

UPLAND DISPOSAL SITES

The Department understands that the Corps is reluctant to enhance wildlife habitat on existing upland disposal sites because of potential seasonal restrictions on disposal imposed by State and/or Federal natural resource agencies to protect fish and wildlife, particularly threatened or endangered species. However, flexibility exists under the existing management of these sites. Therefore, the Department continues to recommend that the Corps pursue a Memorandum of Understanding with the appropriate state and federal natural resource agencies to minimize the potential for temporal or spatial restrictions on the nine existing upland disposal sites. The Department also recommends that the Corps manage the existing upland disposal sites using the same methodology proposed for the four new upland disposal sites. The Corps should also consider partnerships with non-profit conservation organizations to share the financial costs of managing the existing upland disposal sites for the enhancement of wildlife.

Wildlife enhancement on existing Corps disposal areas, similar to that being proposed on the four new upland disposal sites, can be accomplished without jeopardizing the integrity or ability to maintain the disposal sites. Wildlife enhancement on existing Corps disposal areas could be accomplished through Corps initiatives possible through the Delaware River Main Channel Deepening Project or through Section 1135 (b) of the Water Resources Development Act of 1986 (33 U.S.C. 2201 *et seq.*; 100 Stat. 4082) (WRDA).

Information in the FSEIS states that the new upland disposal sites would be committed to open space/environmental uses after project completion in 2050. The Department continues to recommend that the Corps place conservation easements or deed restrictions on all proposed new and existing upland disposal sites after these sites have reached their disposal capacity to ensure that these areas are protected as wildlife habitat in perpetuity.

SAND STOCKPILES

The Corps proposes to establish two sand stockpile areas to provide material for beach nourishment at a later time. The proposal would result in the burial of 730 acres of subtidal habitat, resulting in elimination of the benthic community and water quality degradation. In addition, since sand stockpiles would be dredged for beach nourishment, subsequent recolonization of these areas by benthic invertebrates would be disturbed. For these reasons, the Department does not consider the use of subtidal sand stockpiles as a beneficial use of dredged material, and would prefer consideration of alternative uses. Specifically, the Department continues to recommend that the Corps reevaluate the potential for additional wetland restoration and direct beach nourishment as disposal options for dredged material. At a minimum, a portion of the dredged material could be used for direct beach nourishment at Slaughter Beach and Broadkill Beach in Delaware. However, such use of the material must undergo a rigorous evaluation of impacts on a single project and cumulative project impact basis, and the tradeoffs involved in conversion of shallow water habitat or degraded wetland habitat to other types of aquatic habitat must be assessed.

In further consideration of alternatives to sand stockpiling, the Department continues to recommend that the Corps consider linking Federal projects that involve beach nourishment and wetland creation (e.g., Oakwood Beach, Cape May Villas, Reeds Beach, and Maurice River in New Jersey and Lewes Beach, Broadkill Beach, and Port Mahon in Delaware) with the Delaware River Main Channel Deepening Project to ensure the economic feasibility of providing dredged material to these areas. Direct beach nourishment and wetland restoration would eliminate double handling of dredged material and would eliminate adverse impacts on 730 acres of subtidal habitat, much of which supports benthic communities of high quality. Avoiding double handling of dredged material may also reduce overall monetary costs of dredging the Delaware River and nourishing New Jersey and Delaware beaches. However, again, a rigorous evaluation of the cumulative impacts of these projects and the tradeoffs involved in the conversion of shallow water habitat to other types of aquatic habitat must be assessed.

The WRDA of 1996 (P.L. 104-303) directs the Corps to place a greater emphasis on the use of dredged material for beneficial uses, including beach nourishment. Section 207 of the WRDA of 1996 specifically allows the Corps to select a disposal method that is not the least cost option if the incremental costs are reasonable in relation to the environmental benefits. As stated above, the Department continues to recommend that the Corps avoid subtidal stockpiling of dredged material and use the material for direct beneficial uses (e.g., beach nourishment or wetland restoration) consistent with Section 207 of the WRDA of 1996.

Additionally, the Department is concerned about the *selection* of sites for stockpiling sand. The selection of site MS19B as a candidate site for sand stockpiling is not justifiable and is inconsistent with the high benthic attributes of the site as described and discussed in the FSEIS. The first paragraph in section 8.3.1 contradicts the discussion of the data in sections 8.2.2, 8.2.3, and 8.2.4. Site MS19B has the highest Shannon-Wiener diversity index, the highest percentage of equilibrium species, no significant difference in the abundance of opportunistic species, and the highest number of species with a size greater than 2 cm, compared to riverine and estuarine background. These factors indicate high habitat quality, which makes this site a poor candidate for stockpiling sand. Additionally, selection of site MS19B is not justifiable on economic terms since site MS19A is nearby.

Further, site MS19A is preferable due to lower habitat quality. Site MS19A has a lower diversity index and, in general, differs significantly in six out of eight of the benthic parameters evaluated or calculated. Of the six parameters that differed significantly, MS19A is of lower ecological value than MS19B in five. Candidate sites selected for stockpiling sand, if stockpiling is used in lieu of direct beach nourishment or wetland creation, should be sites with low benthic diversity and ecological attributes that indicate an already disturbed or unstable benthic community. Although it is not clear in the FSEIS, it is likely that the high quality benthic habitat found at candidate site MS19B provides high quality finfish habitat that will be eliminated or at least severely impacted by use as a sand stockpile area. Therefore, the Department recommends that other less ecologically diverse sites be selected for sand stockpiling.

The Department does not concur with the Corps' stated intent to investigate direct placement of sand for beach nourishment as an alternative to sand stockpiles during the Plans and Specifications phase of the project. The Department understands that the Plans and Specifications phase is an internal Corps process, which does not include public review or comment or review by resource agencies. As such, concerns relating to sand stockpiling must be addressed formally through the National Environmental Policy Act (42 U.S.C. 4321 *et seq.*; 83 Stat. 852) review process rather than through the Plans and Specifications phase of the project.

WETLAND RESTORATION

The Corps states in the FSEIS that additional coordination regarding the management of wetland restoration sites (e.g., Egg Island Point and Kelly Island) will be done with natural resource agencies during the Plans and Specifications phase of the project. We are concerned that the level of detail in the FSEIS is not sufficient for the Federal agencies to conclude that the tradeoffs associated with conversion of one type of habitat to another may be acceptable, absent this information on project management. The Department strongly recommends that the U.S. Fish and Wildlife Service be included in reviewing and commenting on management plans for the wetland restoration sites; in fact, our participation will be necessary for the Kelly Island Project to proceed (this is explained below).

The Kelly Island wetland restoration site will connect with lands of the Bombay Hook National Wildlife Refuge and is, in fact, in an area that has eroded over a period of years from the Refuge. Because there are several management concerns that will directly impact the Refuge, including the creation and maintenance of wildlife habitats and possible public uses incompatible with Refuge operations, the Department recommends that a Memorandum of Agreement be developed whereby the Service and the Delaware Department of Natural Resources and Environmental Control would cooperatively manage the restoration site and jointly prepare management plans. Such a statement will be stipulated as a condition of the Special Use Permit issued by the Refuge for the project. Further, additional analysis of the impacts of the proposed project on the NWR may be necessary to meet the USFWS NEPA requirements for issuance of the Special Use Permit.

In addition, the Department is concerned with the proposal to regulate water levels in the Kelly Island wetland over the long-term. The Department concurs with the proposal to use the Corps' outlet works to control the water level during the first few years to establish wetland vegetation and reduce erosion; however, once the wetland becomes firmly established, the objective should be to promote an open tidal system with minimal water level regulation. Tidal flow will maximize use by fish and invertebrates, and minimize potential problems of low water quality and mosquito breeding. Therefore, the Department emphasizes the need to conduct additional coordination with the Service to refine the project design to ensure unrestricted tidal exchange in the wetland. An agreement among the state and federal agencies on this issue must be accomplished before the Refuge issues a special use permit for the project.

HYDRODYNAMIC AND SALINITY MODELING

The Corps states in the FSEIS that hydrodynamic/salinity modeling is the only valid approach that permits a direct and objective assessment of salinity impacts attributable to changes such as channel deepening. In addition, the Corps states that a nationally recognized expert on oyster ecology (i.e., Dr. Eric Powell) concluded that the range of salinity changes predicted by the model would pose no adverse impacts on oyster resources. The Department understands that Dr. Powell's research regarding salinity impacts on oysters was conducted in Galveston Bay, Texas, and may not be applicable to salinity changes within the Delaware Bay. In addition, while the Department concurs that the hydrodynamic/salinity model is the best available tool to predict salinity changes, the Department continues to recommend that the Corps initiate a monitoring program to verify and validate the subject model and the conclusion that hydrodynamic and salinity changes will not have an adverse impact on oysters or other shellfish.

DEPARTMENTAL POSITION

The Department continues to have several outstanding concerns regarding potential project-related adverse impacts on fish and wildlife resources. In order to minimize adverse impacts to fish and wildlife, the following measures are recommended:

1. Enhance wildlife habitat on existing upland disposal sites.
2. Deed restrict, or place conservation easements on, all upland disposal sites after disposal capacity is reached.
3. Use dredged material beneficially for direct beach nourishment or wetland restoration, rather than stockpiling material in subtidal areas, but only after a comprehensive evaluation of the impacts of the conversion of one type of aquatic habitat to another.
4. If sand stockpiles are used, select less ecologically diverse sites (e.g., MS19A) for sand stockpiling.
5. Resolve concerns relating to sand stockpile areas through the NEPA process rather than through the Plans and Specifications phase of the project.
6. Coordinate with the Service during the Plans and Specifications phase of the project regarding the management of Kelly Island and other beneficial use sites.
7. Develop a Memorandum of Agreement between the Service and the Delaware Department of Natural Resources and Environmental Control to cooperatively manage the Kelly Island wetland restoration site and jointly prepare management plans.
8. Coordinate with the Service to refine the Kelly Island project design to ensure unrestricted tidal exchange in the wetland over time. Develop an agreement among the state and federal agencies on this issue prior to requesting a special use permit for Kelly Island from the Service.
9. Monitor water quality, oyster, and shellfish populations prior to, during, and following dredging activities to verify salinity and circulation modeling.

The Department encourages the Corps to resolve the above-mentioned concerns and incorporate Departmental recommendations in the final project design. The Department and the Service will continue to cooperate fully to resolve these concerns.

If you have any questions regarding these comments or require further assistance on issues regarding fish and wildlife resources related to the subject project, including any new information regarding federally-listed threatened or endangered species, please contact the Service at the following address:

U.S. Fish and Wildlife Service
Supervisor, New Jersey Field Office
927 N. Main Street, Building D
Pleasantville, New Jersey 08232
(609) 646-9310

Thank you for the opportunity to provide these comments.

Sincerely,

Don Henne

Don Henne
Regional Environmental Officer

cc: NJFO (2)
GARD, Northern/ES
GARD, Central/RW
NMFS, Gorski
USEPA, Hargrove
NHP, T. Breden
ENSP, L. Niles
CBFO
Bombay Hook NWR
EPFO
DBEP
PAFO

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Environmental Resources Branch

MAR 05 1998

Ms. Susan B. Fruchter
Acting NEPA Coordinator
United States Department of Commerce
Office of the Under Secretary
for Oceans and Atmosphere
Washington, D.C. 20230

Dear Ms. Fruchter:

This is in reply to your letter dated 29 September, 1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

In regard to the wetland restoration site at Kelly Island, Delaware, the Corps of Engineers will coordinate with your agency, as well as other appropriate state and federal resource agencies, prior to construction, to finalize the details of managing this site.

The District could consider recommendations from the National Marine Fisheries Service (NMFS) in regard to supporting studies to define significant habitat for shortnose sturgeon, and to determine their movements in the river portion of the project area during the Plans and Specifications part of this project.

The Corps will continue to coordinate with NMFS regarding the effects of rock blasting on the endangered shortnose sturgeon, as necessary, to ensure compliance with requirements of the Endangered Species Act.

Thank you for your comments and continuing participation in the review of this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

September 29, 1997

Mr. John Brady
U.S. Army Engineer District, Philadelphia
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Mr. Brady:

Enclosed are comments on the Final Supplemental Environmental Impact Statement for Delaware River Main Channel Deepening Project. We hope our comments will assist you. Thank you for giving us an opportunity to review this document.

Sincerely,

Susan Fruchter

Susan B. Fruchter
Acting NEPA Coordinator

Enclosure

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA)

COMMENTS ON

FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT (FSEIS)

FOR

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

The National Marine Fisheries Service (NMFS), NOAA has reviewed the Final Supplemental Environmental Impact Statement (FSEIS) for the Delaware River Main Channel Deepening Project proposed by the Philadelphia District Army Corps of Engineers (Corps). We have coordinated with the Corps on this project for several years, and have provided comments on the Draft Interim Feasibility Report, the Draft Environmental Impact Statement and the Draft Supplemental Environmental Impact Statement while attending numerous interagency meetings and workshops. We appreciate the opportunity to review the FSEIS, and offer the following comments for your consideration. We look forward to working with the Corps to resolve our outstanding concerns, and to minimize the project's impacts to resources of concern to us. Please contact Karen Greene at 732-872-3023 if you have any questions regarding these comments.

Sand Stockpiling

As proposed in the FSEIS, the Corps plans to dispose of 3.3 million cubic yards of sand at two overboard disposal sites in Delaware Bay. The material disposed of at these sites will be stockpiled for possible future use as sand sources for beach nourishment projects along the Delaware Bayshore. Both stockpile sites are in shallow water (-8.0 to -6.0 feet MLW) within 0.5 miles of the shore. The Broadkill Beach sand stockpile area (LC-5) which covers 230 acres is 0.33 miles offshore. The Slaughter Beach site (MS-19) covers 250 acres and is 0.5 miles offshore. This proposal will result in the destruction of the existing benthic communities and the degradation of water quality in the sand stockpile area. In addition, if these sites are used as sand sources for future beach nourishment projects, recolonization of the sites will be impeded because the sites will be continually disturbed. We do not consider the creation of sand stockpiles to be a beneficial use of dredged material, and continue to oppose such use, strongly urging the Corps to seek alternate disposal sites such as direct beach nourishment.

The selection of the proposed sand stockpiling sites do not appear to be adequately justified, and the habitat values of the areas appear to be underestimated. According to the FSEIS, eleven sites were investigated as potential beneficial use sites in 1993. A twelfth site, MS19B located near MS-19 was added in 1995. One of the selected sites, MS19B (also known as MS-19 in the FSEIS) had the highest Shannon-Wiener diversity index of the sites evaluated as potential beneficial use sites. It also had the percentage of equilibrium species and number of species greater than 2 cm in size. The other selected sand stockpile site, LC-5 had the highest number of species among the candidate sites sampled.

In addition, reports from fisherman and charter boat captains familiar with the area indicate that the sand stockpile sites support a highly diverse and productive benthic community. It is likely that the sampling done as part of the benthic surveys for this project did not adequately characterize the benthic communities at the sand stockpile sites, and the value of these communities to finfish. Often, epibenthos are patchy in distribution, and may not be adequately sampled using grab samples. A qualitative dredge sampler, which was not used in the benthic surveys done for this project would have been more appropriate to characterize this component of the benthic community. For example, Sabellaria vulgaris is a polychaete worm found throughout Delaware Bay. However, this species was not captured in the benthic surveys completed for this project. These worms provide a food source for many commercially and recreationally important finfish including summer flounder (Paralichthys dentatus), winter flounder (Pleuronectes americanus), weakfish (Cynoscion regalis), black sea bass (Centropristis striata) and scup (Stenotomus chrysops). Disposing of dredged material on these beds of tube worms will destroy the food source for this fish at these locations. In addition, the changes in depth at the stockpile sites from between eight and six feet to three feet will preclude the recolonization of the site by certain benthic species due to changes in the physical habitat parameters such as turbidity and increased wave action.

The lower Delaware Bay provides valuable habitat for a wide variety of commercially and recreationally valuable finfish including summer flounder, winter flounder, scup, black sea bass, weakfish, white perch (Morone americana), striped bass (Morone saxatilis), bluefish (Pomatomus saltatrix), black drum (Pogonias cromis) and spot (Leiostomus xanthurus). Several species, including weakfish, spawn near the sand stockpile sites. Others use it as an important nursery and forage habitat. Blue crabs (Callinectes sapidus) and horseshoe crabs (Limulus polyphemous) are also commercially and ecologically important species that inhabit the estuary in and around the sand stockpile sites. The Delaware Estuary also provide important nursery and forage habitat for a number of sharks, skates and rays.

In accordance with the provisions of the Magnuson-Stevens Fishery Conservation and Management Act, the Fisheries Management Councils must amend the Fisheries Management Plans (FMPs) to include the description and identification of essential fish habitat, and to identify adverse impacts on that habitat and actions that should be considered to ensure the conservation and enhancement of that habitat. The NMFS, on behalf of the Secretary of the Department of Commerce is working with the Fisheries Management Councils to accomplish this task. Managed species which inhabit the Delaware Estuary include summer flounder, winter flounder, black sea bass, scup and bluefish. Although the final designations of essential fish habitat are not complete, portions of the Delaware Estuary, including the sand stockpiling sites, will likely be designated as essential fish habitat for one or more of the managed species. As a result, disposing of sand at the sand stockpile sites may destroy essential fish habitat for some of these species.

The use of the sand stockpile sites will also alter the depths and exclude certain types of fisheries from those areas. Currently, both commercial fishermen (drift nets and hook and line fishery) and recreational fishermen in private and charter fishing boats use the sand stockpile sites. Decreasing the depths in the sand stockpile areas from between six and eight feet to three feet would exclude both of these user groups. It is also possible that the impacts of the stockpiling will extend beyond the designated areas, as the tidal currents and storm events cause the sand stockpiles to shift.

On page 3-24 and 3-25, the potential disposal options investigated by the Corps are listed. One option was beach fill. The FSEIS indicates that the disposal options were evaluated through five cycles to determine their feasibility and to assess their impacts. The beach fill option was not included as one of the final potential disposal options. The FSEIS does not explain why this alternative was not pursued. We continue to recommend that the sand be placed directly on the beaches of Delaware and New Jersey. Currently, the Corps is studying the feasibility of shore protection and flood control at several locations in Delaware and New Jersey, including Lewes Beach, Broadkill Beach and Port Mahon in Delaware and Cape May Villas, Oakwood Beach, Reads Beach and the Maurice River in New Jersey. Direct beach nourishment would prevent the destruction of 480 acres of benthic habitat and essential fish habitat for summer flounder, and valuable habitat for other commercially and recreationally important finfish and shellfish. It would also eliminate the need to rehandle dredged material and the continued disturbance of the benthic community which would occur each time sand is dredged from the stockpile areas.

Kelly Island

Our comments concerning the Kelly Island wetland restoration project remain unchanged. We continue to oppose the creation of an impoundment and the long-term use of water control structures at Kelly Island. Any wetlands created using dredged material should receive full, unimpeded daily tidal inundation once the dredged material has consolidated. As proposed, the design for the Kelly Island wetlands restoration will include the installation of a water control structure at the north end of the berm. Once the dredged material has consolidated and the marsh becomes vegetated (either by planting the appropriate vegetation or through natural colonization), the water control structure would be used to manage the created wetlands for waterfowl. Managing the wetlands in this manner will not provide any benefits to fish. In fact, fishery habitat will be lost by the filling of open water to create the wetlands at Kelly Island.

We agree that while the dredged material is consolidating behind the berm, it is necessary to implement measures to prevent the fine material from impacting nearby American oyster (Crassostrea virginica) seed beds. Instead of a permanent water control structure, we recommend that the a water filled geotube be used. Once the dredged material has settled and vegetation in the marsh has become established, the geotube could be emptied and removed. The marsh would then be open to unrestricted tidal inundation. If this alternative is technically infeasible, then once the marsh is established, the water control structure must remain open fully at all times to allow unrestricted tidal inundation. We also request the opportunity to review and to approve any management plans developed for this area to ensure that the proposed wetland creation benefits fishery resources.

Shortnose Sturgeon

As discussed in our previous comment letter dated February 14, 1997, the Chester-Philadelphia "pollution zone" mentioned on page 10-29 of the FSEIS no longer exists. As a result, this does not limit shortnose sturgeon's use of the portion of the river in which the channel deepening will begin. Although additional studies are needed to determine the extent to which shortnose sturgeon use this area, the Corps should not assume that shortnose sturgeon use this area only as a migratory route. As stated in the Conservation Recommendations listed in the Biological Opinion issued by NMFS on November 26, 1996 (NMFS 1996), we continue to recommend that the Corps support research to define significant habitat for shortnose sturgeon, and to determine their movements in the river with better accuracy. We are especially concerned about the movement of juvenile shortnose sturgeon for which little information is available.

Rock Blasting

As stated in our letter dated February 14, 1997, the Biological Opinion issued by NMFS for dredging in the Philadelphia District does not cover blasting. Based upon the location of the blasting in the Marcus Hook area, it is not likely that sea turtles and marine mammals will be in the project area. However, shortnose sturgeon may be found near Marcus Hook. While the seasonal restrictions prescribed by the Cooperative and included in our Biological Opinion are necessary to reduce impacts to anadromous fishes, we recommend that the Corps continue coordination with the NMFS to ensure compliance with the requirements of the Endangered Species Act.

In conclusion, we continue to oppose the use of the sand stockpile sites, and we strongly urge the Corps to place the sand dredged from the lower portions of the deepening project directly on the beaches rather than stockpiling the sand offshore. The use of the sand stockpile sites will result in the destruction of productive benthic habitat and food sources for commercially and recreationally valuable fish species and the potential destruction of essential fish habitat. The decrease in water depths to three feet at the stockpile sites will also negatively impact commercial and recreational fishing by excluding certain types of gear and boats and alter the composition of the benthic communities. In addition, the continued, long-term dredging of the areas for beach nourishment will impede the recolonization of the stockpile sites.

We also continue to oppose the creation of an impoundment at Kelly Island. Long-term management of the site must include unrestricted daily tidal inundation at all times or fisheries habitat will be lost. While we concur with the need to prevent the fine sediments from impacting nearby oyster beds, the ultimate management of the site must include full, unrestricted tidal flow, either through the removal of any water control structures necessary during the construction phase of the project, or by maintaining these structures in the open position.

CENAP-PL-E
6554/am
25 FEBRUARY 1998
BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

Dr. James H. Gilford, Chairman
Mid-Atlantic Fishery Management Council
Room 2115 Federal Building
300 South New Street
Dover, Delaware 19901-6790

MAR 05 1998

Dear Dr. Gilford:

This is in reply to your letter dated 27 August, 1997, as well as a letter from David R. Keifer, dated 30 September, 1997, concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

In January 1997, the draft SEIS was circulated for review and comment. During the review of this draft SEIS numerous time extensions were requested and granted to accommodate a complete and a thorough review. Your office was furnished a copy of the draft SEIS. As part of that review the Council did not comment. The draft SEIS was revised considering comments received and a final SEIS was prepared in July 1997 and filed with the U.S. Environmental Protection Agency. Due to requests for extension of the comment period, an additional 30 days was granted until September 30, 1997. At this point, we are in the process of completing the National Environmental Policy Act (NEPA) process with the preparation of the Record of Decision.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

In regard to the wetland restoration site at Kelly Island, Delaware, the Corps of Engineers will coordinate with your agency, as well as other appropriate state and federal resource agencies, prior to construction, to finalize the details of managing this site.

The Final SEIS also documents that (Section 4.0), based on field sampling and subsequent data analysis, no significant impacts to the aquatic ecosystem are expected from dredging and the disposal of dredged material. None of the sediment samples taken revealed significant levels of contaminants. The fine-grained material from the industrial northern portion of the project area will be placed in upland, confined dredged material disposal facilities, away from the river. The sediment toxicity data from this project was reviewed by the Corps of Engineers' Waterway Experiment Station, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the New Jersey Department of Environmental Protection, the Delaware Department of Natural Resources and Environmental Control, and the Pennsylvania Department of Environmental Protection. The U.S. Environmental Protection Agency in a letter dated 17 March 1997 stated that "....EPA continues to believe that there will be no adverse impacts associated with the disposal of sediments generated by the project". In addition, in their letter of 12 September 1997, the U.S. Environmental Protection Agency stated that "... we have concluded that the proposed project would not result in significant adverse environmental impacts; EPA has no objection to the implementation of the proposed project." Neither the U.S. Department of the Interior (parent agency of the U.S. Fish and Wildlife Service)in their letter of September 11, 1997, nor the U.S. Department of Commerce (parent agency of the National Marine Fisheries Service) in their letter of September 29, 1997, have expressed any concern about contaminants in the dredged material. Furthermore, the Commonwealth of Pennsylvania and the states of Delaware and New Jersey have reviewed the sediment data as part of their coastal zone management consistency review. Each concluded that this project was consistent with the Coastal Zone Management Act.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

ROOM 2115 FEDERAL BUILDING
300 South New Street
Dover, Delaware 19901-6790
302-674-2331
FAX 302-674-5399

Dr. James H. Gilford
Chairman

Anthony D. DiLernia
Vice Chairman

David R. Keifer
Executive Director

30 September 1997

Mr. Robert L. Callegari
Environmental Resources Branch
Philadelphia District, Corps of Engineers
Wanamaker Building,
100 Penn Square East
Philadelphia, PA 19107

Dear Mr. Callegari:

On 27 August we sent you a letter expressing our serious concerns about the Delaware River Main Channel Deepening Project (letter attached). Our major environmental impact concerns were: the sand stockpiling off of Slaughter and Broadkill Beaches, some of the assumptions and decisions regarding Kelly Island, conversion of subtidal habitats to *Spartina alterniflora* wetlands, and the resuspension of sediment contaminants distributed throughout the river and estuary caused by the dredging of the upper river around the heavily industrialized area of Camden and Philadelphia.

Our focus of the letter detailed the issue of essential fish habitat (EFH) and how the two areas where it was proposed to stockpile sand would in all likelihood be defined as EFH for federally managed species. We requested that you allow the comment period for this project to remain open until at least two weeks after NMFS finalizes the guidelines on EFH. In early September we heard from Mr. John Brady, of your office, that you would be unable to extend the comment period beyond today. We understand your reluctance to allow an open-ended extension, however regrettably, NMFS has not yet finalized their EFH guidance.

Using the criteria that were in the proposed EFH rules when they were published in May, there is no question that sites L-5 and MS-19 will be considered essential fish habitat for at least the federally-managed, overfished resources of summer flounder and black sea bass. This is new information, and as such warrants you holding a public hearing. We believe that by the time a hearing is scheduled we will have the Congressionally mandated EFH guidelines.

Thank you for considering our comments. We look forward to working with you in the immediate future. Please do not hesitate to call me or Tom Hoff should you have any questions.

Sincerely yours,

David R. Keifer

DRK/TBH

cc: A. Rosenberg
S. Gorski
T. Goodger
S. Grabowski
J. Bryson

MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

Dr. James H. Gilford
Chairman

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David R. Keifer
Executive Director

27 August 1997

Mr. Robert L. Callegari
Environmental Resources Branch
Philadelphia District, Corps of Engineers
Wanamaker Building,
100 Penn Square East
Philadelphia, PA 19107

Dear Mr. Callegari:

We have reviewed the SEIS for the Delaware River Main Channel Deepening Project, and have several serious concerns. Our major environmental impact concerns are: the sand stockpiling off of Slaughter and Broadkill Beaches, some of the assumptions and decisions regarding Kelly Island, conversion of subtidal habitats to *Spartina alterniflora* wetlands, and the resuspension of sediment contaminants distributed throughout the river and estuary caused by the dredging of the upper river around the heavily industrialized area of Camden and Philadelphia.

When Congress reauthorized the Magnuson-Stevens Fishery Management and Conservation Act last fall, they mandated significantly more attention be paid to fishery habitat conservation through their addition to the Act's purpose: "to promote the protection of essential fish habitat in the review of projects conducted under Federal permits, licenses, or other authorities that affect or have to potential to affect such habitat." We have been assured that NMFS will publish the final guidelines on essential fish habitat (EFH) within the next few weeks. While we do not know exactly what the final guideline criteria for EFH will be, we are assured that the definition of EFH will almost certainly include nursery and spawning areas for Federally managed commercial and recreationally important species. As identified in the SEIS, summer flounder, black sea bass, drum and weakfish are all in the vicinity of sites L-5 and MS-19 where the stockpiling of sand is proposed. These sites are in spawning and nursery areas.

We are aware that other Federal and State agencies have questioned the efficacy of the concept of 'beneficial use' of these sand stockpiles in important shallow water habitat. We wish to add our voice to that concern, express our opposition to overboard disposal in nursery areas, and request that you extend the proposed 35 day limited comment period (that expires on 30 August) until at least two weeks after NMFS finalizes the guidelines on EFH. Rather than to possibly permanently lose nearly 500 acres of fishery important habitat - that may be shortly classified as EFH for overfished resources - it would seem prudent to wait until the quidelines are finalized. What can possibly be the ecological benefits of this sand stockpiling?

We cannot support the creation of an impoundment from shallow water habitat of Delaware Bay as a beneficial use of dredged material at Kelly Island. Any wetlands that are created or restored using dredged material must receive daily tidal inundation and simply can not restrict the tidal flow. This may benefit birds, but certainly not the fishery resources that we are charged with conserving and managing.

Please consider these our preliminary comments on this SEIS. We know that other agencies and environmental groups have asked for an extension of the comment period based on the large volume of information in the SEIS, however we want an extension because we believe there will be new information once NMFS has finalized their EFH guidance. If these sand stockpile sites meet the criteria for EFH, as we expect them to, then we would like you to hold a public hearing.

Thank you for considering our extension request and our comments. We look forward to working with you in the immediate future if these areas meet the criteria for EFH. Please do not hesitate to call David Keifer or Tom Hoff of Council staff should you have any questions.

Sincerely yours,

David R. Keifer /for

James H. Gilford Ph. D.

DRK/TBH

DEPARTMENT OF THE ARMY
Philadelphia District, Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

JAN 21 1998

Planning Division

Mr. Gerald M. Hansler
Executive Director
Delaware River Basin Commission
P.O. Box 7360
West Trenton, New Jersey 08628-0360

Dear Mr. Hansler:

This will acknowledge your letter of August 26, 1997 concerning the salinity modeling methodology in the Final Supplemental Environmental Impact Statement (FSEIS) for the Delaware River Main Channel Deepening Project. Our discussion in order of your presentation is attached.

The conclusions in the FSEIS that there will be no adverse impacts from the project on fresh water supplies, either direct withdrawals or ground water supplies, do not warrant revision.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Attachment

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

RESPONSES

TO

DELAWARE RIVER BASIN COMMISSION

LETTER OF 26 AUGUST 1997

ATTACHMENT

Our June 12, 1997 meeting enabled three-way discussions with the Waterways Experiment Station (WES) on the three-dimensional hydrodynamic/salinity modeling that was completed for the Delaware River Main Channel Deepening Project and how the Delaware River Basin Commission (DRBC) may arrange with WES to do additional work for its purposes.

There are no strict guidelines applied by the numerical modeling community to quantify a calibration as "poor, fair, good, etc.," although various error measures can be computed, e.g., relative mean error. The three-dimensional hydrodynamic/salinity model of Delaware estuary was calibrated to observed data from October 1992 and then applied to other events, e.g., the low flow event of June-November 1965. If one considers the range of freshwater inflows, winds, and tides included in the verification process, the comparison of modeled versus observed elevations, velocities, and salinities at various locations throughout the system has been considered "good" by other peer modelers at national and international conferences, e.g., National ASCE Conference in Buffalo, New York, and the Second International Hydrosciences Conference in Beijing, China.

If one focuses only on salinities at Chester and Ben Franklin Bridge during a portion, e.g., October, of the June-November 1965 simulation, one might conclude that the calibration is poor. However, considering the fact that the salinity being computed ranges from over 30 parts per thousand (ppt) (equal to 30,000 parts per million (ppm)) down to essentially zero in the upper river, the ability of the model to reproduce the proper intrusion of salinity, based on mean daily observed values, down to levels of less than 0.1 ppt (100 ppm) at Ben Franklin Bridge is actually quite good. In fact, the average difference between the computed and observed average daily value of chlorinity over the entire June-November 1965 period is less than 25 ppm. We consider this to be an entirely reasonable and accurate representation considering the uncertainties associated with the modeling effort, e.g., levels of background chlorinity in lateral inflows, spatial variability of the wind field, salinity boundary conditions, etc.

It should be reemphasized that the purpose of the model is to determine the relative impact of channel deepening. Any errors associated with numerics, boundary condition forcings, etc. will tend to cancel out so that the *difference* between runs with and without deepening will reflect only the impact of the deepening on salinity intrusion.

We recognize that the conversion of specific conductance to chlorinity using the US Geological Survey (USGS) tables yields generally higher chlorinity values than the use of the equations shown on Page 5-19 of the Final Supplemental Environmental Impact Statement (FSEIS). These equations were adopted for use in the Delaware River Main Channel Deepening Study based on their inclusion in the report "Development and Application of a Deterministic Time-Varying Salinity Intrusion Model for the Delaware Estuary" (Thatcher and Harleman, 1978) prepared for DRBC. The Thatcher and Harleman report states "Graphic correlations of conductance and chlorides in the tidal Delaware River have been made by Durfor and Keighton (1954). Based on their graphs, Dr. Tortoriello of the DRBC extracted the following equations . . . ." It is these equations that were applied in the WES model verification to convert observed conductivity data to "observed" chlorinity values.

Figure 1 (attached) shows chlorinity as a function of conductivity, using the USGS tabulated relationships (line labeled "USGS Tables") and the equations cited by Thatcher and Harleman (line labeled "DRBC Equations.") The third line, labeled "Ratio," indicates the ratio of the table-predicted chlorinity to the equation-predicted chlorinity, expressed as a percent. While we recognize that the USGS tables produce higher chlorinity values than the cited equations, it can be seen that over the specific conductance range from 400 to 4,000 microsiemens, the greatest percentage difference between the two approaches is only 18%, occurring at the range of conductivity between 1,000 and 1,300 microsiemens. Corresponding chlorinity over this range is approximately 200 to 300 ppm. At higher and lower values of conductivity, the curves converge and the difference between the two relationships decreases, with the exception of the trivial anomaly at a specific conductance of 250 microsiemens.

Figure 2 (attached) displays the same two curves, with the addition of 114 discrete data points. These data points represent water samples obtained and analyzed by USGS during Water Years 1964, 1965, and 1966, at five locations between Philadelphia (Ben Franklin Bridge) and Marcus Hook (source: USGS "Water Quality Records in Pennsylvania"). These data thus represent actual water quality conditions, including conductivity and chlorinity of river water samples, during the drought of record for the Delaware River. The samples were obtained from the zone of greatest concern for potential salinity intrusion and its impacts on ground water recharge and municipal and industrial withdrawals. The range of data included in Figure 2 was expanded relative to that in Figure 1 to include the highest observed conductivity/chlorinity data point from the 114 USGS water samples.

It can be seen in Figure 2 that the USGS conductivity/chlorinity data points from water sample analyses generally lie between the two curves, with neither curve uniquely representing a "best-fit" over the full range of the data. Although we concur that use of the "USGS Tables" yields higher chlorinity than the "DRBC equations," we do not find that the use of the "Tables" provides a superior representation of the conductivity-chlorinity relationship for the Philadelphia-Marcus Hook area than the "Equations." Further, we do not believe that the procedures used by the WES result in "conclusions which may be incorrect," especially since the purpose of the modeling was to determine the <u>relative</u> change in salinity distribution attributable to the deepening.

The prototype ("boat run") data provided by DRBC for the periods of 1965 and 1992-1993 are being evaluated by Dr. Billy Johnson, the principal model investigator at WES. However, there were no commitments made at the June 12, 1997 meeting to perform additional model runs based on receipt of the historic DRBC salinity data, nor was there a commitment to modify the FSEIS.

The salinity model investigation demonstrated that with the deepened channel, even under a recurrence of the drought of record, chlorinity at River Mile(RM) 98 does not exceed existing DRBC standards. The recurrence of the drought of record was selected as the worst-case scenario with respect to low flows and potential salinity intrusion. It is reasonable to expect that any other inflow scenario will result in impacts which are not as severe as those associated with the drought of record. Additionally, there is evidence from recent published investigations by USGS (Navoy, USGS) that the present chlorinity standards for RM 98 are overly conservative with respect to possible impacts on Potomac Raritan Magothy(PRM) aquifer water quality in the Camden County area recharged by Delaware River water. Based on the above findings, it was concluded that there will be no adverse long term economic impacts to water users in the Estuary and as a result not included as part of the Benefit to Cost analysis.

The Corps of Engineers did model a one-foot sea-level rise scenario. The information from this simulation was not included in the FSEIS, but will be published with the WES Technical Report on the three-dimensional numerical hydrodynamic/salinity model study. A copy of this report will be provided to your office. However, the Corps believes that modeling of existing and potential future sea level conditions demonstrates that impacts of such sea level rise on salinity distribution are comparably small and thus negligible.

In order to put the model-predicted changes in salinity distribution due to deepening and sea level rise into proper perspective, it is helpful to examine the range in salinity which occurs at representative locations within the estuary over a wide range of time scales. Time series of salinity data for each reference location show the variation of salinity over time scales which include the tidal cycle (12.4 hours,) variations over periods of two to six months, and variations over periods with significantly different inflow regimes, from drought to high-flow. Reference FSEIS Tables 5-2 and 5-5, which respectively present salinity range data for a recurrence of the drought of record (July through November 1965,) and for the period July through November with monthly averaged inflows. In addition, the simulation presented in FSEIS Section 5.11.3 documents salinity range data for a recent high-flow period, April to May 1993.

As an example of this natural variability, data from RM 54 show that for the July- November 1965 simulation, salinity ranged between 6 and 17 ppt. For the same months with long-term averaged monthly inflow, salinity ranged between 1 and 9 ppt. Finally, during the April-May 1993 period, salinity never rose above 0 ppt. This represents a range of salinity from "fresh water" with 0 ppt salinity to "half-strength" seawater at 17 ppt. For perspective on the impacts of deepening and sea level rise, it should be noted that at RM 54, the hydrodynamic/salinity model predicts changes of less than 1 ppt attributable to deepening and sea level rise. A similar, if less dramatic, pattern of salinity variation over time occurs at locations throughout the estuary. It is judged that the large, natural variability of salinity within the estuary renders the changes associated with deepening and sea level rise largely a negligible environmental impact.

As discussed at our coordination meeting, a single run of the model was used to explore flow and salt exchange through the Chesapeake and Delaware (C&D) Canal and its impact on subtidal circulation and salinity in Delaware Bay and Upper Chesapeake Bay. Members of your staff may recall from coordination workshops during the course of the Delaware River Main Channel Deepening Study that this scenario was the last item selected by consensus of workshop participants for inclusion in the prioritized list of model production runs. The model run included boundary conditions for the regulated June to November 1965 period, first with the C&D Canal open, and then with the Canal closed.

In the simulation of this period with the canal open, net flow was westward, from Delaware Bay to Chesapeake Bay, contrary to the frequently quoted net eastward flow direction for the canal. In the simulation with the canal closed, there was of course no flow or salt exchange through the canal. In addition, the model run with the canal closed lowered chlorinity at RM 98, by about 25-50 ppm, compared to the run with the canal open. Although the results of this cursory investigation of C&D Canal impacts are clearly interesting, the use of only one set of boundary conditions limits the applicability of these results. However, the relationship of the C&D Canal to the proposed 45 foot Delaware River project has been adequately modeled by developing a set of representative boundary conditions for modeling changes in the Delaware River. As detailed at the December 18, 1997 workshop for the C&D Canal Deepening Study, we will further plan to investigate the impacts of incremental changes to the depth of the C&D Canal in light of a already completed deepening of the Delaware River to 45 feet.

The simulations to address the impacts of the proposed 45 foot channel were run with 1986 depletive uses, as determined by DRBC and provided to the Corps for application in the salinity model runs. It is our view that it is not necessary to make additional model runs with projected higher depletive uses for a number of reasons. First, there is evidence from recent published investigations by USGS (Navoy, USGS) that the present DRBC chlorinity standards for RM 98 are overly conservative with respect to possible impacts on PRM aquifer water quality in the Camden County area recharged by Delaware River water. Further, it is reasonable to believe that there are several possible alternate drought management strategies which could be investigated and implemented to conserve basin storage for more effective repulsion of salinity/chlorinity in the vicinity of RM 98 during drought conditions. Also, it is not likely that the DRBC would approve increased depletive uses without compensating storage provisions.

Compare DRBC Tables to DRBC Eqns

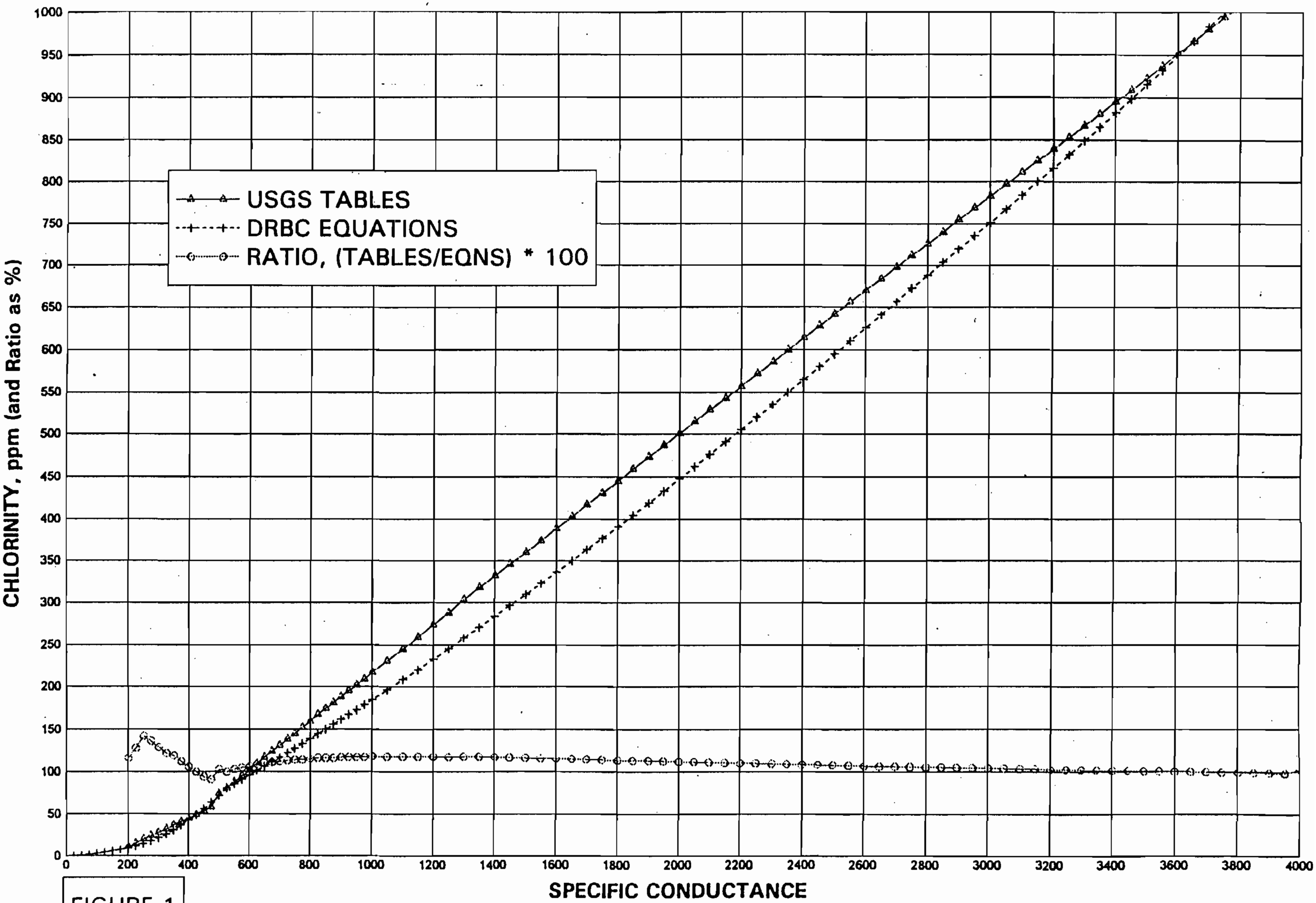
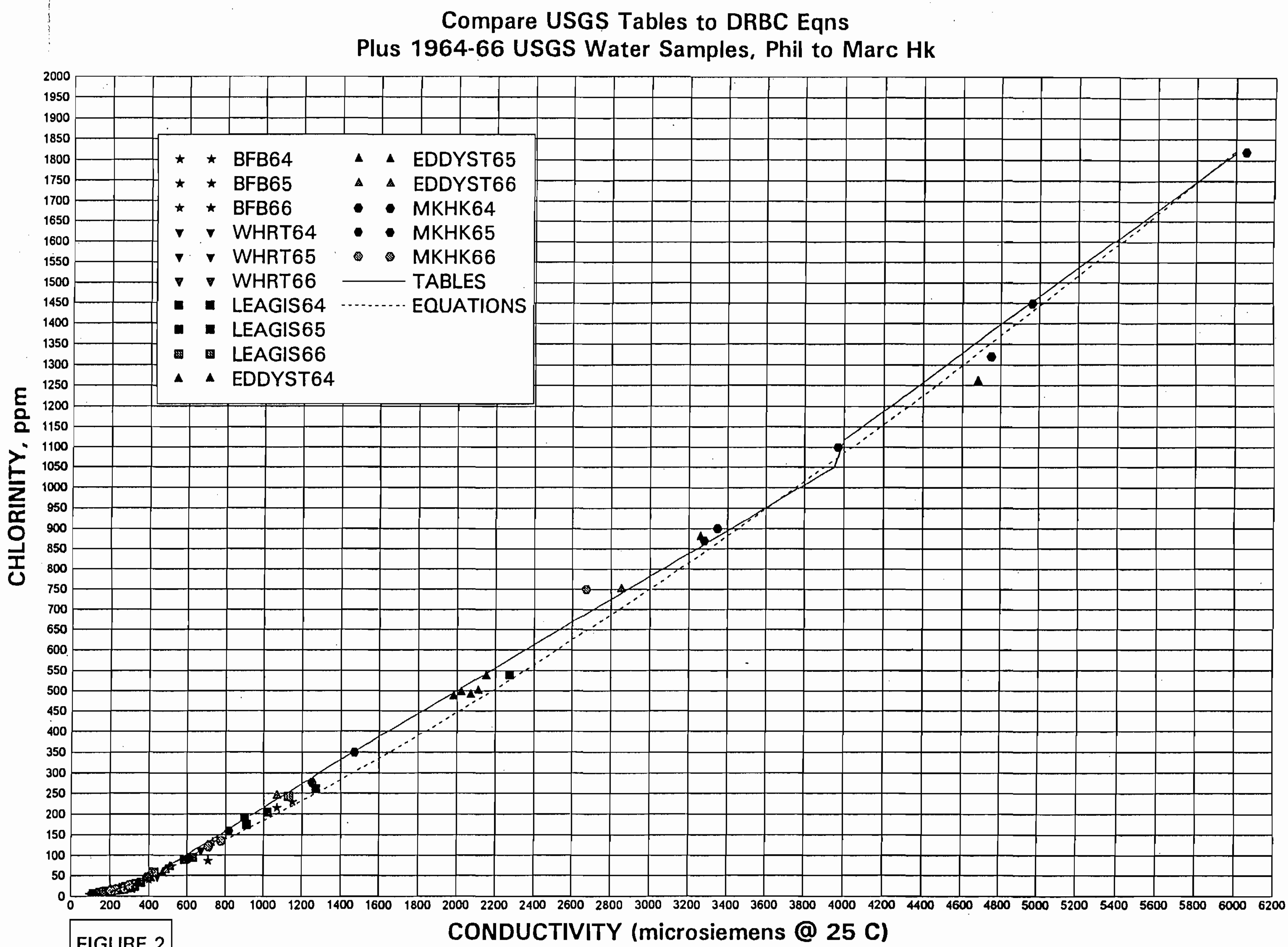


FIGURE 1



Compare USGS Tables to DRBC Eqns
Plus 1964-66 USGS Water Samples, Phil to Marc Hk
CHLORINITY, ppm
CONDUCTIVITY (microsiemens @ 25 C)
BFB64
BFB65
BFB66
WHRT64
WHRT65
WHRT66
LEAGIS64
LEAGIS65
LEAGIS66
EDDYST64
EDDYST65
EDDYST66
MKHK64
MKHK65
MKHK66
TABLES
EQUATIONS

FIGURE 2

DELAWARE RIVER BASIN COMMISSION
P. O. BOX 7360
WEST TRENTON, NEW JERSEY 08628-0360
(609) 883-9500
FAX (609) 883-9522

GERALD M. HANSLER
EXECUTIVE DIRECTOR

HEADQUARTERS LOCATION
25 STATE POLICE DRIVE
WEST TRENTON, N. J.

August 26, 1997

Mr. Robert L. Callegari
Chief, Planning Branch
U.S. Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

This is in response to your request for comments on the Final Environmental Impact Statement for the proposed Delaware River Main Channel Deepening Project. We have compared the section on impacts of the project on salinity in the Estuary and find no changes were made as a result of our meeting with U.S. Army Corps of Engineers staff, including Billy Johnson, of the W.E.S. At that meeting questions were raised concerning the poor calibration of chlorides of the model for some months at Chester and at the Ben Franklin Bridge and the possibility of the model under-predicting due to use of observed data and the conversion of that data that may not be correct. In response to this latter point, the Commission subsequently provided the Corps with measured river boat run chloride data for the 1965 and 1992-93 periods of calibration and verification. This was to allow the Corps to make additional comparisons of predicted and observed chlorides. Also, our analysis indicated that conversion of specific conductance to chlorides using the tables provided by the U.S. Geological Survey yields significantly higher chlorides than those determined from conversion equations used by the Corps. The tabular conversion appears more consistent with the data found in the 1954 report by Keighton (U.S.G.S. WSR 1262). The use of model results which under predict chlorides in the area of the ground aquifer interface at and above River Mile 98, can result in conclusions which may be incorrect.

While the above questions the model's ability to reproduce the actual salinity in the areas discussed, we have no reason to question the model's prediction of the change in salinity resulting from the channel deepening. We concur that the Corps' use of the new complex 3-dimensional model should more accurately predict change resulting from changes in channel geometry. The impact of the proposed channel deepening on the upstream movement of the chloride profile, according to the Corps model will be substantial, up to 40 mg/l of chlorides. An increase of this magnitude is substantial and will have a major economic impact on the water users in the Estuary. The economic impacts of increased chlorides were not evaluated but should be included in the cost/benefit analysis for the proposed project. The Corps completed an earlier study on impacts of increased chlorides on municipal and industrial water costs (Delaware Estuary Salinity Intrusion Study, December 1982).

Coupled with this impact are those of the effects of future sea level rise and the effect of the proposed deepening of the C & D Canal. It is our understanding that the Corps has not included any future sea level rise. We can understand the uncertainty of using one of the accelerated theories based on the "greenhouse effect", but to totally ignore the measured historic change does not seem prudent. We know of no expert that has recommended zero rise for the future. The Delaware Basin was selected for a major study by the U.S. Geological Survey on climate change and that report is titled "Sensitivity of Water Resources in the Delaware River Basin to Climate Variability and Change" (Open file report 92-52). Also, EPA has recently published a revised report "The Probability of Sea Level Rise", (EPA 230-R-95-008). All indicate some sea level rise for the foreseeable future.

At the meeting, staff learned that the C & D Canal has had a significant impact on the chloride levels at River Mile 98 and also was informed that the Corps was concurrently working on a plan to deepen the entire C & D Canal by five feet. While we are not familiar with all aspects of both projects to evaluate the independence of the two channel deepening projects, it is clear that the EIS of the Delaware River channel deepening is not complete and would be remiss to not fully disclose all available information. The C & D Canal deepening to forty feet should be linked to and combined with the impact of the Delaware River project for the total impact analysis.

The Commission also provided estimates of the Year 2020 depletive uses for determination of the increased chlorides caused by these increases. We have not seen any results of the Corps study in which these future uses were assessed.

Thank you for the opportunity to allow further comment on this E.I.S. for the proposed Delaware River Channel Deepening. We would welcome further opportunity to discuss our comments with you.

Sincerely,

Jerry Hansler

Gerald M. Hansler

c: All Commissioners
Council on Environmental Quality

CENAP-PL-E
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25 FEBRUARY ~~1998~~
BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Sarah W. Cooksey
Delaware Coastal Management Program
89 Kings Highway
P.O. Box 1401
Dover, Delaware 19903

Dear Ms. Cooksey:

Thank you for your letter dated August 29,1997 on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

As stated in our letter of April 30, 1997, the Corps will restrict dredging within close proximity of the Pea Patch Island wading bird colony between 1 April and 30 August.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project. If you wish to meet with us, or have any questions, please contact John Brady of my staff at 215-656-6555.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

State of Delaware
Department of Natural Resources and Environmental Control
Division of Soil and Water Conservation
89 Kings Highway
P.O. Box 1401
Dover, Delaware 19903

Office of the Director

Telephone: (302) 739 - 3451

August 29, 1997

Mr. Robert Callegari
U.S. Army Corps of Engineers
Philadelphia District
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

RE: ***Delaware River Main Channel Deepening Project***
July 1997 - Supplemental Environmental Impact Statement

Dear Mr. Callegari:

The Delaware Coastal Management Program (DCMP) has received and reviewed the above referenced document. The DCMP would like to offer the following comments on the July 1997 Supplemental Environmental Impact Statement (SEIS) for the Delaware River Main Channel Deepening Project.

Underwater Sand Stockpiles

The DCMP's position on offshore sand stockpiles MS-19 and L5 has evolved from one of concern to one of vigorous opposition. Instead, the DCMP seeks the restoration of our coastal defenses and the creation of habitat as the highest and best use of this valuable material. The apparent cost savings of sand placement underwater does not negate the negative impacts to benthic resources and fisheries habitat. Please refer to the attached memo from Andy Manus, Director of the Delaware Division of Fish and Wildlife to Sarah Cooksey, Administrator of the DCMP.

The DCMP would like to further note that the May 1, 1997, Federal Consistency Concurrence for this project was based upon the Corps agreement to address this issue in their April 30, 1997 letter.

Request for a Public Hearing

In the May 1, 1997, Federal Consistency Certification, the DCMP requested that the Corps hold an informational public meeting for the citizens of the State of Delaware so that they could be aware of this project and understand its scope. In addition to the DCMP's request for a public meeting, Appendix D of the SEIS contains nine separate written requests from Delawareans for a public hearing on the Main Channel Deepening Project. The Corps response to State Representative, Shirley A. Price's request for a public hearing states that in order for a public hearing to be held there must be substantial environmental controversy and a request for a hearing by another agency with jurisdiction over the action that is supported by reasons why a hearing would be helpful. The mere number of citizens that have signed their names to requests for a public hearing indicates that there is a substantial degree of controversy regarding this project. The Federal Coastal Zone Management Act of 1972 as amended, gives the DCMP authority over Direct Federal Activities that effect the land, water, or natural resources of Delaware's coastal zone. Since the DCMP has authority to request a public hearing for the citizens of the State of Delaware and the fact that this project has proven to be controversial, it is imperative that the Corps hold a public hearing on the Main Channel Deepening Project.

The DCMP is adamant about it's request for a public hearing. The Corps inability to address numerous written and verbal requests is unacceptable at this point in the project's process.

Pea Patch Island Heronry

In the April 30,1997 letter the Corps agreed to restrict dredging for initial construction and subsequent maintenance of the 45 foot channel within close proximity to the wading bird colony at Pea Patch Island between 1 April and 30 August. In the July 1997 SEIS, Table 1-1 indicates that this restriction is only between 1 April and 1 August. The table should be amended to reflect this discrepancy.

The DCMP thanks the Army Corps of Engineers for the opportunity to comment and hopes that the issues raised herein are addressed promptly.

Sincerely,

Sarah W. Cooksey

Sarah W. Cooksey, Administrator
Delaware Coastal Management Program

SWC/jll
Enclosure

cc: Senator Joseph Biden
Senator William Roth
Representative Michael Castle
Governor Thomas Carper
Andrew Manus, DNREC
John Hughes, DNREC
Gerard Esposito, DNREC

A:\MCDCOM2.DOC
8/29/97

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF FISH AND WILDLIFE
89 KINGS HIGHWAY
PO BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE
DIRECTOR

AUG 27 1997

MEMORANDUM

TO: Sarah Cooksey, Administrator, Delaware Coastal Management Program

Andrew T. Manus

FROM: Andrew T. Manus, Director, Division of Fish and Wildlife

SUBJECT: Proposed Sand stockpile/Beneficial Use of Dredged Spoils/Mid Channel Deepening Project

DATE: August 20, 1997

The purpose of this memo is to provide input from the Division of Fish and Wildlife regarding the proposed beneficial use of sand dredged material from the Mid-channel deepening project. Division of Fish and Wildlife staff attended the 10 July 1997 public meeting on proposed sand stockpiles off Slaughter Beach and Broadkill Beach for future beach nourishment of these beaches. The Division of Fish and Wildlife, acknowledges that appropriate sources of sand for future replenishment have been largely exhausted in these areas, and that there is a need to protect beach-front development in these areas.

During the past two years, Jeff Tinsman of my staff has been involved in helping with the planning efforts for beneficial use of dredged material in the Mid-channel deepening project, specifically with regard to Kelly Island marsh creation. The recent Supplemental Environmental Impact Statement circulated for comment by the Corps. provided the first opportunity for Division of Fish and Wildlife review of the proposed sand stockpile beneficial use of dredged spoil. The meeting on 7/10/97 provided an opportunity for commercial and recreational fishermen to react to proposed beneficial use and provide input.

Having heard the public input, the Division of Fish and Wildlife has the following comments regarding proposed sand stockpile sites L5(Broadkill) and MS-19(Slaughter):

1. Evidence (samples) was presented by Jerry Blakeslee at the 7/10/97 meeting that hard substrate exists off Slaughter Beach to support a highly productive, diverse, epibenthic community. This benthic community includes sand coral (*Sabellaria vulgaris*), northern coral (*Astrangia donae*), serpulid worm colonies (*Hydroides dianthus*), sulfur sponge (*Cliona cellata*), blue mussels (*Mytilus edulis*). These community dominant species in turn support commercially and recreationally important fish, including weakfish (*Cynoscion regalis*), summer flounder (Paralichthys dentatus) and other species.

2. Proposed sand stockpile MS-19, off Slaughter Beach, would receive 1.4 million cubic yards of sand on 250 acres of bay bottom. Depth would change from 8' to 3'. Proposed sand stockpile L5, off Broadkill Beach, would receive 1.9 million cubic yards on 230 acres. Depth would change from 6' to 3'.

3. John Brady of the Corps. disputed the importance of MS-19 as a sand coral community, indicating that *Sabellaria* had been collected in only one of many benthic grab samples. His conclusion may not be valid because all epibenthos are patchy in distribution and may be under represented in quantitative grab samples. This component of the benthos is better characterized using a qualitative dredge sampler. This type of sampling was not done in the Corps. study.

4. Numerous recreational and commercial fishermen made the point that the area adjacent to MS-19 is a very important feeding and spawning area for weakfish and other game fish. In that regard, this area may be considered essential fish habitat as defined in the reauthorized Magnuson-Stevens Conservation and Management Act. (P.L. 94-265).

5. Because MS-19 is a valuable, productive fisheries habitat, it is an important commercial (draft net, commercial hook and line) and recreational (private, head and charter boat) fishing area. Altering the depth from 8' to 3' will not only alter productive habitat but exclude both fisheries. The 250 acres to be initially impacted will change as this sand moves due to tidal currents and storm events.

6. Opposition to sand stockpiles is broad based including recreational and commercial fishermen, environmentalists and federal agencies. The Planning Aid Document for the beneficial use aspects of this project, prepared for the Corps. by the U.S.F.W.S. New Jersey office, noted problems with the stockpile concept.

7. Essential fish habitat and the users of this area would benefit from placement of sand directly on the two beaches proposed and other areas also in severe need of beach nourishment:

1. Port Mahon to Pickering Beach
2. S. Kitts Hummock to St. Jones River
3. Big Stone Beach to Mispillion River
4. Fowler's Beach

(See ATM memo to J. Hughes 7/23/97)

8. The Corp's only opposition to placing sand directly onto the beach is an economic one, a projected cost of about $1.00 per cubic yard or $3.3 million in a total budget in excess of $300. million.

Please convey to the Corps. of Engineers that loss of highly productive fish habitat which economically impacts both recreational and commercial fishers can not be considered "Beneficial Use". The Delaware Division of Fish and Wildlife favors a more diversified approach of enhancing Delaware's bayfront by placing clean sand material directly on the beach, rather than stockpiling it in nearshore fish habitat.

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6554/am
05 MARCH 1998
BRADY

PASQUALE

LULEWICZ

KAMPER

MARALDO

JHB BURNES

CALLEGARI
for JHB

Environmental Resources Branch

MAR 0 5 1998

Gerard L. Esposito
Director
Division of Water Resources
Department of Natural Resources
and Environmental Control
89 Kings Highway, P.O. Box 1401
Dover, Delaware 19903

Dear Mr. Esposito:

Thank you for your letter dated February 8, 1998 on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement*, dated July, 1997.

As requested, attached is a copy of the project authorization, PL. 102-580 Section 101(6). As we have previously stated, the Section 404(r) exemption waves the requirement for a water quality certificate and/or 404 permit for that portion of this project that had been included in an environmental impact statement that was submitted to Congress prior to discharge of dredged or fill material. If we are able to replace the approved sand stockpiles and place the sand on nearby beaches, we would obtain a corresponding Delaware Coastal Zone Consistency Determination for the change. Appropriate state approvals will be obtained during the Plans and Specifications phase of this project. We would like to meet and consult with you to discuss any concerns that you may have. John Brady of my staff will be contacting you soon to arrange a meeting.

Concerning requests for a public hearing, we intend to turn our attention to this next. An appropriate public proceeding will be announced in a separate public notice. In the interim, my staff would welcome the opportunity to meet with you or your organization to discuss the project.

Thank you for your comments and continuing participation in the review of this project.

Sincerely,

Robert L. Callegari
Chief, Planning Division

Attachment

cc: Mr. William F. Moyer, Program Manager

DELAWARE RIVER MAIN CHANNEL DEEPENING AUTHORIZATION

Water Resources Development Act of 1992-102 Congress - PL 102-580 Section 101(6)

(6) DELAWARE RIVER MAINSTEM AND CHANNEL DEEPENING, DELAWARE, NEW JERSEY, AND PENNSYLVANIA.—The project for navigation, Delaware River Mainstem and Channel Deepening, Delaware, New Jersey, and Pennsylvania: Report of the Chief of Engineers, dated June 29, 1992, at a total cost of $294,931,000, with an estimated Federal cost of $195,767,000 and an estimated non-Federal cost of $99,164,000.

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY, P.O. BOX 1401
DOVER, DELAWARE 19903

OFFICE OF THE
DIRECTOR

TELEPHONE: (302) 739 - 4860
FAX: (302) 739 - 3491

February 5, 1998

Mr. Robert Callegari, Chief
Planning Division
Philadelphia District, Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3391

RE: Delaware River Main Channel Deepening Project

Dear Mr. Callegari:

In the past year, two letters regarding the above referenced project, as it relates to the requirements for Water Quality Certification and Subaqueous Lands Permitting, have been sent to the Planning Division. (copies attached) I would very much appreciate receiving a response to our inquiry regarding the 404 exemption for Water Quality Certification and submission of a subaqueous lands permit application. I do not want to find ourselves in a situation that would cause unnecessary delays as a result of our permitting/certification process.

Thank you for your attention to this matter.

Sincerely,

Gerard L. Esposito
Director

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY, P.O. BOX 1401
DOVER, DELAWARE 19903

WETLANDS & SUBAQUEOUS LANDS SECTION

TELEPHONE (302) 739-4691
FACSIMILE (302) 739-3491

Mr. Robert Callegari, Chief
Planning Division
Philadelphia District, Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3391

Re: Delaware River Main Channel Deepening Project July, 1997 Supplemental Environmental Impact Statement

Dear Mr. Callegari:

This office has reviewed the above referenced document and would like to offer the following comments:

In my April 11, 1997 to Dr. John Brady (in Appendix D), I requested clarification of the 404® exemption for Section 401 Water Quality Certification. Although the exemption is not being contested, appropriate documentation in the form of any legal opinion, case law and a copy of the congressional authorization for this project is needed for our file.

In appendix D of the document, it states that all appropriate state and local permits will be obtained prior to construction. Would you please advise as to the anticipated date for submitting a Subaqueous Lands Permit application to this office.

I would also like to reiterate the request for a public hearing on this project as stated in Sarah Cooksey's August 29, 1997 letter to you. A project of this magnitude should be scrutinized not only by federal, state and local governments but also by the citizens who would like to participate in the process.

Thank-you for the opportunity to comment.

Sincerely,

William F. Moyer

William F. Moyer
Program Manager
Wetlands & Subaqueous
Lands Section

cc: Gerard Esposito
Sarah Cooksey

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY, P.O. BOX 1401
DOVER, DELAWARE 19903

WETLANDS & SUBAQUEOUS LANDS SECTION

TELEPHONE (302) 739-4691
FACSIMILE (302) 739-3491

April 11, 1997

Mr. John Brady
U.S. Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107

RE: Delaware River Main Channel Deepening Project

Dear Mr. Brady:

In a Fax to this office dated January 24, 1997, you stated that, "The Corps does not intend to apply for a 401 because we have an exemption under 404 (R)" I requested and have received an opinion from the Delaware Office of the Attorney General regarding Section 404(r) of the Clean Water Act (CWA).

To summarize, it is our position that section 404(r) specifically exempts qualifying projects from the requirements of section 404 but not the requirement of section 401 of the CWA. The limited nature of this exemption is also established in 33 C.F.R. §323.4(d) which provides that, "Federal projects which qualify under the criteria contained in Section 404(r) of the CWA are exempt from Section 404 permit requirements, but may be subject to other state and or Federal requirements".

Unless this office is provided with irrefutable justification for why water quality certification is not required, we will expect an application for a subaqueous lands permit and section 401 Certification for the above referenced project.

If you have any questions regarding this matter, please feel free to call.

Sincerely,

William F. Moyer

William F. Moyer
Program Manager II
Wetlands and Subaqueous
Lands Section

pc: Gerard L. Esposito
Jeanne Langdon
Sarah Cooksey
Laurie Moyer
Laura Herr

WFM/djr
wfm97025

Delaware's good nature depends on you!

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25 FEBRUARY 1998

BRADY
PASQUALE
LULEWICZ
KAMPER
MARALDO
BURNES
CALLEGARI

Environmental Resources Branch

MAR 05 1998

Mr. Robert R. Jordan, State Geologist
Delaware Geological Survey
University of Delaware
Newark, Delaware 19716-7501

Dear Mr. Jordan:

Thank you for your letter dated August 26,1997 on the *Delaware River Main Channel Deepening Project, Final Supplemental Environmental Impact Statement* (FSEIS), dated July, 1997.

We are pleased that you are in agreement with our study findings that there should be no adverse effects on the quality of the ground-water supply of Delaware.

The effects of placing dredged sandy sediments in submerged stockpiles in Delaware Bay have been evaluated using several procedures which include numerical modeling of both wave and current transport, and an empirical assessment of stockpile stability. The results of these analyses indicate that the sand placed at the stockpile sites would be gradually dispersed, principally in the onshore and alongshore directions, over a period of decades. The numerical wave and sediment transport modeling indicates that the stockpile sites, with the crest of four feet below MLW, would have no detectable effect on wave distribution or sediment transport at the shoreline landward of the stockpiles. Since the stockpiles are limited to an elevation of five feet below MLW and are limited in area, there would be no significant impact on wave climate on the coast.

The FSEIS called for the stockpiling of sand at offshore locations in the vicinity of Broadkill Beach and Slaughter Beach, Sussex County, Delaware for future beach replenishment. Comments on the FSEIS noted fishery and habitat-related concerns at the sites identified and approved for interim placement of sandy dredged materials. In response, and to avoid potential impacts at these locations, the Philadelphia District has begun the design and cost evaluation process to shift placement of this dredged material to beneficial use at nearby beach sites, such as Broadkill Beach. The District will develop site specific data as part of the Plans and Specifications for the lower Delaware Bay portion of the overall project, and make available appropriate environmental documents, prior to actual beach construction; about 2 years from now. The initial assessment indicates this modification is both economically and environmentally feasible.

Although the material may not be fully compatible with the existing beach material, it is a clean, fine to medium sand that will provide substantial protection to the Delaware Bay coast, and will perform adequately as a beachfill.

Thank you for your comments and continuing participation in the review of this project. If you have any questions, please contact John Brady of my staff at 215-656-6555.

Sincerely,

Robert L. Callegari
Chief, Planning Division

State of Delaware
DELAWARE GEOLOGICAL SURVEY
UNIVERSITY OF DELAWARE
Newark, Delaware
19716-7501

ROBERT R. JORDAN, STATE GEOLOGIST
DELAWARE GEOLOGICAL SURVEY BUILDING
PHONE: 302-831-2833
FAX: 302-831-3579
E-MAIL: DGS@MVS.UDEL.EDU

August 26, 1997

Mr. Robert L. Callegari
Chief, Planning Division
U. S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Callegari:

The Delaware Geological Survey reviewed the Final Supplemental Environmental Impact Statement for the Delaware River Main Channel Deepening Project dated July 1997. Our comments pertain only to the potential impacts of this project on the geologic and hydrologic resources of Delaware and are discussed in the attached position paper. If you have any questions, please feel free to contact me or other members of the DGS staff at (302) 831-2833.

Sincerely,

Robert R. Jordan
State Geologist & Director

dcw

attachment

26 August 1997

Delaware Geological Survey
Position Paper

on the

Delaware River Main Channel Deepening Project
US Army Corps of Engineers

The U. S. Congress authorized the Delaware River Main Channel Deepening Project (Project) in October 1992 as part of the Water Resources Development Act of 1992. In July 1997 the Philadelphia District of the U. S. Army Corps of Engineers (USACE) released a Supplemental Environmental Impact Statement (SEIS) to provide additional information and environmental analyses to address concerns raised during review of the Feasibility Report and Environmental Impact Statement (FREIS; February 1992). The Project includes deepening the existing navigation channel from 40 to 45 feet from Philadelphia to deep water in Delaware Bay, widening of several channel bends, and deepening of the Marcus Hook anchorage. Dredged material from the riverine portion of the project area would be placed in upland disposal sites. In Delaware Bay, the dredged material would be used for wetland restoration and for stockpiling of sand for future beach nourishment projects.

Questions have been asked of the Delaware Geological Survey (DGS) about the impact of this project on the geologic and hydrologic resources of Delaware. DGS staff reviewed the FREIS and SEIS and identified the following two potential issues of concern:

1) What are the effects of channel enlargements on the quality of ground-water resources?
2) What are the effects of stockpiling sand in the Delaware Bay offshore Delaware?

1. Effects of channel enlargements on the quality of ground-water resources.

Based on our current understanding of the hydrogeologic framework of the aquifer systems near the river, the effects of channel enlargements on the quality of the ground-water resources of Delaware should be negligible. Navoy, in Appendix A of the SEIS, reached a similar conclusion for the reach of the river above Wilmington. The potential for infiltration from the river to the Potomac aquifer system is suggested by ground-water levels in the aquifers that are below the level of the river (Martin. 1984). More direct evidence includes chloride concentrations in the aquifers that are above background levels (Philips, 1987). The SEIS addresses the concern that channel modifications could increase the potential for saltwater infiltration due to either the breaching of a confining unit or the movement of saltwater upriver to existing recharge locations.

Recharge most likely occurs in exposures of the aquifer in the river (in the reach upstream of Little Tinicum Island; Navoy, Appendix A of SEIS) and through relatively high-permeability sediments that fill Pleistocene river channels that cut through the Potomac confining unit into the underlying aquifer (Philips, 1987). The existing shipping channel is laterally offset from this Pleistocene channel. Based on the work reported in the FREIS and SEIS and review of other documents (Duran. 1986; Talley, 1985; Lewis et al., 1991), planned deepening should not breach any major confining units upstream of Pea Patch Island. While data are insufficient to fully evaluate the effects in the parts of the channel south of Pea Patch Island, our current understanding of the hydrogeologic framework of the aquifer systems near the river indicates that dredging should not breach any significant confining units. We conclude that channel changes should have no significant adverse impact on ground-water systems due to the breaching of confining units.

The SEIS presents a thorough discussion reviewing the spatial and temporal distribution of salinity and the results of hydrodynamic and salinity modeling in the estuary. Modeling indicates that the proposed dredging will result in salinity increases in the Philadelphia/Camden area during a recurrence of the drought of record. However, based on ground-water modeling of the Potomac aquifer system in the Camden area, the SEIS concludes that these increases should not have any adverse effects on potable wells adjacent to the fresh-water portion of the river. The part of the estuary adjacent to the Delaware shoreline is not classified as fresh water but rather as various grades of haline (oligo- ,meso-, and poly-haline) water (Figure 5-9 of SEIS). Results of the SEIS hydrodynamic modeling show relatively minor increases in salinity in these reaches. Based on these results and our current understanding of ground-water recharge in these areas, we do not anticipate any adverse effects on the ground-water supply of Delaware.

2. Effects of sand stockpiles on beach erosion/deposition.

The FREIS and SEIS do not adequately document the effects of offshore sand stockpiling on the wave climate of the adjacent beaches nor the feasibility of using this stockpiled material for beach nourishment. The report states that longshore transport of sand on the beach would not be affected by the sand stockpiles, but does not fully address the long-term changes in the wave climate that may affect coastal processes. More information is needed to determine if the dredge material is texturally compatible to that of the existing beaches. Only four cores were analyzed over the 12-mile reach of channel proposed to be the source of stockpile material. Given the heterogeneity of lithologies expected. such a small number of sample sites may not adequately characterize the dredge material to be encountered. The available documents do not provide enough textural data on the sand fraction of the cores to determine the suitability of the dredge material for beach nourishment. If the spoil is amenable with beach nourishment, placing it directly on the beach rather than stockpiling it offshore appears to be a more beneficial use and would be less likely to trigger unexpected effects on the local wave climate and sediment transport regimes.

References Cited

Duran, P. B., 1986, Distribution of bottom sediments and effects of proposed dredging in the ship channel of the Delaware River between northeast Philadelphia Pennsylvania and Wilmington, Delaware, 1984: USGS HA-697; scale 1:48,000.

Lewis, J. C., J. J. Hochreiter Jr., G. J. Barton, J. Kozinski, and F. J. Spitz, 1991, Hydrogeology of, and ground-water quality in, the Potomac-Raritan-Magothy Aquifer System in the Logan Township Region, Gloucester and Salem Counties, New Jersey: USGS Water-Resources Investigations Report 90-4142, 92 p.

Martin, M. M., 1984, Simulated ground-water flow in the Potomac Aquifers, New Castle County, Delaware: USGS Water Resources Investigations Report 84-4007, 85 p.

Phillips, S. W., 1987, Hydrogeology, degradation of ground-water quality, and simulation of infiltration from the Delaware River in the Potomac Aquifers, Northern Delaware: USGS Water-Resources Investigations Report 87-4185, 86 p.

Talley, J. H., 1985, Geologic Cross-Section of Delaware River, Red Lion Creek to Killcohook National Wildlife Refuge: Delaware Geological Survey Miscellaneous Map Series No. 3.

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02 MARCH 1998
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KAMPER
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CALLEGARI

Environmental Resources Branch

MAR 05 1998

Ms. Rita Shade Simpson
Principal Planner, Environmental
Salem County Planning Board
94 Market Street
Salem, New Jersey 08079

Dear Ms. Simpson:

Thank you for letter dated August 15, 1997 concerning comments on the *Delaware River Main Channel Deepening Project, Final Supplemental Impact Statement*, dated July, 1997.

Our economic and environmental analysis concluded that the most viable disposal plan of dredged material from the deepened Delaware River channel in the vicinity of Elsinboro Township, Pennsville and Penns Grove would be placement to confined upland disposal areas.

Under a separate ongoing Corps study,"*Delaware Bay Coastline - Delaware and New Jersey, Oakwood Beach Interim Feasibility Study*", various alternative plans, including sand placement, are being evaluated to arrest the erosion at Oakwood Beach in Elsinboro Township. For the other two communities, studies could be conducted by the Corps under two other authorities. Section 204 of the Water Resources Development Act of 1992 provides the authority for the Corps to investigate the beneficial use of dredged material in connection with dredging for construction, operation, or maintenance of an authorized Federal navigation project and improvement of an ecosystem habitat. Section 145 of the Water Resources Development Act of 1976 allows for placement of sand on beaches, if requested by a state, which has been dredged in constructing or maintaining a navigation channel adjacent to such beaches, if the studies conclude that such an action is in the public interest. Studies or project costs under these authorities would be cost shared with a non-Federal sponsor. A request would have to be made by the municipality or the State of New Jersey to initiate either of these type of studies and financially participate therein.

ACKNOWLEDGEMENT BETWEEN
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
AND
U.S. ARMY CORPS OF ENGINEERS, PHILADELPHIA DISTRICT

PURPOSE

The purpose of this memorandum is to set forth the acknowledgements between the New Jersey Department of Environmental Protection and the U.S. Army Corps of Engineers, Philadelphia District regarding the following dredging and dredged material disposal issues:

A. NJDEP Water Quality Certification 0880-90-0001.4 for the maintenance of the Delaware River Philadelphia to Sea 40-foot Federal Navigation project, and

B. NJDEP Coastal Zone Consistency Determination 0000-90-0005.3 for construction and maintenance of the Delaware River 45-foot Federal Navigation Project.

This memorandum provides the framework to accomplish the following:

1. Implement management and monitoring for surface dewatering discharges from existing confined upland disposal facilities for the maintenance dredging of the existing Federal Navigation Project, Delaware River Philadelphia to the Sea 40-foot Project, and additional confined upland disposal facilities for the construction and maintenance dredging of the Delaware River Main Channel 45-foot Deepening Project.

2. Implement management and monitoring for ground water discharges from existing confined upland disposal facilities for the maintenance dredging of the existing Federal Navigation Project, Delaware River Philadelphia to the Sea 40-foot Project, and additional disposal facilities for the construction and maintenance dredging of the Delaware River Main Channel 45-foot Deepening Project.

3. Provide public fishing access to the Delaware River at the Racoon Island confined upland disposal facility.

4. Confirm and further evaluate the effects of potential salinity changes on oyster populations due to the deepening project.

5. Develop and implement a monitoring plan to assess the long term effectiveness of the habitat development project at Egg Island Point and any effects of the habitat development project to the oyster beds proximate to this site.

6. Develop sediment sampling and testing protocols to be implemented throughout the life of the Delaware River Main

Channel 45' Deepening Project.

PROJECT AREA

The project area is located within the Delaware River and Bay and the borders of the Commonwealth of Pennsylvania, and the States of New Jersey and Delaware. It extends over 100 river miles of the Delaware River and Bay, from Philadelphia, Pennsylvania to the mouth of the Delaware Bay.

OVERVIEW

The Philadelphia District of the U.S. Army Corps of Engineers (Corps) and the New Jersey Department of Environmental Protection (DEP) will form a working group to develop appropriate coordinated sediment sampling and testing programs, surface water discharge monitoring plans and ground water protection program plans which will be implemented in conjunction with the maintenance dredging of the existing 40-foot Federal Navigation project, and the construction and maintenance dredging of the 45-foot Main Channel Deepening Project. These plans will consider the results of previously collected Delaware River sediment quality data, the location of dredging within the Delaware River, and the technical design of the confined upland disposal facility to be used for each reach of the channel. Sampling, testing and monitoring plans will be implemented at the appropriate time based on the timing of the dredging activities for both the maintenance dredging of the existing project and the construction and maintenance dredging of the deepening project.

SEDIMENT SAMPLING AND TESTING

Previously collected sediment quality data will be used to identify contaminants of concern, which will then be the focus of additional sediments tests. The level and frequency of sampling and type of testing will be determined by the working group. This testing will include bulk sediment chemistry analysis. Sampling plans will consider the location of dredging within the Delaware River. More extensive sampling may be required in industrialized portions of the river (i.e. between Philadelphia, Pennsylvania and Wilmington, Delaware) than in less developed areas such as the lower portion of the river and Delaware Bay. Sampling may also be reduced over time in areas provided that a data base is established to document that the sediments are adequately characterized and not contaminated at levels of concern.

In areas which are determined by the working group to be sufficiently characterized, if contaminants have not been detected, or contaminants have been detected at levels below concern, additional evaluation will not be required at this time. However, the full spectrum of contaminants will require periodic testing over the life of the project, to insure that sediment conditions have not changed.

Based on an evaluation of the previously collected data and any additional sediment testing, modifications to design and method of operation of the confined upland disposal facilities will be evaluated by the working group and implemented by the Corps as needed to protect human health and wildlife. Management of the CDFs may include institutional controls, sequencing of disposal, or other techniques. The Corps shall coordinate the development and implementation of final closure plans for each confined upland disposal facility with the DEP when the facilities are no longer to receive dredged material.

SURFACE WATER MANAGEMENT AND MONITORING

Previously collected data will be used to identify contaminants of concern, which will then be the focus of additional water quality tests. The level and frequency of sampling and type of testing will be determined by the working group. This testing will include modified elutriate testing of sediment and monitoring of effluent discharge from the confined upland disposal facilities. Sampling and monitoring plans will consider the location of dredging within the Delaware River. More extensive sampling may be required in industrialized portions of the river (i.e. between Philadelphia, Pennsylvania and Wilmington, Delaware) than in less developed areas such as the lower portion of the river and Delaware Bay. Sampling and monitoring may also be reduced over time in areas provided that a database is established to document that surface water quality is not impacted.

In areas that are determined by the working group to be sufficiently characterized, if contaminants have not been detected, or contaminants have been detected at levels below concern, additional evaluation will not be required at this time. However, the full spectrum of contaminants will require periodic testing over the life of the project, to insure that sediment conditions have not changed.

Based on an evaluation of the previously collected data and any additional water quality testing/monitoring, modifications to the design and method of operation of the confined upland disposal facilities will be evaluated by the working group and implemented by the Corps as needed to protect water quality. Modifications to improve the quality of dewatering effluent discharged from the sites will primarily be directed to increasing the residence time on a site, which would allow additional settling of suspended sediment prior to the discharge.

GROUND WATER MONITORING

In consideration of previous geotechnical and hydrogeologic investigations contracted through or conducted by the Corps, NJDEP has agreed to allow the use of the following confined upland disposal facilities (CDF) for disposal and containment of sediments from the subject dredging operations: National Park, Oldmans No. 1, Pedricktown North, Pedricktown South, 17G, Raccoon Island, 15D, 15G, Penns Neck, Killcohook Nos. 1, 2 and 3 and Artificial Island.

This acknowledgement is based upon the development of ground water protection program (GWPP) plans that will be developed by Corps in coordination with DEP for all of the CDFs listed above with the exception of the facility at Artificial Island. The GWPP plan will be developed in accordance with DEP guidelines and include any or all of the following components:

1. A ground water classification for each Impacted aquifer in the area of each CDF pursuant to the New Jersey Ground Water Quality Standards, N.J.A.C. 7:9-6. This is a primary component of each GWPP and the results of each classification will dictate the need for pursing the measures outlined in 2, 3 and 4 below. Where a CDF is located within an area with ground water classifications of III-A or III B, DEP may waive the need for pursing the requirements in 2, 3, and 4 below provided that the existing use of the ground water within the area is not impaired as a result of the operation of the subject CDF.

2. A ground water monitoring well system, consisting of monitoring wells located in each aquifer that may be impacted by the discharge and capable of producing uncompromised samples of ground water quality both upgradient and downgradient of the subject CDF. The number of ground water monitoring wells shall be adequate to characterize and intercept any contaminant plume emanating from the subject CDF.

3. A ground water sampling program for each ground water monitoring well system comprised of a list of ground water analyses, a sample collection schedule, sample preservation and shipment procedures, analytical procedures and chain of custody control. The sampling program shall be developed in consideration of the quality of the sediments dedicated to each CDF, the frequency of use of each site and onsite hydrogeologic conditions.

4. The ground water quality data generated from each ground water sampling program shall be subjected to appropriate statistical analysis in order to determine whether the discharge from any CDF is resulting in a contravention of the ground water quality standards.

FISHING ACCESS

When the Raccoon Island CDF is modified to eliminate the existing road which crosses the site, a perimeter road shall be constructed and maintained by the Corps at the facility to provide direct access to the Delaware River, with provision for several pull off areas along the road and a 3 to 5 acre area suitable for boat trailer parking provided by the Corps to be constructed by others in the future. Plan details for the road and parking area location shall first be coordinated with the DEP.

OYSTERS AND RELATED ISSUES

The Corps is relying on the conclusions of Rutgers University oyster researcher Dr. Eric Powell, a nationally recognized expert on oyster ecology, that the range of salinity changes predicted by the hydrodynamic model discussed model discussed in the Final SEIS would pose no adverse impact on the oyster resource in the Delaware River and Bay. Documentation of these conclusions, or those of another expert in the field of oyster ecology, shall be provided to the Department prior to beginning the main channel deepening project. The Corps in cooperation with NJDEP, will develop and implement, a monitoring plan to ensure that the long term impacts of any potential salinity change due to the deepening of the navigation channel have been accurately assessed with respect to the oyster population in the Delaware River and Bay.

HABITAT DEVELOPMENT

Prior to the construction of the habitat development project at the Egg Island Point site, the Corps shall provide the DEP with data validating that the material to be used will be at least 90% sand, based on each individual vibracore. The Corps will develop and implement a monitoring plan to assess the long-term effectiveness of the habitat development project, and any impacts to oysters beds proximate to the site.

COORDINATION

The NJDEP Dredging Task Force Committee will be the primary vehicle for future coordination efforts. The Corps and NJDEP will form a working group to develop appropriate coordination of sediment sampling and testing, surface water discharge and ground water monitoring plans. The cost of any additional testing or monitoring will be considered by the working group, as it is recognized that funding constraints will limit the amount of data that can be collected in a given fiscal year.

The Corps and the DEP will meet at a minimum of once every 5 years to evaluate the effectiveness of this document, review the management of the confined upland disposal facilities and evaluate the data generated in accordance with the document.

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Robert C. Shinn, Jr. Date
Commissioner, New Jersey Department
of Environmental Protection

Robert B. Keyser Date
Lieutenant Colonel, Corps of Engineers
Philadelphia District Engineer

FISHING ACCESS

When the Raccoon Island CDF is modified to eliminate the existing road which crosses the site, and perimeter road shall be constructed as part of the Delaware River Main Channel Deepening Project and maintained by the Corps and the project sponsor. This road could be used to provide direct access to the Delaware River for fishing and boating activities. Any proposed plans for these activities will be coordinated with the Corps, the project sponsor, and DEP.