DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Kelly Island Wetland Restoration

PROJECT DESIGN

U.S. Army Corps of Engineers, Philadelphia District

Kelly Island Wetland Restoration

Project Description

Introduction:

The Kelly Island Project is a wetland restoration. The main purposes of the project are to restore intertidal wetlands using dredged sediment from the deepening of the Delaware River navigation channel, stem erosion of the Kelly Island shoreline estimated at 20 feet per year, provide extensive sandy beach for spawning horseshoe crabs, and provide continued protection to the entrance of the Mahon River.

Restoring wetlands in this environmentally sensitive area has been a high priority for the State of Delaware. A plan has been developed with the assistance of the Federal and State resource agencies to restore 60 acres of intertidal habitat. The site will be constructed as an impoundment and remain as such until the sediments consolidate and vegetation becomes established. At that time, the State of Delaware will decide whether to open the site up to unregulated tidal inundation. The option to convert back to an impoundment will be maintained. Following construction, the site will be monitored to insure that the goals of the project are met and that no adverse impacts occur, particularly impacts to oyster beds.

Features of the project include:

- Sixty acres of wetlands where the substrate will consist of an estimated 240,000 cubic yards of silt and 460,000 cubic yards of sand.
- An offshore containment dike made of 1.7 million cubic yards of sand that will provide up to 5,000 linear feet of sandy beach. The crest of the dike will be at +10 ft MLW providing substantial spawning habitat for horseshoe crabs.
- A geotextile tube within the core of the offshore dike that provides overwash protection.
- Sheetpile groins to limit sand transport along the beach.
- Options for water level control or free tidal exchange with the bay.

Construction:

Construction of the sand dikes will begin at the south end gaining access to the site from the Mahon River channel. Once the dikes are constructed, the interior will be filled. Fine-grained sediment will be placed first followed by placement of sand. The volume of sediment to be placed in the site will ultimately achieve a surface elevation of +5 feet MLW which is at the upper part of the tidal range. After construction, and possibly for several years, the water levels in the site will be controlled.

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. It is only

during rare events that this sand dike will be overtopped. The dike is expected to provide up to 5,000 linear feet of spawning habitat for horseshoe crabs.

The crest width of the dike will be 200 feet at its narrowest and 350 feet at its widest. 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 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 slope of the dike is estimated to be initially 1:20, and after the first year of "weathering" it should equilibrate to a milder 1:40 slope.

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 levels from damaging any portion of the interior of the project. The dike will also extend beyond its connection with the landward dike.

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 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 due to overwash.

A landward dike will be constructed along the edge of the existing marsh with a crest elevation of +8 feet MLW. The dike crest width will be 20-30 feet. The dike will prevent dredged material from flowing across or settling in the existing marsh. The dike will be built-up by trucking sand from the larger offshore dike to the landward dike during construction. The dike will not be constructed by hydraulic placement of sand. The dike will be left in place after construction to impound the site. In the future, if the State of Delaware decides that the site should function with unregulated tidal exchange with the bay, the landward dike may be removed. However, if the capability to impound the site at some future date is necessary, then the landward dike should not be removed.

Sheetpile Groins

Sheetpile groins made of either timber or vinyl 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. The groins will extend seaward from the crest of the dike about 240 feet. They will extend landward from the crest of the dike about 50 feet.

Therefore, their total length is 290 feet. The groins will follow the initial profile of the dike having a 1:20 slope from the crest of the berm to MLW. The crests of the groins will be nominally about 2 feet above the sand berm initial cross-section. The groins will be spaced about 750 feet apart. At both ends of the project, terminal timber sheetpile groins will be constructed that are 450 feet long. The groins will be constructed after the sand berm is constructed.

Outlet Works

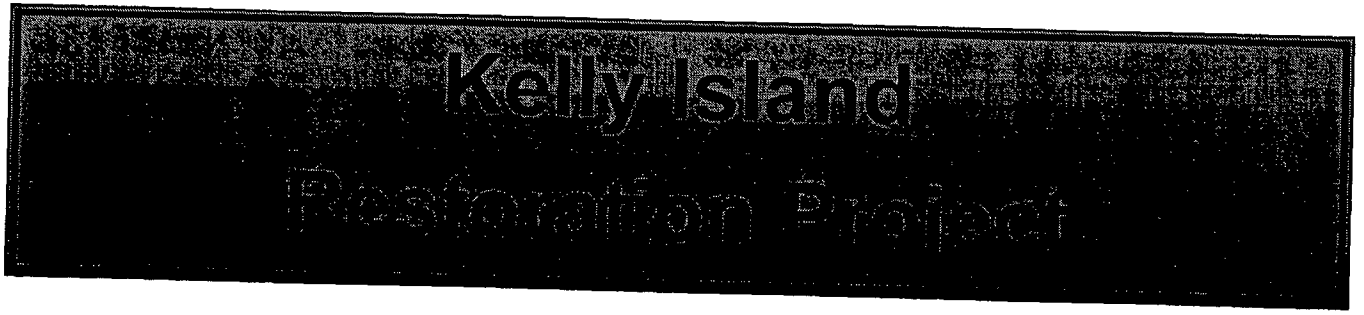
The outlet works for the marsh will be placed through a cross-shore sand dike at the north end of the project extending from the tip of Deepwater Point to the offshore dike. The elevation of the crest of the cross-shore dike will be +8 feet MLW which is sufficient to prevent even the annual highest high-tide from overtopping the dike. 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 mainly on the depth of water above the weir crests.

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 are planned. The capacity of the outlet works will depend on the size of the dredge pump and discharge line, the frequency of hopper discharges (cycle time), and water control requirements for post-construction marsh management. But the potential to release water at a rate as high as 75-100 cfs may be required.

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 will be achieved, for example, through small tidal guts through the existing marsh to the Mahon River and not through the offshore dike. A tidal gut presently exists near the south end of the project and may provide an ideal connection with the Mahon River.

Delaware Bay Main Channel Deepening Project



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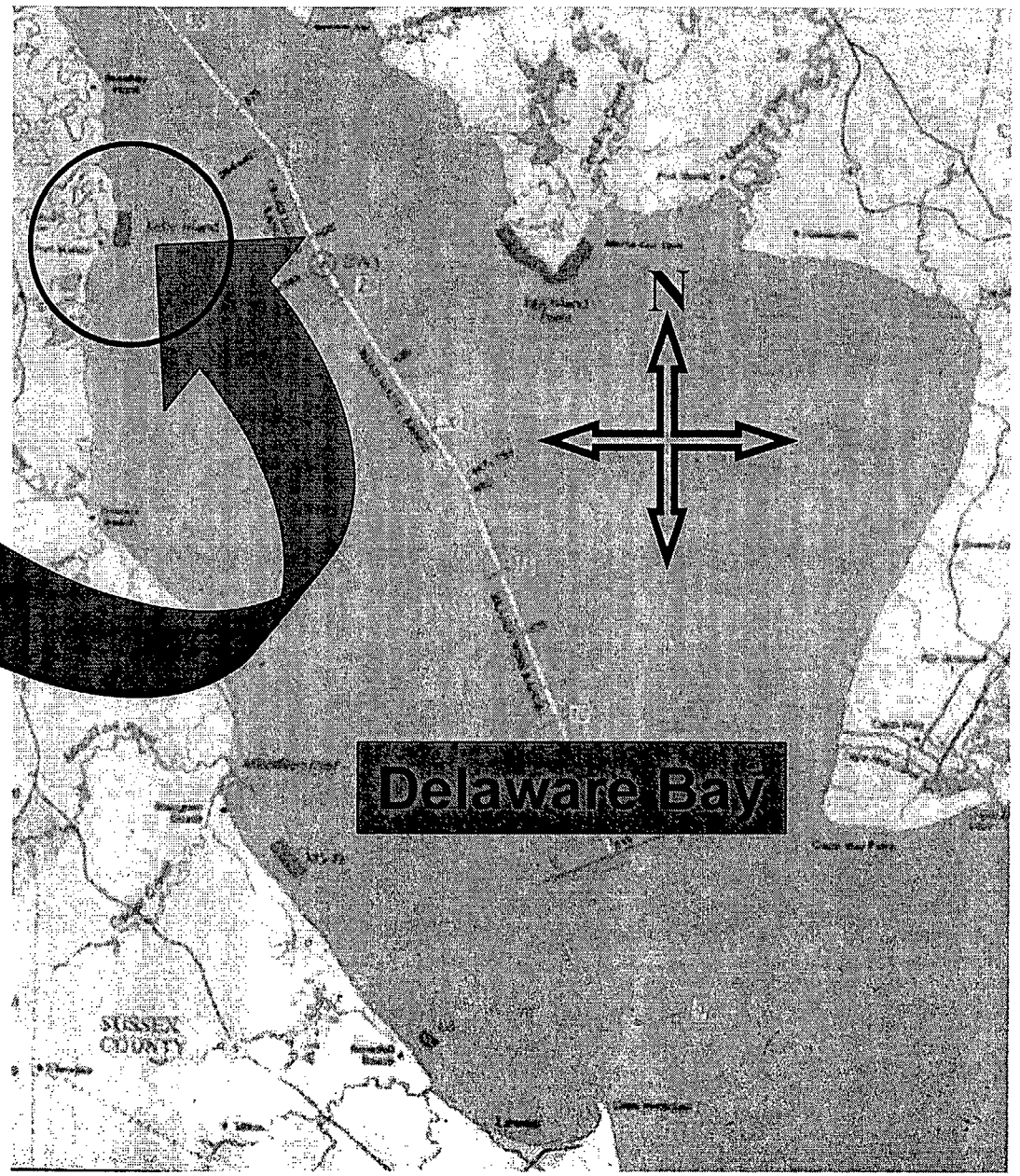
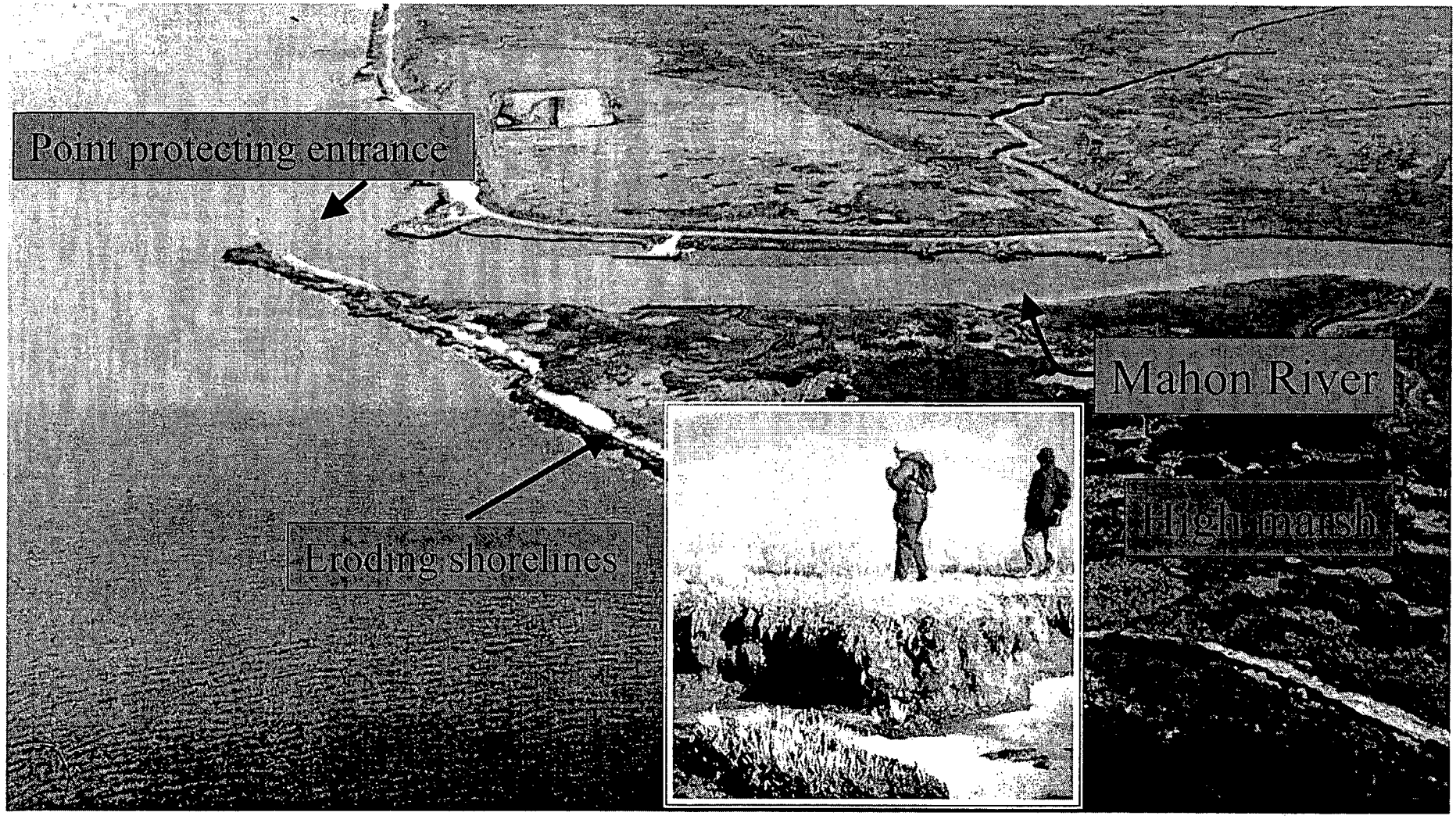
Kelly Island

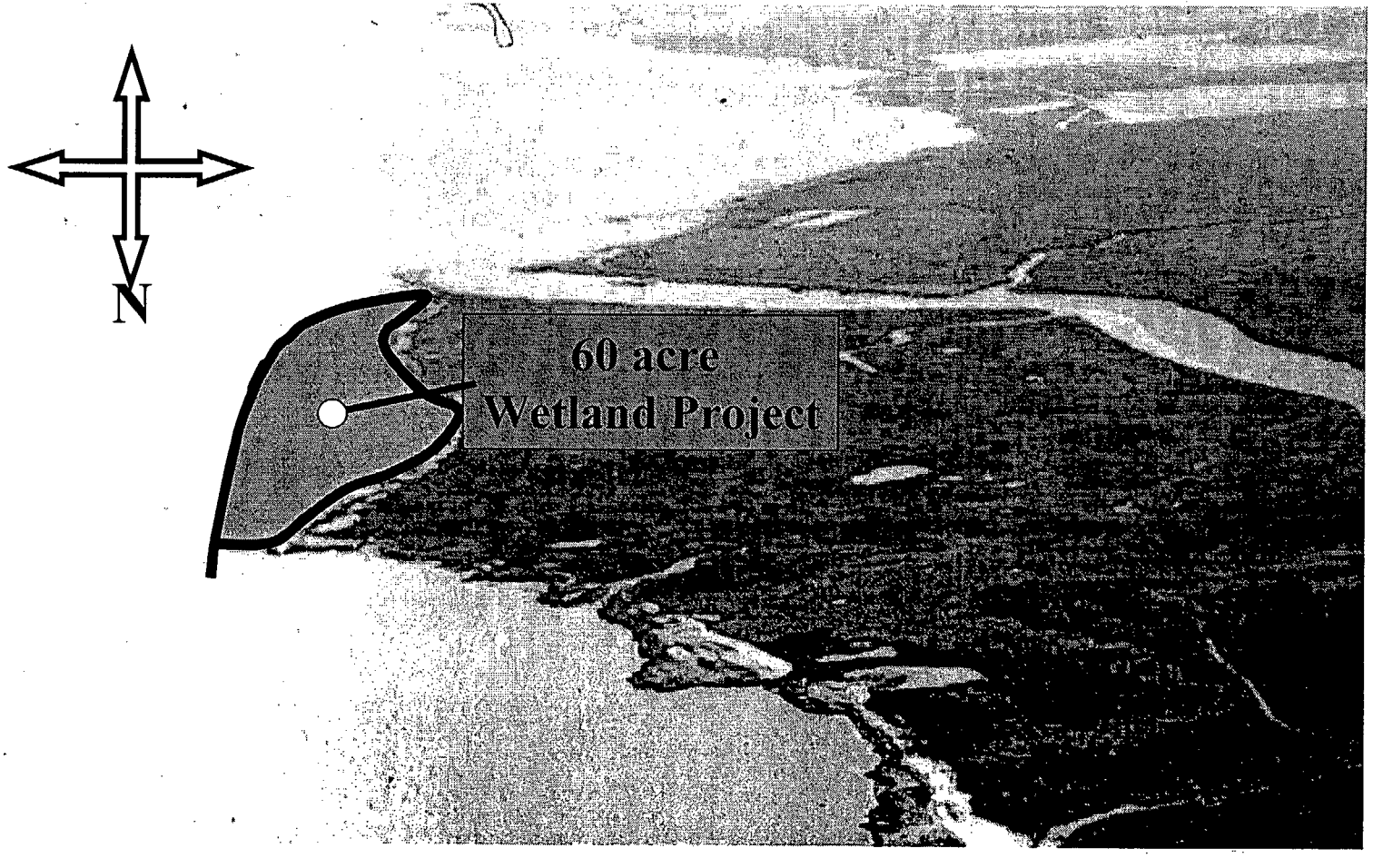
Restoration Project

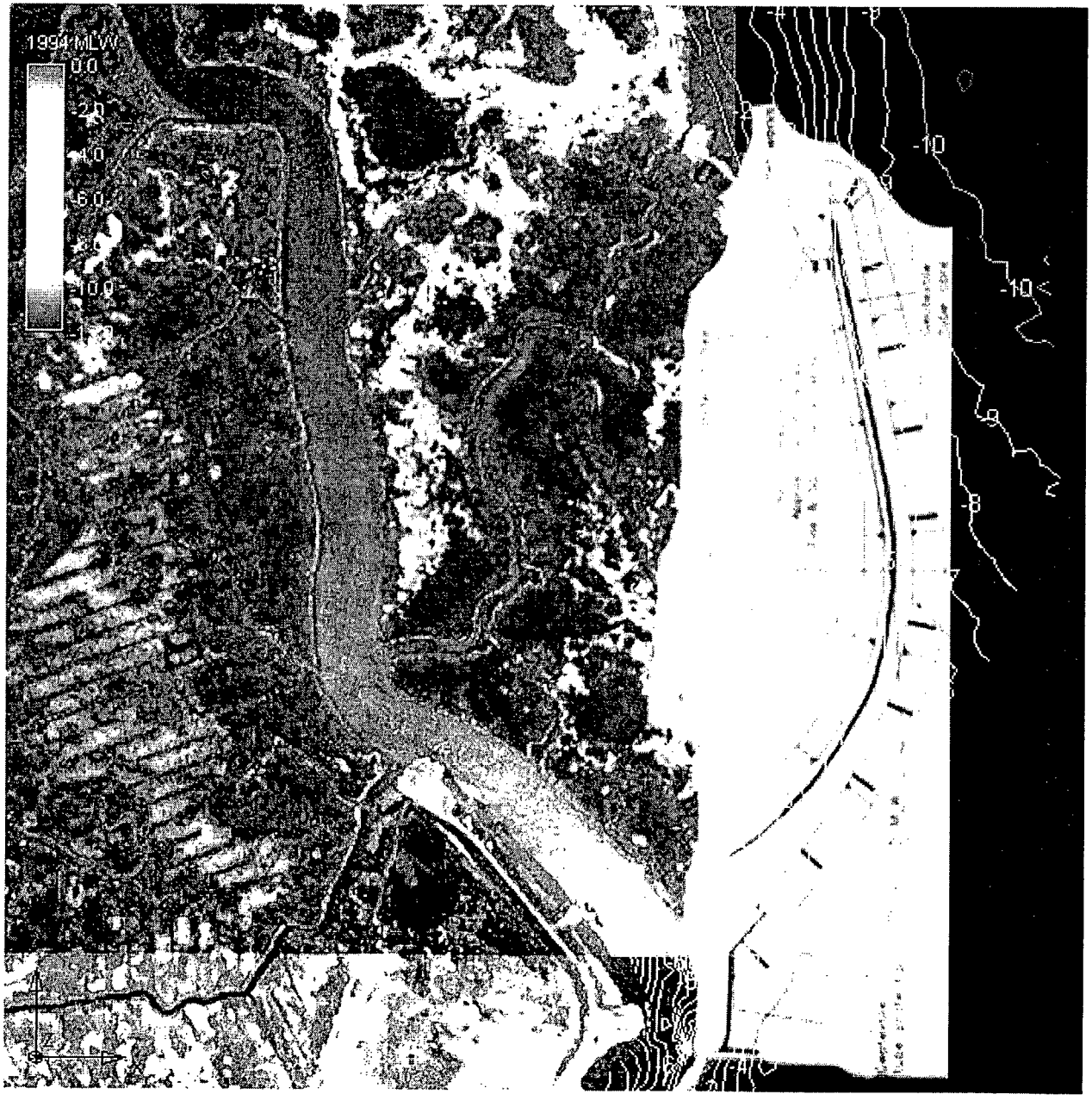


[redacted] Kelly Island [redacted]



Kelly Island




1994 MLW
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
-10
-10
-8

Kelly Island Project Design

Project Objectives:

- Restore intertidal wetland acreage
- Protect existing marsh
- Create habitat
- Avoid ecological impacts
- Protect Mahon River entrance
- Use dredged sediments
- Create a stable long-term project

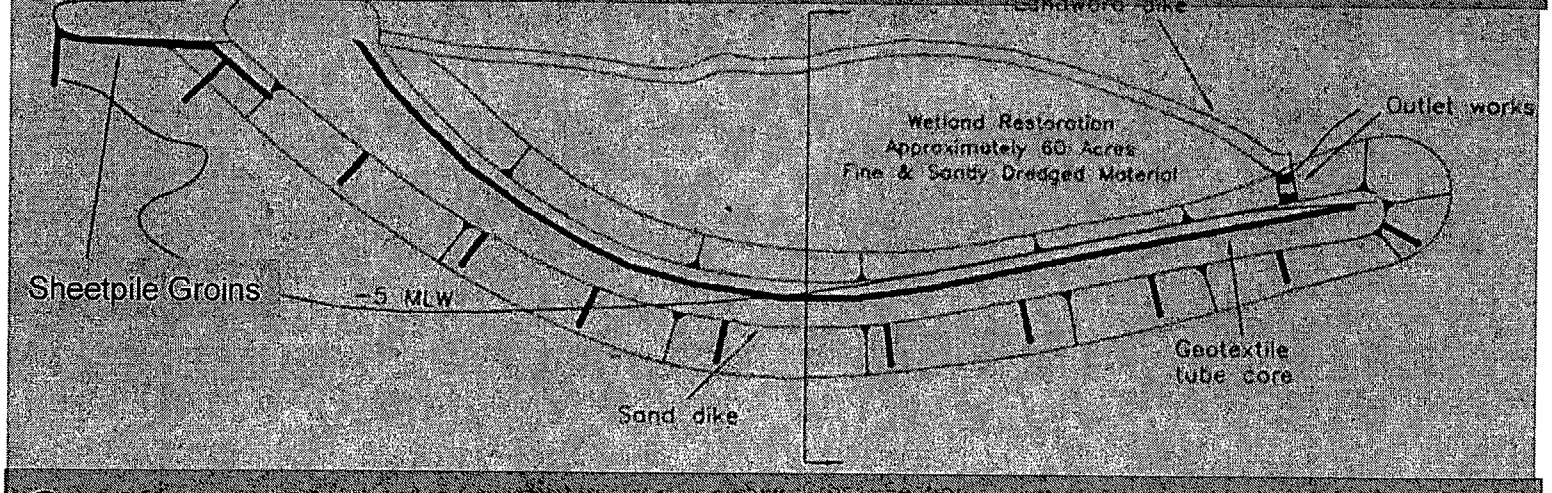
Kelly Island Project Design

Project Features:

60 acre wetlands (240K cy silt & 460K cy sand)

Offshore Dike (1.7 M cy sand) & 5000 ft of sandy beach

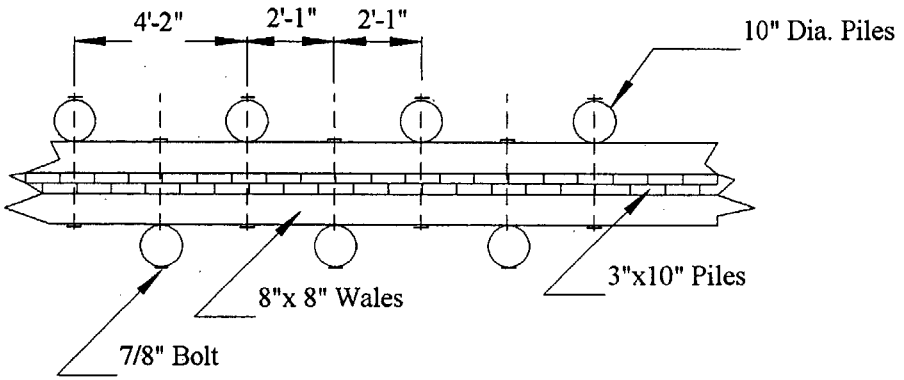
Geotextile tube core for overwash protection

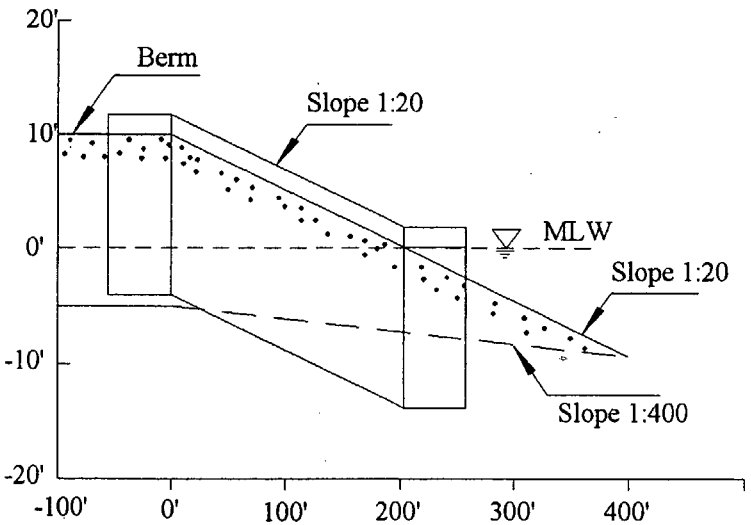


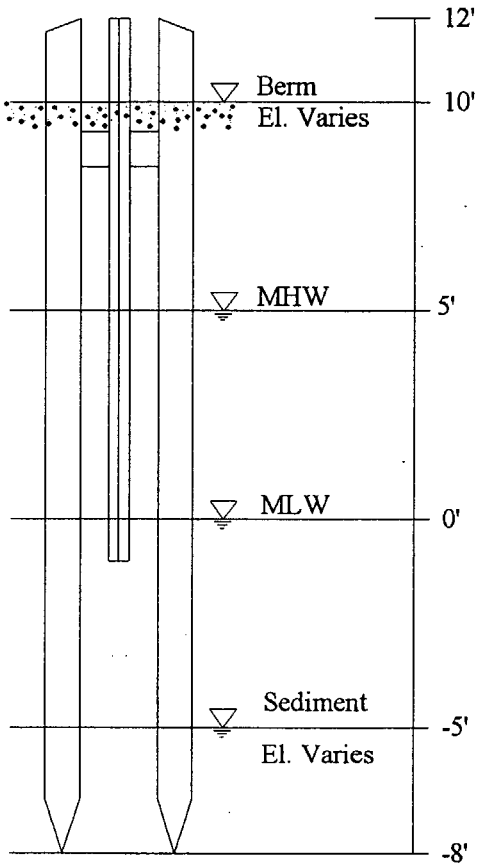
Groins to limit transport away from site

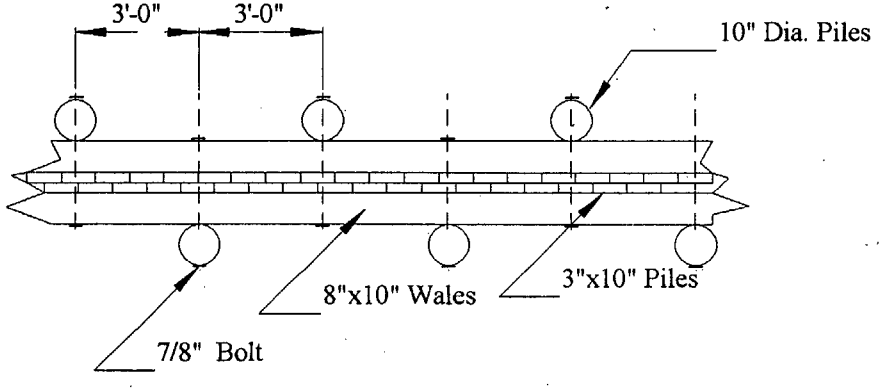
Protection of southern tip of island

North outlet & possible south outlet

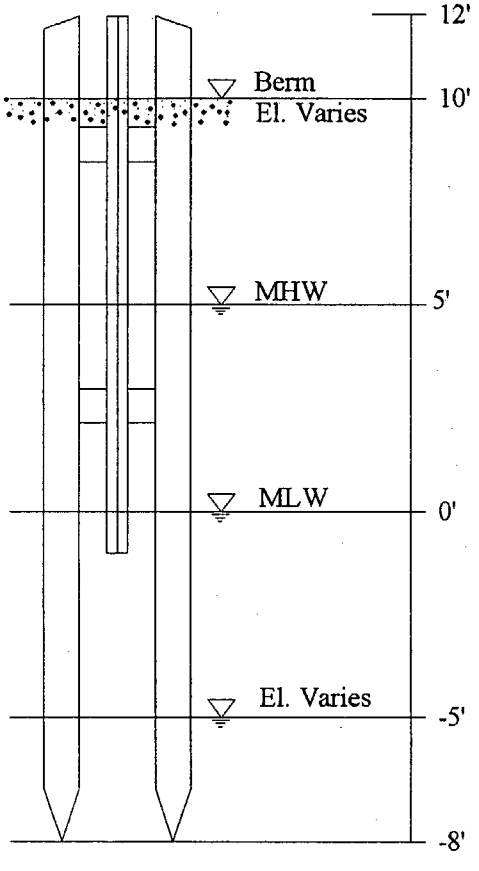

4'-2"
2'-1"
2'-1"
10" Dia. Piles
8"x 8" Wales
3"x10" Piles
7/8" Bolt


20'
10'
0'
-10'
-20'
Berm
Slope 1:20
MLW
Slope 1:20
Slope 1:400
-100'
0'
100'
200'
300'
400'

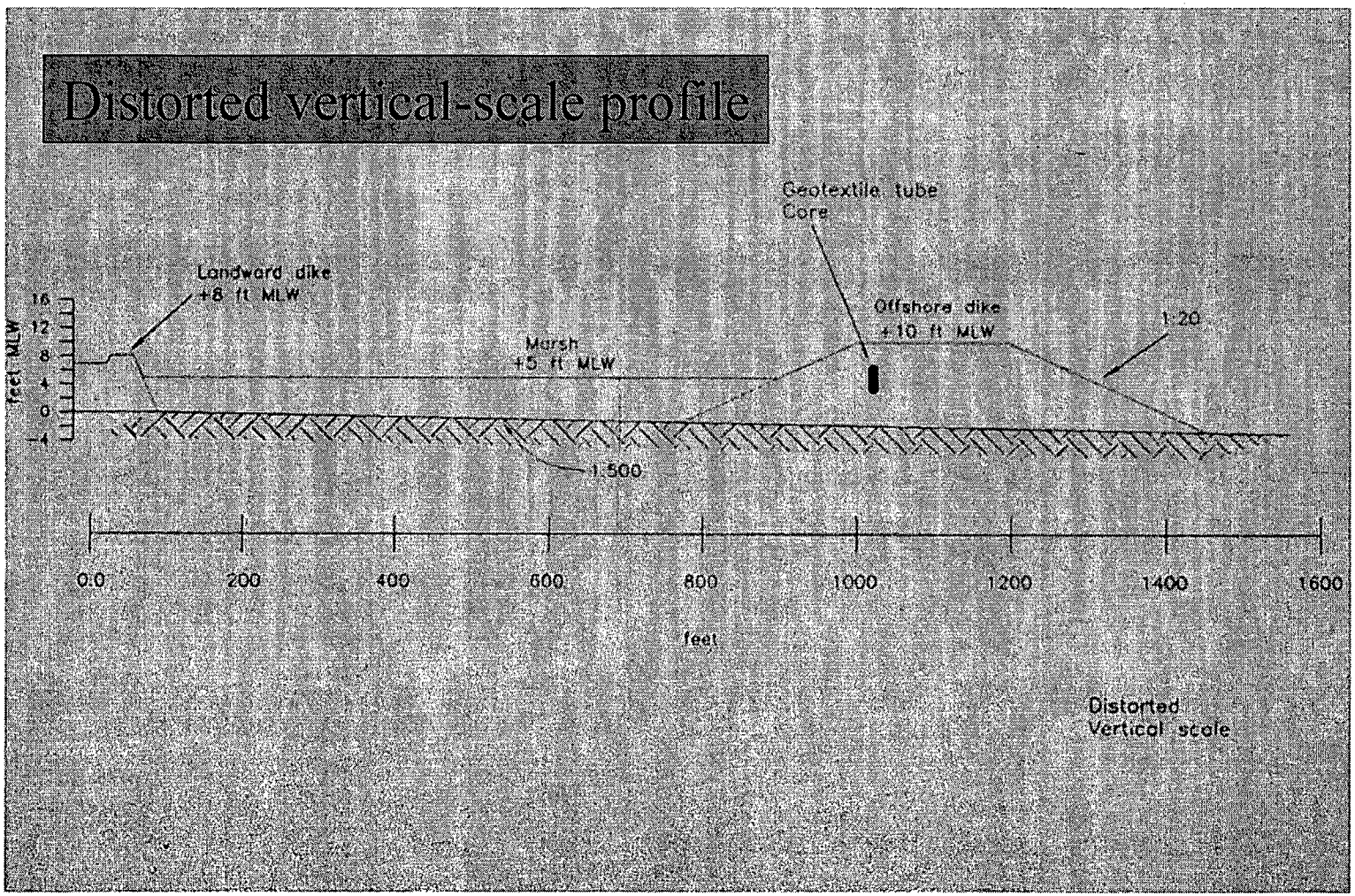

12'
10'
5'
0'
-5'
-8'
Berm
El. Varies
MHW
MLW
Sediment
El. Varies



Terminal Groin Profile is the same as for groins
but extends 450 ft offshore from the berm crest.

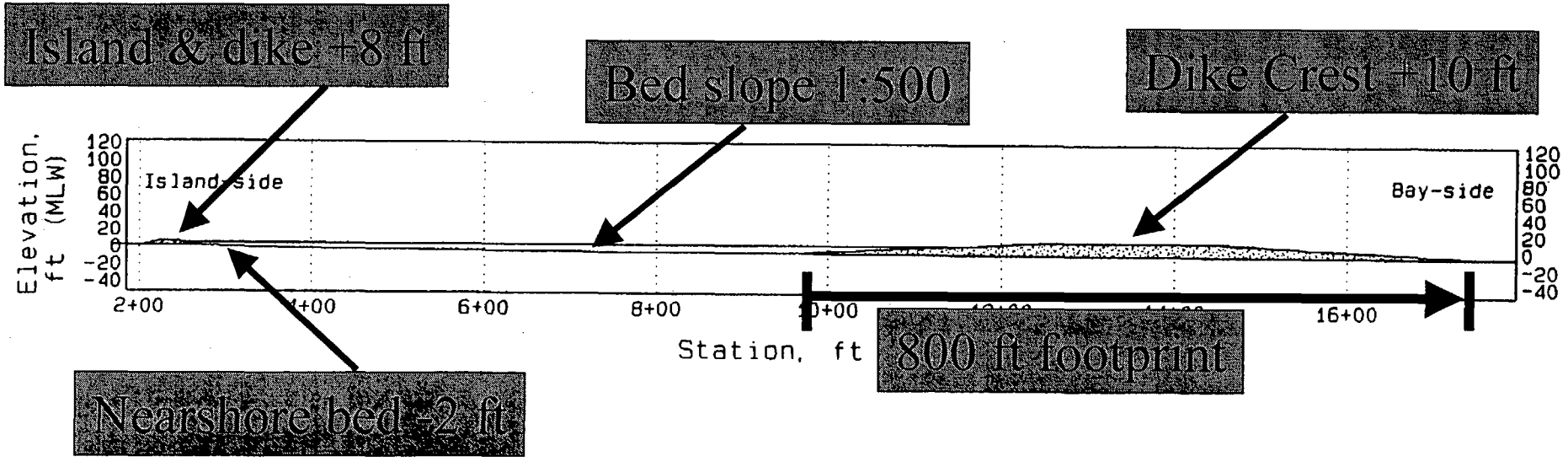


Kelly Island Project Design

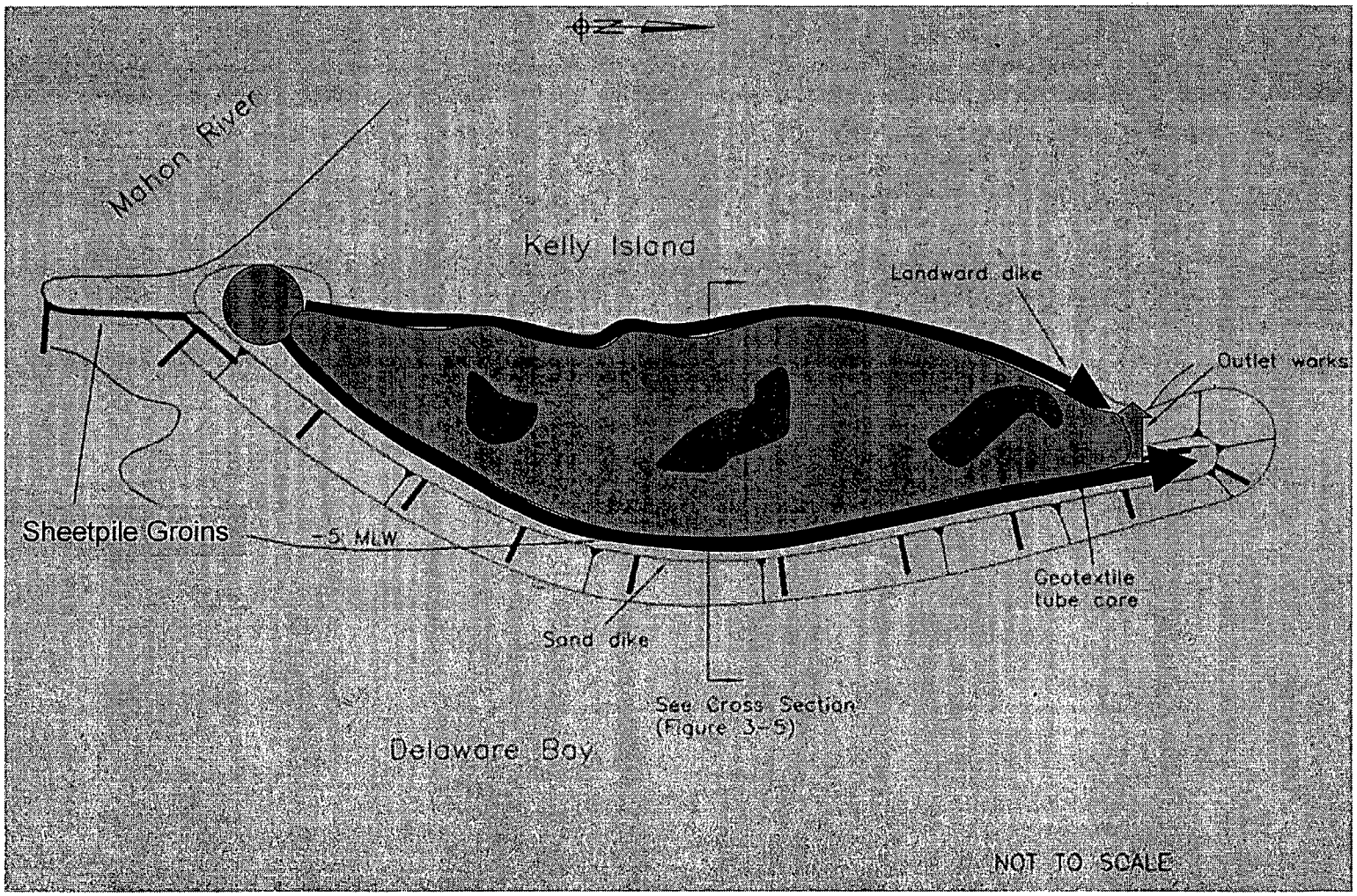


Kelly Island Project Design

Undistorted profile:

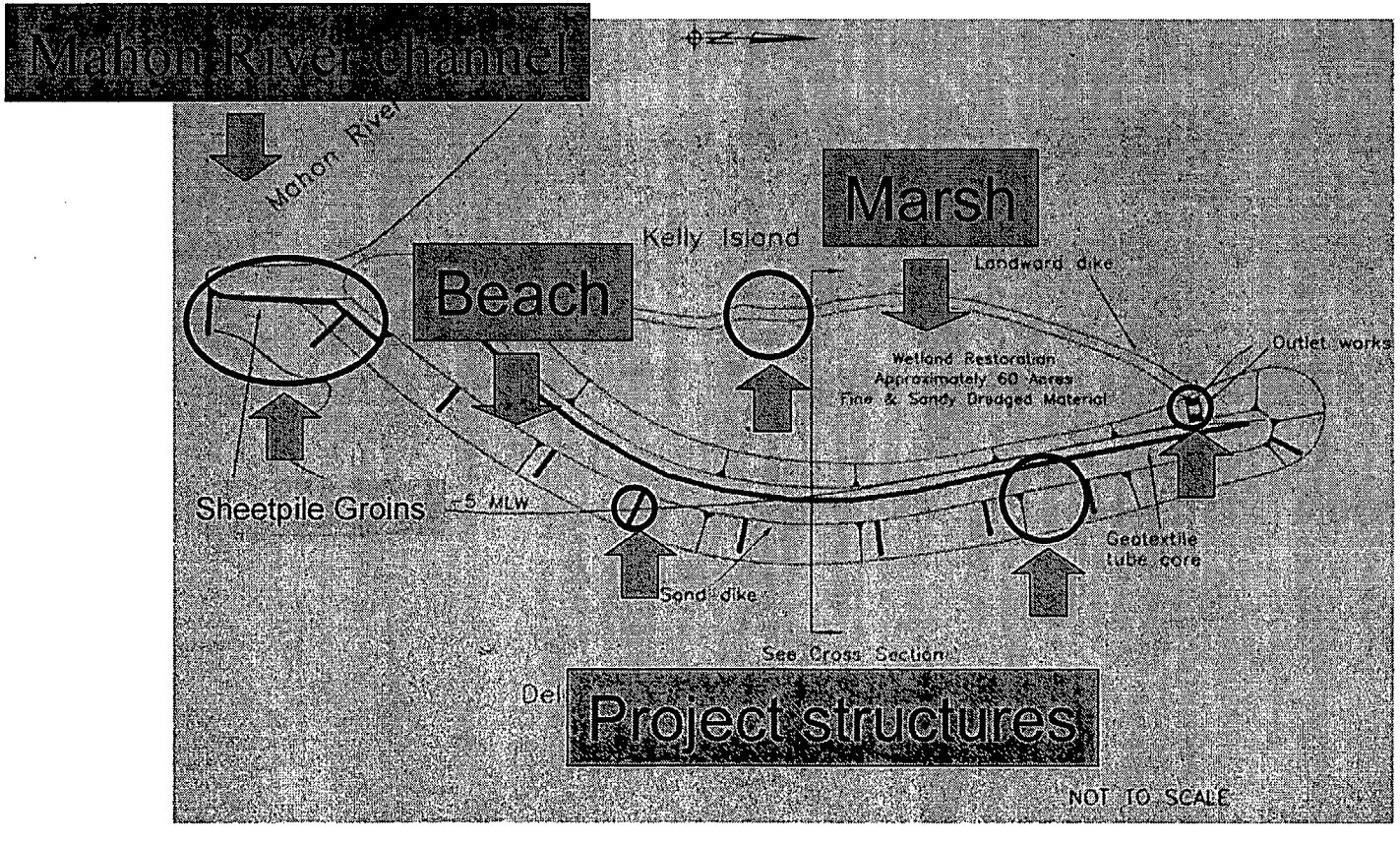


Kelly Island Construction



Kelly Island Maintenance

Maintenance Areas:

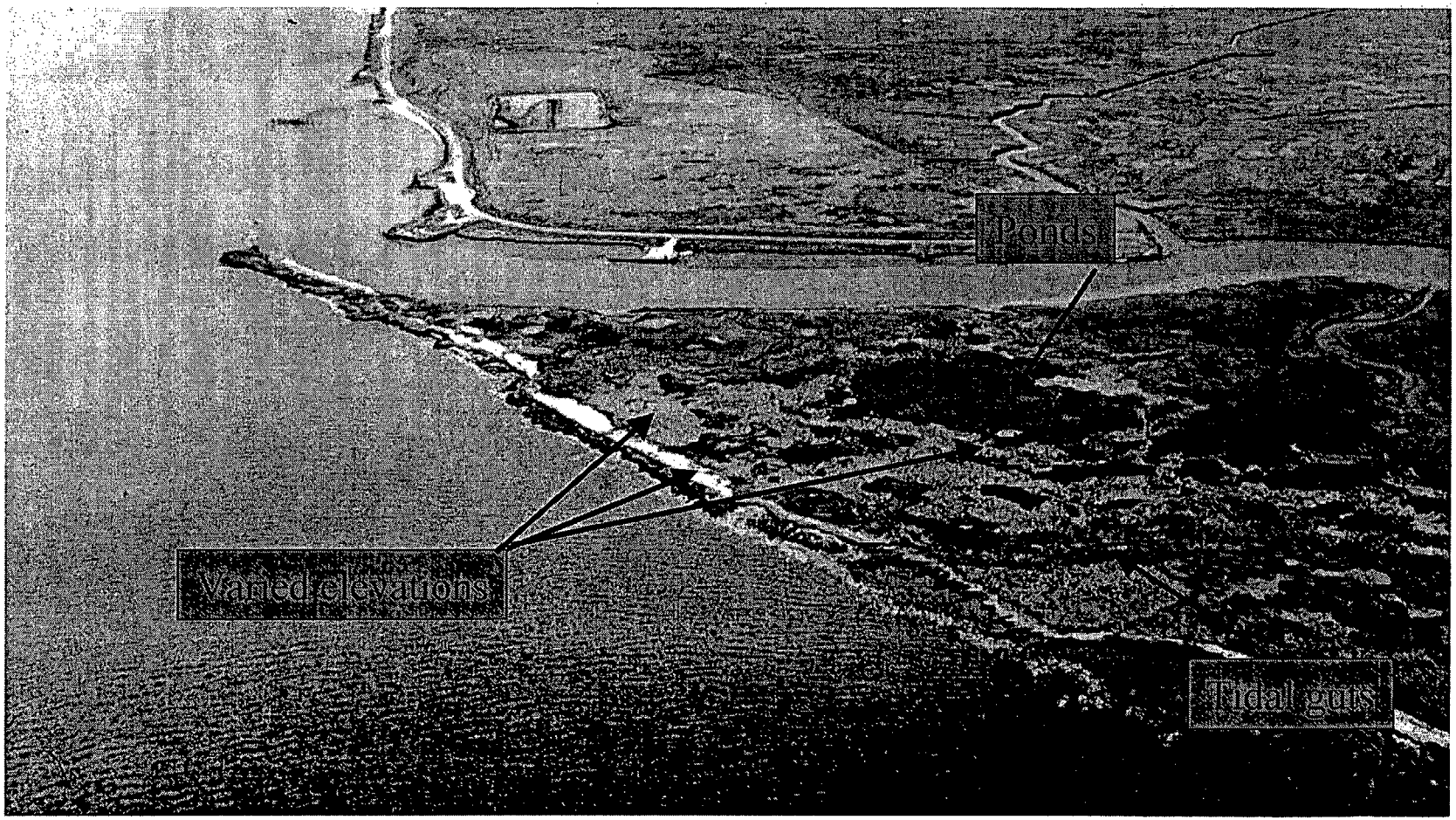


Kelly Island Maintenance

Maintaining Habitat Areas:

- Marsh
  - Topographic contouring for habitat
    - Channels, ponds, mounds, flats
  - Adaptive management
    - water flow, plantings, or eradication
- Beach
  - Obstructions or hindrances to crabs & shorebirds

Kelly Island Maintenance



Kelly Island Maintenance

Maintaining Structures:

- Offshore dike
  - Replace sand every 10 years
  - Breach repairs (to bury geotextile tube)
- Outlet works
  - Clogging, deterioration
- Groins
  - Repair as necessary
- Dredging Mahon River Channel
  - 40,000 cubic yards every 3 years

Kelly Island Monitoring

Monitoring Plans:

- Annual visual inspections
- Beach survey
  - Profiles along length of dike
  - Aerial photographs
- Habitat
  - Vegetation
  - Fisheries
  - Birds
  - Other

Delaware River Main Channel Deepening Project

Kelly Island - Wetland Restoration/Protection: Goals Table 01-Nov-00

Goal	Objectives	Performance Standard	Measurement Method	Remedial Action
Use dredged material to create and establish 60-acre tidal wetland that provides habitat for native species (horseshoe crab, shorebirds, fish, *Spartina*, waterfowl) and prevents continued erosion of Kelly Island without significant adverse impacts to contiguous habitats.	**Prevent deleterious effects to adjacent shellfish (oyster) populations and habitat.**	**No significant increase in anaerobic (smothered) conditions of shellfish beds when compared to pre-project conditions in the same locations.**	**Using sediment profiling camera with plan view attached, develop reference photographs of existing oysters so that reasonable color comparisons can be made in the future. Reference photos of anaerobic sediments will be obtained from existing imagery files. Photos will be taken quarterly during preconstruction and construction and for three years following construction. Transects will be set up between Kelly Island and the nearest oyster areas as well as control transects both north and south of Kelly Island.**	**1. Validate cause of anaerobic conditions to determine if project related. 2. Investigate restoration technology and methods. 3. Restore oyster habitat.**
		No transport of placed sand from project onto nearby oyster beds or leases.	**Sediment grab sampling of bay bottom between project and oyster beds (Drum Bed, Silver Bed, and Pleasanton's Rock) once during preconstruction, and quarterly for one year after construction when the need for future sampling will be reevaluated. In addition, grab samples will be taken between the project and the nearest oyster beds after major storms, which is defined as either (1) a tide based storm where post-storm surveys shall be obtained when water levels at Lewes and/or Port Mahon equal or exceed +7.5 ft above MLLW during a storm event, regardless of whether there are erosion impacts detected/observed at the Kelly Island berm; or (2) Observation-based, where post storm surveys shall be obtained if there is apparent scarping or shoreline retreat of the Kelly Island berm, even if tide gage measurements at Lewes and Port Mahon fail to equal or exceed +7.5 ft MLLW. Samples taken after construction will be compared to samples taken prior to project construction. This assumes that the sand from the project will be (Continued on next page)**	**1. Alternatives will be developed to divert sediment transport away from oyster grounds. 2. Construct diversions. 3. If diversions are not successful, investigate restoration technology and methods. 4. Restore oyster habitat.**

Delaware River Main Channel Deepening Project

Kelly Island - Wetland Restoration/Protection: Goals Table 01-Nov-00

Goal	Objectives	Performance Standard	Measurement Method	Remedial Action
			distinctly different from the pre-project bay bottom and will therefore be traceable. Within one year before construction, side scan sonar or a similar imaging technology will be used to characterize the bay bottom between Kelly Island and the nearest oyster areas.This will be repeated one year after construction..Transects will be set up between Kelly Island and the nearest oyster areas as well as control transects both north and south of Kelly Island.	
		No significant increase in suspended solids from fine grained material contained by the berm. A significant increase would be more than 25% above the yearly preconstruction mean.	Install a turbidity measuring instrument. Data will be gathered for one year prior to the construction of Kelly Island, during construction, and for three years after construction. In addition quarterly inspections will be done to inspect the berm for breaches.	Repair berm. Restore oyster habitat.
	Silt retained for periods between maintenance of the offshore sand dike and other features.	Shoreline retreat rate of less than 14 ft per year on average over 10-year period after construction. Additionally, equilibration of dike slope in first year should not result in shoreline recession of greater than 30 ft. (WES design criteria).	Annual cross-sectional surveys of offshore dike from landward edge of crest of dike to offshore toe of slope. Annual aerial photographs at 1:2400 scale.	Replenish cross-section of dike with sand if deemed necessary by the Corps and DNREC. Evaluate reasons for accelerated erosion. Mitigate with appropriate volume of sand to restore berm to expected condition.
	Contain silty dredged material.	Sufficient capacity in site to contain 200,000 cubic yards of fine sediments mixed with an additional 500,000 cubic yards of sandy sediments.	Observation of placement operation to be sure that placement of sand over silts reasonably mixes in the site. Water quality standards in the discharge from the site should not exceed those specified prior to dredging. During disposal of dredged material into the wetland restoration area, water quality will be monitored at the discharge pipes with an automatic sampler. Emphasis will be on monitoring total suspended solids.	If water quality standards are not met, dredging operation will be modified to bring discharges within limits by methods such as increasing the ponding period, or decreasing the discharge rate.

Delaware River Main Channel Deepening Project

Kelly Island - Wetland Restoration/Protection: Goals Table 01-Nov-00

Goal	Objectives	Performance Standard	Measurement Method	Remedial Action
	Average annual sediment transport rate away from structure should not exceed 35,000 cubic yards.	Annual topographic and bathymetric surveys of offshore sand dike show change in dike volume not exceeding 35,000 cubic yards per year. (Some sediment will move on and offshore but can be accounted for in the volume calculations. Interest here is sand lost from the project to the north or south.)	Annual cross-sectional surveys of offshore dike from landward edge of crest of dike to offshore toe of slope. Annual aerial photographs at 1:2400 scale.	Assess cause and determine appropriate action .
	Created marshes similar to native low marshes on 40 acres (including hummocks).	Similar to adjacent reference marsh located on northern third of Bombay Hook tidal marsh.	1 year after tidal exchange established, survey area to assess natural plant recruitment using random or systematic 1-m plot methods used by the National Wildlife Refuge to be sure desired plants are present.	Assess cause and determine appropriate action.
			3 years after tidal exchange established, within +/- 3% species composition similarity with reference marsh or a desirable species composition as determined by the Corps, DNREC, and Federal Resource Agencies. In the creation of the vegetated low marsh, flexibility will be used when evaluating if the marsh is a success. Although the standard of having the vegetation within +/- 3% of the reference marsh will be used as a guideline, the Corps, DNREC and the Federal resource agencies will determine if the marsh is a “success” after vegetation has become established.	Consider modification of topography, eradication of undesirable species, planting of desired species, modification of water flow characteristics, and protection against geese and other animals eating the plants.
	Establish 50 ft width of beach grass on crest of berm/dike.	75% survival after 1 year from planting.	Field surveys for survival of planted stems yearly for three years.	More plantings of beach grass.

Delaware River Main Channel Deepening Project

Kelly Island - Wetland Restoration/Protection: Goals Table 01-Nov-00

Goal	Objectives	Performance Standard	Measurement Method	Remedial Action
	Optimize habitat for use by summer and winter flounder juveniles. Although the objective of maximizing summer and winter flounder habitat will focus on these species, an attempt will be made to create a diverse aquatic community that is similar to that which exists in the adjacent reference tidal marsh waterways.	Establish at least 1000 linear feet of tidal channel at least 0.1 m deep at mean low water (NMFS, 1999) within 1 year after tidal exchange is established. The width of the channel will be determined to maximize tidal exchange without causing erosion to the sides of the channels.	Yearly air photos. Seining in new and reference channels of created marsh and adjacent tidal marsh waterways in late spring one year after tidal flow is established to determine if species are present.	Assess cause and determine appropriate action such as modification of topography and modification of water flow characteristics.
	Maximize habitat for horseshoe crabs.	At mean high water line: 1. Depth of sand is at least 16 inches. 2. Sand has 2 to 6 % moisture at 3.7 in. below the surface. 3. Beach slope is 5 to 9 %. 4. Grain size is between 0.5 and 1.0 mm at 3.7 inches below the surface.	Measure variables as described in Brady and Schrading (1996) every 500 feet along the berm face, biweekly between 1 May and 1 July, for three years after construction. Measure density of horseshoe crabs eggs at same locations following protocol that is being developed by the Atlantic States Marine Fisheries Commission.	1. Adding sand to berm. 2. Grade berm.
	Insignificant horseshoe crab mortality due to design of project. For example, in or around structures, or in the marsh (if they were to migrate over the sand dike).	Less than 10 % of crabs trapped in structures or on landward side of berm.	Yearly visual observation and counts of crabs during spawning season. Comparisons will be made between the project and other natural areas where mortality occurs.	Sand fence at edge of vegetated top of berm.

Delaware River Main Channel Deepening Project

Kelly Island - Wetland Restoration/Protection: Goals Table 01-Nov-00

Goal	Objectives	Performance Standard	Measurement Method	Remedial Action
	On beachface, maximize feeding habitat for sanderlings, red knots, turnstones.	**Since the main food for these species in Delaware Bay is horseshoe crab eggs, if horseshoe crab habitat is maximized, feeding habitat for these species will be as well.**		
	In marsh, maximize habitat on a minimum of 20 acres for migratory shorebirds such as dowitchers, dunlin, semiplamated sandpiper, etc.	**Less than 25% vegetative cover (Manomet, 1999) with 75% in a combination of mud flats and shallow water less than 12 cm at mean low water (Harrington, Undated).**	**Yearly air photos. Observations and counts of species using area during spring and fall migrations (could be incorporated into the aerial census being done by NJ and DE).**	**Assess cause of failure and determine appropriate action such as modification of topography and modification of water flow characteristics.**
	Limit invasion of *Phragmites* Create marshes similar to native low marshes (including hummocks).	**Less than 1% populated by *Phragmites* in monotypic stands in the marsh, as well as the berm and back dike.**	**Yearly air photos. Ground surveys.**	**Control of *Phragmites* using methods such as spot treatment of herbicides or water level manipulation.**

APPENDIX F
INTAKE OR OUTFALL STRUCTURES
(Kelly Island Wetland Restoration/Protection Site)

* **The appropriate Dredging and Fill appendices should also be completed if applicable.**

* **Please make sure answers to all of the questions in this appendix correspond to information on the application drawings.**

1. **How many feet will the outfall structure(s) be placed channelward of the:**

   A. **Tidal waters:** **mean high water line? __0__ ft.**
   mean low water line? __0__ ft.

   B. **Non-tidal waters:** **ordinary high water line? _N/A__ ft.**

2. **What type of material(s) will be used to construct the intake or outfall structure(s)?** The outfall structure will be constructed during construction of the rest of the facility and will be made of a combination of steel, wood, and other manmade materials.

3. **What is the appropriate median stream flow rate at the:** The flow rate will depend on the dredging plant used to empty the hopper. We anticipate a 24 inch to 30 inch dredge outflow pipe. For estimation purposes, 75-100 cfs.
   A. **intake site _N/A____ cfs**
   B. **outfall site __75-100_ cfs**
   (If this information is unknown check here_____)

4. **What will be the daily rate of withdrawal at the intake site? ___N/A_ gpd**

5. **What will be the intake velocity? ___N/A____ fps**

6. **What will be the mesh size of the screen used on the intake structure? N/A**

   _____ inches _____ other (explain)

7. **What will be the daily rate of return at the outfall site? _____ gpd**
   The hopper dredge will transport and pump the dredged material into the facility intermittently through the day. The hopper will be loaded with dredge material, travel to the facility, unload the sediments into the facility, and then return to the dredge site. The number of circuits the hopper will make in a day is unknown at this point, so estimating the daily rate of return is difficult.

8. **Have you applied for the National Pollutant Discharge Elimination System (NPDES). permit for this project? _____ Yes __x__ No**
If your answer is "No", contact the Surface Water Discharges Section, DNREC. The Corps does not recognize the NPDES program (Section 402 of the Clean Water Act) for CDF discharges; CDFs are regulated under Section 401 of the Clean Water Act. The project has a 404 (r) exemption.

9. **Will a splash apron be employed at the outfall site? __x__ Yes ___ No** (as needed to prevent undermining or scour at the base of the outfall structure).
If your answer is "Yes" complete Appendix I.
If your answer is "No", explain your proposed method of preventing bank erosion.

10 **How far will any associated structures for support or erosion control (e.g. wing walls, pile, bents, splash aprons, etc.) extend channelward of the:** The outflow structure will not extend channelward anymore than does the rest of the facility.

A. **Tidal waters:** **mean high water line? _____ ft.**
mean low water line? _____ ft.

B. **Non-tidal waters:** **ordinary high water line? _____ ft.**

11. **How many square feet of any associated structures for support or erosion control will be located:**

A. **Channelward of mean high water? __N/A__ sq. ft.**
The outflow structure will be built into one of the containment dikes for the placement facility. That containment dike will be seaward, and perpendicular to the existing shoreline. However, all of the containment dike cannot be considered support for the outflow structure.

B. **In vegetated wetlands? __N/A___ sq. ft** The outflow structure and associated support or erosion control structures will not be constructed on existing wetlands

APPENDIX H
FILL
(Kelly Island Wetland Restoration/Protection Site)

* **Please make sure answers to all of the questions in this appendix correspond to information on the application drawings.**

* **See Joint Application Form Reference Guide - How to Calculate Square Feet, Cubic Feet, and Cubic Yards.**

1. **How many feet will the fill be placed channelward of the:**

   A. **Tidal waters:** **mean high water line?** __1,500__ **ft.**
   mean low water line? __1,500__ **ft.**
   The fill will be placed within a containment area. The entire facility will be constructed in the water adjacent to the existing Kelly Island shoreline. A small sand dike (2-3 feet high) will be constructed on edge of Kelly island The seaward containment dike is a much larger sand berm. The seaward toe of the berm is about 1500 feet from the edge of Kelly Island.
   B. **Non-tidal waters:** **ordinary high water line?** __N/A__ **ft.**

2. **How much fill will be located:**

   A. **on subaqueous land (channelward of mean high water)** Considering the placement area and the footprint of the sand berms (containment dike), the fill may cover 120-140 acres (roughly estimated)
   B. **on vegetated wetlands?** __160,000__ **sq. ft.** For conservative estimation purposes, assuming the containment dike on the island has a 40 ft footprint and is 4,000 feet long, it would cover roughly 3.5 acres (160,000 sq ft).

3. **The fill will be (check one)**

   A. _____ **Hauled in from upland sources**
   B. __x__ **Obtained from dredged material**

4. **What is the total volume of fill?** __2.4 million__ **cubic yards**
   What is the total fill per running foot of shoreline? __2.4 million/6000feet=400__ **cubic yards**

5. **What method will be used to place the fill?** At Kelly Island, the sand material for construction and wetland filling will be delivered to the site in the same manner as the beaches (hopper dredge pumpout from a point offshore of Kelly Island). Once it reaches the site the pipeline will land on the shore and be extended offshore along the alignment of the containment beach. Material will be hydraulically placed. Dozers will push the fill ahead in addition to hydraulic advancement. See Section 3.3.3.2 of the SEIS (July, 1997) (Page 3-49)

6. **How will the fill be retained?** Sand berm. See Section 3.3.3.2 of the SEIS (July, 1997)

7. **State the type and composition percentage of the fill material (e.g. sand 80%, silt 5%, clay 15%, etc.)** The sand material is 90-95% sand. The fine grained portion is 100% silt.

8. **Describe the type(s) of structure(s) to be erected on the filled area (if any).** No structures will be erected on the fill material. The site will be come an intertidal wetland. See Section 3.3.3.2 of the SEIS (July, 1997).

9. **What type of ground cover will be provided for the filled area(s) to prevent soil erosion and help keep sediment from reaching State waters?** A sand berm will contain the other dredged material. The berm will be planted with American beach grass (*Ammophila breviligulata*) will be monitored and maintained. See the attached table "Delaware River Main Channel Deepening Project, Kelly Island Wetland Restoration/Protection", November, 2000. This table shows the parameters that will be monitored to insure the success of the wetland restoration and protect adjacent resources such as oyster beds.

APPENDIX I
RIP-RAP

(Kelly Island Wetland Restoration/Protection Site)

* **Please make sure answers to all of the questions in this appendix correspond to information on the application drawings.**

* **See Joint Application Form Reference Guide - How to Calculate Square Feet, Cubic Feet, and Cubic Yards.**

* **To calculate average number of cubic yards of rip-rap per running foot of shoreline: Divide the average length of shoreline structure into the total cubic yards.**

1. **Will the project be considered new construction or repair and replacement of an existing rip-rap structure? __x__ New Construction _____ Repair and Replacement If repair/replacement, photographs must be submitted of entire project length.**

2. **What will be the overall length of the rip-rap structure? 20 ft wide X 100 ft**
3. **What will be the average number of cubic yards of rip-rap used?**
   Per running foot of shoreline? ____NA_____ cubic yards
   Total? ____100_____ cubic yards

4. **How many feet will the rip-rap structure be placed channelward of the:**

   Structure will be placed on constructed berm entirely between MHW and MLW.

   A. Tidal waters: mean high water line? _NA_____ ft.
   mean low water line? ___NA_____ ft.

   B. Non-tidal waters: ordinary high water line? _____ ft.

5. **How much of the rip-rap structure will be located:**

   A. channelward of mean high water? ____200____ sq. ft.

   B. on vegetated wetlands? _____0_____ sq. ft.

6. **What type of material(s) will be used for construction of the rip-rap structure (e.g. quarry stone, broken concrete, cinder blocks, etc.)? Quarry stone**

7. **Will the rip-rap structure be backfilled? _____ Yes __x__ No If your answer is "Yes", complete Appendix H.**

8. **Will filter cloth be used behind the rip-rap structure? __x__ Yes _____ No**

9. **What will the average weight of the:**

A. armor (Larger size rip-rap) material? _____ pounds

Graded riprap with weight range between 5 lbs and 100lbs.

B. core (smaller size rip-rap) material _____ pounds

(See sample drawing in Joint Application Form Reference Guide for illustration of armor and core material.)

10. **What is the average slope of the existing bank? NA**

11. **What will the average slope of the rip-rap structure?**

Slope = 100 ft. (Run Horizontal distance):
3 ft. (Rise-Vertical distance):

HOW TO CALCULATE SLOPE

FORMULA: SLOPE = RUN (Horizontal distance or Base Width)
RISE (Vertical distance or Height)

PROBLEM: Stabilize an eroding bank by filling an area 4 feet high and 8 feet wide with quarry stone rip-rap.

CALCULATION: SLOPE = RUN therefore,
RISE

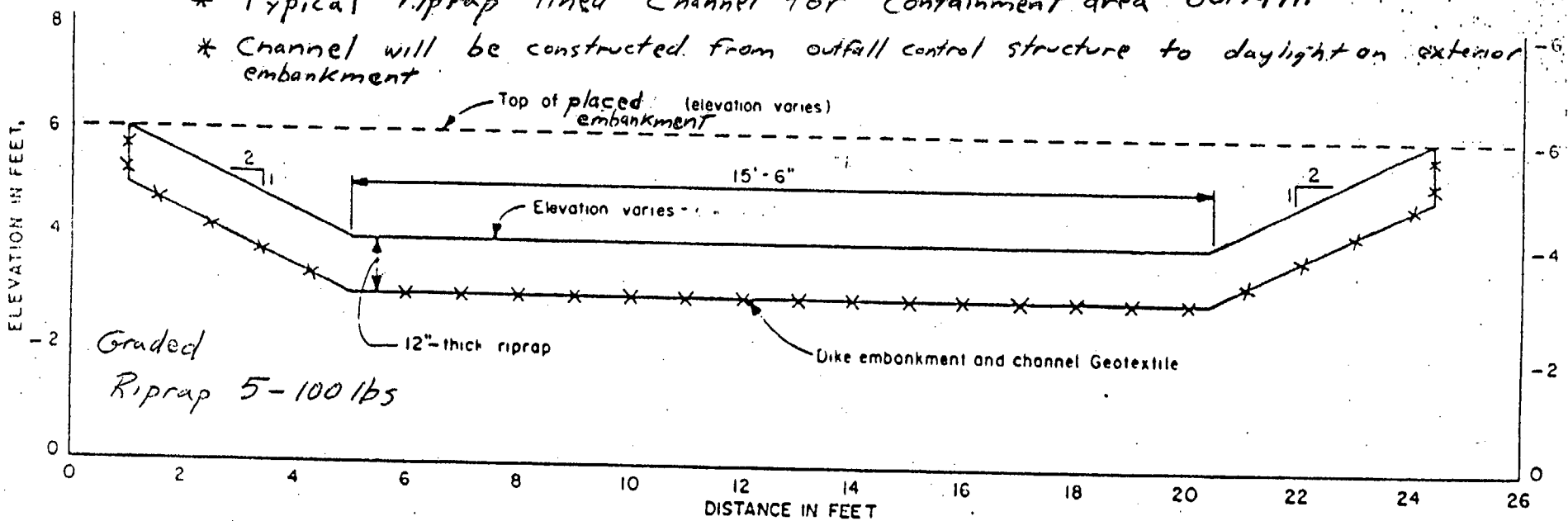
SLOPE = 8 or,
4

SLOPE = 2 OR,
1

SLOPE = 2H:1V

Kelly Island DE
Del. Riv. Deepening
Beneficial Use of Dredged Material Site

* Typical riprap lined channel for containment area outfall.
* Channel will be constructed from outfall control structure to daylight on exterior embankment



CROSS SECTION

12/00

APPENDIX K

JETTIES, GROINS, OR BREAKWATERS

(Kelly Island Wetland Restoration)

* **Please make sure answers to all of the questions in this appendix correspond to information on the application drawings.**

1. **What type of material(s) will be used for the construction of the structure(s) (e.g. quarry stone, timber, rock gabions, sandbags, etc.)?** The groins will be constructed from timber or vinyl sheetpile supported by circular timber piles.

2. **How many feet will the structure(s) (groins on the sand berm) be placed channelward of the:**

   A. **Tidal Waters: mean high water line?** Approximately 150 ft.
   mean low water line? Approximately 50 ft.

   B. **Non-tidal waters: ordinary high water line?** N/A **ft.**

3. **How much of your (entire) project will be located:**

   A. **channelward of mean high water?** The wetland area will cover 2.6 million sq ft (60 acres). The offshore sand berm foot print will add approximately another 2.5 million sq. ft. (50-60 acres). All of the project is adjacent to Kelly Island and covers bay bottom.

   B. **on vegetated wetlands?** No vegetated wetlands are expected to be used. The fringe along the bayside edge of Kelly Island will be covered by a low sand dike. However, the edge of the island has limited (or no) live vegetation.

4. **What will be the distance of separation between individual structures?**
The groins will be separated by about 750 ft.

5. **Are there similar structures in the vicinity of the project?** ____ **Yes** __x__ **No If your answer is "Yes", describe the type and location(s) of the structures.**

6. **The structure(s) will be of: (check one)**
   A. ____x_____ **Low-Profile design** (The profile of the groin roughly mimics the slope of the sand berm and is initially only 2 ft above the elevation of the berm.)

   B. N/A **Continuous height**

7. **How many feet will the structure(s) (on the sand berm) be placed landward of the:**

   A. tidal waters: mean high water line? Approximately 140 ft.
   mean low water line? Approximately 240 ft.

   B. non-tidal waters: ordinary high water line? N/A **ft.**

8. **Will the area in the vicinity of the structure(s) be artificially nourished?**
   __x__ **Yes** _____ **No If the answer if "Yes", complete Appendix H.** The groins will be constructed with the large sand dike that acts as containment for the dredged sediments. The dike is described in Section 3 of the July 1997 SEIS. See the attached Appendix H for a description of the fill for the sand dike.

9. **Approximately how many feet of shoreline have you lost over the last year?**
   _____ **ft. (width)** _____ **ft. (length)** The shoreline in this area is estimated to erode at up to 30 ft/yr along its entire length (roughly 5000 ft).

10. **Will the landward end(s) of the structure be protected from out flanking with rip-rap?** _____ **Yes** __x__ **No If our answer is "Yes", complete Appendix I.**

APPENDIX M

CONSTRUCTION IN STATE WETLANDS (TYPE II)

KELLY ISLAND WETLAND RESTORATION

* **Please make sure that all answers in this appendix correspond to information on the application drawings.**

* **See Joint Application Form Reference Guide - How to Calculate Square Feet, Cubic Feet, and Cubic Yards.**

* **TYPE II Permits (Full Procedure) are required for:**

  A. Projects involving more than one (1) acre of wetlands.

  B. Projects involving the building of structures.

  C. The construction and maintenance of lines for the transmission of electrical energy that require artificially solidified bases, and/or the construction of permanent access roads or other fixed works related thereto, which alter the flow of the tide or the natural contour of the wetlands.

  D. The construction and maintenance of water, gas or petroleum lines.

1. Project description and explanation of need.

PROJECT DESCRIPTION: The Kelly Island Wetland Restoration Project will restore approximately 60 acres of tidal wetlands along a 5,000 foot long shoreline of the Bombay Hook National Refuge. See Project Description at the beginning of the Kelly Island appendices and the attached Kelly Island Restoration Project Design Package for more detailed information.

NEED: Kelly Island has been eroding severely for many years, and has lost much of its shoreline, including almost all of its intertidal marsh. Wetlands at this location are eroding at a rate of up to 30 feet per year. Besides creating the additional wetland acres, the project will protect hundreds of acres of other tidal wetlands located landward of the restoration. 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)

2. **What is area of impact for each activity in state wetlands?**

Filling	**60,000**	**sq. ft.**
Dumping	**0**	**sq. ft.**
Excavation	**0**	**sq. ft.**

3. **What is volume of fill or excavated material involved in this project?**

Fill	**2,400,000**	**cubic yards**
Excavation	**0**	**cubic yards**

ENVIRONMENTAL SUMMARY - PLEASE SUBMIT AN EVALUATION OF IMPACT OF THE PROPOSED ACTIVITY ON THE FOLLOWING (ATTACH ADDITIONAL SHEETS):

4. **State reasons that structures cannot feasibly be located on lands other than wetlands.** A project that will restore and protect the wetlands at Kelly Island needs to be built in this location. Although approximately 3.5 acres of wetlands were mapped on the Delaware wetlands map in 1988, these areas have been largely lost due to continuing erosion.

5. **Detail temporary and permanent changes which would be caused by the proposed project and the impact of these changes on the project area and adjacent areas.** The Kelly Island Wetland Restoration Project will restore approximately 60 acres of tidal wetlands along a 5,000 foot long shoreline of the Bombay Hook National Refuge. The project will convert approximately 60 acres of shallow water habitat to a tidal marsh bordered by a large sand berm. See Sections 9.1 and 9.3 of the SEIS (July, 1997), Essential Fish Habitat Evaluation (May, 2000), and the Kelly Island "Goals" Table (November 2000).

6. **Describe alternatives to the proposed action which would reduce or avoid environmental damage.** The State of Delaware requested that this environmentally sensitive area be considered for protection as part of the Delaware River Main Channel Deepening Project. Also, refer to Section 3.3.2.1 of the SEIS (July 1997) and Section 3.4.4 of the EIS (Feb, 1992).

7. **Describe all measures to be taken during and after the completion of the proposed project to reduce detrimental effects.** The measures to reduce environmental impacts consists of avoiding the times of year that are critical to sensitive resources, testing the sediment that will be used to build the project and monitoring critical parameters to insure that the project is successful. All of these measures have been developed in coordination with DNREC and Federal resource agencies. See attached environmental window for dredged material placement at Kelly Island. See Section 4.0 of the SEIS (July 1997) for a discussion of the sediment testing that was done, and the Kelly Island "Goals" Table (November 2000).

8. **Describe all permanent environmental impacts which cannot be avoided.** The major environmental impact that can not be avoided is the change of 60 acres of shallow water habitat to tidal marsh. The change from shallow water habitat to tidal marsh was found to be acceptable during coordination with Federal and State regulatory agencies as part of

the NEPA process. Tidal marsh is being lost (converted to) shallow water in many areas along the Delaware Bay shoreline. See Sections 9.1 and 9.3 of the SEIS (July, 1997), Essential Fish Habitat Evaluation (May,2000).

9. **Submit detailed evaluation of impact of the proposed project on the following:**

A. **Value of tidal ebb and flow**

1. **Production Value: carrying organic matter to adjacent estuaries and coastal waters which serve as breeding areas for certain animal species (especially fish and shellfish).** The production value is expected to increase with the addition of 60 acres of tidal marsh. See Sections 8.0 (Site LC9 is Kelly Island), 9.1.3, 9.1.5.1, 9.4, 9.3 of the SEIS (July, 1997). In addition, see the Kelly Island "Goals" Table (November 2000).
2. **Value as a natural protective system of absorption of storm wave energy, flood waters, and heavy rainfall, thereby decreasing flood and erosion damage.** N/A
3. **The prevention of silting in certain harbors and inlets thereby reducing dredging. N/A**
4. **Removal and recycling of inorganic nutrients.** The restored 60 acre tidal marsh will increase the ability of the ecosystem to remove and recycle inorganic nutrients.
5. **Effect on the estuarine waters.** By reducing shore erosion and increasing the ability of the ecosystem to remove and recycle inorganic nutrients, the wetland restoration will have a positive impact on estuarine waters.

B. **Habitat Value.** The wetland restoration will replace shallow water habitat with tidal marsh and beach (sand) habitat. Due to severe erosion in many areas along the Delaware Bay shoreline, beaches and tidal marsh are being lost and being replaced by shallow water habitat. Although approximately 3.5 acres of wetlands were mapped on the Delaware wetlands map in 1988, these areas have been largely lost due to continuing erosion.

1. **Habitat for resident species of wildlife including furbearers, invertebrates, finfish.** Habitat for species such as furbearers and finfish, that use tidal marshes will increase. Habitat for species such as benthic invertebrates and finfish that use shallow water habitat will decrease. See Sections 8.0 (Site LC9 is Kelly Island), 9.1.3, 9.1.5, and 9.3 of the SEIS (July, 1997); Kelly Island "Goals" Table (November, 2000), and, Essential Fish Habitat Evaluation (May, 2000).

2. **Habitat for migratory wildlife species including waterfowl, wading birds, shorebirds, passerines, finfish, shrimp.** This project will increase habitat for migratory species such as waterfowl, long legged wading birds, shorebirds, and horseshoe crabs. Habitat for finfish that use shallow water habitat will decrease. See Sections 9.1.3, 9.1.5, and 9.3 of the SEIS (July 1997); Kelly Island "Goals" Table (November 2000), and, Essential Fish Habitat Evaluation (May, 2000).
3. **Rearing area, nesting area, breeding grounds for various species.** The project will increase the breeding habitat for horseshoe crabs and certain

species of waterfowl such as black duck. See Sections 9.1.3, 9.1.5, and 9.3 of the SEIS (July 1997); Kelly Island "Goals" Table (November 2000), and, Essential Fish Habitat Evaluation (May, 2000).

4. **Habitat for rare or endangered plants.** No rare or endangered plants are known from this area based on coordination with State and Federal resource agencies and studies that were performed during the preparation of the SEIS (July 1997). See Section 10.1.1.3.
5. **Presence of plants or animals known to be rare generally, or unique to the particular location.** None are known to occur in this area based on coordination with State and Federal resource agencies and studies that were performed during the preparation of the SEIS (July 1997). See Section 10.2.
6. **Presence of plants or animals near the limits of their territorial range.** None are known to occur in this area based on coordination with State and Federal resource agencies and studies that were performed during the preparation of the SEIS (July 1997).
7. **Presence of unique geological or wetland features.** No unique geologic feature is known to occur in this area based on coordination with State and Federal resource agencies and studies that were performed during the preparation of the SEIS (July,1997). The tidal wetlands in the vicinity of Kelly Island are extremely valuable to many fish and wildlife species. This is described in Section 3.3.2.7 of the SEIS (July 1997).

C. **Aesthetic Effect - Consideration of the aesthetic effect may include:**

1. **Presence of plants or animals of a high visual quality.** The project would benefit species such as migratory waterfowl, horseshoe crabs, shorebirds and tidal marsh which have a high visual quality.
2. **The presence of an associated water body.** The Delaware Bay is the associated waterbody. The restoration of the tidal marsh should increase the aesthetic effect.
3. **Wetland type of topographic diversity.** There is minimal topographic diversity in this area. The project should be compatible with the surrounding landscape.

D. **Impact of Supporting Facilities**

The supporting facilities to be considered include any public or private construction, whether or not the construction occurs in the wetlands, which would be required for construction or operation of the proposed wetlands activity, such as roads, sewage disposal facilities, electric lines, water supply systems, and schools. Effects shall be separately determined for the lands neighboring such facilities. All construction of Kelly Island will be done from the water. No supporting facilities are required.

E. Effect on Neighboring Land Uses

1. **The effects of the proposed wetland activity on neighboring land use are to be considered whether or not the neighboring lands are wetlands.** The restoration of this 60-acre wetland is compatible with the surrounding land use, which is wetlands.
2. **The environmental, aesthetic and economic effects of the proposed wetlands activity on land uses neighboring the lands on which supporting facilities will be located may be considered.** There are no supporting facilities that will impact adjacent lands to the proposed project.

F. Federal, State, Regional, County and Municipal Comprehensive Plans. Compliance of the proposed activities with the plans of the jurisdiction in which it is proposed to take place, and its impact on the plans of other affected jurisdictions. The project has been coordinated with Federal, State, and local jurisdictions through the NEPA process. Based on that coordination, there was no indication that the plan was in conflict with any plans of these jurisdictions.

G. Economic Impact. The improved channel will have a significant economic impact in allowing more efficient vessel loading, reducing the lightering requirements of crude oil tankers in the lower Delaware Bay, and attracting larger, more efficient container and dry bulk vessels. It is estimated that the proposed deepening will result in annual transportation savings of $40.1 million. Also, indirect benefits in terms of tax revenue will be realized during the construction of the project. Refer to the attached fact sheet for potential generated tax revenues. Jobs and revenues also would be generated to the local communities at the various beaches that would receive sand from the project.

Economic Impact shall include a short and long-term evaluation of the following factors to the extent the effect is directly attributable to the proposed activity:

1. **Jobs created or lost and the net income effect of jobs.** See Fact Sheet that is attached to the basic application.
2. **Increases in revenues to or increases in expenditure by State, County and local governments (e.g., increased taxes from an increased tax base and increased expenditure for maintaining supporting facilities).** See Fact Sheet that is attached to the basic application.
3. **Increases or decreases in the value attributable to the wetland as a source of nutrients to finfish, crustacea and shellfish and as habitats of such species or other flora or fauna of significant actual or potential economic value.** Although the wetland restoration will change shallow water habitat to tidal wetland and beach habitat, the net benefit to fish and wildlife resources should be positive. Due to severe erosion in many areas along the Delaware Bay shoreline, beaches and tidal marsh are being lost and being replaced by shallow water habitat.
4. **Increases or decreases in the value of the land as a recreational area.** There should be a net increase to the value of the land as a recreational resource since the wetland will provide habitat for a number of recreational

resources such as waterfowl, nursery habitat for finfish, and increased opportunity to observe wildlife such as migratory shorebirds and horseshoe crabs.

5. **Increases or decreases in the cost of flood control or expected flood damage which might be caused by the effect of the activity on the natural capacity of the wetland to reduce flood damage.** N/A

6. **Increases or decreases the costs of maintaining navigable harbors and waterways which would result from altering the capacity of the wetlands to absorb silt.** The wetland restoration at Kelly Island will reduce the erosion of existing natural tidal wetlands that is occurring along approximately 5,000 feet of shoreline where the project is being built. This erosion contributes primarily silt-sized sediment to the Delaware estuary. Sand from the sand berm that will contain the wetland restoration may be transported to the south toward the Mahon River channel. These impacts are discussed on page 9-22 of the SEIS (July 1997). A series of groins is included in the Kelly Island berm plan in order to reduce the along shore transport of sand toward the Mahon River entrance. The change in costs for maintaining this navigation channel is unknown, but is predicted to be negligible.

7. **The net economic effect, both public and private, or any contemplated supporting facilities.** There will be no supporting facilities.

8. **The net economic effect, both public and private, of the proposed activity on neighboring land uses.** The Kelly Island wetland restoration is not expected to have any significant economic effect on neighboring land uses that are also wetlands.

APPENDIX Q

PONDS AND IMPOUNDMENTS
(OTHER THAN STORMWATER MANAGEMENT FACILITIES)

(Kelly Island Wetland Restoration/Protection Site)

Please make sure to answer all questions in this appendix correspond to information on the application drawings. Attach additional sheets if necessary.

1. **Please describe proposed project and purpose (including size of pond/impoundment):** This wetland restoration is to build a 60 acre tidal marsh at Kelly Island where wetlands have been eroding at up to 30 feet per year. The project is described in Section 3.3.3.2 of the SEIS (July, 1997) with recent refinements in the Project Description in the Kelly Island portion of this application as well as the attached Kelly Island Restoration Project Design Package.
2. **Discuss alternative project locations, with emphasis on why these locations were dismissed. Alternative locations should include upland as well as wetlands sites.** Alternatives are discussed in Section 3.4 of the EIS (February, 1992) and 3.3.2 of the SEIS (July, 1997). This site has been located in an aquatic area so that a wetland can be restored using dredged material.
3. **Will the project be constructed by the installation of a dike, by excavation, or by the combination of these methods?** The project will be constructed by the installation of a dike.
   Describe construction method (including equipment type): See page 3-49 of the SEIS (July, 1997).
4. **Characterize project water/bottom profiles (i.e. provide either a cross-sectional description or drawing of proposed water depths at normal pool level). How does normal pool level relate to adjacent wetland and uplands (i.e. will these areas be covered by water)?** The site will be maintained as an impoundment until vegetation can be established. At that time, it will be converted to a tidal marsh. The elevation of the marsh is approximately + 5 feet mlw, which is the average elevation of the adjacent marsh. A cross section is provided in Figure 3-5 of the SEIS (July, 1997), and the design is discussed in 3.3.3.2 of this document.

5. **Estimate average water depth during normal pool level. ____*____ ft.**
   * This is a tidal marsh which will vary for 0 to 5 feet deep in the wetland.

6. **Estimate cubic volume of spoil to be excavated and plot spoil disposal location on the attached map depicting pond/impoundment locations (See Note below). Describe depth of spoil at disposal site and methods proposed for spoil containment. N/A.**

7. **Will a water control structure (e.g. culvert with splashboard riser) be installed?**
   _x_ Yes _____ No

Describe structure type and size and structure location. Depict structure location on attached maps (See Note below). As noted in Kelly Island Wetland Restoration Design Package drawings, the outlet structure will be located at the north end of the project at what is marked as Deepwater Point on charts of Delaware Bay. The structure will be sized to accommodate dredging activities. The outlet will provide sufficient capacity to discharge effluent during the filling process.

8. **If a water control structure is proposed, describe the proposed water level manipulation plan, with emphasis on water depths and variations in management by season (indicate dates):** The water level will be manipulated during the dredged material placement process to ensure sufficient ponding for settling of sediment. Once placement is complete, the effluent will be monitored to insure that levels of turbidity are acceptable to the District and DNREC, at which time the site will be open to regular tidal exchange without water level control.

*** If project is located in tidal wetlands, plot location and configuration of pond on a State of Delaware wetlands map (scale 1" = 200'). If project involves activities in a non-tidal stream, provide a scaled drawing on an 8 ½" x 11" sheet of paper of proposed project configuration and location. Depict spoil disposal areas on these maps.** The acres of tidal wetlands that would be impacted were calculated using the State of Delaware wetlands map from 1988. The wetlands that would be impacted are adjacent to the shoreline. A drawing showing the aerial extent of the Kelly Island wetland restoration will be submitted when the detailed Plans and Specifications are completed.