6. RECOMMENDED PLAN

The plan formulation process identified a 1,080-acre Study Area to the north and northeast of existing 1,140-acre Poplar Island project as the preferred location for a lateral expansion alignment. The Study Area is bounded to the west, north, and east by oyster bars, and to the south by the existing project. This area was evaluated to determine the size and location of a lateral expansion alternative that would preserve the optimum balance of engineering, environmental, cultural, social, and economic considerations.

The recommended plan (Alternative 3) consists of the expansion of the existing PIERP to the north and northeast, with a 575-acre lateral expansion component consisting nominally of 29 percent wetland habitat (165 acres), 47 percent upland habitat (270 acres), and 24 percent open water habitat (130 acres of open-water embayment habitat plus 10 acres of tidal gut habitat); plus a vertical expansion component consisting of a 5-ft raising of the upland cells of the existing project (Figure 6-1). It is anticipated that the recommended plan will provide approximately 435-acres of dredged material placement area, as calculated from the centerline of the exterior dike, plus a 10-acre tidal gut. The area from the centerline of the exterior dike outward to the end of the toe dike encompasses approximately 25 acres of additional bottom. Therefore, the total area of impact analyzed for Alternative 3 is a footprint of approximately 470 acres in size. The recommended plan would provide an additional 28 mcy of placement capacity and extend the project life by approximately seven years.

Based on consultation with resource agencies (USEPA, USFWS, NMFS, MDNR, and MDE), the open-water embayment could potentially range between 80 to 140 acres in size. Specifically, USFWS has proposed reducing the size of the open-water embayment to between 80 and 90 acres (Appendix F, agency consultation dated April 25, 2005). Recommendations from USFWS would result in the habitat proportion of 39 percent wetland (225 acres), 47 percent upland (270 acres), and 14 percent open water (80 acres) within the lateral expansion (Appendix F, agency consultation dated August 5, 2005). MDNR has requested further evaluation of the location of the proposed open-water embayment and the size of the embayment (as it related to long-term maintenance and stability concerns), and MDE has raised concerns about sediment transport and water quality issues arising from the location of the open-water embayment on the western side of the lateral expansion (Appendix F, agency coordination). The final size and location of the open-water embayment will be discussed and evaluated further in the next design phase of the project based on additional consultation with each resource agency and MPA (the non-Federal sponsor); results of additional hydrodynamic modeling studies; and additional design considerations. For the purposes of the analyses and description of the recommended plan in this document, the size of the open-water embayment within the northern lateral expansion is estimated at 130 acres in size.

To support the construction of the northern lateral alignment, including the vertical expansion of the existing upland Cells 2 and 6 (5-ft raising) a total of approximately 19 acres of hydraulic dredging for sand borrow will be required from a 215-acre borrow area located to the southwest of the existing project (Figure 6-1). The recommended plan also includes the activities required to complete the existing project, namely raising the existing temporary

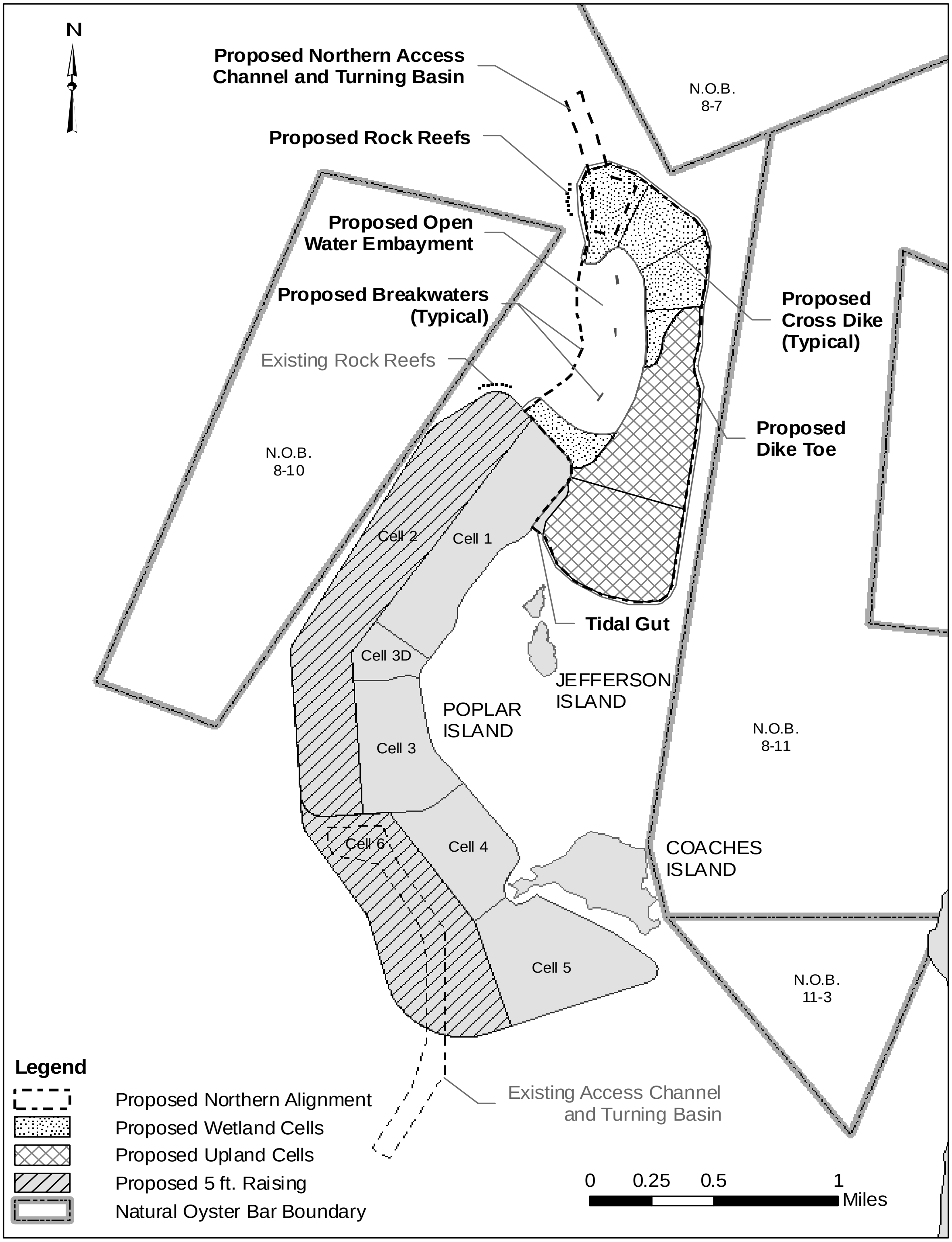

Figure 6-1. Recommended Plan (29% wetland, 47% upland, and 24% open-water embayment; plus a 5-ft raising of existing PIERP upland cells)

upland dikes from +23 ft MLLW to +25 ft MLLW to allow for placement and consolidation of the dredged material necessary to reach the final upland target elevations; the restoration of internal borrow sites within Cell 4 and the construction of temporary cross dikes in Cell 5; and constructing new discharge, pier, and bulkhead structures to accommodate the closure of Cell 6. These actions will require sand borrow from an approximately additional 119 acres from the southwestern borrow area outside the existing project footprint (Table 6-1).

Therefore, a total of 138 acres of the southwestern sand borrow area will be disturbed to complete the recommended plan. In addition, the Cell 6 closure will utilize the sand resulting from the dredging of approximately 28 acres for the southern access channel and basin.

Table 6-1. Sand Borrow Required for the Recommended Plan

Project Feature	Borrow Source	Borrow Yield (mcy)	Borrow Area Disturbed (acres)
Lateral Expansion with 5-foot Dike Raising	Southwestern Borrow Area	0.2	19
Cell 6 Dike Raising to +23	Southwestern Borrow Area	0.9	54
Cell 4 Restoration	Southwestern Borrow Area	0.6	38
Misc. Cell Development	Southwestern Borrow Area	0.4	27
	TOTAL (for Southwestern Borrow Area)	**1.1**	**138**
Cell 6 Closure	South Access Channel & Basin	0.6	28

The recommended plan also includes potential recreational and/or educational components associated with the expansion and recommendations for potentially accepting dredged material from other Federal, State, and local dredging projects at PIERP.

The recommended plan is in full compliance with the NEPA of 1969, the Clean Water Act of 1972 (as amended), the Endangered Species Act of 1973, the Fish and Wildlife Coordination Act of 1958 (as amended), the Clean Air Act of 1972 (as amended), and Section 106 of the National Historic Preservation Act of 1966. A Clean Water Action Section 404(b)(1) evaluation was completed to assess discharge into a Water of the United States (Appendix K). The lateral and vertical expansion will be constructed under a water quality certification that will be obtained from MDE prior to the start of construction, as required by section 401(c) of the Clean Water Act. Once the construction for the lateral and expansion is completed, the water quality certification for the existing project will be amended, and the entire project (existing plus the expansion) will operate under one comprehensive water quality certification.

6.1 SITE CONDITIONS

The northern expansion alignment will be exposed to a relatively high-energy wave regime to the west and north, and a lower energy regime to the east, which will dictate the stone armor design required for the proposed perimeter dikes. The depth of the Chesapeake Bay bottom within the expansion boundary ranges from approximately -6 to –12 ft MLLW, and consists of silt, clay, and sand deposits. Evaluation of the foundation conditions indicated that only the soft clay and silt deposits would be problematic with respect to dike stability and settlement, and that most of those deposits can be avoided by adjustments to the alignment. The sand deposits appear to be sufficient in quantity to provide most, if not all, of the materials required to construct the dikes for the lateral expansion component of the project. A more detailed explanation of the borrow conditions is presented in Section 6.4

6.1.1 Hydrographic Surveys

Bathymetric data for this study came from the Poplar Harbor Morphological Model (M&N 2004). M&N compiled the data for the model from the NOAA National Ocean Service (NOS) Digital Elevation Models (DEM) (NOS, 2000) and Charts 12230, 12263, 12264, 12266, 12268, 12270, 12272, 12273, 12274, and 12278. These data were extracted from a 3-arc second gridded (90 m) DEM. The vertical and horizontal data are referenced to MLLW based on the 1960 to 1978 tidal epoch, and the Maryland State Plane, North American Datum 1983, respectively.

M&N used three additional hydrographic surveys from 1994 (USACE), 2002 (M&N), and 2003 (GBA) in the vicinity of PIERP to generate initial model bathymetries. The last two (2002 and 2003) were combined to generate the existing conditions bathymetry. The vertical datum of these surveys was referenced to MLLW.

M&N converted data to Mean Tide Level (MTL) and developed a grid for their model. There was an error in the conversion related to the 2002 survey, which was corrected prior to the release of the report. Although the conversion error was corrected, there are still some concerns from the USACE-Baltimore District as to how the 2002 survey was referenced to MLLW. For use in this expansion study, the M&N model grid was converted back to MLLW, and contours were created from the grid.

The contours from the grid were checked against bottom elevations observed at geotechnical borings drilled north of the existing PIERP. These observations were corrected for tide, but should be considered approximate. The contours averaged 1-ft deeper than the boring elevations. This would indicate that the quantities estimated from these contours are conservative. Given this, and concerns about the 2002 M&N survey, a complete bathymetric survey would need to be performed during the design phase to cover design, construction, and any additional hydrologic and hydrodynamic (H&H) studies that may be required.

6.1.2 Subsurface Investigations

<u>6.1.2.a Subsurface Investigations for the PIERP</u> During the design and construction of the original PIERP (approximately 1994 through 2000), extensive subsurface investigations were conducted. Most of the borings were located within the footprint of the existing project, but some of the borings extended to the north, south, and southwest of the existing project. Those original investigations provide some useful subsurface information for each of the expansion alternatives, particularly where the expansion footprint connects to the existing project. During November and December 2001, fifty-six (56) borings were drilled to depths of 30 to 70 ft, and samples were obtained to investigate six alternative alignments associated with the reconnaissance studies for the expansion of PIERP (E2CR, 2002). Laboratory testing of borings collected for the reconnaissance study included grain size analyses for basic soil classification and geotechnical tests to determine shear strength and compressibility characteristics of the fine-grained (clay and silt) soils. Field testing included cone penetrometer and vane shear tests at several locations. The grain size analyses on the sandy soils provided information about the location, quantity, and quality of potential borrow materials for dike construction. Logs for all of the borings and results of laboratory testing are presented in the geotechnical reconnaissance study (E2CR, 2002).

<u>6.1.2.b Subsurface Investigations for the Lateral Expansion</u> Thirty-four (34) borings were completed to investigate subsurface conditions for the northern expansion area, supplementing approximately 30 borings that were previously completed in the area. Borings associated with the potential lateral dike alignment were advanced 25 ft into the Bay bottom deposits, and borings associated with potential borrow materials sources were advanced up to 40 ft into the Bay bottom deposits. Samples of the foundation soils were recovered for classification (grain size and shear strength) testing in the laboratory. Several undisturbed Shelby tube samples of the foundation clay deposits were also recovered. Logs of the completed borings and results of laboratory testing are presented in Appendix A.

The additional drilling provided information needed to delineate two distinct subsurface conditions within the northern expansion area. The foundation within the western portion of the area, extending approximately 3,000 ft to the north of the existing project, consists of a deep deposit of medium to very soft clay. To the maximum extent possible, the weakest and deepest of these clay deposits were avoided in the design of the proposed dike alignment. If future subsurface investigations reveal unavoidable areas of very soft materials, they may have to be removed and replaced with suitable sand backfill.

The remainder of the expansion area footprint generally has a sandy bottom that will provide a solid dike foundation. The thickness of the sand deposit ranges from 10 to about 25 ft. Results of grain size analysis testing indicate that the fine sand (mean grain size equivalent to a No. 70 sieve) contains an average of approximately 14 percent fines (percent passing the No. 200 sieve) and would be suitable for dike construction. A detailed analysis of the quantity and quality of the sand borrow materials is addressed in Appendix A.

<u>6.1.2.c Subsurface Investigations for the Vertical Expansion</u> During April 2003, eleven (11) borings were completed to investigate subsurface conditions related to the potential raising of the existing upland cell dikes to elevations above +23 ft MLLW. Eight of the borings were located along the perimeter of Cell 2, and three borings were located at locations on the perimeter of Cell 6. The borings were typically drilled to a depth of 40 ft from a starting elevation of approximately +10 ft MLLW with the purpose of intercepting foundation clay materials that are critical to the analysis of the slope stability of the containment dikes. Twelve undisturbed samples of the clay were obtained and laboratory testing included undrained triaxial shear testing and consolidation testing of selected samples. The primary goal of the dike raising investigations was to obtain samples of the weaker clay strata beneath the dike that were not removed and replaced during the original construction. These clays represent the weakest materials within the dike foundation and control the maximum height of the vertical raising of the existing upland cells. It is anticipated that these clays may have consolidated under the load of the dikes and gained additional strength compared to their original pre-dike strengths. Logs of the completed borings and results of laboratory testing are presented in the Appendix A.

6.2 LATERAL EXPANSION DESIGN

6.2.1 Lateral Alignment

The recommended plan (Alternative 3) for the lateral expansion alignment encompasses approximately 575 acres, containing 29 percent wetland habitat, 47 percent upland habitat, and 24 percent open-water embayment habitat; plus a vertical expansion component consisting of a 5-ft raising of the upland cells of the existing project with a final average upland elevation of +20 ft MLLW (Figure 6-1). The proposed lateral alignment was selected based on the consideration of multiple factors, including: foundation conditions, borrow sources, dike stability, dredged material placement requirements, engineering efficiency, hydrodynamics, constructability of initial dikes, constructability of desired habitat, environmental, and cultural factors.

The lateral expansion project involves the construction of containment dikes attached to the northern end of the existing project and filling the containment cells with clean dredged material from various dredging sources. The preferred dike alignment has a perimeter of approximately 24,000 ft (including that portion in common with the existing project), and encloses 575 acres of new dredged material placement area. Of the 575-acres, approximately 5-10 acres will be used to support a tidal gut to provide necessary tidal access to wetlands located in Cell 1 (Figure 6-1). Subsurface investigations of the expansion area determined that approximately 75 percent of the foundation consisted of sand deposits ranging from 10 to over 20 ft thick, and that the remaining 25 percent of the site consisted of clay deposits, ranging from moderate to extremely low strength. The borrow areas are presented in Figure 6-2. To the maximum extent practicable, the very weak clays, which are located along the western side of the site, were avoided and the dike was aligned to maximize the borrow quantity that can be obtained from within the dike footprint.

The wetland cells of the existing project are all located along the more protected eastern side of the project, and tidal exchange will be accomplished by breaching the cells along the external eastern dikes. In the proposed lateral expansion, the wetland cells are to be located on the northern, and northeastern sides of the alignment (Figure 6-1) so the borrow area is within the footprint of the upland cells. The boundaries of the wetland area will be modified slightly to provide wetland habitat around a significant proportion of the shoreline of the 130-acre open-water embayment. The 10,600-foot embayment perimeter will consist of approximately 3,400 feet of breakwater, 1,500 feet of upland shoreline, and 5,700 feet of wetland shoreline. The shoreline of the southern end of the open-water embayment was adjusted to provide a smoother alignment that should simultaneously improve hydraulic performance (by minimizing the potential for areas of poor circulation) and increase the proportion of marsh shoreline.

6.2.2 Dike Design

6.2.2.a Coastal Engineering Design The armor stone size prediction and damage development used in the Phase I and Phase II design for the PIERP were conducted using tools developed for single storm design. However, these tools are not appropriate for life-cycle analysis to estimate damages that accumulate over the life of the structure. Limitations of the old dike design model included: (1) water level estimates that were based on a 25-year storm surge analysis, and (2) characterization of the winds throughout the Chesapeake Bay using only one anemometer location at Baltimore-Washington International Airport (BWI). In addition, the methods for wave run-up and overtopping design were recently updated in the Coastal Engineering Manual (CEM), and the life cycle simulations conducted previously required the use of assumptions about the probability of combined events that may have been unreasonable. Because of these limitations, the USACE-Baltimore District, requested that the USACE Coastal and Hydraulics Laboratory at ERDC conduct a life cycle performance analysis for the revetment design for the expansion of PIERP.

The cross-sectional design of the dike was based on the CEM, which requires predicting life-cycle damage to both the armor layer and the toe. The most common technique presently used by the USACE in coastal studies to extend historical storms within a life cycle or risk analysis utilizes the Empirical Simulation Technique (EST) with historical wave and water levels. Recent advances in numerical modeling technology have provided tools for significantly improved accuracy of wave and water level estimates for historical storm events. Using EST, the time variation of winds, waves, and water levels during historical storms can be hindcast based on available historical information. This method is superior to other techniques because it is based entirely on historical events and their analysis, and it does not presuppose any knowledge of correlation between various parameters that are usually nonlinearly related.

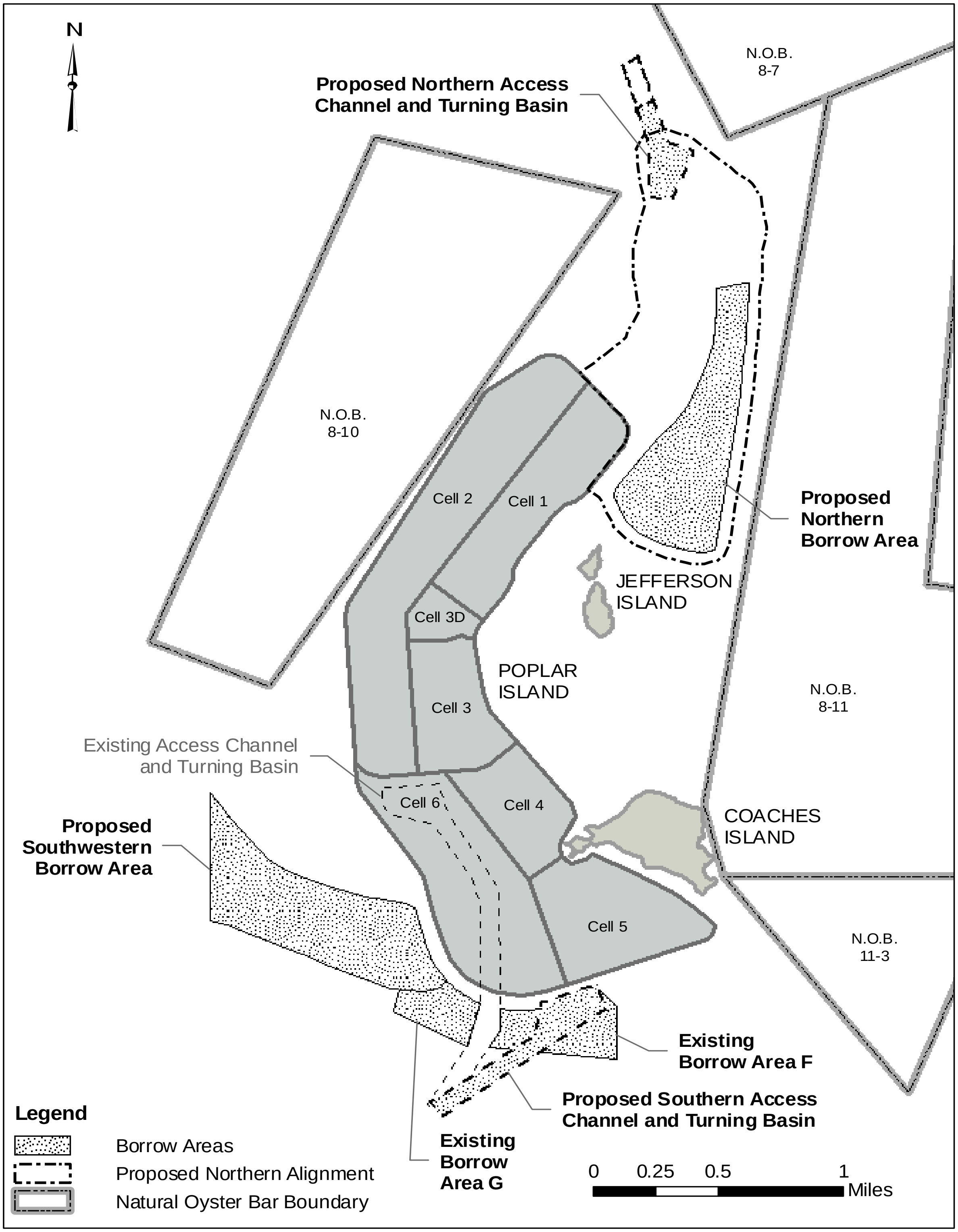

Figure 6-2. Location of Existing and Proposed Sand Borrow Areas and Proposed Access Channels

The life-cycle performance analysis for the PIERP expansion was conducted using the following approach (USACE-ERDC, 2005c):

1. Identify the historical tropical and extratropical storms that have passed through the Chesapeake Bay region to develop realistic storm condition water level predictions for use in the dike design conditions for PIERP.

2. Acquire the wind fields for the historical storms identified in 1, to be used for water level modeling. Data for the open-ocean wind fields for most of the historical storms were available from previous studies.

3. Adjust the wind fields as needed to more closely represent winds over Chesapeake Bay waters for use in the water level modeling.

4. Analyze existing historical data from regional anemometers to develop local winds over Chesapeake Bay fetches for wave analysis.

5. Compute historical storm water levels using the existing ADCIRC numerical model and using updated regional bathymetry and a shoreline grid developed for USACE-Baltimore District studies at Ocean City Inlet and Assateague Island.

6. Hindcast historical storm waves using model-derived winds in addition to measured winds from several area anemometers. Compute historical offshore waves using known relationships for wind-wave growth over irregular, restricted fetches.

7. Transform waves through shallow nearshore waters to shore using a spectral wave transformation model (STWAVE).

8. Compute the responses of the dike for these historical events; such as wave run-up, overtopping as a function of crest height, structural damage as a function of stone size, and required toe stone weight. Use techniques based on recommendations given in the CEM.

9. Recreate multiple life cycles of storms and model the responses of the PIERP dike using the EST. Each life cycle represented a possible future condition, which was statistically consistent with historical storm forcing, response, and sequencing information. The EST simulation included progressive revetment damage as a result of successive storms that may occur between maintenance opportunities. Realistic maintenance cycles were incorporated into the simulation.

10. Compute life-cycle damage and function for dike designs that appear to be favorable.

The first step in the process was to select the historical tropical and extratropical storms for the PIERP site. The North Atlantic Hurricane Track Database (1851-2003) was examined, and fifty-two hurricanes that traversed the Chesapeake Bay region were selected. Hurricanes were selected from the database for simulation based upon the following criteria: storms with maximum wind speeds greater than 50 knots in the area between 75 and 79 deg W longitude and 36 and 39 deg N latitude (USACE-ERDC, 2005c).

Similarly, forty-three northeasters (1954-2003) that traversed the Chesapeake Bay region were identified in the Atmospheric Environmental Service of Canada (AESO40) wind fields (Swail *et al*., 2000) and in the reanalysis project database (Kalnay *et al*., 1996) by the U.S. National Centers for Environmental Prediction (NCEP) and the National Center for Atmospheric Research (NCAR). Northeasters were selected based upon the criteria of peak wind speeds greater than 20 m/sec (66 ft/s) or 10 m/sec (33 ft/s) with durations exceeding 3 days at the ocean entrance of the Chesapeake Bay. Once the storms were selected (total of 95) adjustments for overland and overbay were made to the wind fields. The wind and pressure fields recorded for each historical storm were then applied in the ADCIRC model simulations for Chesapeake Bay to attain the response of the bay to each storm (USACE-ERDC, 2005c).

Next, the USACE regional circulation model ADCIRC was applied to the Chesapeake Bay area for each of the 95 selected storm events. A regional scale ADCIRC grid with a rudimentary representation of Chesapeake Bay was developed through previous studies conducted by the Coastal Inlets Research Program (CIRP) and Offshore and Coastal Technologies, Inc. (OCTI). This grid was refined in Chesapeake Bay, far-field, and upland areas for the present study, and is considered representative of 2004 conditions. Results of the model simulations reported the predicted water levels for each storm event, and indicated that water levels for the historical storms reached as high as eight ft above MSL. Water level predictions based on the historical storm record were recorded for several locations around the existing PIERP and locations around the proposed lateral expansion for use in the wave modeling and life cycle analysis tasks (USACE-ERDC, 2005c).

Once the water levels were determined, the wave modeling could be performed. Three steps were required for wave modeling to produce the life cycle inputs: (1) a restricted-fetch wave growth model (Smith, 1991) in the Automated Coastal Engineering System (ACES), (2) application of a parametric spectral shape in the Surface Water Modeling system (SMS), and (3) the spectral transformation model STWAVE (Smith *et al*., 2001). Based on the wave modeling results, storm wave heights ranged from 2-8 ft and storm wave periods ranged from 3-9 seconds (USACE-ERDC, 2005c).

Once the waves and water level time histories were calculated and recorded for each of the 95 selected historical storms, the life-cycle simulation was conducted. The life-cycle simulation approach requires a known wave and water level time history over a multi-year time period. Initially, the time history is based on historical data or hindcasts. The time period covered by tropical storms was 148 years (1856-2003), while the time period covered by northeasters was only 50 years (1954-2003). The final time history used in the life-cycle simulation contains 179 storms covering 148 years at 3-hr intervals (USACE-ERDC, 2005c). The 148 year offshore time history of historical storm waves and water levels was created based on the 50-year period of northeasters available in the hindcasts by folding the existing northeasters information backwards and populating the previous 98 years of the simulation (years with tropical storm data, but no data from northeaster). Northeasters are more common in the Chesapeake Bay region than tropical storms, and are less likely than tropical storms to be atypically severe, and the northeasters used for the simulation were representative of the range of northeasters affecting the project area.

The last step of the life-cycle performance analysis for the PIERP expansion was to determine the optimal cross-section for the perimeter dikes. The basic premise of the optimization scheme was to minimize total amortized costs, including maintenance and first costs. First costs and maintenance costs vary depending on the design return period wave event. For shorter return period designs, the armor will be smaller and the crest height lower. Shorter return period designs will cost less to construct but will produce higher maintenance costs. Designing for longer return periods produces a more reliable structure but costs more in up front costs. The optimal design of the perimeter dike is a balance between first costs and maintenance costs. Variables that most influence the optimization of the perimeter dike cross-section are the crest height, armor stone size and structure slope. A computer program was developed that calculated a representative zero damage cross-section for each return period wave condition. The fixed parameters used in this calculation included: stone density; crest height; depth relative to MLLW; zero damage levels for armor and toe; number of waves at mean period for zero damage computation; structure permeability; structure slope, and toe berm crest height. Values calculated include: primary and toe armor weights, filter layer and core material sizes, armor and filter layer thicknesses, cross sectional area of each material for the given cross section, and the initial cost of the cross section. Results from the program include summaries of all predicted damage, overtopping and repair, as well as overall summaries. A time history of damage, run-up, and overtopping was written for instances where either damage or overtopping occur. Initial material volumes and material costs are also calculated for each return period cross section.

Preliminary results based on just the historical wave climate indicate that the least cost alternative would consist of two different perimeter dike sections for Alternatives 1 and 2. The first section would extend from the tie-in on the northwestern side of the existing PIERP and extend around the northeast corner of the proposed expanded island. The optimal armor and toe stone sizes for this area are 2,300 and 1,000 lbs., respectively. The optimal structure slope is 2.5 horizontal to 1 vertical (2.5H:1V), and the optimal crest height is +9 ft MLLW. The second section of the perimeter dike would encompass the rest of the proposed lateral expansion and consist of armor and toe stone of 350 and 1,600 lbs., respectively. The optimal perimeter dike configurations discussed above were determined without consideration to possible future conditions, and additional storm time series simulations may yield different results. The cross sections given above may not be optimal ones given other simulations. Also, the toe stone has not been optimized for the perimeter dike cross-sections discussed above, but will be included in the final analysis.

Subsequently, based on experience during Hurricane Isabel and potential environmental consequences resulting from a dike breach, it was determined that overtopping and subsequent failure of the perimeter dikes should be avoided if at all practical. A third alternative that included an embayment along the western edge of the expanded island was also added for consideration (Figure 6-1). As such, a breach prediction analysis will be conducted and incorporated into the final design, which may result in different crest heights than the optimum design, based solely on cost considerations. A third perimeter dike cross-section for the southern exposure of the expansion will also be considered because of possible impacts from waves refracting around the island during storms approaching from the south.

Until the results of further optimization analyses and breach predictions can be incorporated into the final design of the dike cross-sections, two perimeter dike cross-sections were considered for cost estimating purposes. Based on preliminary results, cross-sections for the embayment dikes and breakwaters were also determined. For purposes of the cost estimate, the western and northern dike of the lateral expansion would consist of armor and toe stone sizes of 2,500 and 1,500 pounds, respectively. The remainder of the perimeter dike would consist of 350 lb. armor and 1,500 pound toe stone. All perimeter dike heights would be set at +10.5 ft MLLW, all primary dike slopes would be 3H:1V, and toe dike slopes would be 2H:1V. The breakwater sections would have a crest height of +6 ft MLLW and width of 6.8 ft. The armor layers would consist of 2500 lb. stone with a 1.5H:1V side slope. The perimeter dikes along the interior of the embayment would consist of a cross-section similar to the eastern perimeter dike. During the final design phase, based on more detailed analyses, these sections may change slightly, but are deemed appropriate for cost estimating purposes for this phase of the study.

6.2.2.b Geotechnical Engineering and Dike Construction The perimeter dikes for the lateral expansion will be constructed with fine sand obtained from borrow sources located within the footprint of the upland cell of the proposed lateral alignment (Figure 6-2). Based on past experience and the close proximity of the oyster bars, it is anticipated that the sand will be dredged from the Bay bottom deposit, stockpiled at a location immediately north of the existing project, and mechanically placed into the perimeter dike section using trucks, excavators, and bulldozers to compact the fill into the dike section. The fine sand provides a suitable material for the perimeter dike section, provided that adequate filters and armor are located on the exterior dike surfaces. Therefore, the entire exterior slope of the perimeter dike will be covered with a geotextile filter material and overlain with a series of progressively larger stone armor layers. Perimeter dike reaches that are most exposed to wave action will receive heavier stone armor, while dike reaches that are more protected will receive lighter stone armor. Interior dike slopes will not be armored, but may receive some type of erosion protection to minimize long-term dike maintenance requirements.

Most of the dike foundations consist of sand that will provide a strong, incompressible base. A portion of the western dike that will contain the wetland areas will be constructed on clay and silt foundation soils. These soils range from moderately strong with low compressibility characteristics to very weak and highly compressible. The alignment has been selected to avoid the least favorable of these materials (those least likely to support the weight of the perimeter dike), but it may still be necessary to remove and replace some foundation soils if the final subsurface investigations reveal the presence of weak clays beneath the alignment.

The perimeter dike will be constructed with exterior slopes at 3H:1V, and interior slopes at 3H:1V. The external slopes are the same as those used for the existing project, and it was considered appropriate to maintain the same design for the expansion dikes. The internal slopes are steeper than the 5H:1V initially used for the existing project because of the allowance for placement of dike fill using hydraulic methods. However, since the perimeter dike construction for the lateral expansion will require mechanical placement, steeper side slopes can be achieved. To reduce the tendency for erosion of the internal dike surfaces, it will be necessary to at least provide vegetative cover, and it may be necessary to employ additional erosion protection measures. Sections of the heavily armored western and northern dike are presented in Figure 6-3, and the lightly armored eastern and southern dike is presented in Figure 6-4.

The dikes will be constructed following a construction sequence similar to that used to build the Phase I & II dikes for the PIERP. A stone toe dike section will be constructed on a geotextile and maintained several hundred feet ahead of placement of dike sand zones. The toe dike acts as a breakwater structure providing a much quieter environment for placement and shaping the fine sand fill materials, and minimizing the loss of dike fill because of wave erosion. Given the close proximity of the oyster bars, this is an important benefit of the proposed construction sequence. Sand for dike construction will be dredged from both the designated borrow area and the required access channel excavation and stockpiled immediately north of the existing project. Fill will be loaded into trucks and hauled to the advancing end of the dike where it will be spread and compacted with large bulldozers. Final shaping of the exterior slope of the dike will be accomplished immediately prior to placement of geotextile filters and bedding stone. Thereafter, underlayer and armor stone will be placed with excavators and specialized stone placement equipment. For the exterior layer of the larger armor, each stone will be placed individually to assure proper orientation and maximum stone-to-stone contact.

Interior dikes separating upland and wetland cells and subcells will be constructed entirely of sand. These dikes will typically have 3H:1V side slopes and will be constructed to at least elevation +6.5 ft MLLW to accommodate dredged material placement to elevation +1.5 to 2.0 ft MLLW. Interior dikes separating upland and wetland areas will be permanent, but most of the interior dikes between the wetlands will be partially or totally removed to allow tidal flow between developed subcells.

Because most or all of the borrow material for dike construction will be obtained from within the expansion footprint, it will be necessary to construct the upland perimeter dikes to the full height at approximately elevation +25 ft MLLW in the initial construction contract. The perimeter dikes containing the wetland cells will be built to approximately +10.5 ft MLLW, subject to adjustment based on future hydrodynamic studies. Generally, the stone armor will be carried to the 10.5 elevation, but will not be applied to the upper slopes of the upland cells.

At the 10.5 elevation, a permanent perimeter roadway consisting of crushed stone overlying a geotextile will be constructed along the perimeter dike crest.

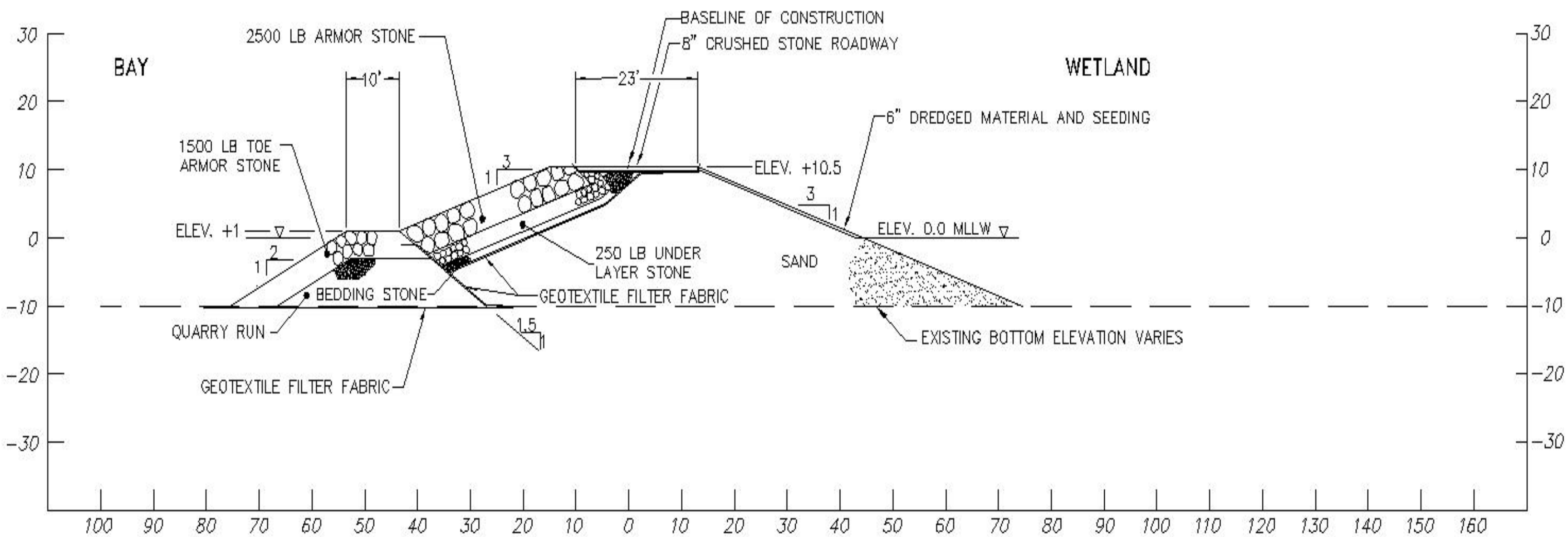

Figure 6-3. Typical Western and Northern Perimeter Dike Section

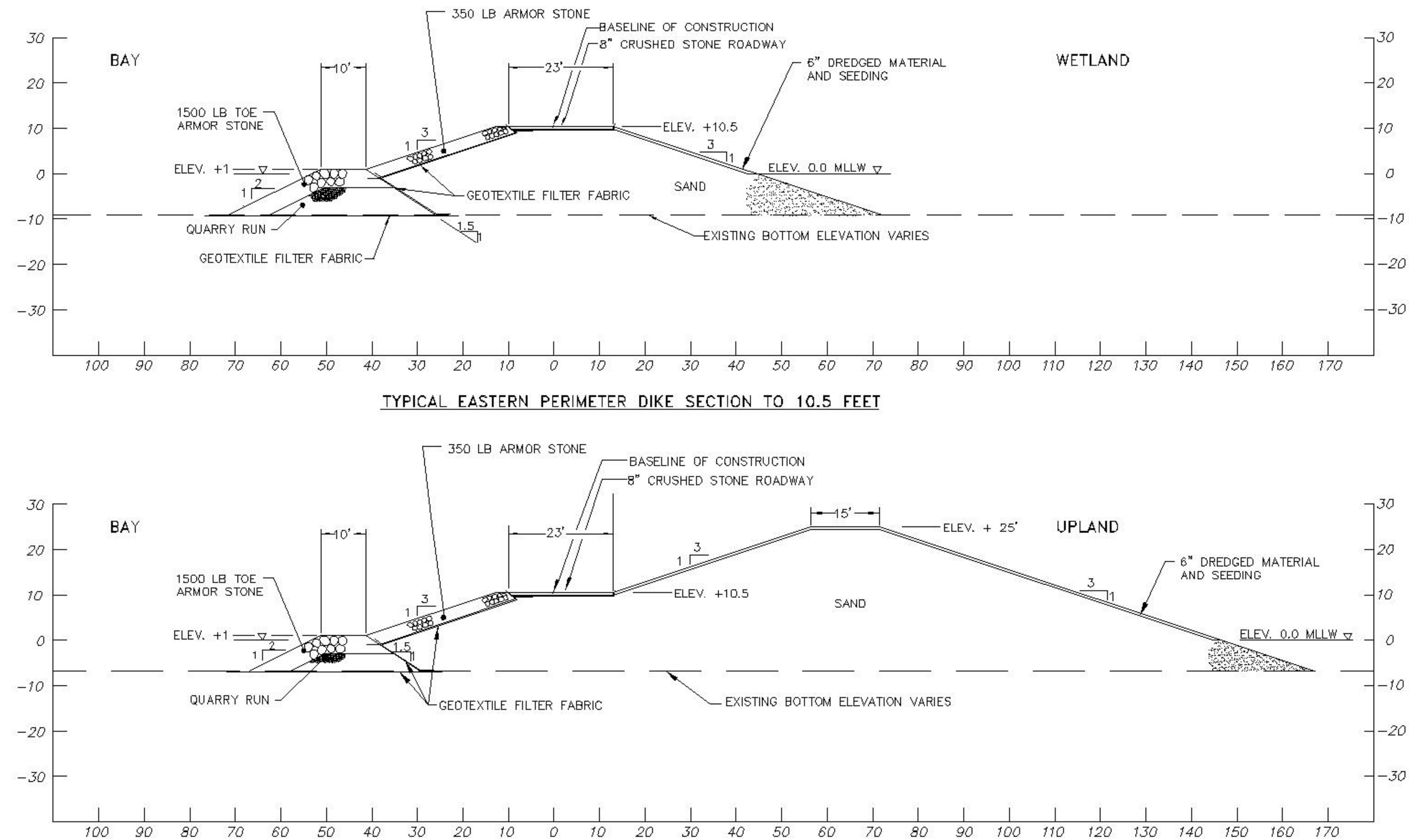

Figure 6-4. Typical Eastern and Southern Perimeter Dike Section

Construction of the armor stone sections will be similar to the sections used for the existing project, adjusted for differences in exposure. The basic section consists of a monofilament geotextile with precise filter control placed directly on the surface of the sand dike, and protected by a 12-inch layer of bedding stone. The armor layers consist of approximately 2.5 ft of underlayer stone (typically having a mean weight of 250 pounds), overlain by larger armor ranging from 1,500 to 3,000 pounds mean weight. Portions of the eastern perimeter dike will require only an underlayer stone, having a mean weight of 350 pounds. For the open-water embayment, a segmented stone breakwater structure will replace a substantial portion of the armored western dike section, and light armor will be required along the interior perimeter of the embayment.

Breakwater structures associated with the open-water embayment will consist of two layers of 2500 pound armor stone overlaying a core of 250 pound stone founded on a high strength geotextile. Because of the relatively large fetch within the embayment, the interior dike slopes will require some light armoring similar to the 350 pound stone section proposed for the eastern slopes of the perimeter dike.

6.2.2.c Expansion Configuration The recommended expansion alignment consists of 29 percent wetland habitat, 47 percent upland habitat, and 24 percent open-water embayment habitat. The wetland segment of the site will be divided into approximately five sub-cells, ranging in size from approximately 30 to 40 acres. Temporary sand dikes separating the sub-cells will be constructed during the initial contract, and will be removed after the completion of dredged material placement as needed to form two or three larger wetland areas. The wetland areas will contain numerous habitat islands. Some habitat islands may be constructed during the initial contract, and others will be constructed as part of the wetland development process using the temporary cross-dike materials removed after dredged material placement is complete. Channel systems will be mechanically excavated within the wetland cells following the completion of dredged material placement. Several construction techniques may be employed to achieve the topography that will define the proportions of open water, low marsh, and high marsh. Final channel excavation and grading has been completed for several wetland cells within the existing PIERP, and will be used as examples for channel excavation for the wetland cells located within the lateral expansion. As part of the of the final wetland construction for the expansion, the spillways will be replaced with temporary outlet control structures that will connect the wetland cells to the open-water embayment to allow full tidal exchange while marsh plants are established and the dredged materials are stabilized to minimize erosion.

The upland segment of the site will consist of two cells of between 100 and 120 acres each, and the perimeter dikes of the upland cells will constructed to a temporary elevation +25 ft MLLW during the initial construction contract.

6.2.2.d Tidal Gut As part of the recommended plan, a small tidal gut (approximately 5-10 acres) will be located at the southern end of the expansion footprint adjacent to existing wetland Cell 1 (Figure 6-1), and will provide necessary tidal access to Cell 1. At this time, it not anticipated that connection of the tidal gut to the open-water embayment will be necessary. A Clean Water Act Section 404(b)(1) evaluation was performed for the recommended plan and is included in Appendix K.

6.2.2.e Water Control Structures Water control structures will be necessary to discharge excess water from the cells during both initial dredged material placement and subsequent site operations. Some of the structures will consist of typical spillway structures with stoplogs to control water surface elevations and large pipes to accommodate large discharge quantities normally associated with initial dredged material placement. Other structures connecting the wetland subcells will consist of several small pipes with stoplog controls at both ends. A Clean Water Act Section 404(b)(1) evaluation was performed for the recommended plan and is included in Appendix K.

It is currently anticipated that during placement of dredged material into wetland cells, water will be discharged in accordance with water quality permit requirements into the open-water embayment through approximately three spillway structures (two associated with the northern wetland area, and one associated with the separate southern area). During placement into the upland cell, water will be discharged to the Chesapeake Bay through one primary spillway located at the southern end of the cell. The spillway will be located a minimum of 1500 feet from the nearest oyster bar. A second spillway will be located along the western side of the cell to allow for occasional discharge into the open-water embayment, primarily toward the latter stages of upland placement when it is necessary to even out the upland surface elevations. It is anticipated that the upland area will be graded to drain toward the adjacent wetland and open-water embayment areas rather than toward the Bay.

After placement of dredged material in wetland cells is complete, temporary interior dikes will be removed and channel systems will be established to assure hydraulic interconnection throughout the wetland areas. As part of the of the final wetland construction, the spillways will be replaced with temporary outlet control structures that will connect the wetland cells to the open-water embayment to allow full tidal exchange while marsh plants are established and the dredged materials are stabilized to minimize erosion.

6.2.2.f Perimeter Dike Breakwater Structures To create the open-water embayment, segmented breakwaters will be constructed along approximately 3,400 feet of the western leg of the perimeter dike. The breakwater segments are currently designed to be approximately 200-ft long and separated by about 50-ft of open water except for one or two larger openings of approximately 200 feet. The breakwater structures will consist of a core of 250-lb underlayer stone and two layers of stone armor having a mean weight of approximately 2,500 lbs. The structure is planned to have a width of 6.8 feet at crest elevation +6 ft MLLW, and 1.5 horizontal on 1 vertical (1.5H:1V) side slopes. A high-strength geotextile sheet will be placed on the Bay bottom to minimize loss of stone into soft or loose surface deposits. Hydraulic analyses will be performed to optimize the breakwater crest height, stone size, and dimension of openings between segments. Any proposed changes to the size of the openings will also be evaluated for potential impacts on fish passage.

6.2.2.g Submerged Rock Reefs Small subtidal artificial reefs within the open-water embayment will be constructed (Figure 6-1). It is anticipated that the reefs will be constructed either entirely of rock with a cross section similar to the breakwater structures or may consist of a sand core with external armor, depending on the size of the reef. The location of the rock reefs will be determined based on the results of the hydrodynamic modeling conducted for the open-water embayment to reduce incoming wave energy and to provide protection to the interior eastern dikes. However, the reefs would be kept at least 200 feet away from the breakwater structures to provide adequate opening into the open-water embayment to provide for fish utilization. Analysis and design of the breakwater structures and the rock reefs included as part of the open-water embayment will be completed during the next design phase of the project. The breakwaters and rock reefs will be designed to ensure stability under storm conditions, proper functioning within the open-water embayment (sufficient dampening of wave energy), and sufficient water exchange.

6.3 VERTICAL EXPANSION DESIGN

Early in the plan formulation process, it was recognized that significant additional dredged material placement capacity could be realized by raising the existing upland cells vertically to extend the existing upland surfaces (Cells 2 and 6) above the currently authorized elevation +20 ft MLLW (Table 6-2) (Figure 6-5). Vertical dike raising is a cost-effective means of providing significant additional placement capacity because the vertical raising would be accomplished primarily with sand with no additional stone erosion protection. Results of subsurface investigations indicated that based on the composition of the foundation soils, the perimeter dikes of the existing upland cells could be raised to a maximum elevation of +40 ft MLLW while maintaining a factor of safety of 1.3 with respect to external slope stability. However, the vertical expansion of the existing upland cells at the PIERP would be limited to 5-ft, based on the minimal environmental benefits from vertical expansion alone and public concerns (Section 4.5.3), the vertical raising was limited to 5-ft. The vertical expansion of the existing upland cells will provide approximately 6 mcy of additional placement capacity.

To realize the full upland capacity, the development of the upland habitat will be delayed beyond the completion of the final dredged material placement. It is estimated that the delay would be in the range of 3 to 5 years after final placement, and would be in addition to the 2 to 4 years required to fill the raised portion of the cells. If this delay is not acceptable, a significant portion of the theoretical placement capacity will be lost because it is not practical to postpone habitat development until consolidation is complete.

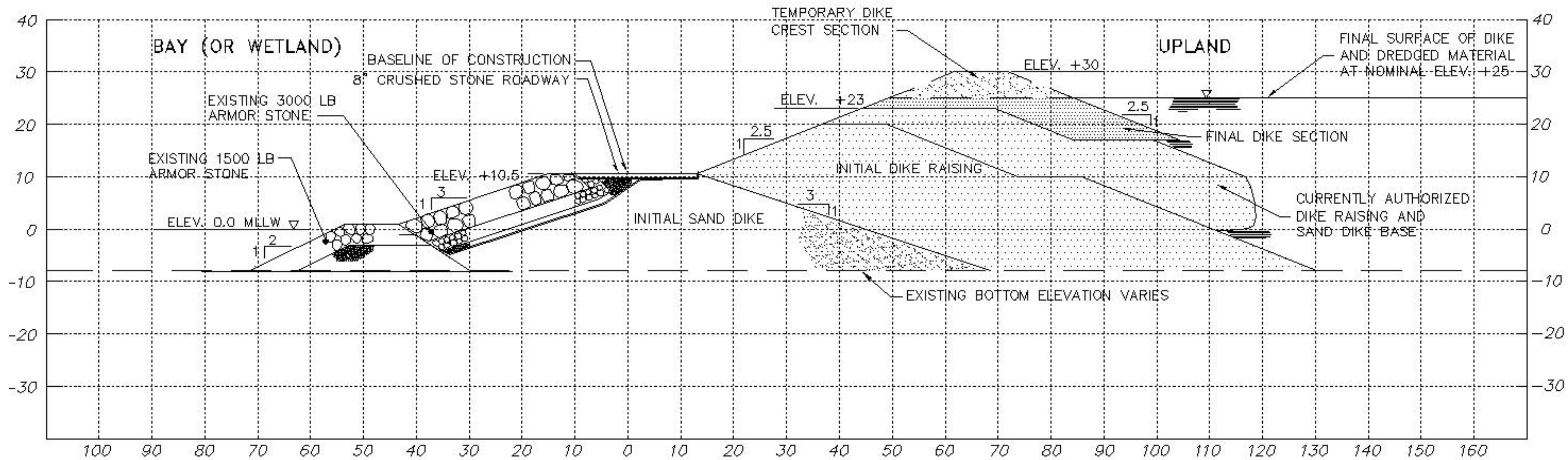

Figure 6-5. Typical 5 ft. Dike Raising Section for Existing Upland Cells 2 and 6

Table 6-2. Temporary and Final Upland Dike Heights for the Recommended Plan

	Authorized Final Dike Height	Authorized Temporary Dike Height
Uplands of the Existing PIERP (Cells 2 and 6)	+ 20 ft MLLW	+ 23 ft MLLW*
Uplands of Existing PIERP (Cells 2 and 6) plus 5-ft Raising	**+ 25 ft MLLW**	**+ 30 ft MLLW**
Uplands in Lateral Expansion	**+ 20 ft MLLW**	**+ 25 ft MLLW**

** As part of the actions to complete the existing project, the Cell 6 dikes would be raised to a temporary height of +25 MLLW prior to construction of the vertical expansion*

6.4 MATERIAL SOURCES

The principal materials required for perimeter dike construction includes sand from on-site borrow sources, and stone from commercial sources.

6.4.1 Stone Sources

Armor stone for the expansion project will have to meet the same stone quality criteria set for the previous project, but the stone sources will not be specified in the construction specifications. Armor stone for the existing project was obtained from two different quarries. Most of the stone for Phase I of the PIERP consisted of dolostone obtained from the Bardon quarry located near Harpers Ferry, West Virginia. This stone has been in place for approximately 5 years and some stone have exhibited a tendency to deteriorate along weak seams (if present) in the rock. The remainder of the Phase I armor consisted of diabase (metagabbro) stone obtained from the Arundel quarry near Havre de Grace, Maryland. This stone has been in place for approximately three years with no significant deficiencies noted to date. Other stone materials required for construction include bedding stone and crushed stone roadway materials, both of which will be obtained from commercial sources barged to the site. Stone for toe dike construction will be placed directly from the barges, while all other stone materials will be off-loaded to the island and placed mechanically with land-based equipment.

6.4.2 Sand Sources for Existing Project and Expansion Project Construction

Sand for construction of both the expansion project and several existing project features will be obtained from five sources of borrow or required excavation. These sources include: the partially utilized Borrow Areas F and G, the southern access channel and turning basin, the southwestern borrow area, the northern borrow area, and the northern access channel and turning basin (Figure 6-2). The total quantity of borrow material required will be dependent upon the selected expansion alternative. Estimates of the quantity of borrow material required for construction include a factor of safety generally ranging from 1.5 to 2.0 to account for losses during dredging, efficiency of recovery from stockpiles, losses during placement, and uncertainty of subsurface conditions at the borrow source. Appropriate safety factors have been applied in estimating the borrow area limits that may be disturbed to construct the various features of work.

6.4.2.a Material Requirements for Existing Project Construction Construction of the existing 1,140-acre project has not yet been completed to its authorized configuration. Closure of the existing access channel opening at the southern end of Cell 6, raising the Cell 6 perimeter dike to elevation +25 ft MLLW, and construction of a new access channel and turning basin to replace the channel currently located inside of Cell 6 are the primary remaining construction activities. Other tasks include restoration of internal borrow sites within wetland Cell 4 and construction of temporary cross dikes within wetland Cell 5. These activities will require approximately 1.5 mcy of sand. A small portion of the required sand (0.4 mcy) will be generated by the access channel and turning basin excavation, but the majority must be obtained from other borrow sources. During the construction of PIERP – Phase II, Borrow Areas F and G, located immediately south of Cells 5 and 6, were partially utilized as a borrow source for sand and are no longer in an undisturbed condition. Remaining materials within these areas may be used for the current project work, but are insufficient to satisfy quantity requirements. Therefore, after exhausting Borrow Areas F and G, additional borrow to complete the current project will be obtained from the southwestern borrow area.

6.4.2.b Material Requirements for Expansion Project Construction The expansion project has lateral and vertical expansion components. The lateral expansion consists of a 575-acre expansion to the north and northeast of the existing project requiring between 3 and 4 mcy of sand. The vertical expansion component will be accomplished by raising existing upland Cells 2 and 6 to a temporary dike crest elevation of +30 ft MLLW (requiring less than 0.5 mcy of sand) to allow the raising of upland surfaces to approximately elevation +25 ft MLLW. The lateral expansion has been aligned and configured so that borrow sources for the sand dike construction will be obtained from within the footprint of the project, specifically from within the footprint of the upland cell(s), to the maximum extent possible. The preliminary estimates of available borrow and dike volume indicate that it will be necessary to obtain some borrow material from outside the footprint of the lateral expansion. It is anticipated that all of the sand for the vertical expansion (i.e., the vertical raising of the existing upland cells) will be obtained from the southwestern borrow area.

6.4.2.c Anticipated Use of Borrow Areas

Southwestern Borrow Area

The southwestern borrow area was investigated as part of the reconnaissance studies conducted by MPA in 2002 (GBA, 2003). Based on several recent borings, in addition to borings conducted for the original PIERP, a 215-acre area of sand was delineated immediately west of existing Cell 6 (Figure 6-2). The bottom elevations of the area currently range from –8 ft MLLW near the outside toe of the Cell 6 dike to approximately –16 ft MLLW at the southwestern corner of the area. The sand deposit ranges from approximately 10 to 22 ft in thickness, providing a total volume of approximately 4.4 mcy of suitable dike fill material. If the borrow site was completely exhausted, the final bottom elevations would range from approximately –16 ft MLLW near Cell 6 to approximately –34 ft MLLW at the extreme southwest corner. It is currently estimated that approximately 3.4 to 4.0 mcy of borrow material is required to construct the currently authorized project plus the proposed expansion project. Therefore, it may be possible to limit the depth of borrow removal to an elevation of approximately –25 ft MLLW by restricting the borrow excavation to about 10 ft below the existing bottom elevations. However, because of the unpredictability of sand borrow areas, it may be required to excavate deeper than –25 ft MLLW. It is also proposed that the borrow area excavation begin at the western limits of existing Borrow Area G, and advance to the west into the southwestern borrow area as needed, always maintaining a deep water connection to deep portions of Borrow Area G to assure adequate circulation.

One cultural resource avoidance area (T-28) was identified during a Phase I investigation of the southwestern borrow area, located to the southwest of Cell 6 (Figure 3-28). This cultural resource area will be avoided when the southwestern borrow area is dredged for sand.

Upon completion, the borrow site would have a relatively flat bottom similar to existing bottom grades. Typical changes in grade are 1 vertical foot over 100 horizontal ft or flatter. At the lateral limits of the site, the excavation slopes would be limited to not steeper than approximately 5H:1V, although the actual side slopes tend to be much flatter as seen by the post-excavation results for Borrow Areas F and G. The total area disturbed in the southwestern borrow area would total 138 acres, or 64 percent, (119 + 19 acres) to support actions to completed the existing PIERP plus a 575-acre lateral expansion that includes a 130-acre open-water embayment and a 5-foot vertical raising of the existing upland cells (Table 6-3).

<u>Borrow Areas F and G</u>

During the Phase II construction for the PIERP, Borrow Areas F and G, located immediately south of Cells 5 and 6, were partially utilized as a borrow source for sand (Figure 6-2). Sand fill materials required to complete the Cell 6 closure and additional cell activities will be obtained from the existing borrow areas on either side of the access channel immediately outside of Cell 6 (Borrow Areas F and G), and the southern portion of the southwestern borrow area (Figure 6-2). The actions required to complete the existing project will require sand borrow from previously disturbed areas in Borrow Area F (approximately 60 acres) and Borrow Area G (approximately 35 acres). After exhausting Borrow Areas F and G, borrow to complete the current project will be obtained from the southwestern borrow area (Figure 6-2).

Borrow Areas F and G encompass approximately 60 and 50 acres, respectively, and were originally estimated to contain approximately 0.7 and 1.0 mcy of sand, respectively. Approximately 20 acres of Borrow Area G is located within the proposed southwestern borrow area. Phase II construction for the PIERP extracted approximately 60 to 70 percent of the original estimated quantity of borrow material. Current bottom elevations within the disturbed area range from –18 to –20 ft MLLW. Additional subsurface investigations will be required to quantify the remaining borrow quantities within these areas, however based on the original borrow estimates, approximately 0.5 mcy is estimated to remain in Borrow Areas F and G. Some additional suitable borrow materials may be obtained from this site by dredging to a depth of –25 ft MLLW and extending the borrow area slightly to the east and/or south. At that final bottom elevation, both Borrow Areas F and G would merge with the –25 ft MLLW existing Bay bottom contour and assure connection to, and circulation with, the deeper bottom waters.

Table 6-3. Summary of Potential Southwestern (SW) Borrow Area Use

Expansion Alternatives	SW Borrow Area Disturbed (acres)	Percentage of SW Borrow Area
50% Wetland + Existing Project	119	56%
55% Wetland + Existing Project	148	69%
60% Wetland + Existing Project	161	75%
50% Wetland + 5' Raising + Existing Project	168	78%
55% Wetland + 5' Raising + Existing Project	197	92%
60% Wetland + 5' Raising + Existing Project	210	98%
Open-Water Embayment + 5' Raising (Recommended Plan) + Existing Projects	**138**	**64%**

Northern Access Channel & Turning Basin

The northern access channel and turning basin will provide access to the expansion cells for placement of dredged materials. This channel will extend from existing Bay bottom elevation –25 ft MLLW contour northwest of the site, to the northern end of the placement site (Figure 6-2). The turning basin and about 20 percent of the new channel will be contained within the northern wetland cell, while the remaining 80 percent of the channel will extend outside the expansion footprint**.** The total area disturbed by the channel and basin excavation will be approximately 30 acres. Approximately 0.5 mcy of excavation will be required for the new access channel and turning basin. Based on preliminary subsurface excavations, about 60 percent of the excavated material will consist of sand suitable for dike fill, and 40 percent will consist of clay or silt that will be placed within the existing project limits. The channel and basin will be excavated to elevation –25 ft MLLW with up to 2 ft of over-depth dredging allowed. The bottom width will be 400 ft and side slopes of the channel will be 3H:1V.

Northern Borrow Area

The northern borrow area was investigated as part of the reconnaissance studies conducted by the MPA in 2002 (GBA, 2003). Based on those borings, in addition to the borings conducted for the original PIERP, two separate borrow areas were delineated to the north and northeast of the existing project (Figure 6-2). After the screening performed during the plan formulation phase of the study, a single northern Study Area was delineated with a single merged borrow source. An additional 34 borings were completed within the northern Study Area to further define subsurface conditions relevant to potential dike alignments and borrow sources.

The bottom elevations of the northern borrow area currently range from –5 ft MLLW at the southern end of the expansion footprint, to approximately –10 ft MLLW at the northern end of the area. The sand deposit ranges from approximately 10 to 23 ft in thickness providing a total volume of suitable dike fill material of approximately 5.1 to 5.7 mcy. If the borrow site was completely exhausted, the final bottom elevations would range from approximately –20 ft MLLW at the northern end of the area, to approximately –30 ft MLLW at the southern end. It is currently estimated that the dike construction for the expansion alternatives will require a borrow source containing between 5.7 and 5.8 mcy of suitable sand.

Since the northern borrow area is completely within the upland cell of the expansion alignment, it will be buried beneath the contained dredged material. To assure that the stability of the containment dikes is not compromised, the borrow excavation will be offset 50 to 100 ft from the interior toe of the dike, and side slopes of the borrow area will not be permitted to be steeper than 3H:1V. The total area disturbed by borrow excavation in the northern borrow area will be approximately 144 acres.

6.5 CELL DEVELOPMENT

6.5.1 Dredged Material Placement

An average of 3.2 mcy of dredged material per year will be placed at PIERP, consisting of clean, fine-grained silt and clay sediments from the maintenance dredging of the outer approach channels to the Port of Baltimore. Maintenance material placed into the existing PIERP in 2003-2004 consisted of fine-grained silt and clay, with 30 percent of the samples classified as silt (MH) and 70 percent classified as clay (CH), with average liquid limit and plasticity index values of 122 and 78 respectively.

The dredged material is mechanically dredged from the approach channels, barged to PIERP, and hydraulically off-loaded into the containment cells at the site. The initial slurry has an average moisture content typically in excess of 300 percent, corresponding to approximately 90 percent water and 10 percent solids by volume. The shear strength of the initial slurry is almost immeasurable. The dredged materials consolidate under their own weight for a period of years after placement in the containment site, and excess water is removed from the cell through spillway structures. The total duration of self-weight consolidation varies as a function of initial layer thickness and the degree of surface drying and crust formation. The thicker the initial lift (the layer of dredged material placed), the longer the pathway for drainage of water from within the dredged material layer. Any increase in the desiccated crust thickness resulting from crust management practices will apply more loading to the underlying dredged materials and accelerate the consolidation process. However, only the upper 2 to 3 ft of a dredged material layer can be significantly affected by typical drainage methods in combination with drying from solar exposure. After a year in place, the average moisture content will decline to approximately 150 percent corresponding to a void ratio of approximately 4, depending on the thickness of the initial lift and the proportion of crust that develops as a result of crust management activities. The shear strength of the dredged material under the surface crust typically ranges from 50 to 150 psf and is capable of supporting only specialized trenching and excavation equipment.

With continued crust management, the average moisture content can be reduced to approximately 100 percent, corresponding to a void ratio under 3 and a shear strength of approximately 250 psf beneath the surface crust. Placement of subsequent fresh dredged material lifts will retard consolidation until the new material has been drained and desiccated by solar exposure. In wetland cells where the total thickness of dredged materials is less than ten ft, the surface crust of the dredged material can support equipment needed for channel excavation and surface grading within about four years after initial placement if drainage and crust development has been aggressively pursued. In upland cells where the total thickness of dredged material typically ranges from 25 to 30 ft (or up to 50 ft if the cell contained a mined borrow area extending the bottom to elevation -25 or -30 ft MLLW), consolidation will take much longer, and final grading of the dredged material surface will probably not be initiated until several years after the final placement of material within the cell.

6.5.2 Wetland Cell Development

Wetland cells will be graded to provide roughly 80 percent low marsh (includes open water, mud flats, and islands) habitat, and 20 percent high marsh habitat. The break between low marsh and high marsh is currently defined as the +1.8 ft MLLW contour. The break in slope between the relatively flat low marsh surface and the steeper side slopes of the channels is generally set at elevation +1.0 ft MLLW, although some low marsh vegetation may extend below the +1.0 elevation. A successful wetland cell must be graded to satisfy the tight vertical surface grading tolerances required for high marsh and low marsh plants, and must not be subject to any additional settlement after planting has been completed.

Wetland cells will typically require at least four years of crust management and aggressive drainage before they are ready to be graded for planting. The duration may be greater if the cell filling sequence is not continuous.

Existing Cell 3D (Figure 6-6) consists of a 30-acre demonstration cell where placement and cell development were accelerated to gain experience working with dredged material. Dredged material was first placed into the cell in April 2001, and was followed by three additional inflow events. Active crust management occurred in the 2002 and 2003 summer drying seasons, and mechanical excavation of channels and surface grading was accomplished between April and November 2004. The total inflow during 2001 amounted to approximately 70 percent of the cell capacity, and these materials experienced self-weight consolidation for approximately one year before being subjected to a program of drainage and crust development. As the upper 12 to 18 inches of the dredged material was drained, the material changed from a buoyant state to a saturated state and its effective unit weight approximately doubled. The drained surface layer applied a consolidating load to the underlying materials that would not have been achieved by self-weight consolidation alone. Consequently, the underlying dredged materials have been *over-consolidated* under the temporary load of the drained crust. After the cell has been opened to tidal exchange, a portion of the drained dredged materials will return to a buoyant state (as the clay materials incorporate water), the load on the underlying materials will be reduced, and the risk of subsequent settlement will be minimized.

This process resulted in a surface crust with enough strength to support the construction equipment needed to excavate the required channel system, and grade the surface to satisfy the topographic requirements. A variety of low-pressure excavators, bulldozers, and tracked dump trucks were used to move materials to their final locations within the cell. As channels extended in depth and drying conditions improved, the dredged materials continued to consolidate and gain strength, steadily improving conditions for operation of construction equipment. Because of the increased consolidation induced by this approach, the placement capacity of the cell was increased by approximately 35 percent over an approach that would accomplish dredged material placement entirely by hydraulic placement methods with minimal drainage and crust development. The degree of additional consolidation exceeded the original estimates, and some additional dredged material and sand was mechanically added to the cell to achieve the final grades. Cell 3D was successfully configured in accordance with the proposed design using the development techniques described above. The cell will be monitored closely during the next several years after planting has been completed to document performance. The planting plan proposed for Cell 3D is presented in Figure 6-6. These techniques will provide a basis for planning for future wetland cell development, although adjustments in the approach to improve efficiency are anticipated. In view of the complexity of the process and the variable conditions within each wetland cell, other placement and development techniques will be investigated to improve on cell development efficiency and adjust to needed changes in wetland design. It may be that other placement and development techniques may be more appropriate for site conditions that differ significantly from those applicable to Cell 3D.

6.5.3 Upland Cell Development

Upland cells will be graded to provide a final surface at approximately elevation +20 ft MLLW (or +25 ft MLLW if a raising of the existing upland cells is included as a component of the lateral expansion alternative). In general, the proportion of crust in comparison to the total thickness of the dredged material is considerably less than in wetland cells. Therefore, the underlying dredged materials are subjected to much lower consolidation loads than will occur in wetland cells. Maximum consolidation loading can be imposed if the individual placement lifts are maintained close to about 3 ft so that subsequent crust management can effectively drain to majority of each new lift. Typically drainage trenches and desiccation cracking extend only about 15 to 18 inches below the exposed dredged material surface. Whenever possible, allowing two years between placement events is beneficial in promoting the development of the maximum drained surface crust layer.

Figure 6-6. Typical Planting Plan Proposed for Cell 3D

The current habitat development plan anticipates subdividing the larger upland cells as one portion of the cell approaches the final upland elevation. Using Cell 2 as an example, the southern 80 to 100 acres of the 326-acre cell will be separated by a temporary sand cross dike once the dredged material level at the south end of the cell approaches elevation +20 ft MLLW. Subsequent inflow will be located along the east side of the cell to develop a surface gradient from east to west toward the wetland cells. It will be desirable to overbuild the center of the cell to compensate for the larger magnitude of settlement that is anticipated in the center although this is difficult to achieve with typical hydraulic placement methods. It will also be desirable to create several feet of elevation difference across the upland surface to promote surface drainage from the final surface toward the wetland areas. Significant regrading of the transition area between the upland and wetland elevations will be necessary after placement has been completed and the upland surface has been graded and planted. It is anticipated that the surface grading techniques will be similar to those already used for wetland development.

Similar to the incremental approach to wetland development, incremental development of the upland areas and the transitional area connecting them to the wetland habitats is planned. The drainage scheme for the uplands will be designed to assure that runoff from the upland areas will be transmitted to the wetlands in a manner that will prevent erosion of the transition area between the two habitats, and that will disperse the flows into the wetlands without damage. A significant part of that design will depend upon the desired manner of discharge into the wetland area (discharge into channels, discharge into high marsh, dispersed discharge, focused discharge, etc.). Once the goals have been defined, the design to achieve those goals will proceed beyond a concept level.

6.6 CONSTRUCTION

Major construction of the expansion project is expected to be accomplished with a single contract that will include the perimeter and internal sand dikes, armor stone, crushed stone roadway, spillways, and any temporary hydraulic structures that may be required to facilitate dredged material placement. A single contract is anticipated based on previous experiences with PIERP contracts, which was completed in two phases with two contracts, each of similar size to the expansion study. Two facilities associated with offloading dredged material may also be included if it is determined that the current facilities associated with the existing project are not adequate. The construction of the lateral and vertical expansion components will occur concurrently and is estimated to be completed in approximately 2 construction seasons.

The current design has incorporated a dredged material offloading basin inside of an open wetland cell at the northwest corner of the expansion site. That cell is currently designated as a future wetland cell and is included in the 60 percent wetland acreage totals. However, this cell could be left open and only a fringe marsh developed along the edges of a protected open water habitat, or could be partially closed so that bottom elevations could be restored to near current elevations. The decision on the final configuration of this cell could be deferred until near the end of placement in the upland cells.

6.7 SITE OPERATIONS

The construction, operation, and maintenance of the PIERP is a cooperative effort between the USACE-Baltimore District and MPA, and will continue to operate under the same arrangement after the expansion has been completed. As each functional element of the project is completed and determined to be functioning as intended, it will become the responsibility of the MPA to operate, maintain, repair, replace, and rehabilitate the project elements as needed. Such functional elements include: containment dikes including armor stone, internal dikes, service structures, access channels, and each of the upland and wetland habitat areas defined by permanent cell divisions. Ultimately, the entire site will become the responsibility of the MPA.

6.7.1 Dredged Material Unloading Arrangements

Dredged material placed at the site will generally be delivered to the site by barges and hydraulically unloaded into the individual upland and wetland cells. The access channel will be located to the northwest of the expansion site and will connect to a turning basin located inside of an open cell at the northwest corner of the expansion site. The channel and basin will initially be dredged to elevation -25 ft MLLW. Parts of the channel, particularly that portion extending outside of the open cell, may require periodic maintenance dredging to assure at least 20 ft of depth.

6.7.2 Perimeter Containment Dikes

The containment dikes will consist of fine sand with exterior slopes faced with various thickness of armor stone. A typical dike construction sequence is presented in Figure 6-7. The crest of the permanent dikes will have a crushed stone roadway. Non-armored surfaces will be vegetated to provide resistance to erosion from wind, precipitation, or wave action within the containment cells. Some non-armored areas, particularly those subject to wave action within the cells, may require more robust erosion protection measures than those provided by vegetation alone. Periodically, the stone roadway surfaces will require resurfacing. Structural monitoring of the containment dikes will be conducted as part of the site operations at the PIERP (see Section 8.3).

6.7.3 Site Infrastructure

Site infrastructure will include those site facilities required to support the project. Infrastructure includes dike roadways, personnel and equipment access, storage areas, operations and monitoring facilities. Infrastructure will be in place through the operational life of the facility.

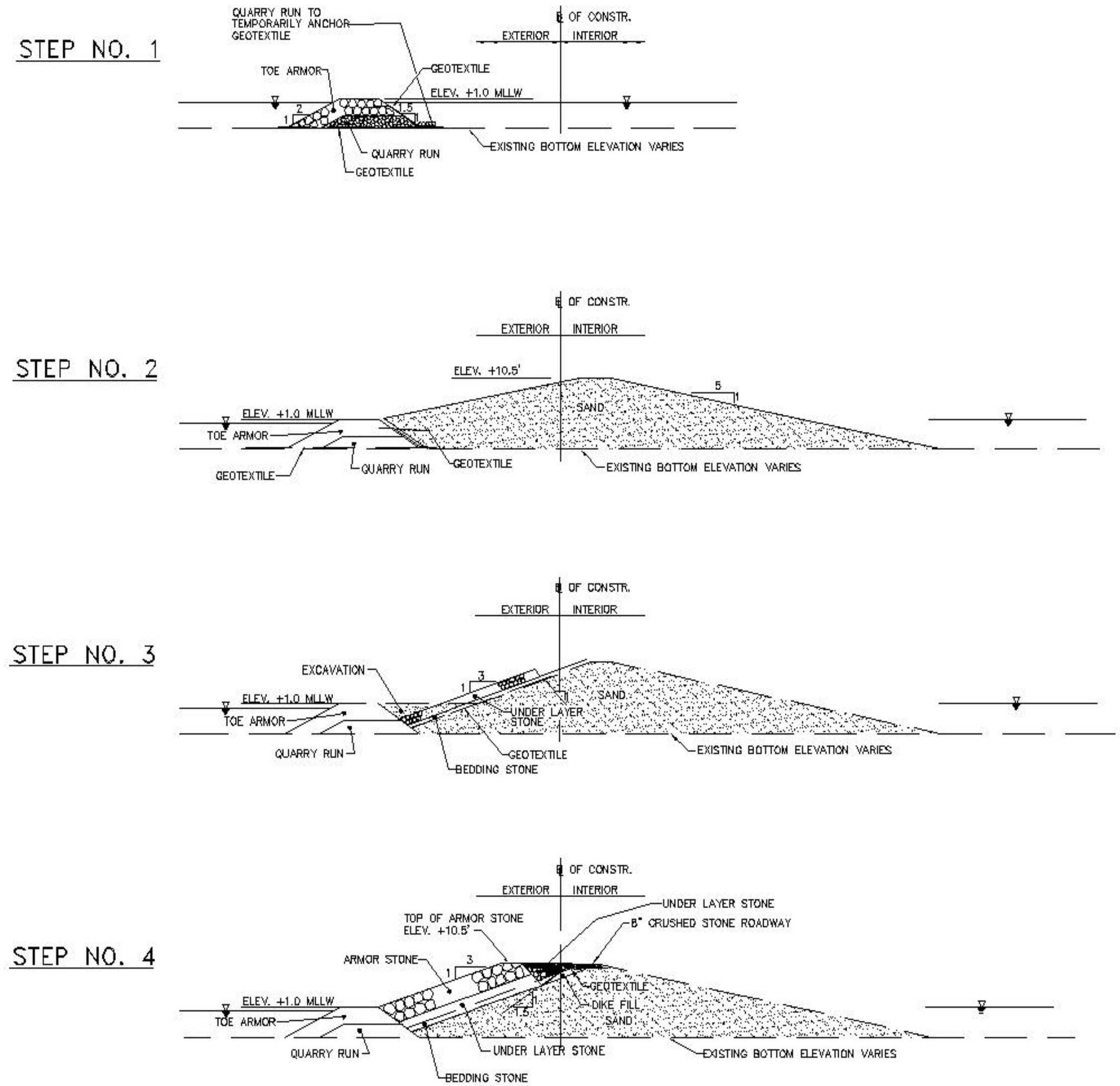

Figure 6-7. Typical Dike Construction Sequence

6.7.4 Cell Materials Management

Dredged materials will be placed into the cells hydraulically. It is anticipated that the fine-grained maintenance materials will typically assume a surface grade of approximately 1000H:1V above water and 250H:1V below water. To achieve the desired final habitat topography, it may be necessary to adjust dredged material discharge locations and cell filling procedures.

6.7.5 Cell Development

After completion of the initial dike construction, clean dredged materials will be hydraulically placed into the containment cells. Typically, a smaller portion of the material will be placed into wetland cells, and the larger balance will be placed into upland cells. The goal of efficient placement will be to limit individual lifts to approximately 3 ft maximum, and as little as one foot in the later stages of wetland cell placement. Between lifts, materials will be trenched to promote drainage, crust development, and consolidation.

Priority for cell drainage and crust development should be given to those wetland cells targeted for development to maximize the probability of maintaining the wetland development schedule.

Islands in the existing project were constructed along with the initial dike construction using sand from borrow sources. It has been necessary to relocate or reconfigure several of the islands as the wetland cells have been developed. It is anticipated that some of the islands may be constructed as part of the dike construction contract, but that others will be built as part of the cell development process as temporary wetland subcell dikes are removed to allow tidal flow. Where possible, dredged materials will be incorporated into the islands to reduce surface erosion potential and to improve conditions for planting.

Planting will be accomplished as subcell filling is completed, primary channel systems are excavated, and surface grading is completed. Current experience has demonstrated that 30 to 40 acre wetland areas can be developed in one year and planted the following year. It is anticipated that two cells totaling 60 to 80 acres could be developed during a single year and planted the following year with advance planning and mobilization of some additional construction resources. These cell grading and planting efforts will have to be coordinated with the more routine cell development activities required of all cells containing dredged materials.

6.8 ACTIONS REQUIRED TO COMPLETE THE EXISTING PIERP

The existing project is not yet completed, and site operations – dredged material placement and habitat development – are ongoing at the PIERP. Under the auspices of the GRR, USACE-Baltimore District assessed the current project and identified several additional project actions required to complete the existing project. The majority of these actions were mentioned in the initial EIS for the existing project (USACE/MPA, 1996), but were not discussed and evaluated in detail. These actions are, therefore, included in this GRR/SEIS evaluation. These actions include raising the existing upland temporary dikes from +23 ft MLLW to +25 ft MLLW, Cell 6 closure, construction of a new discharge, pier, and bulkhead structures to accommodate ongoing operations after the closure of Cell 6, and additional cell development activities.

6.8.1 Raising the Existing Upland Dikes from +23 ft MLLW to +25 ft MLLW

Regardless of the alternative selected, a temporary dike height increase of 2-ft above the existing temporary upland dike elevation is required to support the water drainage (dewatering) in the upland cells necessary for consolidation. Currently, the final design height of the existing cells at the PIERP is +20 ft MLLW. In the EIS for the existing project (USACE/MPA, 1996), the upland dikes were limited to a temporary height 3 feet above the final design height of +20 ft MLLW (+23 ft MLLW). However, based on both the results of on-going site operations, it has been determined that a temporary dike height of +25 ft MLLW is required to achieve proper consolidation of the dredged material to the final target elevation of +20ft MLLW. Therefore, a design modification to raise existing upland dikes from a temporary height of +23 ft MLLW to a temporary height of +25 ft MLLW is evaluated and discussed in more detail below.

The existing Cell 2 perimeter dike has been constructed to elevation +23 ft MLLW to permit upland development to approximately elevation +20 ft MLLW. In fact, the current +23 elevation is not high enough to allow the cell to be filled to the authorized +20 elevation, and several additional feet of temporary dike height will be required to support development of upland surfaces to the authorized +20 ft MLLW elevation. Approximately 5 additional ft of containment dike are required temporarily to allow dredged material to reach any particular target elevation. The actual final upland surfaces will not be perfectly flat, but will require several feet of topographic variation to promote necessary surface runoff.

The dike raising section will consist of sand obtained from the southwestern borrow area located immediately west of the southern end of Cell 6. The sand will be dredged from the southwestern borrow area, temporarily stockpiled within existing Cell 4, and mechanically spread and compacted with bulldozers similar to past dike construction methods to provide the minimum required shear strength. The raised section will have side slopes at 1V:2.5H, a crest width of 15 ft, and will be seeded to establish vegetation needed to control surface erosion. It will also be necessary to raise the level of dredged material inside of the cell to at least elevation +15 ft MLLW to assure that the raised dike section satisfies minimum safety factor requirements with respect to slope stability. After completion of dredged material placement, the upper 5 ft of the perimeter dikes will be removed and that sand material will be used in the final grading of the upland surface. A typical existing upland dike section with the 5 ft raising is presented in Figure 6-5.

6.8.2 Cell 6 Closure and Additional Cell Activities

Cell 6 is currently an open water basin with free, unrestricted tidal exchange with the Chesapeake Bay. The opening at the south end of existing Cell 6 will be closed, and the perimeter dike will be raised to elevation +23 ft MLLW during 2006 or 2007 to accommodate dredged material placement to average elevation +20 ft MLLW. In conjunction with the Cell 6 closure, a new access channel, turning basin, and various support structures will be constructed to replace those features currently located inside Cell 6. Other tasks required to complete the project include restoration of internal borrow sites within wetland Cell 4 and construction of temporary cross dikes within wetland Cell 5. These activities will require approximately 1.5 mcy of sand. A small portion of the required sand (0.4 mcy) will be generated by the access channel and turning basin excavation, but the majority must be obtained from other borrow sources. Sand fill materials required to complete this work will be obtained from the existing Borrow Areas F and G on either side of the access channel immediately outside of Cell 6, and the southwestern extension of the existing areas (Figure 6-2).

Sand Borrow Sources

During the Phase II construction for the PIERP, Borrow Areas F and G, located immediately south of Cells 5 and 6, were partially utilized as a borrow source for sand and are no longer in an undisturbed condition (Figure 6-2). Remaining sand within these areas may be used to complete the projected work, but quantities are insufficient to satisfy project requirements. Therefore, after exhausting Borrow Areas F and G, additional borrow to complete the current project will be obtained from the southwestern borrow area (Figure 6-2). In the southwestern borrow area, approximately 54 acres (0.9 mcy) will be required to complete the Cell 6 dike raising to +23 ft MLLW, approximately 38 acres (0.6 mcy) will be required to complete the Cell 4 restoration, and approximately 27 acres (0.4 mcy) will be required for the completion of miscellaneous cell development.

The southern access channel and turning basin will replace the existing channel and basin after Cell 6 has been closed in 2006 or 2007. This channel will extend from the end of the existing channel at the elevation –25 ft MLLW contour, and extend northeast to the southern end of the longitudinal dike of the existing project where a new turning basin will be excavated. The basin and about 20 percent of the new channel (30 acres) will be located within existing Borrow Area F that was used as a borrow source for the construction of the PIERP Phase II. The remaining 80 percent of the channel (20 acres) will extend outside of the previously disturbed limits of Borrow Area F. The total area disturbed by the channel and basin excavation is approximately 57 acres. Approximately 1.2 mcy of excavation will be required for the new access channel and turning basin and approximately 28 acres (0.6 mcy) of the southern access channel and turning basin will be dredged to complete the Cell 6 closure activities. Based on preliminary subsurface excavations, about 50 percent of the excavated material will consist of sand suitable for dike fill and 50 percent will consist of clay or silt that will be placed within the existing project limits. It is anticipated that the sand portion of the excavation will provide most of the material needed to complete the closure of the existing gap in the Cell 6 dike alignment. The channel and basin will be excavated to elevation –25 ft MLLW with up to 2 ft of over-depth dredging allowed. The bottom width will be 400 ft and side slopes of the channel will be 3H:1V.

Borrow Areas F and G

Borrow Areas F and G (Figure 6-2) encompass approximately 60 and 50 acres, respectively, and were originally estimated to contain approximately 0.7 and 1.0 mcy of sand, respectively.

Approximately 20 acres of Borrow Area G is located within the proposed southwestern borrow area. It is estimated that Phase II construction for the PIERP extracted approximately 60 percent to 70 percent of the original estimated quantity of borrow material. The original bottom elevations varied from about elevation –5 ft MLLW to –13 ft MLLW, and the current bottom elevations within the disturbed area range from –18 to –20 ft MLLW, corresponding to approximately 1.0 to 1.2 mcy of borrow excavation. The borrow area slopes parallel to the Cell 6 dikes were limited to a slope of approximately 10H:1V to minimize the effect on the wave environment adjacent to the dikes. Additional subsurface investigations will be required to quantify the remaining borrow quantities within these areas. Based on the original borrow estimates, approximately 0.5 mcy would be expected to remain in this area. However, the depth of excavation in Borrow Area G was restricted to material above bottom elevation –20 ft MLLW. Therefore, some additional suitable borrow materials may be obtained from this site by excavating to a depth of –25 ft MLLW and extending the borrow area slightly to the east and/or south. At that final bottom elevation, both Borrow Areas F and G would merge with the –25 ft MLLW existing Bay bottom contour and assure connection with the deeper bottom elevation of the existing Bay.

6.9 RECREATIONAL/EDUCATIONAL OPPORTUNITIES

Recreational components at ecosystem restoration projects should be compatible with the objectives of the project and enhance the public's experience by taking advantage of natural values (ER 1105-2-100). The social, cultural, scientific, and educational values of recreational components should be considered within the framework of the ecosystem restoration project purpose. Recreational components of the project may be implemented only to the extent that recreation does not adversely impact the ecosystem restoration process. A more detailed discussion of the plan formulation process of the recreational and educational components is included in Section 4.11.3 and an analysis of impacts associated with each component is included in Section 5.3.3.

Several proposed project features would provide increased recreational opportunities around the project. The rock reefs, segmented breakwater structures, and armored perimeter dikes constructed for the lateral expansion will provide additional fish cover, increasing their potential as high-functioning fish habitat that could support a more productive recreational fishery in the vicinity of the project. The inclusion of an open-water embayment within the footprint of the lateral expansion will provide semi-protected fisheries habitat adjacent to wetland and upland cells, and will increase the trophic interaction between the wetland cells and the open-water embayment within the lateral expansion and enhance fish habitat. Access to the open-water embayment could potentially provide additional opportunities for recreational fishermen and recreational boaters.

Passive recreational and educational components considered included developing low-impact recreational/educational spaces in a way that benefits the local jurisdictions, the State of Maryland, as well as the objectives of the restoration project. The majority of the passive recreational components are interpretive guidance and media, including: self-guided/interpretive nature trails and boardwalks, kiosks with informative signage, a demonstration garden, a stone sculpture/monument/memorial area, resting/viewing areas, and avian observation areas. Other components such as the public tours of the island, research opportunities for universities, and volunteer opportunities will augment and continue programs already in place at the existing project. A detailed discussion of the impacts associated with each of these components is included in Section 5.

Recreational and educational features implemented at PIERP or within the proposed lateral expansion area will be consistent with the goals of the restoration project, and implementation will be coordinated with interested parties and local jurisdictions. In the future, stakeholders will be encouraged to participate and provide input on the specific types of recreational/educational uses, and to help shape the plan for the island. Recreational and educational features will not exceed 10 percent of the project total cost as per USACE guidelines (Policy Guidance Letter No. 59).

6.10 RECOMMENDATIONS FOR ACCEPTING DREDGED MATERIAL FROM ADDITIONAL CHANNELS

The potential for the PIERP to accept dredged material from additional Federal navigation channels, as well as other small navigation projects (including Federal, State, and local channels), not specified in the original EIS (USACE/MPA, 1996) was investigated as part of this GRR/SEIS. Dredged material from Federal navigation channels within Baltimore Harbor (west of the North Point-Rock Point line) was not considered for placement at PIERP.

Currently, only dredged material from Federally authorized approach channels to the Port of Baltimore specifically identified in the Poplar Island EIS (USACE/MPA, 1996) is accepted for placement at PIERP. Under the Poplar Island project cooperation agreement (April 1997), dredged material approved for placement at PIERP is limited to eight Upper Chesapeake Bay Federal navigation channels: the Craighill Entrance Channel, the Craighill Channel, the Craighill Angle, the Craighill Upper Range, the Cutoff Angle, the Brewerton Channel Eastern Extension, the Tolchester Channel, and the Swan Point Channel (Figure 1-3).

Formal discussions with Federal and State regulatory and resource agencies (USACE-Baltimore District, USACE-Philadelphia District, MPA, MES, USEPA, MDE, MDNR, MGS, USFWS, and NMFS) were conducted on March 17, 2005. Details of the agency coordination are provided in Chapter 9, and draft meeting minutes are provided in Appendix F.

6.10.1 Acceptance of Material from the C&D Canal Approach Channels

Acceptance of dredged material from the southern approach channels to the C&D Canal (Figure 6-8) was specifically considered for inclusion in the re-authorization of PIERP. On average, approximately 1.2 mcy of dredged material is removed from the southern approach channels to the C&D Canal (south of the Sassafras River) each year. This material is currently placed at permitted open water placement sites near Pooles Island that have a maximum capacity of approximately 7.5 mcy. The Pooles Island sites are scheduled for closure by 2010, or earlier if the 7.5 mcy capacity is reached prior to 2010. Following closure of the Pooles Island sites, it is proposed that the material be placed at the PIERP. Placement of material from the southern approach channels to the C&D Canal will increase the annual placement volume at the PIERP from approximately 2 mcy to 3.2 mcy per year. The lateral and vertical expansion components of the recommended plan were designed to accommodate this additional annual placement need.

To assess the potential for accepting the material from the southern approach channels to the C&D Canal, a white paper study was conducted (EA, 2005b). The white paper:

1. compared sediment quality data for the southern approach channels to the C&D Canal to data for the Upper Chesapeake Bay Approach Channels that are currently authorized for placement at PIERP,
2. evaluated procedures and project constraints for potentially accepting dredged material from other navigation projects (Federal, State and local channels), and

3. summarized sediment quality guidance to facilitate agency discussions for developing criteria for dredged material placement at PIERP.

The white paper evaluation revealed that the sediment from the southern approach channels to the C&D Canal was physically and chemically consistent with the material authorized and currently being placed at PIERP (EA, 2005b). Sediments proposed for maintenance dredging in the Federal navigation channels, including the southern approach channels to the C&D Canal, are tested every three years in accordance with Tier II procedures in the *Inland Testing Manual* (ITM) (USACE/USEPA, 1998) as specified in the Poplar Island EIS (USACE/MPA, 1996):

> *"Confirmatory testing of project sediments is currently underway and will be repeated at intervals not to exceed three years during the life of the project. Testing and evaluation will conform to guidance provided in Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual [Inland Testing Manual] (USEPA/USACE 1998). Contaminant levels in channel sediments will be compared to reference sediments collected near the Poplar Island site. For the most part, analyses will focus on the Priority Pollutant List less the volatile compounds which are seldom present in dredged material and which would necessitate specialized sampling procedures."*

Formal discussions with Federal and State regulatory and resource agencies (March 17, 2005) indicated that the agencies supported the recommendation for future placement of the material from the southern approach channels to the C&D Canal at the PIERP following the mandatory closure of the Pooles Island open water sites in 2010. The agencies also requested that the current Federal navigation channel testing program be updated and re-designed to include components from the *Upland Testing Manual* (USACE, 2003) that would applicable to beneficial use and island restoration projects. This request will be considered and implemented in consultation with appropriate regulatory and resource agencies.

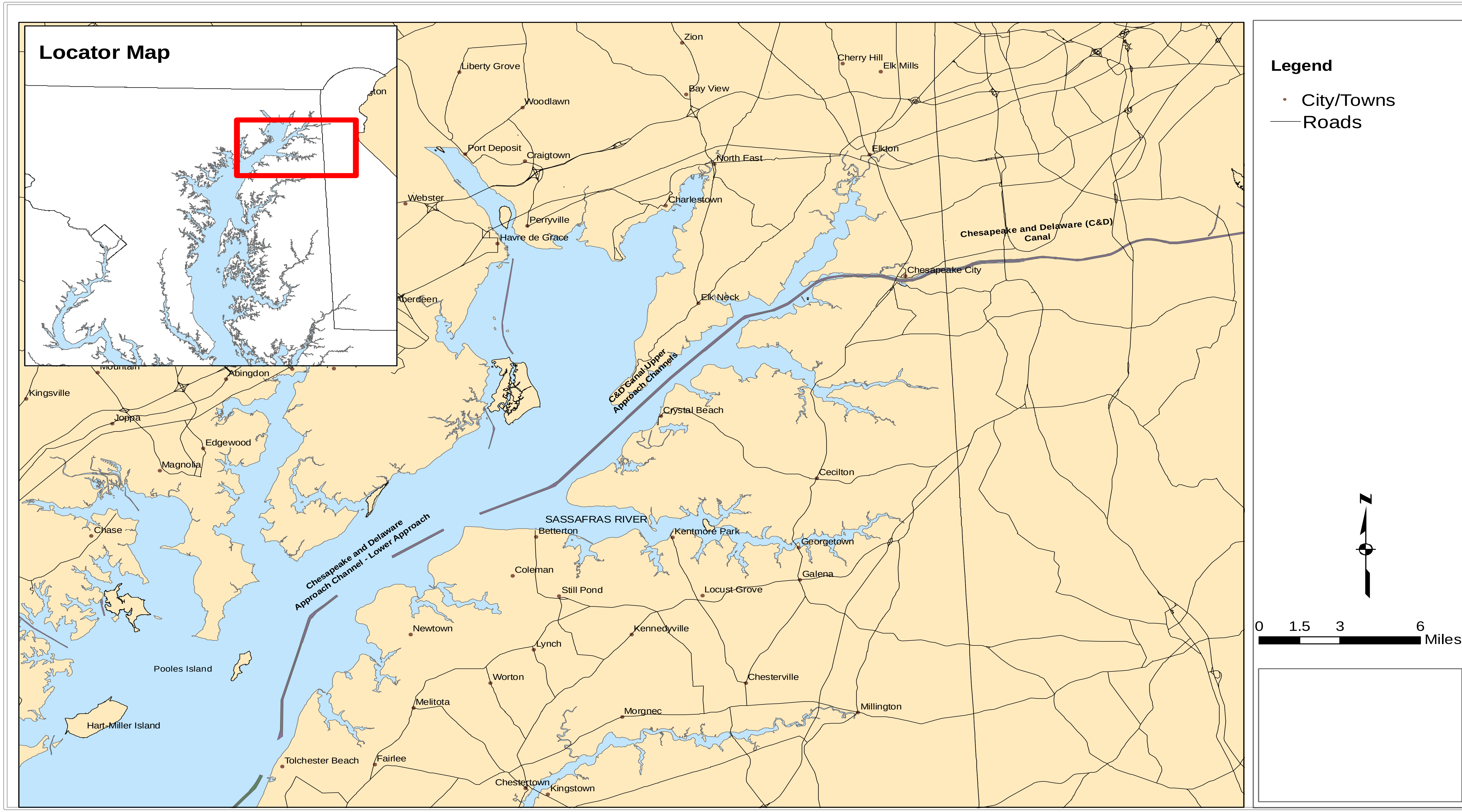

Figure 6-8. Chesapeake and Delaware (C&D) Canal Proper and Approach Channels

6.10.2 Acceptance of Material From Other Dredging Projects

Acceptance of dredged material from other Federal, State, County, or local navigation projects was also considered as part of the PIERP GRR/SEIS. Dredged material from Federal navigation channels within Baltimore Harbor/Patapsco River (west of the North Point-Rock Point line) was not considered for placement at PIERP.

Based on discussions by the PDT, primary issues associated with accepting material from other projects included: dredged material volumes, operational feasibility, and sediment quality.

- Dredged material volumes would need to be small enough to not significantly impact the overall PIERP capacity.
- It would need to be operationally possible to incorporate projects into the placement schedule.
- The quality of the dredged material would need to be consistent with the physical and chemical characteristics of the dredged material from the upper Chesapeake Bay navigation channels authorized for placement at PIERP.

Federal and State resource agencies have agreed that maintenance dredged material from other Federal navigation channels could be placed at PIERP if local beneficial uses and other placement options are not feasible within the near vicinity of each project. In addition, sediments from these maintenance projects must undergo the same testing requirements as the deep-draft Federal navigation channels.

Formal discussions with Federal and State regulatory and resource agencies (March 17, 2005), however, revealed numerous agency concerns regarding placement of material from other State, County, or local dredging projects at the PIERP. Primary concerns included the following:

- Agencies preferred to use the PIERP's capacity for the upper Chesapeake Bay Federal navigation channels and did not want to shorten the lifespan of the PIERP by accepting material from other projects.
- Each potential project, regardless of size, would need to comply with the sediment testing requirements that are in place for the Federal channels. Sediment quality at the PIERP could not be compromised for small State or local projects.
- Significant effort from State resources/agencies would be necessary to review sediment data packages for each potential project.
- Making the PIERP an available placement site for County and local dredging projects could potentially stimulate dredging and decrease participation in local beneficial use projects (i.e., sand for beach renourishment, shoreline stabilization, and wetland creation).

In summary, the agencies did not support acceptance and placement of material from other State, County, or local dredging projects at Poplar Island. Although USACE Policy Guidance

Letter (PGL) No. 47 (USACE, 1998a) states that the USACE may allow non-Federal entities to utilize Federal disposal facilities, acceptance of material from other non-Federal dredging projects at the PIERP is not part of the recommended plan because of concerns expressed by regulatory and resource agencies.

6.11 FUTURE EXPANSION OF THE PIERP AND OTHER FUTURE PROJECTS

In the future, if/when the USACE is in need of placement capacity, Corps policy will require an assessment of expansion and maximization of existing sites first. Based upon the results of the engineering analyses (including engineering suitability and placement analyses), agency concerns and public comments, environmental benefits analyses (including the ICU analysis to quantify the environmental benefits of the project), and the incremental cost analysis conducted as part of this study, it does not appear that further vertical expansion (additional raising of the upland dikes) would result in additional substantive environmental benefits to the PIERP. In addition, lateral expansion in the future would be geographically unlikely based on the existing environmental and engineering constraints at the site (i.e., locations of NOBs and availability of borrow materials). The current recommended plan was designed to maximize the benefits of a one-time lateral expansion. Further study of additional environmental restoration in this geographic area (vicinity of Polar Island) would not, as currently assessed, lead to recommended future expansion scenarios at the PIERP.

It is important to note that USFWS and NMFS have indicated that the inclusion of an open-water embayment in lieu of wetland habitat within the northern lateral expansion is an environmentally preferred option based on site-specific conditions. Both agencies have indicated that the open-water embayment design would be applicable only to the lateral expansion of Poplar Island. The general agency agreement of constructing 50 percent (minimum) vegetated wetland habitat would continue to be applicable for future island ecosystem restoration projects.

6.12 ENVIRONMENTAL MONITORING

Environmental monitoring is performed to ensure regulatory compliance, to document the creation of beneficial habitat, to confirm the expected findings of no negative impacts, and to provide operational input on the success of habitat creation and potential changes which will increase the habitat value and utilization. As of 2005, the PIERP Monitoring Framework consisted of thirteen monitoring components: (1) turbidity monitoring, (2) shellfish bed sedimentation, (3) sediment quality, (4) wetland vegetation, (5) water quality, (6) benthic and epibenthic community, (6) fisheries use of exterior proximal waters, (7) wetlands use by fish, (8) wetlands use by wildlife, (9) bird utilization, (10) interior water quality/algae, (12) terrapin monitoring, and (13) SAV monitoring in Poplar Harbor. The existing monitoring framework will be expanded to include the lateral and/or vertical expansion of PIERP. The location and number of additional monitoring locations, and the frequency of monitoring events for each component would be determined based on consultation with the appropriate agency representatives, and approved by members of the Monitoring Subgroup. Changes and updates to the monitoring framework will be evaluated as part of Adaptive Management Plan.

Additional details about the environmental monitoring components of PIERP are located in Chapter 8.

6.13 COMPLIANCE WITH APPLICABLE FEDERAL LAWS, REGULATIONS, AND EXECUTIVE ORDERS

FEDERAL STATUTES	LEVEL OF COMPLIANCE[1]
The American Indian Religious Freedom Act	NA
Antiquities Act	FULL
Archeological and Historic Preservation Act	FULL
Archeological Resource Protection Act	FULL
Clean Air Act	FULL
Clean Water Act	PARTIAL*
Coastal Barrier Resources Act	NA
Coastal Zone Management Act	FULL
Comprehensive Environmental Response, Compensation, and Liability Act	FULL
Endangered Species Act	FULL
Estuary Protection Act	FULL
Farmland Protection Policy Act	NA
Federal Water Project Recreation Act	FULL
Fish and Wildlife Coordination Act	FULL
Fishery Conservation and Management Act	FULL
Historic Sites Act of 1935	FULL
Land and Water Conservation Fund Act	FULL
Magnuson-Stevens Fishery Conservation and Management Act	FULL
Marine Mammal Protection Act	FULL
Marine Protection, Research, and Sanctuaries Act	FULL
Migratory Bird Conservation Act	FULL
National Environmental Policy Act	FULL
National Historic Preservation Act	FULL
Native American Graves Protection and Repatriation Act	NA
Noise Control Act	FULL
North American Wetlands Conservation Act	FULL
Occupational Health and Safety Act	FULL
Resource Conservation and Recovery Act	FULL
Rivers and Harbors Act	FULL
Safe Drinking Water Act	FULL
Solid Waste Disposal	FULL
Water Resources Development Acts	FULL
Water Resources Planning Act	FULL
Watershed Protection and Flood Prevention Act and the River and Harbor Flood Control Act	FULL

FEDERAL STATUTES	LEVEL OF COMPLIANCE[1]
Wild and Scenic Rivers Act	NA
Wilderness Act	FULL
Executive Orders, Memoranda, etc.	
Protection and Enhancement of Environmental Quality (EO 11514)	FULL
Protection of Cultural Property (EO 12555)	FULL
Protection and Enhancement of Cultural Environment (EO 11593)	FULL
Protection of Cultural Property (EO 12555)	FULL
Floodplain Management (EO 11988)	FULL
Protection of Wetlands (EO 11990)	FULL
Prime and Unique Farmlands (Memorandum, Council on Environmental Quality, 11 August 1980)	FULL
Federal Compliance with Pollution Control Standards (EO 12088)	FULL
Environmental Justice (EO 12898)	FULL
Protection of Children from Health and Safety Risks (EO 13045)	FULL
Responsibilities of Federal Agencies to Protect Migratory Birds (EO 13186)	FULL
Recreational Fisheries (EO 12962)	FULL
Environmental Effects of Major Federal Actions (EO 12114)	FULL
Facilitation of Cooperative Conservation (EO 13352)	FULL

***** *The lateral and vertical expansion will be constructed under an separate water quality certification that will be obtained from MDE prior to the start of construction, as required by section 401(c) of the Clean Water Act. Once the construction for the lateral and expansion is completed, the water quality certification for the existing project will be amended, and the entire project (existing plus the expansion) will operate under one comprehensive water quality certification.*

[1] Level of Compliance:

Full Compliance **(Full):** Having met all requirements of the statute, executive order, or other environmental requirements for the current stage of planning
Partial Compliance **(Partial):** Not having met some of the requirements that normally are met in the current stage of planning.
Non-Compliance **(NC):** Violation of a requirement of the statute, executive order, or other environmental requirement.
Not Applicable **(N/A):** No requirements for the statue, executive order, or other environmental requirement for the current stage of planning.