ENVIRONMENTAL APPENDIX
TIER 1 CLEAN WATER ACT
SECTION 404(B)(1) EVALUATION

NEW JERSEY BACK BAYS
COASTAL STORM RISK MANAGEMENT
FEASIBILITY STUDY

PHILADELPHIA, PENNSYLVANIA

APPENDIX F.6

August 2021

NJBB
NEW JERSEY BACK BAYS STUDY

U.S. Army Corps of Engineers
Philadelphia District

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1.0 INTRODUCTION

The New Jersey Back Bays (NJBB) Study employs a tiered National Environmental Policy Act (NEPA) compliance approach, in accordance with the Council on Environmental Quality's (CEQ's) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500—1508, specifically 1502.20)1. Under this structure, the USACE will conduct additional environmental reviews for certain measures included in the Recommended Plan. For projects as large and complex as the NJBB Study, this approach has been found to better support disclosure of potential environmental impacts for the entire project at the initial phase.

The NJBB Study contains two levels of environmental review. The measures in the Tentatively Selected Plan (TSP) that are in the first level of environmental review are referred to in the Draft Integrated Feasibility Report and Tier 1 Environmental Impact Statement (DIFR-EIS) as Tier One Measures. The Tier One Measures are project features included in the Tentatively Selected Plan that will require future tier two environmental reviews. Other measures that are being carried forward such as three perimeter plans and Natural and Nature Based Features are also part of this Tier 1 review. These Tier One Measures will have Section 404(B)1 evaluations preformed as part of the future tier two environmental studies. The project delivery team has coordinated with resource agencies to identify environmental impacts, including actions subject to 404 of the Clean Water Act. The tier one analysis of the impacts for these measures is a broad level review and we are not seeking final CWA compliance on any of the Tier One Measures in this review. The broad level analyses of impacts for the Tier One Measures can be found in Section 8.2.4 of the DEIS.

The DIFR-EIS contains environmental reviews for five project measures identified as the TSP (3 Storm Surge Barriers and 2 Cross-Bay Barriers (also described as "Bay Closures") along with the inclusion of Natural and Nature-Based Features that would result in discharges of dredged or fill materials into waters of the United States including wetlands. Additionally, 3 perimeter plans require further economic evaluations to determine their viability as "TSP" alternatives. At this time, none of the measures are considered actionable based on the level of detail available including the quantity and nature of the discharges, duration of the discharges, specific site information/delineations and other effects studies that require further investigation. Therefore, this evaluation only provides general impact analyses. It is expected that compliance with the Clean Water Act would be achieved through subsequent phases where actionable items are identified and evaluated in greater detail.

2.0 PROJECT DESCRIPTION

2.1 Location

The geographic limits of the study area include the footprint of the Federal Emergency Management Agency (FEMA) 0.2% AEP (500-year recurrence interval) flood. This inundation boundary represents the storm surge floodplain associated with the maximum storm tide levels caused by extreme hurricane scenarios across the region, and therefore provides a reasonable approximation of the most extreme flooding extent. Detailed information regarding the with municipalities in the study area can be found in the Plan Formulation Appendix.

The study area includes the bays and river mouths located landward of the barrier islands and Atlantic Ocean-facing coastline in the State of New Jersey. The study area covers more than 950 square miles, and 3,500 linear miles of shoreline from Long Branch at the northern study area boundary to Cape May Point at the southern boundary. It comprises portions of eighty-nine municipalities and five counties including Monmouth, Ocean, Atlantic, Burlington and Cape May Counties.

The action area is defined as all areas that may be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. It encompasses the geographic extent of environmental changes (i.e., the physical, chemical and biotic effects) that will result directly and indirectly from the action and is a subset of the NJBB Study Area.

For the NJBB Study, the action area is all areas directly and indirect affected by the tentatively selected plan (TSP), presented . The TSP includes the following project components:

- Three inlet closures or storm surge barriers (SSB)
  - Manasquan Inlet (Monmouth County/Ocean County)
  - Barnegat Inlet (Ocean County)
  - Great Egg Harbor Inlet (Atlantic County/Cape May County)
- Two bay closures
  - Absecon Blvd (Atlantic County)
  - South Ocean City (Cape May County)
- Non-structural measures (All)
  - 18,800 structures eligible for elevation and floodproofing

Additionally, the action area considers the effects of the following options, which have not yet been eliminated.

- Non-structural measures only (elevation and floodproofing for 23,152 structures) in the North Region (Alternative 3A).
- Non-structural measures only alternative (elevation and floodproofing for 10,895 structures) in the Central Region (Alternative 4A; see Figure 3).
- Non-structural measures for (elevation and floodproofing for 1,189 structures) and perimeter plan alternative in the Central Region (Alternative 4D1; see Figure 3).

- Non-structural measures for (elevation and floodproofing for 2,340 structures) and perimeter plan alternative in the Central Region (Alternative 4D2; see Figure 3).
- Non-structural (656 structures) and perimeter plan alternative in the South Region (Alternative 5D2; see Figure 4).

Note that non-structural measures consist of elevating or floodproofing already existing structures in previously developed areas and are not likely to result in discharges of dredged or fill material into waters of the United States and wetlands. Therefore, the action area would primarily be defined by the effects of the storm surge barriers, bay closures, and perimeter plans. Non-structural measures are not included in this evaluation. In addition, Natural and Nature Based Features (NNBF) are being considered for all study area regions, but no specific measures and locations are being proposed at this time. NNBFs are likely to result in discharges.

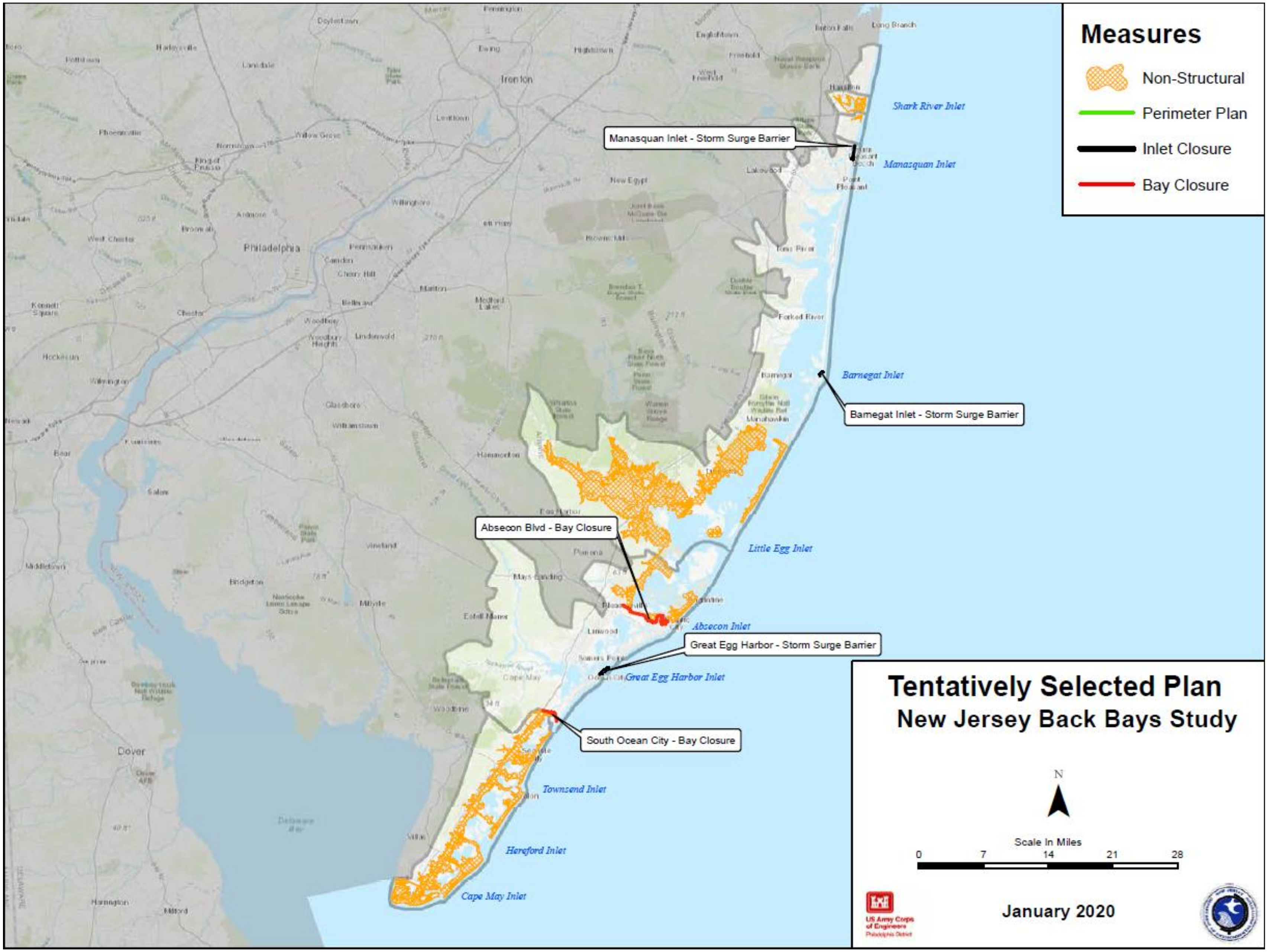
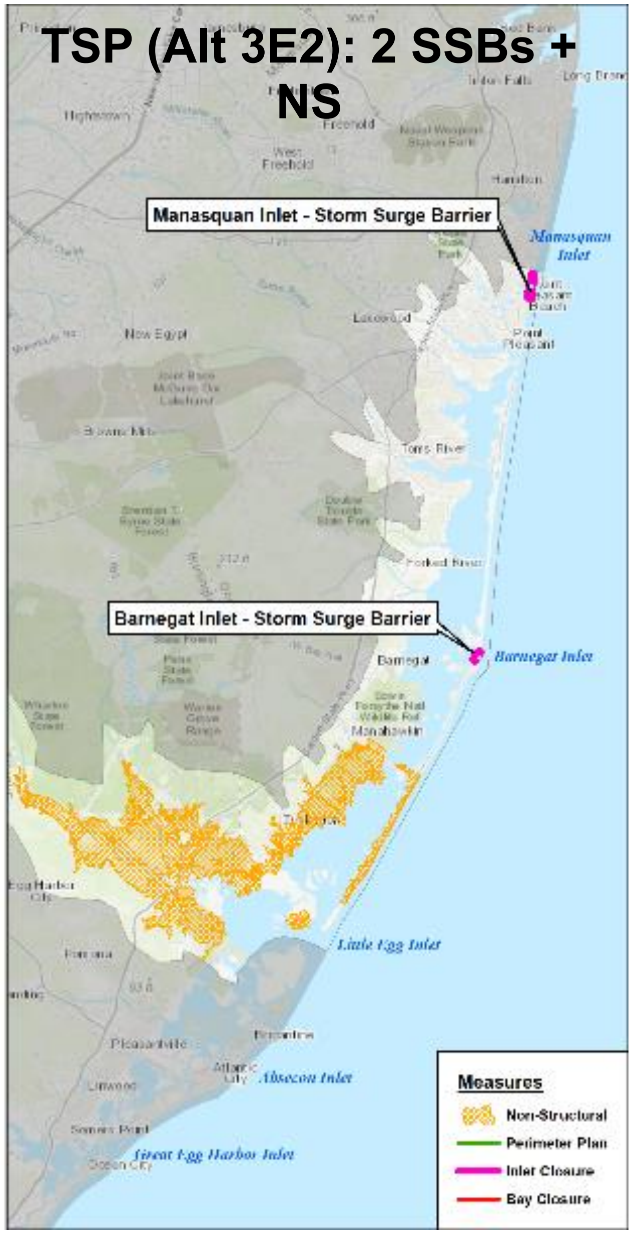


Figure 1. The TSP for the NJBB Study Area.



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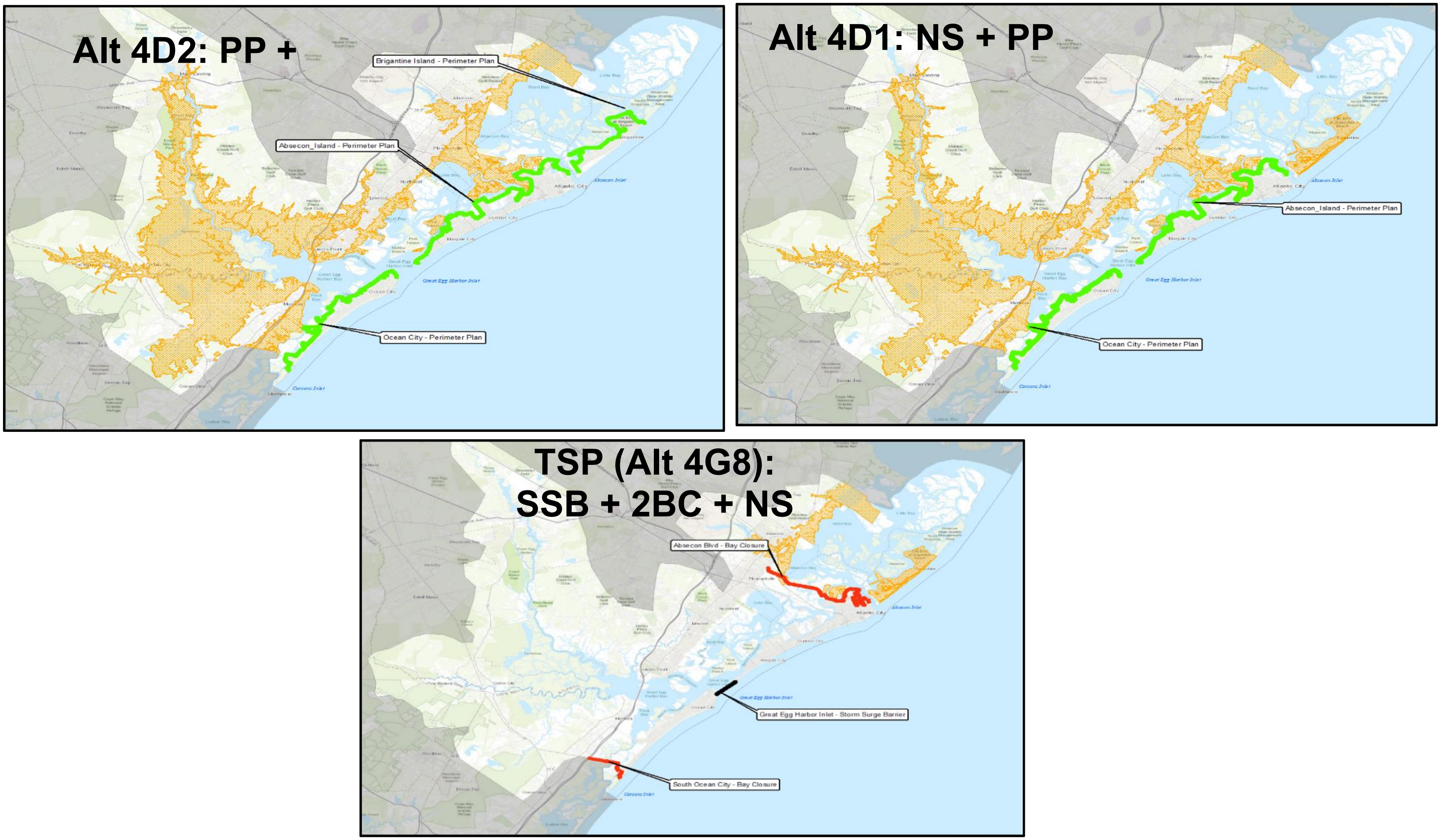
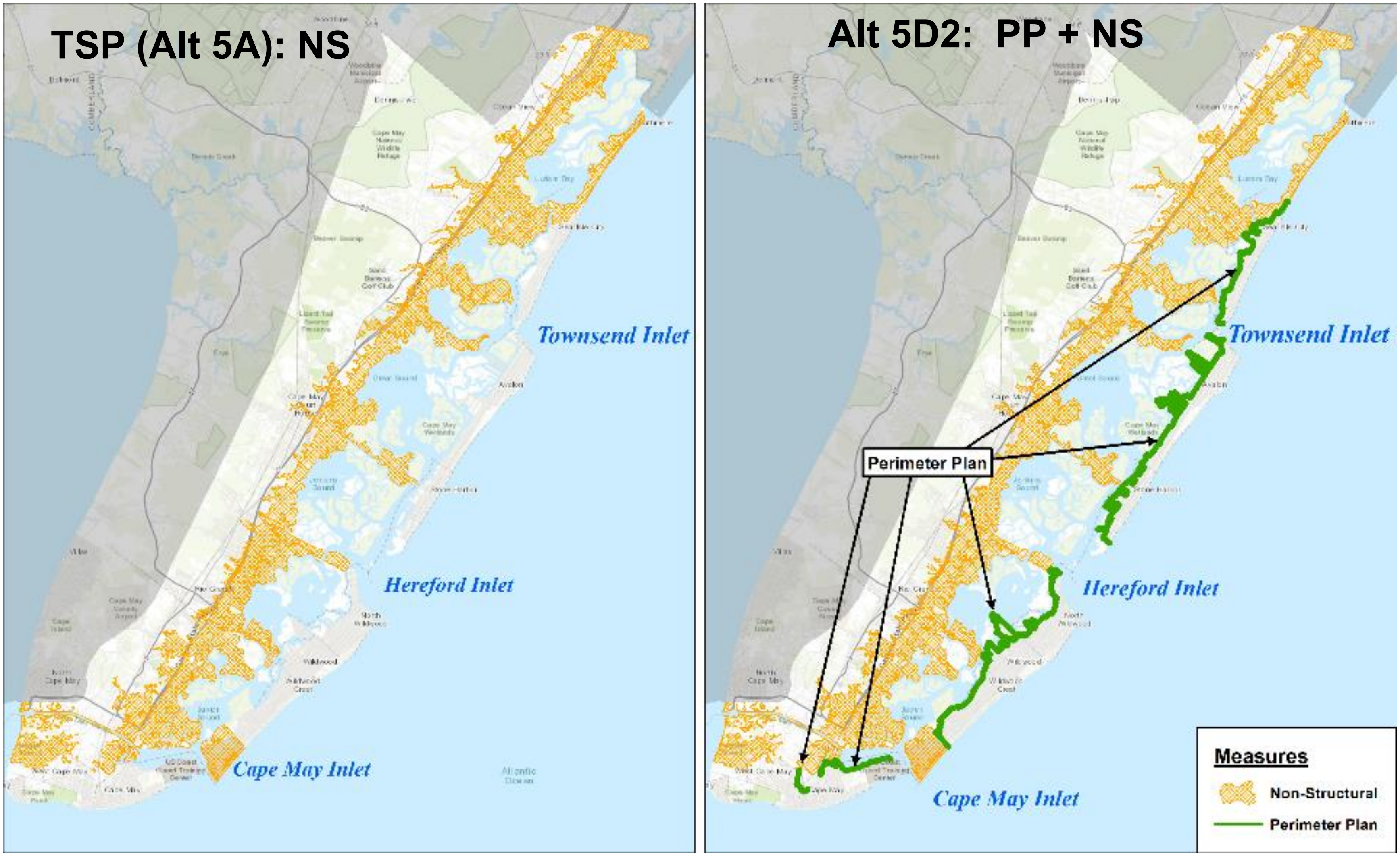
Notes: TSP = Tentatively Selected Plan; Alt = Alternative, NS = Nonstructural; SSB = Storm Surge Barrier, PP = Perimeter Plan

Figure 2. The TSP in the Northern Region.



Notes: TSP = Tentatively Selected Plan; Alt = Alternative, NS = Nonstructural; SSB = Storm Surge Barrier, BC=Bay Closure, PP = Perimeter Plan

Figure 3. Comparison of the Non-Structural and Perimeter Plan Alternatives and the TSP in the Central Region.



Notes: TSP = Tentatively Selected Plan; Alt = Alternative, NS = Nonstructural; PP = Perimeter Plan
Figure 4. Comparison of the TSP and the Perimeter Plan and Nonstructural Alternative in the South Region

2.2 General Description

2.2.1 TSP Storm Surge Barriers and Cross Bay Barriers/Bay Closures

Three storm surge barriers at inlets (Manasquan Inlet, Barnegat Inlet, Great Egg Harbor Inlet) and two interior bay closure barriers across the bay (Absecon Blvd and Southern Ocean City) are included in the TSP. The selected storm surge barriers reduce storm surge from propagating into the bays from the ocean during storm events lowering flood elevations. The storm surge barriers across the bay (cross bay barriers/bay closures) reduce storm surge from propagating into Central Region from adjacent inlets (Absecon Inlet, Little Egg Inlet, and Corson's Inlet) that would remain open and unaltered in the TSP. Storm surge barriers span the inlet opening with a combination of static impermeable barriers and dynamic gates that are only closed during storm events. Each storm surge barrier includes a navigable gate (sector gate) to provide a navigable opening with unlimited vertical clearance and a series of auxiliary flow gates, vertical lift gates, to maintain tidal flow during non-storm conditions. In addition, the cross-bay barriers (bay closures) have perimeter components of levees and floodwalls. Conceptual drawings/layouts and cross-sections, for the storm surge barriers are included in Figures 5-19. Storm surge barrier gate types and alignments are considered tentative and may change in future phases of the study with more detailed engineer analyses and designs.

Navigable sector gates span the full width of the federal navigation channel with a 10-foot buffer on either side with opening spans ranging from 120 feet at the Bay Closures to 340 feet at Manasquan Inlet. Auxiliary flow gates have an opening span of 150 feet and are located along the storm surge barrier in water depths that are deemed constructible and practical. In shallow water, where vertical lift gates are impractical, shallow water gates (SWG) consisting of 24-foot x 8-foot box culverts with sluice gates are used. Bottom sill elevations for the navigable and auxiliary flow gates are designed at or near the existing bed elevations to promote tidal flow and are well below the federally authorized depths at the federal navigation channels.

Impermeable barriers are open water structures that flank the navigable and auxiliary flow gates to tie the barrier into high ground or existing CSRM features (i.e. dunes or seawalls). Site specific impermeable barrier types have not been selected at this stage of the study but will be further investigated as the study continues. Several of the storm surge barriers, particularly the bay closures, include levees, floodwalls, and seawalls along roads, shorelines, and low-lying areas to tie into high ground or existing CSRM features (i.e. dunes or seawalls). The crest elevation of the storm surge barriers is between 17 and 20 feet NAVD88. A summary of the storm surge barrier components is provided in Table 1.

The two cross bay barriers (Bay Closures) at Absecon Boulevard and southern Ocean City contain perimeter features that tie into the gate structures. These features include levees (Type A), and floodwalls (Type B and C) Other features attributed to the Bay Closures include miter gates, sluice gates and road closures.

In-water construction activities for the construction of storm surge barriers and bay closures include installation and removal of temporary cofferdams, temporary excavations/dredging, fill and rock placement, concrete work, and pile driving. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, concrete work, pile driving, and soil stockpiles. For bay closures with perimeter components, in-water construction activities for the construction of levee and floodwalls include installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and pile driving. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, concrete work, pile driving, and soil stockpiles.

The purpose of Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) is to sustain the constructed project. The most significant OMRR&R is associated with the Storm Surge Barriers. At this point of the study, it is estimated that storm surge barriers and bay closures would be closed for a 5-yr and higher storm surge event, with an average of one closure operation every five years. In the next phase of the study the storm surge barrier operations plan, and closure criteria will be revaluated. OMRR&R for storm surge barriers typically include monthly startup of backup generators/systems, annual closure of surge barrier gates pre-hurricane season, dive inspections, gate adjustments/greasing, gate rehab and gate replacement.

Table 1. TSP – Storm Surge Barrier Components

Storm Surge Barrier	Navigable Gate	Auxiliary Flow Gates	Impermeable Barrier	Perimeter Barrier
Manasquan Inlet	1 Sector Gate	None	None	Levee = 7,280 FT
Inlet Closure	Length = 340 FT			Seawall = 2,366 FT
	Crest Elev = 20 FT			
	Sill Elev = -18.25 FT			
Barnegat Inlet	1 Sector Gate	15 Vertical Lift Gates	Length = 798 FT	Floodwall = 897 FT
Inlet Closure	Length = 320 FT	Length = 150 FT each	Area = 18,365 SF	Seawall = 795 FT
	Crest Elev = 17 FT	Crest Elev = 17 FT		1 Road Closure Gate
	Sill Elev = -25 FT	Sill Elev = -5 to -11 FT		
		18 Shallow Water Gates		
		Length = 24 FT each		
		Crest Elev = 17 FT		
		Sill Elev = -4 FT		
Great Egg Inlet	1 Sector Gate	19 Vertical Lift Gates	Length = 863 FT	Levee = 974 FT
Inlet Closure	Length = 320 FT	Length = 150 FT each	Area = 20,716 SF	Seawall = 1,275 FT
	Crest Elev = 19 FT	Crest Elev = 19 FT		
	Sill Elev = -35 FT	Sill Elev = -5 to -18 FT		
Absecon Blvd.	1 Sector Gate	4 Shallow Water Gates	Length = 869 FT	Levee = 27,524 FT
Bay Closure	Length = 120 FT	Length = 24 FT each	Area = 14,772 SF	Floodwall = 28,890 FT
	Crest Elev = 13 FT	Crest Elev = 13 FT		4 Road Closure Gates
	Sill Elev = -20 FT	Sill Elev = -2 FT		5 Mitre Gates
Southern Ocean City	1 Sector Gate	None	None	Levee = 9,467 FT
Bay Closure	Length = 120 FT			Floodwall = 4,124 FT
	Crest Elev = 13 FT			1 Mitre Gate
	Sill Elev = -10 FT			1 Sluice Gate

Figure 5. Manasquan Inlet SSB Plan View Layout

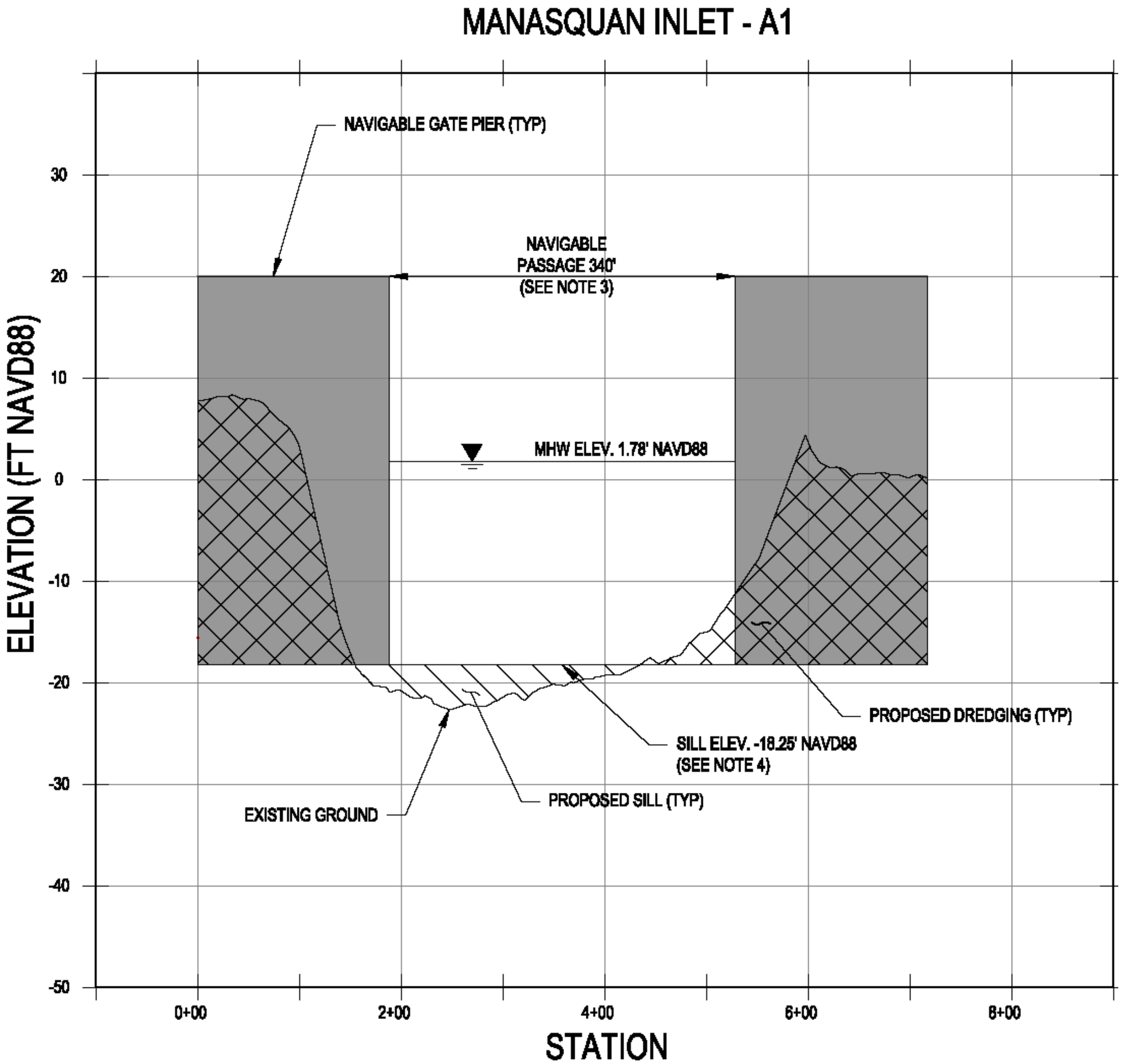


Figure 6. Manasquan Inlet SSB A-1 Cross Section

Figure 7. Barnegat Inlet SSB Plan View Layout

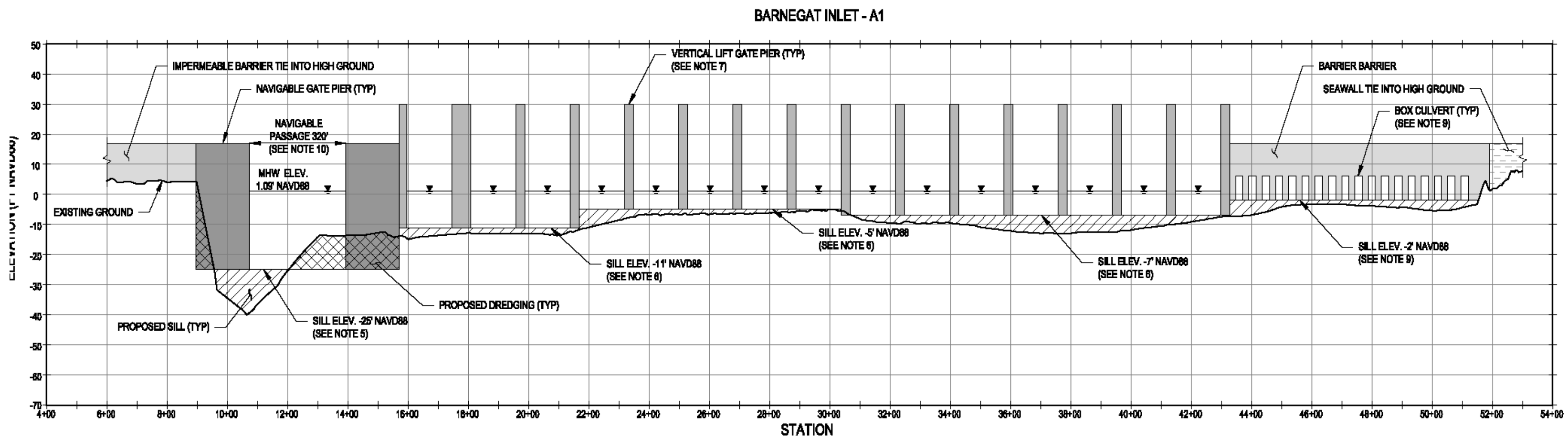


Figure 8. Barnegat Inlet SSB A-1 Alignment Cross Section

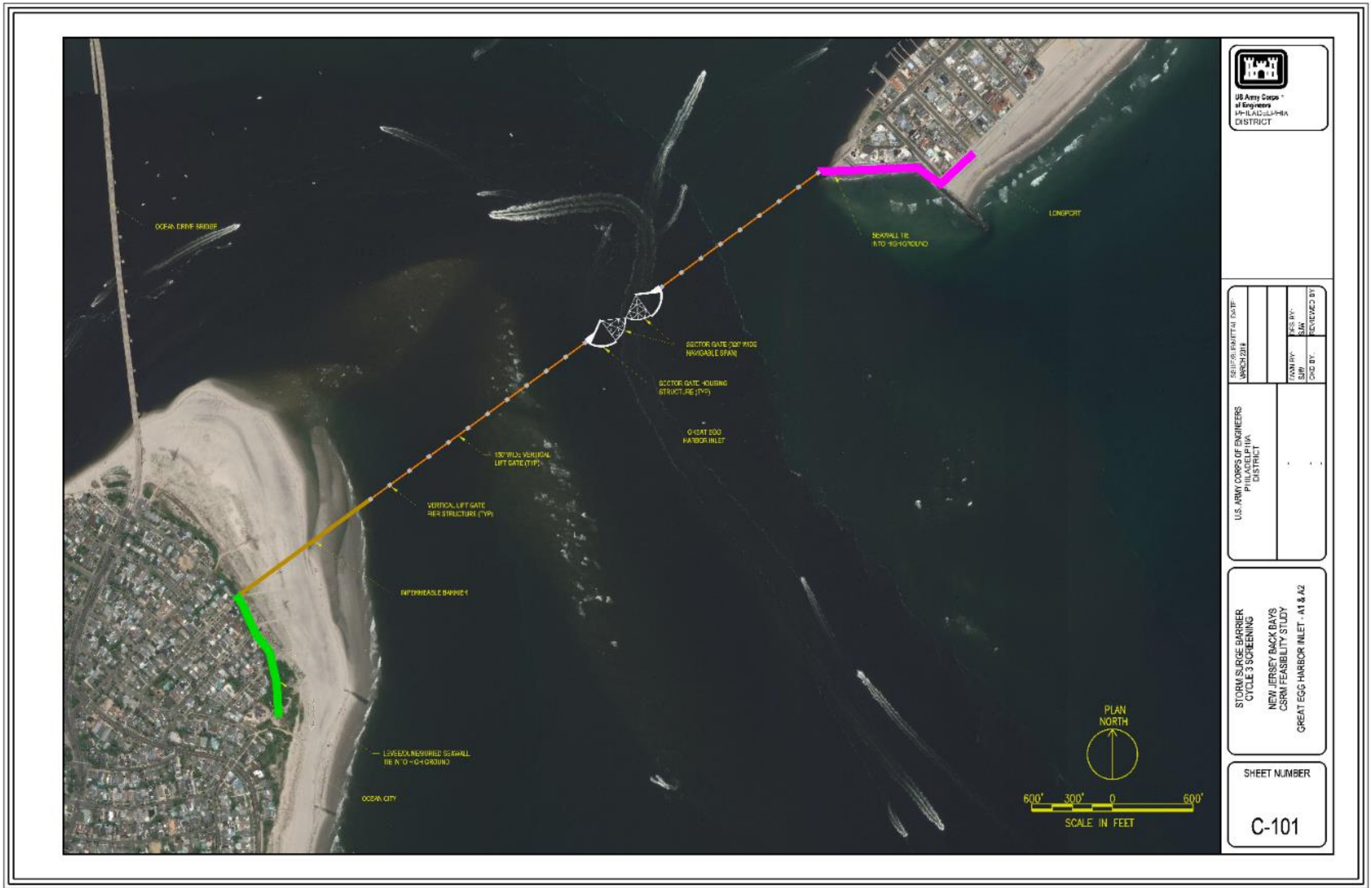


Figure 9. Great Egg Harbor Inlet SSB Plan View Layout

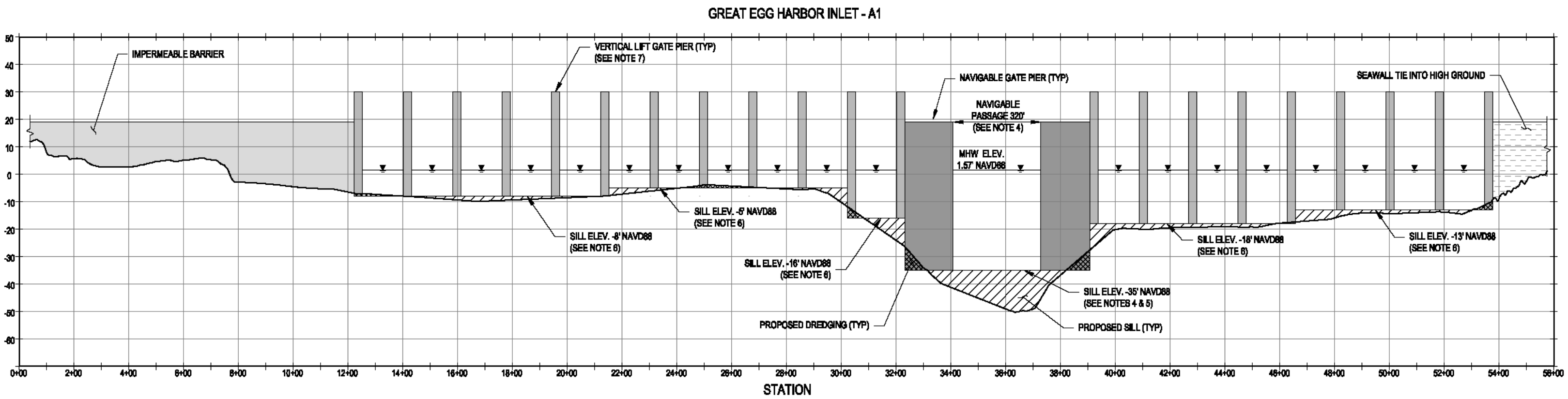


Figure 10. Great Egg Harbor Inlet SSB A-1 Cross Section

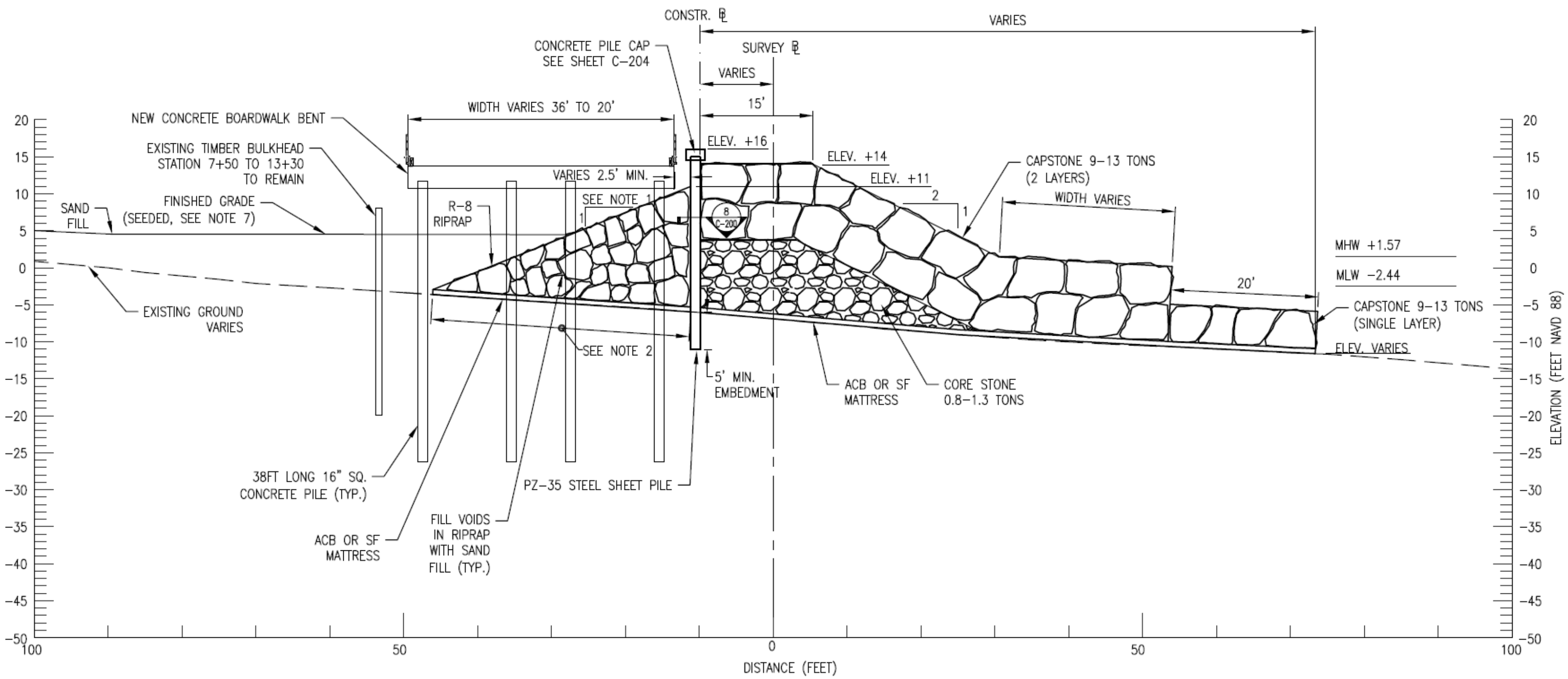


Figure 11. Typical Section of an SSB Seawall

Figure 12. Absecon Blvd. Cross-Bay Barrier (Bay Closure) Plan View Layout

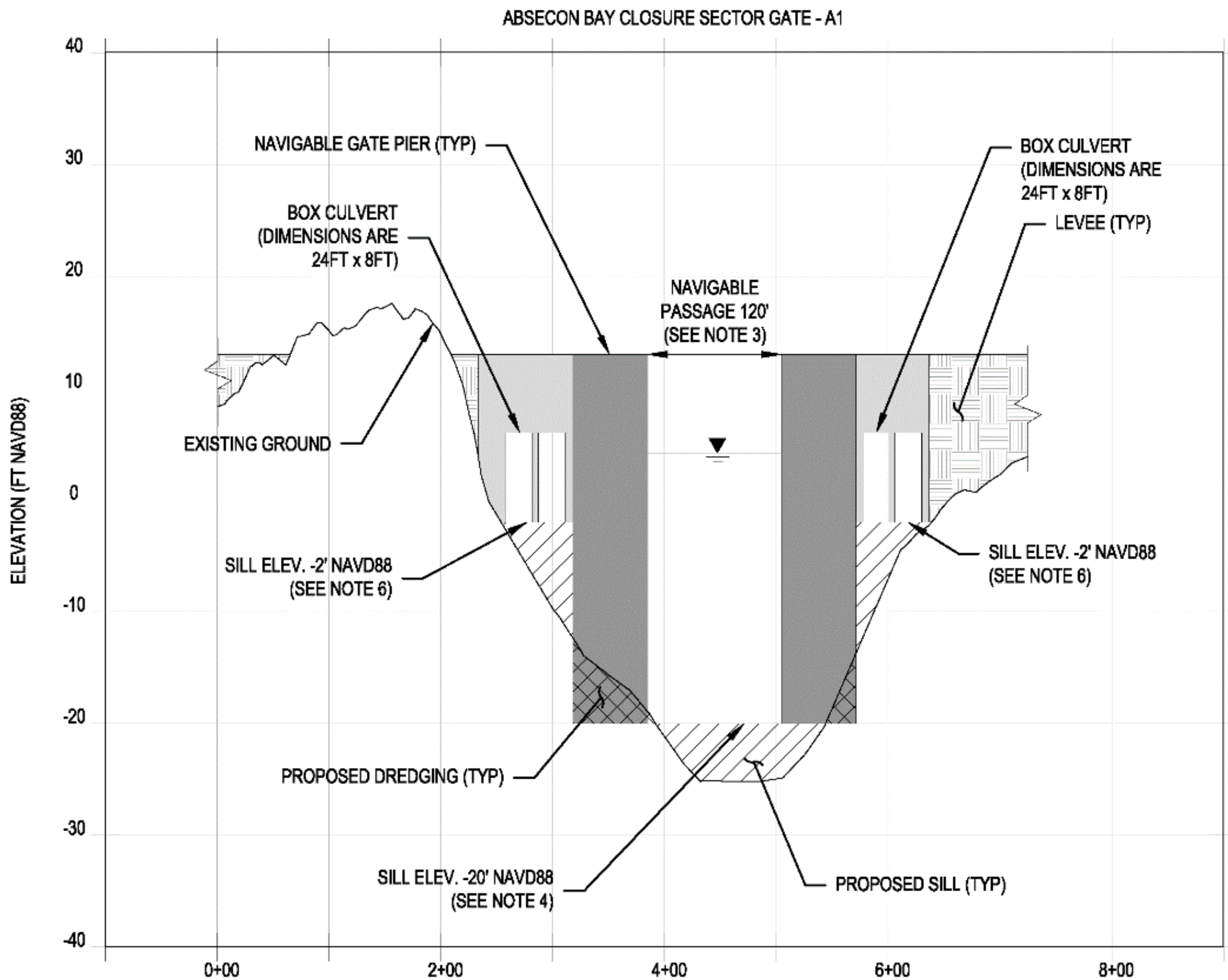


Figure 13. Absecon Blvd. Cross-Bay Barrier (Bay Closure) A-1 Navigable Gate Cross Section

Figure 14. Southern Ocean City Cross-Bay Barrier (Bay Closure) Plan View Layout

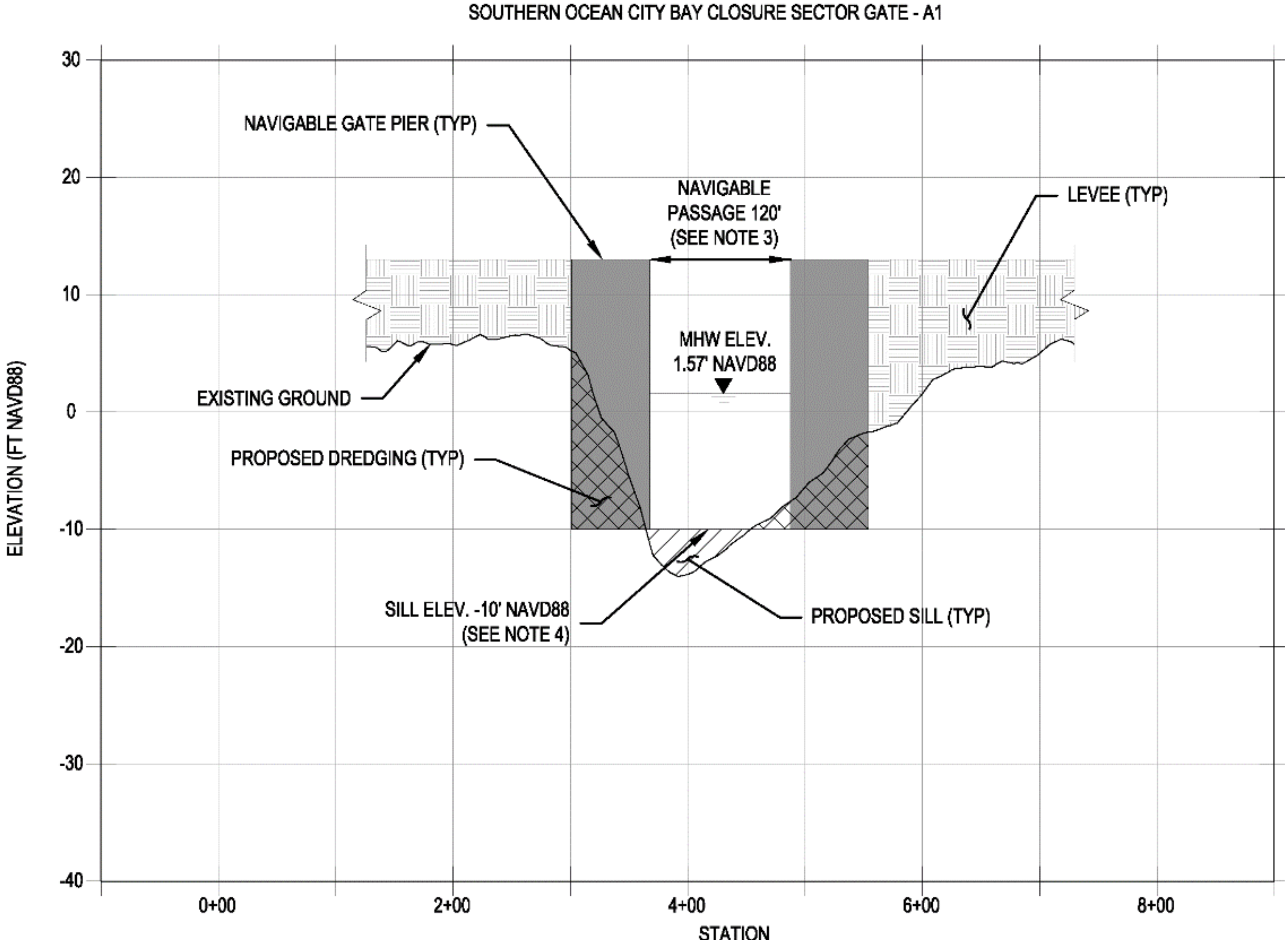


Figure 15. Southern Ocean City Cross-Bay Barrier (Bay Closure) A-1 Navigable Gate Cross Section

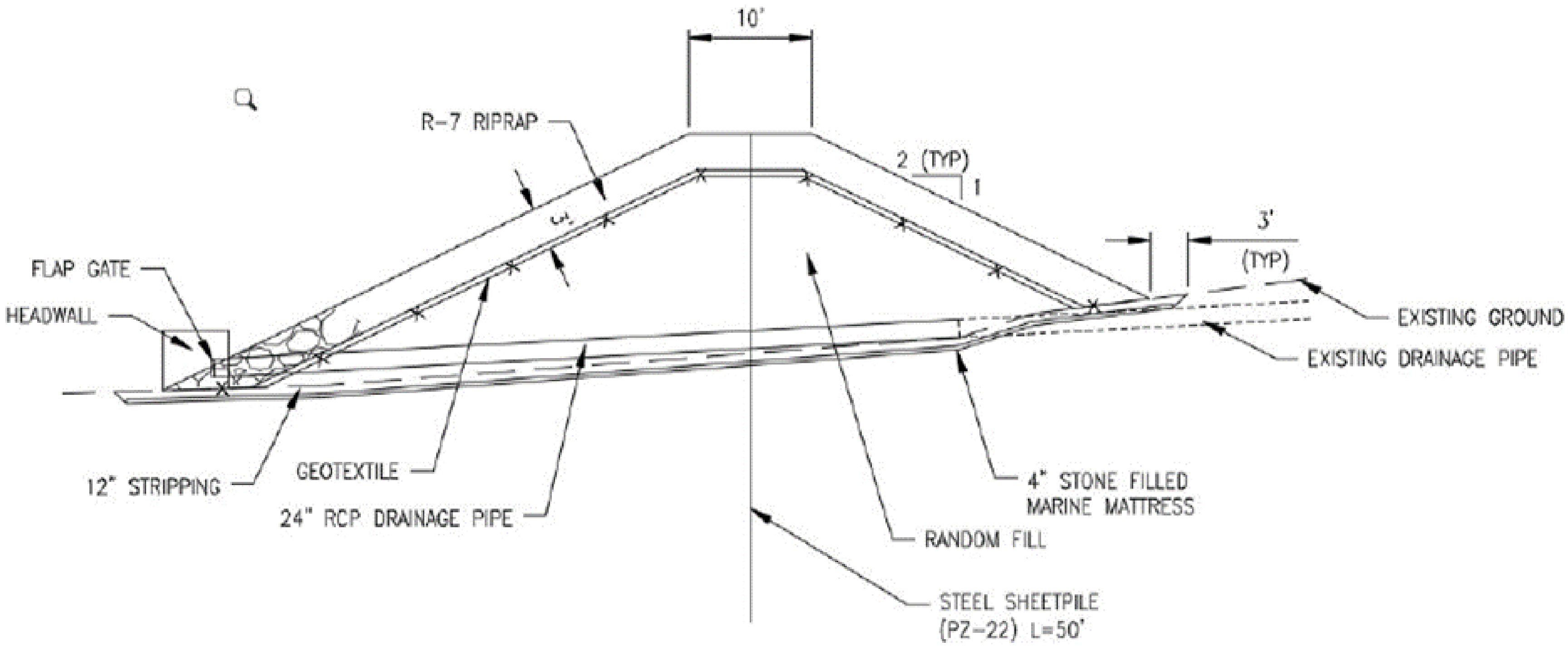


Figure 16. Typical Section of Levee "Type A" Perimeter (Perimeter Plans)

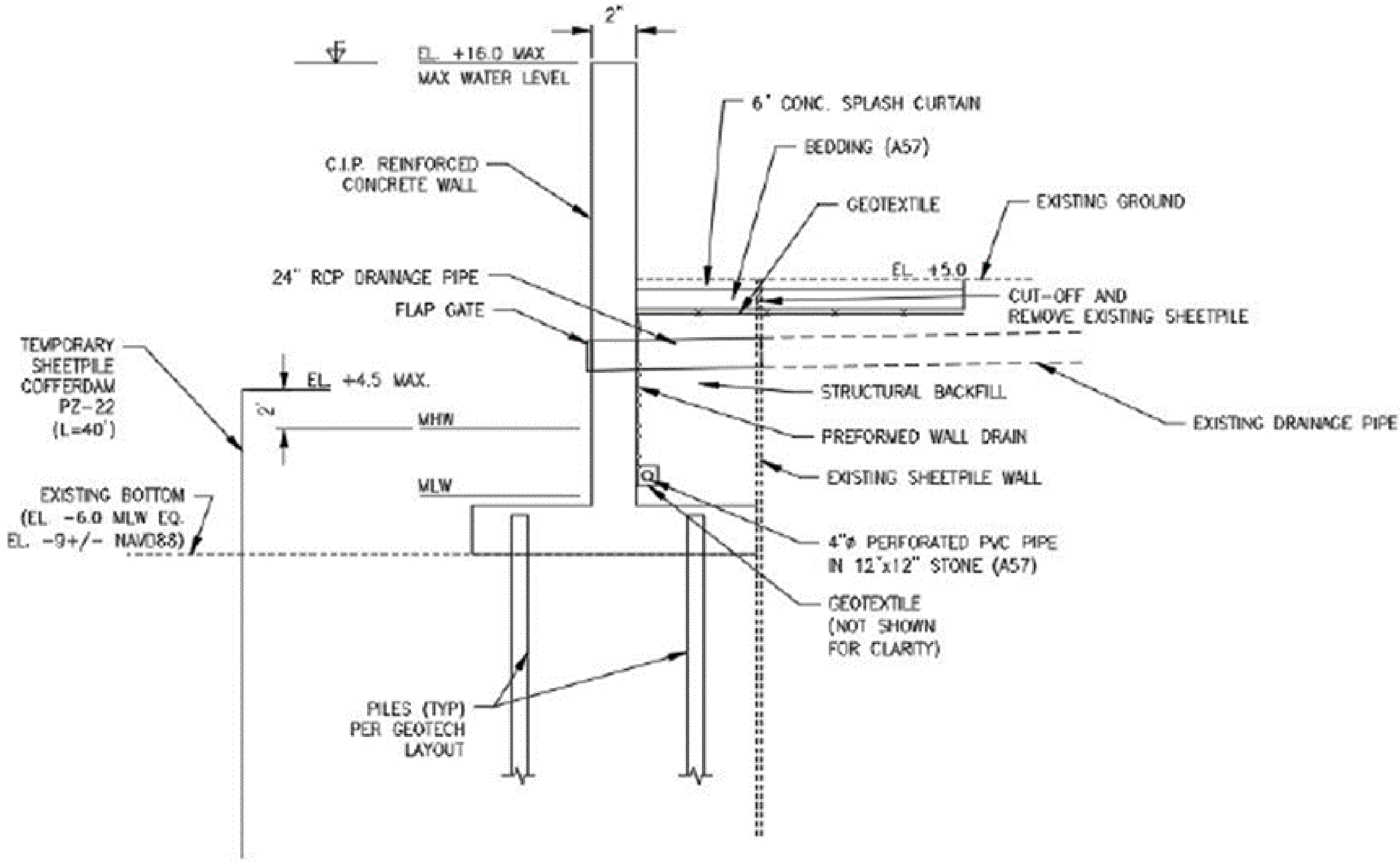


Figure 17. Typical Section Type B Concrete Cantilever Floodwall on Piles (Perimeter Plans)

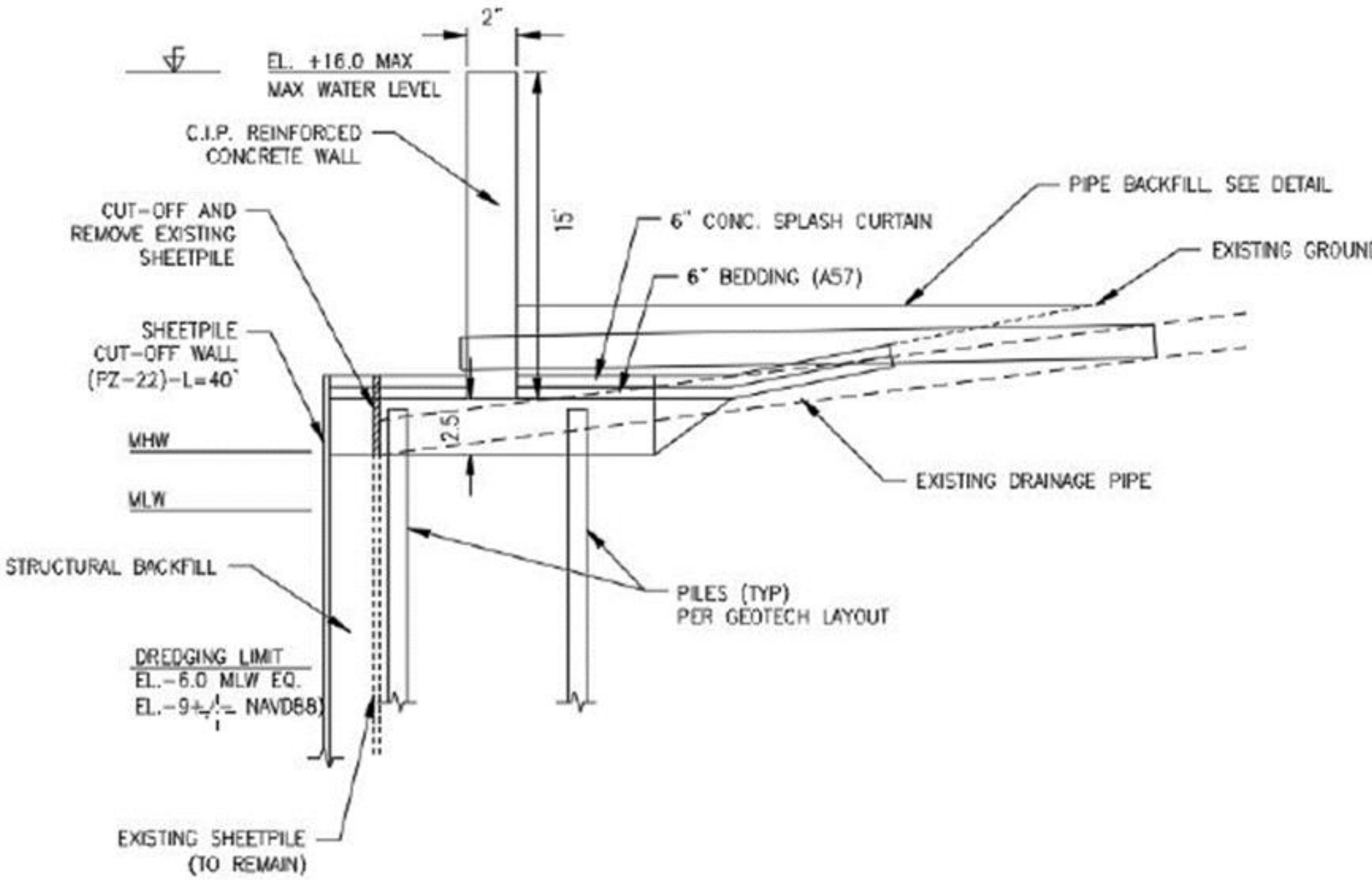


Figure 18. Typical Section Type C Cantilever Concrete Floodwall (Perimeter Plans)

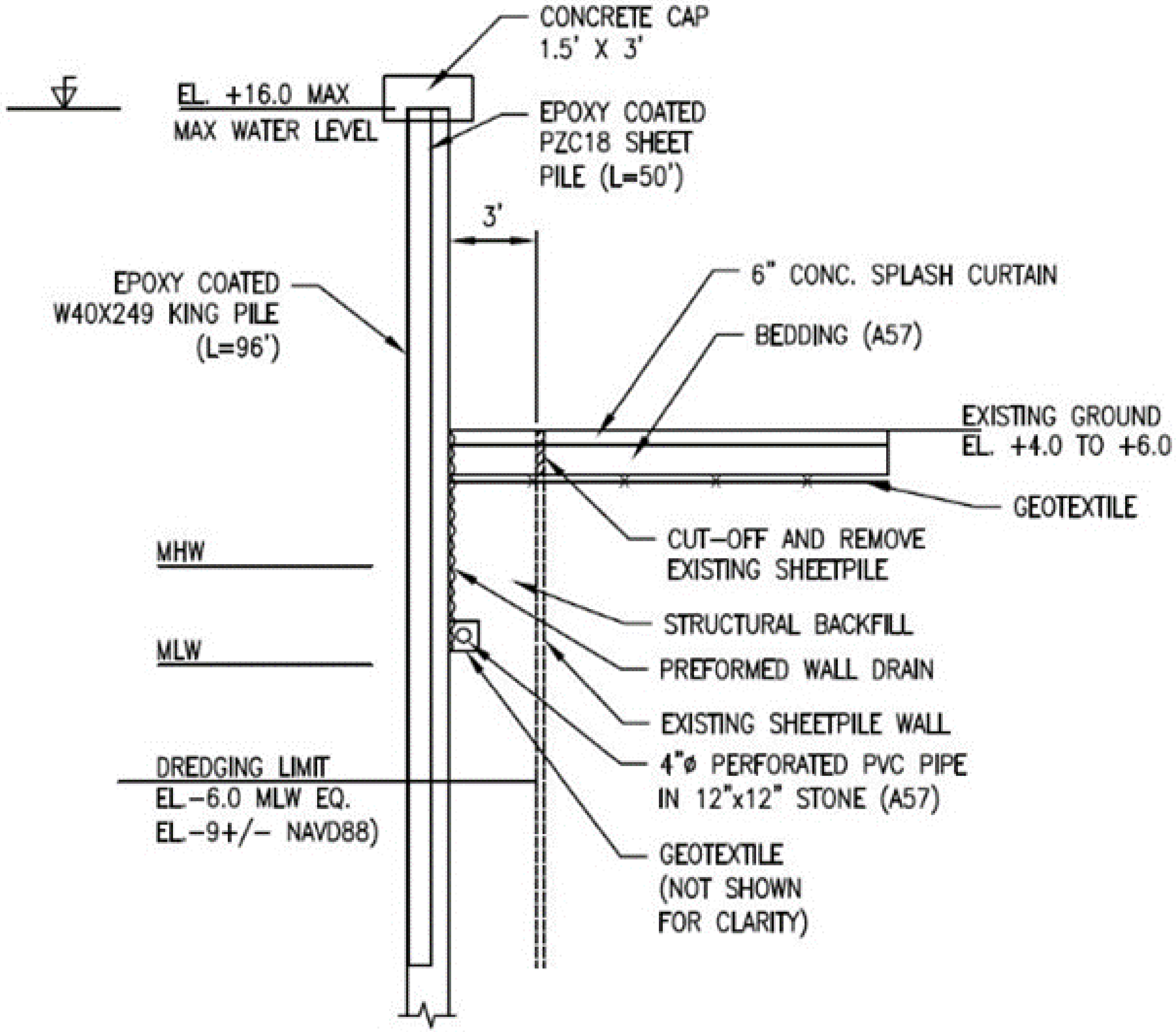


Figure 19. Typical Section Type D King Pile Combined with Sheetpile Floodwall (Perimeter Plans)

2.2.2 Perimeter Plans Requiring Further Economic Evaluation

The perimeter plan options that are still being considered in the Central and South regions include floodwalls and levees that would be constructed on the western side of the barrier islands along residential bayfronts and would tie into existing dunes at the northern and southern ends of the barrier islands., and **Error! Reference source not found.**show typical sections which have been used in the perimeter plan design to date.

Options. The following are the perimeter plan options still under consideration. The number of structures under consideration for nonstructural measures is noted for each perimeter plan option.

- Non-structural measures for (elevation and floodproofing for 1,189 structures) and perimeter plan alternative in the Central Region (Alternative 4D1; see Figure 3).
- Non-structural measures for (elevation and floodproofing for 2,340 structures) and perimeter plan alternative in the Central Region (Alternative 4D2; see Figure 3).
- Non-structural (656 structures) and perimeter plan alternative in the South Region (Alternative 5D2; see Figure 4).

The location, length, and construction duration for the perimeter plans for these options are presented in Table 2.

Table 2. Location, Length, and Construction Duration for Perimeter Plan Options

ALTERNATIVE	LOCATION	BARRIER	CONSTRUCTION
		LENGTH (LF)	DURATION (MONTHS)
4D1	Ocean City	78,732	89
	Absecon Is.	111,111	126
4D2	Ocean City	78,732	89
	Absecon Is.	111,111	126
	Brigantine	48,699	55
5D2	Cape May City	15,825	18
	Wildwood Is.	54,171	62
	West Wildwood	11,726	13
	Sea Isle City	35,167	40
	West Cape May	4,480	5

In-water construction activities for the construction of levee and floodwalls include installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and pile driving. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, concrete work, pile driving, and soil stockpiles.

As part of the perimeter plan, miter gates will be installed and operated across smaller channels that require navigable access. These gates would remain open during normal conditions and would be closed during significant storm events. Regular maintenance is performed on the gates to keep the system running as designed.

2.2.3 Natural and Nature Based Features (NNBF)

An initial suite of NNBF opportunities for integration into the TSP are identified in this section for each of the NJBB Regions. NNBF opportunities are demonstrated in maps outlining location specific concepts. The features shown on the map are drawn to locate the general area an NNBF might be considered and are not representative of a specific design. Because these features are highly conceptual at this time, they would require subsequent rigorous site identification and planning, construction methods, impact assessments, and implementation schedules/plans. Because these features would require significant amounts of fill material, consideration would first be given to beneficial use of dredging sources and potential sources within existing dredged material confined disposal facilities (CDFs). These considerations will continue throughout the Feasibility Study Phase and into the Engineering and Design Phase as part of the Tier 2 EIS. A complete discussion of the entire range of NNBF strategies considered can be found in the Natural and Nature-Based Features Appendix G inclusive of key design concepts which are documented in Parts II and III of that Appendix.

2.2.3.1 Shark River and Coastal Lakes Region

Within the Coastal Lakes Region, due to the highly variable conditions of the various lakes, very few generalizable NNBF responses are possible within this region (Figure 20). The reduction of flood risk is something that must be considered on a lake-by-lake basis. However, the opportunity of terracing or lining lakes with vegetation that could serve as stormwater filters, habitat, and increased recreational amenities is one overall strategy that may be applicable. Other possibilities include the creation of islands within the river itself in order to reduce storm effects to the surrounding coastlines.

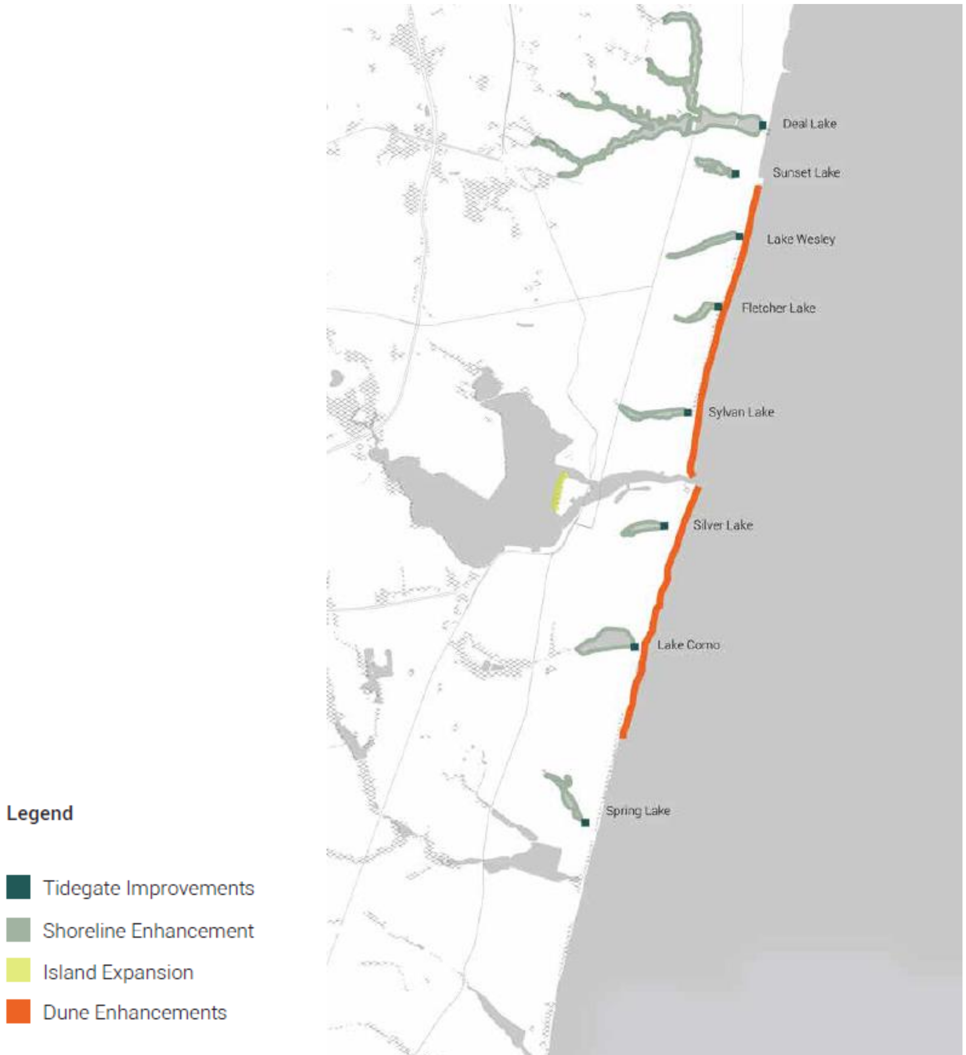


Figure 20. NNBFs within the Shark River/Coastal Lakes Region

2.2.3.2 North Region

As the largest region of the study, and a collection of somewhat similar conditions throughout the region, the North Region provides the opportunity to study a series of strategies that could be repeatedly deployed at large scale, calibrated to specific conditions. For this report, Barnegat Bay is used as an example for this approach, demonstrating the range of NNBF strategies that could be used at a bay-wide scale to address some of the more ubiquitous conditions there (Figure 21). Since the Holgate cross-bay barrier and the Little Egg-Brigantine Storm Surge Barrier are not included in the TSP, importance is placed on the performance of the Tuckerton Peninsula/Great Bay Boulevard wetland complex and the system of sedge islands to the northeast of the peninsula. Two possible NNBFs are included in this area, including possibilities for the Tuckerton Peninsula and the modifications of the sedge islands to enhance their performance as a surge filter.

Figure 21. NNBFs within the North Region

2.2.3.3 Central Region

One of the significant challenges of the Central Region is the flooding of urban areas from the bay during periods of high water. In addition to the aforementioned SSB and bay closures, there is likely to be some consideration of flood wall or levee construction to protect urban populations on the barrier islands (Figure 22). Horizontal levee opportunities exist in Ocean City. Many previously wetland creation and bayfloor shallowing opportunities exist in this region particularly in and around Reed’s Bay given inclusion of the Absecon cross-bay barrier in the TSP.

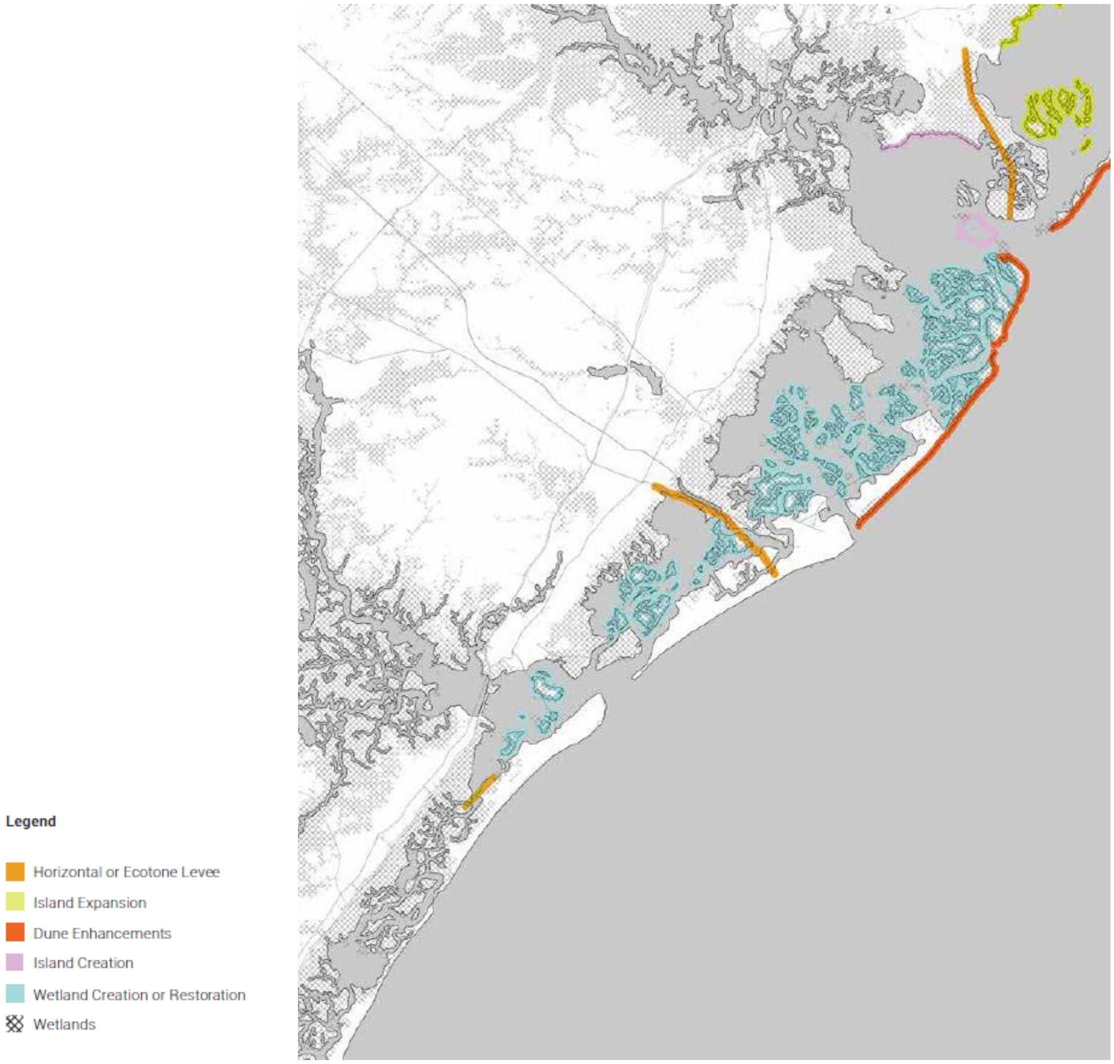


Figure 22. NNBFs within the Central Region

2.2.3.4 South Region

Due to the infeasibility of structural CSRM measures in the TSP in the South Region, this region will likely require significant investments to enhance wetlands to complement nonstructural strategies in order to provide enhanced storm protection (Figure 23). NNBFs similar to those described for Ocean City above or the wetland enhancement projects described elsewhere in this section may be applicable to the South Region. Dune enhancement and beach nourishment is also possible in this region as a method of protecting barrier island communities. An additional opportunity is the Seven Mile Island Innovation Lab which is a collaborative project between the USACE, the Wetlands Institute, and the State of New Jersey. It is developing innovative methods of sediment management that have significant potential to contribute to CSRM.

Figure 23. NNBFs within the South Region

2.2.3.5 NNBF Construction

In-water construction activities for the construction of NNBF include installation and removal of temporary cofferdams, temporary excavations, dredging and filling and rock placement, and wetland/upland vegetation planting. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, and temporary roads.

2.2.3.6 Operation and Maintenance

NNBFs are expected to be self-sustaining with low maintenance, but still may require periodic maintenance activities such as infusions of sediments from beneficial use of dredged material navigation projects or other methods to maintain elevations of subtidal and intertidal features. Maintenance may become necessary after significant storm events, general erosion or adaptation to Sea Level Rise. Post-construction monitoring and adaptive management would identify specific maintenance issues and repair, or rehabilitation needs, and the scale and duration of construction activities required. Therefore, environmental effects and compliance would be required on a case-by-case basis at the time of need.

2.3 AUTHORITY AND PURPOSE

As a result of Hurricane Sandy in October 2012, Congress passed Public Law (P.L.) 113-2, Disaster Relief Appropriations Act, 2013 which authorized supplemental appropriations to Federal agencies for expenses related to the consequences of Hurricane Sandy. Chapter 4 of P.L. 113-2 identifies those actions directed by Congress specific to the USACE, including preparation of two interim reports to Congress, a project performance evaluation report, and a comprehensive study to address the flood risks of vulnerable coastal populations in areas affected by Hurricane Sandy within the boundaries of the North Atlantic Division of the U.S. Army Corps of Engineers (NAD).

The NACCS identified nine focus areas in the NACCS Study Area to more comprehensively identify problems, needs and opportunities including the development of CSRM strategies to manage risk associated with coastal flooding and sea level rise in areas of need. The Back Bays of the State of New Jersey is one of these focus areas.

The New Jersey State Chapter within the State and District of Columbia Analyses Appendix of the NACCS discussed State-specific conditions, presented a risk analyses, developed focus areas and CSRM strategies within New Jersey. The NJBB CSRM Study aligns with the NACCS goals and purpose towards the conduct of a systems analysis/plan to better understand and manage coastal risk.

The study authority for the NJBB CSRM Study was the New Jersey Shore Protection Authority (1987). The resolution reads as follows:

> Resolutions adopted by the Committee on Public Works and Transportation of the U.S. House of Representatives and the Committee on Environment and Public Works of the U.S. Senate in December 1987, and by House resolution adopted by the Committee on Public Works and Transportation on December 10, 1987 offers specific authority for the conduct of study along the coast of New Jersey:

"that the Board of Engineers for Rivers and Harbors, created under Section 3 of the Rivers and Harbors Act, approved June 13, 1902, be, and is hereby requested to review existing reports of the Chief of Engineers for the entire coast of New Jersey with a view to study, in cooperation with the State of New Jersey, its political subdivisions and agencies and instrumentalities thereof, the changing coastal processes along the coast of New Jersey. Included in this study will be the development of a physical, environmental, and engineering database on coastal area changes and processes, including appropriate monitoring, as the basis for actions and programs to prevent the harmful effects of shoreline erosion and storm damage; and, in cooperation with the Environmental Protection Agency and other Federal agencies as appropriate, develop recommendations for actions and solutions needed to preclude further water quality degradation and coastal pollution from existing and anticipated uses of coastal waters affecting the New Jersey Coast. Site specific studies for beach erosion control, hurricane protection, and related purposes should be undertaken in areas identified as having potential for a Federal project, action, or response".

The purpose of the U.S. Army Corps of Engineers (USACE) New Jersey Back Bays (NJBB) Coastal Storm Risk Management (CSRM) Draft Integrated Feasibility Study and Tier 1 Environmental Impact Statement (Draft Integrated Report) is to implement comprehensive CSRM strategies to increase resilience and to reduce risk from future storms and compounding impacts of sea level change (SLC). The objective of the NJBB CSRM Study is to investigate CSRM problems and identify solutions to reduce damages from coastal flooding that affects population, critical infrastructure, critical infrastructure, property, and ecosystems.

The Atlantic Coast of New Jersey is fronted by a Federal CSRM program (USACE, 2013) along it's ocean fronting coastline. However, the region currently lacks a comprehensive CSRM program that will protect communities on the bay side of the barrier islands. As a result, the NJBB region experienced major impacts and devastation during Hurricane Sandy and subsequent coastal events thus damaging property and disrupting millions of lives owing to the low elevation areas and highly developed residential and commercial infrastructure along the back-bay coastline.

2.4 General Description of Dredged or Fill Material

In accordance with 33 CFR Part 323 and 40 CFR Part 232 a final rule was published in 2002 to provide a definition of “fill material”, which was defined *as material placed in waters of the U.S. where the material has the effect of either replacing any portion of a water of the United States with dry land or changing the bottom elevation of any portion of a water. The examples of ‘‘fill material’’ identified in today's rule include rock, sand, soil, clay, plastics, construction debris, wood chips, overburden from mining or other excavation activities, and materials used to create any structure or infrastructure in waters of the U.S.*

2.4.1 General Characteristics of Material

Inlet Storm Surge Barriers (TSP) – For all three inlet barriers, dredging would be required in intertidal areas and subtidal areas consisting of silty muds to coarse sands. As designs are refined in subsequent project phases, geotechnical borings would be utilized to provide detailed characterizations of the dredged material. Excess dredged/excavated materials that cannot be re-used would be de-watered (with containment) and transported offsite to either an existing confined dredged material disposal facility (CDF) or other suitable locations. Fill material would consist of backfill and re-use of suitable coarse materials dredged from the areas requiring dredging/excavation. Imported fill would also be necessary to construct the subaqueous sills and foundations consisting of sand/aggregate, stone of various grades, and concrete supported by concrete or steel piles anchored into the substrate. Concrete, steel, steel sheet piles and/or other composite materials would be required to construct the piers, sector and lift gates, dolphins and tidewalls, box culverts, and impermeable barriers (Figures 5-11). Seawalls would consist of steel sheetpiles, marine mattress, core stone, capstone and riprap (Figure 11). Backfill on land for the dune/levee structure on the upper beach along the north side of Manasquan Inlet would likely be supplied from either existing commercial quarries/sand pits or offshore sources (to be evaluated at a later phase).

Cross Bay Barriers/Bay Closures (TSP) - For both cross bay barriers, dredging would be required in intertidal areas and subtidal areas consisting of silty muds to coarse sands. As designs are refined in subsequent project phases, geotechnical borings would be utilized to provide detailed characterizations of the dredged material. Excess dredged/excavated materials that cannot be re-used would be de-watered (with containment) and transported offsite to either an existing confined dredged material disposal facility (CDF) or other suitable locations. Fill material would consist of suitable backfill and re-use of suitable coarse materials dredged from the areas requiring dredging/excavation. Imported fill would also be necessary to construct the subaqueous sills and foundations consisting of sand/aggregate, stone of various grades, and concrete. Concrete, steel sheet piles and/or other composite materials would be required to construct the piers and gates (Figures 12-15).

Both cross bay barriers have significant perimeter components composed of levees (Type A) and flood walls (Types B, C, and D) (Figures 16-19). Dredging would be required for floodwall types B, C, and D, and is likely to be composed of materials ranging from clays to fine silts to coarse sands. Rock/rip rap and other anthropogenic sources such as concrete rubble and debris could be present in dredging locations. As designs are refined in subsequent project phases, geotechnical borings would be utilized to provide detailed characterizations of the dredged material. Fill material would consist of imported backfill and/or re-use of suitable coarse materials dredged from the areas requiring dredging or excavation.

Type A (Levee) – fill materials consist of random (suitable) fill free of organic material to make up the core of the structure, sheetpiles, stone filled marine mattress as a foundation, geotextile and riprap (Figure 16.)

Types B, C, and D (Floodwalls) – fill materials consist of combinations of these materials: sheetpiles, pilings, concrete wall, and suitable structural backfill (Figures 17-19). Some high-energy locations may also require toe protection consisting of either stone or concrete.

Perimeter Plans (Plans that require further economic evaluation) – have the same components as the cross-bay barriers (bay closures) with Type A (Levees) and Types B, C, D Floodwalls and would require similar dredging and filling activities. Dredging would be required for floodwall types B, C, and D, and is likely to be composed of materials ranging from clays to fine silts to coarse sands. Rock/rip rap and other anthropogenic sources such as concrete rubble and debris could be present in dredging locations. As designs are refined in subsequent project phases, geotechnical borings would be utilized to provide detailed characterizations of the dredged material. Fill material would consist of backfill and re-use of suitable coarse materials dredged from the areas requiring dredging/excavation. See fill materials for Type A levees and Types B, C, and D Floodwalls for cross bay barriers. Other structural components for the perimeter plans that include structures placed in waters consist of miter gate structures at various points to maintain local navigation for recreational boat access to docks and wharves.

Natural and Nature Based Features (NNBF) – NNBFs would require significant amounts of fill materials to raise subaqueous and/or intertidal bottom elevations to construct the NNBF features such as estuarine islands, surge filters or other NNBF concepts being considered in 2.2.3. Variable types of fill materials would be considered for aquatic placement including suitable sands and silts either mined from existing confined dredged material disposal facilities (CDFs) or beneficially placed during maintenance dredging or from upland or offshore sources. Other fill materials may include biogenic shell materials, coir logs and fabrics, geotextile, stone/riprap, and plant materials.

2.4.2 Sources and Quantity of Material

Inlet Storm Surge Barriers (TSP) – For the inlet surge barriers, dredging would be required in the intertidal areas and subtidal areas consisting of silty muds to coarse sands to house the navigable sector gates, while filling with sands/gravels along with concrete supported by pilings would be required to construct sills to maintain consistent bottom elevations. The fill would either be utilized from onsite suitable dredged material or imported from outside commercial sources. At this time, dredged and fill quantities are not available, but estimates would be developed during subsequent planning and design phases. Structural elements would include imported concrete, steel and other fabricated materials to construct the gates, piers, and sills of the barriers. Imported stone from approved quarries would be utilized for scour and toe protection. Quantities of these materials would become available in subsequent planning or design phases.

Cross Bay Barriers/Bay Closures (TSP) - For both cross bay barriers, dredging would be required in the intertidal areas and subtidal areas consisting of silty muds to coarse sands to house the navigable sector gates, while filling would be required to construct sills to maintain consistent bottom elevations. The fill would either be utilized from onsite suitable dredged material or imported from outside commercial sources. At this time, dredged and fill quantities are not available, but estimates would be developed during subsequent planning phases. Structural elements would include imported concrete, steel and other fabricated materials to construct the gates, piers, and sills of the barriers. Imported stone from approved quarries would be utilized for scour and toe protection. Quantities of these materials would become available in subsequent planning or design phases.

Both cross bay barriers have significant perimeter components composed of levees (Type A) and flood walls (Types B, C, and D). Dredging would be required for floodwall types B, C, and D, and is likely to be composed of materials ranging from clays to fine silts to coarse sands. Fill material would consist of imported backfill and/or re-use of suitable coarse materials dredged from the areas requiring dredging or excavation. Quantities of these materials would become available in subsequent planning or design phases.

Type A (Levee) – fill materials would be imported and consist of random (suitable) fill to make up the core of the structure, sheetpiles, stone filled marine mattress as a foundation, geotextile and riprap, which would originate from commercial sources. Suitable fill material may also originate from existing confined dredged material disposal facilities (CDFs). Quantities of these materials would become available in subsequent planning or design phases.

Types B, C, and D (Floodwalls) – fill materials consisting of combinations of these materials would be imported from commercial sources: sheetpiles, pilings, concrete wall, and suitable structural backfill. Suitable fill material may also originate from existing confined dredged material disposal facilities (CDFs). Some high-energy locations may also require toe protection consisting of either imported stone or concrete. Quantities of these materials would become available in subsequent planning or design phases.

Perimeter Plans (Plans that require further economic evaluation) – have the same components as the cross-bay barriers (bay closures) with Type A (Levees) and Types B, C, D Floodwalls and would require similar dredging and filling activities. If perimeter plans are adopted, detailed estimates of quantities and sources would be developed at subsequent planning and design phases.

Natural and Nature Based Features (NNBF) – NNBFs would require significant amounts of fill materials to raise subaqueous and/or intertidal bottom elevations to construct the NNBF features such as estuarine islands, surge filters or other NNBF concepts being considered in 2.2.3. Variable types of fill materials would be considered for aquatic placement including suitable sands and silts either mined from existing confined dredged material disposal facilities (CDFs) or beneficially placed during maintenance dredging or from upland or offshore sources. Other fill materials may include biogenic shell materials, coir logs and fabrics, geotextile, stone/riprap, and plant materials. Since no locations or designs have been selected at this time, quantities of these materials would become available in subsequent planning or design phases.

2.5 Description of the Proposed Discharge Sites

2.5.1 Location

Inlet Storm Surge Barriers (TSP) – see Figures 1, 2, 3, 5, 7 & 9.

Cross Bay Barriers/Bay Closures (TSP) – see Figures 1, 3, 12, & 14.

Perimeter Plans (Plans that require further economic evaluation) – see Figures 3 & 4.

Natural and Nature Based Features (NNBF) – see Figures 20 to 23.

2.5.2 Size and Type of Site and Habitat

The affected wetland/aquatic habitats of the TSP measures and Perimeter Plans still in evaluation are presented in Tables 3 and 4 along with estimated footprint acreage ranges. Impact acreages for NNBFs are not available at this time, but it is assumed that NNBFs would affect estuarine intertidal and subtidal habitats.

2.5.3 Timing and Duration of Discharge

Preliminary estimates were developed for construction durations beginning in the assumed year of 2030 and are presented in Table 5.

Table 3. Estimated Construction Durations of Structural and NNBF Measures

Alternative	CSRM Measure	Estimated Construction Duration (Months)
3E(2)*	Manasquan SSB	81
	Barnegat SSB	105
4D(1)	Perimeter Plans	89-126
4D(2)	Perimeter Plans	55-126
4G(8)*	GEHI SSB	126
	Absecon Blvd. BC	50
	S. Ocean City BC	49
5D(2)	Perimeter Plans	5-62
NNBFs	All	Unknown
*TSP Components		

2.5.4 Description of Disposal Method

Inlet and Cross Bay Barriers – In-water construction activities for the construction of storm surge barriers and bay closures include installation and removal of temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and pile driving. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, concrete work, pile driving, and soil stockpiles. As plans become further developed, BMP's would be established to minimize turbidity and fill movement.

Perimeter Plans (Plans that require further economic evaluation) - In-water construction activities for the construction of levee and floodwalls include installation and removal of

temporary cofferdams, temporary excavations, fill and rock placement, concrete work, and pile driving. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, concrete work, pile driving, and soil stockpiles. As plans become further developed, BMP's would be established to minimize turbidity and fill movement.

Natural and Nature Based Features (NNBF) - In-water construction activities for the construction of NNBF include installation and removal of temporary cofferdams, temporary excavations, dredging and filling and rock placement, and wetland/upland vegetation planting. On land construction activities include clearing, grading, excavations, backfilling, movement of construction equipment, and temporary roads. As plans become further developed, BMP's would be established to minimize turbidity and fill movement.

Table 4. Wetland Types and Estimated Affected Areas

		Saline Low Marsh	Saline High Marsh	Scrub Shrub Deciduous	Scrub Shrub Coniferous	Forested Wetlands	Phragmites Dominated Wetland	Herbaceous Wetlands	Disturbed Wetlands	Managed Wetlands (Lawn)
ALTS	**NWI Class:**	E2EM1N, E2EM1Nd, E2EM1P	E2EM1N, E2EM1P	E2SS1P, E2EM5P, PSS1/4B	PEM1R, E2EM1P	PF01	E2EM1N, E2EM5P, E2EM1P	E2EM1N, PEM1A, PEM1E	PEM1R, E2EMP	PEM1R
		Impact Acres	Impact Acres	Impact Acres	Impact Acres		Impact Acres	Impact Acres	Impact Acres	Impact Acres
	Features									
3E-2	**Manasquan + Barnegat SSB**									
	Barnegat Inlet SSB (A1)	-	-	-	-	-	-	-	-	-
	Manasquan Inlet SSB (A1)	-	-	-	-	-	-	-	-	-
	TOTAL	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
	20% Impact Range*:	0	0	0	0	0	0	0	0	0
4D-2	**Central ALL PP**									
	Ocean City PP	37.9	2.9	2.7	3.4	-	18.6		4.8	4.7
	Absecon Island PP	15.7	5.1	4.3	-	-	0.6	0.3	-	-
	Brigantine PP	14.5	3.6	0.1	-	-	-	0.4	-	-
	TOTAL	**68.1**	**11.6**	**7.1**	**3.4**	**0.0**	**19.2**	**0.7**	**4.8**	**4.7**
	20% Impact Range*:	**54-82**	**9-14**	**6-8**	**2.7-4.0**	**0**	**15-23**	**0.6-0.9**	**4-6**	**4-6**
4D-1	**Central ALL PP**									
	Ocean City PP	37.9	2.9	2.7	3.4	-	18.6	-	4.8	4.7
	Absecon Island PP	15.7	5.1	4.3	-	-	0.6	0.3	-	-
	TOTAL	**53.6**	**8.0**	**6.9**	**3.4**	**0.0**	**19.2**	**0.3**	**4.8**	**4.7**
	20% Impact Range*:	**43-64**	**6-10**	**6-8**	**2.7-4.0**	**0**	**15-23**	**0-1**	**4-6**	**4-6**
4G-8	**GEHI SSB+Absecon CBB+SOC CBB**									
	Great Egg Harbor Inlet SSB (A1)	-	-	-	-	-	-	-	-	-
	Absecon Blvd. Cross-bay barrier CBB	38.9	10.8	1.5	-	1.3	2.6	0.3	1.0	-

		Saline Low Marsh	Saline High Marsh	Scrub Shrub Deciduous	Scrub Shrub Coniferous	Forested Wetlands	Phragmites Dominated Wetland	Herbaceous Wetlands	Disturbed Wetlands	Managed Wetlands (Lawn)
ALTS	**NWI Class:**	E2EM1N, E2EM1Nd, E2EM1P	E2EM1N, E2EM1P	E2SS1P, E2EM5P, PSS1/4B	PEM1R, E2EM1P	PF01	E2EM1N, E2EM5P, E2EM1P	E2EM1N, PEM1A, PEM1E	PEM1R, E2EMP	PEM1R
		Impact Acres	Impact Acres	Impact Acres	Impact Acres		Impact Acres	Impact Acres	Impact Acres	Impact Acres
	South Ocean City 52ND ST CBB	20.6	2.9		1.8	-	0.3	-	-	-
	TOTAL	**59.5**	**13.7**	**1.5**	**1.8**	**1.3**	**2.9**	**0.3**	**1.0**	**0.0**
	20% Impact Range*:	**48-71**	**11-16**	**1.2-1.8**	**1.5-2.2**	**1.0-1.6**	**2.3-3.5**	**0-1**	**0.8-1.2**	**-**
5D-2	**All Perimeter**									
	Cape May PP	2.0	3.7	2.4	2.1	3.7	1.1	1.3	-	0.5
	Wildwood PP	22.4	10.7	7.6	-	-	1.4	-	-	-
	Stone Harbor/Avalon PP	16.9	7.3	0.3	4.1	-	0.9	-	-	-
	Sea Isle City PP	22.6	10.3	3.4	-	-	6.4	-	-	-
	TOTAL	**63.9**	**32.0**	**13.7**	**6.2**	**3.0-4.4**	**9.8**	**1.3**	**0.0**	**0.5**
	20% Impact Range*:	**51-77**	**26-38**	**11-16**	**5-7**	**3.7**	**8-12**	**1-2**	**-**	**0-1**

TSP Component **Alternative Requiring Further Evaluation** *Due to the uncertainty of impact and mitigation estimates at this level of design and evaluation at a Tier 1 level, a 20% variation of the current alignment is presented as a range of impacts.

Table 5. Aquatic Habitat Types and Estimated Affected Areas

		Open Water Subtidal Soft Bottom	Open Water Subtidal Soft Bottom (shellfish)	SAV Beds (subtidal)	Subtidal Open Water Hardened Shoreline	Subtidal Open Water Hardened Shoreline (shellfish)	Intertidal Rocky SL (lf.)	Intertidal Mudflat	Intertidal Mudflat (shellfish)	Intertidal Sandy Beach	Intertidal Sandy Beach (shellfish)
ALTS	**NWI Class:**	E1UBL, E1UBLx, M1UBL		E1AB3L, E1ABLx, E1ABL	E1UBL, E1UBLx, E1UBL6		E2RS2, M2USN, Riprap	E2USM, E2USP, E2USN		E2USS, E2USM,E2USP,E2US2P,E2USN,M2US2N,M2US2P	
		Impact Acres	Impact Acres	Impact Acres	Impact Acres	Impact Acres	Impact lf.	Impact Acres	Impact Acres	Impact Acres	Impact Acres
	Features										
3E-2	**Manasquan + Barnegat SSB**										
SSB.09	Barnegat Inlet SSB (A1)		12.2	2.6							0.8
SSB.10	Manasquan Inlet SSB (A1)	2.1					2279				0.0
	TOTAL	**2.1**	**12.2**	**2.6**	**0.0**	**0.0**	**2279**	**0.0**	**0.0**	**0.0**	**0.8**
	20% Impact Range*	**1.7-2.6**	**9.8-14.6**	**2.1-3.1**	**0**	**0**	**1824-2736**	**0**	**0**	**0**	**0.6-0.9**

		Open Water Subtidal Soft Bottom	Open Water Subtidal Soft Bottom (shellfish)	SAV Beds (subtidal)	Subtidal Open Water Hardened Shoreline	Subtidal Open Water Hardened Shoreline (shellfish)	Intertidal Rocky SL (lf.)	Intertidal Mudflat	Intertidal Mudflat (shellfish)	Intertidal Sandy Beach	Intertidal Sandy Beach (shellfish)
ALTS	**NWI Class:**	E1UBL, E1UBLx, M1UBL		E1AB3L, E1ABLx, E1ABL	E1UBL, E1UBLx, E1UBL6		E2RS2, M2USN, Riprap	E2USM, E2USP, E2USN		E2USS, E2USM,E2USP,E2US2P,E2USN,M2US2N,M2US2P	
		Impact Acres	Impact Acres	Impact Acres	Impact Acres	Impact Acres	Impact lf.	Impact Acres	Impact Acres	Impact Acres	Impact Acres
4D-2	**Central ALL PP**										
G12	Ocean City PP		1.0		10.3	23.9		2.0	1.6		0.6
G18	Absecon Island PP	0.5	2.2		32.9	12.5	4196	6.2	6.6	9.0	1.7
G23	Brigantine PP		0.8		1.8	13.9		1.8	8.1	0.3	0.6
	TOTAL	**0.5**	**4.0**	**0.0**	**45.1**	**50.2**	**4196**	**10.0**	**16.2**	**9.2**	**2.9**
	20% Impact Range*	**0.4-0.6**	**3.2-4.8**	**0**	**36-54**	**40-60**	**3357-5036**	**8-12**	**13-19**	**7-11**	**2.3-3.5**
4D-1	**Central ALL PP**										
G12	Ocean City PP		1.0		10.3	23.9		2.0	1.6		0.6
G18	Absecon Island PP	0.5	2.2		32.9	12.5	4196	6.2	6.6	9.0	1.7
	TOTAL	**0.5**	**3.2**	**0.0**	**43.2**	**36.3**	**4196**	**8.2**	**8.1**	**9.0**	**2.3**
	20% Impact Range*	**0.4-0.6**	**2.6-3.8**	**0**	**35-52**	**29-44**	**3357-5036**	**7-10**	**6-10**	**7-11**	**1.8-2.8**
4G-8	**GEHI SSB+Absecon CBB+SOC CBB**										
SSB.06	Great Egg Harbor Inlet SSB (A1)	20.0								5.6	
CBB.01	Absecon Blvd. Cross-bay barrier CBB	0.7	2.4		4.5	13.4	1831	2.3	1.0	1.1	1.6
CBB.08	South Ocean City 52ND ST CBB		1.6								
	TOTAL	**20.7**	**4.0**	**0.0**	**4.5**	**13.4**	**1831**	**2.3**	**1.0**	**6.6**	**1.6**
	20% Impact Range*	**17-25**	**3-5**	**0**	**4-5**	**11-16**	**1465-2197**	**1.9-2.8**	**0.8-1.2**	**5-8**	**1.3-2.0**
5D-2	**All Perimeter**										
G1	Cape May PP	0.1				6.4	2324		0.5		7.3
G2	Wildwood PP		0.5			19.2			21.5		2.0
G5	Stone Harbor/Avalon PP		0.4		3.5	63.2	79	1.0	8.7	1.0	
G10	Sea Isle City PP		0.4			13.2			0.5		0.1
	TOTAL	**0.1**	**1.3**	**0.0**	**3.5**	**102.0**	**2404**	**1.0**	**31.2**	**1.0**	**9.4**
	20% Impact Range*	**-**	**1.1-1.6**	**0**	**2.8-4.2**	**82-122**	**1923-2885**	**0.8-1.2**	**25-37**	**0.8-1.2**	**7-11**

TSP Component **Alternative Requiring Further Evaluation** *Due to the uncertainty of impact and mitigation estimates at this level of design and evaluation at a Tier 1 level, a 20% variation of the current alignment is presented as a range of impacts.

3.0 FACTUAL DETERMINATIONS

3.1 Physical Substrate Determinations

3.1.1 Substrate Elevation and Slope

Inlet Storm Surge Barriers (TSP) – Table 1 provides crest elevations of the proposed structures and sill elevations for the bottom of the gate structures. The existing bathymetry is variable with the deepest portions of the inlet to contain the navigable sector gates while the shallowest areas are subtidal or intertidal at the flanks, which would be either auxiliary flow lift gates, box culverts or impermeable barriers. The structures in Table 1 have uniform crest elevations at the top with variable sill depths based on existing bathymetry. Manasquan Inlet navigable sector gate has a crest elevation of +20 ft. NAVD and a bottom sill elevation of -18.25 ft. NAVD (Figure 6). Barnegat Inlet would have a navigable sector gate with a crest at +17 ft. NAVD and sill at -25 ft. NAVD and auxiliary flow lift gates with a crest of +17 ft. NAVD and sills varying from -4 ft. to -11 ft. NAVD (Figure 8). Great Egg Harbor Inlet would have a navigable sector gate with a crest at +19 ft. NAVD and sill at -35 ft. NAVD and auxiliary flow lift gates with a crest of +19 ft. NAVD and sills varying from -5 ft. to -18 ft. NAVD (Figure 10). Barnegat Inlet and Great Egg Harbor Inlet barriers would also have impermeable barriers along the flanks and a typical cross section is provided in Figure 11).

Cross Bay Barriers/Bay Closures (TSP) – Table 1 provides crest elevations of the proposed structures and sill elevations for the bottom of the gate structures, which span across the navigable waterways. The existing bathymetry is deep across the subtidal channels with abrupt edges to existing intertidal elevations. Navigable sector gates would span across the navigation channel with box culverts at the shallower edges. The structures in Table 1 have uniform crest elevations at the top with variable sill depths based on existing bathymetry. The Absecon Boulevard barrier would have one navigable sector gate that would have a crest elevation of +13 ft. NAVD and a bottom sill elevation of -20 ft. NAVD (Figure 13). This barrier also includes approximately 29,000 feet of floodwall along the inner harbor areas of Clam Creek, Gardner's Basin, Snug Harbor, Delta Basin, State Marina, Clam Thorofare to Huron Avenue and Absecon Avenue consisting of Type B and C floodwalls (Figures 17 and 18), which are along existing hardened shorelines rising vertically from the bottom substrate above the intertidal zone. The Absecon Boulevard barrier also includes approximately 27,500 feet of Type A Levee (Figure 16), which will mostly abut the road embankment and extend into the adjacent saltmarsh with a 2H:1V slope. The Southern Ocean City barrier would have one navigable sector gate with a crest at +13 ft. NAVD and sill at -10 ft. NAVD. This barrier also includes approximately 4,100 feet of floodwall that would begin at the dune near the southern end of Central Avenue and extend around homes along 59th Street and along West Avenue to 56th Street and Road Closure at Bay Avenue. Floodwall would continue along the marsh sides of Safe Harbor Drive, W. 55th Street and Ensign Drive to W. 52nd St. This wall would consist of Type B and C floodwalls (Figures 17 and 18). At 52nd Street a Type A levee (Figure 16) extends westward approximately 9,500 feet along the abandoned railroad embankment with a navigable sector gate at Crook Horn Creek, miter gate at Edward Creek and sluice gate at an unnamed tidal creek at the western end of the levee. Levee then ties into the Garden State Parkway embankment. The levee would mostly abut the abandoned railroad embankment and extend into the adjacent saltmarsh with a 2H:1V slope.

Perimeter Plans (Plans that require further economic evaluation) – All of the plans that include perimeter plans would have combinations of Type B and C floodwalls (Figures 17 and 18) and Type A levees (Figure 16). Type B and C floodwalls would extend vertically from the subaqueous substrate to the prescribed crust elevation above MHW. The Type A levee would have variable dimensions based on the existing topography but would basically have a trapezoidal configuration with 2H:1V side slopes on areas that are either upper intertidal or supratidal.

Natural and Nature Based Features (NNBF) – NNBFs would raise bottom elevations in subtidal, intertidal and supratidal habitats for CSRM purposes. Although no specific designs are available at this time, NNBFs would likely be designed to mimic natural and more gradual slopes consistent with the surrounding environment.

3.1.2 Sediment Type

Existing substrates are expected to have variable sediment types ranging from clays, silts, and fine, medium and coarse sands. Sandy materials are expected to mostly occur within the high energy inlet areas and fine-grained materials would mostly occur within the depositional environments of the bays. Localized exceptions are possible. Additionally, areas along saltmarshes are likely to contain fine silts/muds and peaty materials. Urbanized areas are likely to have higher amounts of rock (riprap), rubble and anthropogenic debris in the substrate. Geotechnical borings would be conducted during the design phases to fully characterize the underlying substrate of the proposed structures and/or NNBF features.

Backfill materials would be placed in accordance with their engineering properties and purpose. Structural backfill in confined areas or levees may be blended soils free of organic materials. Unconfined material for structure bases such as sills would consist of coarse-grained sands and gravels. NNBFs may utilize beneficial use of dredged materials including sands and silts. In areas of saltmarsh restoration for NNBF, unconfined or semi-confined thin-layer placement of dredged sediments could be used.

3.1.3 Dredged/Fill Material Movement

In most instances, project actions would use a containment structure to hold materials in situ; in other instances, thin layer placement (for NNBFs) would be performed where some material movement throughout the marsh is intended. For structural CSRM features, no material is intended to move once in place. Measures to retain fill material in place would include sheetpiles, geotextile, stone riprap armoring or NNBF (vegetation), where appropriate.

3.1.4 Physical Effects on Benthos

There would be direct impacts to benthic organisms, which would be buried or removed during construction of the TSP structural features. Excavation of sediments removes and buries benthic organisms, whereas placement of dredged material and structures and imported fill materials smother or bury benthic communities. Direct and permanent losses of benthic habitats in wetlands and aquatic habitats are summarized in Tables 3 and 4, which have varied benthic communities based on substrate types, and tidal and salinity regimes. Dredging and placement activities may cause ecological damage to benthic organisms due to physical disturbance, mobilization of sediment contaminants, and increasing concentrations of suspended sediments (Montagna et al., 1998). Thin-layer placement in marshes and mudflats for some NNBF measures would have temporary effects on benthos, but recovery is expected to occur within months from either horizontal and/or vertical migrations of benthic organisms.

3.1.5 Other Effects

Construction impacts such as generation of turbidity are likely to be localized and should cease upon cessation of activities. Potential long-term indirect effects of barrier structures on circulation, salinity, and tidal amplitudes with gates open and closed scenarios are likely. These effects are discussed in greater detail in the EIS.

3.1.6 Actions Taken to Minimize Impacts

As design details are refined for all structural measures, opportunities for avoidance and minimization on aquatic habitats and wetlands will be exercised wherever practicable. For measures where avoidance and minimization are not practicable, compensatory mitigation would be necessary. A preliminary compensatory mitigation plan is being developed in consultation with resource agencies and is discussed in Appendix F.4.

3.2 Water Circulation, Fluctuation, and Salinity Determinations

3.2.1 Water

3.2.1.1 Salinity

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – Salinity changes are not expected to occur during direct discharges during construction of the inlet and bay barriers. However, once the structures are in place, some salinity changes are likely. Therefore, changes in salinity were modeled utilizing the AdH model for the open-gate conditions. Table 95 in the DIFREIS presents the open-gate baseline salinities and the salinities of the with-project TSP-SSBs and CBBs in place per location. Little variability in mean salinity was evident between the baseline condition and with-project TSP at individual stations with station JACNEWQ (Lower Mullica River) showing the largest change at +0.34 ppt.

McAlpin and Ross (2020) conclude that overall, the with-project TSP SSBs do not significantly impact the salinity in the back-bay region. The mean salinity does not vary by more than 0.34 ppt for the TSP. There is a slightly larger range in the salinity variation among the sea level rise alternatives, but this is still generally less than 2 ppt (SLR TSP showed a 1.1 ppt reduction at Barnegat Bay Rt. 37 Bridge area). The variation at specific times may be larger but overall, the impact is small. Given the well-mixed nature of the inlets, ocean salinity is pushed into the back-bay areas and allowed to move easily throughout the area. The restrictions created by the alternative structures and the reduction in tidal prism are not large enough to significantly impact the salinity at the analysis locations.

Perimeter Plans (Plans that require further economic evaluation) – No significant effects on salinity anticipated.

Natural and Nature Based Features (NNBF) – No significant effects on salinity anticipated.

3.2.1.2 Water Chemistry

Actions requiring dredging and placement would result in short-term and localized impacts and would not be expected to degrade the long-term water quality within the project area. These patterns would return to their previous condition following completion of dredging. Temporary changes to dissolved oxygen (DO), nutrients, turbidity, and contaminant levels may occur due to sediment disturbance and mixing during construction. Temporary DO decreases may also happen from aerobic decomposition from short-term increases in organic matter suspended within the water column.

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP)- The TSP barrier measures once implemented will constrict water flows through the openings (particularly in the inlets), which could be expected to have minor to moderate impacts on water and sediment quality throughout the bay systems at Manasquan River, Barnegat Bay, Little Egg Harbor, and Great Egg Harbor by reductions in flushing and mixing of the shallow bays. These effects could affect water quality such as nutrients and retention of pollutants longer in the system. To assess these effects, AdH modeling and particle tracking modeling (PTM) was completed utilizing the open-gate scenario (predominant condition) for TSP barrier measures. PTM was used to evaluate the impact of the storm surge barriers (open gates conditions) have on residence time in the NJBB study area. Overall, the PTM results, (Table 96 in DIFREIS) shows that the structures had little discernable changes to residence time with modeled differences generally within the uncertainty range from innate model randomness caused by diffusion. Model results show that the TSP in general increases in residence time in South and Central Regions by 2 to 5 days and reduces residence time in North region by 1 to 2 days. Additionally, an investigation of sea level rise (SLR) with PTM, showed that flushing increases with SLR for all structural configurations.

Based on these model outputs, it is reasonable to conclude that the small changes in residence times would not contribute to large scale increases in stagnation and/or water quality degradation associated by nutrient loading in areas most affected by SSBs. However, subtle changes are more difficult to model, thus implementation of these structures still present a high risk for determining water quality impacts especially in estuarine systems stressed by nutrient enrichment. In order to mitigate this risk, additional modeling, and refinements along with collecting long-term data sets on measured attributes would provide a better baseline to compare changes prior to any SSB implementation. Additionally, incorporating and budgeting for environmental mitigation through either subsequent refinement in design or adaptive management is an important part in assuring that this risk is minimized.

No modeling for closed-gate scenarios has been conducted to date to assess for potential effects on water chemistry. It can be assumed that closed gates would produce temporary changes in residence time and flushing would be poor, thus causing temporary water quality degradation until the gates are fully open.

Perimeter Plans (Plans that require further economic evaluation) – Perimeter plans are not expected to have significant adverse effects on water chemistry. Turbidity generated during construction would be localized and minimized by implementing BMP's to isolate in-water work segments, if required. No significant indirect or long-term effects are anticipated.

Natural and Nature Based Features (NNBF) – NNBFs are not expected to have significant adverse effects on water chemistry. Turbidity generated during construction would be localized and minimized by implementing BMP's to isolate in-water work segments, if required. If dredged or fill materials are placed in waters or wetlands, they would need to meet NJDEP water quality standards and testing protocols in the document "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters" (NJDEP, 1997). No significant indirect or long-term effects are anticipated with implementing NNBFs.

3.2.1.3 Clarity

Short-term localized effects on water clarity are expected during construction activities for any of the structural and NNBF's as turbidity is expected to increase in areas undergoing construction.

3.2.1.4 Color

Short-term localized effects on water color are expected during construction activities for any of the structural and NNBF's as turbidity is expected to increase in areas undergoing construction.

3.2.1.5 Odor

Negligible amounts of hydrogen sulfide may be expected during excavation and placement activities, which would be temporary and localized.

3.2.1.6 Taste

It is anticipated that no drinking water sources would be impacted by the TSP; no effects to taste are anticipated.

3.2.1.7 Dissolved Gases

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) - Negligible amounts of hydrogen sulfide (H_2S) may be expected from any dredging or deposition of dredged materials associated with TSP measures. H_2S and other gases like methane are associated with high amounts of decaying organic matter, which are not expected to be present in excavated and placed materials in the inlet areas but could be encountered in the saltmarsh areas where cross bay barriers will have structures such as levees and floodwalls that require excavations. These effects would be temporary.

As discussed previously with constrictions in the inlets associated with SSBs, there is a potential for indirect effects on dissolved oxygen levels due to changes in residence times of bay water and potential stagnation. However, AdH and PTM modeling do not indicate significant increases in residence times of the affected bays with gates-open scenarios.

Perimeter Plans (Plans that require further economic evaluation) – H_2S and other gases like methane are associated with high amounts of decaying organic matter, which could be encountered in lagoons and saltmarsh areas where perimeters will have structures such as levees and floodwalls that require excavations. These effects would be temporary and localized.

Natural and Nature Based Features (NNBF) – H_2S and other gases like methane are associated with high amounts of decaying organic matter, which could be encountered in lagoons and saltmarsh areas where NNBF's may be constructed with sediments dredged from anaerobic sources. These effects would be temporary.

3.2.1.8 Nutrients

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – Minor amounts of nutrients could be released through the disturbance of sediments during construction activities where fine-grained or organic sediments are present, but these effects would be short-term. Implementation of BMP's would minimize nutrient releases through minimizing turbidity.

Long-term indirect effects could result in reductions in tidal flushing by construction of barriers, which could alter nutrient balance by reducing phosphorus input into the bay and nitrogen transport out of the bay. Changes in ratios of nitrogen and phosphorus could change plankton communities in the bays. However, AdH and PTM modeling for open-gate scenarios do not indicate any significant changes in bay residence times with TSP barriers in place. Additional modeling will be completed in subsequent phases to determine the effects on residence times on closed-gate scenarios.

Perimeter Plans (Plans that require further economic evaluation) – Minor amounts of nutrients could be released through the disturbance of sediments during construction activities where fine-grained or organic sediments are present, but these effects would be short-term. Implementation of BMP's would minimize nutrient releases through minimizing turbidity.

Natural and Nature Based Features (NNBF) – Minor amounts of nutrients could be released through the disturbance of sediments during construction activities where fine-grained or organic sediments are present, but these effects would be short-term. Implementation of BMP's would minimize nutrient releases through minimizing turbidity.

3.2.1.9 Eutrophication

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – Minor amounts of nutrients could be released through the disturbance of sediments during construction activities where fine-grained or organic sediments are present, but these effects would be short-term and not expected to increase eutrophication. Implementation of BMP's would minimize nutrient releases through minimizing turbidity and any indirect causes of eutrophication.

Long-term indirect effects could result in reductions in tidal flushing by construction of barriers, which could alter nutrient balance by reducing phosphorus input into the bay and nitrogen transport out of the bay. Changes in ratios of nitrogen and phosphorus could change plankton communities in the bays, which could indirectly result in increases in eutrophication. However, AdH and PTM modeling for open-gate scenarios do not indicate any significant changes in bay residence times with TSP barriers in place. Additional modeling will be completed in subsequent phases to determine the effects on residence times on closed-gate scenarios.

Perimeter Plans (Plans that require further economic evaluation) – Minor amounts of nutrients could be released through the disturbance of sediments during construction activities where fine-grained or organic sediments are present, but these effects would be short-term and not expected to increase eutrophication. Implementation of BMP's would minimize nutrient releases through minimizing turbidity and any indirect causes of eutrophication.

Natural and Nature Based Features (NNBF) – Minor amounts of nutrients could be released through the disturbance of sediments during construction activities where fine-grained or organic sediments are present, but these effects would be short-term and not expected to increase eutrophication. Implementation of BMP's would minimize nutrient releases through minimizing turbidity and any indirect causes of eutrophication.

3.2.1.10 Others as Appropriate

No other potential impacts to water quality have been identified.

3.2.2 Current Patterns and Circulation

3.2.2.1 Current Patterns and Flow

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – AdH modeling was only conducted for the TSP CSRM measures and has shown that once the barriers and gate structures are constructed there would be net reductions of flow into and out of the affected inlets. Modeling results suggest that the average tidal prism and average tidal amplitudes at various locations did vary between with and without project over the simulation year. Results of the open-gate AdH modeling indicate localized increases in velocity surrounding the SSB structures, which would increase at all three inlets for which SSBs are present, respectively, indicating significant localized changes; however, the impact of the velocity magnitudes away from the structures would be very little. The tidal prism (volume of water exchange) would be relatively unchanged at Manasquan Inlet, and would be reduced by 2.5% and 4.8% at Barnegat Bay and Great Egg Harbor, respectively. The impacts to tidal amplitudes were found to not be evenly distributed throughout the bays with individual reduction in tidal amplitude ranging from 1.3% to 8.3% through Barnegat Bay and 0.1% to 4.5% in Great Egg Harbor for the TSP. Closed-gate scenarios have not been modeled, to date, but are expected to have significant changes in current patterns, circulation, and tides while the gates remain closed. This condition would be temporary (duration of storm event or maintenance/testing) and normal tidal exchange would be restored upon re-opening of the gates.

Perimeter Plans (Plans that require further economic evaluation) – No significant changes in current patterns or circulation are anticipated.

Natural and Nature Based Features (NNBF) – Effects of NNBFs on current patterns and circulation are unknown. Factors to consider are the location of an NNBF, its geometry, and the local current and tidal conditions. Once more information is gathered on NNBFs, modeling would be conducted to ascertain the degree of effect that an NNBF would have on currents and circulation.

3.2.2.2 Velocity

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – Results of the open-gate AdH modeling indicate localized increases in velocity surrounding the SSB structures, which would increase at all three inlets for which SSBs are present, respectively, indicating significant localized changes; however, the impact of the velocity magnitudes away from the structures would be very little. Closed-gate scenarios have not been modeled, to date, but are expected to have significant changes in current patterns, circulation, and tides while the gates remain closed with little or no velocity entering or exiting the inlets. This condition would be temporary (duration of storm event or maintenance/testing) and normal tidal exchange would be restored upon re-opening of the gates.

Perimeter Plans (Plans that require further economic evaluation) – No significant changes in current patterns, velocity or circulation are anticipated.

Natural and Nature Based Features (NNBF) – Effects of NNBFs on current patterns, velocity and circulation are unknown. Factors to consider are the location of an NNBF, its geometry, and the local current and tidal conditions. Once more information is gathered on NNBFs, modeling would be conducted to ascertain the degree of effect that an NNBF would have on currents and circulation.

3.2.2.3 Stratification

All of the measures under consideration are not expected to have significant effects on stratification as the affected bays are shallow lagoonal systems that are well-mixed by wind-driven and tidal currents and do not exhibit under normal circumstances significant thermal or saline stratification. Exceptions may occur seasonally in deeper waters such as the intracoastal waterway and dredge holes where stratification may develop.

3.2.2.4 Hydrologic Regime

The affected regimes for all CSRM measures are mainly marine, estuarine and freshwater subtidal, intertidal, and supratidal. Although the proposed barriers would have some effects on tidal amplitudes and salinities, the overall hydrologic regimes would remain the same with open-gate scenarios. Closed-gate scenarios would likely affect tidal influence and exchange with marine waters during closure events temporarily affecting the hydrologic regime.

3.2.3 Normal Water Level Fluctuations

The NJBB study area experiences semidiurnal tides and tidal ranges are variable throughout the NJBB study area. Mean tidal ranges in the coastal bays are generally least in the Northern Barnegat Bay at approximately 0.3 to 0.5 feet and gradually increase further south with tide ranges in Cape May Harbor at approximately 4.0 to 4.5 feet. NJ Atlantic Coast marine tides are more consistent that range from 3.5 to 4.0 feet to 4.0 to 4.5 feet.

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – Effects of TSP structures on tides affecting water level fluctuations were evaluated in the AdH modeling, which was only conducted for the TSP CSRM measures. This modeling has shown that once the barriers and gate structures are constructed, there would be net reductions of flow into and out of the affected inlets. Modeling results suggest that the average tidal prism and average tidal amplitudes at various locations did vary between with and without project over the simulation year. Results of the open-gate AdH modeling indicate localized increases in velocity surrounding the SSB structures, which would increase at all three inlets for which SSBs are present, respectively, indicating significant localized changes; however, the impact of the velocity magnitudes away from the structures would be very little. The tidal prism (volume of water exchange) would be relatively unchanged at Manasquan Inlet, and would be reduced by 2.5% and 4.8% at Barnegat Bay and Great Egg Harbor, respectively. The impacts to tidal amplitudes were found to not be evenly distributed throughout the bays with individual reduction in tidal amplitude ranging from 1.3% to 8.3% through Barnegat Bay and 0.1% to 4.5% in Great Egg Harbor for the TSP. Closed-gate scenarios have not been modeled, to date, but are expected to have significant changes in current patterns, circulation, and tides while the gates remain closed. This condition would be temporary (duration of storm event or maintenance/testing) and normal tidal exchange would be restored upon re-opening of the gates.

Perimeter Plans (Plans that require further economic evaluation) – No significant changes in current patterns or circulation are anticipated.

Natural and Nature Based Features (NNBF) – Effects of NNBFs on current patterns and circulation are unknown. Factors to consider are the location of an NNBF, its geometry, and the local current and tidal conditions. It can be assumed that NNBFs would convert some areas from subtidal to intertidal regimes. However, overall regular tidal fluctuations would remain. Once more information is gathered on NNBFs, modeling would be conducted to ascertain the degree of effect that an NNBF would have on water level fluctuations.

3.2.4 Salinity Gradients

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) - Salinity changes are not expected to occur during direct discharges during construction of the inlet and bay barriers. However, once the structures are in place, some salinity changes are likely. Therefore, changes in salinity were modeled utilizing the AdH model for the open-gate conditions. Table 95 in the DIFREIS presents the open-gate baseline salinities and the salinities of the with-project TSP-SSBs and CBBs in place per location. Little variability in mean salinity was evident between the baseline condition and with-project TSP at individual stations with station JACNEWQ (Lower Mullica River) showing the largest change at +0.34 ppt.

McAlpin and Ross (2020) conclude that overall, the with-project TSP SSBs do not significantly impact the salinity in the back-bay region. The mean salinity does not vary by more than 0.34 ppt for the TSP. There is a slightly larger range in the salinity variation among the sea level rise alternatives, but this is still generally less than 2 ppt (SLR TSP showed a 1.1 ppt reduction at Barnegat Bay Rt. 37 Bridge area). The variation at specific times may be larger but overall, the impact is small. Given the well-mixed nature of the inlets, ocean salinity is pushed into the back-bay areas and allowed to move easily throughout the area. The restrictions created by the alternative structures and the reduction in tidal prism are not large enough to significantly impact the salinity at the analysis locations.

No modeling has been completed to date on closed-gate scenarios. It can be assumed closed gates, by eliminating influxes of seawater into the estuary, would cause decreases in salinity within the affected estuaries. This effect may be magnified if precipitation is high creating greater influxes of freshwater from direct rain and tributary discharges into the bays. This effect would be most acute during an event while the gates are closed and would subside after regular tidal influxes of seawater are established.

Perimeter Plans (Plans that require further economic evaluation) – No significant effects on salinity anticipated.

Natural and Nature Based Features (NNBF) – No significant effects on salinity anticipated.

3.2.5 Actions that Will Be Taken to Minimize Impacts

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – The TSP design configurations are preliminary. Refinements in design would consider measures that could increase the with-project tidal prism such as modifying the openings of the constrictions imposed by the gate piers and impermeable barriers. Thus, additional open cross sections of the barriers would promote greater ingress and egress of tidal flows and minimize any effects on tidal amplitudes, salinity, and residence time. Adverse effects that cannot be avoided or minimized would be addressed through compensatory mitigation to be developed further in subsequent phases.

Perimeter Plans (Plans that require further economic evaluation) – With the exception of implementing BMPs during construction to minimize turbidity, no other specific actions to minimize effects are proposed at this time.

Natural and Nature Based Features (NNBF) – With the exception of implementing BMPs during construction to minimize turbidity, no other specific actions to minimize effects are proposed at this time.

3.3 Suspended Particulate/Turbidity Determination

3.3.1 Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site

For all CSRM structural and NNBF measures, there would be expected temporary increases in local turbidity during in-water construction activities where dredging/excavation and fill material discharges occur. Turbidity is expected to be acute during these activities but would subside upon cessation of turbidity generating activities. BMP's such as temporary de-watering, silt-curtains (if practicable) and any other measures that reduce turbidity will be considered as part of construction.

3.3.2 Effects on Chemical and Physical Properties of the Water Column

For all CSRM structural and NNBF measures, there would be expected temporary increases in local turbidity during in-water construction activities where dredging/excavation and fill material discharges occur. Turbidity is expected to be acute during these activities but would subside upon cessation of turbidity generating activities. BMP's such as temporary de-watering, silt-curtains (if practicable) and any other measures that reduce turbidity will be considered as part of construction.

For the storm surge barriers and cross-bay barriers, modeled effects on salinity show some minor changes in mean salinities with the gates open. Closed gates during storm events may result in significant but temporary acute reductions in salinities where precipitation combined with runoff from tributaries would dilute any remaining salinity for the duration of the closure event. Similarly, any non-point source pollutants entering from the tributaries and stormwater may be temporarily elevated during a closure event. These effects will be modeled in subsequent phases to determine the severity and duration of this effect with various closure and precipitation scenarios.

3.3.2.1 Light Penetration

For all CSRM measures including NNBF, temporary and localized turbidity during construction (excavation/dredging and fill placement) actions would have temporary and localized impacts to light penetration. Normal levels of light penetration are expected upon cessation of construction activities that would produce turbidity.

3.3.2.2 Dissolved Oxygen

For all CSRM measures including NNBF, temporary and localized increases in turbidity particularly in areas with higher organic matter in sediments that may place an oxygen demand through aerobic decomposition may result in temporary decreases in DO during construction (excavation/dredging and fill placement) actions. Normal levels of DO are expected upon cessation of construction activities that would produce turbidity/organic matter discharges.

Fill placement for CSRM structures is not expected to result in any long-term decreases in DO. Indirect effects of the surge barriers where marine tidal flushing could be reduced could affect DO levels through promoting eutrophication. However, AdH and PTM modeling with open-gate scenarios indicate that residence time is not significantly increased in the affected estuaries. The effects of gate closures would likely increase residence times dependent on the duration of the closure event. Gate closures will be modeled in subsequent study phases to determine if this effect is significant.

3.3.2.3 Toxic Metals and Organics

For all CSRM measures including NNBF, discharges of toxic metals and organics are not expected to be released during construction. Fill materials whether they be construction materials such as concrete, steel, wood, or fabricated materials would be non-polluting and/or imported fill such as sand/gravel, soil, and stone would originate from approved commercial sources. If dredged or fill materials are placed in waters or wetlands, they would need to meet NJDEP water quality standards and testing protocols in the document “The Management and Regulation of Dredging Activities and Dredged Material in New Jersey’s Tidal Waters” (NJDEP, 1997).

3.3.2.4 Pathogens

For all CSRM measures including NNBF, sediments or fill materials are not expected to contain or influence pathogens.

3.3.2.5 Aesthetics

For all CSRM measures including NNBF, discharges that generate turbidity could temporarily degrade aesthetics of odor .

3.3.2.6 Others as Appropriate

For all CSRM measures including NNBF, no other potential impacts to water quality have been identified.

3.3.3 Effects on Biota

3.3.3.1 Primary Production, photosynthesis

For all CSRM measures including NNBF, minor, short term localized effects related to increased turbidity during construction are expected. The effects of turbidity on light penetration would reduce photosynthesis of phytoplankton thus, reducing primary production.

3.3.3.2 Suspension/Filter Feeders

For all CSRM measures including NNBF, minor, short term localized effects related to increased turbidity during construction.

3.3.3.3 Sight Feeders

For all CSRM measures including NNBF, minor and short-term localized effects are expected that are related to increased turbidity during construction.

3.3.4 Actions Taken to Minimize Impacts

For all CSRM measures including NNBF, implementation of BMPs during construction would minimize the effects of turbidity on aquatic biota.

3.4 Contaminant Determinations

For all CSRM measures including NNBF, no sediment testing has been performed within the affected areas. Discharges of toxic metals and organics are not expected to be released during construction. Fill materials whether they be construction materials such as concrete, steel, wood, or fabricated materials would be non-polluting and/or imported fill such as sand/gravel, soil, and stone would originate from approved commercial sources. If dredged or fill materials are placed in waters or wetlands, they would need to meet NJDEP water quality standards and testing protocols in the document "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters" (NJDEP, 1997).

3.5 Aquatic Ecosystem and Organism Determinations

3.5.1 Effects on Plankton

For all CSRM measures including NNBF, minor, short term localized effects related to increased turbidity during construction are expected. The effects of turbidity on light penetration would reduce photosynthesis of phytoplankton thus, reducing primary production. Indirect impacts could be the resuspension of sediments containing nutrients and a decrease of transitional upland areas (by increasing hardened shoreline) that act as filters for non-point source run-off. An indirect effect of increased run-off and nutrients would contribute to eutrophication and phytoplankton blooms.

Indirect effects attributed to the SSBs and CBBs on plankton abundance and distribution in the affected bays by altering water quality, velocities, salinity levels and nutrient levels. Recent AdH hydrodynamic modeling does not indicate significant water quality issues with SSBs and CBBs with an open-gate condition. However, during the operation of the gates when they are closed during storm events, these changes may be more profound, albeit temporary, but could affect the survival rate of plankton. A salinity reduction due to gate closures (>5 days) could result in a 100% post-hatch zooplankton larvae mortality rate.

3.5.2 Effects on Benthos

For all CSRM measures including NNBF, the direct impacts of structural measures such as perimeters (floodwalls, levees, miter gates), storm surge barriers (SSBs), and cross-bay barriers (CBBs) will result in direct mortalities of benthic fauna and permanent loss of their habitat located within the footprint of the construction. Footprints of fill impacts for CSRM structural measures on wetland and aquatic habitats are summarized in Tables 3 and 4. Dredging would temporarily remove the benthic community and filling would either temporarily or permanently smother the benthic community. In locations of construction fills associated with the CSRM structures, permanent losses of the benthic community would occur. In areas where fills retain the hydrologic regime, benthic community losses would be temporary. However, depending on the post-fill substrate composition and tidal regime (e.g. subtidal to intertidal), shifts in benthic community composition are likely.

3.5.3 Effects on Nekton

For all CSRM measures including NNBF, the direct effects on nekton during construction utilization of dredging and fill placement would temporarily displace nektonic species, which many would be capable of moving outside of the impact areas until construction activities cease. However, some smaller or less mobile species may become entrained or smothered during these activities. Permanent impacts of structural measures on nektonic habitats would be physical displacement of various structures and fills, which are summarized in Tables 3 and 4.

Other effects of SSBs and CBBs on nekton are increases in velocities around the opened gates and blockages of migratory pathways during closure events.

3.5.4 Effects on Aquatic Food Web

For all CSRM measures including NNBF, dredging/excavation and fill placement within construction areas would have localized temporary effects on the aquatic food web by displacing habitat of benthos, primary producers – phytoplankton and smaller consumers such as zooplankton and smaller nekton including various finfish, cnidarians and mollusks. Indirect effects of SSBs and CBBs with gates open and closed are not well understood at this time warranting further investigations into their indirect effects on the aquatic food web.

3.5.5 Effects on Special Aquatic Sites

3.5.5.1 Sanctuaries and Refuges

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – The Barnegat Inlet SSB A-1 alignment has box culverts and a seawall that tie into the north side of the inlet at an existing inlet stone revetment at the southeast corner of the Sedge Island Marine Conservation Zone. The beach, dunes, and wetlands at this area are also designated as a state natural area as part of Island Beach State Park. The SSB tie-in would mainly affect the existing hardened revetment structure, except for the seawall that would extend approximately 100 feet into the existing dune. Other encroachments include perimeters that pass-through Absecon Wildlife Management Area (Absecon Blvd. CBB) and Corson's Inlet State Park and Cape May Coastal Wetlands W.M.A. (S. Ocean City CBB). AdH modeling conducted for the TSP SSB and CBB measures indicate minor effects on tidal amplitudes on intertidal habitats. Therefore, portions of Edwin B. Forsythe National Wildlife Refuge, Cape May National Wildlife Refuge and several state wildlife management areas with intertidal habitats may experience these indirect effects. The Great Egg Harbor Inlet SSB would produce similar indirect effects on wetlands in the Great Egg Harbor Wild and Scenic River area. These effects are discussed in greater detail in Section 8.2.4.19 in the DIFREIS.

Perimeter Plans (Plans that require further economic evaluation) – Perimeter floodwalls and levees in the plans 4D(1) and 4D(2) in the Central Region would encroach on the North Brigantine Natural Area and Corson's Inlet State Park. Alternative 5D(1) in the south would encroach on Cape May Wetlands W.M.A.

Natural and Nature Based Features (NNBF) – Because NNBFs could be potentially situated throughout the NJBB study area, numerous public lands that could be considered "sanctuaries and refuges" could be affected. It is assumed that an NNBF would be consistent with the purposes of a sanctuary or refuge and would be implemented in close consultation with the agency that manages these areas.

3.5.5.2 Wetlands

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – the direct effects of inlet storm surge barriers and cross-bay barriers are summarized in Tables 3 and 4. Inlet storm surge barriers have the least direct effects on saltmarshes while the cross-bay barriers have significantly more impacts to saltmarshes. AdH modeling conducted for the TSP SSB and CBB measures indicate minor effects on tidal amplitudes on intertidal habitats. Therefore, intertidal wetlands may experience slight reductions in tidal elevations, which may affect upper fringes of high marshes. These effects are discussed in greater detail in Section 8.2.4.19 in the DIFREIS.

Perimeter Plans (Plans that require further economic evaluation) – fill material placement associated with the perimeter floodwalls and levees would result in significant losses in wetland habitats. These effects are summarized in Tables 3 and 4.

Natural and Nature Based Features (NNBF) – The installation of NNBFs could result in conversions of habitat. For instance, a subtidal soft-bottomed subtidal habitat may be changed to an intertidal saltmarsh, mudflat, beach, or reef. Wetlands meet the criteria as an NNBF and wetland creation or expansion would be considered based on their CSRM benefits.

3.5.5.3 Mudflats

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – the direct effects of inlet storm surge barriers and cross-bay barriers are summarized in Table 4. Approximately 3 acres of intertidal mudflat habitat would be directly affected by the Absecon Blvd. cross-bay barrier. AdH modeling conducted for the TSP SSB and CBB measures indicate minor effects on tidal amplitudes on intertidal habitats. Therefore, intertidal mudflats may experience slight reductions in tidal ranges, which may affect upper and lower edges of intertidal mudflats. These effects are discussed in greater detail in Section 8.2.4.19 in the DIFREIS.

Perimeter Plans (Plans that require further economic evaluation) – fill material placement associated with the perimeter floodwalls and levees would result in significant losses in intertidal mudflat habitats. These effects are summarized in Table 4. In the Central Region, Alternative 4D(1) and 4D(2) could directly impact 31 acres and 20 acres, respectively. In the Southern Region, Alternative 5D(2) could directly impact over 38 acres.

Natural and Nature Based Features (NNBF) – The installation of NNBFs could result in conversions of intertidal habitat. For instance, a subtidal soft-bottomed subtidal habitat may be changed to an intertidal saltmarsh, mudflat, beach, or reef. However, the installation of NNBFs could have beneficial impacts, by providing overall ecological uplifts of wetland and aquatic habitats in the NJBB study area. Mudflats could be an NNBF measure or feature that could be integrated into a NNBF design to increase this habitat.

3.5.5.4 Vegetated Shallows

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – the direct effects of inlet storm surge barriers and cross-bay barriers are summarized in Table 4. Approximately 3 acres of historic (NWI mapping) submerged aquatic vegetation (SAV) habitat would be directly affected by the Barnegat Inlet SSB A-1 alignment. Other structural features indicate historic (1979) SAV beds near the Absecon Blvd. CBB and Southern Ocean City CBB. No SAV or vegetated shallow surveys have been completed for this study and would be required for subsequent phases to determine presence/absence within project footprints. These effects are discussed in greater detail in Section 8.2.4.18 in the DIFREIS.

Perimeter Plans (Plans that require further economic evaluation) – Direct impacts of fill placement on SAV beds were not identified for alternatives 4D(1) and 4D(2) in the Central Region and 5D(2) in the Southern Region. However, no SAV or vegetated shallow surveys have been completed for this study and would be required for subsequent phases to determine presence/absence within project footprints.

Natural and Nature Based Features (NNBF) – The installation of NNBFs could result in conversions of intertidal habitat. For instance, a subtidal soft-bottomed subtidal habitat may be changed to an intertidal saltmarsh, mudflat, beach, or reef. NNBFs would likely avoid areas mapped or surveyed to contain SAVs. SAVs are also considered an NNBF, and their utilization would be considered in designs in appropriate locations.

3.5.5.5 Coral Reefs

There are no coral reefs within the affected area for any of the CSRM structural measures and NNBFs considered.

3.5.5.6 Riffle and Pool Complexes

There are no riffle and pool complexes within the affected area for any of the CSRM structural measures and NNBFs considered.

3.5.6 Threatened and Endangered Species

Because of the large affected areas in the TSP, a number of Federal and State listed threatened and endangered species or other special status species inhabit a number of habitat types within these areas as either breeding populations and/or migratory populations. Section 8.2.4.25 of the DIFREIS and Appendix F.3 provide greater detail of the special status species, their habitats and potential impacts. Table 6 provides a summary of the effects on special status species from the TSP structural measures and perimeter plans that remain under consideration.

Table 6. Special Status Species Affected by TSP and Other Measures

Species	Status	Habitat in NJBB	Perimeter Impacts (see note #1)	SSB Impacts (TSP Features)	CBB Impacts (TSP Features)
American Bittern (*Botaurus lentiginosos*) BR	SE	Freshwater and brackish marshes for breeding season. Salt marshes rest of year.	Direct habitat impacts are likely on non-breeding saltmarsh losses. Indirect impacts through disruptions in food chain.	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	Direct habitat impacts are likely on non-breeding saltmarsh losses. Indirect impacts through disruptions in food chain.
Bald Eagle (*Haliaeetus leucocephalus*) BR/NB	SE/ ST	Forest edges, open water	Indirect impacts through disruptions in food chain.	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	Indirect impacts through disruptions in food chain.
Northern Harrier (*Circus cyaneus*) BR	SE	Tidal marshes	Direct habitat impacts/losses are likely on breeding in higher saltmarshes. Indirect impacts through disruptions in food chain.	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	Direct habitat impacts/losses are likely on breeding in higher saltmarshes. Indirect impacts through disruptions in food chain.
Red knot* (*Calidris canutus rufa*) NB	**FT***, SE	Sandy beaches, spits, marsh islands, tidal flats	Direct habitat impacts are likely on non-breeding saltmarsh and tidal flats losses. Indirect impacts through disruptions in food chain.	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	Direct habitat impacts are likely on non-breeding saltmarsh and tidal flats losses. Indirect impacts through disruptions in food chain.
Short-Eared Owl (*Asio flammeus*) BR	SE	Coastal marshes	Direct habitat impacts/losses are likely on breeding in higher saltmarshes. Indirect impacts through disruptions in food chain.	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	Direct habitat impacts/losses are likely on breeding in higher saltmarshes. Indirect impacts through disruptions in food chain.
Black-Crowned Night-Heron (*Nycticorax nycticorax*) BR	ST	Maritime forests, scrub-shrub, mixed *Phragmites* marshes	Direct habitat impacts/losses are likely on breeding in higher saltmarshes/transitional wetlands. Indirect impacts through disruptions in food chain.	Approximately 0.4 acres of maritime forest would be affected by a floodwall associated with the Barnegat Inlet SSB at Barnegat Inlet State Park. The Tier 2 EIS during Engineering and Design Phase will consider any alternative alignments to avoid/minimize this impact.	Direct habitat impacts/losses are likely on breeding in higher saltmarshes/transitional wetlands. Indirect impacts through disruptions in food chain.
Yellow-Crowned Night-Heron (Nyctanassa violacea)	ST	Maritime forests, scrub-shrub on barrier and bay islands	Direct habitat impacts/losses are likely on breeding in higher saltmarshes/transitional wetlands. Indirect impacts through disruptions in food chain.	Approximately 0.4 acres of maritime forest would be affected by a floodwall associated with the Barnegat Inlet SSB at Barnegat Inlet State Park. The Tier 2 EIS during Engineering and Design Phase will consider any alternative alignments to avoid/minimize this impact.	Direct habitat impacts/losses are likely on breeding in higher saltmarshes/transitional wetlands. Indirect impacts through disruptions in food chain.
Osprey (*Pandion haliaetus*) BR	ST	Coastal rivers, marshes, bays & inlets. Nest on dead trees, platforms, poles	Potential disturbance to nests/nesting platforms throughout bay areas. Indirect impacts through disruptions in food chain.	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	Potential disturbance to nests/nesting platforms throughout bay areas. Indirect impacts through disruptions in food chain.
Piping plover* (*Charadrius melodus*)	**FT*** SE	Ocean beaches, inlets, washover areas, tidal flats	Potential disturbance to nests/foraging areas on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.	Potential disturbance to nests/foraging areas on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.	Potential disturbance to nests/foraging areas on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.
Black Rail* (*Laterallus jamaicensis*) BR/NB	FT/SE/ST	High marshes	Direct habitat impacts/losses are likely on breeding in higher saltmarshes. Indirect impacts through disruptions in food chain.	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	Direct habitat impacts/losses are likely on breeding in higher saltmarshes. Indirect impacts through disruptions in food chain.
Black Skimmer (*Rynchops niger*)	SE	Sandy beaches, inlets, sandbars, offshore islands	Potential disturbance to nests on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.	Potential disturbance to nests on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.	Potential disturbance to nests on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.
Least Tern (*Sternula antillarum*)	SE	Sandy beaches, bay islands	Potential disturbance to nests on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.	Potential disturbance to nests on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.	Potential disturbance to nests on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.

Species	Status	Habitat in NJBB	Perimeter Impacts (see note #1)	SSB Impacts (TSP Features)	CBB Impacts (TSP Features)
Roseate Tern (*Sterna dougallii*)	**FE**/SE	Beaches w/ vegetated dunes	No breeding population currently in NJ. Potential disturbance to foraging areas. Indirect impacts through disruptions in food chain.	No breeding population currently in NJ. Potential disturbance to foraging areas. Indirect impacts through disruptions in food chain.	No breeding population currently in NJ. Potential disturbance to foraging areas. Indirect impacts through disruptions in food chain.
Sedge Wren (*Cistothorus platensis*)	SE	High marshes	Direct habitat impacts/losses are likely on breeding in higher saltmarshes/transitional wetlands. Indirect impacts through disruptions in food chain.	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	Direct habitat impacts/losses are likely on breeding in higher saltmarshes/transitional wetlands. Indirect impacts through disruptions in food chain.
American oystercatcher (*Haematopus palliates*)	SOC	Breed in coastal beaches, inlet spits, and back bay marshes.	Potential disturbance to nests/foraging areas on beaches, inlet dune tie-ins, and saltmarsh losses. Indirect impacts through disruptions in food chain.	Potential disturbance to nests/foraging areas on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.	Potential disturbance to nests/foraging areas on beaches, inlet dune tie-ins, and saltmarsh losses. Indirect impacts through disruptions in food chain.
Common Tern (*Sterna hirundo*)	SOC	Nest on islands, barrier beaches, coastal promontories, dredged material islands, and some other artificial structures.	Potential disturbance to nests/foraging areas on beaches, inlet dune tie-ins, and saltmarsh losses. Indirect impacts through disruptions in food chain.	Potential disturbance to nests/foraging areas on beaches and inlet dune tie-ins. Indirect impacts through disruptions in food chain.	Potential disturbance to nests/foraging areas on beaches, inlet dune tie-ins, and saltmarsh losses. Indirect impacts through disruptions in food chain.
Atlantic Loggerhead* (*Caretta caretta*)	**FT***/SE	Marine/Estuarine Pelagic/demersal	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	May enter through inlets to forage in NJBB. Potential impingement on SSB gates when closed. Indirect impacts through disruptions in food chain.	May enter through inlets to forage in NJBB. Potential impingement on CBB gates when closed. Indirect impacts through disruptions in food chain.
Kemp's Ridley* (*Lepidochelys kempii*)	**FE***/SE	Marine/Estuarine Pelagic/demersal	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	May enter through inlets to forage in NJBB. Potential impingement on SSB gates when closed. Indirect impacts through disruptions in food chain.	May enter through inlets to forage in NJBB. Potential impingement on CBB gates when closed. Indirect impacts through disruptions in food chain.
Atlantic Green Sea Turtle* (*Chelonia mydas*)	**FT***/ST	Marine/Estuarine Pelagic/demersal	No direct impacts anticipated. Indirect impacts through disruptions in food chain.	May enter through inlets to forage in NJBB. Potential impingement on SSB gates when closed. Indirect impacts through disruptions in food chain.	May enter through inlets to forage in NJBB. Potential impingement on CBB gates when closed. Indirect impacts through disruptions in food chain.
North Atlantic Right Whale (*Eubalaena glacialis*)	**FE**/SE	Marine pelagic	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.
Blue Whale (*Balaenoptera musculus*)	**FE**/SE	Marine pelagic	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.
Fin Whale (*Balaenoptera physalus*)	**FE**/SE	Marine pelagic	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.
Humpback Whale (*Megaptera novaeangliae*)	**FE**/SE	Marine pelagic	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.
Sei Whale (*Balaenoptera borealis*)	**FE**/SE	Marine pelagic	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.
Sperm Whale (*Physeter microcephalus*)	**FE**/SE	Marine pelagic	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.	No direct or indirect impacts anticipated.

Species	Status	Habitat in NJBB	Perimeter Impacts (see note #1)	SSB Impacts (TSP Features)	CBB Impacts (TSP Features)
Northern Long-Eared Bat (*Myotis septentrionalis*)	FT	Summertime roosts beneath the bark of live and dead trees.	A perimeter plan for Cape May was screened out that would have impacts on forested wetland	Approximately 0.4 acres of maritime forest would be affected by a floodwall associated with the Barnegat Inlet SSB at Barnegat Inlet State Park. The Tier 2 EIS during Engineering and Design Phase will consider any alternative alignments to avoid/minimize this impact.	A deciduous forested wetland is mapped at the western end of the Absecon Boulevard CBB. Approximately 1.3 acres would be impacted by the levee structure that ties into higher ground. Additional investigation would be required to determine if suitable swamp pink habitat exists and to consider alternative alignments that avoid this wetland altogether.
Atlantic Sturgeon* (*Acipenser oxyrinchus oxyrinchus*)	FE*/SE	Marine/estuarine Demersal/pelagic	Construction/noise vibrations could impact migrations/feeding habits of adults and subadults. Indirect impacts through disruptions in food chain.	Construction/noise vibrations could impact migrations/feeding habits of adults and subadults. Hydrodynamic/velocity changes could affect migrations through inlets. Indirect impacts through disruptions in food chain.	Construction/noise vibrations could impact migrations/feeding habits of adults and subadults. Hydrodynamic/velocity changes could affect migrations through CBB gates. Indirect impacts through disruptions in food chain.
Northeastern Beach Tiger Beetle (*Cincindela d. dorsalis*)	SE	Atlantic coast sandy beaches	Potential disturbance to habitat on beaches and inlet dune tie-ins.	Potential disturbance to habitat on beaches and inlet dune tie-ins.	Potential disturbance to habitat on beaches and inlet dune tie-ins.
Bronze Copper (butterfly) (*Lycaena hyllus*)	SE	Brackish marshes	Potential disturbance to habitat: brackish marshes.	No direct or indirect impacts anticipated.	Potential disturbance to habitat: brackish marshes.
Seabeach amaranth* (*Amaranthus pumilus*)	FT*/SE	Upper sandy beaches, accreting ends of inlets	Potential disturbance to habitat on beaches and inlet dune tie-ins.	Potential disturbance to habitat on beaches and inlet dune tie-ins.	Potential disturbance to habitat on beaches and inlet dune tie-ins.
Swamp Pink (*Helonias bullata*)	FT/SE	Forested wetlands, primarily in Atlantic white cedar forests	A perimeter plan for Cape May extends into a forested wetland area. If this plan goes forward, then T&E surveys will be done to establish if swamp pink habitat is present and/or for the presence of swamp pink.	No direct or indirect impacts anticipated.	A deciduous forested wetland is mapped at the western end of the Absecon Boulevard CBB. Approximately 1.3 acres would be impacted by the levee structure that ties into higher ground. Additional investigation would be required to determine if suitable swamp pink habitat exists and to consider alternative alignments that avoid this wetland altogether.

FT= Federally Threatened

FE= Federally Endangered

ST=State Threatened

SE= State Endangered

SOC=Species of Concern

BR= Breeding Population Only

NB= Non-Breeding Population Only

Note: 1. Perimeter Plans were screened out but may be considered for High Frequency Flooding for smaller, localized CSRM measures after additional evaluation.

2. There are over 800 species of Special Status Plants in NJ. Due to the large study area, site specific species data searches will be conducted for the TSP

*Informal or formal Section 7 Endangered Species Act consultation anticipated

3.5.7 Other Wildlife

For all CSRM structural alternatives, disturbance during construction including habitat losses and noise will temporarily displace most of the wildlife as described in the Affected Environment section of the DIFREIS. Most of the wildlife are expected to return to the vicinity of the work areas once construction activities cease and the areas are stabilized. However, permanent displacement of aquatic and terrestrial wildlife through permanent loss of habitat will result in significant adverse impacts on wildlife. Wildlife species such as shorebirds and wading birds that feed in intertidal mudflats, sandy beaches and saltmarshes would lose this habitat. Additionally, affected areas would require an evaluation of their potential for impacting nesting migratory birds, and the implementation of appropriate measures to be in compliance with the Migratory Bird Treaty Act. Vertical barriers such as floodwalls may cut-off access between aquatic and terrestrial habitats, which could affect diamondback terrapins migrating from the bays and saltmarshes to nest in sand dunes (Although, this effect may be minimal since the majority of floodwall areas are located at existing bulkheads/hardened shorelines, and the terrestrial land behind them is urbanized.). In some locations, a floodwall may act as a barrier that prevents diamondback terrapins from crossing roads thereby, preventing mortalities resulting from vehicle strikes.

For NNBFs, Implementation during construction is expected to have short-term adverse impacts on wildlife species, particularly for migratory shorebirds, water birds and waterfowl. However, NNBFs have the potential for having substantial beneficial impacts on these wildlife species by providing suitable foraging, resting, and breeding habitats such as saltmarshes, SAV beds, and living shorelines. This benefit would depend on the scale of implementation and the quality of habitat to meet the life requisites of target species.

3.5.8 Actions Taken to Minimize Impacts

For all CSRM structural measures, mitigation is being employed that will first seek to avoid impacts, second, minimize impacts, and third, compensate for unavoidable impacts. Appendix F.4 details the mitigation plan to date, which includes estimates for compensatory mitigation for direct impacts on affected aquatic ecosystems. As more information is generated concurrently and in subsequent phases, the ecosystem impacts and compensatory mitigation will be informed by additional modeling such as the implementation of the New York Bight Ecological Model (NYBEM), which is currently in development. Designs of the various structures would also become further refined and opportunities to avoid and minimize direct and indirect adverse effects will be identified and implemented, if practicable.

3.6 Proposed Disposal Site Determinations

3.6.1 Mixing Zone Determination

For any of the CSRM structural alternatives and NNBFs, it is assumed that there would be no discharge quality concerns and that no mixing zones would be required.

3.6.2 Determination of Compliance with Applicable Water Quality Standards

Prior to undertaking any actions for the CSRM structural alternatives or NNBFs, a Clean Water Act Section 401 Water Quality Certification and a Coastal Zone Management Act Federal Consistency Determination would be obtained from NJDEP.

3.6.3 Potential Effects on Human Use Characteristics

3.6.3.1 Municipal and Private Water Supply

For all CSRM structural measures and NNBFs there would be no effect on municipal and private water supplies.

3.6.3.2 Recreational and Commercial Fisheries

For all CSRM structural alternatives or NNBFs, construction impacts would have temporary adverse impacts on finfish and shellfish through the generation of turbidity and noise/vibrations due to pile-driving and other construction activities. Most mobile fish species are capable of moving out of the area until these activities cease. However, smaller, and less mobile fish and prey species are more likely to be impacted. All subtidal and intertidal habitats summarized in Tables 3 and 4 are essential fish habitat (EFH) regulated under the Magnuson-Stevens Act would be permanently and directly impacted by habitat displacement. See Appendix F.2. Unavoidable losses of these habitats would require compensatory mitigation as discussed in Appendix F.4.

Indirect effects of inlet and cross-bay barriers on fisheries are potentially significant based on constrictions through the gates which affect velocity, tidal prism, tidal amplitude, salinity, and residence times. To date, AdH modeling was conducted throughout the affected area and TSP alternatives to compare without project (baseline), with project, future without project and future with project conditions. These effects are discussed in greater detail in Sections 8.2.24 in the DIFREIS. It is assumed that additional modeling would be conducted in subsequent phases to evaluate closed-gate conditions and any other refinements to the existing outputs to help inform any potential effects on the affected fisheries.

3.6.3.3 Water-related Recreation

<u>Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP)</u> - Storm surge barriers in the inlet and cross-bay barriers would maintain navigable access under normal conditions through opened sector gates or miter gates (in smaller waterways). However, navigation in these locations would be restricted to only locations where there are navigable sector gates. Miter gates are also a component of the perimeter plans but exist in the CBB plans too. The gates of these structures during extreme flood events would be closed, thereby, cutting off all recreational access during this closure. However, this effect would not have significant impacts on recreation because recreational activities are not likely during a storm event. Additionally, gate openings (when open) may permanently constrict flows causing higher velocity changes around these structures and could have significant adverse effects on recreational boaters. Therefore, further evaluation of potential effects

on velocity changes would be required to determine if there are any indirect effects such as changes to navigation channel velocities and effects on recreational water uses.

Perimeter Plans (Plans that require further economic evaluation) – For the perimeter protection plans, the implementation of floodwalls and levees could have potential significant adverse effects on recreation by limiting easy access to the bays and other waterways for water- oriented activities as described in the Affected Environment Section. In many locales within the focused array of alternatives, the floodwalls would form a barrier that would be approximately 5 to 10 feet higher than the ground surface elevation, which would make it difficult for persons to access docks, boats, or the bay shoreline. This potential effect would require further evaluation to determine the extent of this impact, and to identify acceptable means to avoid or minimize this impact. In some locales, levees are also a perimeter feature that could also limit access to recreational activities.

Natural and Nature-Based Features - NNBFs during their implementation phases, may result in reduced recreational access and opportunities. However, long-term recreational opportunities may be increased in some NNBFs that offer greater fishing, clamming, birdwatching, and hunting opportunities. Therefore, NNBFs are expected to have beneficial impacts on recreation.

3.6.3.4 Aesthetics

For all CSRM structural and NNBF alternatives, land-based and in-water work would have significant, but temporary adverse effects where sensory items such as visual, noise, and smell would be affected based on active construction sites with diesel powered equipment moving materials around, delivery vehicles, marine vehicles and equipment, pile-driving, stacks of materials, dirt and rock piles, and turbidity generated in-water. These effects would stop upon cessation of construction activities.

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – Inlet storm surge barriers would resemble bridge-like concrete and steel structures spanning Manasquan Inlet, Barnegat Inlet and Great Egg Harbor Inlet that that may have significant visual impacts at their locations. The Manasquan Inlet SSB would have the least effect on visual resources because it would be situated in the most urbanized setting whereas, the Barnegat Inlet SSB would be tying into a state natural area on the north side of the inlet located at Island Beach State Park. The Great Egg Harbor Inlet SSB is not expected to have any effect on visual resources from within the Wild and Scenic River portions of the Great Egg Harbor River due to its distance from the area and existing bridges and urbanization that occurs between those locations.

Portions of the Cross-bay barriers contain perimeter (floodwall or levee) features that abut existing residential and commercial areas in Atlantic City and Southern Ocean City where first floor views may become obstructed by these structures. For Atlantic City, these areas would mostly be along the waterfronts of Gardner's Basin, Snug Harbor, Delta Basin, State Marina, and along the Clam Thorofare waterfront walkway. In Southern Ocean City, first floor view obstructions would likely be experienced from 59th Street to 52nd Street where a perimeter floodwall or levee would be required.

Perimeter Plans (Plans that require further economic evaluation) – Perimeter protection plan structures such as floodwalls, levees, miter gates, and pump stations, have the potential to produce significant adverse impacts on aesthetics, particularly for visual resources, which may affect several key human needs dimensions under the "Other Social Effects" category in the system of accounts. Floodwalls with heights ranging from approximately 5 to 10 feet along the back bay communities would obstruct first-floor and patio views of the bays, marshes, and other waterways. Therefore, many residents, restaurants, hotels, and other businesses that include attractive bay views may lose this amenity. Levees with vegetation would be more aesthetically pleasing than floodwalls but would still obstruct bay and marsh views. Also, views would be obstructed along roadways and walking paths. It is anticipated that these effects would be of great interest to adjacent landowners and the communities in general. As such, further evaluation of these potential impacts would be required to determine their social acceptability. Pump stations, depending on their locations, are expected to have localized minor effects on the aesthetics and visual resources.

Natural and Nature-Based Features -Most of the NNBFs would be constructed in aquatic ecosystems, and would therefore, be low-profile. Therefore, they are not expected to have adverse effects on viewsheds. Additionally, NNBFs in most cases, may improve aesthetics by providing natural features that are consistent with the surrounding landscapes and bay features.

3.6.3.5 Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – The Barnegat Inlet SSB A-1 alignment has box culverts and a seawall that tie into the north side of the inlet at an existing inlet stone revetment at the southeast corner of the Sedge Island Marine Conservation Zone. The beach, dunes, and wetlands at this area are also designated as a state natural area as part of Island Beach State Park. Other encroachments include perimeters that pass-through Absecon Wildlife Management Area (Absecon Blvd. CBB) and Corson's Inlet State Park and Cape May Coastal Wetlands W.M.A. (S. Ocean City CBB). AdH modeling conducted for the TSP SSB and CBB measures indicate minor effects on tidal amplitudes on intertidal habitats. Therefore, portions of Edwin B. Forsythe National Wildlife Refuge, Cape May National Wildlife Refuge and several state wildlife management areas with intertidal habitats may experience these indirect effects. The Great Egg Harbor Inlet SSB would produce similar indirect effects on wetlands in the Great Egg Harbor Wild and Scenic River area. These effects are discussed in greater detail in Section 8.2.4.19 in the DIFREIS.

Perimeter Plans (Plans that require further economic evaluation) – Perimeter floodwalls and levees in the plans 4D(1) and 4D(2) in the Central Region would encroach on the North Brigantine Natural Area and Corson's Inlet State Park. Alternative 5D(1) in the south would encroach on Cape May Wetlands W.M.A.

Natural and Nature Based Features (NNBF) – Because NNBFs could be potentially situated throughout the NJBB study area, numerous public lands that could be considered "sanctuaries and refuges" could be affected. It is assumed that an NNBF would be consistent with the purposes of a sanctuary or refuge and would be implemented in close consultation with the agency that manages these areas.

3.7 Determination of Cumulative Effects on the Aquatic Ecosystem

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – The cumulative impacts during the construction of the inlet storm surge barriers and cross-bay barriers on water quality are not expected to be significant because the generation of turbidity during construction would be of short duration and limited to within work segments. However, the cumulative effects of turbidity may be increased if there are other similar activities ongoing and nearby that generate turbidity such as dredging, earth disturbance, non-point storm water discharges, etc.

The cumulative impacts of the operation of storm surge barriers and cross-bay barriers on water quality are not well known. Since these structures have the potential to affect bay-wide system water quality, there is a potential for cumulative effects on water quality when coupled with existing water quality trends and the effects of climate change/sea level rise. Results of the AdH modeling for the open gate scenario do not indicate significant effects on the tidal prism or residence times, which can be assumed that the amount of current seawater flushing of these bays would be maintained. However, the closed-gate conditions, although temporary, may result in cumulative effects on water quality. To better understand the effects of the various inlet barriers and cross-bay barriers in the TSP, the next phase of the study will include additional hydrodynamic and water quality modeling that would be applied to better assess the effects that these measures would have on these bay systems.

Indirect cumulative impacts from the implementation of SSBs and CBBs on wetland and other aquatic habitats are potentially significant based on the potential system-wide effects on hydrodynamics including tidal range and salinity. Small, induced changes over a widespread area such as an entire bay system have the potential to result in significant impacts including losses of high marshes/transitional wetlands on the upper end and losses of mudflats on the lower end of the tidal range. These effects coupled with sea level rise and potential habitat shifts as evidenced by SLAMM model runs are uncertain and will require additional hydrodynamic modeling to inform the degree of this effect. Additionally, cumulative losses of wetland and other aquatic habitats will indirectly affect a number of aquatic biotas such as shellfish, finfish, and a number of different types of birds including shorebirds, wading birds, waterfowl, raptors, and neo-tropical migrants.

<u>Perimeter Plans (Plans that require further economic evaluation)</u> – The cumulative impacts of floodwalls and levees on water quality are not expected to be significant because the generation of turbidity during construction would be of short duration and limited to within work segments. However, the cumulative effects of turbidity may be increased if there are other similar activities ongoing and nearby that generate turbidity such as dredging, earth disturbance, non-point storm water discharges, etc.

Direct cumulative impacts from the implementation of perimeter plans on wetland and other aquatic habitats are significant based on the linear nature of these structures over long distances. These linear features encounter a number of wetland aquatic habitats that are predominantly subtidal soft bottom, intertidal mudflats, intertidal sandy beaches, low salt marshes, high salt marshes, scrub-shrub wetlands, and *Phragmites*-dominated wetlands. Losses of these habitats particularly on the upper intertidal range (i.e. high salt marshes, scrub-shrub wetlands) may be more significant when coupled with sea level rise, as these types of habitats will not be able to migrate landward where existing heavy development and hardened structures already exist. Cumulative losses of wetland and other aquatic habitats will indirectly affect a number of aquatic biota such as shellfish, finfish, and a number of different types of birds including shorebirds, wading birds, waterfowl, raptors and neo-tropical migrants where they may be forced to crowd into diminishing suitable habitats affected by sea level rise.

<u>Natural and Nature Based Features (NNBF)</u> – short-term effects on water quality and habitat disruptions are expected to occur and may intensify if other similar actions occur in the region.

Overall, NNBFs would be expected to have beneficial cumulative effects, by providing more "softer" nature-based solutions that could augment existing natural systems that would be under stress from anthropogenic influences such as development, water quality and habitat degradation.

3.8 Determination of Secondary Effects on the Aquatic Ecosystem

Inlet Storm Surge Barriers (TSP) and Cross-Bay Barriers (TSP) – Indirect/secondary impacts from the implementation of SSBs and CBBs on wetland and other aquatic habitats are potentially significant based on the potential system-wide effects on hydrodynamics including tidal range and salinity. Small, induced changes over a widespread area such as an entire bay system have the potential to result in significant impacts including losses of high marshes/transitional wetlands on the upper end and losses of mudflats on the lower end of the tidal range. These effects coupled with sea level rise and potential habitat shifts as evidenced by SLAMM model runs are uncertain and will require additional hydrodynamic modeling to inform the degree of this effect. Additionally, cumulative losses of wetland and other aquatic habitats will indirectly affect a number of aquatic biota such as shellfish, finfish, and a number of different types of birds including shorebirds, wading birds, waterfowl, raptors, and neo-tropical migrants.

Perimeter Plans (Plans that require further economic evaluation) – The indirect/secondary impacts of perimeter structures on aquatic habitats and wetlands are expected to be minimal to moderate and are related to temporary impacts such as sedimentation during construction and long-term impacts where hardened structures could halt landward migration of marshes, particularly with sea level rise. However, this effect is not significant since the majority of the shorelines along the back bays already are hardened with bulkheads, concrete revetments, and riprap.

Significant losses of these habitats will indirectly affect a number of aquatic biota such as shellfish, finfish, and a number of different types of birds including shorebirds, wading birds, waterfowl, raptors and neo-tropical migrants that utilize these habitats for various life requisite stages such as spawning/nesting, nursery/rearing, feeding, reproduction, etc.

Natural and Nature Based Features (NNBF) – The indirect/secondary impacts of NNBFs would be beneficial by providing sustainable aquatic habitats for a number of aquatic biota such as shellfish, finfish, and a number of different types of birds including shorebirds, wading birds, waterfowl, raptors, and neo-tropical migrants.

4.0 FINDINGS OF COMPLIANCE OR NON-COMPLIANCE WITH THE RESTIRICTIONS ON DISCHARGE

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

B. The alternative measures considered for accomplishing the project objectives are detailed in Sections 7.4 and 7.5 of the Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR-EIS).

C. A Section 404 Water Quality Certification will be obtained from the New Jersey Department of Environmental Protection prior to undertaking any of the actions discussed in this evaluation.

D. The proposed actions are not expected to violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

E. The proposed actions would comply with he Endangered Species Act of 1973. Formal Section 7 Consultation would be completed prior to undertaking any of the actions discussed in this evaluation.

F. The proposed actions would not violate the protective measures for any Marine Sanctuaries designated by the Marine Protection, Research, and Sanctuaries Act of 1972.

G. With appropriate mitigation, the proposed actions are not expected to result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. Significant adverse effects on life stages or aquatic life and other wildlife dependent on aquatic ecosystem diversity, productivity, and stability; and recreational, aesthetic, and economic values will not occur.

H. Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems include implementing BMPs and incorporating “avoid” and “minimize” in subsequent design phases along with including compensatory mitigation.

I. On the basis of the guidelines, the proposed discharge of dredged or fill material is specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

5.0 REFERENCES

Lackey, Tahirih, Nathan Mays, Jennifer McAlpin, and Sung-Chan Kim. 2020. Residence Time Analysis to Predict Impact of Proposed Storm Protection Structures in New Jersey Back Bays (NJBB Technical Report TR-20-xx. U.S. Army Engineer Research and Development Center, Vicksburg, MS. *Draft*.

McAlpin, Jennifer and Ross, C. 2020. Analysis of Proposed Storm Protection Structures on the Hydrodynamics and Salinity in New Jersey Back Bays (NJBB). Technical Report TR-20-xx. U.S. Army Engineer Research and Development Center, Vicksburg, MS. Draft.

New Jersey Department of Environmental Protection (NJDEP). 1997. The management and regulation of dredging activities and dredged material in New Jersey's tidal waters.