UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

JUN 28 2016

Peter Weppler, Chief
Environmental Analysis Branch
Planning Division
New York District
U.S. Army Corps of Engineers
26 Federal Plaza
New York, NY 10278-0900

RE: Essential Fish Habitat Assessment, Port Monmouth Flood Risk Management Project, Phase II

Dear Mr. Weppler:

We have reviewed the February 2016 Essential Fish Habitat Assessment (EFH) and the May 2016 Draft Environmental Assessment (DEA) for Phase II of the Port Monmouth Flood Risk Management Project. The proposed project is the second phase of an overall hurricane and storm damage reduction project along the Raritan and Sandy Hook Bays between Pews Creek and Comptons Creek in Middletown, Monmouth County, New Jersey. The first phase of the project included beach nourishment and the construction of groins and vegetated dunes along the Port Monmouth shoreline. Phase II includes the construction of approximately 4,500 linear feet (lf) of earthen levees, 7,000 lf of floodwalls, a vertical lift tide gate, pump stations, road closure structures, road raising, the regrading of some drainage features, and wetlands mitigation. The vertical lift tide gate will be approximately 40 feet wide and 21 feet in height across the entire width of Pews Creek. The tide gate will typically be closed only during storm events and for maintenance.

The potential environmental impacts of Phase I and II were evaluated in the 2000 *Draft Feasibility Report (FS) and Environmental Impact Statement (EIS) for Hurricane and Storm Damage Reduction, Port Monmouth, NJ.* The Record of Decision (ROD) was signed in 2008 and construction of Phase I was completed in 2015. Since the issuance of the original FS/EIS and ROD, the Corps has made a number of changes to the design of Phase II to minimize impacts to the aquatic environment, including reducing wetland fill by replacing earthen levees with floodwall where practicable.

Magnuson Stevens Fishery Conservation and Management Act (MSA)

The project area has been designated as EFH for a number of federally managed species including Atlantic butterfish (*Peprilus triacanthus*), Atlantic mackerel (*Scomber scombrus*), Atlantic sea herring (*Clupea harengus*), bluefish (*Pomatomus saltatrix*), black sea bass (*Centropristis striata*), cobia (*Rachycentron canadum*), king mackerel (*Scomberomorus cavalla*), red hake (*Urophycis chuss*), scup (*Stenotomus chrysops*), Spanish mackerel (*Scomberomorus maculates*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes *americanus),* windowpane flounder (*Scophthalmus aquosus*), clearnose skate (*Raja eglanteria*), little skate (*Leucoraja erinacea*), winter skate (*Leucoraja ocellata*), dusky shark (*Characharinus obscurus*), and sandbar shark (*Charcharinus plumbeus*).

The MSA requires federal agencies to consult us on project such as this that may affect EFH adversely. This process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments, lists the required contents of EFH assessments, and generally outlines each agency's obligations in this consultation procedure.

The EFH final rule published in the *Federal Register* on January 17, 2002 defines an adverse effect as "any impact which reduces the quality and/or quantity of EFH" and further states that:

> An adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

The estuarine wetlands and shallow water habitats within the project area provide nursery and forage habitat for a variety of species of concern to us including alewife (*Alosa pseudoharengus*), Atlantic croaker (*Micropogonias undulatus*), Atlantic menhaden (*Brevoortia tyrannus*), spot (*Leiostomus xanthurus*), striped bass (*Morone saxatilis*) as well as federally managed bluefish, winter flounder and summer flounder. Important forage species such as mummichog (*Fundulus heteroclitus*), Atlantic silverside (*Menidia menidia*), inland silverside (*Menidia beryllina*), striped killifish (*Fundulus majalis*) and bay anchovy (*Anchoa mitchilli*) also use these areas. Mummichog, killifish, anchovies and other small fish and benthic organisms found in estuarine wetlands provide a valuable food source for many of the commercially and recreationally valuable species mentioned above including striped bass, summer flounder, weakfish, red hake, scup and windowpane.

Wetlands also provide many other important ecological functions including water storage, nutrient cycling and primary production, sediment retention, water filtration or purification, and groundwater recharge. The loss of wetlands as a result of this project can adversely affect EFH for a number of federally managed species through the loss of nursery, forage and refuge habitat, the reduction in prey species and primary production and water quality degradation from the reduction in sediment retention and pollution filtration.

The DEA and the EFH assessment do not clearly describe the amount and type of wetlands and open water that will be impacted by the proposed project. According to the EFH assessment, a permanent loss of open bottom for the footprint of the tide gate would occur in Pews Creek, but the aerial extent of this impact is not clearly described. In addition, the total area of permanent and temporary impacts to estuarine wetlands is also not clearly identified. In the DEA, it states that 17 acres of vegetation would be permanently removed in order to construct the project features, but DEA does not specify if vegetation removal means fill placement and the permanent loss of aquatic habitat. In the original 2000 EIS, the impacts from the construction of

Phase II were estimated to be 12.76 acres of direct impacts to wetlands, 5.63 acres of indirect impacts and 2.13 acres of impacts to upland vegetation. Since that time, the project has been modified to reduce the length of the earthen levees, and to use floodwalls where possible. We understand that this has resulted in a decrease in direct impacts to wetlands and possibly a decrease in the indirect effects as well, but neither the EFH assessment nor the DEA clearly quantify the impacts to wetlands that will result from the current project design. As a worse-case scenario, 29.5 acres of mitigation is proposed to offset impacts to "coastal wetlands" as defined by the New Jersey Department of Environmental Protection. However, without more information on the acres of wetlands to be filled or impacted temporarily, it is not possible to determine if the proposed mitigation will offset the adverse effects to EFH or the loss of wetlands functions.

As this project moves forward, additional information is needed on the acres of wetlands to be lost permanently, those impacted temporarily and the compensatory mitigation proposed to offset impacts to wetlands and open waters in the project area. A mitigation plan should be developed in accordance with the federal final mitigation rules published in the Federal Register on April 10, 2008 (33 CFR Chapter 2 Part 332.4 (b)) and provided to us for review. The plan should explain how the proposed compensatory mitigation will offset the impacts to estuarine wetlands. It should also include performance measures, success criteria and a long-term monitoring and maintenance plan.

In general, typical compensatory mitigation ratios used in New Jersey for creation and reestablishment of emergent and scrub-shrub wetlands is 2:1. The ratio is higher for forested wetlands. The ratio for rehabilitation or enhancement of emergent wetlands is generally 3:1 or higher depending upon the existing conditions of the mitigation site. If the 17 acres of permanent vegetation removal mentioned in the DEA is all wetland fill, and the compensatory mitigation proposed is conversion of *Phragmites* to *Spartina alterniflora* and/or *Spartina patens*, the mitigation would be considered rehabilitation of a degraded marsh. This would likely warrant a 3:1 mitigation ratio necessitating 51 acres of compensatory mitigation. This ratio also assumes that the area of *Phragmites* to be removed is the non-native, invasive halotype. Based upon our observations of the project site during a previous site visit with your staff and staff from the U.S Fish and Wildlife Service, it appears that some areas of *Phragmites* on the project site could be the native, non-invasive halotype. Because the native halotype is generally not invasive and can provide some habitat benefits for birds, its removal would not result in improved wetlands functions and would not be considered appropriate compensatory mitigation.

According to the EFH assessment and the DEA, there are no anticipated, long-term changes to the Pews Creek wetlands as a result of the tide gate operations and the placement of the tide gate would have minimal effect on the daily tidal cycle. However, pre and post-construction monitoring of the tidal range and salinity in the Pews Creek marsh will be undertaken to identify impacts due to the construction and operation of the tide gate. We agree with the need to monitor the wetlands before and after construction of the project and look forward to working with you on the development of the monitoring plan.

Essential Fish Habitat Conservation Recommendations
Pursuant to Section 305 (b) (4) (A) of the MSA, we recommend the following EFH conservation recommendations be incorporated into the project:

1. Provide compensatory mitigation for all permanent impacts to aquatic habitat and for any temporary impact remaining longer than 12 months. A compensatory mitigation plan should be developed in accordance with the 2008 federal mitigation rules and provided to us for review to ensure the mitigation offsets impacts to EFH

2. Compensatory mitigation should be undertaken prior to or concurrent with any impacts to wetlands or open water habitat

3. Avoid stockpiling or storing material in wetlands

4. Use mats under any equipment operating in the wetlands

5. Use appropriate best management practices to minimize turbidity during construction

Please note that Section 305 (b)(4)(B) of the MSA requires you to provide us with a detailed written response to these EFH conservation recommendations, including the measures adopted by you for avoiding, mitigating, or offsetting the impact of the project on EFH. In the case of a response that is inconsistent with our recommendations, Section 305 (b) (4) (B) of the MSA also indicates that you must explain your reasons for not following the recommendations. Included in such reasoning would be the scientific justification for any disagreements with us over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate or offset such effect pursuant to 50 CFR 600.920 (k).

Please also note that a distinct and further EFH consultation must be reinitiated pursuant to 50 CRF 600.920 (j) if new information becomes available, or if the project is revised in such a manner that affects the basis for the above EFH conservation recommendations.

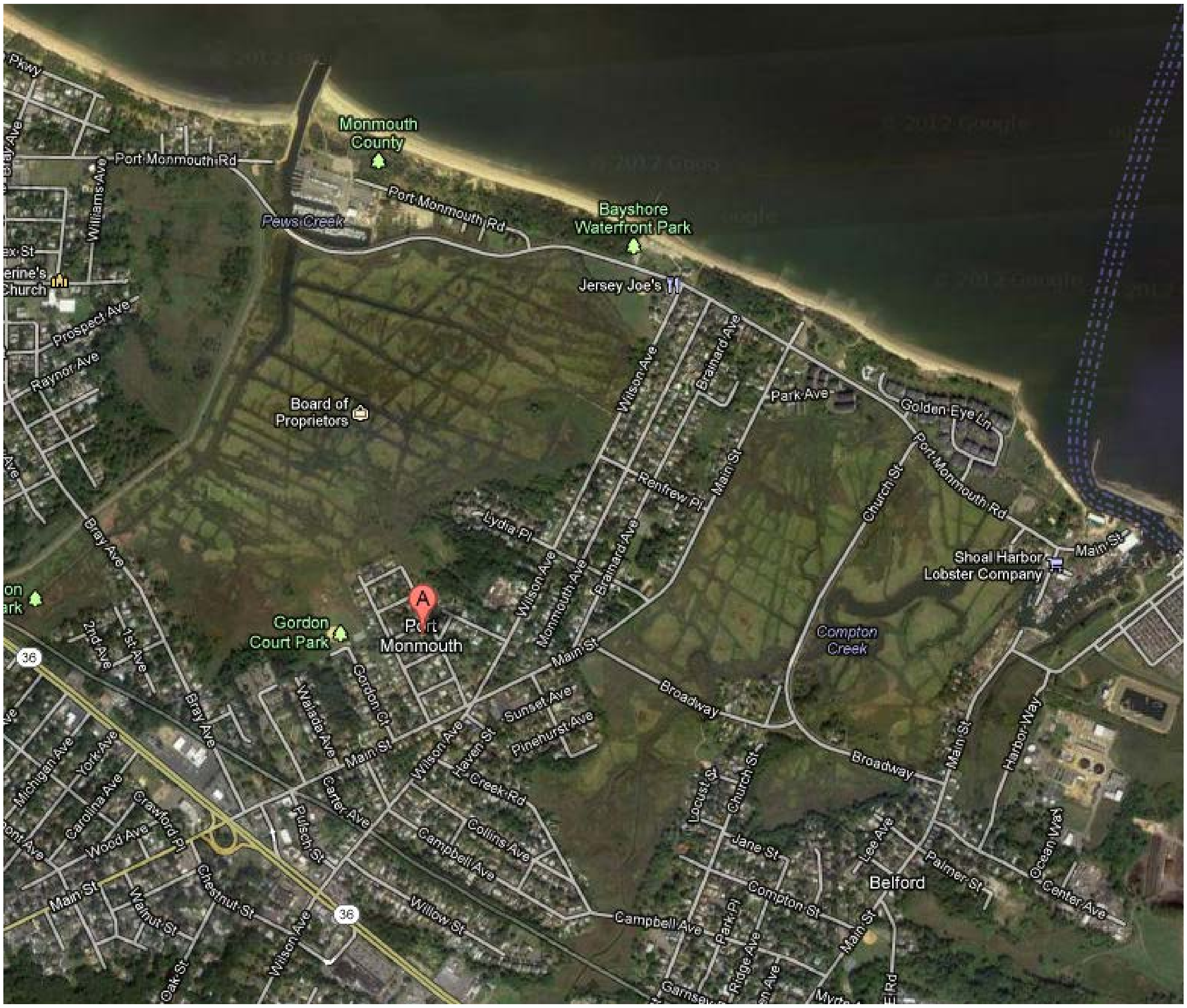
We look forward to continued coordination with your office on this project as it moves forward. If you have any questions or need additional information, please do not hesitate to contact Karen Greene at karen.greene@noaa.gov or (732) 872-3023.

Sincerely,

Louis A. Chiarella,
Assistant Regional Administrator
Habitat Conservation

cc: D. Marrone – GARFO PRD

PORT MONMOUTH FLOOD RISK MANAGEMENT PROJECT, PHASE II



ESSENTIAL FISH HABITAT ASSESSMENT

FEBRUARY 2016

U.S. ARMY CORPS OF ENGINEERS
PLANNING DIVISION
NEW YORK DISTRICT
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10278-0090

PORT MONMOUTH NEW JERSEY
FLOOD CONTROL PROJECT, PHASE II

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ABBREVIATIONS AND ACRONYMS

EFH	Essential Fish Habitat
District	New York District
ft.	feet
MHW	Mean High Water
MLW	Mean Low Water
NEFMC	New England Fisheries Management Council
NAVD	North American Vertical Datum
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Science
NOAA	National Oceanic and Atmospheric Administration
ppt	parts per thousand
RBSHB	Raritan Bay and Sandy Hook Bay
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
YOY	young-of-the-year

1.0 INTRODUCTION

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act, this assessment identifies the potential impacts of the United States Army Corps of Engineers (USACE), New York District's (District) proposed flood damage reduction project on essential fish habitat (EFH) in Port Monmouth, New Jersey. The Magnuson-Stevens Act as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) set forth a number of new mandates for the National Marine Fisheries Service (NMFS), regional fishery management councils, and other federal agencies to identify and protect important marine and anadromous fish habitat.

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Federal agencies that fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding the potential effects of their actions on EFH.

Need for the Project

Hurricanes, nor'easters, and extratropical storms have historically resulted in two major issues in Port Monmouth: shoreline erosion and extensive flooding. These issues have caused damage or destruction to structures within the community and increased the susceptibility of remaining development and infrastructure to storm events.

Historically, significant erosion removed much of the natural beachfront and dune complexes that provided coastal protection to the community from storm surge; Hurricane Sandy further exacerbated these conditions and increased community vulnerability to future storm events.

Tidal surges in Pews and Compton Creeks have caused flooding on both the east and west sides of the community. Tidal surges have also blocked existing municipal storm drainage systems that outlet into Pews Creek and Compton Creek channels and their associated wetlands. Extensive flooding from both issues has resulted in significant damage/destruction of homes, commercial properties, building contents, and community infrastructure such as roads, bridges, utility lines, and storm sewers. This damage has resulted in extensive financial losses and is considered a significant constraint to commerce and regional economic development. Construction of Phase II would reduce the risk of flooding and damages to development and infrastructure from coastal storm events.

Project Description

The U.S. Army Corps of Engineers (USACE), District and the New Jersey Department of Environmental Protection (NJDEP) Bureau of Coastal Engineering propose to construct a Flood Damage Reduction Project in Port Monmouth, Monmouth County, New Jersey (NJ). This flood damage reduction project represents the second phase of an overall Hurricane and Storm Damage Reduction Project and would include approximately 4,500 linear feet (lf) of levees, 7,000 lf of floodwalls, the splicing of sheet pile onto an existing bulkhead, road closure structures, a vertical lift tide gate, pump stations, road raising and re-grading interior drainage facilities, and wetland mitigation (see Figure 1). The boundaries of the project area are roughly Pews Creek to the west, Compton Creek to the east, Route 36 to the south, and landward of the beach/dune system on the north side.

Figure 1: Outline of project alignment and contract areas.

The first phase of the project included beach nourishment, construction of a groin and walkovers for beach access, and extension of a pier along the waterfront in Port Monmouth. National Environmental Policy Act (NEPA) compliance for Phase I was completed under separate documentation and construction is complete; therefore this phase is not evaluated in this document.

Phase II has been divided into 5 contract areas for design and construction and consist of the following (see Figure 1):

- Contract 1 - Wetland Mitigation (note - there are two proposed mitigation sites - one in the Pews Creek wetland and a second in the Compton Creek wetland. The second wetland mitigation site is not identified in Figure 1 since the real estate acquisition has not been confirmed.);
- Contract 2 - Pews Creek Tide Gate; Levee, Pump Station and Sheetpile Wall;
- Contract 3 - Pews Creek Port Monmouth Road Closure Gate and Floodwall;
- Contract 4 - Compton Creek Floodwall, Levees, two Road Closure Gates, Road regrading, and Interior Drainage;
- Contract 5 - Compton Creek Floodwall, Levees, Pump Station, Road Raising and interior Drainage.

Contracts 2-5 contain connecting structures that are integrated to form a single line of protection to reduce flooding from storm events in the Port Monmouth community. The total length of the project is approximately 11,500 linear feet of levees and floodwalls, which makes up the majority of the engineered structures. Individually and in combination, these measures provide protective barriers to prevent storm-induced and/or tidal flooding as well as storm water drainage, storage and pumping to divert storm water away from protected areas and back to surrounding water bodies.

A vertical lift tide gate of approximately 40 ft. in width and 21 ft. in height, will be placed across the entire width of Pews Creek just south of the bridge on Port Monmouth Road. One pump station would be placed adjacent to the gate. A second pump station would be placed on top of the levee along Main

Street. The pump stations are a necessary feature of the alignment because they provides the means necessary to control damaging interior water elevations when the tide gate is in closed position and there is fluvial flow from upland runoff into Pews Creek (Figure 2). Under normal conditions, the gate would remain fully opened, with the pump stations off. Examples of conditions that would trigger closing of the gate and/or operation of the pumps include: a rain event occurs over the drainage basin at the same time as Spring Tide; during storms in which a major tidal event is predicted; during storms in which a major tidal event and rain event occurs over the drainage basin at the same time; maintenance activities.

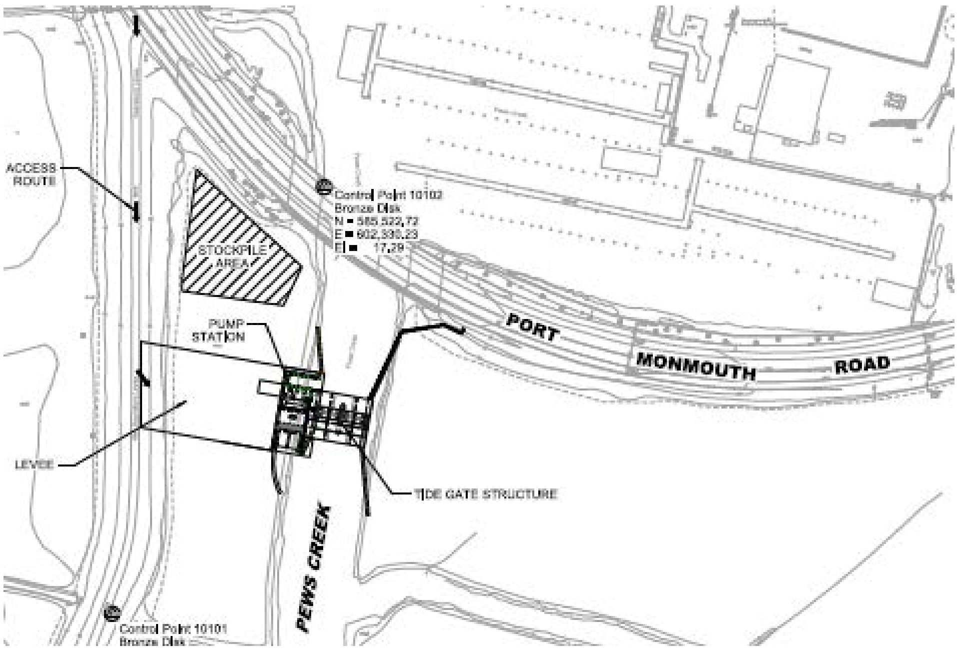

Figure 2: Tide gate to be placed across Pews Creek

The earthen/clay levees that are to be constructed along the project alignment will have a top elevation of +13 ft. North American Vertical Datum of 1988 (NAVD). The top of levee would be grass and would be maintained for vehicular access during flood events and for maintenance activities. Side slopes of the levee would be vegetated and maintained through periodic mowing. On the protected side of the levee, which is the side facing the developed area of the community, a 10 foot wide (approximate) earthen drainage ditch would be constructed along the entire length of the levee, in which water would be diverted towards pump stations. In addition, drainage structures, such as flap valves and sluice gates, would be constructed through the base of the levee to divert water to the unprotected side; where possible, water would spill out into existing, natural drainage features of the wetland. Beyond the ditch, and on the opposite side of the levee, a 15 foot wide (approximate) buffer is required; USACE restrictions dictate that only perennial grasses are permitted in this area and that they must tolerate mowing to heights as low as 3" at least once per year.

Floodwalls would be constructed along segments of the project alignment with a maximum top elevation of +13 ft. NAVD 88. The floodwalls would be reinforced concrete walls supported on steel pile foundations. Drainage ditches and 15 foot buffers would mirror that described in the previous paragraph for levees; however, portions of the floodwall would require drainage structures on both sides of the wall.

Road raising would occur in the project area along a portion of Port Monmouth Road and Route 36. Regrading of property would also occur on Wilson Ave. This road raising/regrading construction would elevate areas along the line of protection to maintain the required +13 ft. NAVD elevation throughout the project.

The construction and placement of permanent project features from Contracts 2-5 would result in impacts to riparian, coastal and freshwater wetland areas. Approximately 17 acres of permanent vegetation would be removed in order to construct the project features. Mitigation proposed in the Pews Creek area would consist of the conversion of a common reed monoculture to maritime forested wetlands for coastal mitigation. Proposed mitigation at the Compton site would include the removal of common reed with the replanting of native salt marsh emergent and scrub/shrub species for coastal and riparian mitigation. Based on tidal datum analyses and site topography, additional tertiary channels could be created to improve tidal ebb and flow to the site. Credits would be purchased to mitigate for freshwater impacts.

2.0 EXISTING ENVIRONMENT

The current in Pews Creek was measured on July 13, 1993 and was used to predict average current velocities in a study conducted by Stevens Institute of Technology (Harrington 1994). Under spring tidal conditions, the average peak flood and ebb currents were approximately 1.7 fps (1.0 knots) and 1.8 fps (1.1 knots) respectively at the critical cross section. Neap tide conditions produced flood and ebb current speeds of 0.5 fps and 0.4 fps. Analogous information for Compton Creek was not available.

Tidal creeks are important to many species of anadromous fish for feeding and spawning purposes. The Pews Creek wetland area contains plant species typical of successional upland, low salt marsh, high salt marsh and brackish tidal marsh plant communities. New Jersey coastline from South Amboy to Atlantic Highlands is low and flat with a gentle southeast slope that generally does not exceed 5 to 6 ft. per mile. Nearshore coastal waters are very shallow, generally 6 ft. below mean low water (MLW) at a distance of 0.5 miles from shore, or about 2.5 ft. (approximately 0.75 meters) at a distance of 1,000 ft. from shore. The depth at 1,000 ft. from shore would increase to about 8 ft. at mean high water (MHW). This shallow coastal water forms a shallow water refuge and nursery for many small forage fish and early life history stages including EFH species.

There is a lack of published fisheries data that is site-specific to Pews or Compton Creek, thus a listing of species that can be found there is unavailable. However, detailed information on EFH species potentially in the near shore area is available and the relative likelihood of individual species frequenting sections of the creeks can be anticipated. The two project creeks, especially the lower reaches, may support a variety of estuarine fish.

3.0 ESSENTIAL FISH HABITAT

EFH designations for federally managed shellfish and finfish species in the northeast United States are described in recent amendments to several different fishery management plans that are administered by the New England Fisheries Management Council (NEFMC). EFH designations for all coastal waters on the New Jersey shore of Raritan Bay and Sandy Hook Bay (RBSHB) consist of two Quadrants A (40207410) and B (40207400) (Raritan Bay shoreline) which include the Port Monmouth project study area

(Quad B) and were based on EFH designations compiled by the National Oceanic and Atmospheric Administration (NOAA). Project study area EFH species relevant life history stages are summarized in Table 1 & 2.

The following two sections identify the EFH-designated species either known to occur in nearshore waters within the vicinity of the project site based on relatively recent field surveys, or likely to occur based on known life history and habitat requirements.

Data collected during 55 hauls with a 100 ft. long beach seine west of the project at Union and Cliffwood beaches during June-November 1999 (USACE 2000f) provide direct evidence for the presence of eight of the designated EFH species in nearshore waters (within 100 ft. or less from shore) during the warmer months (Table A-1, Appendix A). Of these eight species, bluefish (*Pomatomus saltatrix*) and winter flounder (*Pseudopleuronectes americanus*) were the most common, summer flounder (*Paralichthys dentatus*) and windowpane (*Scophthalmus aquosus*) were fairly common, and Atlantic herring (*Clupea harengus*), Spanish mackerel (*Scomberomorus maculatus*), black sea bass (*Centropristis striata*), and cobia (*Rachycentron canadum*) were rare. The fact that all the bluefish and windowpane and most of the winter flounder were young-of-the-year (YOY) juveniles indicates that the nearshore zone at Union and Cliffwood beaches was being used as a nursery ground for these species. Most of the summer flounder collected during this survey were first maturing adults that re-enter coastal waters after spending their first winter on the continental shelf (Able and Fahay 1998); a few were one year old juveniles, but none were YOY juveniles. Utilization of the nearshore waters and lower portions of the two tidal creeks by the same species and life stages is assumed at Port Monmouth.

Additional beach seine data were available from an extensive survey made in New Jersey coastal waters by the NJDEP, Division of Fish, Game and Wildlife, in 1982 and 1983 (Table A-2, Appendix A). Sampling was done at ten sites in RBSHB twice a month for 12 months with a 27 ft. and a 76 ft. beach seine. Only four EFH-designated species were caught: bluefish, winter flounder, summer flounder, and windowpane. Bluefish were the most abundant. No size information was available, but the bluefish were almost all juveniles (D. Byrne, NJDEP, personal communication). Bluefish and winter flounder were caught at all ten sites, windowpane at only two, and summer flounder at one.

Table 1. EFH-Designated Bony Fish Port Monmouth Quadrant

Species	**PM QUAD**			
	E	**L**	**J**	**A**
Red hake (*Urophycis chuss*)		**x**	**x**	**x**
Winter flounder (*Pseudopleuronectes americanus*)	**x**	**x**	**x**	**x**
Windowpane flounder (*Scopthalmus aquosus*)	**x**	**x**	**x**	**x**
Atlantic sea herring (*Clupea harengus*)		**x**	**x**	**x**
Bluefish (*Pomatomus saltatrix*)			**x**	**x**
Atlantic butterfish (*Peprilus triacanthus*)		**x**	**x**	**x**
Atlantic mackerel (*Scomber scombrus*)			**x**	**x**
Summer flounder (*Paralichthys dentatus*)		**x**	**x**	**x**
Scup (*Stenotomus chrysops*)			**x**	**x**

Black sea bass (*Centropristis striata*)			x	x
King mackerel (*Scomberomorus cavalla*)	x	x	x	x
Spanish mackerel (*Scomberomorus maculatus*)	x	x	x	x
Cobia (*Rachycentron canadum*)	x	x	x	x
Winter Skate (*Leucoraja ocellatus*)			x	x
Clear nose Skate (*Raja eglanteria*)	x	x	x	x
Little Skate (*Leucoraja erinacea)*	x	x	x	x

Source: NOAA (1999a)

Key:

E = eggs
L = larvae
J = juveniles
A = adults

Table 2. EFH-Designated Shark Species Port Monmouth Quadrant

Species	Zone 1		
	EJ	LJ	A
Dusky shark (*Charcharinus obscurus)*	x		
Sandbar shark (*Charcharinus plumbeus*)	x	x	x

Source: NOAA (1999b)

Key:

EJ = early juveniles
LJ = late juveniles/subadults
A = adults

In regard to anadromous fish utilizing Pews and Compton Creeks, only Compton Creek has a record of a clupeid run, specifically alewives. The most recent record of confirmation dates back to 1975, no other records were available. The Atlantic herring is an EFH species included in the Port Monmouth EFH Quadrant, the alewife is not.

Beach seine collections made in RBSHB during 1982-1983 and 1999 were limited to 100 ft. or less from shore, thus, there is no information on the presence or abundance of EFH-designated species in the outer portion of the nearshore zone (100-1000 ft.). For this reason, published information on life history and habitat requirements for EFH-designated species and life history stages that were not collected in beach seine surveys was compiled in order to provide a more complete listing of species to include in this assessment. Based on this information the following EFH-designated species and life history stages were identified as probable occupants of the nearshore RBSHB coastal zone:

- Adult bluefish range widely from nearshore to well offshore and are known to pursue food fish into shallow coastal waters (Fahay *et al*. 1999);
- Adult and juvenile windowpane are commonly caught in nearshore coastal waters in RBSHB (USACE 2000d and e);
- Juvenile scup appear in estuaries in June and are most common nearshore during the warmer months (Able and Fahay 1998; USACE 2000d and e);
- Juvenile and adult butterfish (*Peprilus triacanthus*) are common in nearshore areas, including the surf zone, and occur in sheltered bays and estuaries in the mid-Atlantic region during the summer (Cross *et al*. 1999);
- Juvenile Atlantic mackerel are found in bays and estuarine waters from New Jersey to Canada and are common in saline waters of the Hudson-Raritan estuary in the spring and fall (Studholme *et al*. 1999);
- Adult and early juvenile sandbar sharks (*Charcharinus obscurus*) can occur in very shallow, intertidal waters and bear live young in shallow bays and estuaries of the east-central U.S. in the summer (Compagno 1984).

Combining confirmed species and life history stages in the nearshore RBSHB coastal zone with those that probably occur there produced a list that included 12 of the 13 juvenile EFH designations and 6 of the 14 adult EFH designations for this habitat (Table 3).

Information is provided for winter flounder eggs since this species produces demersal eggs and spawns in shallow, nearshore waters of the Hudson-Raritan estuary (Pereira *et al*. 1999). Atlantic herring also produce demersal eggs, but they do not spawn in inshore mid-Atlantic waters (Reid *et al*. 1999). The other two EFH-designated species that are reported to spawn in the estuary are windowpane and scup (Stone *et al*. 1994), but they produce planktonic eggs which disperse over a large area.

Table 3. EFH-Designated Species that Inhabit the Nearshore of the Project Site.

Species	Confirmed *	Probable **
Bluefish	Juveniles	Adults
Winter flounder	Juveniles	
Winter flounder	Adults	
Windowpane	Juveniles	Adults
Summer flounder	Juveniles	
Summer flounder	Adults	
Black sea bass	Juveniles	
Scup		Juveniles
Butterfish		Juveniles
Butterfish		Adults
Cobia	Juveniles	
Spanish mackerel	Juveniles	
Atlantic mackerel		Juveniles
Atlantic herring	Juveniles	

Sandbar shark		Adults Early juveniles

Key: * Captured during 1999 beach seine surveys at Cliffwood/Union Beach.
** Based on life history characteristics and habitat requirements.

Information was compiled from various sources on the diets and prey species consumed by adults and juveniles of EFH-designated species identified in Table 3.A summary of this information is contained in Table 4. Three of the thirteen EFH species listed in Table 4 are bottom feeders and four other species also feed on benthic organisms. This section identifies whether or not the nearshore habitat of RBSHB provides feeding habitat for EFH-designated species.

The dominant benthic invertebrate species collected in beach seine hauls made at ten sites along the coast in 1982-83 by the NJDEP was the grass shrimp, *Palemonetes pugio* (Table A-3, Appendix B). Also present, but less common, were the grass shrimp (*P. vulgaris*) and the sand shrimp, (*Crangon septemspinosa*). All three of these species are preyed upon by most of the EFH-designated species in the nearshore zone (Table 4).

A survey of benthic macroinvertebrates was conducted by the District in nearshore RBSHB between Belford Harbor and Keansburg and in Laurence Harbor in 1994 and 1995 (Ettinger 1996): principal prey taxa for EFH-designated fish species were two bivalve species (*Mya arenaria* and *Gemma gemma*), several species of polychaetes, oligochaetes, and the amphipod *Gammarus lawrencianus* (Tables A-4 and A-5, Appendix A).

Studies of sandy beach infauna in the vicinity of Cliffwood and Union Beaches were conducted by the District in June and September 1999 (USACE 2000b and c, Table A-6, Appendix A). Annelids dominated the samples (17 of the 29 most abundant taxa), accounting for 50.6% of all the organisms in the intertidal samples and 63.8% in the sub-tidal samples. Crustaceans were the next most abundant group (amphipods, isopods, and crabs), followed by mollusks. Amphipods were more abundant in the sub-tidal zone and mollusks in the intertidal zone. Species composition varied considerably between the two zones. The most abundant taxa in the intertidal zone were the polychaetes *Polydora cornuta* and *Pygospio elegans* and turbellarians; in the subtidal zone, the dominant species were the oligochaete *Tubificoides wasselli*, the amphipod *Ampelisca abdita*, and the polychaetes *Streblospio benedicti* and *Streptosyllis verrilli*. Although species composition did vary with depth, there were no consistent differences in species diversity between intertidal and sub-tidal stations. Annelids (polychaetes and oligochaetes), bivalve mollusks, and amphipods provide important food resources for various stages of EFH-designated fish species like winter flounder, scup, and summer flounder that may feed in shallow nearshore waters.

Small fish that serve as prey for piscivorous predators like bluefish and summer flounder are also common in the nearshore zone of RBSHB. Dominant forage species caught in beach seine hauls in 1999 at Union and Cliffwood beaches (USACE 2000f) were Atlantic silversides (*Menidia menidia*), alewives (*Alosa pseudoharengus*), bay anchovies (*Anchoa mitchilli*), and Atlantic menhaden (*Brevoortia tyrannus*). Bay anchovies, mummichogs (*Fundulus heteroclitus*), striped killifish

(*Fundulus majalis*), and Atlantic silversides were also very common in beach seine hauls along the coast in 1982-83 (Table A-2, Appendix A).

Table 4. Prey Species for Primary EFH-Designated Fish Species in the Nearshore of RBSHB
Source: 506 report.

Species	**Life History Stage**	**Principal prey**
Bottom Feeders		
Winter flounder	Juveniles and adults	Mostly polychaetes and amphipods (e.g. *Ampelisca abdita*), also *Crangon*, sand dollars, and bivalves.
Windowpane	Juveniles and adults	Small crustaceans (e.g. mysids and decapod shrimp) and fish larvae.
Sandbar shark	Adults	Small bottom and pelagic fish with some mollusks and crustaceans.
Bottom and Pelagic Feeders		
Summer flounder	Juveniles	Small fish, grass and sand shrimp, polychaetes.
Summer flounder	Adults	Crustaceans (e.g. crabs), bivalves, marine worms, sand dollars, and a variety of fish species (see text).
Scup	Juveniles	Polychaetes, amphipods, other small crustacea (copepods, mysids), small mollusks, fish eggs and larvae.
Black sea bass	Juveniles	Small benthic crustacea (isopods, amphipods, small crabs, sand shrimp, copepods, mysids) and small fish.
Pelagic Feeders		
Butterfish	Juveniles and adults	Zooplanktonic prey.
Atlantic herring	Juveniles	Zooplanktonic prey.
Bluefish	Juveniles	Polychaetes, crustaceans, but mostly fish.
Bluefish	Adults	Variety of fish species.
Cobia	Juveniles	No information available.
Atlantic Mackerel	Juveniles	Small crustaceans such as copepods, amphipods, mysid shrimp, and decapod larvae.
Spanish Mackerel	Juveniles	Crustaceans and variety of fish species.
Winter Skate	Juveniles	Small crustaceans mollusks and bi-valves
Winter Skate	Adults	Soft Shell Clams, crustaceans/bivalves/mollusks
Clear nose skate	Juvenile	Small crustaceans/bivalves/mollusks
Clearnose Skates	Adults	Soft Shell Clams, crustaceans/bivalves/mollusks
Little Skate	Juvenile	Small crustaceans/bivalves/mollusks
Little Skate	Adults	Soft Shell Clams, crustaceans/bivalves/mollusks

4.0 POTENTIAL IMPACTS

Flood control measures are not expected to have any significant or long-term lasting effects on the "spawning, breeding, feeding, or growth to maturity" of the designated EFH species that occupy the project area waters, which include Pews and Compton Creeks, associated wetlands and near-shore zones of Raritan Bay adjacent to the creek mouths. However, proposed activities would result in some permanent changes of land use and construction of project features would have immediate, short-term, minor direct and indirect impacts on EFH for some of the designated fish species and life history stages that occur in the immediate vicinity of the project's construction. The vertical lift tide gate and pump stations would only operate during the occasional and infrequent storm and for maintenance, and would therefore not cause any significant impacts to EFH or designated species.

Tide Gate/levees/Flood Walls/ Pump Stations:
A permanent loss/modification of open bottom for the footprint of the tide gate would occur in Pews Creek; however, the footprint represents a small area compared to the main channel of Pews Creek (see Figure 1). Any loss of benthic prey species for EFH species occurring in the area would be temporary and minor. A permanent loss of wetlands and a change to a portion of the riparian corridor would occur through placement of levees and floodwalls in Pews and Compton Creeks. Impacts to wetlands and riparian areas were minimized by designing project features at the edge of these habitats; unavoidable impacts would be mitigated for through the NJDEP permitting process.

Temporary, localized disturbance to adjacent bottom substrate would occur during construction. Impacts during construction may include increased turbidity, and disturbance, however use of best management practices through a sediment and erosion control plan would minimize this temporary adverse impact.

The tide gate would typically be closed only during storm events and for maintenance. During spring tide events, flooding has occurred on Wilson Avenue, adjacent to the Pews Creek wetland; to minimize this flooding, the pump station would operate instead of closing the tide gate to maintain tidal flow. During events, tidal flow would be interrupted at the surge barrier in Pews Creek to prevent upstream flooding. No long term change in currents or wave patterns are anticipated. There is the likelihood for increases in turbidity and sedimentation at the downstream side of the barrier when the gate is closed. Conversely there may be a temporary increased flow of sediment downstream after the barrier is removed.

Although it is possible that any of the species listed for the Port Monmouth EFH quadrant to be present within the bay water in the vicinity of the project, it is likely that only a few species and life stages would be found regularly within the waters of the project site (Pews and Compton Creeks). Analysis of the available EFH resources along with recent RBSHB monitoring studies show that the species most likely to be affected by construction and future existence and utilization of the Port Monmouth project include, adult and juvenile winter, summer and windowpane flounder, juvenile scup, butter fish and black sea bass. Other juvenile species may be found on occasion but are not likely to be common. The remaining quadrant species, especially the adults are not expected to frequent the immediate near shore and the tidal creeks. Although no specific data for Pews and Compton Creeks is available for very early life stages, larvae of any of the EFH species that can be found in RBSHB could be within the project site estuarine waters during the appropriate season. Thus larvae would be susceptible to certain impacts described above.

4.1 DIRECT IMPACTS

Most EFH species adults have little potential for significant or long term direct impacts from any of the project components. Although small forage fish might be temporarily displaced during construction, this will not affect the feeding success of piscivorous EFH-designated species, since they would simply re-locate to nearby shallow water areas where they could continue to feed successfully. Early life stages (eggs, larvae, early stage juveniles) are more likely to be directly impacted from construction and implementation of the project, as discussed below.

Construction and implementation of the levee, sheet pile and tide gate would create temporary, localized disturbance to bottom substrate which would include the short-term increase in suspended sediments (turbidity), with possible mortality of some benthic organisms, fish eggs and larval forms, if present. Early juvenile stages of flat fish or skates may be at higher risk of respiratory effects from increased turbidity or possible mortality from burial. Other impacts include reduced salinity on the up-stream side of the surge barrier, infrequent interrupted current flow, some permanent loss of bottom habitat as a result of construction (footprint of the surge barrier and levee below the top of bank).

Adults of EFH species are expected to move away from any such disturbance from construction without experiencing significant effects. Tidal flow between the Bay and Pews Creek will be maintained during construction through the construction of a coffer dam; therefore access for EFH species would be maintained. For the long term, the tide gate would typically be closed only during extreme storm surges when water level reaches +5 ft. NGVD to prevent flooding above the Port Monmouth bridge; water will be pumped from upstream to the downstream side of the surge barrier when the tide gate is closed in Pews Creek. There is no anticipated (long term) change in currents or wave patterns. Fish moving within the creek would be temporarily prevented from passing. Any planktonic life stages of EFH species may be susceptible to entrainment through the pump system.

Under normal flow of tidal water in the creeks, there would be no decrease in salinity to surrounding receiving waters. During flood conditions diverted water will likely lower salinity within the wetlands during a rain event. Juvenile and adult EFH species within the receiving waters are not expected to be significantly impacted by this activity. Spawning winter flounder may occupy the project area near the tide gate. Conditions that lowered the salinity by influx of storm runoff could adversely affect eggs if salinity decreased to below 5 ppt. However because spawning conditions in Pews Creek are already very poor, tide gate construction and operation is not expected to adversely affect spawning habitat.

4.2 INDIRECT IMPACTS

Adverse indirect project impacts to EFH species and habitat are anticipated for the loss of wetlands from construction of levees, floodwalls, tide gate and related measures. The wetlands provide nursery, refuge and forage areas for multiple life history stages of designated project site EFH species. Wetlands are highly productive habitats especially in regard to providing prey species for both adult and juvenile fish. Loss of low emergent marsh would cause a proportional loss of these ecological functions relating to juveniles of EFH species *including*, winter flounder, windowpane, bluefish, butterfish, and summer flounder. These potential impacts would remain highly localized within the project area.

Through EPW evaluations and coordination with federal and state agencies, the following path was chosen to mitigate for project impacts: credits from an existing bank would be purchased to mitigate for freshwater impacts; as credits are unavailable for the coastal and riparian impacts, two sites are proposed for mitigation and represented as Contract 1. For both sites to proceed, the real estate would need to be acquired. Results for hazardous, toxic and radioactive wastes were coordinated with NJDEP DLUR and there were no issues.

- Pews 4 is shown in Figure 3 as Contract 1 and consists of dense monocultures of *Phragmites* sp. (common reed), opportunistic weeds and shrubs (e.g., sumacs, etc.), and successional trees. The objective would be to convert the common reed monoculture to maritime forested wetlands to serve as coastal wetland mitigation. After the first year of planting, active management (weeding, etc.) would be necessary to promote optimal tree survival. Per recommendations from the United Stated Fish and Wildlife Service (USFWS) Planning Aid Letter, and the establishment by President Obama of the Pollinator Health Task Force in 2014, the mitigation design would incorporate herbaceous vegetation that would help support pollinator species.

- Due to real estate uncertainties, the location of Compton 6 is not mapped. The site consists of a large dense common reed monoculture adjacent to Compton Creek, a tidal waterbody. The objective would be to remove the common reed and replant it with native salt marsh emergent and scrub/shrub species for coastal and riparian mitigation. Based on tidal datum analyses and site topography, additional tertiary channels could be created to improve tidal ebb and flow to the site. After the first year of planting, active management (weeding, etc.) would be necessary to promote optimal survival.

Impacts to the entire Pews Creek wetland is not anticipated based on the District's hydrodynamic model of Pews Creek, which determined that the placement of a tide gate in Pews Creek would have minimal effect on the daily tidal cycle. However, pre and post-construction monitoring of the tidal range and salinity in the Pews Creek marsh is proposed to identify what if any impacts occur due to the tide gate. The District will coordinate with the NMFS and other resource agencies regarding the results of the monitoring. The District proposes to record data in the spring of 2016 through the start of construction in late 2016 in order to establish a baseline, and then for two years following construction.

4.3 CUMULATIVE IMPACTS

The Council on Environmental Quality regulations (40 CFR 1508.7) define cumulative impacts as the "impact on the environment which results from the incremental impact of the action when added to past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time". NEPA documents should only consider those past, present, and future actions that incrementally contribute to the cumulative effects on resources affected by the proposed action (http://www.epa.gov/sites/production/files/2014-08/documents/cumulative.pdf; accessed on 1/14/16); therefore, this analysis focuses on Phase II (proposed action) of the project only. An analysis of cumulative impacts relevant to Phase I (beach nourishment) was developed for the Union Beach Coastal Storm Risk Management Project (USACE 2015), and included placement of sand from the Sea Bright Borrow Area to beaches in Keansburg, Port Monmouth, Union Beach, etc. This analysis is incorporated by reference and is not considered below.

For this analysis, the spatial boundaries includes the shoreline of RBSHB extending from Matawan to Atlantic Highlands from west to east and from the shoreline of the Bay to Route 36 running north to south, in which the habitat is similar to the project area. The timeframe in which the analysis occurs is October of 2012, post Hurricane Sandy, through 2027.

4.3.1 Actions Considered in Cumulative Analysis

Past and current actions that need to be considered against the proposed action include:

- District and/or NJ State Sponsored Projects: levee repair in Keansburg, adjacent to Pews Creek, due to damages from Hurricane Sandy (completed in 2014); replacement of two existing/failing outfall pipes at the dune in Keansburg (to be completed first quarter of 2016);
- Monmouth County Sponsored Projects: beachfront redevelopment project in Union Beach that restored the beachfront, enhanced public access to the beach, and helped to upgrade adjacent commercial and residential areas (construction completion unknown).

There are several reasonably foreseeable future actions to be considered.

- District and New Jersey state sponsored projects include: flood control features in Union Beach, including levees, floodwalls, road raising, tide gates, interior drainage, and pump stations (approximately 14 months; estimated completion in 2018); shore protection in Highlands, to include the raising of existing bulkheads and construction of some floodwalls (approximately 30 months, with estimated completion in 2020); flood control features in Leonardo through non-structural methods to include the raising of homes (construction estimated in 2017).
- The Monmouth County Bayshore Region Strategic Plan outlines potential projects along Raritan Bay (http://co.monmouth.nj.us/documents/24%5CBayshore%20Region%20Plan.pdf, accessed 1/14/16). The plan was developed as part of a study funded by the Office of Smart Growth of the New Jersey Department of Community Affairs with oversight provided by the Monmouth County Planning Board. It is unclear if and when these initiatives would take place, or if any would overlap with the timeframe of District and NJ State projects. Proposed projects include:
    - waterfront/open space initiatives along Raritan Bay to include:
        - Matawan Creek Wetlands - enhancement and/or restoration;
        - Keyport - revitalization efforts in the waterfront business district; bulkhead replacement, a new promenade, Green Acres pier replacement, harbor dredging, American Legion Drive replacement, downtown and waterfront parking, and a waterfront market;
        - Conaskonk Point - enhancement and/or restoration;
        - Natco Lake - enhancement and/or restoration;
        - Union Beach - access to waterfront north of a proposed corporate campus;
        - Waackaack Creek Greenway - enhancement and/or restoration of a riparian corridor;
        - Belford Seafood Cooperative - gateway from Main Street. For example: landscaping, streetscapes, and features and signage identifying the community to direct drivers;
        - Many Mind Creek Greenway - enhancement and/or restoration of a salt marsh;
        - Popamora Park - enhancement and/or restoration of a trail;
        - Highlands Promenade - proposed completion; and
        - Veteran’s Point Park - enhancement and/or restoration; water taxi service to Sandy Hook;
        - Regional linear park, called the Bayshore Trail System, to provide continuous visual, pedestrian, and bicycle access to and along the Raritan Bay waterfront for the general public and protect and enhance the scenic, natural, historic, cultural, and open space resources of the Bayshore and integrate them into a

major waterfront park. The path would avoid wetlands or other sensitive environmental factors (http://www.visitmonmouth.com/documents/24%5CBayshoreTrailSystemDesignManual1993.pdf, accessed 1/14/16);

- New Sandy Hook bridge;
- Redevelopment in Keansburg - improve access to the beachfront while preserving and restoring natural areas.

4.3.2 Potential Cumulative Impacts

Due to the similarity in project type, habitat, and EFH species' behavior, similar impacts for the Union Beach project are anticipated as described in Section 5.0. Significant adverse cumulative impacts are not anticipated due to the distance between projects and timing of construction.

Beneficial cumulative impacts are anticipated through the restoration and mitigation of wetlands and riparian habitat in Port Monmouth, Union Beach, Highlands (if needed), Waackaack Creek, Matawan Creek, Many Mind Creek, and Natco Lake.

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APPENDIX A
RBSHB SURVEY DATA

Table A-1. Catch and size statistics for EFH designated fish species collected in 55 beach seine hauls at Union Beach and Cliffwood Beach, NJ, June-November 1999.

Species	Number Caught	Number per Haul	Mean Length (mm)	Minimum Length (mm)	Maximum Length (mm)
Bluefish	392	7.13	79.5	19	162
Winter flounder	128	2.33	58.8	30	440
Windowpane flounder	16	0.29	41.8	22	60
Summer flounder	12	0.22	272.5	165	375
Atlantic herring	3	0.05	63.7	60	71
Spanish mackerel	1	0.02	60	NA	NA
Black sea bass	1	0.02	36	NA	NA
Cobia	1	0.02	72	NA	NA

Source: USACE 2000a.

Table A-2. Numbers and percent of fish by species caught in beach seine collections in RBSHB, New Jersey, June 1982-June 1983.

	SAMPLING LOCATION											
Common Name	Perth AmboySTA 2	South Amboy STA3	MorganSTA4	Laurence Harbor STA5	Cliffwood Beach STA6	Keyport STA7	Union Beach STA8	Keansburg STA9	Port Monmouth STA10	Leonardo STA11	Total	Percent
American eel	4	7	46	0	2	32	2	1	0	0	**94**	**0.09**
Blueback herring	1	2	2	5	2	6	1	23	19	4	**65**	**0.06**
Alewife	0	0	0	0	0	0	0	0	3	0	**3**	**0.00**
American shad	0	2	0	2	0	0	2	3	1	1	**11**	**0.01**
Atlantic menhaden	2	1	2	4	5	14	0	178	8	362	**576**	**0.54**
Gizzard shad	0	0	1	1	0	0	0	0	0	0	**2**	**0.00**
Striped anchovy	0	9	0	2	7	0	183	11	183	9	**404**	**0.38**
Bay anchovy	7,785	7,653	2,403	1,085	1,240	4,744	3,415	5,825	1,885	1,670	**37,705**	**35.52**
Goldfish	0	0	0	1	0	0	0	0	0	0	**1**	**0.00**
Golden shiner	0	1	0	0	0	0	0	0	0	0	**1**	**0.00**
Atlantic tomcod	0	0	2	0	3	5	0	0	0	0	**10**	**0.01**
Pollock	0	0	8	0	1	0	0	0	0	1	**10**	**0.01**
Halfbeak	0	0	0	2	0	0	0	0	0	0	**2**	**0.00**
Atlantic needlefish	0	3	0	8	12	4	3	0	1	0	**31**	**0.03**
Sheepshead minnow	0	0	0	0	0	1	0	0	0	0	**1**	**0.00**
Banded killifish	2	0	1	0	1	0	0	1	0	0	**5**	**0.00**
Mummichog	139	16	2,564	29	3,208	3,147	2	2	13	69	**9,189**	**8.66**
Striped killifish	243	1,083	3,709	3,103	6,432	580	13	3	4	341	**15,511**	**14.61**
Inland silverside	4	1	27	1	5	22	3	0	6	5	**74**	**0.07**
Atlantic silverside	2,615	2,694	3,640	14,958	4,651	1,497	3,750	590	783	3,286	**38,464**	**36.23**
Four spine stickleback	0	0	1	0	0	0	0	0	0	0	**1**	**0.00**
Three spine stickleback	1	1	0	3	3	0	2	1	0	0	**11**	**0.01**
Nine spine stickleback	0	0	1	0	0	0	0	0	0	0	**1**	**0.00**
Lined seahorse	0	1	1	0	0	2	0	0	0	0	**4**	**0.00**
Opossum pipefish	0	0	1	0	0	0	0	0	0	0	**1**	**0.00**
Northern pipefish	14	12	9	4	12	1	13	11	73	5	**154**	**0.15**
White perch	0	0	2	0	1	0	2	0	1	0	**6**	**0.01**
Striped bass	0	0	0	1	0	1	1	1	1	0	**5**	**0.00**
Pumpkinseed	0	0	0	1	1	0	0	0	0	0	**2**	**0.00**
Bluefish	545	324	181	49	205	190	222	582	116	112	**2526**	**2.38**
Crevalle jack	1	0	0	1	0	12	0	1	1	1	**17**	**0.02**
Round scad	0	0	0	0	0	0	0	0	0	1	**1**	**0.00**

Permit	0	0	0	0	0	0	1	0	1	0	**2**	**0.00**

Table A-2. Numbers and percent of fish by species caught in beach seine collections in RBSHB, New Jersey, June 1982-June 1983 (continued).

Common Name	SAMPLING LOCATION											
	Perth AmboySTA 2	South Amboy STA3	MorganSTA4	Laurence Harbor STA5	Cliffwood Beach STA6	Keyport STA7	Union Beach STA8	Keansburg STA9	Port Monmouth STA10	Leonardo STA11	**Total**	**Percent**
Palometa	0	0	0	0	0	0	0	0	0	1	**1**	**0.00**
Weakfish	181	4	0	0	13	6	54	248	5	126	**637**	**0.60**
Spot	2	0	25	14	0	13	5	0	6	22	**87**	**0.08**
Northern kingfish	0	41	0	1	0	0	4	5	18	0	**69**	**0.06**
Spotfin butterfly fish	1	0	0	0	0	0	0	0	0	0	**1**	**0.00**
Tautog	10	3	48	0	9	9	23	0	7	11	**120**	**0.11**
Striped mullet	1	0	6	10	10	42	6	0	5	12	**92**	**0.09**
White mullet	0	2	7	0	1	57	5	0	3	2	**77**	**0.07**
Northern stargazer	0	0	0	0	0	0	0	4	0	0	**4**	**0.00**
American sand lance	0	0	0	0	0	0	0	5	2	2	**9**	**0.01**
Naked goby	0	0	0	0	0	1	0	0	0	0	**1**	**0.00**
Striped searobin	0	6	0	0	0	0	0	0	0	0	**6**	**0.01**
Grubby	0	0	0	0	0	0	0	2	0	1	**3**	**0.00**
Smallmouth flounder	0	0	0	0	0	0	0	0	2	0	**2**	**0.00**
Summer flounder	0	0	0	0	0	0	0	0	0	5	**5**	**0.00**
Windowpane	0	0	0	0	0	0	0	4	7	0	**11**	**0.01**
Winter flounder	21	8	19	1	26	26	8	3	10	2	**124**	**0.12**
Northern puffer	0	4	5	0	0	0	2	7	8	0	**26**	**0.02**
Bluespotted sunfish	1	0	0	0	0	0	0	0	0	0	**1**	**0.00**

Source: Don Byrne, New Jersey Department of Environmental Protection, Division of Fish, Game and Wildlife, Nacote Creek Research Station.

Table A-3. Numbers and percent of invertebrates by species caught in beach seine collections in RBSHB, New Jersey, June 1982-June 1983.

	SAMPLING LOCATION											
Common Name	Perth Amboy STA2	South Amboy STA3	Morgan STA4	Laurence Harbor STA5	Cliffwood Beach STA6	Keyport STA7	Union Beach STA8	Keansburg STA9	Port Monmouth STA10	Leonardo STA11	**Total**	**Percent**
Horseshoe crab	0	1	4	8	3	0	7	1	0	3	**27**	**0.01**
Grass shrimp (*P. pugio*)	11,401	855	141,224	1,832	1,681	154,683	45	208	39	123	**312,091**	**93.69**
Grass shrimp (*P. vulgaris*)	389	206	5,658	1	223	5,269	62	6	58	20	**11,892**	**3.57**
Sand shrimp	177	875	1,224	40	792	5,434	102	83	48	59	**8,834**	**2.65**
Rock crab	0	0	0	3	0	0	2	1	3	1	**10**	**0.00**
Green crab	0	0	1	0	0	4	1	0	0	1	**7**	**0.00**
Lady crab	0	3	0	2	3	0	9	51	44	5	**117**	**0.04**
Blue crab	2	10	37	0	17	22	0	0	2	2	**92**	**0.03**
Mud crab (*P. herbstii*)	0	0	0	0	0	0	0	0	33	0	**33**	**0.01**
Mud crab (*E. depressus*)	1	0	0	0	0	0	0	0	0	0	**1**	**0.00**
Mud crab (*R. harrissii*)	2	2	0	0	0	1	0	0	0	0	**5**	**0.00**
Mud crab (*N. sayi*)	0	0	0	1	0	0	0	0	18	0	**19**	**0.01**

Source: Don Byrne, New Jersey Department of Environmental Protection, Division of Fish, Game and Wildlife, Nacote Creek Research Station

Table A-4. Species composition (percent by number) of dominant benthic macroinvertebrates at three sampling sites on New Jersey shoreline of Raritan Bay, 1994 and 1995.

	Keansburg		Port Monmouth		Laurence Harbor
Taxon	**1994**	**1995**	**1994**	**1995**	**1995**
Mollusca					
Pelecypoda					
Gemma gemma	- -	58.2	2.8	61.1	65.0
Mya arenaria	62.0	< 1	46.9	< 1	
Gastropoda					
Ilyanassa obsoleta	5.1	< 1			
Annelida					
Polychaetes					
Caulleriella killariensis			8.0	- -	
Heteromastus filliformis	10.8	1.6	16.4	1.4	
Leitoscoloplos (LPIL)			5.7	- -	
Protodriloides (LPIL)	- -	5.3			
Tharyx acutus			< 1	13.6	11.3
Oligochaetes					
Enchytraeidae (LPIL)	- -	15.4			
Arthropoda					
Amphipoda					
Gammarus lawrencianus	< 1	11.7			
Mean number/meter^2	5,482.1	6,182.9	5,773.3	5,692.1	3,282.5
Mean gram/meter^2	- -	195.28	- -	25.10	16.70

Source: Ettinger (1996)

Table A-5. Species composition (percent by number) of dominant benthic macroinvertebrates at three sampling sampling sites on New Jersey shoreline of Raritan Bay, 1994 and 1995, by shoreline zone (A=100 ft. below MLW, B=250 ft. below MLW, and C=500-600 ft. below MLW).

1994									
	Keansburg			Port Monmouth			Laurence Harbor		
Taxon	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Mollusca									
Pelecypoda									
Gemma gemma	< 1	9.0	1.7	- -	< 1	11.6			
Mya arenaria	78.0	52.3	51.6	44.8	61.5	14.7			
Gastropoda									
Ilyanassa obsoleta	1.8	3.9	13.0						
Annelida									
Polychaeta									
Caulleriella killariensis				< 1	1.5	34.2			
Heteromastus filliformis	10.0	13.9	6.6	28.8	12.9	7.2			
Leitoscoloplos (LPIL)				4.3	5.8	7.5			
Mean number/meter^2	6,489.0	6,484.3	3,510.3	5,082.6	8,678.3	3,559.1			
Mean gram/meter^2	- -	- -	- -	- -	- -	- -			
1995									
	Keansburg			Port Monmouth			Laurence Harbor		
Taxon	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Mollusca									
Pelecypoda									
Gemma gemma	< 1	55.0	91.6	4.8	56.1	64.5	29.7	67.6	81.9
Mya arenaria				28.6	< 1	- -			
Gastropoda									
Ilyanassa obsoleta	1.8	3.9	13.0	- -	7.5	- -			
Annelida									
Polychaeta									
Glycera dibranchiata							6.8	1.1	1.6
Heteromastus filliformis							5.4	2.1	< 1
Leitoscoloplos fragilis.				- -	2.1	19.0			
Spio setosa							6.8	4.3	- -

Table A-5 (continued). Species composition (percent by number) of dominant benthic macroinvertebrates at three sampling sampling sites on New Jersey shoreline of Raritan Bay, 1994 and 1995, by shoreline zone (A=100 ft. below MLW, B=250 ft. below MLW, and C=500-600 ft. below MLW).

1995									
	Keansburg			**Port Monmouth**			**Laurence Harbor**		
Taxon	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Streblospio benedicti				- -	8.7	< 1			
Tharyx acutus				- -	2.1	19.0	33.8	6.9	4.7
Oligochaetes									
Enchytraeidae (LPIL)	62.5	- -	< 1						
Arthropoda									
Mysidaces									
Neomysis americana				- -	6.6	- -			
Amphipoda									
Gammarus lawrencianus	11.0	29.9	- -						
Mean number/meter^2	4,547.4	5,594.6	8,406.8	256.0	5,168.0	11,652.3	2,705.9	4.124.6	2.786.3
Mean gram/meter^2	12.37	229.05	344.42	2.02	55.98	17.30	19.52	21.13	17.27

Sources: USACE 2000b and c.

Table A-6. Intertidal and Subtidal Benthic Infauna at Cliffwood Beach and Union Beach, New Jersey, June and September, 1999

Taxon	Percent Composition	
	Intertidal	Subtidal
Annelida		
Polychaeta		
Eteone heteropoda	2.06	
Heteromastus filiformis	4.11	2.11
Leitoscoloplos (LPIL)	2.16	
Leitoscoloplos fragilis	1.46	
Mediomastus ambiseta	1.46	5.66
Microphthalmus sczelkowii	1.46	1.07
Orbiniidae (LPIL)	2.35	
Polydora cornuta	20.66	2.54
Pygospio elegans	8.60	
Scolelepis texana		1.83
Spio setosa		1.27
Streblospio benedicti	2.22	9.12
Streptosyllis verrilli	4.09	10.71
Tharyx acutus		2.38
Oligochaeta		
Paranais littoralis		1.61
Tubificidae (LPIL)	4.28	3.42
Tubificoides wasselli	4.94	22.07
Mollusca		
Gastropoda		
Crepidula fornicata		1.47
Ilyanassa obsoletus	1.38	2.01
Pelecypoda		
Gastropod Egg Case	1.55	2.36
Gemma gemma	3.54	1.71
Mya arenaria	4.13	
Arthropoda		
Amphipoda		
Ampithoe valida	1.00	
Ampelisca abdita		12.02
Corophium (LPIL)		1.39

Corophium tuberculatum		1.53
Elasmopus levis		1.93
Unciola serrata		1.13
Platyhelminthes		
Turbellaria		
Turbellaria (LPIL)	14.13	

Sources: USACE 2000b and c.