US Army Corps of Engineers

Philadelphia District

DRAFT ENVIRONMENTAL ASSESSMENT (EA)

PROPOSED SAND BORROW AREA B
DELAWARE ATLANTIC COAST
FROM CAPE HENLOPEN TO FENWICK ISLAND
STORM DAMAGE REDUCTION PROJECT

NOVEMBER 2015

PREPARED BY:
U.S. ARMY CORPS OF ENGINEERS, PHILADELPHIA DISTRICT

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DRAFT
FINDING OF NO SIGNIFICANT IMPACT (FONSI)
DELAWARE ATLANTIC COAST
FROM CAPE HENLOPEN TO FENWICK ISLAND
SAND BORROW AREA B

An evaluation was performed for a new proposed sand source (borrow area) identified as “Area B” for the purpose of developing a new source of sand primarily for periodic nourishment and storm repairs for Rehoboth Beach and Dewey Beach Storm Damage Reduction Project, and also for Area B to be used interchangeably with other existing sand borrow areas, as needed. In addition, it is proposed that all existing sand sources (Area E and Fenwick Island Borrow Area) and the proposed Area B be used interchangeably for all of the storm damage reduction projects along the Atlantic Coast of Delaware. The interchangeable use of sand borrow areas provides more operational flexibility for managing sand resource needs for these projects.

There are four existing Federal storm damage reduction projects along the Atlantic Coast of Delaware that require sand resources to maintain beach and dune features to provide storm damage reduction for the communities of Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany, Fenwick Island, and a stretch of beach on the north side of Indian River Inlet to protect State Highway 1 and its approach to the Charles W. Cullen Bridge. These projects require variable quantities of sand for periodic nourishment and to reconstruct the beach templates after significant storm events such as hurricanes and nor’easters. The need for a new sand borrow area (Area B) is based on the discontinued use of the previous borrow area for Rehoboth Beach and Dewey Beach, Area G, which was found to have excessive coarse materials in the sand during the initial construction phase of the project. The Fenwick Island borrow area has been used as an interim sand source, but is more than 15 miles away from the project area resulting in higher transport costs and longer construction periods.

In compliance with the National Environmental Policy Act (NEPA) of 1969, as amended, and CEQ regulations, the Philadelphia District has prepared an Environmental Assessment (EA) to document the proposed modified actions. The Draft EA for the project was provided to the U.S. Environmental Protection Agency Region III, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Delaware State Historic Preservation Office, the Delaware Department of Natural Resources and Environmental Control (DNREC), and all other known interested parties for comment. This EA also supplements existing project NEPA documents and evaluates new information as it pertains to the storm damage reduction projects.

The EA has determined that the utilization of Area B as a sand source, and to utilize the existing sand borrow areas E and Fenwick Island interchangeably (along with the proposed Area B), if implemented, would not likely jeopardize the continued existence of any species or the critical habitat of any fish, wildlife or plant, which is designated as endangered or threatened pursuant to the Endangered Species Act of 1973 as amended by P.L. 96-159.

In accordance with the Clean Air Act, this project will comply with the General Conformity (GC) requirement (40CFR§90.153), and analysis has demonstrated that the emissions are considered as *de minimis*. A Statement of Conformity is provided in the EA.

The EA has concluded that the project can be conducted in a manner, which should not violate Delaware's Surface Water Quality Standards, as amended October 11, 2014. Pursuant to Section 401 of the Clean Water Act, a 401 Water Quality Certificate has been requested from the Delaware Department of Natural Resources and Environmental Control (DNREC). Based on the information developed during preparation of the Environmental Assessment, and the application of appropriate measures to minimize project impacts, it was determined in accordance with Section 307(C) of the Coastal Zone Management Act of 1972 that the plan complies with and can be conducted in a manner that is consistent with the approved Coastal Zone Management Program of Delaware. A consistency determination by DNREC has been requested.

There are no known properties listed on, or eligible for listing on, the National Register of Historic Places that would be affected by the proposed activity. The plan has been designed to avoid archaeologically sensitive areas, and is therefore not expected to impact any cultural resources. The State Historic Preservation Office has concurred with this determination.

Because the EA concludes that the proposed use of Borrow Area B and interchangeable use of existing sand borrow areas does not constitute a major Federal action significantly affecting the human environment, I have determined that a Supplemental Environmental Impact Statement is not required.

Date

Michael A. Bliss
Lieutenant Colonel, Corps of Engineers
District Engineer

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1.0 PROJECT DESCRIPTIONS AND LOCATIONS

This document evaluates a proposed offshore sand source for the Atlantic Coast of Delaware beach communities that utilize beachfill for the purpose of storm damage reduction. These communities are along the Atlantic coastline extending from Cape Henlopen to Fenwick Island including the communities of Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany, Fenwick Island, and for the northern shoreline adjacent to Indian River Inlet. These areas are locations with existing authorized Federal storm damage reduction projects that require periodic sand nourishment along the beaches. The sand source (borrow area) identified as "Area B" is proposed as a primary sand source for Rehoboth Beach and Dewey Beach, and as an alternate sand source for the other project locations. These projects have utilized sand obtained from several offshore sand sources for initial construction, periodic nourishment, and for storm-related repairs under the Flood Control and Coastal Emergency (FCCE) PL 84-99 program to construct and maintain these projects in accordance with their authorized design templates. The information in this document supplements previously published National Environmental Policy Act (NEPA) documents. These documents are listed in Table 1-1.

Table 1-1. Previous Delaware Atlantic Coast Federal Storm Damage Reduction Project Documents Incorporated by Reference.

Project	Document	Purpose
Rehoboth Beach and Dewey Beach	Final Feasibility Report and Final Environmental Impact Statement (EIS) (USACE, 1996)	Presented problems and needs, evaluated alternatives, and recommended a plan to address storm damage reduction. Evaluated environmental impacts.
	Final Environmental Assessment and Finding of No Significant Impact (FONSI) (USACE 2002)	Evaluated environmental impacts of a sand borrow area (Area G).
Bethany Beach and South Bethany	Final Feasibility Report and Environmental Impact Statement (EIS) (USACE, 1998)	Presented problems and needs, evaluated alternatives, and recommended a plan to address storm damage reduction. Evaluated environmental impacts.
	Final Environmental Assessment and Finding of No Significant Impact (FONSI) (USACE, 2005)	Evaluated environmental impacts of changes to the project.
Fenwick Island	Final Integrated Feasibility Report and Environmental Impact Statement (USACE, 2000)	Presented problems and needs, evaluated alternatives, and recommended a plan to address storm damage

Table 1-1. Previous Delaware Atlantic Coast Federal Storm Damage Reduction Project Documents Incorporated by Reference.		
Project	Document	Purpose
		reduction. Evaluated environmental impacts.
Indian River Inlet Sand Bypass	Final Environmental Assessment and Finding of No Significant Impact (USACE, 1984)	Evaluated environmental impacts of the sand bypass plant.
	Final Environmental Assessment and Finding of No Significant Impact (USACE, 2013)	Evaluated environmental impacts of the post-Hurricane Sandy restoration of the shoreline along the North Shore of Indian River Inlet and Indian River Inlet flood shoal sand borrow area.

To reduce duplication, only items involving new pertinent information and changes in the plan as previously proposed are addressed in this document. Items covered previously in the aforementioned documents are incorporated by reference.

1.1 Rehoboth Beach and Dewey Beach

USACE (1996) identified a plan in the form of berm and dune restoration utilizing beachfill to reduce storm damages for the communities of Rehoboth Beach and Dewey Beach, Delaware (Figure 1-1).

- The design template plan* for Rehoboth Beach is a 125-foot wide berm with an elevation of +7.2 ft. NAVD (North American Vertical Datum), and a dune with an elevation of +13.2 ft. NAVD.
- The design template plan* for Dewey Beach is a 150-foot wide berm with an elevation of +7.2 ft. NAVD, and a dune with an elevation of +13.2 ft. NAVD.
- Berm and dune restoration on 13,500 linear feet of the existing beaches.
- Dune grass, dune fencing and periodic nourishment to ensure the integrity of the design.
- Approximately 1.5 million cubic yards of initial sand fill was dredged from an offshore sand source and placed along the shoreline. This plan includes subsequent periodic nourishment of approximately 360,000 cubic yards of sand fill every three years for 50 years (This amount is based on an average need projected over a 50-year project. Actual periodic nourishment amounts and time durations between nourishment cycles may vary.).

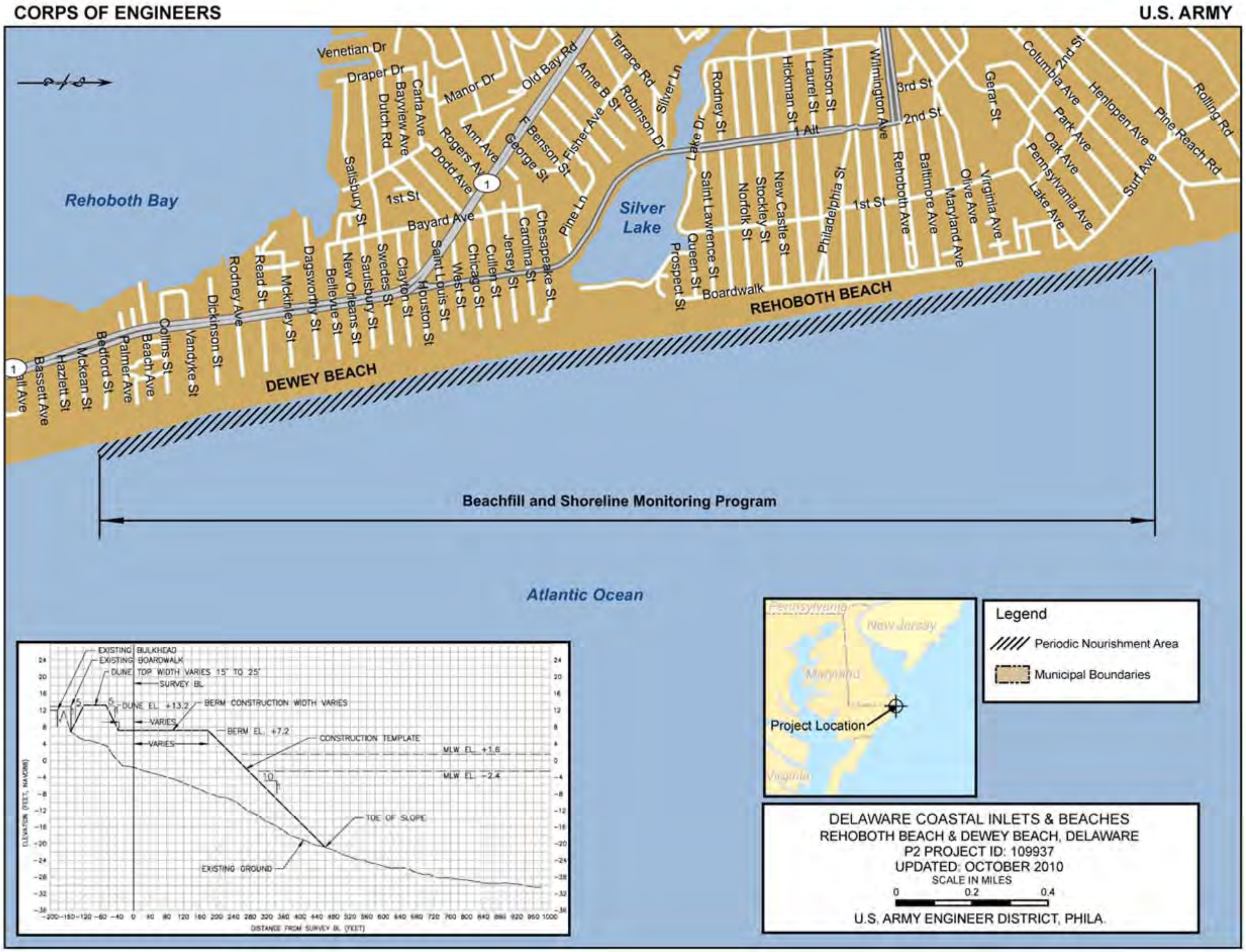

Figure 1-1. Rehoboth Beach and Dewey Beach Project Plan and Template.

- Periodic nourishment and FCCE repairs to the project were conducted subsequent to initial construction, and are presented in Table 1-2.
- The sand source identified in USACE (1996) was a 1,120-acre portion of Hen and Chickens Shoal (HCS) located approximately 1.8 – 3.0 miles offshore of Rehoboth Beach. This site was withdrawn due to fisheries issues. A source identified as “Area G” (1-2 miles southeast of Indian River Inlet) was later proposed (USACE, 2002) and used for the initial construction in 2005 where approximately 1.7 million cubic yards of sand was dredged. Area G produced a large percentage of gravels and pebbles on the beach, which was undesirable for beach recreation. This prompted the use of the Fenwick Island sand source as an interim site for subsequent nourishments conducted in 2009, 2011, and 2013. These borrow area locations are presented in Figure 1-2.

*The design template plan represents the minimum dimensions of the beach for which storm damage reduction benefits were derived. Due to projected sand losses, the design template alone is not sustainable without a quantity of sacrificial sand added to it. This additional sand quantity is described as “advanced nourishment”, which is required to maintain the design template. Advanced nourishment may add an additional 100-200 ft. width to the design template berm. Another consideration is that a berm width may be even wider than the advanced nourishment beach due to construction techniques required to hold a foreshore slope for survey measurements. The combination of these factors produces the “construction template”, which results in a significantly wider berm than the design template at the time of fill placement, but is a temporary condition as this profile will adjust seaward. This seaward adjustment will result in a smaller berm width soon after fill placement, but the rate of this adjustment will depend on the wave climate/erosion rates after fill placement. Over a given time (depending on erosion rates), the berm may erode back to the design template width, which will require re-nourishment. This is considered “periodic nourishment”, which is a projected average of beachfill quantity required over a given time period.

Table 1-2. Rehoboth Beach and Dewey Beach Storm Damage Reduction Project Sand Borrow Area Usage and Project Phases.

Year	Project Phase	Quantity of Sand (CY)	Borrow Area(s)	Dredge Type(s)
2005	Initial Construction	1,690,000	Area G	Hopper
2009	Periodic nourishment (partial-Dewey Bch. only)	290,000	Fenwick Island	Hopper
2012	Periodic nourishment and FCCE Repairs (2009 Nor’Ida storm)	982,000	Fenwick Island	Hopper
2013	FCCE Repair/Restore (2012 Hurricane Sandy)	509,000	Fenwick Island	Hopper

FCCE is Flood Control and Coastal Emergency Project repairs conducted in accordance with PL-84-99.

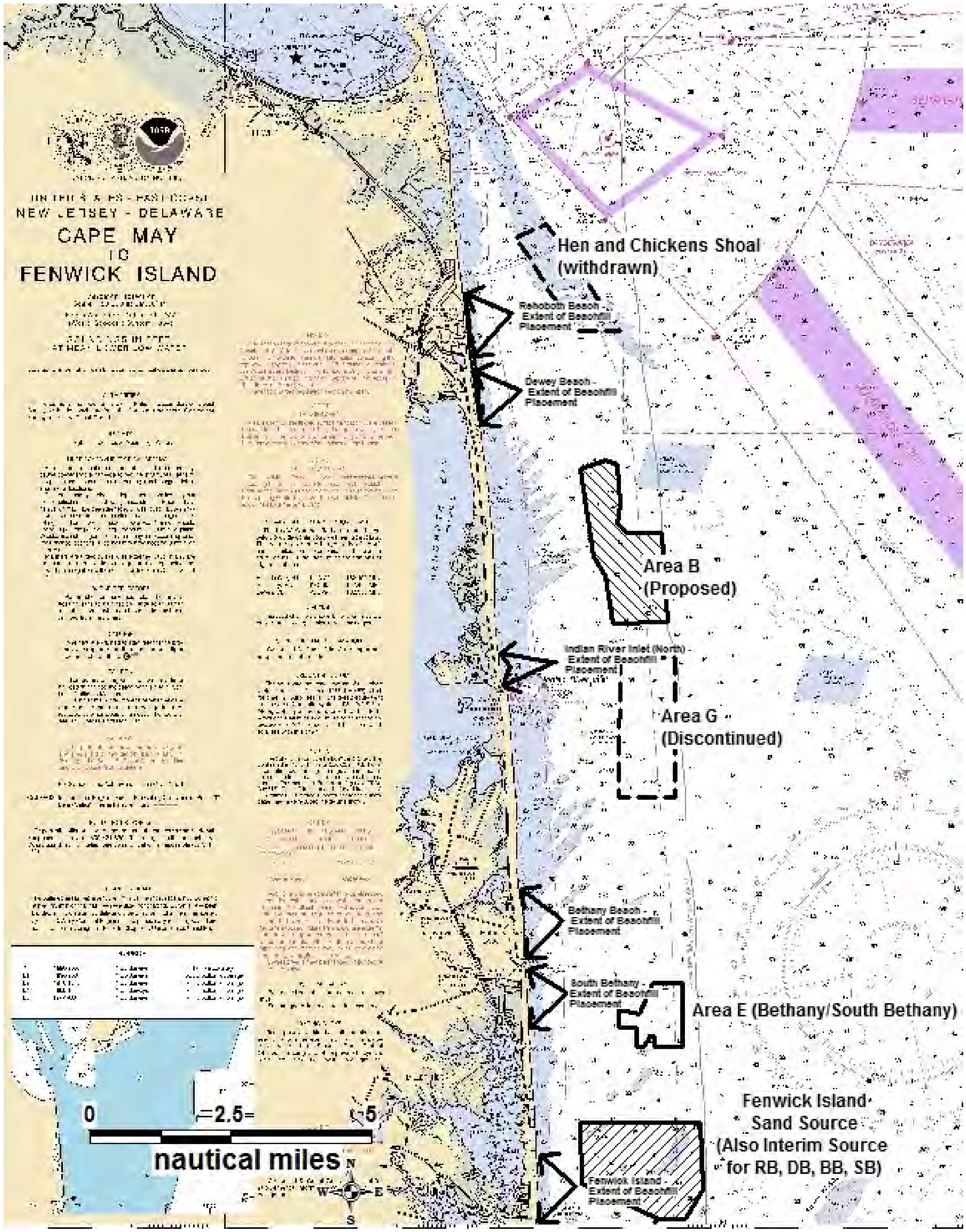

Figure 1-2. Delaware Atlantic Coast Offshore Sand Borrow Areas.

Area G was utilized as a sand source in the initial construction phase of the project in 2005 where approximately 1.7 million cubic yards of material from this site were obtained as beachfill material to construct the authorized berm and dune configuration. Subsequently, the Philadelphia District and its non-Federal partner, the Delaware Department of Natural Resources and Environmental Control, received complaints from the public that the sandy material placed there contained a large percentage of coarse gravel and pebbles, which had unintended adverse effects on beach recreation. A review of vibracore data, which included new data collected subsequent to the 2005 beachfill, demonstrated that it was likely that this type of material would be encountered again during periodic nourishment. Therefore, Area G was discontinued as a sand source. In the interim, the Fenwick Island sand source was identified as having sufficient higher quality sand, and is being used for periodic nourishment until a site is approved for use that is closer to the Rehoboth Beach and Dewey Beach project area. Area B (located 2.5 to 5.0 miles from the Rehoboth Beach/Dewey Beach project area) was considered as an alternative site in USACE (2002), but was eliminated due to the presence of hard bottom benthic habitats (relic corals, mussel beds) and finer sands in the northwest portion. In response to the need to develop a site with compatible sand resources nearer to the project location, additional cores were collected in 2011 in and around the vicinity of the Area B as it was delineated in USACE (2002). Based on these cores, the boundaries of Area B were re-drawn to include the most compatible sand resources required for the Rehoboth Beach/Dewey Beach project. Table 1-2 provides a history of borrow area usage for the Rehoboth Beach and Dewey Beach Federal project.

1.2 Bethany Beach and South Bethany

USACE (1998) identified a plan in the form of berm and dune restoration utilizing beachfill to reduce storm damages for the communities of Bethany Beach and South Bethany, Delaware (Figure 1-3). The plan identified in this document includes the following features:

- Two distinct project areas covering the towns of Bethany Beach and South Bethany separated by approximately 3,500 feet of private beach.

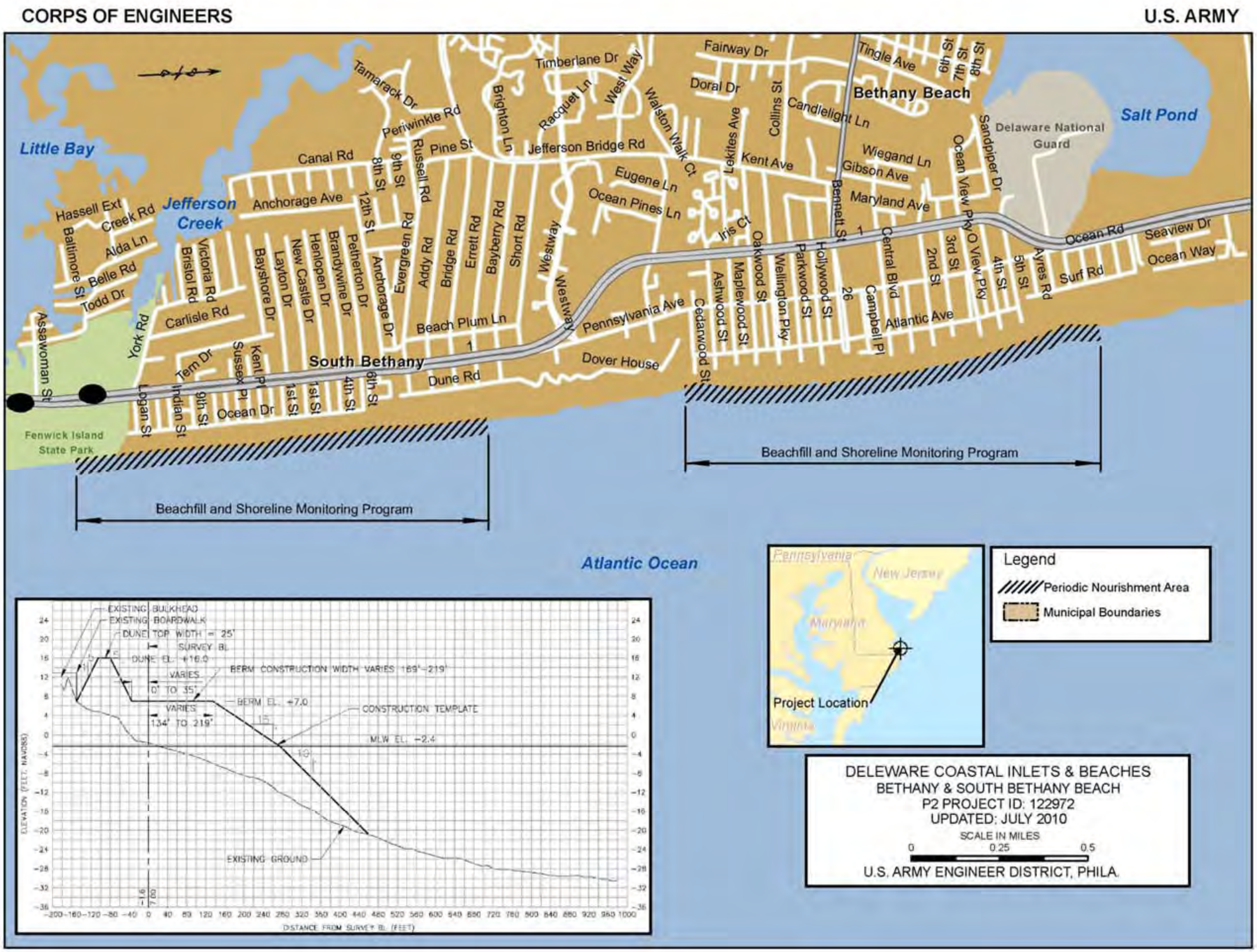

Figure 1-3. Bethany Beach and South Bethany Project Plan and Template.

- For Bethany Beach, the design template plan requires a berm and dune configuration extending seaward a minimum of 150 ft. from the design line at an elevation of +7 ft. North American Vertical Datum (NAVD). For South Bethany, the design template plan requires a berm and dune configuration extending seaward a minimum of 150 ft. from the design line at an elevation of +7 ft. NAVD. Both berm plans have a foreshore slope of 1V:15H to mean low water (MLW). From MLW seaward, the slope parallels the bottom out to the depth of closure.
- The beachfill project for Bethany Beach extends along the entire length of the town with the taper area extending approximately 1,000 ft. to the north and south of the town borders. Likewise, the beachfill project for South Bethany extends along the entire length of the town with the taper area extending approximately 1,000 ft. to the north and south of the town borders. The total length of both proposed beachfill segments is approximately 14,950 l.f.
- On top of both berm plans, in both communities, a dune with a top elevation of +16 ft. NAVD and a top width of 25 ft. would be constructed. The landward and seaward slope of the dune face would be 1V:5H.
- A total sand fill quantity of approximately 3.13 million cubic yards was required for the initial fill placement in Bethany Beach and South Bethany in 2007-2008.
- Dune restoration requires approximately 24 acres of planted dune grass and approximately 27,425 l.f. of sand fence for stabilization of sand on the dune, delineating walkovers, and vehicle access ramps.
- 41 dune walkovers are provided (one at each street end) and 1 vehicle access-way over the dune in Bethany Beach. The vehicle access for South Bethany is located approximately 0.25 miles south of the southern limit of South Bethany within Fenwick Island State Park.
- To maintain the design template, approximately 480,000 cubic yards of sandy beachfill from the offshore sand source would be required every 3 years for the 50-year project life (This amount is based on an average need projected over a 50-year project. Actual periodic nourishment amounts and time intervals between nourishment cycles may vary.).
- Periodic nourishment and FCCE repairs to the project were conducted subsequent to initial construction, and are presented in Table 1-3.
- The primary sand source is the middle portion of Area E, which is a 775-acre area approximately 1.5-2.8 nautical miles offshore of South Bethany (Figure 1-2). Sandy material for periodic nourishments would be required to be dredged from areas either to the north or south of the middle portion. Area E and the Fenwick Island sand source have been used for this project, and this usage is presented in Table 1-3.

Table 1-3. Bethany Beach/South Bethany Storm Damage Reduction Project Sand Borrow Area Usage and Project Phases.				
Year	**Project Phase**	**Quantity of Sand (CY)**	**Borrow Area(s)**	**Dredge Type(s)**
2008	Initial Construction	3,130,000	Area E	Hopper
2009	Post storm maintenance	198,000	Area E	Hopper
2011	FCCE Repairs (2009 Nor'Ida storm)	296,000	Area E/Fenwick Island	Hydraulic cutterhead
2012	Periodic nourishment and FCCE Repairs (2009 Nor'Ida storm)	1,145,000	Fenwick Island	Hydraulic cutterhead
2013	FCCE Repair/Restore (2012 Hurricane Sandy)	536,000	Fenwick Island	Hopper
FCCE is Flood Control and Coastal Emergency Project repairs conducted in accordance with PL-84-99.				

1.3 Fenwick Island

USACE (2000) identified a plan in the form of berm and dune restoration utilizing beachfill to reduce storm damages for the community of Fenwick Island, Delaware (Figure 1-4). The plan identified in this document includes the following features:

- A dune and berm configuration with a minimum design template width of 200 feet (125-ft. dune base and 75 ft. berm). The construction template would provide a berm width (from the seaward toe of the dune) of approximately 285 feet, which includes advanced nourishment. The berm elevation would be +7.7 ft. NAVD (North American Vertical Datum), and the dune elevation would be +17.7 ft. NAVD. The berm plan has a foreshore slope of 1V:15H to mean low water (MLW). From MLW seaward, the slope parallels the bottom out to the depth of closure.
- The beachfill extends along the entire community of Fenwick Island from 1,000 feet below the Maryland state line northward for a distance of approximately 8,000 feet. This includes a taper of 500 feet that would extend from the northern end of the project into Fenwick Island State Park.
- A total sand fill quantity of approximately 1,000,000 cubic yards of initial fill to be placed on the beach and dunes, intertidal areas and nearshore subtidal areas within the project area (Approximately 833,000 cubic yards was actually used for initial construction in 2005).
- The selected plan includes dune grass, sand fencing, and suitable advanced beachfill and periodic nourishment to ensure the integrity of the design.

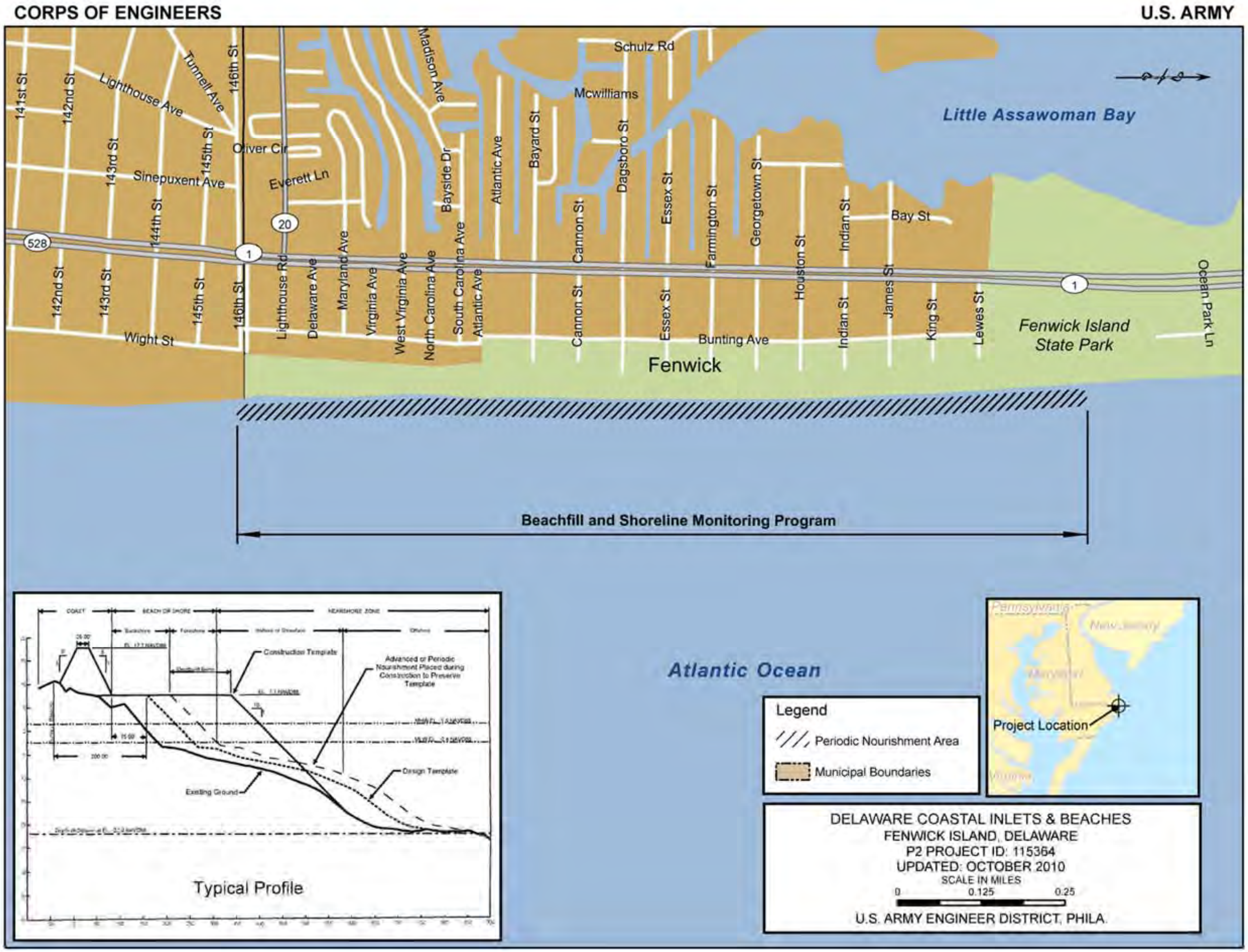

Figure 1-4. Fenwick Island Project Plan and Template.

- Approximately 320,000 cubic yards of beachfill would be required every 4 years for periodic nourishment of the beach.
- A 2,870-acre area that lies approximately 4,600 feet offshore from Fenwick Island (in Delaware waters) is the sand source (Figure 1-2).
- To maintain the design template, approximately 320,000 cubic yards of sandy beachfill from the offshore sand source would be required every 4 years for the 50-year project life (This amount is based on an average need projected over a 50-year project. Actual periodic nourishment amounts and time intervals between nourishment cycles may vary. See Table 1-4).
- Periodic nourishment and FCCE repairs to the project were conducted subsequent to initial construction, and are presented in Table 1-4.

Table 1-4. Fenwick Island Storm Damage Reduction Project Sand Borrow Area Usage and Project Phases.

Year	Project Phase	Quantity of Sand (CY)	Borrow Area(s)	Dredge Type(s)
2005	Initial Construction	833,000	Fenwick Island	Hopper
2011	Periodic nourishment and FCCE Repairs (2009 Nor'Ida storm)	332,000	Fenwick Island	Hydraulic cutterhead
2013	FCCE Repair/Restore (2012 Hurricane Sandy)	368,000	Fenwick Island	Hopper

FCCE is Flood Control and Coastal Emergency Project repairs conducted in accordance with PL-84-99.

1.4 Indian River Inlet Sand Bypass Project

The project was designed to remedy erosion problems on the ocean shoreline north of Indian River Inlet, and to protect the main north-south State highway (Delaware Route 1) along the Atlantic Ocean. The recommended plan included beach nourishment utilizing a sand bypass plant at Indian River Inlet (Figure 1-5). The sand bypassing system at Indian River Inlet transports sand from the updrift (south) ocean beach to the down drift (north) ocean beach. Sand bypassing began in January 1990 and replaced the prior practice of hydraulically dredged beach fills at intervals that averaged about four years between 1957 and 1990. The bypassing system consists of a crane-mounted jet pump operating from the south jetty fillet, a pump house located adjacent to the south jetty, and a pipeline to transport the bypassed sediment across the highway bridge to be deposited along the north ocean beach. The system was designed to bypass approximately 100,000 cubic yards of sand per year during the interval between Labor Day and Memorial Day. Between Memorial Day and Labor Day, bypassing is suspended to avoid disruption of summer recreational use of the north and

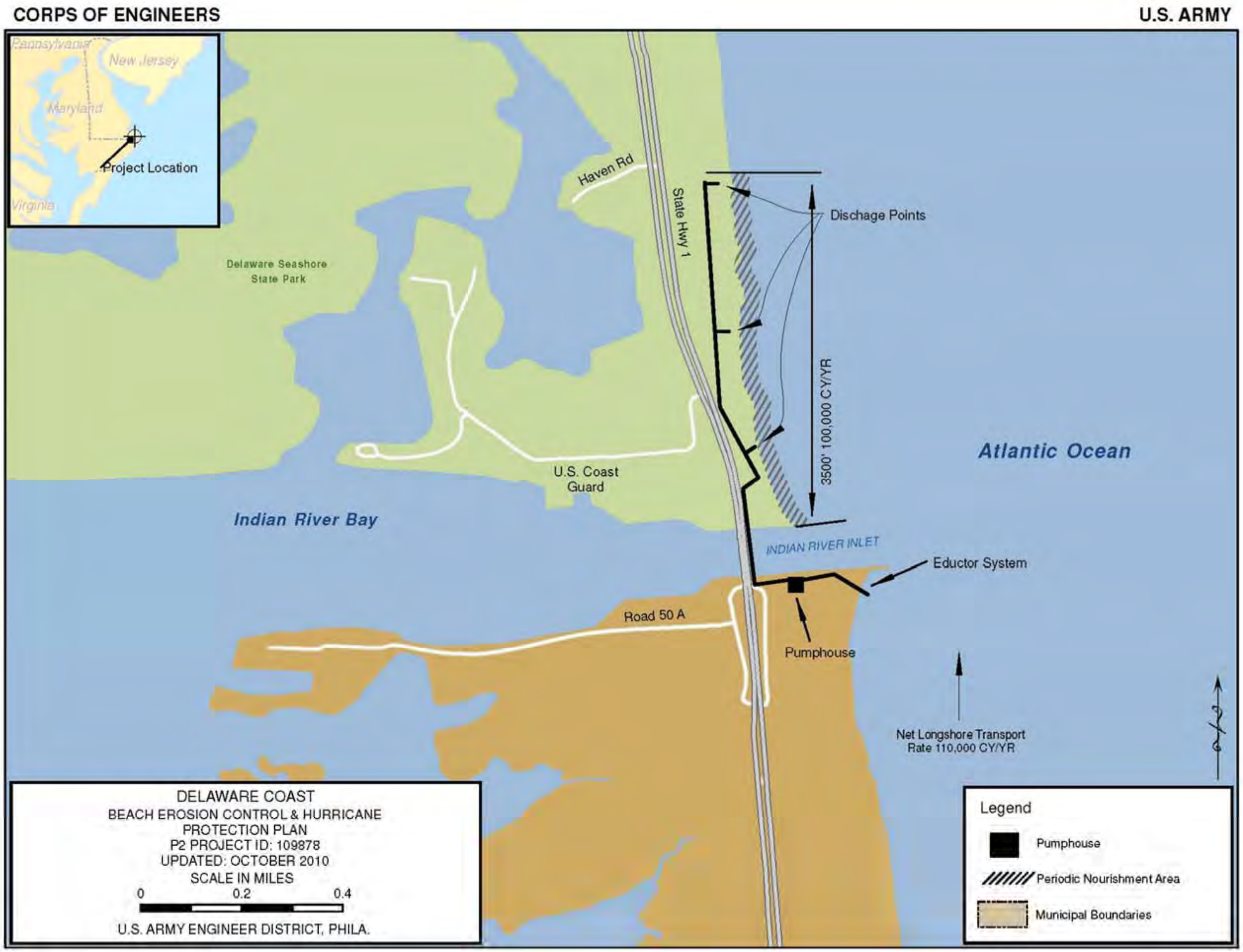

Figure 1-5. Indian River Inlet Sand bypass Project Plan.

south ocean beaches, which are both operated as State parks. Beach profile monitoring of the beaches north and south of the inlet has been performed one or two times per year from 1984 to the present. Because of recent storm activity, the sand bypass system has not kept pace with erosion rates on the north side, and a long-term offshore sand source is required to supplement the bypass system. Due to the effects of Hurricane Sandy in October 2012, approximately 529,000 cubic yards of sand was required to restore the beach template on the north side of Indian River Inlet. This beachfill extended north from the north jetty for approximately 5,200 linear feet. This sand was obtained from a flood shoal within the Indian River Inlet interior area in 2013. Because of potential effects on estuarine fishery resources from dredging within the flood shoal of IRI, an offshore site is being pursued to provide supplemental sand resources to respond to future storm damage repair needs.

2.0 PURPOSE AND NEED

Offshore sand sources are a critical feature for the Federal storm damage reduction projects along the Delaware Atlantic Coast from Cape Henlopen to Fenwick Island. These projects require large quantities of sand to construct/maintain berm and dune configurations that provide a soft buffer from storm surges that could have catastrophic effects on the beach communities. Sand is normally obtained from several types of sources ("borrow areas") that include dredging from offshore sand sources, inlet ebb or flood shoals, inland bays, inlet fillet areas, and land-based sources (i.e. sand pits/quarries). With the exception of the Indian River Inlet area, the Federal storm damage reduction projects along the Atlantic Coast of Delaware have used offshore sand sources to construct/maintain the authorized berm and dune configurations. Offshore sand resources provide a technically feasible and economic means to obtain and supply the large quantities of beachfill quality sand required for these projects. A number of constraints such as sand compatibility, environmental factors, transport distances, obstacles (such as artificial reefs, cables, shipwreck sites, etc.) can limit the number of viable offshore sand sources and quantities available.

The Rehoboth Beach and Dewey Beach project required approximately 1.5 million cubic yards of sand for the initial construction that was completed in 2005. The sand source used for the initial construction was "Area G", which is located 1-2 miles east and southeast of Indian River Inlet. The material from Area G placed on the beach had a large granular component of gravels and pebbles. Although gravels and pebbles (in small amounts) are a normal component of native beach sand for Rehoboth Beach and Dewey Beach, the higher amounts of gravels and pebbles pumped onto the beach in 2005 had unintended adverse impacts on beach recreation/aesthetics (Figure 2-1). Over time, most of these pebbles and gravels have naturally transported or dissipated out of the Rehoboth Beach area (personal communication with Anthony Pratt – DNREC Shoreline Administrator). However, despite this movement of gravels/pebbles, the continued use of Area G as a sand source for periodic nourishment or storm repairs could result in similar impacts on recreation/aesthetics in subsequent periodic nourishments, which was determined to be unacceptable to the State of Delaware.

Therefore, Area G was discontinued as a sand source for Rehoboth Beach and Dewey Beach. In 2009, 2011, and 2013, the “Fenwick Island” sand source (USACE, 2000) was

Figure 2-1. Extensive Pebble Deposits Were Present along Rehoboth Beach's Shoreline Following the 2005 Initial Construction That Utilized Area G as a Sand Source.

used as an interim sand source (identified as having sufficient quantities and suitable sand quality) for periodic nourishment/storm repairs until a new source can be developed. The Fenwick Island sand source is located offshore from the Town of Fenwick Island, and is over 15 miles away from Rehoboth Beach and Dewey Beach.

This distance results in significantly longer construction durations and higher transport costs. Therefore, a need exists to utilize a new offshore sand source that is closer to the Rehoboth Beach and Dewey Beach project. This new source is identified as “Area B”, and is located about 1- 3 miles offshore between Indian River Inlet and Dewey Beach. This source would primarily be used for the Rehoboth Beach and Dewey Beach project, but is proposed for use as an alternate source for the other Federal storm damage reduction projects along Delaware’s Atlantic Coast (Bethany Beach/South Bethany, Fenwick Island, and Indian River Inlet Sand Bypass), if needed.

Another need identified is the ability to use the borrow sites interchangeably among the existing Federal projects. Previously, the Federal Storm Damage Reduction Projects were formulated separately by the communities involved. Each of these projects identified a sand source nearby dedicated to that specific project. Subsequent to the initial construction of these projects, it has become apparent that there is a need to be able to use sand borrow areas interchangeably based on immediate needs during periodic nourishment and storm repairs. To make these sites interchangeable with the destination beaches allows for greater flexibility and would provide readily available permitted sites when a change is required.   This flexibility is most useful to be able to make a change (if necessary) during contract dredging, which would avoid delays and/or remobilization costs. For example, Rehoboth Beach and Dewey Beach utilized Area G for initial construction, but due to the unacceptable pebble/gravel content encountered in Area G, the Fenwick Island borrow area was subsequently used for periodic nourishment and storm repairs, which had more suitable sand. Another recent example was while conducting a renourishment project for Bethany Beach and South Bethany, clay deposits were encountered in Borrow Area E that clogged up screens on the dredge, prompting a move to use the Fenwick Island borrow area for Bethany Beach/South Bethany. Although the clay encountered was in small amounts, it was enough to cause problems due to the type of equipment (i.e. cutter suction dredge with MEC screens) being used by the dredging contractor. Therefore, the interchangeable use of all of the existing borrow areas and the addition of a new source near the Rehoboth Beach and Dewey Beach project would allow greater flexibility for uses during periodic nourishment and storm repair activities for all of the projects if issues develop that may warrant a switch to another borrow area.

3.0 ALTERNATIVES CONSIDERED

All of the Atlantic Coast of Delaware’s Federal storm damage reduction projects were authorized by using beach nourishment to restore/maintain berm and dunes at their prescribed authorized dimensions (see USACE, 1984, 1996, 1998 and 2000). These projects considered and evaluated a number of structural and non-structural alternatives such as bulkheads, sea walls, groins, breakwaters, and permanent evacuation, which are incorporated by reference. The sand bypass facility at Indian River Inlet was constructed in 1990 with bypass operations being conducted annually to the present. In 2013, the north shore of Indian River Inlet was repaired after it was heavily damaged by Hurricane Sandy. This repair resulted in the utilization of the flood shoal as a sand source for over 525,000 cubic yards to restore the berm and dune along a 5,000 - foot long stretch of beach north of the inlet. Rehoboth Beach, Dewey Beach and Fenwick Island were first constructed in 2005 and Bethany Beach/South Bethany's initial construction was completed in 2008.

Because these projects were authorized and constructed previously, the alternatives are focused on the evaluation of sand sources, which are necessary to maintain these projects. Therefore, there will be no consideration for the existing design configurations for these projects in this environmental assessment.

3.1 No Action

The no action alternative was presented in USACE (1996, 2000) and is incorporated by reference. The no action alternative for sand sources would affect the selected plan in USACE (1996), and would, therefore, make berm and dune restoration not feasible. By not constructing a berm and dune restoration project with periodic nourishment, the no action alternative would allow beach erosion to continue resulting in an increased vulnerability to significant property damages and economic losses from storms. No Action would continue the existing conditions as presented in USACE (1996) and in this document due to steady sand losses and storm damage related losses. Aquatic resources in proposed sand sources would remain unaffected from current conditions.

Since the storm damage reduction projects in Delaware are existing Federal projects that use sand replenishment/nourishment to maintain the prescribed beach profiles, no action could also be the continuing of practices that utilize existing sand sources. For Rehoboth Beach and Dewey Beach, the current interim practice of using the Fenwick Island sand source is a high cost practice due to transport distances of 15 nautical miles or more to the receiving beaches. Because of these higher costs associated with sand transportation, an alternative site that is closer to the receiving beaches is being sought. Additionally, another site would provide an alternate sand source if a future need for the other Federal storm damage reduction projects (Bethany Beach/South Bethany, Fenwick Island, and Indian River Inlet) develops.

3.2 Offshore Sand Dredging (Preferred Alternative)

Because of the large volumes of sand required to maintain the storm damage reduction projects along the Delaware Atlantic Coast, offshore dredging is one of the most economical, efficient and technically feasible methods to acquire sand to nourish the beaches. Offshore dredging has the least impact on the communities because it can be accomplished fairly quickly along the beaches with little disturbance to the surrounding communities. Most of the work is conducted on the beaches which are typically closed off to public access in block long segments for a few days to a week at a time. Offshore sand sources are selected based on their sand compatibility with the receiving beaches, quantity of sand available, distance to receiving beaches, and environmental considerations. Environmental and cultural resource concerns with offshore dredging include sand compatibility issues, temporary and long-term impacts on benthic and fishery resources, water quality, entrainment of threatened and endangered species (sea turtles, Atlantic sturgeon), discarded or fired munitions, and submerged cultural resources (shipwrecks and relic prehistoric landforms). Sand sources along the Delaware Atlantic Coast are either within or in close proximity to former military firing ranges, which may increase the potential for encountering munitions and explosives of concern (MECs) during dredging for sand. Therefore, all offshore dredging for beach nourishment projects require screens on the intake end of the dredge and a screen basket at the discharge end on the beach to capture any potential MECs from either entering the dredge or becoming deposited on the beach.

3.2.1 Sand Dredging Methods

All of the Federal storm damage reduction projects along the Atlantic Coast of Delaware for initial construction, periodic nourishment, and storm damage repairs have required sand to be obtained by dredging sand from a “borrow area”. With the exception of the Indian River Inlet North Shore project, all of the projects have utilized offshore sand sources. The Indian River Inlet has in the past used a flood shoal in the interior inlet to provide sand resources when storm repairs to the beach warrant additional quantities of sand that are not available from routine inlet bypass operations. Two types of dredges are typically used along the Delaware Atlantic Coast: a trailing suction hopper dredge (TSHD) and a cutter-suction dredge (CSD).

3.2.1.1 Trailing Suction Hopper Dredge (TSHD)

Trailing suction hopper dredges (TSHDs) are designed to vacuum material from the sea floor through drag arms that load the material into the hold (hopper) of the vessel (3,600 CY to 6,500 CY). The cargo of sand is then sailed to a pump-out location within the nearshore zone where the material is pumped ashore by the ship (or the pump-out station). TSHDs have been used for initial construction and periodic nourishments at Rehoboth Beach/Dewey Beach, Bethany Beach/South Bethany, and Fenwick Island. TSHDs are most beneficial for mining sand from sources that are at far distances from the destination beaches where the vessel can transit between sand source and pump-out location. TSHDs are moving vessels during dredging operations, and typically create shallow furrows within the affected portions after each pass within a borrow area. A typical result would be a broader shallow pit with some uneven furrows within it. Because TSHDs are vessels in motion, they have a higher potential for entraining mobile sea life including threatened and endangered sea turtles and Atlantic sturgeon that may be found along the sea floor. A typical operation of a trailing suction hopper dredge for a beach nourishment project is provided in Figure 3-1.

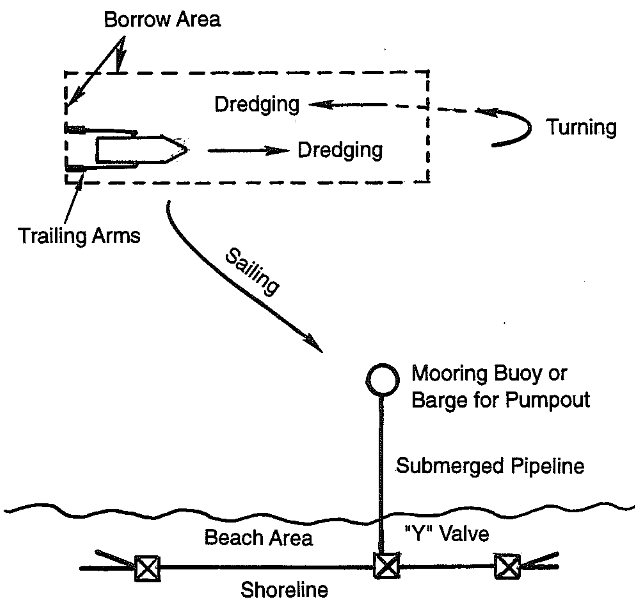

Figure 3-1. Typical Trailing Suction Hopper Dredge Operation for Beach Nourishment. (Source: National Research Council, 1995).

3.2.1.1.1 Overflow (Economic Loading) w/ TSHD

In most cases for beach nourishment projects, TSHDs employ overflow dredging also known as economic loading to maximize sand loads per haul. During the dredging process, sediments are entrained with water to create a slurry, which is typically about 25 percent solids and 75 percent water, and the slurry is pumped into the hopper. As the hopper fills with the slurry, the sediments settle to the bottom of the hopper, creating a bottom layer of higher-density sediment with a top layer of lower-density supernatant. Coarse grained sediments (sediments with high percentages of sand/gravel) and consolidated clay sediments settle to the bottom faster than fine grained sediments (unconsolidated silts and clays). If the slurry is pumped into the hopper until the hopper is full, the overall density of the dredged material in the hopper will be about 25 percent solids and 75 percent water (i.e. the same as the incoming slurry). Dredging such a large amount of water and a relatively smaller amount of sediment per load is very inefficient. However, the proportion of solids in each load can be increased if the low-density supernatant is allowed to overflow the hopper and flow back into the water body and the sediment in the incoming slurry continues to settle to the bottom of the hopper. Depending on the composition of the dredged sediments, the proportion of solids retained in each hopper load can increase to as much as 70 to 90 percent.

The practice of filling a hopper beyond overflow to achieve a higher density load is referred to as economic loading. The result is fewer loads required to transport the same amount of dredged material, which decreases the overall operating time and, hence, the project cost. Economic loading is most effective when dredging coarse grained sediments or consolidated clay sediments due to higher settling velocities (In the case of dredging sand for beachfill, coarse grained materials make up over 90% of the material dredged.) Conversely, there is less potential for benefits from economic loading of fine-grained sediments due to lower settling velocities.

In considering economic loading, potential environmental effects must be reviewed as overflow of the supernatant may result in increased water column turbidity when compared to non-overflow dredging. Therefore, the relationship between dredge production, density of the hopper load, and the rate of material overflow are important variables in maximizing the efficiency of the dredging operation while minimizing environmental impacts.

3.2.1.2 Cutter Suction Dredges (CSD)

Cutter suction or hydraulic cutterhead dredges are floating platforms equipped with a rotating cutter that excavates the sea floor, feeding the loosened material into a pipe (generally 30" diameter) and pump system that transports the material and water slurry up to typical distances of five miles by pipeline. Transport distances can be extended by the addition of booster pumps in the pipeline route. Cutter suction dredges will typically be anchored into the bottom with a spud and remain in a fixed spot, and will excavate uniform deep pits along the arc of the cutterhead. CSDs can be very efficient dredges that can pump 2,000 cubic yards per hour or greater. The limitations for CSDs are that they require booster pumps for pumping distances greater than five miles, and they typically require calmer sea conditions than what a hopper dredge requires. Problems with clays clogging intake screens have been reported in instances when MEC screens are employed. CSDs are not very mobile and not easy to relocate within a borrow area to find optimal sand if suboptimal sand is encountered. A typical operation of a trailing suction hopper dredge for a beach nourishment project is provided in Figure 3-2.

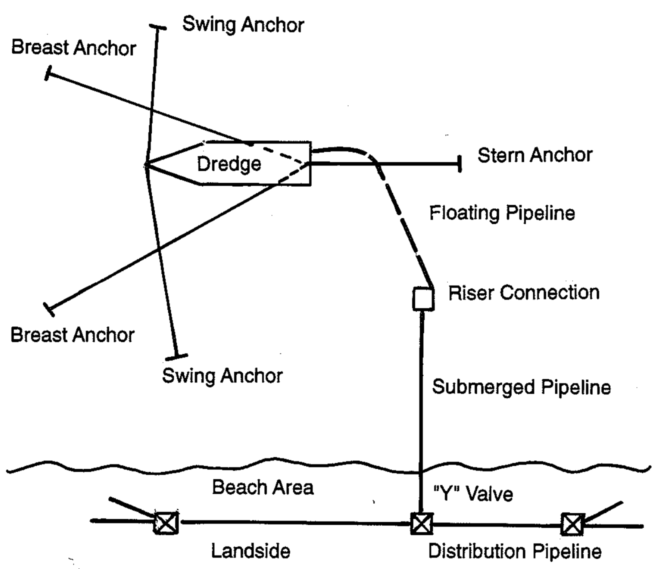

Figure 3-2. Typical Cutter-Suction Dredge Operation for Beach Nourishment.
(Source: National Research Council, 1995).

3.2.2 Beach Construction

Once the sandy material is dredged from the ocean floor, it is transported (or "pumped through") a submerged pipeline, which rises to the shore typically located in the center of a length of beach to be filled. At this point, sand is delivered via a "Y" valve that distributes the sand along the beach in the preferred direction (see Figures 3-1 and 3-2, and 3-3). Pipeline is added as the beachfill progresses along the beach. The sand is pumped on the beach into a basket to screen potential MEC (Munitions and Explosives of Concern) (Figure 3-4), the excess water runs off, then the sand is moved around with a bulldozer to the shape of the template. This is typically done with a small, temporary "training" berm (not to be confused with the beach berm template) constructed along the beach to direct flow and allow sands to settle out as it is de-watered. The water in the slurry is allowed to flow freely back into the ocean. This operation usually occupies up to about 1,000-foot sections of beach at a time. Public access is prohibited within these segments during ongoing operations, which can usually last from several days to a week depending on work progress.

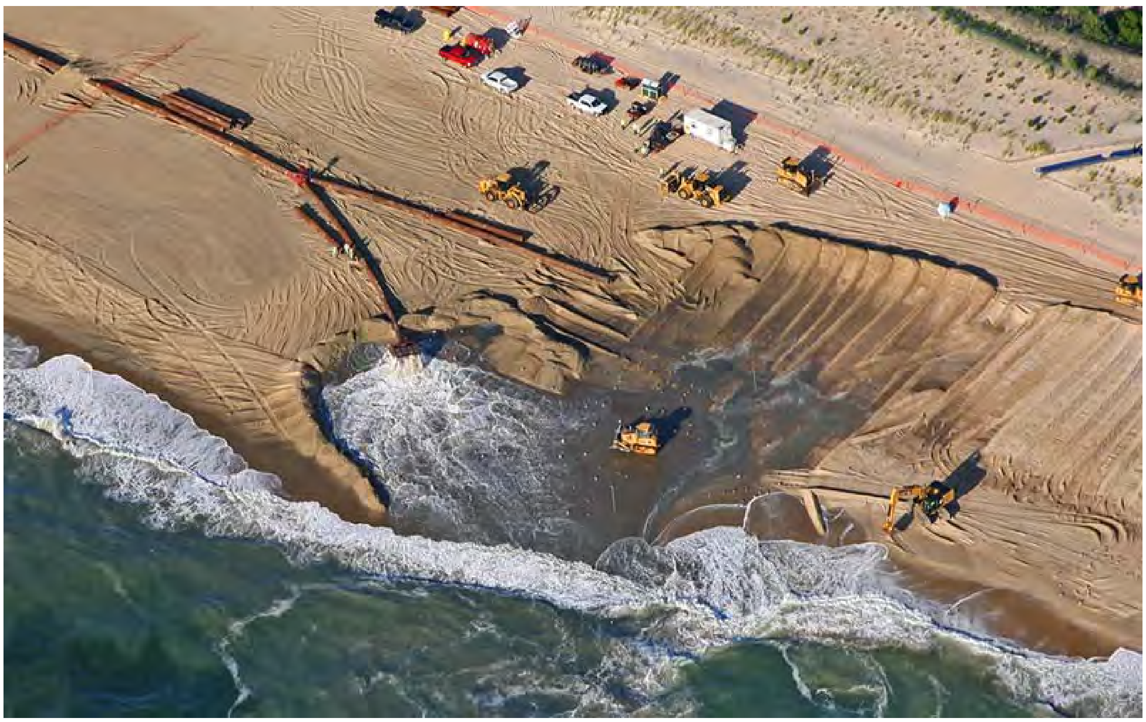

Figure 3-3. A Typical Beachfill Operation along the Delaware Atlantic Coast.
(Source: Great Lakes Dredge and Dock Company website accessed at: http://www.gldd.com/company/projects/coastal-protection/ on 5/7/2015)

Figure 3-4. Sand Being Pumped Through a 3/4 -inch MEC Screen Basket from a Hopper Dredge. (background). Training berms surround pump-out area to allow for sand to settle out.

Within these segments, the project template is achieved through filling and manipulating the sand to desired elevations and widths. The design template berm width is the minimum berm width after the filled beach adjusts to wave action. The construction template (including a quantity of advanced (sacrificial) nourishment) will result in a significantly wider berm than the design template berm because the beach will be initially “overbuilt”. The advanced nourishment is usually the quantity required for periodic nourishment unless more fill is required to address erosion of the design template berm/dune. The inclusion of the advanced nourishment and construction template enables the economic use of standard earth-moving equipment for the distribution of the fill and minimizes relocation of the discharge point. The result is a beach berm that is initially considerably wider (up to two to three times) than the authorized design width. After the first storm season, the berm is expected to adjust landward becoming considerably smaller as the subaqueous beachfill material moves seaward (USACE, 2003). See Figure 3-5 for a cross section of a typical beach nourishment construction template.

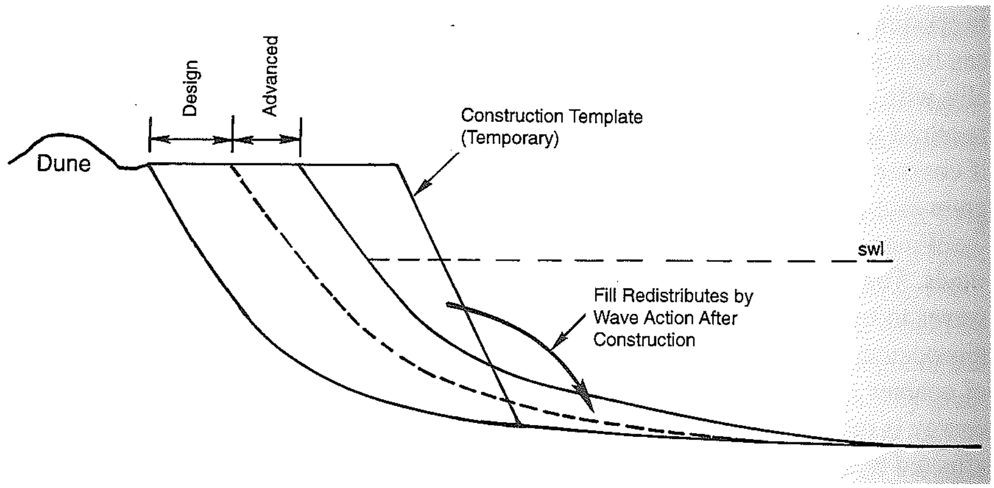

Figure 3-5. A Typical Profile of a Beachfill Construction Template. (Source: National Research Council, 1995).

3.2.3 Offshore Sand Sources Considered

3.2.3.1 Area B (Preferred Borrow Area)

Area B lies about 1.8 to 3.0 nautical miles offshore of Delaware Seashore State Park (north side of Indian River Inlet) in the Atlantic Ocean (Figure 1-2). It is approximately 2,132 acres in size, and is about 2.9 nautical miles (17,700 ft.) long (north to south). This area was described by USACE (1995a) as a linear shoal field containing fine to medium sands with sand strata thickness ranging between 5 feet near the edges of the area to 20 feet near the center. Area B spans three geomorphic regions that contain sandy deposits: the attached shoal field and shoreface, the inner platform, and the outer platform (McKenna and Ramsey, 2002). A smaller portion of this area was previously evaluated in USACE (2002), and was found to have a high component of surface pebbles and cobbles. For these reasons Area B was not recommended in USACE (2002). However, recent cores obtained from an expansion of Area B found better sand quality suitable for use as beachfill.

Due to the long linear nature of Area B and the long linear nature of the destination beaches of Rehoboth Beach and Dewey Beach, the transport distances would vary from 2.3 nautical miles to 7.5 nautical miles with a median transport distance of about 4.9 nautical miles.

Area B lies within the boundaries of a former target range (North Range) that was used by the U.S. Army for artillery practice. Use of the range was discontinued in 1961, but there remains a potential to encounter munitions and explosives of concern (MEC). Screening measures would be employed to insure these objects do not enter the dredge and/or become deposited on the beach.

Area B does not possess any prominent shoal features, but there are hard bottom features (pebble/cobble bottoms) in portions of the area (notably in the southeastern portion of the site), which may be Essential Fish Habitat (EFH) for species such as black seabass (*Centropristus striata*).This was identified in a benthic sled camera investigation of this area in 2000 (Diaz, 2001) where significant pockets of surficial gravel/cobble deposits, which in several locations, supported blue mussel beds. A recent benthic investigation (Versar, 2012) confirmed the cobble/pebble areas, but did not encounter the blue mussel beds encountered in the 2000 investigation.

A magnetometer and side scan sonar identified multiple targets within the area, but only one of them was found to have characteristics of a potential shipwreck site, which would be avoided by placing a “no entry” buffer zone around the target.

Based on more recent coring data collected for the USACE by contract with O’Brien and Gere (O’Brien & Gere 2011), vibracores taken in the northern portion of the site exhibited finer material with a composite mean diameter of 0.309 mm (medium sand). A composite of the southern portion cores resulted in a coarser sand (due to a higher gravel content) with a mean diameter of 0.665 mm. Based on these differences in mean sand diameter, Area B was divided into a northern portion (approximately 684 acres) and the southern portion (approximately 1,448 acres) (Figure 3-6). The northern portion of Area B (Area B North) is estimated to contain up to 11 million cubic yards of sand (assuming a 10 foot deepening), which should have sufficient capacity to sustain the Rehoboth Beach/Dewey Beach project for the 50-year life (assuming current periodic nourishment rates), and could be used on other projects on an “as needed” basis. Therefore, Area B North is preferred based on the best sand compatibility with the receiving beaches and would have less impacts on benthic resources. The southern portion (Area B South) is a large area with a more heterogeneous bottom substrate. Area B South is proposed as a future expansion area should additional cores and surveys identify subareas with suitable sands and less sensitive benthic resources.

Under this alternative, Area B (with avoidance of sensitive areas) is proposed as the sand source for the Rehoboth Beach and Dewey Beach Project, and is also proposed as an alternate sand source for the other Federal projects at Indian River Inlet Sand Bypass System (USACE, 1984), Bethany Beach/South Bethany (USACE, 1998; USACE, 2005), and Fenwick Island (USACE, 2000).

3.2.3.2 Area G (Rehoboth Beach and Dewey Beach in 2005)

Area G is located 2-3 nautical miles east and southeast of Indian River Inlet (Figure 1-2), and is about 7.3 nautical miles (median) from the Rehoboth Beach/Dewey Beach project. It was used for the initial construction of the Rehoboth Beach and Dewey Beach Federal project in 2005. From Area G, approximately 1.5 million cubic yards of sand was dredged and placed on the beach to construct the berm and dune plan as recommended in USACE (1996).

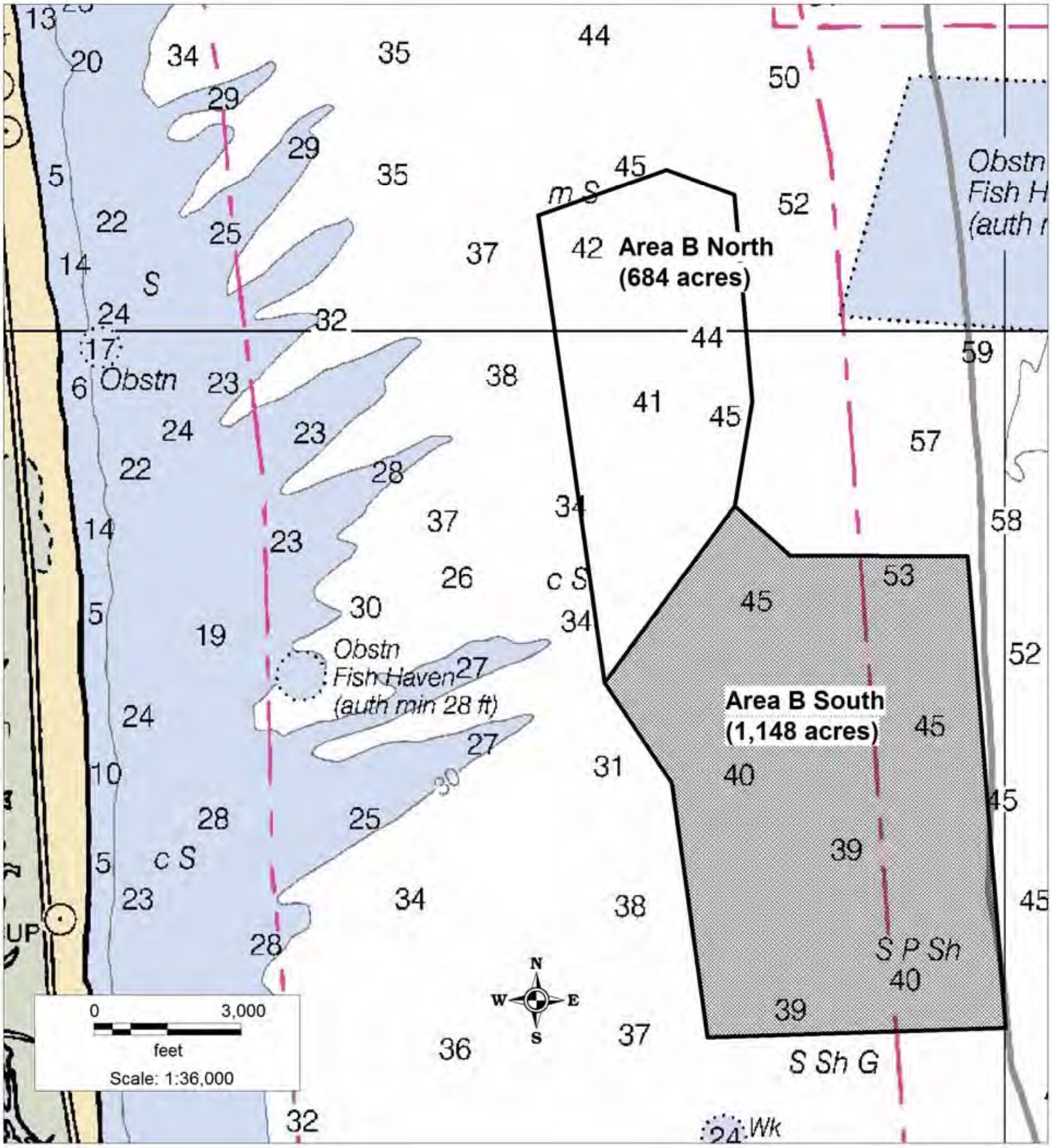

Figure 3-6. Area B North and South.

Area G was evaluated in USACE (2002), which was an EA that proposed Area G as the sand source. However, shortly after Area G's use in 2005, numerous complaints on the gravel and pebble content on the beach were received. Although this high gravel/pebble content was suitable and performed well for storm damage reduction purposes, it had adverse impacts on beach recreation, which is a major economic engine for the resort areas. Because of the concerns associated with the coarseness of the material coming from Area G, the State of Delaware requested that Area G not be used in future re-nourishments/storm repairs. In addition, subsequent cores collected from Area G did not identify any areas within Area G that had material that would be any less coarse than what was encountered in 2005. Therefore, Area G is not recommended for future use.

3.2.3.3 Hen and Chickens Shoal (HCS)

The HCS site was proposed in USACE (1996). The HCS site is described in USACE (1996) as an offshore area approximately 1,120 acres in size, and is located on the southern portion of HCS (Figure 1-2). This site is within 1 to 3.0 miles from the shore in relatively shallow depths ranging from -23 feet to -31 feet (mean low water). HCS rises abruptly off of Cape Henlopen and is linear in a northwest to southeast direction. Towards the southeast, the shoal becomes more broad and flat, and is the location of the originally proposed sand borrow source. This area is bisected by "Sharks Channel", which is known for swift currents (Dames and Moore, 1993). USACE (1996) reported that the area on HCS generally contained high quality beachfill consisting of well-sorted fine to medium sands. Mean grain sizes ranged from 0.22 mm to 0.66 mm with the majority falling between 0.28 mm and 0.34 mm. Sediment compatibility analyses with the native beach materials were performed where an overfill factor of 1.3 was recommended. The HCS site was the most economical site with a median sand transport distance of 2.5 nautical miles. A benthic sled camera investigation in 2000 (Diaz, 2001), determined that this site consists of a bottom surface composed predominantly of a homogeneous rippled sandy bottom. However, as discussed earlier, several environmental concerns associated with the use of HCS became apparent subsequent to USACE (1996). Pursuant to the reauthorized Magnuson Stevens Fishery and Conservation Management Act of 1996, HCS is considered essential fish habitat for a number of Federally managed fish and shellfish species based on its prominent geomorphic shoal feature. Under EFH, HCS was also identified as a Habitat Area of Particular Concern (HAPC) for the sandbar shark. HCS is considered to be an important pupping area for several shark species. Although all of the marine waters along the Delaware Atlantic Coast are considered EFH, prominent shoal features (such as HCS) are viewed to be important habitats based on their greater bathymetric relief than surrounding flat bottom areas.

The southern portion of HCS lies partially within the boundaries of a former target range (North Range) that was used by the U.S. Army for artillery practice. Use of the range was discontinued in 1961, but there remains a potential to encounter munitions and explosives of concern (MEC). Therefore, screening measures would be required to insure these objects do not enter the dredge and/or become deposited on the beach.

Based on the quantity of sand and the compatibility of sand contained within HCS, this area remains a viable sand source. However, this site cannot be recommended until the outstanding fisheries concerns are resolved. Therefore, it is not a preferred alternative at this time, and has been withdrawn subsequent to USACE (1996).

3.2.3.4 Area E (Bethany Beach/South Bethany)

Area E is the sand source utilized for the Bethany Beach and South Bethany project. It lies about 1.5 to 2.7 nautical miles offshore of South Bethany (Figure 1-2), and is about 12.1 nautical miles (median) to the Rehoboth Beach/Dewey Beach project area. In 2007, approximately 3.5 million cubic yards of sand were dredged from Area E for the initial construction of the Federal storm damage reduction project. This site was subsequently used in 2009 and 2011 for periodic nourishment and storm-related repairs. This site contains a few smaller prominent shoals that have been avoided, and is mostly flat in bathymetry. This site is also located within the boundaries of a former artillery target range (South Range), which is known to contain munitions and explosives of concern (MEC). Because of the potential to encounter MEC, screening is required on the intake and outfall locations of the dredging operations to prevent objects larger than 1.25 inches from entering the dredge, and objects larger than 0.75 inches from being discharged onto the beach. In 2011, the dredging contractor encountered pockets of clay, which resulted in delays due to clogged screens while using a cutter suction dredge. During this contract, the sand source was switched to the Fenwick Island sand source, which did not encounter clay. Despite the clay encountered in 2011, Area E remains the primary source for the Bethany Beach and South Bethany Project, but sufficient sand quantities within the current boundaries may be limited. Additional coring within this area may better define the clay deposits so that they can be avoided. Expansion areas were identified in USACE (1998) and USACE (2005). Expansion of the boundaries will require new physical, environmental, and cultural resource surveys along with new approvals by the resource agencies.

3.2.3.5 Fenwick Island Sand Source (Town of Fenwick Island)

The Fenwick Island sand source lies about 0.76 to 2.9 nautical miles offshore of the Town of Fenwick Island (Figure 1-2). The Fenwick Island sand source was used for the initial construction of the Federal storm damage reduction project in 2006 where approximately 1.3 million cubic yards of sand was dredged for the initial construction of the project. The site was also used for periodic nourishment/storm damage repairs for Rehoboth Beach and Dewey Beach in 2009 and 2011; for Bethany Beach and South Bethany and the Town of Fenwick Island in 2011; and all of the Federal project areas in 2013 following Hurricane Sandy. This site contains one prominent shoal that has been avoided, and is, otherwise, mostly flat in bathymetry. This site also has a portion located within the boundaries of a former artillery target range (South Range), which is known to contain munitions and explosives of concern (MEC). Because of the potential to encounter MEC, screening is required on the intake and outfall locations of the dredging operations to prevent objects larger than 1.25 inches from entering the dredge, and objects larger than 0.75 inches from being discharged onto the beach. USACE (2000) described the sand within the site consisting of poorly graded, or well sorted, fine to coarse sands with little to some fines and gravel. Mean grain sizes were calculated that range from 2.53 phi (0.17 mm) to 1.05 phi (0.3 mm). It was estimated that this site contains in excess of 40 million cubic yards of fine to medium sands. Because of the large capacity for sand, this site has been used as an alternate sand source for Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany, and is a proposed alternate site for Indian River Inlet beaches. However, given the long transport distances (over 15 nautical miles) to the Rehoboth Beach and Dewey Beach project area, this site is more costly to use, and is not preferred as a long-term primary site for this project. Therefore, the Fenwick Island Sand Source will remain as a primary source for the Town of Fenwick Island, and as an alternate source for Bethany Beach/South Bethany, Indian River Inlet North Shore, and Rehoboth Beach/Dewey Beach projects.

3.2.4 Land Sources

Beachfill sand obtained from land sources is usually acquired from the mining of sand. This sand is usually mined or dredged from an inland sand pit, and transported by dump truck to the recipient beach where it is placed and re-shaped with earthmoving equipment. Recently, this type of operation was used at Lewes Beach by the State of Delaware in an emergency response to sand losses after Hurricane Sandy. In December 2012, approximately 8,315 cubic yards of sand were transported to and placed on Lewes Beach. In 2013, an additional 22,080 cubic yards were placed by USACE as part of the PL 84-99 program for Flood Control and Coastal Emergencies (FCCE) within the Federal project area at Lewes using this method. This type of operation is a viable alternative for smaller scale projects. However, due to the voluminous quantities of sand required for periodic nourishment or repairs from storms, trucking in of sand is not a preferred alternative as it would be cost prohibitive and would have adverse effects on communities and public roadways. Assuming an average periodic nourishment quantity of 360,000 cubic yards of sand, it would require over 25,000 truckloads that would result in significant wear and tear on public roads, present safety issues and traffic obstacles, noise and air quality impacts, and significantly longer construction durations. Therefore, this alternative is not recommended for larger beachfill projects, but may be a good option for smaller fills for the Delaware Atlantic Coast project sites.

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Table 3-1. Considerations for the Sand Borrow Area Alternatives.

Sand Source	Status	Sand Characteristics	Median Transport Distance to Rehoboth/ Dewey Beaches	Aquatic Biota and Fisheries and Essential Fish Habitat (EFH)	HTRW/ Munitions and Explosives of Concern (MEC)	Cultural Resources	Other Environmental Considerations
Hen and Chickens Shoal (HCS) Size: 1,200 acres	Although previously used by DNREC in 1994 and 1998, this site was withdrawn in 2002 over impacts to fisheries concerns, but may be a viable future sand source upon further data collection efforts and evaluations.	Generally, the material encountered within the limits of the HCS site is beachfill quality sand consisting of poorly graded, fine to medium sands with little to some silt. The Unified Soil Classification System (USCS) classifies these sediments as either SP (Poorly graded, well-sorted sand of uniform size) or SP-SM (silty sand). In comparing the mean grain size and the grain size distribution of the sediments in HCS to the native sand found on Dewey and Rehoboth Beaches, it was estimated that the overfill factor was on the order of 1.3.	2.5 nautical miles	EFH issues involve the potential loss or the degradation of EFH through removal or reduction in bathymetric profile of the shoal habitat. Key species of concern are the sandbar shark, which this area is considered to be a habitat area of particular concern (HAPC), and the sand tiger shark. This area is believed to be a "pupping" area for the sand tiger shark, which is a Federal species of concern. Information on utility of this area by these species is scarce. Therefore, utilization of this site would require additional investigation that would conclude that alteration of this habitat would not have significant adverse effects on these species or appropriate use of mitigation measures. The benthic community of this area is homogeneous consisting of taxa that inhabit high-energy rippled sandy substrates.	No known HTRW sites exist within or in close proximity. However, part of HCS lies within the northern boundary of the former North Firing Range. Use of this site could potentially encounter MEC associated with this range. Screening measures would be required for this site to minimize MEC from becoming deposited on the beach areas.	Two magnetic anomalies exhibiting shipwreck characteristics were reported from a magnetometer investigation. At least a 200-foot buffer zone would be required to avoid impacting any potential shipwreck sites.	This site has been previously utilized as a sand source for the State of Delaware. Subsequently, fishing interests along with fisheries management agencies have raised concerns over the use of this site and potential impacts to EFH. More fisheries data may need to be obtained concerning the importance of this area to EFH and to sufficiently define impacts prior to any further utilization in order to satisfy the fisheries concerns.
Area B (Preferred Alternative) Size: 684 acres (N) 574 acres (S)	Proposed.	The quality of the material encountered in Area "B," is a poorly graded fine - medium sand with varying amounts of silt and gravel. The northern portion of Area B contains more fine to medium sand and the southern portion is described as a medium sand with gravel. The USCS classifications of these materials are SP, SP-SM, and GP (well graded sand). In comparing the mean grain size and the grain size distribution of the sediments in Area "B" to the native sand found on Dewey and Rehoboth Beaches, the estimated overfill factor for 0-10 feet of the borrow area (north) is 1.0 for both beach towns. The overfill factor for the southern borrow area (0 – 10 ft.) is 1.10 for Rehoboth Beach and 1.08 for Dewey Beach.	4.9 nautical miles	This site is primarily flat in bathymetric relief. However, large areas of the southeastern portion of Area B are composed primarily of hard bottom gravel bed. Some of this area includes relic corals and mussel beds. This habitat is considered important EFH for black sea bass. Avoidance of the hard-bottomed portions of this area would minimize impacts on EFH for black sea bass. Utilization of Area B North would mostly avoid this type of habitat.	No known HTRW sites exist within or in close proximity. However, Area B lies entirely within the boundaries of the former North Firing Range. Use of this site could potentially encounter MEC associated with this range. Screening measures would be required for this site to minimize MEC from becoming deposited on the beach areas.	A magnetometer/ side scan sonar investigation of Area B did not identify any targets that exhibit shipwreck characteristics.	. Based on benthic habitat assessments, Area B North has little hard bottom features. Area B South utilization would require delineation of no dredge zones based on presence of hard bottom features.
Area G Size: 1,274 acres	Discontinued due to high prevalence of pebbles and gravels after its only use in 2005.	Based on vibracore data, Area "G," is mostly either a poorly graded or well-graded medium sand with varying amounts of silt and gravel. The USCS classifications of these materials are SP, SP-SM, and SW. In comparing the mean grain size and the grain size distribution of the sediments in Area "G" to the native sand found on Dewey and Rehoboth Beaches, the estimated overfill factor is nearly 1.0.	7.3 nautical miles	This site is primarily flat in bathymetric relief. However, approximately 46% of the sampled bottom habitat of Area G is composed primarily of hard bottom gravel beds and small amounts of relic coral. This habitat is considered important EFH for black sea bass. Avoidance of the hard-bottomed portions of this area would minimize impacts on EFH for black sea bass.	No known HTRW sites exist within or in close proximity. Area G lies outside of any known firing range boundaries, therefore, the potential for encountering MEC is lower than the other sites. However, screening measures would still be required for this site to minimize MEC from	A magnetometer /sidescan sonar investigation of Area G indicated the presence of one target in the southern portion of Area G that exhibited buried shipwreck characteristics. At least a 200-foot buffer zone would be required to	A high percentage (30% in some instances) of gravel/pebble content was encountered in the 2005 initial construction of the Rehoboth Beach/Dewey Beach project, which resulted in numerous complaints regarding beach recreation. Based on the gravel/pebble content, this site was discontinued.

Table 3-1. Considerations for the Sand Borrow Area Alternatives.

Sand Source	Status	Sand Characteristics	Median Transport Distance to Rehoboth/ Dewey Beaches	Aquatic Biota and Fisheries and Essential Fish Habitat (EFH)	HTRW/ Munitions and Explosives of Concern (MEC)	Cultural Resources	Other Environmental Considerations
		However, this site was used in 2005 for Rehoboth and Dewey Beach and contained unacceptable high levels of gravels and pebbles.			becoming deposited on the beach areas.	avoid impacting this target during dredging.	
Area E Size: 762 acres	Active site, but requires further evaluations on capacity. Expansion of existing boundaries may be required.	Area E contains a material consisting for poorly graded and well graded fine to coarse sands. Grain size ranges from -0.45 to 2.51 phi (1.36 to 0.18 mm) with the majority around 1.4 phi (0.37 mm). The USCS classifies these sands as either SP or SW. It was estimated that about 85% of the borrow area was composed of sands with an overfill factor of 1.0 for Bethany/South Bethany. In 2011, clay pockets were encountered prompting a switch to the Fenwick Island site.	12.1 nautical miles	This site is primarily flat with a few small shoals within it. In a 2004 video survey of the bottom, over 57% of the bottom habitat was composed of fine-medium sands. The remaining areas were dominated with 33% pebble-cobble bottom habitat-type, which have been mostly avoided.	No known HTRW sites exist within or in close proximity. However, Area E lies entirely within the boundaries of the former South Firing Range. Use of this site could potentially encounter MEC associated with this range. Screening measures would be required for this site to minimize MEC from becoming deposited on the beach areas.	No high probability shipwreck targets were identified in a 1998 survey of Area E.	
Fenwick Island Sand Source Size: 2,279 acres	Active site currently being used for Town of Fenwick Island, Bethany Beach/South Bethany, Rehoboth Beach/Dewey Beach, and proposed alternate for Indian River Inlet beaches.	USACE (2000) describes the sands of this site as beachfill material consisting of poorly graded, or well sorted, fine to coarse sands with little to some fines and gravel. These sands are classified under the USCS as SP with mean grain sizes ranging from 2.53 phi (0.17 mm) to 1.05 phi (0.48 mm)	15 nautical miles	This site is primarily flat with one large shoal within it. This shoal has been avoided because it represents a prominent feature that may be attractive to fish.	No known HTRW sites exist within or in close proximity. However, the Fenwick site lies partially within the boundaries of the former South Firing Range. Use of this site could potentially encounter MEC associated with this range. Screening measures would be required for this site to minimize MEC from becoming deposited on the beach areas	4 high probability cultural resource targets were identified within the site. Buffer zones have been established around these targets to avoid impacting them.	The Fenwick Island Borrow area continues to provide quality material for all storm damage reduction projects. However, transport distances to Rehoboth and Dewey Beaches make this site a significantly more expensive alternative.
Land Sources	Truck fills have been employed for smaller projects (i.e. Lewes Beach), but not as likely for large-scale (> 100,000 cubic yards) nourishments on the ocean coast.	Sand compatibility is obtainable depending on the source.	Variable Commercial quarries available within 100 miles. This would be cost prohibitive for large quantities.	This alternative would have no impacts on marine aquatic biological resources at the source location.	This should not be a concern if material was obtained from an existing approved commercial sand pit.	Potential cultural resource issue if there is new land disturbance.	Numerous truck loads would adversely affect noise and air quality, roads and other infrastructure in local communities.
Regional Sediment Management (RSM)	No local current studies or authorities for ocean coast beaches are implemented at this time. Consideration is recommended when/where appropriate.	No specific information available.	No specific information available.	Depending on how it is implemented, RSM could potentially reduce impacts to aquatic biota by requiring less dredging in borrow areas and fill placement.	No specific information available.	No specific information available.	Although there are wide-ranging implementation possibilities for RSM, it is believed that implementing RSM strategies would generally have less adverse impacts on air, water, and biological resources than periodic nourishment.

3.2.5 Regional Sediment Management (RSM)

RSM is a system-based approach being implemented by USACE and other stakeholders in parts of the nation that seek to solve sediment-related problems by designing solutions that fit within the context of a regional strategy. This is done by integrating the management of littoral, estuarine, and riverine sediments to achieve balanced and sustainable solutions to sediment-related needs, which lead to greater effectiveness and efficiency. RSM strategies applicable to the Atlantic Coast of Delaware beaches include the identification of a sediment budget (i.e. identify sediment sources and sinks, existing sediment management activities, and natural processes), linking sediment availability and sand needs within the coastal system, coordination of navigation channel maintenance with beach nourishment, and alternative means for retaining sand within the system. There currently is no RSM program for the Atlantic Coast of Delaware. However, RSM strategies are already being employed to some degree. The most prominent RSM strategy is the use of the Indian River Inlet Sand By-pass system, which allows for the continued flow of littoral sand (by hydraulic pumping through a pipeline) around the historic interruption created by the Indian River Inlet jetties. Other measures that retain sand include the judicious use of groins such as the herring point groin in Cape Henlopen State Park, which allows for sand retention and littoral sand transport for the Cape-spit complex. It is recognized that RSM alone cannot provide sufficient quantities of sand for the Atlantic Coast Federal storm damage reduction project areas, however, the implementation of RSM strategies coupled with existing management measures could reduce the need for offshore dredging for sand, and environmental effects of offshore dredging and placement.

4.0 AFFECTED ENVIRONMENT

4.1 Physical Environment

4.1.1 Climate

4.1.1.1 Temperature and Precipitation

The Delaware Bay and Atlantic Ocean coastal region experiences a moderate climate associated with the low elevations of the Coastal Plain and the presence of the large water bodies. A moderate winter season results from winds which are heated by warmer water temperatures of the ocean and bays and blown inland. Summer temperatures are in turn moderated by locally generated winds or sea breezes. The warmest period of the year is normally during late July when maximum afternoon temperatures average 89ºF. Temperatures exceeding 90ºF occur an average of 31 days per year. The coldest period of the year is during late January and early February when early morning temperatures average 24ºF. A minimum temperature of 32ºF or lower occurs on an average of 90 days per year. Lewes, Delaware has an average annual temperature of 56ºF. Lewes experiences an average temperature of 35ºF in January and a July average of 75ºF. The average winter frost penetration ranges from 12 to 24 inches. Daily temperature variations along the shore range from 10ºF to 20ºF throughout the year and are generally much less over the water (Maurer et al. 1974).

4.1.1.2 Wind

Prevailing winds at Breakwater Harbor are from the southwest, however, winds from other direction are nearly as frequent. The average annual wind speed along the Delaware Coast is 14.6 mph. In the 5-degree quadrangle nearest the Delaware Coast, the winds over the offshore areas are distributed with respect to direction as follows: onshore (northeast, east and southeast) 27 percent; (south) 11 percent; offshore (southwest, west and northwest) 44 percent; and (north) 15 percent. Weather data from Atlantic City, New Jersey, which is approximately 50 miles northeast of the study area, but considered valid as a regional source of data, determined that prevailing winds measured at Atlantic City are from the south and of moderate velocities between 14 to 28 mph. Winds from the northeast have the greatest average velocity of approximately 20 mph. The wind data also show that winds in excess of 28 miles per hour occur from the northeast more than twice as frequently as from any other direction. Winds of 50 mph or more may accompany severe thunderstorms, hurricanes, and general winter storms.

4.1.1.3 Storms

There are two major types of damaging storms, which affect the Delaware coast. They are known as “tropical” (hurricanes and tropical storms) and “extra-tropical” (northeasters) storms. Hurricanes usually diminish in intensity by the time they reach the Delaware coast during their usual northward movement. No hurricane has made landfall along the Delaware coast since records have been kept (1871); however, several tropical storms and hurricanes have passed near the Delaware coastline in this period. Recently, the Delaware coast has experienced damages from the Nor’Ida Storm (in 2009), Hurricane Irene (in 2011), and Hurricane Sandy (in 2012). Hurricane Sandy was designated an “extraordinary” storm that exhibited a unique combination of: elevated ocean water levels (storm surge plus spring astronomical tides); continuous gale force or higher winds; and significant ocean wave heights at NDBC buoys that attained 33 feet). Hurricane Sandy inflicted significant damages to the beaches and communities along the Delaware coast. Of particular note, was the beach erosion and washover on the north side of Indian River Inlet and significant damages sustained to the State Route 1 approach to the Charles W. Cullen Bridge over the Indian River Inlet.

The most damaging storm to affect the project areas in the last 100 years was the northeaster of March 6-8, 1962. Two low-pressure areas joined in the ocean off the Mid-Atlantic coast and remained stationary for several days. The sustained high winds over the long fetch produced large waves and a storm surge which lasted over five consecutive high tides. The storm occurred during a period of unusually high astronomical tides. The combined storm tide elevation of 8.1 feet NGVD was the highest recorded in the period of record at Breakwater Harbor, Delaware (USACE, 1996).

4.1.2 Coastal Hydraulics

Coastal hydraulics are discussed in USACE (1996), USACE (1998) and USACE (2000). The Delaware coastal hydraulics are mainly influenced by tides, waves and currents. The tides are semidiurnal with two high tides and two low tides daily with an average tidal period of 24 hours and 50 minutes. The mean tide range is 3.7 feet and the spring tide range is 4.5 feet at Fenwick Island.

Waves are measured in significant wave height, wave period, and wave direction. These factors are influenced by the energy of the wave source, wind direction and fetch, bathymetry, shoreline stabilization structures, and tidal currents from the Delaware Bay and Indian River Inlet. Two stations along the Delaware Atlantic Coast have produced wave statistics generated over a 20 year period. Waves approach the coast from NNE, NE, E, SE and S with the most frequent occurrence from the E and SE directions. The highest significant wave heights were recorded during the 1962 Northeaster at 25 feet and 16.5 feet. In 2012, two NOAA buoys recorded the significant wave heights during Hurricane Sandy at 24 feet (Buoy 4409 off of southern DE) and at 33 feet (Buoy 44065 off of northern NJ) (USACE, 2012).

Three types of currents influence the shoreline stability along the Delaware Atlantic Coast: tidal currents, cross shore currents and longshore currents. Tidal currents are generated by hydraulic head differences between water levels in the oceans and back-bay areas (through Indian River Inlet). Cross-shore currents move sand perpendicularly across the shore and offshore on a daily and seasonal basis. Longshore currents are caused by waves breaking at an angle relative to the shore alignment. The turbulence created in the breaker zone suspends the sediments which are transported in the longshore direction. The result is longshore transport of sand along Delaware's beaches. The net longshore transport of sand from Indian River Inlet and north (including Rehoboth Beach and Dewey Beach is in a northward direction. South of Indian River Inlet there is an area where there is no predominant longshore sand transport, and is described as a "nodal" zone. This zone includes the Bethany Beach and South Bethany area. Further south (Fenwick Island), the net transport is in a southern direction. Figure 4-1 provides a map of the longshore transport zones along the Delaware Atlantic Coast.

4.1.3 Geology

The coastal geology of the project area is described in USACE (1996), and is incorporated by reference. Three types of physiographic regions exist along the Delaware Atlantic Coast: spit complex, headland, and baymouth barrier (Kraft, 1971). Rehoboth Beach is part of a headland-spit complex, which terminates in the north at Cape Henlopen. Dewey Beach primarily consists of a continuous, wide, sandy coastal barrier complex beginning in and extending south of Dewey Beach to the Indian River Inlet area with Rehoboth Bay and Indian River Bay to the west. Bethany Beach is part of another significant headland south of Indian River Inlet. South Bethany and Fenwick Island form another coastal barrier complex with Little Assawoman Bay to the West (Figure 4-1).

USACE (1995a) and Field et.al. (1979) identify four major physiographic units on the shelf offshore from the Delmarva Peninsula, which are classified: (a) shoreface, (b) linear shoal field, (c) shoal retreat massif (geologic unit containing one or more summits surrounded by depressions), and (d) shelf transverse valleys. The linear shoals have been interpreted as Holocene features that formed in the submarine environment and were consequently stranded as sea level rose and the shore retreated. They consist primarily of sands and gravels, and are the most likely to be suitable for beachfill material.

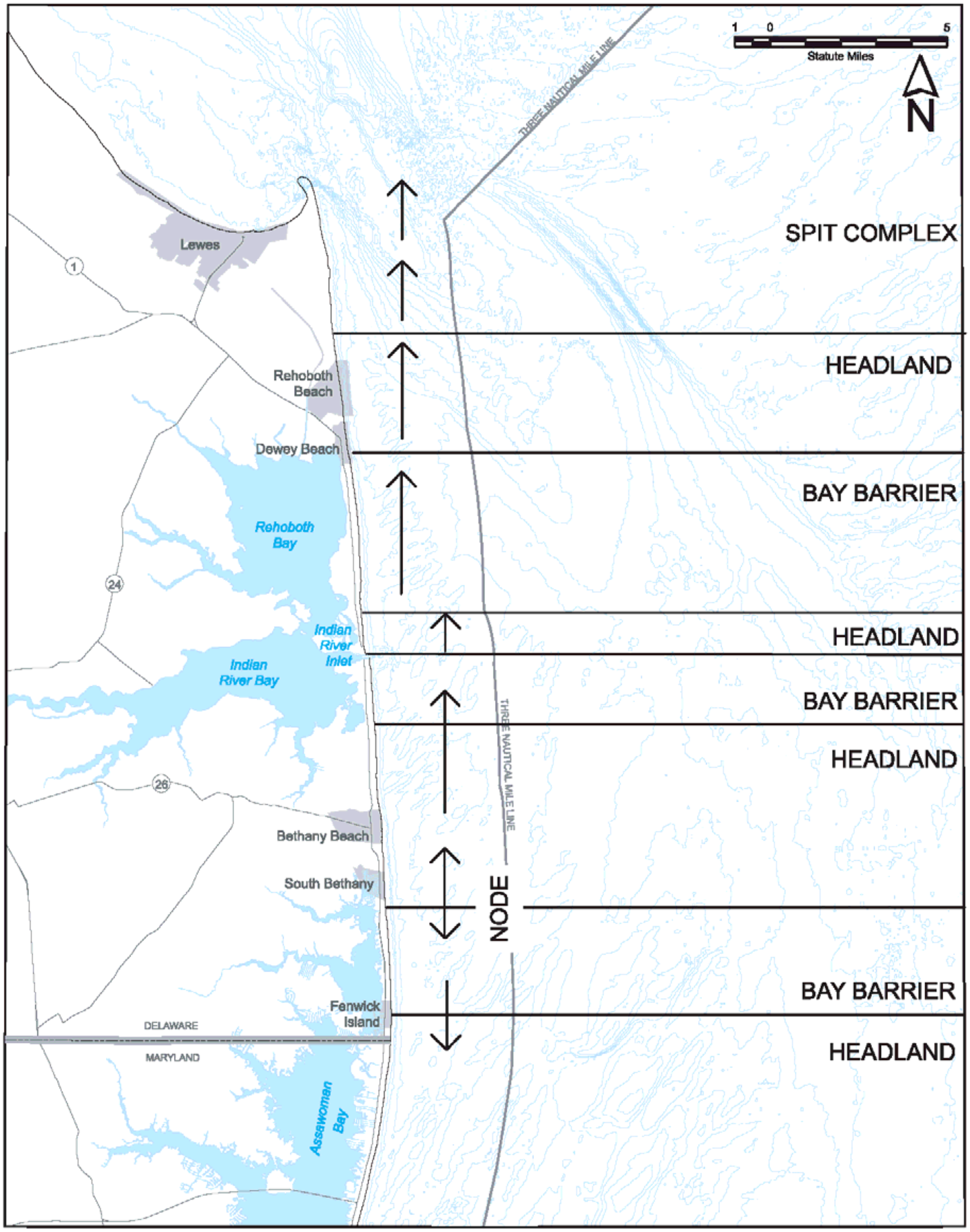


Figure 4-1. General Longshore Transport Directions and Coastal Physiographic Regions along the Delaware Atlantic Coast. (from McKenna and Ramsey, 2002).

USACE (1995a), as part of the geoacoustic subbottom profiling work performed offshore of the Delaware Atlantic Coast, identified six areas labeled A through F as potential sand sources. The primary areas in the north were identified at Hen and Chickens Shoal (HCS) (also identified as Area A in USACE, 1995a) and Area B located directly east of Rehoboth Bay. At HCS, vibracore data and acoustic data described the sediments as mostly poorly graded fine to medium sands, with the coarser material located on the eastern half of the shoal. Sand thickness is in excess of 20 ft. in some areas. Area B is offshore of the bay barrier region, which makes up most of the Delaware Seashore State Park directly east of Rehoboth Bay. Area B spans three geomorphic regions that contain sandy deposits: the attached shoal field and shoreface, the inner platform, and the outer platform. The inner platform makes up the majority of the site (McKenna and Ramsey, 2002) (Figure 4-2). Sand thickness in Area B ranges between 5 feet near the edges of the area to 20 ft. near the center.

A review of the Mid Atlantic Regional Council on the Ocean (MARCO) mapping depicting seabed forms along the Delaware Atlantic Coast shows that Area B lies in a predominantly depressional area with little distinct bathymetric features (Figure 4-3). The MARCO sediment map (Figure 4-4) shows that sediment grain sizes are finest in the northern portion of Area B (from 0.17 mm to 0.48 mm) (fine to medium sands) with coarser materials (>0.48 mm) in the southern portion of Area B.

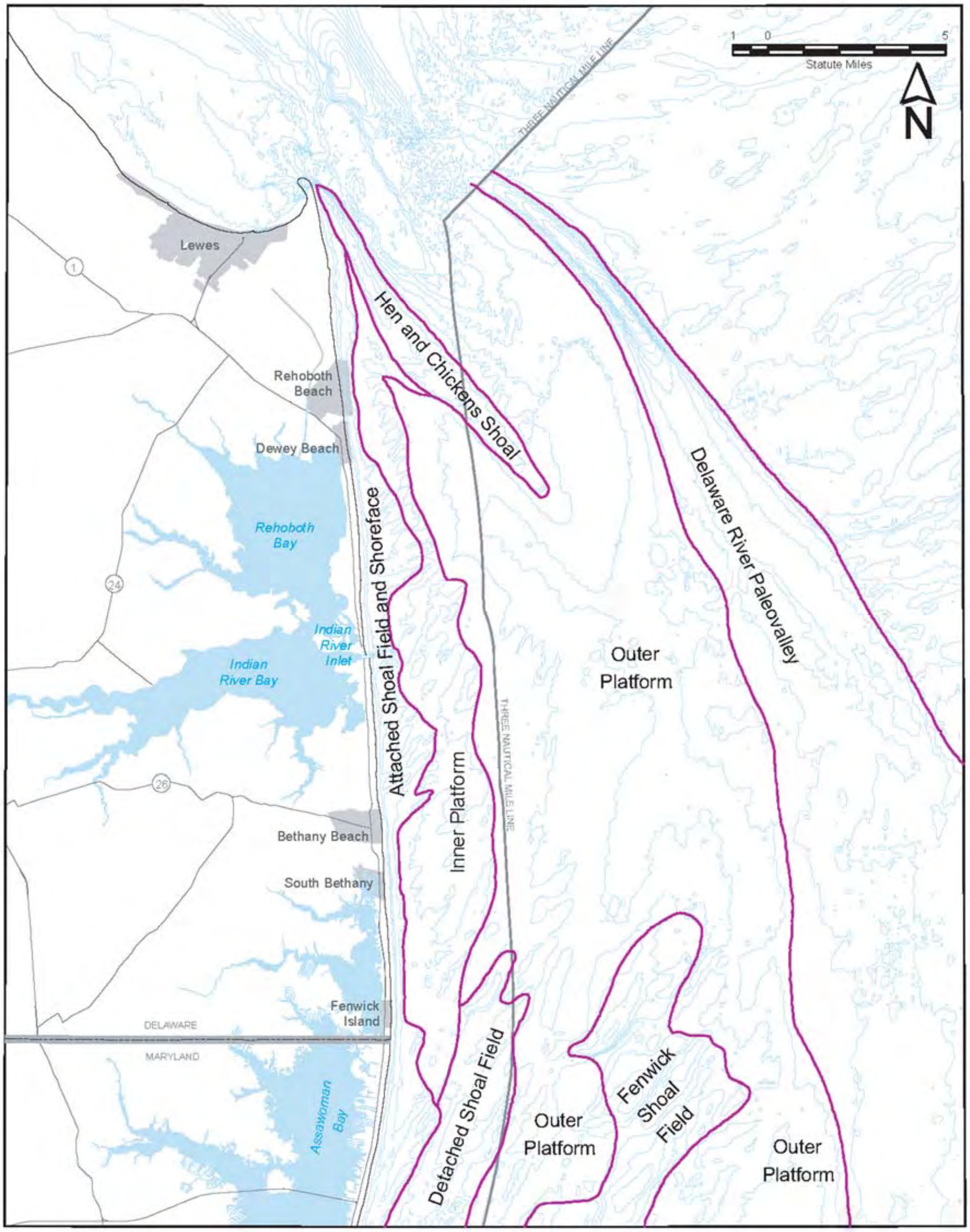


Figure 4-2. Delaware Atlantic Coast Offshore Geomorphic Regions.
(from Mckenna and Ramsey, 2002).

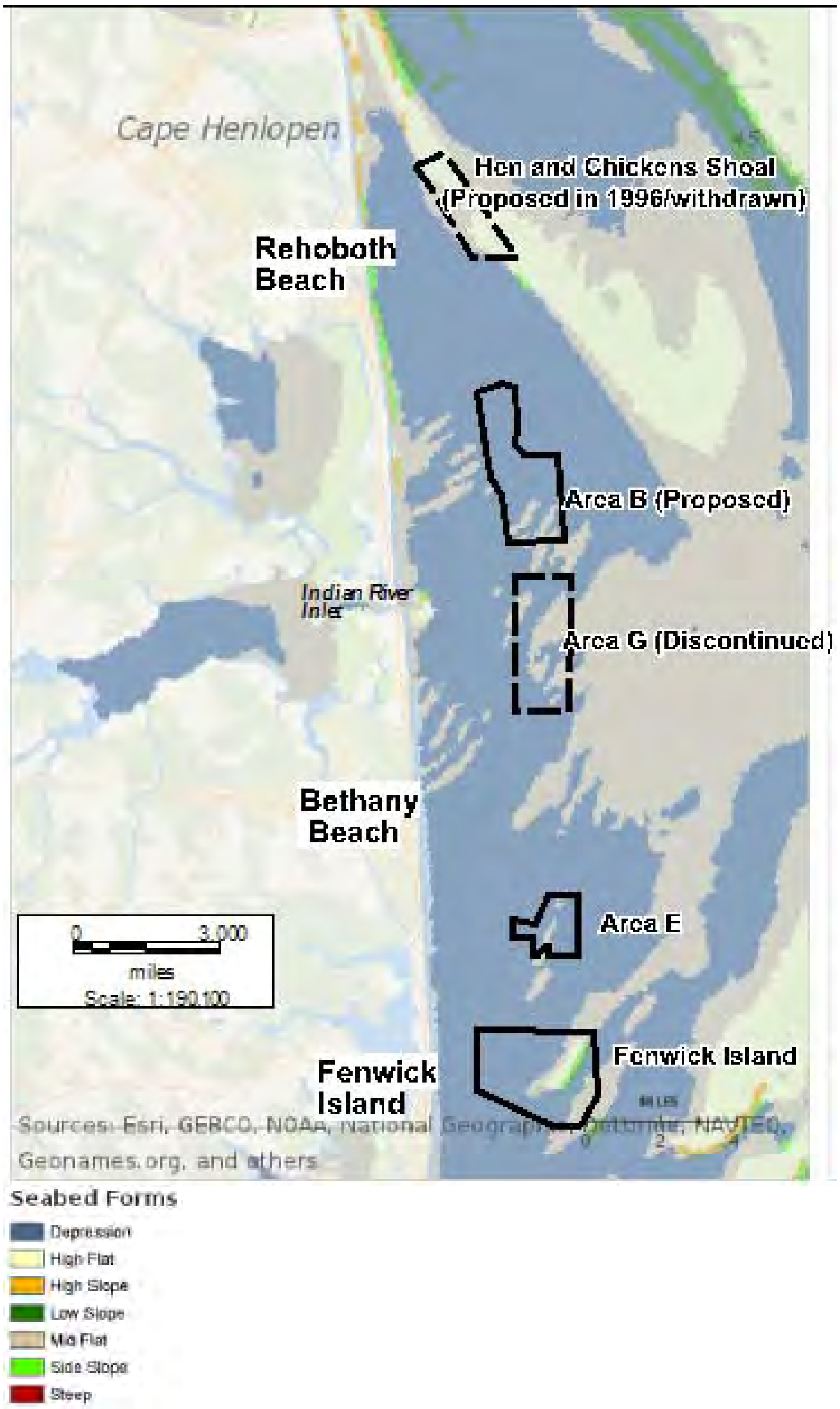


Figure 4-3. MARCO Seabed Forms Along the Delaware Atlantic Coast. (Source: from MARCO marine mapper planner website: http://portal.midatlanticocean.org/planner/ accessed on 3/24/2015)

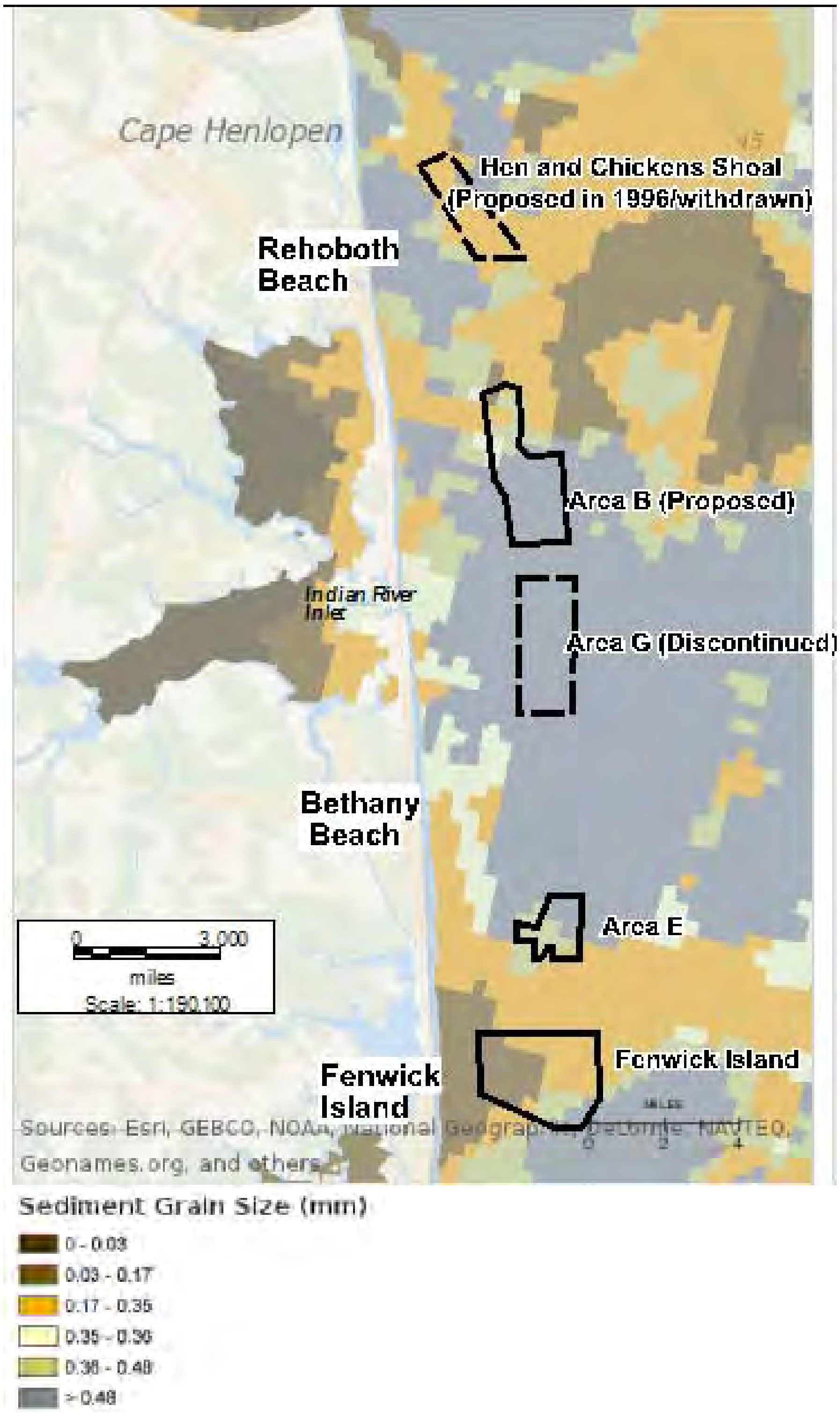


Figure 4-4. MARCO Sediment Grain Sizes Along the Delaware Atlantic Coast. (Source: from MARCO marine mapper planner website: http://portal.midatlanticocean.org/planner/ accessed on 3/24/2015)

4.1.4 Soils

A review of the web soil survey mapping provided on the Natural Resource Conservation Service (NRCS) website (accessed at http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx on 5/11/2015) revealed that the affected beach areas are mapped as “Acquango-Beaches Complex 0-10 percent” (AbC). This soil series was formerly mapped as “Coastal Beach and Dune Land (Co) in the 1974 soil survey (USDA, 1974). The Acquango soils are classified as mixed, mesic Typic Udipsamments formed from sandy eolian deposits and/or fluviomarine sediments. These soils are beach sands consisting of non-coherent loose sand that has been worked and reworked by waves, tides, and wind, and is still subject to such action (USDA, 1974). These soils have also been modified with the addition of beachfill sand obtained from offshore sand sources from beach replenishment projects.

4.1.4.1 Beach Sand Texture

Ramsey (1999) conducted a review of mean beach textures along the Delaware Atlantic Coast (from Cape Henlopen south to the DE/MD state line in Fenwick Island) measured over a 55-year (1929-1984) period prior to any large beach nourishment projects along the coast. The review was broken up into 1-km increments, major geomorphic features, sand transport zones, and inlet locations. The yearly averages did not identify any significant trends through time. Despite some variability among beaches, locations on the beach, seasons and sample years, the sands along the coastal beaches generally fell within the coarse to medium sand size range and were well to moderately well sorted. The overall average sand size for the entire coast was 1.26 phi (± 0.27 phi) (0.4 mm) with an average sorting of 0.46 phi (well sorted). Table 4-1 provides grain size averages and sorting data (in phi units) from data spanning from 1929 to 1984 along the Delaware Atlantic Coast from Ramsey (1999). In 1993, DNREC conducted a comprehensive beach sediment sampling project in support of the USACE feasibility studies for storm damage reduction (USACE, 1996, 1998, 2000) (Table 4-2). This sampling preceded the construction of the Federal beach nourishment projects at Rehoboth Beach/Dewey Beach (2005), Bethany Beach/South Bethany (2007) and Fenwick Island (2005), but followed several State of Delaware beach nourishment projects conducted between 1988 and 1992 (Bethany/South Bethany and Fenwick Island). However, for Rehoboth Beach and Dewey Beach, no beachfills were placed until 1994 and 1998, which followed the beach sampling performed in 1993-1994. Samples were beach composites along 67 survey lines sampled in the winter and spring. The overall mean grain sizes for these areas had a limited range from 0.267 mm to 0.29 mm and were classified as “poorly graded, well sorted fine to medium sands” (Table 4-2).

<table>
<tr><th colspan="6">Table 4-1. Historic Average Grain Sizes (in PHI units) Distribution of Beach Sands along the Delaware Atlantic Coast from 1929 to 1984. (from Ramsey, 1999)</th></tr>
<tr><th>KM SEGMENT (North to South)</th><th>AVG. GRAIN SIZE (PHI)</th><th>INLET SEGMENT</th><th>LONGSHORE TRANSPORT NODE</th><th>GEOMORPHIC REGION</th><th>FEDERAL PROJECT LOCATION</th></tr>
<tr><td>1</td><td>1.72 (med. sand)</td><td rowspan="22">North of Inlet
1.21 (med. sand)
-0.21</td><td rowspan="30">North Transport Node
1.22 (med. sand)
-0.23</td><td rowspan="7">Cape Henlopen Spit Complex
1.31 (med. sand)
-0.25</td><td rowspan="9"></td></tr>
<tr><td>2</td><td>1.5 (med. sand)</td></tr>
<tr><td>3</td><td>1.38 (med. sand)</td></tr>
<tr><td>4</td><td>1.19 (med. sand)</td></tr>
<tr><td>5</td><td>0.95 (crse. sand)</td></tr>
<tr><td>6</td><td></td></tr>
<tr><td>7</td><td>1.14 (med. sand)</td></tr>
<tr><td>8</td><td>1.17 (med. sand)</td><td rowspan="6">Headland
1.16 (med. sand)
-0.06</td></tr>
<tr><td>9</td><td></td></tr>
<tr><td>10</td><td>1.23 (med. sand)</td><td rowspan="4">Rehoboth Beach
Dewey Beach</td></tr>
<tr><td>11</td><td>1.06 (med. sand)</td></tr>
<tr><td>12</td><td>1.18 (med. sand)</td></tr>
<tr><td>13</td><td></td></tr>
<tr><td>14</td><td>1.07 (med. sand)</td><td rowspan="5">Bay Barrier
1.11(med. sand)
-0.24</td><td rowspan="7"></td></tr>
<tr><td>15</td><td>0.85 (crse. sand)</td></tr>
<tr><td>16</td><td>1 (med.-crse. sand)</td></tr>
<tr><td>17</td><td></td></tr>
<tr><td>18</td><td>1.5 (med. sand)</td></tr>
<tr><td>19</td><td>1.26 (med. sand)</td><td rowspan="4">Headland
1.24 (med. sand)
-0.11</td></tr>
<tr><td>20</td><td></td></tr>
<tr><td>21</td><td>1.1 (med. sand)</td><td rowspan="3">Indian River Inlet Sand Bypass</td></tr>
<tr><td>22</td><td>1.35 (med. sand)</td></tr>
<tr><td>23</td><td>0.81(crse. sand)</td><td rowspan="18">South of Inlet
1.3 (med. sand)
-0.32</td><td rowspan="2">Bay Barrier
1.09 (med. sand)
(0.28)</td></tr>
<tr><td>24</td><td>1.37 (med. sand)</td><td rowspan="5"></td></tr>
<tr><td>25</td><td>1.25 (med. sand)</td><td rowspan="10">Headland
1.27 (med. sand)
-0.32</td></tr>
<tr><td>26</td><td>0.88 (crse. sand)</td></tr>
<tr><td>27</td><td>1.36 (med. sand)</td></tr>
<tr><td>28</td><td>1.28 (med. sand)</td></tr>
<tr><td>29</td><td>1.7 (med. sand)</td><td rowspan="5">Bethany Beach
South Bethany</td></tr>
<tr><td>30</td><td>1.3 (med. sand)</td></tr>
<tr><td>31</td><td>1.39 (med. sand)</td><td rowspan="10">South Transport Node
1.37 (med. sand)
-0.35</td></tr>
<tr><td>32</td><td>1.08 (med. sand)</td></tr>
<tr><td>33</td><td>1.81 (med. sand)</td></tr>
<tr><td>34</td><td>0.71 (crse. sand)</td><td rowspan="4"></td></tr>
<tr><td>35</td><td>1.49 (med. sand)</td><td rowspan="5">Bay Barrier
1.38 (med. sand)
-0.17</td></tr>
<tr><td>36</td><td></td></tr>
<tr><td>37</td><td>1.14 (med. sand)</td></tr>
<tr><td>38</td><td>1.52 (med. sand)</td><td rowspan="3">Fenwick Island</td></tr>
<tr><td>39</td><td></td></tr>
<tr><td>40</td><td>1.82 (med. sand)</td><td>Headland
1.82 (med. sand)
(0.40)</td></tr>
<tr><td colspan="2">Average: 1.26 (med. sand)
Maximum: 1.82 (med. sand)
Std. Dev.:0.27
Minimum: 0.71 (crse. sand)
33 sample Sta.</td><td colspan="4"></td></tr>
</table>

Table 4-2. Survey Line Material Grain Size Composite Summary along Delaware Atlantic Coast on Pre-Federal Project Beaches in 1993-1994. (USACE, 1996, 1998, 2000)					
Project Reach	Composite Survey Line	Summer 1993		Winter 1993-1994	
		Mean Diameter PHI	STD. Dev. PHI	Mean Diameter PHI	STD. Dev. PHI
Rehoboth Beach and Dewey Beach	LRP-44	1.78	0.86	1.74	0.81
	LRP-45	1.96	0.74	1.82	0.95
	LRP-46	1.90	0.76	1.60	0.88
	LRP-47	1.80	1.11	1.51	0.82
	LRP-48	2.08	0.81	1.77	0.88
	LRP-49	2.08	1.07	1.77	0.76
	Overall Mean:	1.82 (0.28 mm)	0.85	Poorly graded, fine to medium sands	
Bethany Beach and South Bethany	LRP-59	1.76	0.84	1.73	0.74
	LRP-60	1.92	0.98	1.93	1.03
	LRP-60A	1.98	1.13	1.75	1.06
	LRP-60B	1.90	1.26	1.86	1.09
	LRP-61	1.94	1.12	1.80	1.04
	LRP-62	1.87	1.16	1.61	1.07
	LRP-62A	1.70	1.33	1.70	1.03
	LRP-63	1.91	1.03	1.69	1.12
	Overall Mean:	1.81 (0.29 mm)	1.07	Poorly graded, fine to medium sands	
Town of Fenwick Island	LRP-65	1.75	0.94	1.85	1.12
	LRP-66	1.93	0.98	1.71	0.92
	LRP-67	2.08	0.96	1.59	0.89
	Overall Mean:	1.91 (0.267 mm)	0.97	Poorly graded, fine to medium sands	

4.1.5 Sand Borrow Site Evaluation

Borrow Areas G, E, Fenwick Island and Hen and Chickens Shoal were previously evaluated in USACE (1996), USACE (1998), USACE (2000), USACE (2002) and USACE (2005), and are incorporated by reference. Borrow Area B was evaluated previously in USACE (2002), but has since been expanded and supplemented with new information. As part of this evaluation, Borrow Area B was divided into two areas, based on the initial review of the boring logs and the sieve analysis. The two areas consisted of the Northern Area (Area B North) and the Southern Area (Area B South) (Figure 4-5).

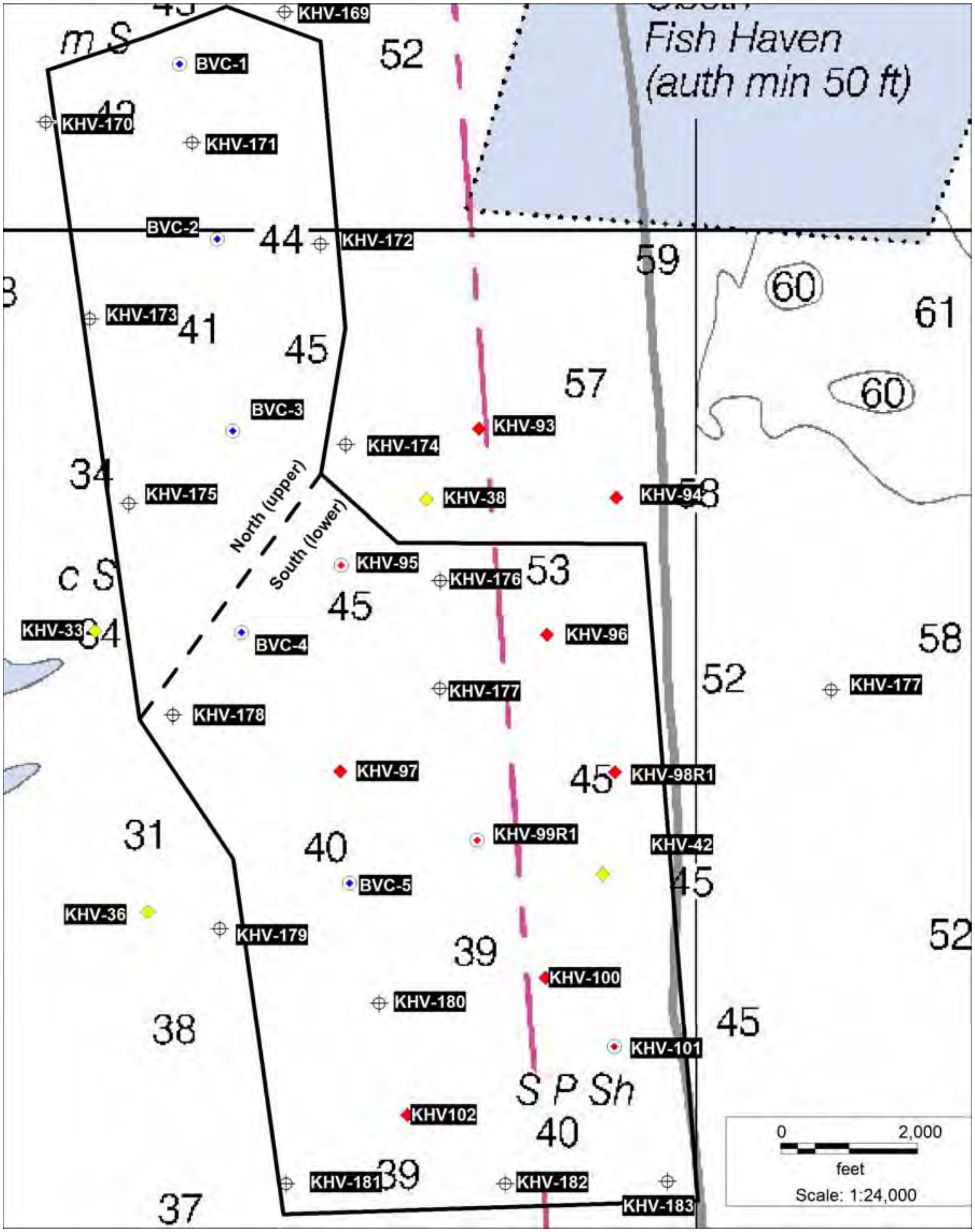


Figure 4-5. Area B Core Locations. (Duffield, 2000a; Duffield, 2000b; O'Brien and Gere, 2011; Versar, 2011).

The geotechnical analysis for Borrow Area B consisted of evaluating all of the samples within the borrow area and then segregating the samples to represent different depths of material present. The analysis to characterize the borrow area material was conducted using the Automated Coastal Engineering System (ACES) computer program. For both the Northern Area B and the Southern Area B, the sections were evaluated using limits of approximately 0-10 feet, 10-20 feet and a composite from cores described in O'Brien & Gere (2011).

4.1.5.1 Native Beach Material

The borrow area characterization was conducted to evaluate a suitable borrow area, which would be used primarily for the Rehoboth and Dewey Beaches. Information regarding the beach sampling that was performed for Rehoboth and Dewey Beaches was included in the Final Feasibility Report and Environmental Impact Statement, dated 1996, and utilized for this evaluation. The mean grain sizes, for the Rehoboth and Dewey beaches, were calculated from composite samples of the native beach material. Tables 4-1 and 4-2 provide historic grain sizes along these beaches.

4.1.5.2 Northern Borrow Area B (Area B North)

The material present in Northern Borrow Area B consisted predominately of a gray to tan, fine to medium, poorly graded sand, from a depth of approximately 0 to 10 feet below ground surface. The material from approximately 10 feet to the completion of the vibracore, consisted of a tan to gray, fine to medium, poorly graded sand, with some silt and gravel. The ACES evaluation for the Northern Borrow Area B resulted in a composite Mean Grain Size of 1.684 phi (0.311 mm), and a standard deviation = 1.049 phi (0.483 mm). Table 4-3 provides a summary of the ACES evaluation results for the Northern Borrow Area B.

The Northern Borrow Area was further divided into the upper portion (0-10' interval) and the lower portion (10-20' interval). The Mean Grain Size, for the upper interval (0-10') was calculated to be 1.694 phi (0.309 mm) with a standard deviation of 0.926 phi (0.526 mm), and the Mean Grain Size for the lower portion was calculated to be 1.667 phi (0.315 mm), with a standard deviation of 1.096 phi (0.468 mm).

Table 4-3. ACES Evaluation of Area B Cores.						
Sample ID	**Sample Elevation (ft.)**	**Mean Diameter (phi)**	**Mean Diameter (mm)**	**Standard Deviation (phi)**	**Standard Deviation (mm)**	**Description**
Upper (Northern) BA-B						
BA-B (0-10 foot)	0-10'	1.694	0.309	0.926	0.526	Fine to medium SAND, poorly graded (SP)
BA-B (10-20 foot)	10-18'	1.667	0.315	1.096	0.468	Fine to medium SAND, poorly graded (SP), with some silty sand (SP-SM) and gravel (GP)
Upper BA-B (Composite)	0-18'	1.684	0.311	1.049	0.483	
Lower (Southern) BA-B						
BA-B (0-10 foot)	0-10'	0.589	0.665	1.866	0.274	Medium SAND, poorly graded (SP), with gravel (GP)
BA-B (10-20 foot)	8.3-19.4'	-0.207	1.154	1.962	0.257	Medium SAND, poorly graded (SP) and gravel (GP), with some silty sand (SP-SM)
Lower BA-B (Composite)	0-19.4'	0.662	0.632	1.830	0.281	

4.1.5.3 Southern Borrow Area B (Area B South)

The material present in Southern Borrow Area B consisted predominately of a gray to tan, medium, poorly graded sand, from a depth of approximately 0 to 10 feet below ground surface. The material from approximately 10 feet to the completion of the vibracore, consisted of a tan to gray, medium, poorly graded sand, and gravel. The ACES evaluation for the Southern Borrow Area B resulted in a composite Mean Grain Size of 0.662 phi (0.632 mm), and a standard deviation = 1.830 phi (0.281 mm). Table 4-3 provides a summary of the ACES evaluation results for the Lower Borrow Area B.

The Southern Borrow Area was also divided into the upper portion (0-10' interval) and the lower portion (10-20' interval). The Mean Grain Size, for the upper interval (0-10') was calculated to be 0.589 phi (0.665 mm) with a standard deviation of 1.866 phi (0.274 mm), and the Mean Grain Size for the lower portion was calculated to be -0.207 phi (1.154 mm), with a standard deviation of 1.962 phi (0.257 mm).

4.1.5.4 Overfill/Renourishment Ratio

The overfill ratio (R_a) and re-nourishment ratio (R_j) for the Rehoboth and Dewey beaches were calculated using ACES. The overfill and re-nourishment ratios were calculated for each of the proposed areas from within Borrow Area B, which included:

- Northern Borrow Area B – 0-10'
- Northern Borrow Area B – 10-20'
- Southern Borrow Area B – 0-10'
- Southern Borrow Area B – 10-20'

Mean grain sizes, for the Rehoboth and Dewey beaches, were calculated from composite samples of the native beach material, collected during the June 1996 Feasibility Report and Environmental Impact Statement. The mean grain size for each of the beaches are:

Rehoboth Beach

- Mean grain size – 1.80 phi (0.287 mm)
- Std. deviation – 0.85 phi (0.555 mm)

Dewey Beach

- Mean grain size – 1.84 phi (0.280 mm)
- Std. deviation – 0.90 phi (0.533 mm)

The overfill (R_a) and re-nourishment (R_j) ratios for each of the scenarios for both the Rehoboth and Dewey Beaches, are as follows:

Rehoboth Beach

- Northern Borrow Area B 0-10'; R_a – 1.00, R_j – 0.158
- Northern Borrow Area B 10-20'; R_a – 1.00, R_j – 0.125
- Northern Borrow Area B - Composite'; R_a – 1.00, R_j – 0.134
- Southern Borrow Area B 0-10'; R_a – 1.10, R_j – 0.039
- Southern Borrow Area B 10-20'; R_a – 1.20, R_j – 0.054
- Southern Borrow Area B - Composite'; R_a – 1.13, R_j – 0.058

Dewey Beach

- Northern Borrow Area B 0-10'; R_a – 1.00, R_j – 0.183
- Northern Borrow Area B 10-20'; R_a – 1.00, R_j – 0.149
- Northern Borrow Area B - Composite'; R_a – 1.00, R_j – 0.158
- Southern Borrow Area B 0-10'; R_a – 1.08, R_j – 0.055
- Southern Borrow Area B 10-20'; R_a – 1.17, R_j – 0.076
- Southern Borrow Area B - Composite'; R_a – 1.11, R_j – 0.079

Based on the ACES results for the beach overfill and re-nourishment factors, the overfill factor for Rehoboth Beach, utilizing material from Northern Area B will be R_a = 1.00, and a re-nourishment factor of R_j = 0.142 ± 0.023. For Dewey Beach, utilizing material from the Northern Borrow Area B the overfill factor will be R_a =1.00, and a re-nourishment factor of R_j = 0.166 ± 0.024. The results for overfill and re-nourishment from the Southern Area B Borrow Area for Rehoboth Beach would be approximately R_a =1.15, and the re-nourishment factor would be R_j = 0.047 ± 0.011, and for Dewey Beach R_a =1.13 and R_j =0.066 ± 0.015.

4.1.6 Hazardous, Toxic, and Radioactive Wastes (HTRW)

A HTRW site search was conducted using the Delaware Environmental Navigator (DEN)(internet website http://maps.dnrec.delaware.gov/navProgramMap/ was accessed on 5/12/2015 to provide an updated snapshot of potential sources of contamination in the immediate vicinity of the project affected areas). This review included SIRB (Site Investigation and Restoration Branch) sites, leaking tanks, underground storage tanks, air emissions permits, certified brownfields sites, solid and hazardous waste generators, NPDES (National Pollution Discharge Elimination System), and above ground storage tanks. This search was limited to any sites east of Route 1 along the Delaware Atlantic Coast. The results of this search are provided in Table 4-4 and maps are provided in Appendix B.

Land uses within the project areas are primarily composed of beachfront properties (residences, retail businesses, restaurants, lodging), boardwalks, and undeveloped portions and are discussed in USACE (1996), USACE (1998) and USACE (2000).

Table 4-4. Summary of DEN-Identified Sites East of State Highway 1 along the Delaware Atlantic Coast.

FACILITY NAME	**DNREC PROGRAM**	**LOCATION**
Fort Miles	SIRS	Cape Henlopen State Park
USN Naval Facility	SIRS	Cape Henlopen
Dewey Beach Cylinder	SIRS	Dewey Beach
Delaware Target Areas - FUDS	SIRS	Delaware Seashore State Park
Indian River Life Saving Station	SIRS	North of Indian River Inlet
Indian River Inlet Cylinder	SIRS	North side of Indian River Inlet
Bethany Beach – Defense Site	SIRS	Bethany Beach
Bethany Beach Gap Filler Annex	SIRS	Sea Colony
North Shores Pumping Station (City of Rehoboth Beach)	Underground Storage Tank	S. Rodney and Ocean Drive, Rehoboth Beach
Henlopen Acres Marina	Underground Storage Tank (No Further Action)	Henlopen Acres
Thomas Property Above Ground Storage Tanks	Above Ground Storage Tanks	Columbia Ave, Rehoboth Beach
7-Eleven Store	Underground Storage Tank (No Further Action)	Rehoboth Ave. and Grove St. Rehoboth Beach
Phillips Property (Formerly Exxon Property)	Underground Storage Tank (No Further Action)	319 Rehoboth Ave. Rehoboth Beach
City of Rehoboth Beach (City Hall)	Underground Storage Tank (No Further Action)	229 Rehoboth Ave. Rehoboth Beach

Table 4-4. Summary of DEN-Identified Sites East of State Highway 1 along the Delaware Atlantic Coast.

FACILITY NAME	DNREC PROGRAM	LOCATION
William Ehrlich Trust	Underground Storage Tank (No Further Action)	107 & 111 Rehoboth Ave. Rehoboth Beach
Addison Property	Underground Storage Tank (No Further Action)	101 New Castle St. Rehoboth Beach
Rehoboth Shell	Underground Storage Tank (No Further Action)	3900 Route 1. Rehoboth Beach
Amoco	Underground Storage Tank (No Further Action)	3716 Route 1 Rehoboth Beach
Ocean Bay Mart Shopping Ctr.	Underground Storage Tank (No Further Action)	3712 Route 1 Rehoboth Beach
Estate of Marc Scheer	Underground Storage Tank (No Further Action)	107 Silver Lake Dr. Rehoboth Beach
Delux Dairy	Underground Storage Tank (No Further Action)	Route 1 & Cullen Rehoboth Beach
Dewey Exxon	Underground Storage Tank (No Further Action)	2104 Hwy 1 Dewey Beach
Coast Guard Life Saving Station	Above Ground Storage Tanks	Hwy 1. North of Indian River Inlet
Bethany Beach Fire Station	Underground Storage Tank (No Further Action)	215 Hollywood Street Bethany Beach
Pep Up #1	Underground Storage Tank	32919 Coastal Hwy. Bethany Beach
Sea Colony	Underground Storage Tank (No Further Action)	
Brown Derby Food Stores	Underground Storage Tank (No Further Action)	Route 1 & Dagsboro St. Fenwick Island
Fenwick Island Service Center	Underground Storage Tank (No Further Action)	Ocean Hwy and Bayard Fenwick Island

Table 4-4. Summary of DEN-Identified Sites East of State Highway 1 along the Delaware Atlantic Coast.		
FACILITY NAME	**DNREC PROGRAM**	**LOCATION**
Pep Up #20	Underground Storage Tank (No Further Action)	Route 1 & 54 Fenwick Island

Several potential environmental concerns associated with the offshore sand borrow areas were identified relating to HTRW, which may involve unknown hazardous waste sites, sunken ships (possibly with weapons), weaponry from WWII shooting ranges, and rubble piles (used to create artificial reefs). No known hazardous waste sites or major spills were identified within the State and Federal databases within 1 mile of the Delaware Coastline. However, the U.S. Coast Guard National Response Center reported several occurrences of unknown sheens in Delaware Coastal waters or tar-like substances washed up on Delaware beaches where the origin or substance is unknown (National Response Center, 2001). There are no known radioactive sites within three miles of the coast. One experimental stabilized coal waste fish reef lies approximately 1.5 miles southeast of Indian River Inlet. This reef contains 250 tons of stabilized coal waste blocks along with 90 tons of concrete control blocks that were placed within a 75-foot long by 60-foot wide area (Eklund, 1988). This reef is not within the boundaries of any existing or proposed sand source.

No known ocean dumpsites were identified within the sand source areas or in the immediate vicinity of the borrow areas or sand placement areas. However, a historic sewage sludge dump area existed approximately 16 miles off of the Delaware Coast (Rehoboth Beach). This site was used mainly by the City of Philadelphia for the disposal of municipal sewage sludge from 1961 to 1973. Dumping at this site was discontinued because it was determined to be a potential threat to existing commercial surfclam beds and shellfish beds located south and west of the site (Muir, 1983 and Buelow et al. 1968). HCS is the nearest (previously proposed) borrow site at approximately 13 miles from this site, and Area B is approximately 13.6 miles from the site.

4.1.6.1 Munitions and Explosives of Concern (MEC)

Two former artillery-firing ranges have historically occupied tracts of land along the Delaware Atlantic Coast (Figure 4-6). One range occupied a 275-acre portion of beach area north of Indian River Inlet in the present Delaware Seashore State Park, and was known as the North Firing Range. The second range occupied a 108-acre tract of land south of South Bethany in present day Fenwick Island State Park, and was known as the South Firing Range. These ranges were associated with the former military installation of Fort Miles, which is now Cape Henlopen State Park. These areas have been the subjects of investigations conducted under the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS). Both ranges were utilized as artillery ranges by the Delaware National Guard from 1950 – 1959. In 1959, control of the Delaware National Guard was transferred from the Department of the Army to the State of Delaware. There were no indications of usage of the North Range after 1959. However, the South Range received continued use as an artillery range by the Delaware National Guard until 1970 and then as a small

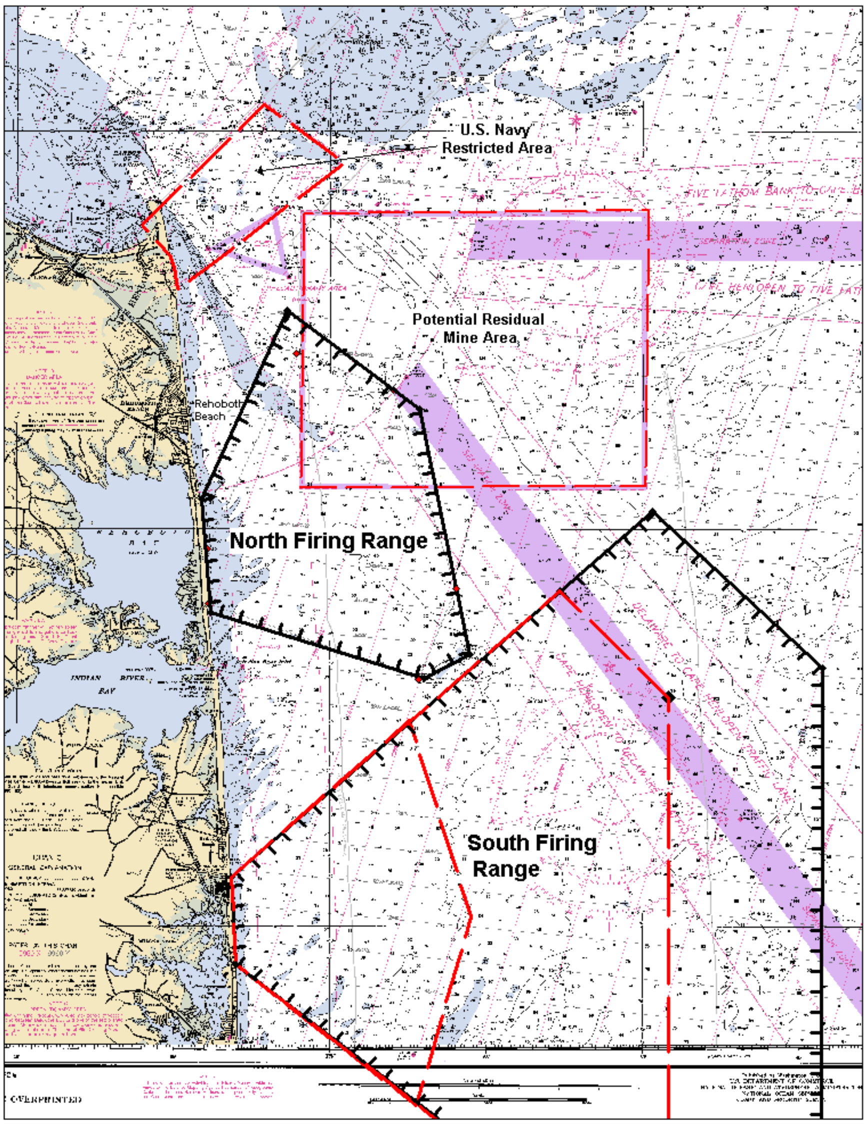


Figure 4-6. Former Firing Range Locations and Other Areas of Concern Along the Delaware Atlantic Coast.

arms range until at least 1974. The South Firing Range was previously used to conduct surface-to-air firing at radio-controlled aerial targets by self-propelled 40-mm air defense artillery weapons. Also the area was used for surface-to-surface firing with 40-mm artillery and for practice tests of target detection of high performance aircraft.

The North Artillery Range, which is part of the Formerly Used Defense Sites (FUDS) program (C03DE006402), is about 6,000 feet to the north of the beachfill project boundary for IRI North Shore. This site is approximately 364 acres in size, and was used as an automatic weapons firing point for anti-aircraft target practice by the U.S. Army. This site is now part of Delaware Seashore State Park. A Site Inspection Report (USACE, 2010) investigated the potential for munitions and explosives of concern (MEC) and munitions constituents (MC) at the site. The types of munitions identified in this report that were likely used at this range include small arms, 40 mm HE (high explosive) HEI (high explosive incendiary), Mark II and 3.25 –inch target rockets, MK1. After a thorough inspection of the property, which included sampling the soils and sediments for explosives and explosive residues and metals, this investigation concluded that the land portion of this site has no reports of MEC or MD (munitions debris) that are known to exist; and surface soil, subsurface soil and sediment analyses yielded no explosive MC detections. This report further concluded that no Chemicals of Potential Concern (COPC) or Chemicals of Potential Ecological Concern (COPEC) were identified in any of the media at this site. A portion of the HCS site lies within the northern edge of the North Firing Range envelope. Area B lies entirely within the North Firing Range envelope, and Area G is situated outside of both ranges, but lies between the outside boundaries of both ranges.

The South Firing Range may also have been used as a firing range for M60 Machine guns, M79 Grenade Launchers, and 45 caliber submachine guns. A 1950 memorandum from the Department of the Army to the U.S. Coast and Geodetic Survey indicated that firing was conducted in the South Firing Range utilizing 90-mm and 120-mm projectiles, and the North Firing Range was used as an “Automatic Weapons Area” during the 1950s. Area E lies entirely within the impact area of this range and the northern half of the Fenwick Island Borrow Area lies within the southern border of this range.

Because of the presence of these ranges along the Delaware Atlantic Coast, there exists a high potential for encountering MEC’s when dredging within these offshore borrow areas. This high potential was evident in previous beach nourishment project where live ammunition rounds and munitions debris have been discovered on nourished beaches prompting calls for Explosive Ordnance Disposal teams and a detect and removal project in the Bethany Beach/South Bethany areas. Because MECs present a significant hazard to the public and beachfill crew, the Philadelphia District has required that screens be placed on intakes on all dredges and basket screens on the beach pump-out locations to minimize the potential for these items becoming entrained in the dredge and being pumped out on to the beaches. Additionally, crews trained in MEC monitoring and safety protocols provide 24-hour support during dredging operations. This has been the practice since 2005 on all beach nourishment projects along the Delaware Atlantic Coast.

The National Oceanic and Atmospheric Administration (NOAA) Cape Henlopen to Indian River Inlet Soundings Map indicates an area approximately three miles off the coast that has been designated a danger zone (Figure 4-6). Ocean-going vessels are permitted to navigate in this zone, however, all vessels are cautioned not to anchor, dredge, trawl, lay cable, or conduct any other activity that involves disturbing the substrate due to the potential danger from mines being buried within the substrate. The HCS sand borrow source is located in close proximity to this area; however, it is outside of this area. Areas B and G are also outside of this area.

4.1.7 Sediment Quality of Sand Source Areas

Subsequent to USACE (1996) physical and chemical analyses were performed on sediment composite cores obtained from HCS (Kelley, 1999; Duffield Associates, 1999) and Areas B and G (Duffield Associates, 2000) to provide baseline data to screen for any contamination of these sites. These analyses included bulk sediment chemistry (all areas), elutriate on HCS composites, and water quality at HCS. The results of these analyses were evaluated in USACE (2002) and are incorporated by reference. Sediment quality was also evaluated for Area E and the Fenwick Borrow Area in USACE (2000) and USACE (2005). A more recent sediment investigation (Versar, 2011) was conducted for the reconfigured Area B. Both investigations for Area B are presented here. Figure 4-5 provides core locations within Area B from these investigations.

4.1.7.1.1 Physical Sediment Quality

Sediment grain size distribution analyses were conducted along with chemical analyses in vibracores obtained from within Area B. Three vibracores were obtained by Duffield Associates (2000) and composited from the sediment interface to depths ranging from 7.0 feet to 8.6 feet. All three composites had silt-clay contents less than 4.2%. All of the cores were mainly composed of sands. Two cores (KHV-95E and KHV-101E) had greater than 90% sand. KHV-99E had the most granular material where it was composed of 59% sand 38% gravel. TOC was low in all three composites ranging from 0.008% in KHV-101E to 0.025% in KHV-95E. Among the six stations sampled by Versar, Inc. (2011)

for contaminant analysis, four were composed primarily of sands (BVC-1, BVC-2, BVC-3, and BVC-5 (Table 3-8). The surface sediments at BVC-4 were dominated by gravel (46%) and sand (31%), while the subsurface sediments at this station were 96% silt/clays. Sediments collected at station BVC-6 were also mostly silt clays consisting of 77% silt/clay in the surface composite and 92% silt/clay in the subsurface composite. Because of the high silt/clay component in BVC-6, the Area B boundaries were moved to exclude this area because of its unsuitability as beachfill.

Table 4-5. Results of Grain Size and Total Organic Carbon (TOC) Analysis for Composite Samples Taken from Area B. (Duffield, 2001a; Versar, 2011)

	BVC-1 (0-3 ft.)	**BVC-1 (3-10 ft.)**	**BVC-2 (0-3 ft.)**	**BVC-2 (3-10 ft.)**	**BVC-3 (0-3 ft.)**	**BVC-3 (3-10 ft.)**
TOC (%)	0.47	0.40	0.56	0.57	0.86	0.61
Silt/Clay (%)	4.80	5.29	5.18	4.57	11.28	11.70
Gravel (%)	0.02	0.82	0.67	13.97	13.76	0.83
Sand (%)	95.19	93.89	94.15	81.46	74.96	87.47
	BVC-4 (0-3 ft.)	**BVC-4 (3-10 ft.)**	**BVC-5 (0-3 ft.)**	**BVC-5 (3-10 ft.)**	**BVC-6 (0-3 ft.)**	**BVC-6 (3-10 ft.)**
TOC (%)	0.66	2.54	0.39	0.69	1.67	2.46
Silt/Clay (%)	23.18	96.26	3.36	6.42	77.11	91.90
Gravel (%)	45.85	0.00	20.41	3.41	2.52	0.00
Sand (%)	30.97	3.74	76.23	90.17	20.37	8.10
	KHV-95E (0-7.0 ft.)	**KHV-99E (0-8.0 ft.)**	**KHV-101E (0 – 8.6 ft.)**			
TOC (mg/kg)	251	169	77			
Silt/Clay (%)	3.5	2.7	4.1			
Gravel (%)	5.7	38.3	3.6			
Sand (%)	90.8	59.0	92.3			

4.1.7.1.2 Inorganic and Organic Chemistry of Sediments

4.1.7.1.2.1 Area B Sediments

Metals: Sampling conducted by Duffield Associates (2000) and Versar Inc. (2011) analyzed 23 target analyte list (TAL) metals (Tables C-2 and C-3, Appendix C). Among 15 samples (from 9 core locations), all TAL metals were detected in Area B sediments. The concentrations of these metals were compared to the DNREC SIRS Screening Levels for Soil (human health) and Marine Sediments (ecological) (DNREC, 2014) and sediment effects levels on benthic organisms “Effects Range – Low” (ERL) (Long et.al., 1995). The SIRS screening levels are used to identify contaminants of particular concern (COPC), which may require further risk analysis. Of the metals detected, nickel and thallium exceeded some of the criteria. Nickel slightly exceeded the marine sediment level (15.9 ppm) in one sample (BVC-4) in the 3 to 10 ft. strata, which was measured at 20.9 ppm. Thallium exceeded the DNREC soil screening levels (0.0178 ppm) at BVC-4 (3 – 10 ft. strata) at 0.16 ppm and both BVC-6 sample strata at 0.11 ppm and 0.14 ppm. BVC-6 sample location lies about 800 ft. outside of the southern boundary of Area B. Samples KHV-95E, 99E, and 101E were listed as undetected for Thallium, but they all had method detection levels that were above the DNREC soil screening levels.

Volatile Organic Compounds (VOCs): Two VOCs were detected in Area B sediment samples taken in 2000 (Duffield Associates, 2000) (Figure C-4, Appendix C). Acetone, a common laboratory solvent, was detected at concentrations that exceeded the DNREC URS for sediment. The likelihood of acetone's presence in marine sediments is improbable due to the fact that it is almost completely miscible in water and evaporates readily when exposed to air. The other VOC detected in the analyses was perchloroethylene (PCE), which was detected at concentrations below any regulatory criteria. PCE is a common solvent associated with dry-cleaning facilities and commercial or industrial de-greasing operations. It has a density that is greater than water and is not very soluble in water. If released to a body of water in significant volume, PCE may settle to the bottom and pool as a separate liquid. There are no known likely sources of this compound, however, it is possible that vapors from dry cleaned garments of laboratory personnel could be a source (Duffield Associates, 2000a). Given the fact that these compounds were found in most of the samples obtained from the ocean floor that were in most cases several miles apart from each other, actual sediment contamination is less likely. It should be noted that VOC samples were obtained from sediment composites, which may affect the recovery of VOCs, if present. No VOC's were analyzed in Versar (2011).

Semi-Volatile Organic Compounds (SVOCs), Aroclors and Pesticides: No TCL (Target Compound List) SVOCs, pesticides or Aroclor forms of polychlorinated biphenyls (PCBs) were detected in sediment samples obtained from 3 cores within Area B samples analyzed by Duffield Associates (2000) (Table C-5, Appendix C). Six cores were later sampled and analyzed by Versar Inc., (2011) (Table C-6, Appendix C). Several polynuclear aromatic hydrocarbons (PAH's) were detected in BVC-3, BVC-4 and BVC-5, but were lower than DNREC screening levels or sediment effects levels (Long et. al. 1995). Detections of phenol were observed in several cores and two phthalates were present, but below screening levels. Several organic pesticides and their metabolites were detected in the Versar Inc. (2011) samples (Table C-7, Appendix C), which included 4,4-DDD, 4,4-DDE, 4,4-DDT, Dieldrin, Endosulfan sulfate, and gamma-Chlordane. None of these pesticides exceeded DNREC screening levels for soil and marine sediments; however, Dieldrin exceeded the ER-L (Long et.al. 1995) value in three samples by an order of magnitude.

Concentrations that exceed an ER-L value, but are below an Effects Range-Median (ER-M) value, suggest that there are possible effects of this concentration on benthic organisms. No Aroclor PCBs were detected in the 2011 samples.

High Resolution PCBs, Dioxins, and Furans: Seventy-five PCB congener and coplanar PCBs were analyzed in Area B sediment composites (Duffield Associates, 2000). A number of PCB detections were recorded within the parts per trillion (pptr) range. These detections were summed to produce a total PCB concentration value (Table C-11, Appendix C). The core at KHV-95E had a total PCB concentration of 352.7 pg/g (pptr). KHV-99E had a total PCB concentration of 666.3 pg/g (pptr) and KHV-101E had a total PCB concentration of 582.4 pg/g (pptr). All of these concentrations were less than the total concentration reported for the method blank of 812.5 pg/g (pptr). Sum total PCB concentrations for Area B sediment composites were both less than 1 ng/g (1 µg/kg) (Duffield Associates, 2000). The DNREC screening levels for soils and marine sediments are 220 µg/kg and 40 µg/kg, respectively. The ER-L for total PCBs is 22.7µg/kg. Versar Inc. (2011) analyzed 208 PCB congeners at two Area B cores (BVC-2 and BVC-5), and grouped them into their homolog groups (Table C-8, Appendix C). The sum of these homolog groups fell below 1 ng/g (1 µg/kg).

Several of the targeted dioxins and furans were detected in the composite samples in Area B sediments (Duffield Associates, 2000 and Versar Inc., 2011) (Tables C-8 thru C-13, Appendix C). Since there are no standards for most of the targeted dioxins and furans, Toxicity Equivalents (TEQs) (Van den Berg, 2006) are used to determine the relative toxicity of a constituent when compared to the most toxic form of dioxin (2,3,7,8-TCDD), which has a DNREC Screening Level for Soils of 4.0 pg/g (parts per trillion). A Toxicity Equivalent Factor value is assigned to constituents relative to its toxicity when compared to 2,3,7,8-TCDD. The calculated TEQ of vibracores from both, Duffield and Versar are presented in Tables C-9, C-10, C-12, and C-13. Based on this, the total TEQs of detected concentrations of dioxins and furans in Area B sediments are an order of magnitude below the DNREC Soil Screening Level of 4.5 pg/g (parts per trillion) for 2,3,7,8-TCDD. One sample for coplanar PCBs exceeded this level at 12.9 pg/g at BVC-5 (surface).

Radionuclides: Versar Inc. (2011) analyzed 4 radionuclides from 6 cores obtained from Area B (Table C-14, Appendix C). Versar Inc. (2011) reports that the concentrations were within the range of background concentrations observed in Chesapeake Bay sediments (Olsen et al. 1989).

4.1.8 Water Quality

The Delaware Department of Natural Resources and Environmental Control conducts beach water quality monitoring of recreational waters to ensure their quality for swimming. Point sources of pollution, and rainfall-driven runoff from the land (nonpoint source pollution), may introduce disease-causing organisms into swimming waters. However, because of improvements in wastewater treatment and the elimination of some discharges, Delaware's guarded beaches are no longer impacted by point sources of pollution. DNREC reports that efforts are also underway to control nonpoint source pollution by installing central wastewater collection and treatment systems to eliminate septic systems and by better managing agricultural, commercial and residential lands.

Bacteriological water quality can be affected by a number of factors, including human-induced contamination and a number of natural factors. For example, windy conditions create water turbulence. Naturally occurring bacteria that live on the bottom can be churned up into the water column by wind-induced waves. This will result in elevated levels of Enterococcus bacteria. If elevated levels are the result of natural conditions, and are presenting no threat to the public's health, an advisory will not be issued (source DNREC website: http://apps.dnrec.state.de.us/recwater/MoreInfo.aspx accessed on 5/4/2015).

Along Delaware's Atlantic coast, stormwater discharges are the primary sources of pollutants in recreational water. Rehoboth Beach currently has 6 stormwater ocean outfalls at Lake Avenue, Grenoble Place, Laurel Avenue, Maryland Avenue, Rehoboth Avenue and Delaware Avenue. DNREC monitors 19 water quality monitoring locations along Delaware's Atlantic Coast, which includes all of the guarded beaches in the State parks, and municipalities. Recreational water samples are analyzed to determine the levels of Enterococci bacteria. Enterococcus is one of several indicator organisms that signal the presence of potentially harmful bacteria and viruses. Currently, Delaware uses the following Enterococcus standards (colonies per 100 milliliters):

Table 4-6. Delaware Enterococcus Standards.

Water Type	Geometric Mean (# colonies)	Instantaneous Value (# colonies)	Resample Value (# colonies)
Fresh	100	185	
Salt	35	104	104

The geometric mean is calculated to determine the long-term safety of a recreational beach for swimming. The instantaneous value allows DNREC to assess current water quality conditions. Results are available 24 hours after the sample is delivered to the laboratory. Standards that are exceeded are used (in addition to other factors) to make a decision as to the safety of the waterbody for swimming, which could result in the issuance of a "no swimming" advisory. (DNREC internet website http://apps.dnrec.state.de.us/RecWater/MoreInfo.aspx accessed on 5/4/2015).

Delaware's Atlantic Coast recreational beaches from Cape Henlopen to Fenwick Island historically have excellent water quality based on long term testing for enterococcus indicator bacteria conducted by the Delaware Shellfish and Recreational Water Programs. Bacterial sampling occurs annually from the first Monday in May through the third Monday in September to coincide with the summer swimming season. Bacterial results are available on the State's website, which is updated as new results are received.

Exceedances of water quality along the Atlantic Coastal beaches are rare, with the last recorded advisory occurring in 2013 from Atlantic Beach near Gordon's Pond through the southern end of Rehoboth Beach. These exceedances were attributed to storm water pipes located at several locations along Rehoboth Beach which increased indicator bacterial levels in the nearshore environment following a heavy rain event in June of 2013. Rehoboth experienced a similar swimming advisory in 2011 attributed to storm water influences at the Rehoboth Ave. sampling location. For the remaining Atlantic Coastal beaches there have been no exceedances of the instantaneous single sample maximum value or the geometric mean which caused any swimming advisories to be issued since 2010 (personal communication with Michael Bott - DNREC Shellfish and Recreational Water Program on 5/6/2015).

Shellfish harvesting designations are based on water quality monitoring by DNREC. There is one area along the Atlantic Ocean Coast where shellfish harvesting is prohibited year round. The Sussex County South Coastal Sewage Treatment Plant operates an ocean outfall that discharges treated wastewater approximately 1.25 miles offshore of the Sea Colony Condominiums. The Shellfish and Recreational Water Branch of the Delaware Department of Natural Resources and Environmental Control has established a ½ mile buffer zone around the outfall discharge point to prohibit the harvesting of shellfish. Sand Borrow Area E is located near this outfall. A 1-mile no dredging buffer zone has been established around this outfall.

DNREC regularly monitors for harmful algal blooms. In 2007, a red tide was experienced along the Atlantic coast of Delaware. The red tide was caused by a dinoflagellate organism, *Karenia brevis*, which is normally found along the Gulf Coast of Florida. It was believed that this organism was brought to near shore waters by an eddy from the Gulf Stream. K. brevis produces a brevetoxin, which may become aerosolized when the organism is broke up in the surface. Its effects can cause respiratory irritation to the general public (DNREC internet website http://www.dnrec.delaware.gov/Pages/RedTideINformation.aspx accessed on 5/4/2015).

For offshore borrow areas, the water quality discussions in USACE (1996, 1998, 2000, and 2005) are incorporated by reference. For Area B, various water quality parameters were measured in Scott and Wong (2012) as part of the benthic biological condition evaluations. Scott and Wong (2012) performed physical and chemical water quality measurements on two occasions to provide water quality conditions at the time of biological sampling of Area B. During benthic grab sample collection in October 2011, water quality measurements were taken at 6 stations near the surface (0.5 m) and near the bottom (13.5 m – 16.6 m). In this investigation, little to no stratification was observed. Surface water temperatures ranged from 12.5 ^{o}C to 13.8 ^{o}C and bottom water temperature ranged from 13.4 ^{o}C to 13.8 ^{o}C. Other parameters also showed slight variabilities between surface and bottom. Dissolved oxygen levels ranged from 11.4 to 12.3 mg/l along the surface and 9.6 to 10.1 mg/l along the bottom. Salinity ranged from 26.99 to 27.83 ppt along the surface and 29.55 to 30.57 ppt along the bottom. These slight variations suggest a well-mixed water column at the time of sampling.

4.1.9 Air Quality and Noise

4.1.9.1 Air Quality

The Environmental Protection Agency (EPA) adopts National Ambient Air Quality Standards (NAAQS) for the common air pollutants, and the states have the primary responsibility to attain and maintain those standards. Through the State Implementation Plan (SIP), The Delaware Department of Natural Resources and Environmental Control – Division of Air Quality manages and monitors air quality in the state. The goal of the SIP is to meet and enforce the primary and secondary national ambient air quality standards for pollutants. Criteria pollutants have primary ambient air quality standards designed to protect public health, including an adequate margin of safety to protect sensitive populations such as children and asthmatics. The criteria pollutants being monitored in Delaware are: ozone (O3), carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO2), particulate matter (PM – PM2.5/PM10) and lead (DNREC, 2013).

Changes and overall improvement in ambient air quality were noted in Delaware's 2013 annual air quality report (DNREC, 2013). In 2013, only one pollutant, ozone, exceeded the national ambient air quality standard. Other pollutants monitored in Delaware (SO2, CO, NO2, PM2.5, PM10 and lead) were below the national standards. According to the air quality index (AQI), there were only a few days that fell into the category of moderate or unhealthy for sensitive populations. Based on recent trends, the number of days with good air quality continues to increase. The U.S. Environmental Protection Agency (EPA) announced on August 4, 2014 that New Castle County has met the previous annual and 24-hour air quality standards for fine particulate matter. On August 19, 2014, EPA also determined that all of Delaware has met the even stricter annual fine particulate standards that were put into place in 2012. Substantial pollution control improvements due to federal rules and Delaware regulations have contributed to the much improved fine particulate air quality. For ozone, there were two days with exceedances of the 8-hour ozone standard in 2013 statewide, with one exceedance occurring in New Castle County and one in Sussex County. There were no exceedances of the state 1-hour ozone standard. Ozone concentrations continue to show a generally decreasing trend in all three counties over recent years. Concentrations of air toxics in Wilmington continue to show generally low or declining levels. Emissions of air pollutants are calculated every three years as part of a comprehensive emissions inventory (DNREC, 2013).

The Clean Air Act requires that all areas of the country be evaluated and then classified as attainment or non-attainment areas for each of the National Ambient Air Quality Standards. Areas can also be found to be "unclassifiable" under certain circumstances. The 1990 amendments to the act required that areas be further classified based on the severity of non-attainment. The classifications range from "Marginal" to "Extreme" and are based on "design values". The design value is the value that actually determines whether an area meets the standard. In 2008, the U.S. Environmental Protection Agency (EPA) promulgated a revised National Ambient Air Quality Standard (NAAQS) for ground level ozone at a concentration of 0.075 ppm averaged over eight hours. The new standard supersedes the previous 8-hour ozone standard of 0.08 ppm. New Castle and Sussex counties exceeded the new 0.075 ppm standard based on 2009-2010-2011 3-year monitoring data. Based on the 2009-2011 monitoring data, EPA designated New Castle County a "marginal nonattainment area (NAA)" within the Philadelphia-Wilmington-Atlantic City NAA, and Sussex County a stand-alone "marginal Seaford NAA," under the new 0.075 ppm standard (Figure 4-7). Kent County was designated as an attainment area because it met the standard (DNREC, 2013).

The EPA established the calendar year 2011 as the base year inventory for the new 0.075 ppm ozone standard. Ground-level ozone is created when

Figure 4-7. Delaware Non-Attainment Areas for Ozone. (Source: DNREC, 2013)

nitrogen oxides (NOx) and volatile organic compounds (VOC's) react in the presence of sunlight. NOx is primarily emitted by motor vehicles, power plants, and other sources of combustion. VOC's are emitted from sources such as motor vehicles, chemical plants, factories, consumer and commercial products, and even natural sources such as trees. Ozone and the pollutants that form ozone (precursor pollutants) can also be transported into an area from sources hundreds of miles upwind (DNREC, 2013).

4.1.9.2 Noise

Noise is of environmental concern because it can cause annoyance and adverse health effects to humans and animal life. Noise can impact such activities as conversing, reading, recreation, listening to music, working, and sleeping. Wildlife behaviors can be disrupted by noises also, which can disrupt feeding and nesting activities. Because of the developed nature of the municipalities and resorts along the Delaware Atlantic Coast, noises are common and can come in the form of restaurant and entertainment facilities, automobiles, boats, and recreational visitors. However, the affected communities impose local restrictive noise ordinances to minimize noise impacts.

4.2 Biological Environment

4.2.1 Terrestrial

The terrestrial environment of the impacted areas are described in USACE (1984), USACE (1996), USACE (1998), and USACE (2000) and, and are incorporated by reference. The entire terrestrial portion of the project impact area contains a high-energy sandy beach with land features such as headlands in the north (Rehoboth Beach) and coastal barrier to the south (Dewey Beach). Indian River Inlet North Shore is a coastal barrier beach. Another major headland exists at Bethany Beach, and coastal barriers exist in the South Bethany to Fenwick Island stretch of shoreline. The entire Delaware Atlantic Coastline is about 24 miles long. Approximately 14 miles of the coast is sparsely developed composed mostly of state park beaches, which include (from North to South) Cape Henlopen State Park, Delaware Seashore State Park and Fenwick Island State Park. Except for the north shore of Indian River Inlet, the affected project areas are highly developed landward of the dune line. Rehoboth Beach and Bethany Beach are the most densely developed beaches consisting of boardwalks, hotels, homes, condominiums, and other commercial establishments. Dewey Beach, South Bethany and Fenwick Island are made up mostly of single family homes and/or smaller hotels. Within these communities, a single maintained dune has been constructed along the shore front as part of the existing Federal storm damage reduction projects.

4.2.1.1 Dune and Upper Beach Flora and Fauna

The predominant vegetation growing on the primary dune areas consists of American beachgrass (*Ammophila breviligulata*), sea rocket (*Cakile dentata*) and beach clotbur (*Xanthium echinatum*). The constructed dunes also contain seaside panic grass (*Panicum amarum*) along the dune crest and landward side of the dune. The sparsely developed state park beaches contain secondary dunes that offer more vegetative diversity including: beach heather (*Hudsonia tomentosa*), saltmeadow hay (*Spartina patens*), broom sedge (*Andropogon virginicus*), beach plum (*Prunus matitima*), seabeach evening primrose (*Oenothera humifusa*), sand spur (*Cencrhus tribuloides*), seaside spurge (*Ephorbia polygonifolia*), joint-weed (*Polygonella articulate*), slender-leaved goldenrod (*Solidage tenuifolia*), and prickly pear (*Opuntia humifusa*). Some areas where depressions have formed between dunes have developed freshwater wetlands with bog-like characteristics. None of these wetlands occur within the affected beach areas. The primary and secondary dunes typically transition into scrub-thicket habitat composed primarily of shrubs and small trees including: wax myrtle (*Myrica cerifera*), bayberry (*M. pensylvanica*), dwarf sumac (*Rhus copallina*), black cherry (*Prunus serotina*), American holly (*Ilex opaca*), grounsel bush (*Baccharis halimifolia*), beach plum, and the non-native Japanese black pine (*Pinus thunbergiana*).

Because most of the dune present within the affected area is a primary dune, fauna inhabiting the dune is scarce, but may include several species of passerine birds, and typical mammalian species such as the eastern cottontail (*Sylvilagus floridanus*). Some of the plants found on the dune may also be found on the upper beach, which transitions into a mostly barren area above the high tide line with little biological activity. Several species of gulls (*Larus* spp.) may be present within the upper and lower beach and may be observed feeding on carrion, plant matter or invertebrates within the beach wrack. One of the most active organisms in the upper beach zone is the ghost crab (*Ocypode quadrata*), which is a scavenger, predator, and deposit sorter that lives in semi-permanent burrows in the upper beach. The lower beach including the intertidal zone is frequently inhabited by shorebirds including sanderling (*Calidris alba*), semipalmated sandpiper (*C. pusilla*), and western sandpiper (*C. mauri*), which utilize these areas to feed on invertebrate infauna.

4.2.2 Aquatic Environment

4.2.2.1 Benthic Environments

Projects that involve dredging and fill placement have direct and indirect effects on the benthic environment principally on the macrofauna inhabiting this environment. Benthic macroinvertebrates refer to those organisms living along the bottom of aquatic environments. They can be classified as those organisms dwelling in the substrate (infauna) or on the substrate (epifauna). Benthic invertebrates are an important link in the aquatic food chain, and provide a food source for a variety of bottom feeding fish species and shorebirds in the intertidal zone. Various factors such as hydrography, sediment type, depth, temperature, irregular patterns of recruitment and biotic interactions (predation and competition) may influence species dominance in benthic communities. Benthic assemblages in Delaware coastal waters exhibit seasonal and spatial variability. Generally, coarse sandy sediments are inhabited by filter feeders and areas of soft silt or mud are more utilized by deposit feeders. Benthic communities along the Delaware Atlantic Coast are variable from those dominated by mollusks, polychaete worms or amphipods.

4.2.2.1.1 Benthos of Intertidal Zone and Nearshore Zone

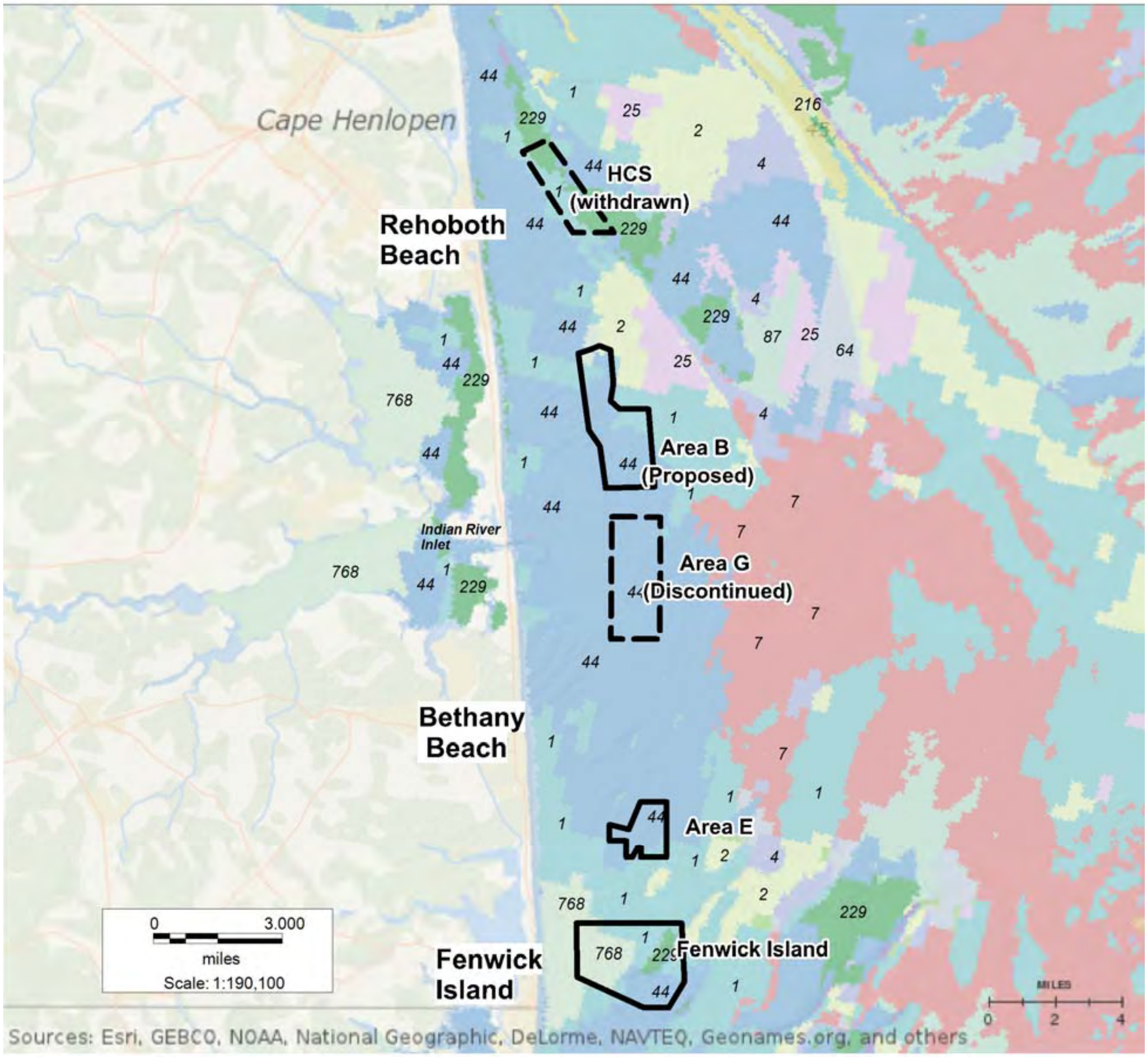
Benthic invertebrates inhabiting the upper marine intertidal zone along the Delaware Atlantic beaches are scarce in a zone characterized by little biological activity. The beach wrack line provides a moist microhabitat inhabited by crustaceans such as the amphipods: *Orchestia spp.* and *Talorchestia spp*., which are also known as beach fleas. Biological activity becomes more intense within the intertidal zone, which is characterized as a high-energy environment due to pounding wave action and shifting sands. Fauna inhabiting the intertidal zone of a high-energy beach have developed special morphological adaptations to allow these organisms to rapidly burrow, relocate, and feed to enable their survival in this extreme environment. Typical benthic organisms that are likely to be found within the intertidal zone of beaches along the Delaware Atlantic Coast include the mole crab (*Emerita talpoida*), the coquina clam (*Donax variabillis*), a haustorid amphipod (*Haustorius canadensis*) and a spionid worm (*Scolelepis squamata*). Within the nearshore zone, diversity increases due to the transition into deeper water. The nearshore may include some of the intertidal species and some of the offshore species.

4.2.2.1.2 Benthos of Offshore Borrow Areas

Offshore benthic habitats along the Delaware Atlantic Coast are highly variable depending on depth and substrate type, which influence the benthic community composition. Here, benthic communities generally exhibit greater diversity than those within the intertidal and nearshore areas, which can be attributed to more stable physical environments. The Delaware Atlantic Coast has a number of different benthic habitat types within the nearshore and offshore waters. Figure 4-8 provides a map (accessed from Mid-Atlantic Regional Council on the Ocean (MARCO) marine mapper planner website) of these habitat types, their associated species, and an overlay of the proposed, withdrawn, discontinued and active sand source areas.

4.2.2.1.2.1 Hen and Chickens Shoal (HCS)

USACE (1996) and USACE (2002) described the benthic infaunal community inhabiting the substrate of Hen and Chickens Shoal and are incorporated by reference. Hen and Chickens Shoal is a shallow shoal feature heavily influenced by the tidal flow from the Delaware Bay. The bottom substrate is fairly homogeneous mainly composed of fine to medium sands. A benthic sled



*numbers on map correspond to code descriptions

Mid-Atlantic Benthic Habitats

	Code	Description	Selected Species
	1	Depressions and mid-position flats, shallow to moderate depth (0 - 45 m) on coarse to fine sand	Shimmy worm , Astarte, Lancelet
	2	Flat depressions at shallow to moderate depth (0 - 45 m) in medium sand	Chevron worm , Burrowing anemone , Dog welk
	4	Mid-position flats in shallow water (25 - 45 m) on coarse to medium sand	Bamboo worm , Thread worm , Chestnut astarte
	7	Mid-position flats and depressions in shallow water (25 - 45 m) on medium to coarse substrate	Fringe worm , Frilled anemone , Common sea star
	25	Depressions at moderate depths (15 - 82 m) on fine to coarse sand	Bristle worm , Moon snail, Lined anemone
	32	Mid-position flats at shallow to moderate depths (22 - 45 m) on medium sand	Atlantic rock crab , Longnose spider crab, Common northern moon snail
	38	Depressions in water shallow (15 - 22 m) on medium to coarse sand	Bamboo worm , Olivepit porcelain crab , Arctic paper-bubble
	44	Depressions and mid-position flats mostly very shallow (0 - 22m), but occasionally very deep on fine to coarse sand	Jonah crab , Amethyst gemclam , Northern sea star
	64	Depressions and mid-position flats in shallow water (15 and 22 m) on medium sand	Blood worm , Sharp-tailed cumacean , Blue mussel
	84	All types of flats at moderate depth (22 - 82 m) on fine to medium sand	Beardworm, Sea urchin , Nutclam
	87	Depressions and high flats in shallow water (15 - 22 m) on medium sand	Burrowing scale worm , Glass shrimp , Sand dollar
	216	High slopes in deep water (95 - 592 m) on medium to fine sand	American lobster , Sea feather , Bobtail squid
	218	Depressions at moderate depths (45 - 82 m) on medium to coarse sand	Feather duster worm , Bean mussel , Conrad's thracia
	219	High flats at moderate depths (45 - 82 m) on coarse to fine sand	Prawn, Sea scallop , Mud star
	229	High flats and depressions at shallow to deep depths (22- 592 m) on a fine to medium sand	Jonah crab , Green sea urchin , Anemone
	301	Any seabed form at moderate to deep depths (45 -592) on any substrate	Gould's pandora , Calcareous coral , Foraminiferida
	306	All types of flats at medium depth (45 - 82 m) on medium sand	Acadian hermit crab , Daisy brittle star
	384	High slopes and canyons in deep water (95 - 592 m) on any substrate	Scale worm , Florida lobsterette , Royal red shrimp
	395	Depressions and high flats at moderate depths (45 - 82 m) on fine to medium sand	Spionid mud worm, Paper clam , Sea star
	505	Slopes and canyons in very deep water (>592 m) on silt and mud	Beardworms, Hairy sea cucmber , Stony corals
	520	Mid position flats and depressions at moderate depths (45 - 82) on mostly coarse to occsasionaly fine sand	Long-horned skeleton shrimp , Hatchet shell , Peanut worm
	592	Mid-position flats at moderate depth (45 - 82 m) on medium sand	Paddle worm , Cumacea, Arctic rock borer
	768	Depressions in very shallow water (0 - 15 m) on silt to fine sand	Mysid shrimp , Elongated macoma , Burrowing brittle star
	1223	High flats in moderately deep water (82 - 95 m) on medium sand	Eunice worm , Striate scallop , Margined sea stars

Figure 4-8. Benthic Habitat Mapping along the Delaware Atlantic Coast. (Source: from MARCO marine mapper planner website: http://portal.midatlanticocean.org/planner/ accessed on 3/24/2015).

camera investigation of this area revealed that the bottom substrate within HCS is primarily composed of small asymmetric rippled bedforms consisting of fine to medium sands with little or no apparent biogenic (produced by living organisms such as shell deposits, coral reef, etc.) features (Diaz et. al. 2001). The MARCO marine mapper planner lists two benthic habitats on HCS in equal distribution. The first is described as a depression or mid-position flat with shallow to moderate depth on coarse to fine sand (code #1 in Figure 4-8.). Selected species within this habitat include the shimmy worm (*Nephtys* sp.), Astarte clam (*Astarte castanea*), and the lancelet (cephalochordate), a small eel-like organism. The second habitat is described as high flats and depressions at shallow to deep depths on a fine to medium sand (code #229 in Figure 4-8). Selected species within this habitat are the Jonah (or rock) crab (*Cancer* spp.), sea urchins (Echinoidea), and anemones. HCS has been the subject of several benthic investigations that involved the sampling of benthic macroinfauna and epifauna inhabiting the substrate. Maurer et al. (1974) recorded a total of 168 species obtained from quarterly sampling at HCS. The most abundant taxa found within the benthic community included the amphipod (*Parahaustorius longimerus*), surfclam (*Spisula solidissima*) and the dwarf tellin clam (*Tellina agilis*). Additional benthic sampling was conducted at HCS by Dames and Moore (1993) in support of USACE (1996). In this study, a total of 82 taxa were recorded. The most common and frequently sampled species included the haustorid amphipods (*Protohaustorius wigleyi* and *Parahaustorius sp*.), the isopod (*Chiridotea tuftsi*), the dwarf tellin clam, and the red-lined polychaete worm (*Nephtys bucera*). A more recent benthic investigation of HCS was conducted by Scott (2000) where a total of 36 taxa were recorded from 3 stations situated on HCS. The most dominant taxa found in this sampling event were several arthropods such as *Pseudunciola obliquua* and *Tanaissus psammophilus* and *Protohaustorius spp*. Although the number of taxa was successively lower with each study through time, this may be more attributable to differences in sampling frequency, number of samples, and collection gear sizes rather than changes in habitat or benthic community structure.

4.2.2.1.2.2 Area B (Preferred Sand Source)

A review of the MARCO marine mapper planner reveals that the Area B benthic environment is mainly classified as “depressions and mid-position flats mostly very shallow (0-22m), but occasionally very deep on fine to coarse sand” (code#44 on Figure 4-8.). Selected species within this habitat classification include the Jonah/rock crab (*Cancer* spp.), amethyst gem clam (*Gemma gemma*) and sea star (*Asterias* sp.). Despite this classification in MARCO, video camera surveys and benthic grab samples have revealed Area B to contain a fairly heterogeneous bottom consisting of various bottom substrates ranging from rippled fine/medium sands to coarse sand/gravel to pebble/cobble and blue mussel bed (*Mytilus edulis*) patches (Diaz et al. 2001; Scott, 2000; Scott and

Wong, 2012). One unique aspect of this site is the identification of encrusting bryozoans or relic corals within the hard-bottom (cobbles) portions of this site. However, this type of bottom habitat only makes-up a minor component of the bottom structure in Area B (Diaz *et al*. 2001). Scott (2001) and Diaz et al. (2001) identified patches of blue mussel beds in the southeast portion of area B, which were associated with gravelly bottoms (Figure 4-9.). A high abundance of starfish (*Asterias* spp.) was observed in association with these mussel beds. However, a subsequent benthic investigation conducted by Scott and Wong (2012) did not locate any mussel bed-dominated bottoms in either benthic grab samples or video images of the bottom. Investigations by Diaz et al. 2001, Scott (2001) and Scott and Wong (2012) described general differences in physical sediments and benthic communities between the eastern and western portions of Area B, and to some extent, the northern and southern portions. These differences in benthic communities are mainly attributed to bottom sediment compositions and depth (Scott, 2000 and Scott and Wong, 2012). Scott (2001) found that benthic community composition varied between the eastern and western portions of Area B. The eastern portion, which represents the deeper habitat of Area B, had a total of 74 taxa including 17 epifaunal taxa. The blue mussel was collected from all sampling sites in the southeastern portion and was extremely abundant at Station B4-3. The eastern portion of Area B also had large numbers of epifaunal polychaete taxa that are typically associated with hard bottom habitats such as mussel beds. The most abundant infauna taxa in the eastern portion were oligochaete worms, and a number of polychaete worms including *Mediomastus ambiseta*, *Dipolydora sociallis*, and *Aphelochaeta* spp. Ribbon worms (Nemertinea) and razor clams (*Ensis directus*) were also abundant in the eastern portion of Area B. Samples obtained from the western portion of Area B likewise contained large numbers of infauna taxa including oligochaetes, razor clams, dwarf tellins, and the polychaetes: *Spiophanes bombyx*, *Spio setosa* and *Asabellides oculata*. The western portion of Area B had a total number of 55 taxa, which was considerably less than the eastern portion of 74 taxa.

Subsequently, Scott and Wong (2012) conducted additional investigations of benthic infauna/epifauna along with benthic video habitat mapping in these areas. This investigation also included the new expansion areas not sampled in previous investigations. A total of 121 taxa were recorded within Area B. The overall dominant taxa collected among 34 stations were the polychaete worms: *Mediomastus ambiseta*, *Polygordius* spp., *Parapionsyllis longicirrata*, *Tharyx* sp. A: and the small ascidid: Ascidiacea (tunicates/sea squirts). However, these species were not evenly distributed among the 34 stations. Differences in dominant taxa were evident with differing sediment types (Table 4-7). Stations with higher amounts of silt/clay were dominated by the bubble snail (*Acteocina canaliculata*) and the bivalve *Nucula proxima*. Stations composed of fine sands were dominated by the amphipods: *Protohaustorius* cf. *deichmannae*,

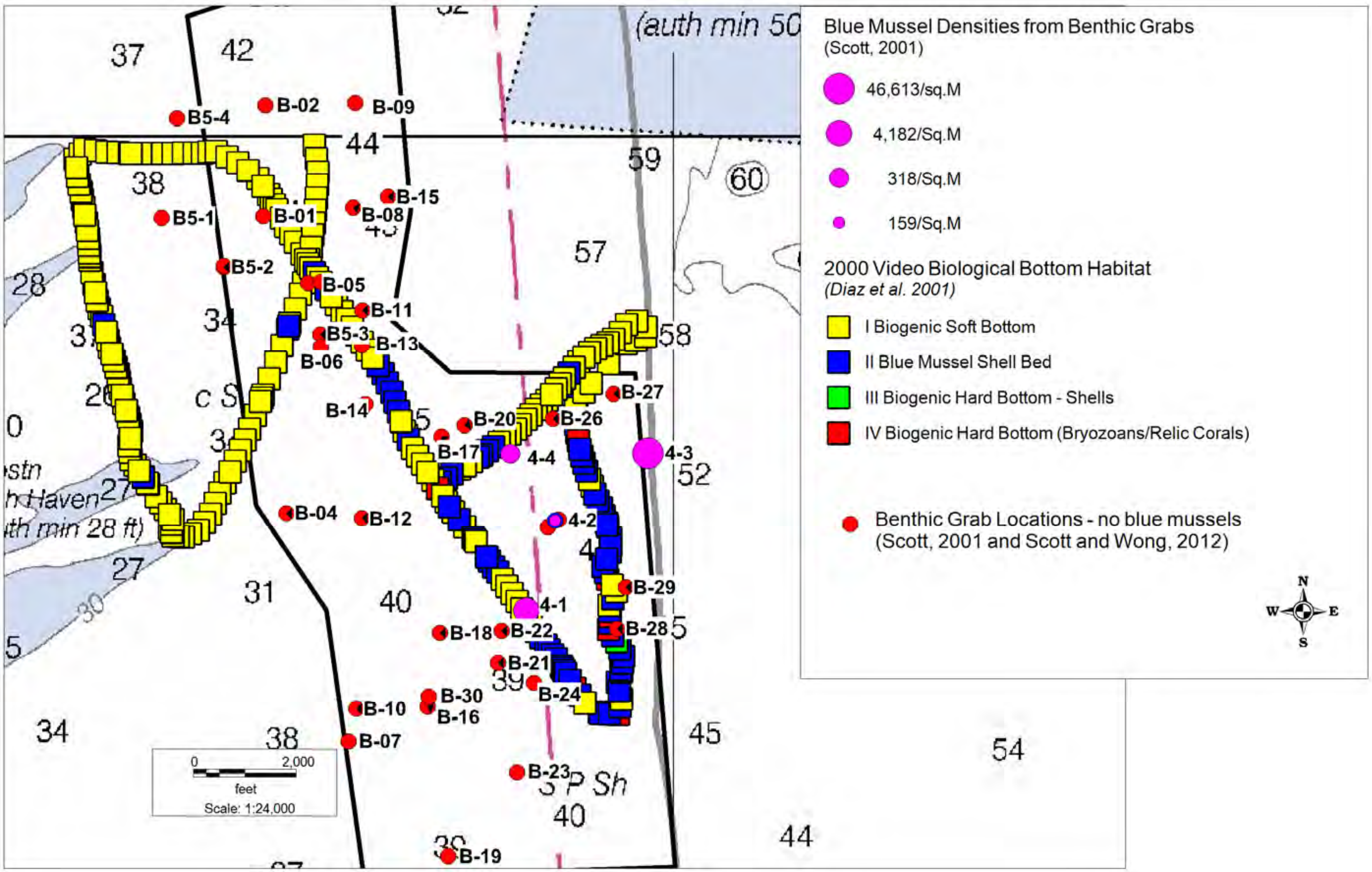


Figure 4-9. Area B Blue Mussel Beds from Benthic Video Tracklines and Benthic Grab Samples.

Table 4-7. Mean Abundance of the Dominant Taxa Collected from Area B in 2011 by Sediment Type. (From Scott and Wong, 2012)		
Taxonomic Group	**Species**	**Mean abundance/m^2**
Silty/Fine Sand Stations		
Annelida : Polychaeta	*Mediomastus ambiseta*	1022.7
Mollusca : Gastropoda	*Acteocina canaliculata*	418.2
Nemertina	*Carinomella lactea*	281.8
Mollusca : Bivalvia	*Nucula proxima*	250.0
Annelida : Polychaeta	*Paraprionospio pinnata*	195.5
Annelida : Polychaeta	*Tharyx* sp. A	172.7
Fine Sand Stations		
Arthropoda : Amphipoda	*Protohaustorius* cf. *deichmannae*	227.3
Annelida : Polychaeta	*Apoprionospio pygmaea*	200.8
Mollusca : Bivalvia	*Tellina agilis*	189.4
Arthropoda : Amphipoda	*Rhepoxynius hudsoni*	143.9
Arthropoda : Decapoda	*Pinnixa* spp.	140.2
Arthropoda : Amphipoda	*Acanthohaustorius similis*	125.0
Medium Sand		
Mollusca : Bivalvia	*Tellina agilis*	363.6
Annelida : Polychaeta	Nephtyidae	318.2
Nemertina	*Carinomella lactea*	250.0
Echinodermata : Echinoidea	Echinoidea	181.8
Mollusca : Bivalvia	*Nucula proxima*	159.1
Annelida : Polychaeta	*Mediomastus ambiseta*	113.6
Coarse Sand		
Annelida : Oligochaeta	Oligochaeta	1785.7
Annelida : Polychaeta	*Polygordius* spp.	681.8
Annelida : Polychaeta	*Parapionosyllis longicirrata*	285.7
Annelida : Polychaeta	*Mediomastus ambiseta*	250.0
Annelida : Polychaeta	*Aricidea catherinae*	233.8
Annelida : Polychaeta	*Tharyx* sp. A	181.8
Gravel Sand		
Annelida : Oligochaeta	Oligochaeta	2011.4
Annelida : Polychaeta	*Parapionosyllis longicirrata*	790.6
Annelida : Polychaeta	*Tharyx* sp. A	688.3
Annelida : Polychaeta	*Polygordius* spp.	621.8
Annelida : Polychaeta	*Mediomastus ambiseta*	579.5
Chordata : Ascidiacea	Ascidiacea	571.4

Rhepoxynius hudsoni, and *Acanthohaustorius similis*. The bivalve *Tellina agilis* and the Nephtyid polychaete worm showed a preference for the medium sand station. Few differences were noted among the coarse sand and gravel-sand stations, which were dominated by oligochaete and polychaete worms. One difference was the affinity of the epifaunal ascidid to the gravel-sand stations. Benthic infauna and epifauna tended to group according to three sediment types: gravel and coarse sands, fine and medium sands, and silty fine sands. The blue mussel which was abundant in samples obtained in the southeast portion of Area B in Scott (2001), was non-existent in Scott and Wong (2012).In addition to the benthic grab samples, benthic video sleds were deployed along the bottom to provide a description of the physical and biological benthic habitats in 2000 and 2011 (Diaz *et. al.* 2001 and Scott and Wong, 2012). A plot of the type of physical habitats encountered and their coverage along with benthic grab sample sediment types in Area B is provided in Figure 4-10.

Diaz et al. (2001) observed that Area B had a diverse array of bottom habitats. About 75% of the sled track was either physical habitats II (small-rippled sands), III (larger-rippled sands), or IV (larger-rippled sands with gravels and pebbles in troughs), with about equal areas of each habitat type. In Area B, highest abundance of organisms was associated with physical habitat I (flat surface with fine to medium sands), followed by V (large straight ripples with gravel and pebbles in troughs) and VI (gravel bed with no ripples), which were mostly starfish and urchins associated with coarser sediment.

Most of the biological characteristics of the habitats in Area B were not distinctive with over half of the sled track having little obvious biogenic activity. Mussel beds (*Mytilus edulis*) with shell and live mussels covered about 30% of the video track and biogenic hard bottom composed of encrusting bryozoans or relic coral pieces covered about 3% of the video track. Shell bed composed of mostly surfclam (*Spisula solidissima*) valves was a very minor component of the bottom in Area B (Diaz *et al*. 2001).

Larger benthic invertebrates in Area B were identified in video surveys and a commercial surfclam survey in both Scott (2001) and Scott and Wong (2012). These include the horseshoe crab (*Limulus polyphemus*), hermit crab (*Epizoanthus* spp.), knobbed whelk (*Buscyon* spp.), Atlantic rock crab (*Cancer irroratus*), starfish (Asteroidea), sea urchin (Echinoidea), lady crab (*Ovalipes ocellatus*), American lobster (*Homarus americanus*), blue mussel, and spider crab (Majidae).

4.2.2.1.2.3 Area G

Area G like Area B also contains a fairly heterogeneous bottom substrate composed of sand, sand/gravel/shell, and sand/gravel/mussel beds. Area G is generally flat in bathymetry with depths ranging from 35 feet to 42 feet. The most abundant infauna at Area G included oligochaetes and the polychaetes: *Spio setosa*, *Parapionosyllis longicirrata, Brania wellfleetensis, Aricidea cahterinae* and *Travisia* sp. A

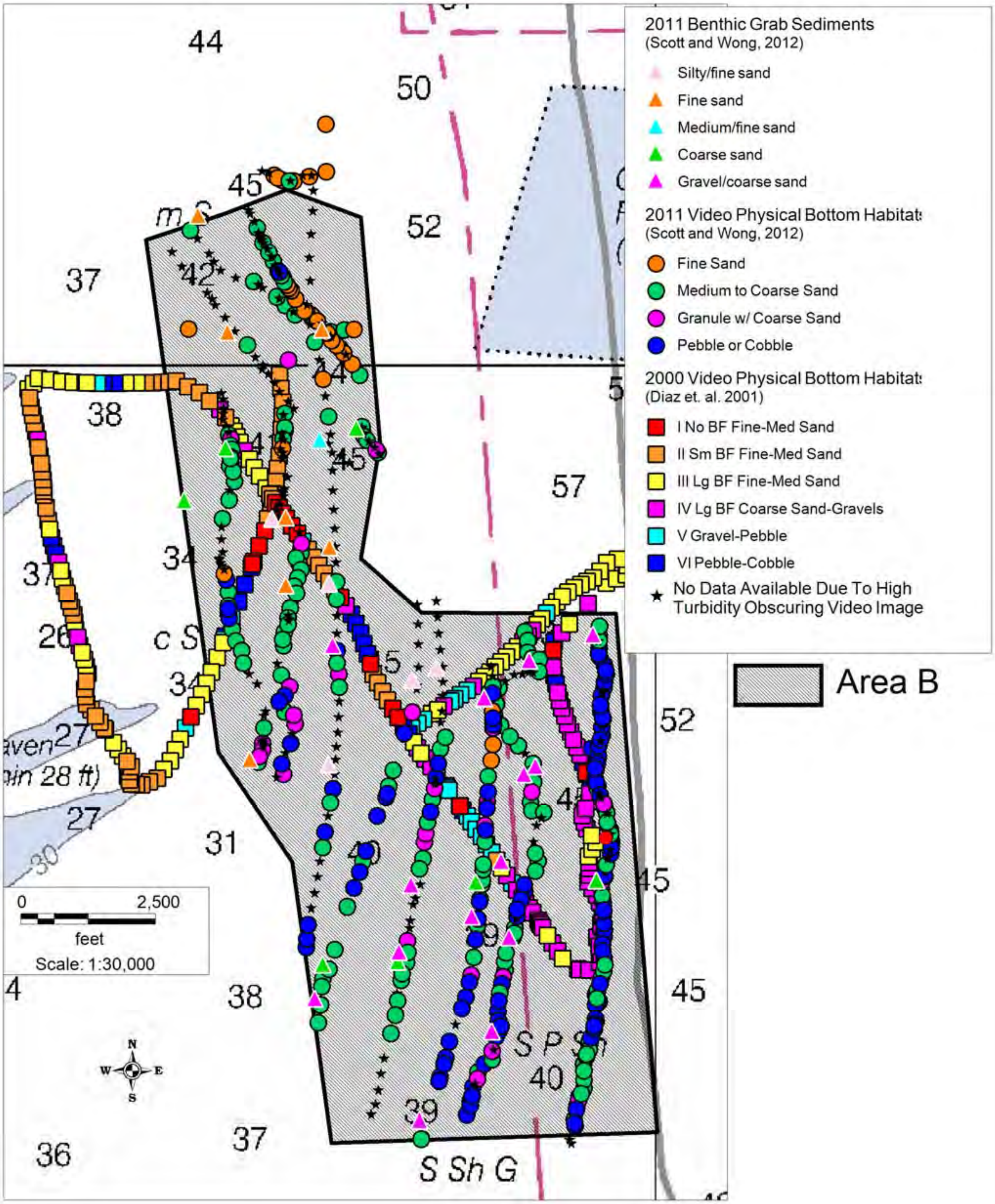


Figure 4-10. Physical Benthic Habitats in Area B. (Diaz et. al. 2001; Scott, 2001; and Scott and Wong, 2012).

(Morris). Epifaunal species found within Area G include blue mussel, starfish, horseshoe crabs, rock crabs, purple sea urchins, and spider crabs.

In December 2000, a video sled track was utilized to provide a description of the physical and biological benthic habitats within the borrow areas. Based on the video sled track data, Area G had the highest organism abundance associated with physical habitats. The highest abundance of organisms was associated with physical habitat Class VI (gravel bottom) followed by Class I (sandy bottom). Area G was intermediate between HCS and Area B in the grand mean of organism abundance associated with both physical and biological habitats (Diaz *et al*. 2001).

4.2.2.2 Fisheries

4.2.2.2.1 Shellfish

Shellfish inhabiting the Atlantic Ocean project impact areas are discussed in USACE (1996) and are incorporated by reference. Subsequently, populations of the Atlantic surfclam, *Spisula solidissima*, were sampled in the borrow areas using two types of gear that collects different size classes (Scott, 2001). A Young grab was used to estimate the abundance and biomass of smaller clams henceforth referred to as juvenile and small adult clams. A hydraulic clam dredge sampled for larger clams, greater than 7.6 cm in length, henceforth referred to as adult clams. Table 4-8 provides a comparison of juvenile and small adult surfclams based on abundance and biomass within the Atlantic Ocean offshore borrow areas sampled with a Young grab sampler.

Table 4-8. Mean Abundance and Biomass of Juvenile Surfclams <2cm in Grab Samples from Three Atlantic Ocean Offshore Sample Areas. (Scott, 2001; Scott and Wong, 2012)

Parameter	**Hen and Chickens Shoal Area (2000)**	**Area B (2000)**	**Area B (2011)**			**Area G (2000)**
			Total	North	South	
Mean Abundance $\#/m^2$	15.2	39.8	6.7	3.8	8.3	90.9
Mean Abundance > 2 cm ($\#/m^2$)	0.0	0.0	NM	NM	NM	2.8
Mean AFDW Biomass (g/m^2)	0.01	0.06	0.07	0.06	0.08	0.43

Only one adult surfclam was collected in the 16 commercial surfclam dredge tows conducted for this study. This clam was collected within Area G and was 66-mm in size. One hard shell clam (Southern quahog) was also collected in Area G.

Scott and Wong (2012) conducted benthic grab samples at 34 stations in Area B in 2011. This study noted that very few juvenile surfclams were collected, and that only nine stations had one single surfclam, and only Station B4-1 had two clams in the grab. All nine stations with a surfclam(s) were in either a coarse sand or gravel habitat.

A small commercial and recreational whelk fishery exists along the Delaware Atlantic Coast. Two species are principal targets: the channeled whelk (*Buscyon canaliculatum*) and the knobbed whelk (*B. carica*). These species (often referred to as "conchs") are harvested either by pots or dredges.

4.2.2.2.2 Finfish

The proximity of several embayments allows the coastal waters of Delaware to have a productive fishery. Many species utilize the estuaries of Delaware Bay, Rehoboth Bay and Indian River Bay for forage and nursery grounds. The finfish found along the Delaware Atlantic coast are principally seasonal migrants. Winter is a time of low abundance and diversity as most species leave the area for warmer waters offshore and southward. During the spring, increasing numbers of fish are attracted to the Delaware Atlantic coast because of its proximity to several estuaries, which are utilized by these fish for spawning and nurseries (USACE, 1996).

An investigation of the fish inhabiting the proposed borrow sites was performed by Wirth (2001) to determine fish community differences between habitats of high relief such as in HCS and areas of lower relief such as Areas B and G. Seasonal sampling was performed over a one-year period in 2000 in subareas of HCS and surrounding habitat, and Areas B and G. Seventy-five species of finfish and invertebrates were collected with commercial and experimental trawl gears and gill nets during this effort including all areas and seasons. Of this, a total of 55 finfish species were identified over all of the areas and seasons. In the winter sampling, 20 fish species were collected. Little skates (*Raja erinacea*) and windowpane flounder (*Scopthalmus aquosus*) were the most abundant finfish, overall. In the spring, 29 fish species were collected. Clearnose skates (*Raja eglanteria*), smooth dogfish (*Mustelus canis*), and little skates were the most abundant finfish overall. The summer sampling yielded the greatest species richness with 36 fish species collected. Of these, the clearnose skate, bay anchovy (*Anchoa mitchilli*), summer flounder (*Paralichthys dentata*), and black sea bass (*Centropristis striata*) were among the most abundant finfish species. The fall sampling resulted in 31 fish species collected. Bay anchovies, little skates, and windowpane were abundant in the catches. Data from catch per unit effort (CPUE) of fish species were compiled and used in a statistical factor analysis to determine if the fish data were correlated to the habitat sampled. Wirth (2001) found that overall the fish and shellfish communities at Hen and Chickens Shoal do not appear to be any different from the communities observed at the areas immediately to the east and west of the shoal (outside of the proposed borrow area). In all seasons, the high relief area (HCS), did not appear to be different from the communities observed in the flatter areas east and west of the shoal. These areas consistently grouped together based on the species composition, and in one season (Spring), they also grouped with the inshore habitat of Area B. With the exception of the winter sampling, both subareas of Area G tended to group with the eastern offshore (deeper) subarea of Area B. Overall, the HCS area and its adjacent areas generally contained fewer species and a lower number of individuals then Areas B and G to the south. Benthic sled camera investigations determined that HCS itself is a generally broad, flat sand bar, which contrasts with the flat bottom habitat found in Areas B and G, which consist of several different habitat types including expanses of cobbles and pebbles, shells, hard bottoms with encrusting bryozoans or relic corals, and sand habitat with attached shellfish and other live bottom features not observed at HCS. Based on this, Wirth (2001) suggested that bottom type (substrate) may play a larger role in defining fish habitat differences than bathymetric relief alone.

Specifically in Area B, 34 fish species were collected among all gear types and seasons sampled. Additionally, Area B was sampled by subareas: Area 4 (southeast portion) and Area 5 (northwest portion). The number of species were about evenly divided between subareas with 29 in Area 4 and 28 in Area 5. However, species that favored hard/rocky bottoms such as black sea bass (*Centropristis striata*), tautog (*Tautoga onitis*), and scup (*Stenotomus chrysops*) were more prevalent in Area 4 (southeast portion). A list of species collected in Area B subareas by season and gear type is provided in Table 4-9.

Table 4-9. Seasonal Finfish Collected by Three Gear Types in Area B. (Wirth, 2001)

Scientific Name	Common Name	Area B Southeast (4)	Area B Northwest (5)
Anchoa mitchilli	Bay anchovy		WET
Brevoortia tyrannus	Atlantic menhaden	SPG	FG
Carcharhinus obscurus	Dusky shark	SPG,SUG	SUG
Carcharhinus plumbeus	Sandbar shark	SPG	
Centropristis striata	Black sea bass	WET,SPCT,SUCT	WET
Chilomycterus schoepfi	Striped burrfish	SUCT	SUCT
Cynoscion regalis	Weakfish	FCT, SPG,FG	FCT,SUG,FG
Dasyatis americana	Southern stingray	SUCT	SPCT,SUCT
Etropus microstomus	Smallmouth flounder	FET,SUCT	SPET,SUET,
Leiostomus xanthurus	Spot	FCT	SUCT,SUG
Menticirrhus saxatilis	Northern kingfish	FCT, SPG	SPCT
Micropogonias undulatus	Atlantic croaker	FCT, SPG,SUG	FCT,SUG,FG
Mustelus canis	Smooth dogfish	SPCT,SUCT, SPG,SUG	SPCT,SUCT,SUG
Myliobatis freminvillei	Bullnose ray	SPCT,SUCT, SPG,SUG	SPCT,SUCT
Ophidion marginatum	Striped cusk-eel		WOT
Paralichthys dentatus	Summer flounder	WCT,SPCT,SUCT,FCT, SPG	WET,SPET,WCT,SPCT,SUCT,FCT
Peprilus triacanthus	Butterfish	SPG	FG
Pleuronectes americanus	Winter flounder	WCT	
Pomatomus saltatrix	Bluefish	SPG,SUG,FG	SUG,FG
Prionotus carolinus	Northern searobin	FET,SUCT,FCT	WET,SUET,SUCT
Prionotus evolans	Striped searobin	FET,SUCT,FCT	SUCT,FCT

Table 4-9. Seasonal Finfish Collected by Three Gear Types in Area B. (Wirth, 2001)			
Scientific Name	Common Name	Area B Southeast (4)	Area B Northwest (5)
Raja eglanteria	Clearnose skate	WCT,SPCT,FCT,SUG	WET,SPET,SUET,WCT,SPCT,FCT
Raja erinacea	Little skate	WET,WCT,SPCT,FCT	WET,SPET,WCT,SPCT,FCT,FG
Raja ocellata	Winter skate		WCT
Scomberomorus maculatus	Spanish mackerel	SUG	
Scophthalmus aquosus	Windowpane	SPCT,FCT,FG	WET,SUET,SPCT,FCT
Sphoeroides maculatus	Northern puffer		SUET,FCT
Squalus acanthias	Spiny dogfish	FCT,FG	WCT,FCT,FG
Squatina dumeril	Atlantic angel shark	SPG	
Stenotomus chrysops	Scup	SPCT,SUCT	SUCT
Syngnathus fuscus	Northern pipefish	SUET	
Tautoga onitis	Tautog	WCT	
Urophycis chuss	Red hake		WET
Urophycis regia	Spotted hake	WET,SUCT,FCT	WET,WCT,SPCT
Seasons: W=winter, SP=spring, SU=summer, F=fall Gear types: ET=experimental trawl, CT=commercial trawl, G=gill net.			

DNREC manages several artificial reef sites offshore of the Delaware Atlantic Coast. These reefs are usually sited on featureless bottoms composed of sand and mud. The reefs are composed of durable, stable, non-toxic materials from deployed items such as concrete products, ballasted tires, decommissioned military vehicles and vessels, which provide a substrate for a substantially richer benthic invertebrate community. These reefs provide important habitat for reef-dwelling species such as tautog, black seabass, scup, spadefish (*Chaetodipterus faber*) , trigger fish (*Balistes capriscus*), and attract important gamefish such as flounder, bluefish, striped bass (*Morone saxatilis*), weakfish, tunas, and sharks (Delaware Division of Fish and Wildlife, 2013). Delaware Artificial Reef Site #9 is the nearest to the affected areas, and its southwest corner lies approximately 2,000 feet to the east of the northern tip of the proposed Borrow Area B.

4.2.2.2.3 Essential Fish Habitat (EFH)

Under provisions of the reauthorized Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSA), the entire project area including the borrow areas, nearshore and intertidal beach areas were designated as Essential Fish Habitat (EFH) for species with Fishery Management Plans (FMPs), and their important prey species. EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity under the MSA. The MSA requires Federal agencies to perform an EFH assessment when activities may affect EFH. The National Marine Fisheries Service has identified EFH within 10 minute X 10 minute squares, and are provided in Figure 4-11. The study area contains EFH for various life stages for 33 species of managed fish, shellfish and other invertebrates. Table 4-10 presents the managed species and their life stage that EFH is identified for within the corresponding

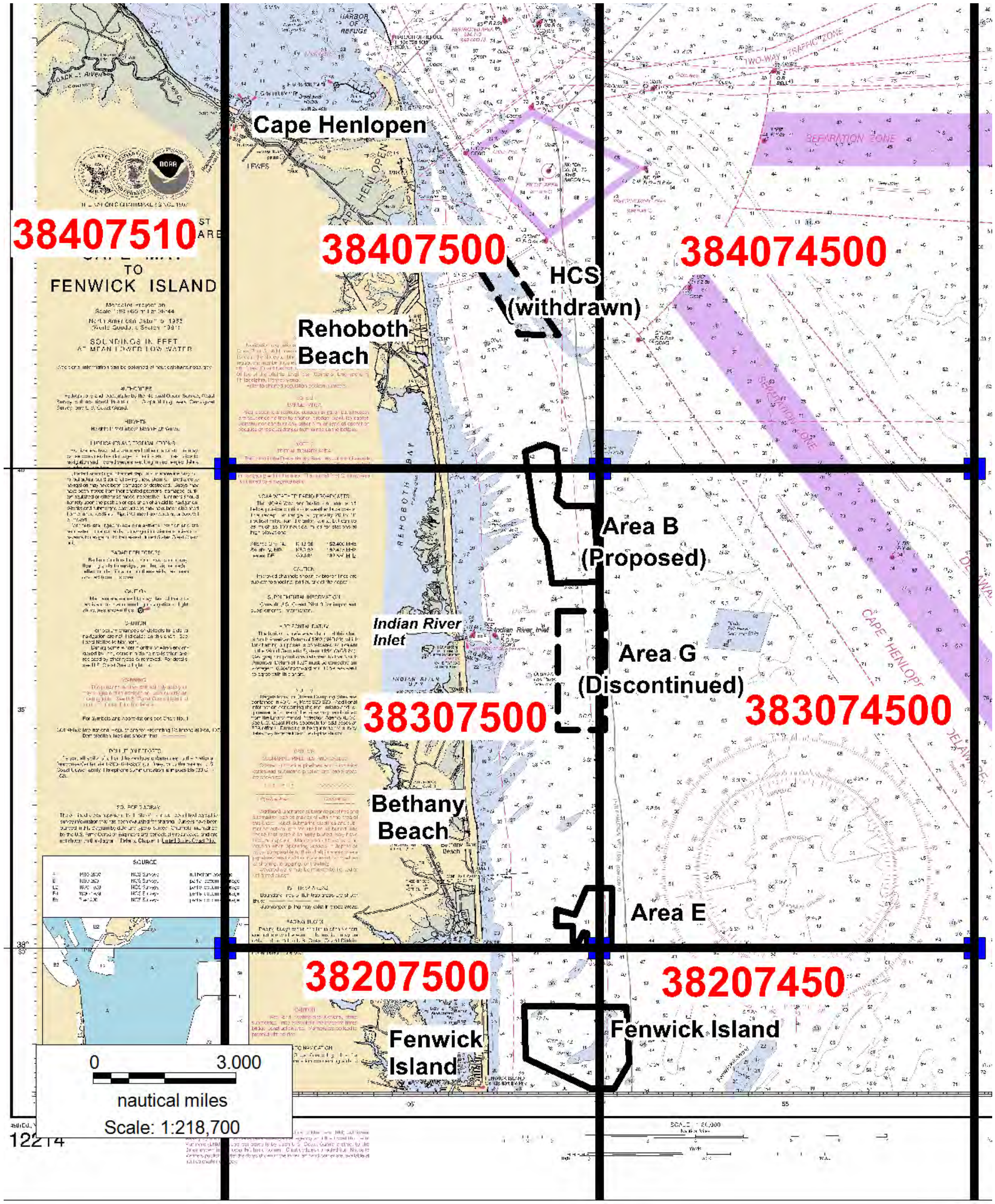


Figure 4-11. EFH Ten Minute Square Designations along the Delaware Atlantic Coast.

Table 4-10. Summary of EFH Designations Along the Delaware Atlantic Coast. EFH Designation in the 10 Min. X 10 Min. Squares Affected By Project Activities (Guide to EFH in Northeastern United States accessed from internet website: **http://www.greateratlantic.fisheries.noaa.gov/hcd/STATES4/DelaNJ.htm**. on 5/7/2015.				
Managed Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
Atlantic cod *(Gadus morhua)*				38407500 38307500 38207500 38307450 38207450
Red hake *(Urophycis chuss)*	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500
Winter flounder (*Pleuronectes americanus*)	38407500 38307500	38407500 38307500	38407500 38307500	38407500 38307500
Yellowtail flounder (*Limanda ferruginea*)	38307450 38207450	38307450		
Windowpane flounder *(Scopthalmus aquosus)*	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Atlantic sea herring *(Clupea harengus)*			38407500 38307500 38207500 38307450	38407500 38307500 38207500 38307450 38207450
Monkfish *(Lophius americanus)*	38407500 38307500 38207500 38307450	38407500 38307500 38207500 38307450		
Bluefish *(Pomatomus saltatrix)*		38307450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Long finned squid *(Loligo pealei)*	n/a	n/a	38207450	
Short finned squid *(Illex ilecebrosus)*	n/a	n/a		
Atlantic butterfish *(Peprilus tricanthus)*	38207500 38307450	38407500	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Atlantic mackerel (*Scomber scombrus*)				38207450
Summer flounder *(Paralichthys dentatus)*		38307500 38207500	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Scup *(Stenotomus chrysops)*	n/a	n/a	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Black sea bass *(Centropristus striata)*	n/a	38407500	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Surfclam *(Spisula solidissima)*	n/a	n/a	38407500 38207500 38307450	38207450

Table 4-10. Summary of EFH Designations Along the Delaware Atlantic Coast. EFH Designation in the 10 Min. X 10 Min. Squares Affected By Project Activities (Guide to EFH in Northeastern United States accessed from internet website: **http://www.greateratlantic.fisheries.noaa.gov/hcd/STATES4/DelaNJ.htm**. on 5/7/2015.				
Managed Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
			38207450	
Ocean quahog *(Artica islandica)*	n/a	n/a		
Spiny dogfish *(Squalus acanthias)*	n/a	n/a	38307450 38207450	38407500 38307450 38207450
King mackerel *(Scomberomorus cavalla)*	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Spanish mackerel *(Scomberomorus maculatus)*	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Cobia *(Rachycentron canadum)*	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Sand tiger shark *(Odontaspis taurus)* (Species of Concern)		38407500 38307500 38207500 38307450 38207450		38407500 38307500 38207500 38307450 38207450
Blue shark (*Prionace glauca*)				38207450
Atlantic angel shark *(Squatina dumerili)*		38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450	38407500 38307500 38207500 38307450 38207450
Atl. Sharpnose shark *(Rhizopriondon terraenovae)*				38407500 38307500 38207500 38307450 38207450
Dusky shark *(Charcharinus obscurus)*		38407500 38307500 38207500 38307450 38207450		
Sandbar shark *(Charcharinus plumbeus)*		38407500 HAPC 38307500 38207500 38307450 38207450	38407500 HAPC 38307500 38207500 38307450 38207450	38407500 HAPC 38307500 38207500 38307450 38207450
Shortfin mako shark (*Isurus oxyrinchus*)			38207450	
Scalloped hammerhead shark (*Sphyrna lewini*)			38407500 38307500 38207500 38307450 38207450	
Tiger shark *(Galeocerdo cuvieri)*		38307500 38207500 38307450 38207450	38207450	
Little skate (*Raja erinacea*)			All	
Winter skate (*Raja ocellata*)			All	

Table 4-10. Summary of EFH Designations Along the Delaware Atlantic Coast. EFH Designation in the 10 Min. X 10 Min. Squares Affected By Project Activities (Guide to EFH in Northeastern United States accessed from internet website: **http://www.greateratlantic.fisheries.noaa.gov/hcd/STATES4/DelaNJ.htm**. on 5/7/2015.				
Managed Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
Clearnose skate (*Raja eglanteria*)			All	All

Square "38407500" Description: This square is bounded on the north and east at 38° 50.0' N, 75° 00.0' W and south and west at 38° 40.0' N, 75° 10.0' W. Waters within the square within the salt water salinity zone of Delaware Bay affecting the following: north and east of Cape Henlopen, DE., from just northwest of Roosevelt Inlet within Breakaway harbor north of Lewes, DE, within the Harbor of Refuge, around the cape south past Rehoboth Beach, DE., to ½ way down Dewey Beach, east of northern Rehoboth Bay. Also affected are waters within the Delaware Inland Bay estuary within northern Rehoboth Bay, and over the Hen and Chickens Shoals. **This square includes the Rehoboth Beach/Dewey Beach beachfill placement site, the northern tip of the proposed borrow Area B and the HCS (formerly proposed) alternative borrow area.**

Square "38307500" Description: This square is bounded on the north and east at 38° 40.0' N, 75° 00.0' W and south and west at 38° 30.0' N, 75° 10.0' W. Waters within the square within the Delaware Inland Bay estuary affecting the following: within southern Rehoboth Bay, and Indian River Bay affecting White Neck and White Creek, Rehoboth Marsh, and Burton I. Also, these waters are within the Atlantic Ocean and affect east of from Dewey Beach on the north, south past Rehoboth Marsh and the Indian River Inlet, to Bethany Beach, DE., Miller Creek, and Salt Pond. **This square includes the Indian River Inlet North Shore and Bethany Beach/South Bethany placement sites, and the proposed Area B and alternative borrow Area G (now discontinued) and the existing (active) western portion of Borrow Area E.**

Square "38207500" Description: This square is bounded on the north and east at 38° 30.0' N, 75° 00.0' W and south and west at 38° 20.0' N, 75° 10.0' W. Atlantic Ocean waters within the square east of southernmost Delaware and northernmost Maryland from just east of Little Assawoman Bay on the north, south pas Fenwick island, DE., past Maryland Beach and Fenwick Island, MD., to Ocean City, MD. These waters also affect the following: within Assawoman Bay around Dirickson Neck and Miller Neck and Isle of Wight Bay from the state border south past Greys Creek, Poplar Pt. on the Isle of Wight, the St. Martin River, Cedar Pt., Manklin Creek, Turville Creek east of Taylorville, MD., Herring Creek and Heyser Pt., to the Inlet to the Bays, along with Collier Islands, Mallard Islands, Reedy Island, Swan Pt., Devil Island, and Horse Island and many other small islands. **This square includes the beachfill placement site for the Town of Fenwick Island, DE and the western portion of the existing (active) Fenwick Island borrow area.**

Square "38307450" Description: This square is bounded on the north and east at 38° 40.0' N, 74° 50.0' W and south and west at 38° 30.0' N, 75° 00.0' W. Atlantic Ocean waters within the square one square east of the square affecting Indian River Inlet in Delaware, including within the Cape Henlopen/Delaware shipping traffic inbound and outbound lanes. **This square includes the eastern edge of the discontinued borrow Area G and the eastern portion of the existing (active) Borrow Area E.**

Square "38307500" Description: This square is bounded on the north and east at 38° 30.0' N, 74° 50.0' W and south and west at 38° 20.0' N, 75° 00.0' W. Atlantic Ocean waters within the square one square east of the square affecting Fenwick Island on Isle of Wight Shoal and Fenwick Shoal. **This square includes the eastern portion of the existing (active) Fenwick Island borrow area.**

"n/a" for scup and black sea bass indicates that there is insufficient data for the egg and larvae life stages, and no
EFH designation has been made as of yet, and, "n/a" for long finned squid, short finned squid, surf clam, and ocean quahog which are referred to as pre-recruits and recruits corresponds with juveniles and adults in the table.

10 x 10 minute squares that cover the study area. These squares are within the seawater biosalinity zone (NOAA, 1999a). The habitat requirements for identified EFH species and their representative life stages are provided in Table 4-11.

A review of EFH within square,38407500, contains areas designated as "Habitat Areas of Particular Concern" (HAPC) for the sandbar shark *(Charcharinus plumbeus)*. HAPC are areas of EFH that are judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation (NOAA, 1999a). Shallow areas of the lower Delaware Bay and possibly Hen and Chickens shoal may be considered HAPC for sandbar shark.

Table 4-11. Habitat Requirements of Identified EFH Species and Their Representative LIfe Stage(s) (NOAA, 1999)				
Managed Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
Atlantic cod *(Gadus morhua)* (Fahay, 1998)				**Habitat:** Demersal. Bottom (rocks, pebbles, or gravel) winter for Mid-Atlantic **Prey:** shellfish, crabs, and other crustaceans (amphipods) and polychaetes, squid and fish (capelin redfish, herring, plaice, haddock).
Red hake *(Urophycis chuss)* (Steimle et al. 1998)	**Habitat:** Surface waters, May – Nov.	**Habitat:** Surface waters, May –Dec. Abundant in mid-and outer continental shelf of Mid-Atl. Bight. **Prey:** copepods and other microcrustaceans under floating eelgrass or algae.	**Habitat:** Pelagic at 25-30 mm and bottom habitat at 35-40 mm. Young inhabit depressions on open seabed. Older juveniles inhabit shelter provided by shells and shell fragments. **Prey:** small benthic and pelagic crustaceans (decapod shrimp, crabs, mysids, euphasiids, and amphipods) and polychaetes).	**Habitat:** Demersal. Inhabit bottom habitats in depressions with a substrate of sand and mud in depths of 10 – 130 meters in temperatures below 12ºC. **Prey:** small benthic and pelagic crustaceans (decapod shrimp, crabs, mysids, euphasiids, and amphipods) and polychaetes).
Winter flounder (*Pleuronectes americanus*) (NOAA, 1999b; Pereira et al., 1998; McClane, 1978)	**Habitat:** Bottom habitats consisting of sand, muddy sand, mud, and gravel.	**Habitat:** Planktonic, then bottom oriented in fine sand or gravel, 1 to 4.5 m inshore. **Prey:** nauplii, harpacticoids, calanoids, polychaetes, invertebrate eggs, and phytoplankton.	**Habitat:** Demersal. Shallow water. Winter in estuaries and outer continental shelf. Equally abundant on mud or sand shell. **Prey:** copepods, harpacticoids, amphipods, and polychaetes.	**Habitat:** Demersal. 1-30 m inshore; less than 100 m offshore. Bottom habitats including estuaries with a substrate of mud, sand, and gravel. Spawning occurs in the same habitat from February - June. **Prey:** amphipods, polychaetes, bivalve siphons, and crustaceans.
Windowpane flounder *(Scopthalmus aquosus)* (Chang, 1998)	**Habitat:** Surface waters <70 m, Feb-July; Sept-Nov.	**Habitat:** Initially in pelagic waters, then bottom <70m,. May-July and Oct-Nov. **Prey:** copepods and other zooplankton	**Habitat:** Demersal. Bottom (fine sands) 5-125m in depth, in nearshore bays and estuaries less than 75 m **Prey**: small crustaceans (mysids and decapod shrimp) polychaetes and various fish larvae	**Habitat:** Demersal. Bottom (fine sands), peak spawning in May , in nearshore bays and estuaries less than 75 m **Prey**: small crustaceans (mysids and decapod shrimp) polychaetes and various fish larvae
Atlantic sea herring *(Clupea harengus)* (Reid et al., 1998)			**Habitat:** Pelagic waters and bottom, < 10 C and 15-130 m depths **Prey:** zooplankton (copepods, decapod larvae, cirriped larvae, cladocerans, and pelecypod larvae)	**Habitat:** Pelagic waters and bottom habitats; **Prey:** chaetognath, euphausiids, pteropods and copepods.
Monkfish *(Lophius americanus)*	**Habitat:** Surface waters, Mar. – Sept. peak in June in upper water column of inner to mid Continental shelf	**Habitat:** Pelagic waters in depths of 15 – 1000 m along mid-shelf also found in surf zone **Prey:** zooplankton (copepods, crustacean larvae, chaetognath)		
Bluefish *(Pomatomus saltatrix)*		**Habitat:** Pelagic cont. shelf waters greater than 49 ft. in depth	**Habitat:** Pelagic waters of cont. shelf and in Mid- Atlantic estuaries from May-Oct. **Prey:** squids, smaller fish	**Habitat:** Pelagic waters; found in Mid-Atlantic estuaries April – Oct. **Prey:** squids, smaller fish
Long finned squid *(Loligo pealei)*	**Habitat:** EFH for pre-recruits is pelagic waters over the Cont. Shelf	**Habitat:** EFH for recruits is pelagic waters over the Cont. Shelf		
Short finned squid *(Illex ilecebrosus)*	**Habitat:** EFH for pre-recruits is pelagic waters over the Cont. Shelf	**Habitat:** EFH for recruits is pelagic waters over the Cont. Shelf		

Table 4-11. Habitat Requirements of Identified EFH Species and Their Representative LIfe Stage(s) (NOAA, 1999)

Managed Species	Eggs	Larvae	Juveniles	Adults
Atlantic butterfish *(Peprilus tricanthus)*	**Habitat:** Pelagic waters in bays and estuaries, but can be in waters with depths up to 6,000 ft.	**Habitat:** Pelagic waters, greater than 33 feet deep	**Habitat:** Pelagic waters in 10 – 360 m	**Habitat:** Pelagic waters **Prey:** jellyfish, crustaceans, worms, and small fishes
Atlantic mackerel *(Scomber scombrus)*				**Habitat: Pelagic found in depths ranging from 10 to 380 m. Prey :wide assortment of invertebrates**
Summer flounder *(Paralichthys dentatus)*		**Habitat:** Pelagic waters, nearshore at depths of 10 – 70 m from Nov. – May.	**Habitat:** Demersal waters (mud and sandy substrates) in lower estuaries. **Prey:** mysid shrimp	**Habitat:** Demersal waters (mud and sandy substrates). Shallow coastal areas in warm months, offshore in cold months. **Prey:** fish, shrimp, squid, worms
Scup *(Stenotomus chrysops)*	n/a	n/a	**Habitat:** Demersal waters	**Habitat:** Demersal waters offshore from Nov – April. **Prey:** small benthic inverts.
Black sea bass *(Centropristus striata)*	n/a	**Habitat:** Larvae are pelagic within Continental Shelf Waters and Estuaries. Larvae later become demersal over structured inshore habitat.	**Habitat:** Demersal waters over rough bottom, shellfish and eelgrass beds, man-made structures in sandy-shelly areas	**Habitat:** Demersal waters over structured habitats (natural and man-made), and sand and shell areas. **Prey:** benthic & near bottom inverts., small fish, squid
Surfclam *(Spisula solidissima)*	n/a	n/a	**Habitat:** Throughout bottom sandy substrate to 3' in depth from beach zone to 60 m.	
Ocean quahog *(Artica islandica)*	n/a	n/a		
Spiny dogfish *(Squalus acanthias)*	n/a	n/a	**Habitat:** Pelagic in same waters as adults. **Prey:** ctenophores, salps, scallops, squid, euphausiids, *Cancer* spp. crabs, herring, bay anchovies, hakes, sand lances, mackerels, butterfish	**Habitat:** Pelagic or demersal in coastal waters in depths from 1-500m. **Prey:** ctenophores, salps, scallops, squid, euphausiids, *Cancer* spp. crabs, herring, bay anchovies, hakes, sand lances, mackerels, butterfish, spot, croaker and weakfish.
King mackerel *(Scomberomorus cavalla)*	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone.	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. **Prey:** zooplankton and fish eggs	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone **Prey:** zooplankton, shrimps, crab larvae, squids, herrings, silversides, and lances.	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone **Prey:** squids, herrings, silversides, and lances.
Spanish mackerel *(Scomberomorus maculatus)*	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone.	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory **Prey:** zooplankton and fish eggs	**Habitat:** Pelagic waters with sandy shoals of capes & offshore bars, high profile rocky bottom & barrier island ocean-side waters from the surf to the shelf break zone. Migratory **Prey:** zooplankton, shrimps, crab larvae, squids, herrings, silversides, lances.	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory **Prey:** squids, herrings, silversides, and lances
Cobia *(Rachycentron canadum)*	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone.	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	**Habitat:** Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory **Prey:** crabs, shrimps, and small fishes

Table 4-11. Habitat Requirements of Identified EFH Species and Their Representative LIfe Stage(s) (NOAA, 1999)				
Managed Species	**Eggs**	**Larvae**	**Juveniles**	**Adults**
			Prey: crabs, shrimps, and small fishes	
Sand tiger shark *(Odontaspis taurus)*		**Habitat:** Shallow coastal waters, bottom or demersal. Lower DE Bay and HCS areas are believed to be important pupping areas.		**Habitat:** Shallow coastal waters, bottom or demersal **Prey:** small fishes (including mackerels, menhaden, flounders, skates, sea trout, and porgies), crabs, squids.
Blue shark (*Prionace glauca*)				**Habitat:** oceanic–epipelagic, fringe–littoral, cosmopolitan species, occurring throughout the tropical, subtropical, and temperate open waters. Highly migratory
Atlantic angel shark *(Squatina dumerili)*		**Habitat:** Shallow coastal waters	**Habitat:** Shallow coastal waters	**Habitat:** Shallow coastal waters, bottom (sand or mud near reefs)
Atl. Sharpnose shark *(Rhizopriondon terraenovae)*				**Habitat:** Shallow coastal waters
Dusky shark *(Charcharinus obscurus)*		**Habitat:** Shallow coastal waters		
Sandbar shark *(Charcharinus plumbeus)* (Pratt 1999)		**Habitat:** Shallow coastal waters; submerged flats (1-4 m). HAPC is identified within lower DE Bay and possibly HCS Area.	**Habitat:** Shallow coastal waters; submerged flats (1-4 m). HAPC is identified within lower DE Bay and possibly HCS Area..	**Habitat:** Shallow coastal waters; submerged flats (1-4 m). HAPC is identified within lower DE Bay and possibly HCS Area.
Shortfin mako shark (*Isurus oxyrinchus*)			**Habitat:** offshore littoral and epipelagic species found in tropical and warm temperate waters that is seldom found in waters below 16°C.	
Scalloped hammerhead shark *(Sphyrna lewini)*			**Habitat:** Shallow coastal waters	
Tiger shark *(Galeocerdo cuvieri)*		**Habitat:** Shallow coastal waters		
Clearnose skate (*Raja eglanteria*)			**Habitat:** continental shelf waters but will occasionally come into shallow waters and bays during the summer months. Eggs are laid off the coast in spring. **Prey:** Fish, benthic organisms and other macro-invertebrates. .	**Habitat:** continental shelf waters but will occasionally come into shallow waters and bays during the summer months. Eggs are laid off the coast in spring. **Prey:** Fish, benthic organisms and other macro-invertebrates.
Little skate (*Raja erinacea*)			Same as clearnose skate, but they leave shallow water during summer.	
Winter skate (*Raja ocellata*)			Occur in deep continental shelf waters.	

In Wirth (2001), a total of sixteen species with Federal management plans and identified EFH within the borrow areas were collected throughout the year. Some of these species exhibited seasonal and habitat-based preferences. Area G and the eastern portion of Area B had abundant black sea bass in the spring and summer. Bluefish had a higher rank score in these sites in the spring and scup and spiny dogfish had a high rank in summer. Summer flounder had a high rank score in the winter sampling in the western portion of Area G and was high in the HCS area in the fall. Windowpane was high in the HCS area in the winter.

4.2.2.3 Marine Mammals and Sea Birds

A number of marine mammals are frequent transients along the nearshore and offshore waters of the Delaware Coast. Cetaceans (whales and dolphins) include the right whale (*Eubalaena glacialis*), the humpback whale (*Megaptera novaengliae*) and minke whale *(Balaenoptera acutorostrata),* and are likely to venture into the nearshore waters along the Delaware Atlantic Coast. Bottlenose dolphins (*Tursiops truncates*) are common summertime migrants, and can be found in nearshore water along Delaware's beaches. Coastal waters may also be visited by the harbor porpoise (*Phocoena phocoena*). Pinnipeds (seals) are more frequently encountered during winter and spring months along the coast, and sometimes stranded on the beaches. These include the gray seal *(Halichoerus grypus),* harbor Seal *(Phoca vitulina), and* harp Seal *(Pagophilus groenlandicus).*

Many species of birds utilize open water marine habitat for feeding and resting. Birds utilizing this area may include gulls, terns (*Sterna* spp.), scoters (*Melanitta* spp.), oldsquaw *(Clangula hyemalis*) and loons (*Gavia immer*). Open ocean species such as gannet (*Sula bassanus*), blacklegged kittiwake (*Rissa triadctyla*), storm petrel (*Oceanites oceanicus*), and shearwaters (*Puffinus* spp.) may also be present offshore.

4.2.3 Threatened and Endangered Species

Coordination was undertaken with the Delaware Division of Fish and Wildlife – Wildlife Species Conservation and Research Program (WSCRP) for an update on species that are Federally listed threatened or endangered, state rare or Species of Greatest Conservation Need (SGCN) within or in close proximity to the affected beach areas (letter from WSCRP dated 12/9/2014). Table 4-12 provides information on several species identified within or close proximity to the affected beach areas.

Table 4-12. Rare, Threatened, and Endangered Species along Delaware's Beaches

Scientific Name	Common Name	Taxon	Habitat	Federal Status	State Status	State Rank	SGCN Tier
Charadrius melodus	Piping Plover	Bird	Sandy beaches/overwash areas	T	E	S1	1
Haematopus palliates	American Oystercatcher	Bird	Sandy beaches/overwash areas	--	E	S1B	1
Photuris bethaniensis	Bethany Beach Firefly	Insect	Interdunal swales (freshwater wetlands)	--	E	S1	1
Amaranthus pumilus	Seabeach Amaranth	Plant	Sandy beaches/overwash areas	T	--	S1	--
Dicanthelium dichotonum	Witch Grass	Plant	Interdunal swales (freshwater wetlands)	--	--	S2	--
Fimbristylis caroliniana	Carolina Fimbry	Plant	Interdunal swales (freshwater wetlands)	--	--	S1	--

Table 4-12. Rare, Threatened, and Endangered Species along Delaware's Beaches							
Scientific Name	**Common Name**	**Taxon**	**Habitat**	**Federal Status**	**State Status**	**State Rank**	**SGCN Tier**
Sabatia campnulata	Slender Marsh Pink	Plant	Interdunal swales (freshwater wetlands)	--	--	S1	--
Spiranthes vernalis	Twisted Ladies' Tresses	Plant	Interdunal swales (freshwater wetlands)	--	--	S2	--

Nesting pairs of the piping plover, which are Federally threatened and State endangered, normally occur within Cape Henlopen State Park and less frequently Delaware Seashore State Parks. No known piping plover nesting activity has been recently observed within Rehoboth Beach, Dewey Beach, Indian River Inlet North Shore, Bethany Beach, South Bethany and Fenwick Island project areas. The American oystercatcher, a state endangered bird, nests on sandy beaches, and has nested on the north side of Indian River Inlet during the last two breeding seasons. Other potential colonial beach nesting birds that are listed as endangered in Delaware are: black skimmer (*Rynchops niger*), least tern (*Sterna antillarum*), and the breeding populations of common tern (*Sterna hirundo*) and Forster's tern (*Sterna forsteri*). The rufa red knot (*Calidris canutus rufa*), is a Federally threatened and state endangered shorebird that can be found in lower densities during the spring and fall migrations along Atlantic Coast beaches, and could occur within the project area. In wintering and migration habitats, red knots may forage on bivalves, gastropods, and crustaceans along the shoreline (USFWS 2013; Harrington 2001).

The sea beach amaranth or "pigweed" (*Amaranthus pumilus*) is a Federally threatened plant that primarily occurs on overwash flats at accreting ends of barrier islands and lower foredunes and upper strands on non-eroding beaches. This plant has been found within Cape Henlopen State Park, Delaware Seashore State Park, and Fenwick Island State Park. Most recently, seabeach amaranth was observed growing 1.4 miles north of the Indian River Inlet. This species has not been found in any of the municipal Federal project beaches, but did occur within the affected project area of the North Shore of Indian River Inlet in 2002.

As discussed in USACE (1996, 1998, 2000, 2002 and 2005), Federally threatened and endangered sea turtles including the loggerhead sea turtle (*Caretta caretta*), Kemp's ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*) and green sea turtle (*Chelonia mydas*) may occur in waters along the Delaware Atlantic Coast especially during the summer months. The endangered humpback whale (*Megaptera novaengliae*) and North Atlantic right whale (*Eubalaena glacialis*) among four other species may also be present within Delaware Coastal Waters.

The New York Bight distinct population segment (DPS) of the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) was recently listed as endangered by the NMFS. Atlantic sturgeon are anadromous, spending a majority of their adult life phase in marine waters, migrating up rivers to spawn in freshwater then migrating to brackish water in juvenile growth phases. The Atlantic sturgeon are known to spawn within the Delaware River and migrate along the coast of Delaware. Studies have indicated that depth distribution appears seasonal, with sturgeon inhabiting the deepest waters during the winter and the shallowest during summer and early fall. Tagging studies by Fox and Breece (2010) confirm that nearshore waters along the Delaware Atlantic coast are frequently inhabited by Atlantic sturgeon with over 85% of those detected within State waters. Recent telemetry studies suggest that there is a strong seasonal pattern of arrival and departure of Atlantic sturgeon along the Delaware coast. Marine phase Atlantic sturgeon return to Delaware's coastal waters in mid-late March through mid-late May and depart between early September and mid-December. During the summer months, it is reported that these sturgeon may either return to the Delaware River to spawn (mature adults), occupy river/upper estuary foraging areas (mostly sub-adults), or remain in the lower estuary mouth/Cape Henlopen region. Few Atlantic sturgeon have been detected in Delaware's Atlantic coastal waters during the winter months (mid-December through mid-March) (coordination between Dr. Dewayne Fox, Delaware State University and DNREC WSCRP referenced in a WSCRP to USACE letter dated 12/9/2014).

The sand tiger shark and sandbar shark are listed as NOAA species of concern and are frequently in Delaware's coastal waters between April and November. The project areas are also listed as EFH for the sand tiger shark and sandbar shark (see Tables 4-10 and 4-11).

The Bethany Beach firefly (*Photuris bethaniensis*) is a state endangered insect species that could potentially inhabit areas near and within the project impact areas. It occurs in interdunal wetland swale habitats. Other state species that occur in these types of habitats are the following plants: witchgrass, Carolina fimbry, slender marsh pink, and twisted ladies' tresses.

4.3 Cultural and Social Environment

4.3.1 Cultural Resources

The US Army Corps of Engineers, Philadelphia District (USACE) and others have completed numerous cultural resources investigations along Delaware's Atlantic Ocean coastline in order to identify and evaluate cultural resources that could be impacted by proposed beach nourishment, inlet jetty repair and other construction activities. The following is a brief summary of this previous work.

Gilbert/Commonwealth prepared a study titled, *Cultural Resources Overview in the Philadelphia COE District, Indian River and Bay, Delaware* in 1978. This study provided a preliminary cultural resources overview of the Indian River and Bay area and identified areas sensitive to cultural site locations.

Thunderbird Archaeological Associates prepared a Phase 1A cultural resource investigation in 1983 titled, *A Preliminary Cultural Resources Reconnaissance of the Delaware Atlantic Coast*. This research identified known archaeological and historic resources along the Atlantic coast beach line and adjacent areas extending from Cape Henlopen south to the state line.

Complementing the above referenced study, an offshore Phase 1A cultural resource study titled, *Underwater Cultural Resources Background Study and Field Survey of the Delaware Inner Continental Shelf*, prepared by Karell Archaeological Services, dated 1984 investigated historic map and archival documentation to identify known shipwreck sites. A predictive model for unidentified shipwreck locations was also prepared.

Dolan Research, Inc. conducted the first remote sensing investigation for the Rehoboth Beach and Dewey Beach Interim Feasibility Study for the USACE in 1993. The report of this investigation titled, *Submerged Cultural Resources Investigation, Delaware Atlantic Coast From Cape Henlopen to Fenwick Island,* dated 1995, describes three high probability targets identified in two offshore borrow areas. A supplemental remote sensing survey was conducted in Borrow Area "E" in 1998 (Dolan Research, Inc. 1998, addendum). No high probability targets were identified.

In a 2001 cultural resources investigation report titled, *Phase I Submerged and Shoreline Cultural Resources Investigation, Delaware Atlantic Coast, Rehoboth Beach and Dewey Beach, Sussex County, Delaware* prepared for the USACE by Dolan Research, Inc., February, 2001, researchers surveyed newly proposed offshore borrow areas “B”, “G” and “Indian River Inlet” (Indian River Inlet Area was subsequently eliminated as a source and not considered in the Environmental Assessment due to sand quality and quantity considerations). Inspection of the remote sensing records confirmed the presence of one target in Borrow Area “G” that is suggestive of potentially significant submerged cultural resources. No potentially significant targets were identified in Area “B”.

A subsequent investigation was conducted by Dolan Research, Inc. for expansion areas in Borrow Area “B” not previously investigated and documented in a report titled, *Phase I Underwater Archaeological Investigation Delaware Atlantic Coast Expanded Borrow Area B Atlantic Ocean, Sussex County, Delaware*, dated 2011. This investigation of “B” included comprehensive remote sensing surveys. Magnetic and acoustic data were collected to identify and assess remote sensing targets that may have an association with submerged cultural resources. The comprehensive remote sensing survey resulted in the identification of six low-intensity magnetic anomalies and 10 isolated sonar features. However, none of the 16 remote sensing targets generated signature characteristics typically associated with submerged cultural resources. Therefore, no additional underwater archaeological work is recommended within the Delaware Coast Borrow Area “B”.

4.3.2 Socioeconomics

4.3.2.1 Population and Land Use

The project area is composed of Rehoboth Beach, Dewey Beach, Bethany Beach, South Bethany, the Town of Fenwick Island and adjacent unincorporated communities which lie within the 950 square miles of Sussex County. Sussex County is the southernmost and largest of the three counties in Delaware, encompassing 48% of the state's land. Although it is the largest of the counties it is also the least populated, with only 197,145 year round residents, totaling 21.9% of the state's permanent population, according to the 2010 Census.

Rehoboth Beach and Dewey Beach are located in Sussex County, Delaware, which is the largest yet least populated county, with only 197,145 year round residents, totaling only 21.9% of the State's permanent population. The coastal study area is virtually devoid of manufacturing, relying almost 100% on the service/retail industry. Despite this dependency on the tourist industry, both Rehoboth Beach and Dewey Beach continue to display extremely low unemployment rates and high median household incomes. Rehoboth Beach is reported to have a low unemployment rate of 4.2% with a median per capita income of $67,715. Dewey Beach has an unemployment rate of 4.2% and a median per capita income of $51,958.

Rehoboth Beach remains the most developed and heavily populated resort area on the Delaware Coast. The beach is lined with high-rise hotel and condominium complexes as well as the typical summer cottages. There are a total of 3,182 housing units within the town, of which only 22% are occupied year round.

While there are only 1,327 year-round residents, Rehoboth Beach attracts thousands of summer residents every year with its beaches and its own boardwalk. The boardwalk contains all of the associated stores, fast food establishments, arcades and amusement rides. The town provides public access to the municipality's beach, and has many metered parking spaces along with various shuttle services. Still, parking may be difficult on weekends at the height of the tourist season as the population in Rehoboth soars to 110,000 on a holiday weekend.

The unincorporated area of Silver Lake is directly south of Rehoboth Beach. This area is designated in the Coastal Barrier Resources Act System. Despite the CBRA inclusion, there are eleven houses that were constructed between Silver Lake and the Atlantic Ocean during the late 1990’s.

Similar to Rehoboth Beach, the northern portion of Dewey Beach is backed by uplands, but the southern end of Dewey Beach differs greatly in its geography and vulnerability to storm damage. The southern end of Dewey Beach is situated on a narrow strip of land between the Atlantic Ocean and Rehoboth Bay. The town of Dewey Beach has become a developed overflow area of Rehoboth Beach, with additional public beach access. Dewey Beach is a changing community where older residences still exist. Many of the older properties are being sold, the cottages on them razed, and new modern townhouses built in their place. This is occurring in the southern part of town where it is zoned for multi-family dwellings, however the northern properties remain zoned for single family residences allowing some of the uniqueness to remain in the town.

The oceanfront of Bethany Beach is lined with hotel and condominium complexes as well as the typical summer cottages. There are a total of 2,524 housing units within the town, of which about 92% were single housing units.

Bethany Beach is heavily developed with very little available land in the city, particularly along the ocean front. However, before any construction can begin, whether it is new construction or rehabilitation, property owners must receive the proper permits from DNREC. DNREC helps the applicant arrange meetings with the appropriate state officials as well as answer any questions on permit requirements. Bethany Beach also strictly adheres to the Federal Emergency Management Agency (FEMA) guidelines. The structures' foundations along the ocean block are mixed, with most structures built after the March 1962 storm on piles. While, according to the 2010 Census, there were only 1,060 year-round residents, Bethany Beach attracts thousands of summer residents every year with its beaches and its own boardwalk. The boardwalk is predominantly residential with a few commercial structures. Garfield Parkway, which is perpendicular to the boardwalk, provides public access to the municipality's beach, and has many metered parking spaces. Still, parking may be difficult on weekends at the height of the tourist season.

The unincorporated communities of Sea Colony and Middlesex Beach are directly south of Bethany Beach. Presently, Sea Colony consists of a multiple building high rise condominium complex and Middlesex Beach consists of residential structures.

South Bethany is situated approximately 3,500 ft. south of Bethany Beach. The town of South Bethany has become a developed overflow area of Bethany Beach, with additional public beach access. South Bethany is almost entirely composed of single housing units. All revenues come from property tax, parking permits, traffic tickets, building permits and realty transfer fees. Delaware State Route 1 provides the sole means of access to both Bethany Beach and South Bethany. The largest portion of vacationers attracted to both communities is those staying overnight but less than a week.

Fenwick Island, DE is an incorporated Township with 379 year round residents. It is zoned mostly single family residential. It has an active city council, a police department, and garbage and sanitation department. Fenwick Island provides lifeguard protection at its beaches from Memorial Day through Labor Day. Bayside residents or renters have access to a parking pass to park at street ends on the ocean front, should they wish to drive to the beach. The 2010 census data identified that there were 715 housing units in Fenwick Island, of which about 86% were single housing units. There is also an unincorporated section of Sussex County homes between the incorporated

Town of Fenwick Island and the Maryland State line. The median household income (per 2010 census) was $63,750 also higher than the county median ($52,710).

Both the State of Delaware and Sussex County are projected to increase in population over the next twenty years. Sussex County is growing faster than the state of Delaware as a whole.

4.3.2.2 Economic Development

Major industries providing employment in the county as per the census are construction, manufacturing of nondurable goods, and retail trade. Other industries providing employment are health services, educational services, food services; finance, insurance, and real estate; manufacturing of durable goods, wholesale trade; agriculture, forestry, and fisheries; transportation, public administration, communications, and other public utilities. The top sectors in Sussex County were Special Trade Contractors, Eating and Drinking Places, Miscellaneous Retail Trade, and General Building Contractors. The number of employees in these top sectors are not large. Special trades contractors only averaged 5 employees per business in Sussex County, while eating and drinking places averaged 14 employees.

The estimated Bureau of Labor Statistics unemployment rate for Sussex County for 2015 is 4.4%. This is slightly below the state average of 4.9%, and below the national average of 5.3%. Historically, Sussex County generally has a relatively low unemployment rate compared to the national and state averages.

The coastal area differs from the rest of Sussex County, and Delaware, in its reliance on the tourism industry rather than agriculture and manufacturing/processing. In Sussex County, 1/3 of those employed in the county are in retail or services, while another 1/3 are in manufacturing. The coastal study area is devoid of manufacturing, relying almost 100% on the service/retail industry.

Even when economically hard times hit the State's economy (particularly poor agricultural crops or recession in the manufacturing industry), the economy of the Delaware coast should remain buoyant as it serves as a summer resort for the residents of the regional urban and suburban areas.

4.3.3 Environmental Justice

In accordance with Executive Order 12989 dated February 11, 1994 (Environmental Justice in Minority Populations), a review was conducted of the populations within the affected areas. The U.S. Environmental Protection Agency definition for Environmental Justice is: " the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." Based on a review of recent census data of the affected areas, the affected areas are not composed of disproportionately of minority or low income populations. Table 4-13 provides a breakdown of the populations within the affected areas.

Table 4-13. U.S. Census Data of Race and Income Populations within the Affected Project Areas.							
Category	**State of Delaware**	**Sussex County**	**Rehoboth Beach**	**Dewey Beach**	**Bethany Beach**	**South Bethany**	**Fenwick Island**
Population, estimate 2010	897,934	197,145	1,327	341	1,060	449	370
White alone, percent, 2010	68.9%	79.0%	97.3%	92.1%	99%	98.4%	97.6%
Black or African American alone, percent, 2010	21.4%	12.7%	1.1%	2.6%	0.2%	0.0%	0.5%
American Indian and Alaska Native alone, percent, 2010	0.5%	0.8%	0.2%	0.3%	0.0%	0.2%	0.0%
Asian alone, percent, 2010	3.2%	1.0%	0.7%	0.3%	0.4%	0.0%	0.8%
Native Hawaiian and Other Pacific Islander alone, percent, 2010	0.0%	0.1%	0.0%	0.6%	0.0%	0.0%	0.0%
Two or More Races, percent, 2010	2.7%	2.3%	0.2%	1.2%	0.5%	0.9%	0.3%
Hispanic or Latino, percent, 2010	8.2%	8.6%	3.6%	5.9%	1.5%	1.1%	1.1%
Median household income, 2009-2013	$59,878	$52,710	$80,481	$55,000	$61,806	$72,396	$63,750
Persons below poverty level, percent, 2009-2013	11.7%	13.4%	9.6%	11.8%	4.6%	3.1%	2.7%

Source: U.S. Census data retrieved from http://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml on 5/4/2015)

4.3.4 Recreation

Recreation services provided by the beach areas are a major draw for tourism along the Delaware Coast, which is a vital part of the State's economy. The affected areas including Rehoboth Beach, Dewey Beach, Silver Lake, Bethany Beach and South Bethany, the unincorporated Sea Colony, Sussex Shores, and Middlesex Beach, Fenwick Island State Park, Delaware Seashore State Park, and the Town of Fenwick Island and surrounding areas offer numerous recreational opportunities. The ocean side offers residents and visitors boating and beach activities such as swimming, surfing (board and body), skimboarding, surf fishing, sunbathing, and many other beach activities. The nearshore and offshore offers activities such as boating, wave runners, kayaking, parasailing, and SCUBA diving/snorkeling. Many recreational charter boats, head boats and private boats fish within Indian River Inlet and along the Delaware Atlantic Coast's artificial reefs and structures. These boats generally launch from Indian River Marina, Lewes (Roosevelt Inlet), and Ocean City, MD. The area State Parks offer several surf fishing vehicle access points. Surf fishing and jetty fishing (Indian River Inlet) along the Delaware Atlantic Coast beaches are very popular activities year round. Generally, recreational fishing along the beaches and Indian River Inlet is most productive in the spring and fall when anglers target fish such as striped bass (rockfish), bluefish, kingfish, summer flounder, weakfish, croaker, spot, red hake and red drum that migrate into inshore waters. Anglers can also target several shark species, but are required to release prohibited species such as sandbar shark and sand tiger shark. The jetties of IRI are a popular spot to catch tautog (blackfish) and other species transiting the inlet. Summer time recreational fishing slows down along the beaches where common fish taken are dogfish and skates. Despite the slower surf fishing in the summertime, many of the State Park beaches are often filled with vehicles with surf fishing tag permits that allow them to drive on. State laws require that vehicle occupants must be actively fishing and can only access the beaches from designated access points in the State parks. Surf fishing and jetty fishing activities significantly slow down following the fall runs as the coastline has fewer numbers of targeted species in the area.

Nearshore and offshore fishing is also a popular activity where wrecks, artificial reefs, and lumps hold fish. Some of the same species targeted by surf fishers can be caught by boat on headboats/party boats, charter boats and private boats originating out of Indian River Inlet, Delaware Bay, and Ocean City, MD. Reef and other structured bottoms usually hold black seabass, tautog, scup and flounder. Highly pelagic species such as dolphinfish, tunas and billfish are targeted further offshore. Figure 4-15 and 4-16 provide MARCO maps showing the distribution of party and charter boat trips and recreational boating uses and intensity along the Delaware Atlantic Coast. The Inland Bays offer activities such as clamming, crabbing, fishing, hunting, sailing, windsurfing, and birdwatching.

The MARCO mapping along the Delaware Atlantic Coast identifies the intensity of recreational activities along the coastal waters and beaches. Figures 4-12 to 4-14 identify various recreational uses and their intensity of use along the coast.

Recreational interests are an important constituency along the Delaware Atlantic Coast and are represented by many advocacy organizations that promote their interests. Surfing and fishing are two such interests that are well represented in this area.

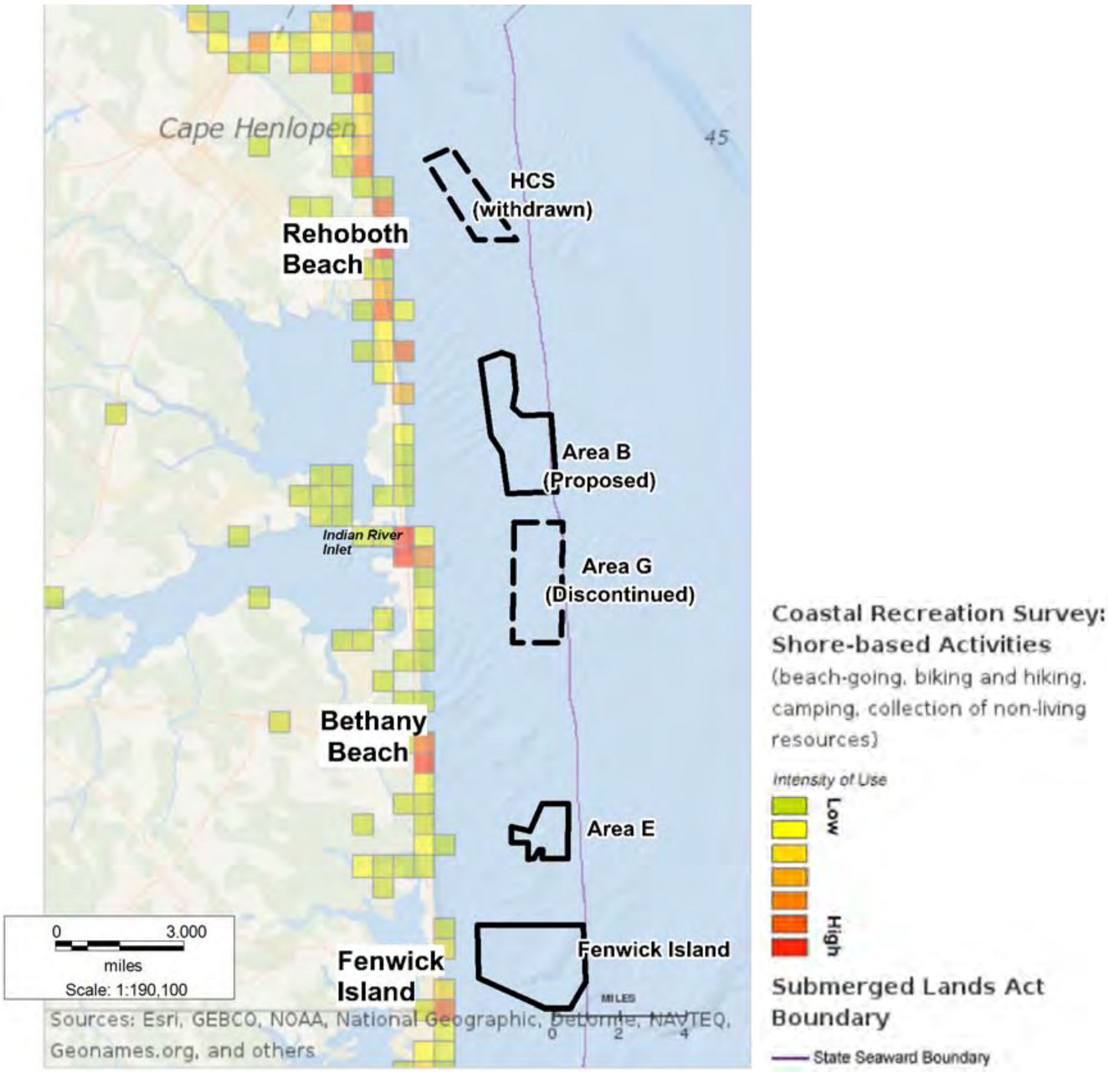


Figure 4-12. Intensity of Uses for Shore-Based Recreational Activities.
(Source: from MARCO marine mapper planner website: http://portal.midatlanticocean.org/planner/ accessed on 3/24/2015).

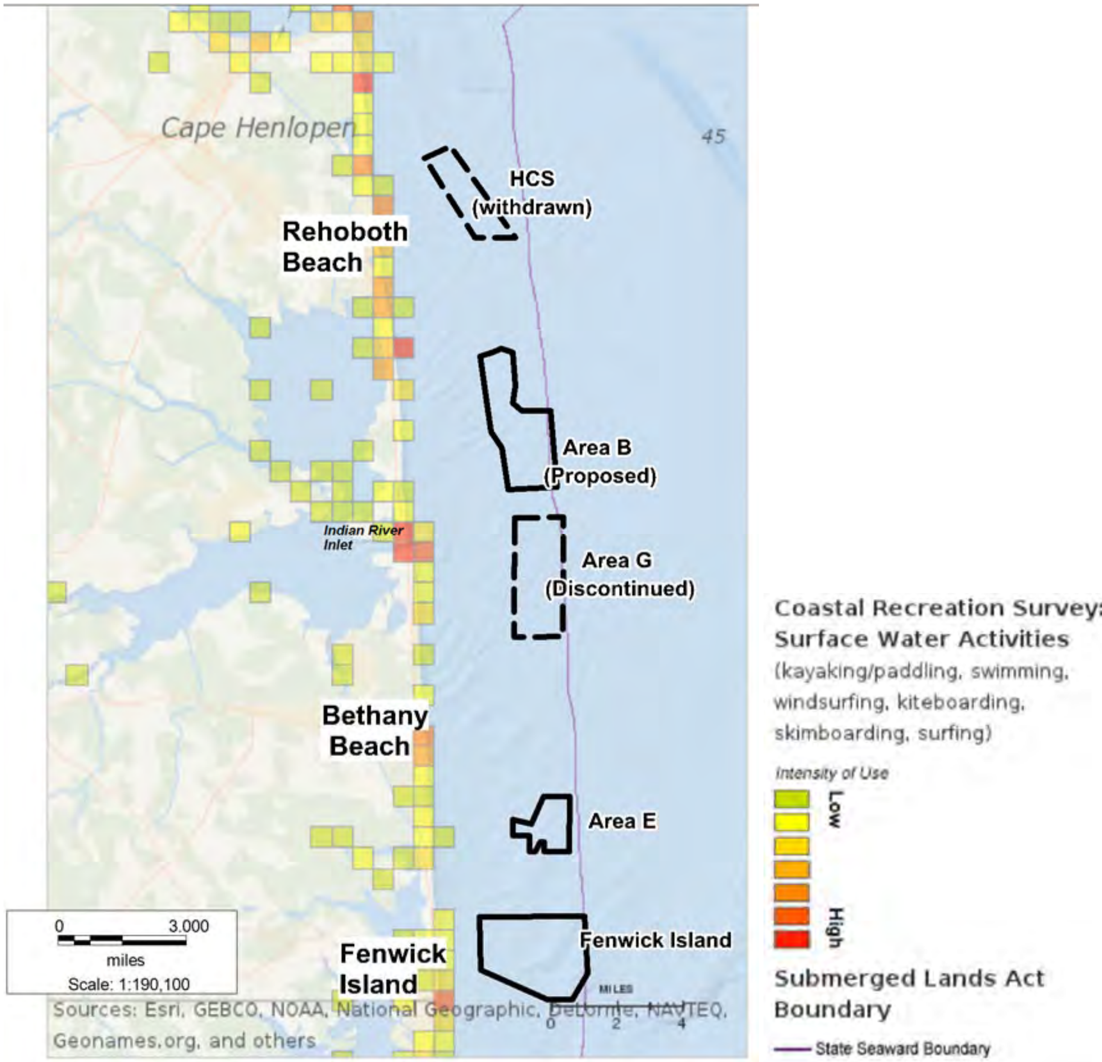


Figure 4-13. Intensity of Uses for Surface Water Recreational Activities.
(Source: from MARCO marine mapper planner website:
http://portal.midatlanticocean.org/planner/ accessed on 3/24/2015).

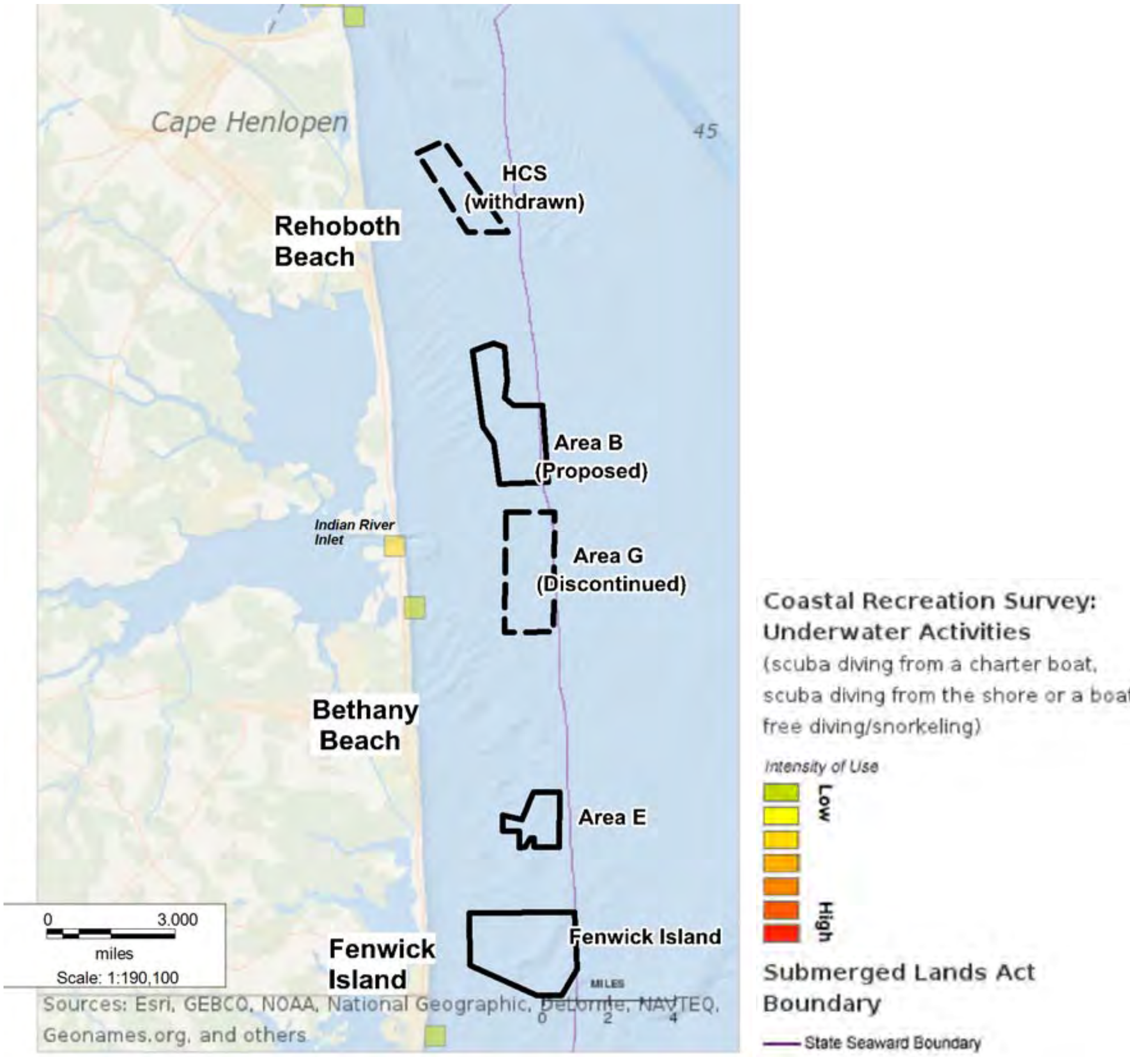


Figure 4-14. Intensity of Uses for Underwater Recreational Activities.
(Source: from MARCO marine mapper planner website: http://portal.midatlanticocean.org/planner/ accessed on 3/24/2015).

4.3.5 Visual and Aesthetic Values

Aesthetics refer to the sensory quality of the resources (sight, sound, smell, taste, and touch) and especially with respect to judgment about their pleasurable qualities (Canter, 1993; Smardon et al. 1986). The aesthetic quality of the study area is influenced by the natural and developed environment. The beachfront of the affected municipal areas is developed with homes, hotels, condominiums, restaurants, retail businesses, and boardwalks. However, these resort towns draw on the high aesthetic values of the seashore environment, which includes clean sandy beaches, dunes, and ocean views. Resident and visitor beachgoers are attracted to the area for the beach scenery and clean, attractive beaches and structures that are present in the affected area. The State Park beaches including Cape Henlopen State Park, Delaware

Seashore State Park, and Fenwick Island State Park offer visitors a more natural aesthetic quality with natural beaches, vegetation, wildlife, and surf.

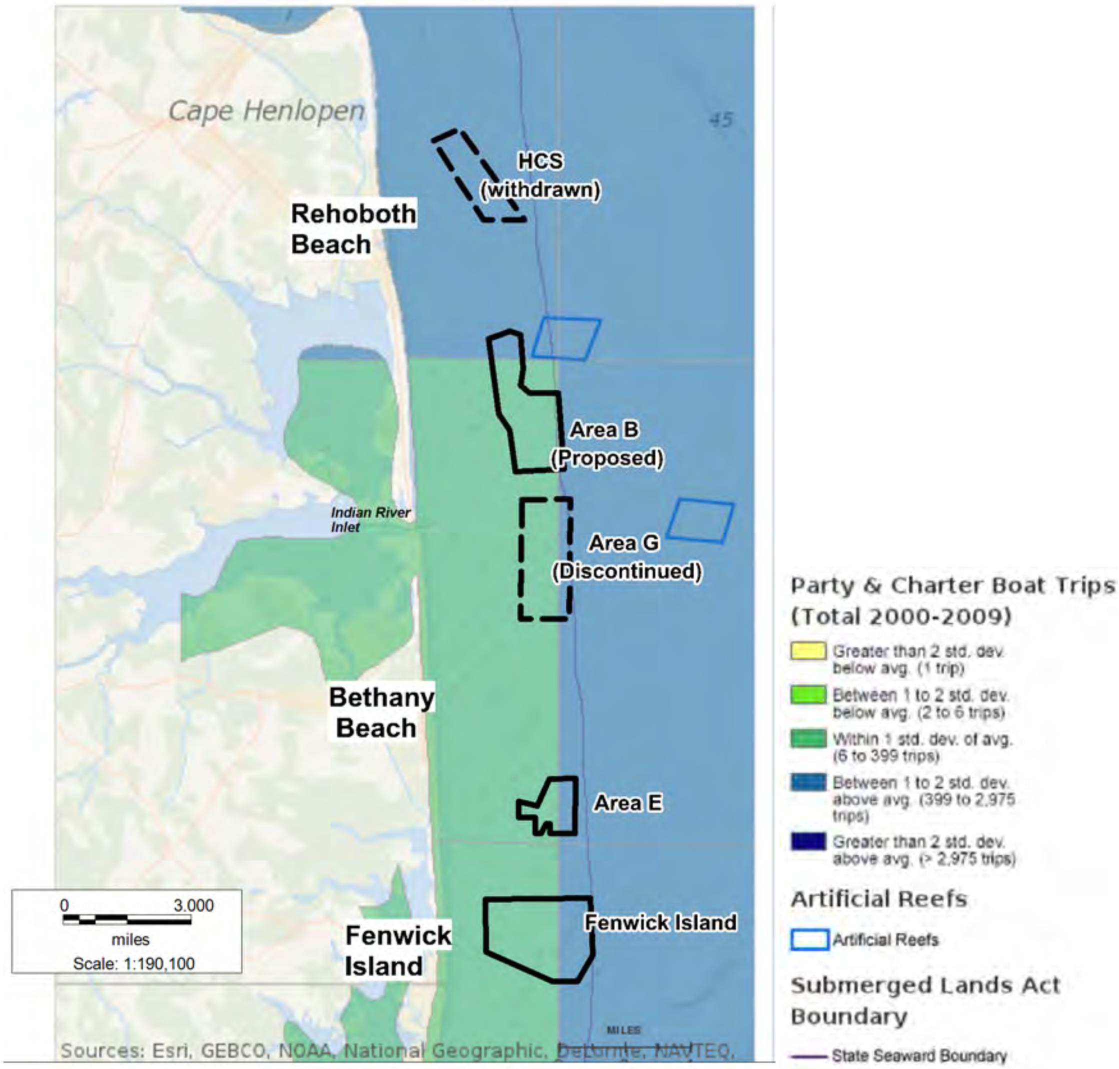


Figure 4-15. Intensity of Uses for Party and Charter Boat Trips along the Delaware Atlantic Coast. (Source: from MARCO marine mapper planner website: http://portal.midatlanticocean.org/planner/ accessed on 3/24/2015)

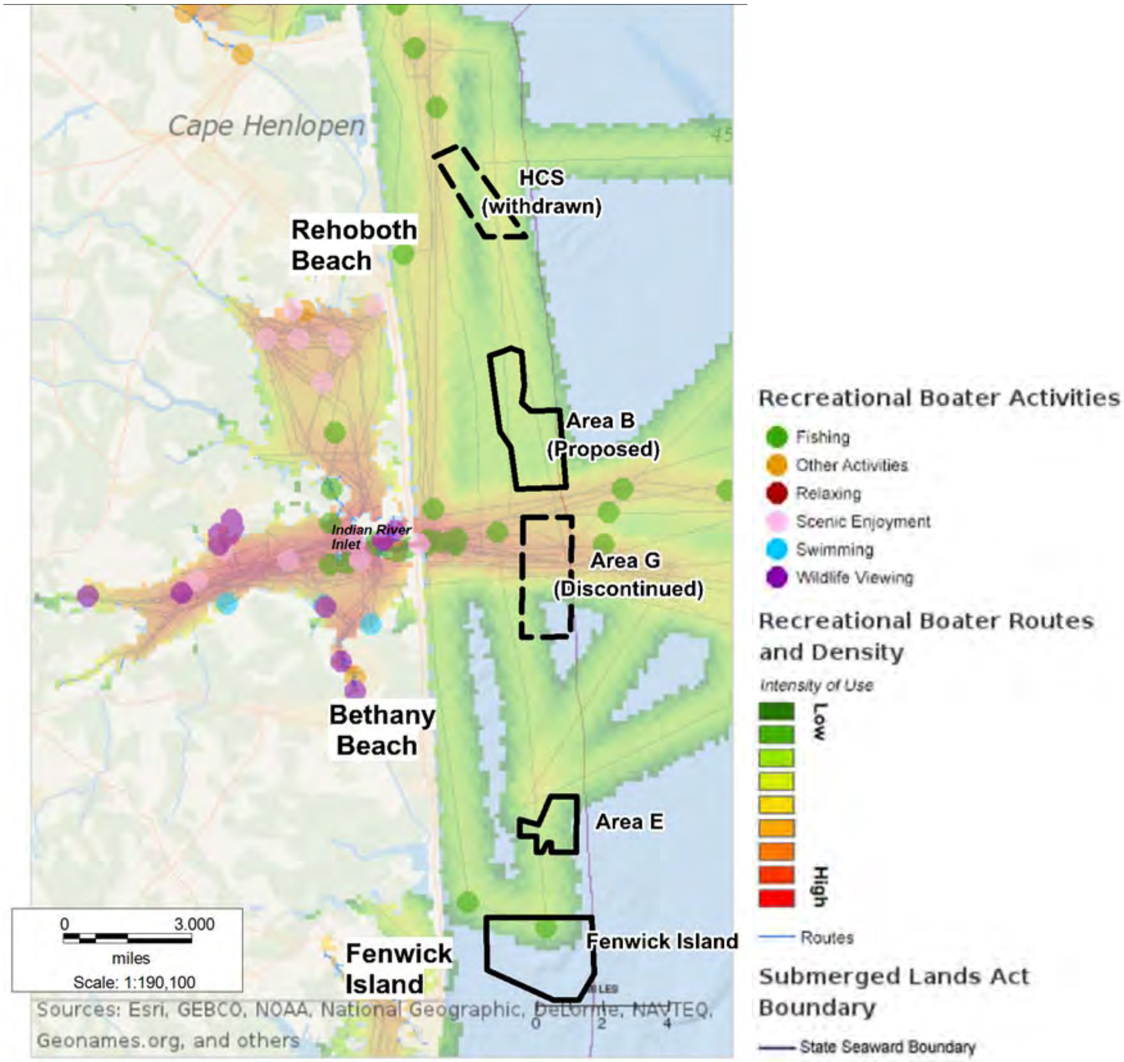


Figure 4-16. Recreational Boater Activities, Routes and Density along the Delaware Atlantic Coast. (Source: from MARCO marine mapper planner website: http://portal.midatlanticocean.org/planner/ accessed on 3/24/2015)

5.0 ENVIRONMENTAL IMPACTS

The environmental impacts associated with dredging existing and proposed sand sources and beachfill placement along the Delaware Atlantic Coast are presented in USACE (1996) (1998) (2000) (2002) and (2005), (2013) and are incorporated by reference.

5.1 Physical Environment

5.1.1 Offshore Sand Source Areas

Dredging within HCS would increase the depths of the shoal and may reduce the shoal profile to the same bathymetry surrounding the shoal. This would occur in increments over the 50-year project life, which may have an overall reduction in the profile of the southern portion of the shoal. Based on vibracore data, similar substrate characteristics would remain.

Dredging in either Areas B or G would result in the excavation of shallow pits less than or equal to 10 ft. deeper than the surrounding bathymetry. This is due to the existing flat nature of the sea floor surface. Initially, the dredge cuts may produce abrupt edges. However, these cuts are expected to become reworked by oceanic currents, which would “round-out” the edges from being abrupt. Based on vibracore data, similar substrate characteristics would remain. Because the areas would be deepened, minor and localized changes in hydrodynamics are expected in the vicinity of the borrow area.

In regard to Borrow Area B (Proposed Sand Source) specifically, it is anticipated that dredging within Area B would have negligible effects on nearshore wave conditions and sedimentation patterns along the beaches of the Atlantic Coast of Delaware. This is based on results from an investigation utilizing detailed numerical modeling of borrow areas similar to Area B which are located to the south offshore Fenwick Island, Delaware and Ocean City, Maryland (“*Atlantic Coast of Maryland Hurricane Protection Project*” (August 1989), Appendix B, Section 5). The conclusion from this investigation indicated that dredging of the offshore borrow sites appeared to have very little effect on wave patterns and longshore sediment transport potential. The modeling also indicated that wave run-up at the beach face also appeared to be unchanged when dredging was performed at the site. Based on the negligible effects of dredging on nearshore physical processes as demonstrated by the above referenced analysis, it was concluded that dredging from Area B would likewise produce negligible changes in nearshore physical processes along the Atlantic Coast of Delaware. However, it is recommended that dredging should not excavate deeper than 10 feet below the surrounding sea floor surface to avoid having any measurable effects on the regional nearshore wave patterns.

5.1.2 Receiving Beaches and Nearshore

Section 3.3.2 discusses typical beachfill construction practices. A large infusion of sand will initially change the beach sand composition and topography/slope. These changes are a result of the volume of sand placed and the textural properties of the borrow material (grain size and sorting). Sand grain sizes can be a contributing factor to beach slopes along with other factors such as storm frequency, duration and intensity; wind patterns, prevailing littoral drift, water currents, beach usage and maintenance and beach project templates. Generally, coarse sands tend to be associated with steeper foreshore slopes whereas fine sands are generally associated with flatter foreshore slopes. Recent concerns have arisen regarding foreshore slopes on Delaware beaches, and persistent “shore break” conditions that could have adverse effects on recreation uses in the turbulent breaker zone. Table 5-1 provides a comparison of sediment samples from Area B with historical beach sand grain sizes and sorting. Based on historical sand grain sizes observed on Delaware beaches, the composite sand grain size of Borrow Area B North indicate that they are similar to the 1993-1994 and Ramsey (1999) findings. It is assumed that using the Area B North borrow source would not contribute to steeper foreshore slopes, and gravel would be minimal. However, the Area B South composite does show a significantly higher mean grain size (and a higher gravel content at 24%), and could possibly contribute to a steeper foreshore slope. Grading classifications are similar between the proposed Area B North sands and the receiving beaches where sediments tend to be poorly graded/well sorted. The mean diameter of the Area B North composite (0.309 mm) shows that the sands are slightly coarser than the 1993 seasonal beach sampling study (0.267 mm to 0.29 mm), and are finer than the historical (1929-1984) overall Delaware Coast composite (0.425 mm) and the range of diameters for the Rehoboth Beach and Dewey Beach reach (0.43 mm to 0.48 mm) as reported in Ramsey (1999). On the whole, Area B North mean grain sizes do not deviate significantly with historical coastal beach grain sizes.

Table 5-1. Mean Grain Sizes of Area B Composite Cores Compared with Historical Delaware Beach Composite Grain Sizes.

Sample Area	Location	Mean Diameter (mm)	Classification
Borrow Area B (O’Brien and Gere, 2011)	North Composite (0-10 ft.)	0.309	Fine to medium sand-poorly graded/well sorted
	South Composite (0-10 ft.)	0.665	Medium sand w/ gravel – well graded/poorly sorted
Delaware Coast Beach Samples from Summer 1993 and Winter 1993-1994 (USACE, 1996, 1998, 2000)	Rehoboth/Dewey Beach	0.28	Fine to medium sand – poorly graded/ moderately well sorted
	Bethany Beach/South Bethany	0.29	Fine to medium sand – poorly graded/well sorted
	Fenwick Island	0.267	Fine to medium sand – poorly graded/well sorted
Delaware Atlantic Coast from 1929 to 1984 (Ramsey, 1999)	Delaware Coast Composite	0.425	Medium sand – poorly graded/well sorted
	Rehoboth/Dewey Beach	0.43 to 0.48	Medium sand – poorly graded/moderately well to well sorted

Table 5-1. Mean Grain Sizes of Area B Composite Cores Compared with Historical Delaware Beach Composite Grain Sizes.			
Sample Area	Location	Mean Diameter (mm)	Classification
	Indian River Inlet Sand bypass (south and north shores)	0.38 to 0.56	Medium to coarse sand-poorly graded/ moderately well to well sorted
	Bethany Beach/South Bethany	0.28 to 0.475	Medium sand – poorly graded/moderately well sorted to well sorted
	Fenwick Island	0.28 to 0.345	Medium sand – poorly graded/well sorted

It is, therefore, recommended that Area B North be used as the borrow source, and Area B South be considered for use only if additional future cores can identify pockets or subareas with finer materials that provide a better match with historic beach grain sizes.

5.1.3 Hazardous, Toxic and Radioactive Waste (HTRW)

An updated review of the DEN State database does not provide any indications of significant HTRW within the beachfill placement areas or the sand borrow areas. However, this does not rule out a potential for encountering HTRW from unknown sources.

5.1.3.1 Munitions and Explosives of Concern (MEC)

Dredging sand from within all of the sand sources along the Delaware Atlantic Coast has a potential for encountering MEC associated with past artillery target practice activities at the North and South Firing Ranges. All of the existing and or proposed sand sources are within or partially within the boundaries of the former artillery target areas. Based on the situation experienced at Bethany Beach in 1998 where several live 40 mm rounds were encountered following a beach replenishment project, it is necessary that adequate safeguards are implemented to avoid exposure of MEC to the public and workers during and after construction.

Because a potential for encountering MEC has been identified for the existing and proposed borrow areas, MEC screening devices would be placed on the dredge intake or in pipeline section prior to reaching the dredge pump, and at the discharge end of the pipeline on the beach. Specifically, the screening device on the dredge intake would prevent the passage of any material greater than 1.25 inches in diameter and the discharge end screening device would retain all items 0.75 inches in diameter or larger. The beachfill operation would be overseen by an Ordnance and Explosives Safety Specialist(s) (OESS) from the Corps of Engineers Military Munitions Design Center. The OESS will be on-site or in the vicinity (within a 15-minute response time after notification) during the duration of the placement of beachfill. Strict inspection protocols and procedures would be implemented for inspection of screens and detection of oversized materials and our detection of MECs to insure worker and public safety. MEC screening measures have been in place since 2004 on all of the Delaware Atlantic Coast Federal beachfill projects.

5.1.3.2 Storage of Hazardous Materials During Construction

The contractor would be responsible for proper storage and disposal of any hazardous material such as oils and fuels used during the dredging and beach nourishment operations. The U.S. EPA and U.S. Coast Guard regulations require the treatment of waste (*e.g.*, sewage, gray water) from dredge plants and tender/service vessels and prohibit the disposal of debris into the marine environment. The dredge contractor will be required to implement a marine pollution control plan to minimize any direct impacts to water quality from construction activity. No accidental spills of diesel fuel from the dredge plant or tender vessels are expected.

5.1.4 Water and Sediment Quality Impacts

As discussed in USACE (1996) (1998) (2000) (2002) (2005), the discharges associated with offshore dredging and placement of sand would result in short-term minor adverse impacts to water quality in the immediate vicinity of the dredging and beachfill placement. The direct impacts on water quality result from the associated dredging and discharge of a sand slurry material mixed with water as it is pumped on the beach and nearshore area, which would temporarily increase turbidity/suspended solids at the point of dredging and receiving waters. A turbidity plume would be noticeable in both locations, but would dissipate within hours to days after pumping ceases. Most of the sediments are greater than 90% sands and gravels; therefore, suspended particles should settle-out quickly after discharge. Since there are no known sources of chemical contaminants within the affected areas such as dumpsites or industrial outfalls, it is expected that the material to be placed on the beaches and nearshore area will consist primarily of clean sand and gravels (although pockets of silt/clay deposits are possible). This is confirmed through vibracore analysis that has determined that the offshore borrow area contains sand that closely matches the existing beach sand. Additionally, Area B was sampled for bulk sediment organic and inorganic contaminants (Duffield Associates, 2000 and Versar Inc., 2011). With the exception of the metals thallium and nickel, no other constituents exceeded DNREC soil screening levels and marine sediment screening levels (DNREC, 2014). The thallium concentration at BVC-4, which is in the southern portion of Area B was at 0.16 mg/kg and the DNREC soil screening level is 0.078 mg/kg. Thallium was also detected at BVC-6 at 0.11 mg/kg and 0.14 mg/kg, but this station is no longer within Area B. Nickel was detected at 20.9 mg/kg at BVC-4, which exceeded the DE SIRS Marine Sediment Screening Level of 15.9 mg/kg. Two pesticides, dieldrin and lindane exceeded the Effects Range-Low values (from Long et. al. 1995) at two stations, but did not exceed Effects Range-Median (ER-M) values. An exceedance of an ER-L (but is below an ER-M value), indicates that sediment effects are possible within this range where effects would occasionally occur to benthic organisms. Exceedance of an ER-M indicates that constituent concentrations represent a probable effects range within which effects would frequently occur to benthic organisms. No sediment contaminant concentrations were found to exceed published ER-M values.

Turbidity could also be generated offshore if a barge or hopper of a hopper dredge is allowed to overflow. This process is called “economic loading”, which is used to maximize sand loads per haul by allowing coarse grained materials to settle into the hopper and fine grained sediments and mostly water are allowed to overflow back into the water body (Atlantic Ocean). Since the material is beachfill quality sand with little amounts of fines and low-level contaminants present, these impacts are also expected to be minor. As such, the proposed project is not expected to violate State of Delaware water quality standards.

5.1.5 Air Quality and Noise

5.1.5.1 Air Quality

Air quality impacts resulting from the release of carbon monoxide and particulate emissions will occur at the site during project related activities and may be considered offensive, but are generally not considered far-reaching. Exhaust from the construction equipment will have an effect on the immediate air quality around the construction operation but should not impact areas away from the construction area. These emissions will subside upon cessation of operation of heavy equipment.

The 1990 Clean Air Act Amendments include the provision of Federal Conformity, which is a regulation that ensures that Federal Actions conform to a non-attainment area’s State Implementation Plan (SIP) thus not adversely impacting the area’s progress toward attaining the National Ambient Air Quality Standards (NAAQS). In the case of the periodic nourishment and repairs to the storm damage reduction projects along the Delaware Coast, the Federal action is to provide periodic nourishment or sand and/or to repair the berm and dune following storm damages that may occur. The U.S. Army Corps of Engineers, Philadelphia District would be responsible for the construction, which includes dredging from an offshore sand borrow area and construction activities along the beach. Sussex County, Delaware within which the Federal Action will take place is classified as marginal nonattainment for ozone (oxides of nitrogen [NOx] and volatile organic compounds [VOCs]). Sussex County, DE is within the Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE Nonattainment Area.

There are two types of Federal Conformity: Transportation Conformity and General Conformity (GC). Transportation Conformity does not apply to this project because the project would not be funded with Federal Highway Administration money and it does not impact the on-road transportation system. However, GC is applicable to this project. Therefore, the total direct and indirect emissions associated with project construction must be compared to the GC trigger levels presented below in Table 5-2.

Table 5-2. General Conformity Threshold Triggers for Ozone Non-Attainment in Sussex County, Delaware.

Pollutant	General Conformity Trigger Levels (tons per year)
NOx	100
VOCs	50

Total direct and indirect emissions are calculated by determining horsepower-hours (hp-hrs), which are generated by cost engineers as part of the Micro Computer Aided Cost Estimating System (MCACES) cost estimate of the project. The cost estimate provides a detailed account of power equipment, the horsepower of the equipment, and the amount of time the equipment is being used. Once the hp-hrs are generated, a load factor is assigned to the equipment, which provides an average of the degree of how hard the equipment is operating (e.g. full power or half power). Once the hp-hrs are adjusted based on load factor, they are multiplied by the emissions factor, which is an estimate of the amount of emissions produced per hp-hr (an example would be grams of NOx per hp-hr. This value is then converted to tons of the constituent emitted. Indirect emissions for this project are typically computed by estimating the work crew travel trips to the work site and back during the construction period with an estimate of the emissions produced by this activity.

Emissions estimates were developed for two borrow area scenarios: use of proposed Area B and the existing interim Fenwick Island Borrow Area (BA) for a typical renourishment phase assuming a sand quantity of 400,000 cubic yards for the Rehoboth Beach and Dewey Beach project Table 5-3.

Table 5-3. Comparison of Nitrogen Oxides (NOx) and Volatile Organic Compounds (VOCs) Emission Estimates from Utilization of Two Borrow Areas for Rehoboth Beach and Dewey Beach.

BORROW AREA	Sand Qty. (cubic yards)	Hopper Dredge Operating Time (hrs.)	NOx Estimate (tons)	VOCs Estimate (tons)
Fenwick Island (Existing)	400,000	698	76.2	4.1
Area B (Proposed)	400,000	427	47.4	2.6

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Both borrow area scenarios are below *de minimis* thresholds (Tables 5-2 and 5-3) established for NOx and VOCs in Sussex County, DE. Therefore, General Conformity is not required for this action. Additionally, the Fenwick Island BA represents the furthest dredging transport distance to the Rehoboth Beach and Dewey Beach project area, and would result with the highest emission output. This is also the furthest distance among all existing and proposed sand sources and their various beach destinations along the Delaware Atlantic Coast. It is, therefore, inferred that all other sand dredging and beach nourishment borrow area scenarios (assuming a sand quantity of 400,000 cubic yards or less) fall below these thresholds since the Fenwick BA transport to Rehoboth/Dewey Beaches represents a maximum emissions discharge. A statement of conformity is provided in Appendix D along with the supporting estimate data.

5.1.5.2 Noise

Project-related noise at the placement site during construction will consist of the sound of dredged material passing through the pipe and discharging in a plume of water. Earth-moving equipment, such as bulldozers, will shape the newly deposited dredged material and produce engine noise in the nearby vicinity. These activities would produce noise levels in the 70 to 90 dBA (50 feet from the source) range. Utilizing heavy machinery fitted with approved muffling apparatus reduces noise, and vibration will reduce noise impacts, but will not eliminate them.

At the offshore borrow areas, hydraulic suction dredging involves raising loosened material to the sea surface by way of a pipe and centrifugal pump along with large quantities of water. Suction dredgers produce a combination of sounds from relatively continuous sources including engine and propeller noise from the operating vessel and pumps and the sound of the drag head moving across the substrate. Robinson et al. (2011) carried out an extensive study of the noise generated by a number of trailing suction hopper dredgers during marine aggregate extraction. Source levels at frequencies below 500 hertz (Hz) were generally in line with those expected for a cargo ship travelling at modest speed. The dredging process is interspersed with quieter periods when the dragheads are raised to allow the dredge to change positions. Clarke et al. (2003) evaluated sound levels produced by a hopper dredge during its “fill” cycle working in a sandy substrate. They found that most of the sound energy produced fell within the 70 to 1,000 Hz range, with peak pressure levels in the 120 to 140 decibel (dB) range at 40 meters from the dredge. These data correlate well with a study conducted in the United Kingdom which found trailing suction hopper dredge sounds to be predominately in the low frequency range (below 500 Hz), with peak spectral levels at approximately 122 dB at a range of 56 meters (DEFRA, 2003).

In a review by Southall et.al. (2007), several studies showed altered behavior or avoidance by dolphins to increased sound related to increased boat traffic. Clarke et al. (2004) found that cutterhead dredging operations are relatively quiet compared to other sounds in aquatic environments, whereas hopper dredges produce somewhat more intense sounds. Thomsen et al. (2009) conducted a field study to better understand if and how dredge-related noise is likely to disturb marine fauna. This study found that the low-frequency dredge noise would potentially affect low- and mid-frequency cetaceans, such as bottlenose dolphins. Noise in the marine environment has also been responsible for displacement from critical feeding and breeding grounds in several other marine mammal species (Weilgart, 2007). Noise has also been documented to influence fish behavior (Thomsen et al., 2009). Fish detect and respond to sound utilizing cues to hunt for prey, avoid predators, and for social interaction (LFR, 2004). High intensity sounds can also permanently damage fish hearing (Nightingale and Simenstad, 2001). It is likely that at close distances to the dredge vessel, the noise may produce a behavioral response in mobile marine species, with individuals moving away from the disturbance, thereby reducing the risk of physical or physiological damage. Accordingly, any resulting effects would be negligible.

5.2 Biological Environment

5.2.1 Terrestrial

Impacts on terrestrial flora and fauna are discussed previously in USACE (1996) (1998) (2000) (2002) (2005) and (2013), and are incorporated by reference. Existing dune vegetation would be disturbed by dune reconstruction in areas where dune erosion occurs, however, the dunes would be replanted with dune grasses. Rapid recolonization of other types of vegetation such as sea rocket and seaside goldenrod, cocklebur, and other dune associated vegetation is expected, which would provide additional diversity. Impacts to wildlife species inhabiting the beach and dune areas are expected to be short-term and minor as most are highly mobile and capable of moving outside of the impacted areas until construction ceases. Beach and dune re-construction activities may temporarily displace resting shorebirds. Beach nesting birds such as piping plover, black skimmer, least tern and American oystercatchers could potentially be disturbed (particularly along the North Shore of Indian River Inlet) by construction activities. Beach nesting birds have not nested within the town limits of the Delaware Atlantic Coast municipalities (including project impact locations) within recent history (20 years), but a potential exists for nesting to occur within these areas. Potential impacts to these species could be avoided by monitoring and avoidance/buffer zones during the nesting season.

5.2.2 Aquatic

5.2.2.1 Benthic Environments

5.2.2.1.1 Benthos of Intertidal Zone and Nearshore Zone

As part of initial construction for Rehoboth Beach/Dewey Beach, Bethany Beach/South Bethany, and Fenwick Island, approximately 136 acres, 250 acres and 114 acres, respectively of marine benthic habitat in the intertidal and subtidal nearshore zones were impacted by beachfill placement. Indian River Inlet North shore was repaired and restored under FCCE Hurricane Sandy beachfill in 2013, which affected approximately 30 acres of marine intertidal and subtidal habitat. Periodic nourishment would generally affect much less intertidal/subtidal acreage since beachfill would only be placed where it is needed, but this could vary depending on the existing condition of the beach prior to renourishment. Impacts associated with beachfill placement on benthos are incorporated by reference USACE (1996) (1998) (2000) (2002) (2005) and (2013). Infaunal organisms within the placement zone will be impacted by burial. Most of the organisms inhabiting these dynamic zones are highly mobile and respond to stress by displaying large diurnal, tidal, and seasonal fluctuations in population densities (Reilly *et al*., 1983). Despite the resiliency of intertidal benthic fauna, the initial effect of beachfill will result in some mortalities of existing benthic organisms. Recolonization is expected to be rapid because this habitat is extremely turbulent and consists of benthic organisms adapted to high disturbance and environmental stresses. However, beach slope may play a role in the ability for intertidal organisms to recover if the slope is severe, which may be the case initially until the foreshore slope adjusts through wave action. Losses of intertidal habitat are offset by gains of this habitat seaward. Losses of nearshore subtidal habitat are minor as this would be offset seaward, likewise. Grain size compatibility analyses conducted on sediments from the proposed Area B, existing Area E and existing Fenwick Island Borrow sites suggest that fine-grained materials are low and should not significantly affect recolonization of benthic organisms in the intertidal and nearshore zones.

5.2.2.1.2 Benthos of Offshore Borrow Areas

Effects of dredging on benthic communities are presented in USACE (1996), (1998) (2000) (2002) (2005) and (2013) and are incorporated by reference. Essentially, dredging will result in the temporary complete loss and removal of the benthic community within the affected areas of the borrow site. However, this is expected to be a temporary condition. Recolonization by benthic organisms would occur shortly after being impacted as the affected areas would be available for larval and juvenile recruitment along with horizontal migration into the affected areas. Recolonization may initially result in a different benthic community that may change over time. Recovery rates may vary depending on the habitat impacted and the post impact condition of the affected area. Factors such as sediment grain size, dissolved oxygen, and availability of larva and horizontal recruitment can affect the recovery rate of benthos in dredged areas. Two post-dredge monitoring investigations were done by Scott (2009a) and Scott (2009b) in Delaware Atlantic Coastal waters following three years after the use of the Fenwick Island South Borrow Area and Area G. Post dredge monitoring of the Fenwick South Borrow area (Scott, 2009a) showed that with the exception of one station, abundances of infauna taxa and major taxonomic groups were similar. Stations in the affected and unaffected areas of the Fenwick South site tended to be dominated by the amphipod *Unciola serrata* and polychaete *Polygordius* spp., which comprised a cluster grouping of the entire southern portion of the Fenwick Island Borrow Area. However, one station did exhibit a significant difference from the other stations with fewer taxa, biomass and abundances, and was dominated by the bivalve *Tellina agilis*. This station was in the deepest part of the affected area, and may have been experiencing lingering effects of the dredging because it had the highest percent of fine sands and lowest percent of coarse sands and gravels compared to all of the other stations sampled. Scott (2009b) evaluated the post-dredge environment of borrow Area G and found a highly variable benthic community that attributes changes to the benthic community based on post dredge sediment composition and temporal differences. Stations from affected/deepened portions of the borrow area clustered similarly as those in the Fenwick Island South borrow area where there was a higher percentage of fine to medium sands, and lesser coarse sands and gravels. These stations were dominated by the amphipods *Unciola serrata* and *Tanaissus psammophilus*. Although there were some changes in sediment habitat among the deepened areas, Scott (2009b) concludes that a long-term impact of such a change on higher living resources in the area should be minimal.

Area B, like Area G contains a heterogeneous bottom habitat that ranges from fine sands to gravel/cobble bottoms. However, Area B can be subdivided into a northern portion that is dominated by fine to medium sand bottoms and a southern portion that has a higher percentage of coarse sands and gravel/pebble bottoms (particularly in the southeast). Because Area B south has the potential to have the greatest change in a post-dredge sediment composition, which could have a different benthic community composition, it is recommended that the northern portion of Area B be used. Area B north utilization is expected to have short term adverse impacts on the benthic community, where recovery is expected within 2 to 3 years after dredging.

5.2.2.2 Fisheries

5.2.2.2.1 Shellfish

Sampling in Area B by Scott (2000) did not produce any commercial sized surfclams, which utilized commercial gear for sampling. More recent benthic samples were obtained by Scott and Wong (2011) using a Young grab sampler, and found low densities of juvenile surfclams in Area B total (6.7/m^2), Area B North (3.8/m^2) and Area B South (8.3/m^2). Therefore, no special measures to avoid or conduct special harvests of commercial surfclam beds are required. However, based on historical occurrences of commercial densities of surfclams along the Delaware Atlantic Coast, these areas have the potential to develop into commercial beds. Post dredge monitoring of Area G and Fenwick Island Borrow Area showed that juvenile surfclam recruitment did occur following the dredge impact, but abundance and biomass were less than pre-dredge sampling (Scott, 2009a and Scott, 2009b). To minimize impacts on the habitat of a potential future commercial surfclam fishery within the borrow areas, it is important for the affected areas to be left with similar substrate. Shallow dredging depths (10 feet or less) would minimize the deposition of fine-grained sediments and poor oxygen circulation. Monitoring the newly exposed substrate of the affected areas would be conducted to determine if surfclam recruitment occurs subsequent to the disturbance.

Megabenthos such as the channeled and knobbed whelks and horseshoe crabs would be affected during dredging operations and their complete removal within the borrow areas would result. Although these species are present in the borrow areas, they are not known to be particularly concentrated within these locations. It is expected that these species would return following dredging and after some recruitment of the benthic community has occurred.

5.2.2.2.2 Finfish

The potential impacts of a dredging operation on fishery resources include direct physical injury to organisms, and indirect injury due to factors such as water quality degradation, loss of benthic or planktonic food resources, disruption of spawning or nursery habitats and disruption of spawning activities (USACE, 1992). With the exception of some small finfish, most bottom and pelagic fishes are highly mobile and should be capable of avoiding entrainment into the dredging intake stream or burial at the placement location. Turbidity can clog gills and affect sight feeders. However, turbidity is expected to be temporary and localized to the dredging location and placement sites. It is anticipated that some finfish would avoid the turbidity plume while others may become attracted to the suspension of food materials in the water column. Minor impacts to fish eggs and larvae are expected because these life stages are widespread throughout the Middle Atlantic Bight, and not particularly concentrated in the borrow site or surf zone of the project area (Grosslein and Azarovitz, 1982).

The primary indirect impact to fisheries will be from the immediate loss of a food source by disturbing benthic macroinvertebrate communities. Demersal finfish feed heavily on bottom-dwelling species, thus, the loss of benthos and epibenthos entrained or smothered during the project will temporarily disrupt the food chain in the impact area. This effect is expected to be temporary as these areas become rapidly recolonized by infaunal and epifaunal macroinvertebrates.

5.2.2.2.3 Essential Fish Habitat

Essential Fish Habitat (EFH) is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” and covers all habitat types utilized by a species throughout its life cycle. The Magnuson-Stevens Fishery Conservation and Management Act (Public Law 104-267) requires all Federal agencies to consult with National Marine Fisheries Service (NMFS) on all actions, or proposed actions, permitted, funded, or undertaken by the agency, that may adversely affect EFH.

A review of EFH designations and associated direct and indirect impacts along the Delaware Atlantic Coast project area was completed in Table 5-4. The no-action alternative should not have any effect on EFH as defined by the 1996 Magnuson-Stevens Act. Dredging within the proposed offshore borrow area has the potential to impact EFH several ways: by direct entrainment of eggs and larvae; the creation of higher suspended sediment levels in the water column, reduce feeding success for site-feeding fish, alter physical bottom habitat structure, eliminate benthic food resources and reduce water oxygen levels. All of these impacts are temporary in nature, either during the actual dredging period or for a period thereafter. Substrate conditions typically return to preconstruction conditions and the benthic community recovers through recolonization provided deep pits are not created. Impacts to fish species with designated EFH occurs primarily within inlets and estuaries (*i.e.* inshore) as a variety of fish species migrate in and out of inlets, such as summer flounder. Area B North encompasses approximately 684 acres in deep water (34-45 feet). It is not likely that the entire sand area would be impacted at one time. A hopper dredge could affect a larger area by making shallow cuts, whereas, a cutter head dredge could affect smaller areas making deeper cuts. Dredging depths can be variable based on quality of material and

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
1. Atlantic cod *(Gadus morhua)*				**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredge conditions. Hard bottom areas of Area B should be avoided to maximum extent possible. Shoreline placement areas are not expected to have any impacts on Atlantic Cod. **Indirect:** Temporary disruption of benthic food prey organisms in borrow sites.
2. Red hake *(Urophycis chuss)*	Eggs occur in surface waters; therefore, no direct or indirect effects are expected.	Larvae occur in surface waters; therefore, no direct or indirect effects are expected.	**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredge conditions. However, some mortality of juveniles could be expected from entrainment into the dredge. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredge conditions. Shoreline placement areas and stormwater outfall construction are not expected to have any impacts on Red hake habitat. **Indirect:** Temporary disruption of benthic food prey organisms.
3. Winter flounder (Pseudop*leuronectes americanus*)	Eggs are demersal in very shallow waters of coves and inlets in Spring. Borrow sites and placement areas are primarily in high-energy oceanic areas where eggs are not likely to be highly concentrated.	Larvae are initially planktonic, but become more bottom-oriented as they develop. However, borrow sites and placement areas are primarily in high-energy oceanic areas where larvae are not likely to be highly concentrated.	**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredge conditions. However, some mortality of juveniles could be expected from entrainment into the dredge. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms	**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredge conditions. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms.
4. Yellowtail flounder (*Limanda ferruginea*)	Eggs are pelagic and occur over continental shelf waters. Project area is near southern edge of their range. No significant direct or indirect impacts expected.	Larvae are pelagic and occur over continental shelf waters. Their movement limited to water currents. Project area is near southern edge of their range. No significant direct or indirect impacts expected.		
5. Windowpane flounder *(Scopthalmus aquosus)*	Eggs occur in surface waters; therefore, no direct or indirect effects are expected.	Larvae occur in pelagic waters; therefore, no direct or indirect effects are expected.	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of juveniles could be	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward.

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
			expected from entrainment into the dredge. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms.	**Indirect:** Temporary disruption of benthic food prey organisms.
6. Atlantic sea herring *(Clupea harengus)*			**Direct:** Occur in pelagic and near bottom. Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of juveniles could be expected from entrainment into the dredge. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** None, prey items are planktonic	**Direct:** Occur in pelagic and near bottom. Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** None, prey items are primarily planktonic
7. Monkfish *(Lophius americanus)*	Eggs occur in surface waters with depths greater than 25 m; therefore, no direct or indirect effects are expected.	Larvae occur in pelagic waters with depths greater than 25 m; therefore, no direct or indirect effects are expected.		
8. Bluefish *(Pomatomus saltatrix)*			**Direct:** Juvenile bluefish are pelagic species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Adult bluefish are pelagic species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.
9. Long finned squid *(Loligo pealei)*	n/a	Pre-recruits are pelagic. No effects are anticipated.		
10. Short finned squid *(Illex ilecebrosus)*	n/a	Pre-recruits are pelagic. No effects are anticipated.		
11. Atlantic butterfish *(Peprilus tricanthus)*		Larvae occur in pelagic waters. No impacts are expected.	**Direct:** Juvenile butterfish are pelagic species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms in food chain.	**Direct:** Adult butterfish are pelagic species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms in food chain.

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
12. Atlantic mackerel (*Scomber scombrus*)				**Direct Impacts:** Adults are pelagic and highly migratory, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory
13. Summer flounder *(Paralichthys dentatus)*		Larvae occur in pelagic waters; therefore, no direct or indirect effects are expected.	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of juveniles could be expected from entrainment into the dredge. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms.
14. Scup *(Stenotomus chrysops)*	n/a	n/a	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of juveniles could be expected from entrainment into the dredge. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Adults should be capable of relocating during impact. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms.
15. Black sea bass *(Centropristus striata)*	n/a	Larvae are mainly pelagic, however, larvae later become more bottom oriented, which are potentially susceptible to entrainment into the dredge.	**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredge conditions. Area B contains pockets of hard bottom consisting of shell, gravel and cobbles, which, are preferred habitat for black sea bass. Therefore hard bottom areas should be avoided to the maximum extent possible to avoid altering sea bass habitat. MEC screens may minimize the impact by allowing larger rocks and cobbles to remain within Area B. Some mortality of juveniles could be expected from entrainment into the dredge. Several groins in beach	**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredge conditions. Area B contains pockets of hard bottom consisting of shell, gravel and cobbles, which, are preferred habitat for black sea bass. Therefore hard bottom areas should be avoided to the maximum extent possible to avoid permanently altering sea bass habitat. MEC screens may minimize the impact by allowing larger rocks and cobbles to remain within Area B. Some mortality of juveniles could be expected from entrainment into the dredge. Several groins in Rehoboth Beach, which make-up intertidal and subtidal rocky habitat may be impacted due to sand partially covering groins along the shoreline.

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
			areas, which make-up intertidal and subtidal rocky habitat may be impacted due to sand partially covering groins along the shoreline. **Indirect:** Temporary disruption of benthic food prey organisms.	**Indirect:** Temporary disruption of benthic food prey organisms.
16. Surfclam *(Spisula solidissima)*	n/a	n/a	**Direct:** Complete removal within borrow sites during dredging. Exposure of similar substrate is expected to allow for future recruitment. **Indirect:** Temporary reduction in reproductive potential. *See shellfish section for more discussion.	**Direct:** Complete removal within borrow site during dredging. Similar substrate would allow for recruitment. **Indirect:** Temporary reduction in reproductive potential. *See shellfish section for more discussion.
17. Ocean quahog *(Artica islandica)*	Eggs and larvae are planktonic and not particularly concentrated in borrow area or placement areas.	Eggs and larvae are planktonic and not particularly concentrated in borrow area or placement areas.		
18. Spiny dogfish *(Squalus acanthias)*	n/a	n/a	**Direct:** Juveniles are bottom oriented. Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of juveniles could be expected from entrainment into the dredge. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of food chain by removal of benthic food prey organisms.	**Direct:** Adults are bottom oriented. Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of small adults could be expected from entrainment into the dredge. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of food chain by removal of benthic food prey organisms.
19. King mackerel *(Scomberomorus cavalla)*	**Direct Impacts:** Eggs are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Larvae are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Juveniles are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory.	**Direct Impacts:** Adults are pelagic and highly migratory, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory.

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
20. Spanish mackerel *(Scomberomorus maculatus)*	**Direct Impacts:** Eggs are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Larvae are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Juveniles are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory.	**Direct Impacts:** Adults are pelagic and highly migratory, therefore no adverse impacts are anticipated. **Indirect Impacts:** Minor indirect adverse effects on food chain through disruption of benthic community, however, mackerel are highly migratory.
21. Cobia *(Rachycentron canadum)*	**Direct Impacts:** Eggs are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct Impacts:** Larvae are pelagic, therefore no adverse impacts are anticipated. **Indirect Impacts:** None anticipated.	**Direct:** Cobia are pelagic and migratory species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.	**Direct:** Cobia are pelagic and migratory species. No significant direct effects anticipated. **Indirect:** Temporary disruption of benthic food prey organisms.
22. Sand tiger shark *(Odontaspis taurus)*		**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of neonates could be expected from entrainment into the dredge because they may be oriented with the bottom. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.		**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of young could be expected from entrainment into the dredge because they may be oriented with the bottom. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.
23. Blue shark (*Prionace glauca*)				**Direct:** This highly migratory species is not likely to be significantly impacted in the areas of dredging

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
				and beachfill placement. Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of young could be expected from entrainment into the dredge because they may be oriented with the bottom. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.
24. Atlantic angel shark *(Squatina dumerili)*		**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of neonates could be expected from entrainment into the dredge because they may be oriented with the bottom. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of juveniles could be expected from entrainment into the dredge. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Adults are mobile and are capable of avoiding impact areas. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.
25. Dusky shark *(Charcharinus obscurus)*		**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Mortality from dredge unlikely because embryos are reported up to 3 feet in length (McClane, 1978). Therefore, the newborn or neonates may be mobile enough to avoid a dredge or placement areas. Shoreline placement area bottom		

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
		habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.		
26. Sandbar shark *(Charcharinus plumbeus)*		**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. However, some mortality of neonates may be possible from entrainment into the dredge or burial in nearshore, but not likely since newborns are approx. 1.5 ft. in length (pers. conv. between J. Brady-USACE and H.W. Pratt-NMFS) and are considered to be mobile. HAPC identified in the Rehoboth Beach/Dewey Beach square, which includes a small portion of Area B. However, HAPC not likely in affected areas. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Juveniles are mobile and are capable of avoiding impact areas. HAPC identified in the Rehoboth Beach/Dewey Beach square, which includes a small portion of Area B. However, HAPC not likely in affected areas. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Adults are highly mobile and are capable of avoiding impact areas. HAPC identified in the Rehoboth Beach/Dewey Beach square, which includes a small portion of Area B. However, HAPC not likely in affected areas. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.
27. Tiger shark *(Galeocerdo cuvieri)*		**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Mortality	**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Juveniles are mobile and are capable of avoiding	

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
		from dredge or fill placement unlikely because neonates are reported up to 1.5 feet in length (McClane, 1978). Therefore, the neonates may be mobile enough to avoid a dredge or placement areas. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	impact areas. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	
28. Atl. sharpnose shark *(Rhizopriondon terraenovae)*				**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Adults are highly mobile and are capable of avoiding impact areas. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.
29. Shortfin mako shark (*Isurus oxyrinchus*)			**Direct:** Shortfin makos are pelagic and are not likely to be impacted**.** Juveniles are mobile and are capable of avoiding impact areas. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	
30. Scalloped hammerhead shark (*Sphyrna lewini*)			**Direct:** Physical habitat in borrow site should remain basically similar to pre-dredge conditions. Juveniles are mobile and are capable of avoiding impact areas. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. . Shoreline placement area bottom habitats will be temporarily	

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
			impacted and displaced seaward. Juveniles are expected to avoid placement areas during construction. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow and placement sites.	
31. Little Skate (*Raja erinacea*)			**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredged conditions. Juveniles are highly mobile, and most are capable of avoiding impact areas, although some entrainment into dredge is possible. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. Juveniles are expected to avoid placement areas during construction. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow area and placement sites.	
32. Winter Skate (*Raja ocellata*)			**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredged conditions. Juveniles are mobile, and most are capable of avoiding impact areas, although some entrainment into dredge is possible. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. Juveniles are expected to avoid placement areas during construction. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow area and placement sites.	
33. Clearnose Skate (*Raja eglanteria*)			**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredged conditions. Juveniles are mobile, and most are capable of avoiding impact areas, although some	**Direct:** Physical habitat in borrow sites should remain basically similar to pre-dredged conditions. Adults are highly mobile, and most are capable of avoiding impact areas, although some entrainment into dredge is possible. Shoreline placement area

Table 5-4. Direct and Indirect Impacts on Federally Managed Species and EFH.				
MANAGED SPECIES	**EGGS**	**LARVAE**	**JUVENILES**	**ADULTS**
			entrainment into dredge is possible. Shoreline placement area bottom habitats will be temporarily impacted and displaced seaward. Juveniles are expected to avoid placement areas during construction. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow area and placement sites.	bottom habitats will be temporarily impacted and displaced seaward. Adults are expected to avoid placement areas during construction. **Indirect:** Temporary disruption of benthic food prey organisms and food chain within borrow area and placement sites.

dredging methods. However, these depths/cuts generally do not exceed 10 feet at one time or incrementally.

Beachfill placement can affect EFH in the surf zone by displacing intertidal and nearshore shallow habitat, generation of turbidity, and burial/smothering of benthic food prey resources. The displacement of intertidal and shallow nearshore habitat would be likely created seaward assuming that similar substrates remain. Also, beachfill can initially affect fish-holding structures such as manmade rock groins, and nearshore bars and troughs by covering them. Subsequent storms may form new cuts and expose the groins, but these would likely be covered again with periodic nourishment. During construction, turbidity can inhibit respiration and sight feeders, but would be a temporary effect once pumping ceases and fine grained sediments settle out. The loss of benthic food resources is a temporary effect as the benthic organisms that inhabit this zone are typically more resilient to frequent disturbances and are capable of rapid recolonization of newly placed beachfill.

In conclusion, of the species identified with Fishery Management Plans, and highly migratory pelagic species known to occur in the vicinity, the potential for adverse impacts to EFH is considered temporary and minimal. The proposed project could impact surfclams, although the numbers that occur in the offshore borrow areas and placement zone are very low. The egg and larval stages of winter flounder, which occur predominantly in inlets, are less likely to be impacted in offshore deep water where the proposed borrow areas occur. The neonate stages of several shark species are predominately located in shallower coastal waters, not offshore deep water where the proposed borrow areas are located.

The effect on surfclams and other benthic organisms (that include food prey items) in the borrow areas is considered to be temporary as benthic studies have demonstrated recolonization following dredging operations within 13 months to 2 years.

At the beach placement site (nearshore zone), the slurry of dredged material and water pumped onto the beach typically results in an increase in localized turbidity. The Atlantic States Marine Fisheries Commission (Greene, 2002) review of the biological and physical impacts of beach nourishment cites several studies on turbidity plumes and elevated suspended solids that drop off rapidly seaward of the sand placement operation. Other studies support this finding that turbidity plumes and elevated TSS levels are typically limited to a narrow area of the swash zone down-current of the discharge pipe (USACE, 2001). Fish eggs and larvae are the most vulnerable to increased sediment in the water column and are subject to burial and suffocation. Given the location of the placement site (ocean coast as opposed to inlets) impacts to eggs and/or larvae is considered minimal. Juvenile fish and adults are capable of avoiding sediment plumes. Increased turbidity due to placement operations will temporarily affect fish foraging behavior and concentrations of food sources are expected to return to the nearshore zone once placement operations cease due to the dynamic nature of nearshore benthic communities (Burlas *et al*., 2001). Turbidity impacts are anticipated to be minimized by the placement of the dredge pipe above the mean high water line during pump-out and development of the raised beach berm moving along the shoreline. Most shallow water coastal species will leave the area of disturbance at the immediate placement site.

5.2.3 Threatened and Endangered Species

5.2.3.1 Terrestrial (Beach) Species

USACE (1996) (1998)(2000)(2002)(2005) and (20013) identified potential project impacts on beach nesting birds such as the piping plover, which is Federally listed as threatened and State listed as endangered, and the least tern and black skimmer (both State endangered species).

Beach replenishment can potentially have significant direct and indirect adverse impacts on these species. Sand placement can bury nests, and machinery on the beach can crush eggs, nestlings, and adults. Human disturbance related to noise and lights can disrupt successful nesting of these birds (Louis Berger Group, 1999). Also, pipelines used during construction may become barriers to young chicks trying to reach intertidal areas to feed. The presence of these species will require the implementation of protection measures, which may include the establishment of a buffer zone around the nest, and limiting construction to be conducted outside of the nesting period (15 March – 15 August).

Other indirect impacts associated with the proposed plan include the temporary reduction in the quality of forage habitat for piping plover and other shorebirds within the intertidal zone until the area becomes recolonized by benthic fauna such as polychaete worms, mollusks, and crustaceans. This impact may be short-lived as the area could become recolonized as early as a few weeks after filling is completed. The construction of a wider beach may result in the beach becoming more attractive to nesting birds such as piping plover, least tern, and black skimmers. Although this may appear beneficial, it is believed that this could have adverse impacts on these species. This is based on the fact that a replenished wider beach may attract these birds away from natural areas where human disturbance effects are less.

Based on previous coordination with the U.S. Fish and Wildlife Service (USFWS) and the Delaware Division of Fish and Wildlife (DFW), the affected beach areas of Rehoboth Beach/Dewey Beach, Bethany Beach/South Bethany and Town of Fenwick Island are not historically used by nesting piping plovers, which are Federally listed as threatened. The beach along the north side of Indian River Inlet has a greater potential for nesting, but has not had any nesting within the last 10 years. However, since this action involves a 50-year project consisting of periodic renourishment activities, there is a potential to impact future nesting plovers. Therefore, prior to renourishment activities, the District will consult with USFWS and DFW to identify any nesting piping plovers and to establish appropriate buffer zones around any nests, if present. Also, periodic nourishment construction specifications currently have protocols developed in case beach nesting birds are present in an active construction area that provide for monitoring and establishment of buffer zones.

The Federally threatened, red knot, is a migratory shorebird that can be found on Atlantic Coast beaches during spring and fall migrations. Construction during this period (especially the fall migration) could affect foraging patterns by disturbing habitat and temporarily displacing a food source by burying intertidal benthic organisms. Since the affected area is a highly dynamic beach area, this would be a temporary effect.

Another species which may be found within the project area is the Federally-listed threatened plant, seabeach amaranth, which inhabits overwash flats, accreting ends of coastal barrier beaches and lower foredunes of non-eroding beaches. Seabeach amaranth has sporadically appeared along the Delaware Atlantic Coast (within Cape Henlopen State Park, Delaware Seashore State Park and Fenwick Island State Park) and most recently 1.4 miles north of the Indian River Inlet. Therefore, it is possible that seabeach amaranth may become naturally established within the affected project areas within the life of the project. As such, the dunes and upper beach areas that would be affected by periodic nourishment should be inspected prior to renourishment activities. If a plant or groups of plants are located within the affected areas, the District would consult with the USFWS and the Delaware Natural Heritage Program to determine an appropriate course of action to avoid impacting this species. This may involve relocation of the plant(s) to a safer location.

State of Delaware protected species identified in Table 4-12 include the Bethany Beach firefly, and the rare plants: witch grass, Carolina fimbry, slender marsh pink, and twisted ladies' tresses. These species occur within interdunal swales and depressions, which could be in close proximity to project activities. However, they are not likely to be impacted since beach nourishment project activities are mostly limited to the seaward side of the dunes. Any future activities that could occur in these areas (such as access and staging) will be coordinated with the Delaware Division of Fish and Wildlife and Division of Parks and Recreation prior to the action to insure that appropriate measures can be implemented.

5.2.3.2 Marine Species

As discussed in USACE (1996) (1998)(2000)(2002)(2005) and (2013), from June through November Delaware's coastal waters may be inhabited by transient sea turtles, especially the loggerhead (Federally listed threatened) or the Kemp's ridley (Federally listed endangered). Sea turtles have been known to be adversely impacted during dredging operations that have utilized a hopper dredge. Dredging encounters with sea turtles have been more prevalent within waters of the southern Atlantic and Gulf coasts; however, incidences of "taking" sea turtles have been increasing in waters of the Middle Atlantic Coast in hopper dredges, which utilize high-suction heads. Endangered whales such as the endangered Right whale may also transit the project area. As with all large vessels, there is a potential for a collision of the dredge with a whale that could injure or kill a whale.

Formal consultation with the National Marine Fisheries Service (NMFS) in accordance with Section 7 of the Endangered Species Act was undertaken on all Philadelphia District Corps of Engineers dredging projects utilizing a hopper dredge that could have impacts to Federally threatened or endangered species (including shortnose sturgeon, sea turtles, and marine mammals). A Biological Assessment (USACE, 1995b) that discusses Philadelphia District hopper dredging activities and potential effects on Federally threatened or endangered species of sea turtles, marine mammals and shortnose sturgeon was prepared, and formally submitted to NMFS in accordance with Section 7 of the Endangered Species Act. A subsequent Programmatic Biological Opinion (BO) (NMFS, 1996) from NMFS was completed and submitted to the Corps in 1996. As a term and condition of the incidental take statement included in this opinion, NMFS required monitoring of all hopper dredge operations in areas where sea turtles are present between June and November by trained endangered species observers.

Since 1996, projects that have utilized a hopper dredge between June and November have included NMFS approved sea turtle observers on the dredge to monitor for sea turtles during dredging. Observers inspected the hopper, skimmer, and draghead after each load looking for signs of interaction with endangered or threatened species. Recent changes to dredging protocols in the State of Delaware now require all dredges being used for beach nourishment to be outfitted with munitions screening of 1 ¼ inches. This size screening makes it highly unlikely that turtle monitors would be able to observe any impacts to turtles during the dredging activities. For this reason, NMFS has not required the presence of monitors for recent hopper dredging activities where munitions screens are required.

As discussed previously, the New York Bight Distinct Population Segment (DPS) of the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) was recently listed as endangered by NMFS, and although transient in the marine environment, this species could be present within the project area. With regard to physical injuries to the Atlantic sturgeon, the potential exists for them to become entrained during dredging operations. It is expected, however, that most adult sturgeon would actively avoid a working dredge. As with other fish species, the temporary impacts to water quality due to increased turbidity can impact prey availability during construction activities. Noise generated from a working dredge at the dredge site and beachfill placement could potentially be a factor affecting sturgeon. However, it is expected that sturgeon will avoid the borrow areas and nearshore beachfill areas during construction. Due to the open water nature of the borrow sites, this temporary movement away from the borrow areas does not constitute a significant effect on this species.

Because of the listing of the Atlantic sturgeon and changes in dredging methods that use MEC screens, the Philadelphia District reinitiated consultation by letter of February 21, 2013, in accordance with 50 CFR 402.14(c) under Section 7 of the Endangered Species Act to address the District's beach nourishment projects' effects on protected marine species. A Programmatic Biological Assessment (BA) (USACE, 2014) that covered all beach nourishment projects along the Atlantic Coasts of Delaware and New Jersey was subsequently prepared by the Philadelphia District and submitted to NMFS on March 28, 2014. This BA evaluated each project (existing and proposed) within the geographical boundaries of the Philadelphia District Atlantic Coast projects that utilize beach nourishment. A subsequent Biological Opinion (BO) was issued by NMFS on June 26, 2014 (NMFS, 2014). The BO evaluated project activity impacts on protected marine species and concluded: "After reviewing the best available information on the status of endangered and threatened species under our jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects, it is NMFS' biological opinion that the proposed actions may adversely affect but are not likely to jeopardize the continued existence of the Gulf of Maine, New York Bight, Chesapeake Bay and South Atlantic DPS of Atlantic sturgeon, Kemp's ridley or green sea turtles or the Northwest Atlantic DPS of loggerhead sea turtles and is not likely to adversely affect leatherback sea turtles, the Carolina DPS of Atlantic sturgeon, right, fin or humpback whales. Because no critical habitat is designated in the action area, none will be affected by the proposed action."

Since NMFS determined that these actions "may adversely affect" sea turtles and Atlantic sturgeon, an Incidental Take Statement (ITS) was developed in the

BO. Due to the uncertainty of monitoring for these species with MEC screens in place, the ITS within the BO provides incidental takes “by proxy” as 1 take per every 3.8 million cubic yards dredged for sea turtles and 1 take per every 8.6 million cubic yards dredged for Atlantic sturgeon. The BO also issued reasonable and prudent measures (RPMs), which are necessary and appropriate to minimize and monitor impacts of incidental take resulting from these actions. Adherence to the RPMS insures project compliance with Section 7 ESA. The RPMs are as follows:

1. NMFS must be contacted prior to the commencement of dredging and again upon completion of the dredging activity.

2. All dredges must be operated in a manner that will reduce the risk of interactions with sea turtles.

3. All Atlantic sturgeon must have a fin clip taken for genetic analysis. This sample must be transferred to NMFS.

4. All dead loggerhead sea turtles must have a sample taken for genetic analysis. This sample must be transferred to NMFS.

5. Any dead sea turtles or sturgeon must be held in cold storage until proper disposal procedures can be discussed with NMFS.

6. All sturgeon and turtle captures, injuries or mortalities associated with any dredging activity and any sturgeon and sea turtle sightings in the action area must be reported to NMFS within 24 hours.

7. The USACE shall ensure that for all dredge operations where UXO screening is in place, a lookout/bridge watch, knowledgeable in listed species identification, will be present on board the hopper dredge at all times to serve as a lookout during transits and to inspect the draghead each time it is removed from the water.

8. The USACE shall continue to implement measures to ensure UXO screens are properly in place and in a manner that will reduce the risk of interactions with sea turtles or Atlantic sturgeon.

9. All material discharge cages must be inspected at least every 12 hours by someone knowledgeable in listed species identification. All biological material that may be a sea turtle or sturgeon must be reported to NMFS. Any sea turtle or sturgeon parts or potential parts must be placed into cold storage until further instructions can be provided by NMFS.

5.3 Cultural and Social Environment

5.3.1 Cultural Resources

In preparing the Environmental Assessment, the USACE has consulted with the Delaware State Historic Preservation Office (DE SHPO) and other interested parties to identify and evaluate historic properties in order to fulfill its responsibilities under the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800.

The USACE did not conduct cultural resources investigations in shoreline and submerged near-shore project areas. These locations are in an active surf zone which has been subjected to severe wave induced impacts and erosion. In a letter dated January 11, 1996, the DE SHPO concurred with this assessment.

A submerged remote sensing investigation was conducted in borrow areas “B”, “G”, and “Indian River Inlet” (later deleted as a borrow site). Researchers identified one remote sensing target that exhibited shipwreck characteristics in Borrow Area “G” which can be avoided by a 300-foot radius buffer. No potential cultural resources were found in Borrow Area “B”.

In a letter to the DE SHPO dated February 22, 2001, the USACE requested an expedited review of project modifications including the possible use of three new offshore sand borrow areas (“B”, “G” and “Indian River Inlet”) and outfall pipe rehabilitation and construction. The DE SHPO agreed to provide an expedited review in a letter dated March 5, 2001. In a letter to the DE SHPO dated April 5, 2001, the USACE found that these project modifications with the application of a buffer for the anomaly within area “G” would have *No Adverse Effect* on historic properties. The DE SHPO concurred in a letter dated April 30, 2001.

In 2011, at the request of the USACE, Dolan Research conducted a submerged cultural resource investigations on the areas within a newly expanded Borrow Area “B” for the Delaware Beach Nourishment project. A total of 16 magnetic and sonar targets were located; however, none of them generated remote sensing signatures suggestive of potentially significant submerged cultural resources.

5.3.2 Socioeconomics

The No Action alternative would allow the beach to continue to erode, and this would increase the risk of damage to private property from flooding or direct wave action as the protective beach decreases in size. Property values would also fall as this risk becomes more and more perceived by the market. Recreational opportunities would decrease with the size of the beach. This would be translated into lost tourism revenue, which would have a secondary effect on employment. DNREC (2006) reports that beach erosion can have significant impacts on tourism. It is estimated that in 2 years, 45,000 tourists each year would choose other destinations if careful management of the coastline is not implemented. This would translate to about 2 million potential visitors not coming to Delaware's beaches over a 10 year period, which could devastate local economies and damage the state's economy (DNREC, 2006).

Periodic nourishment used to maintain the beaches along the Delaware Atlantic Coast would permit the accommodation of both present and expected future demands for recreational beach areas along the Delaware Atlantic Coast. This influx of seasonal population is reflected by a greater demand for social services such as housing, transportation, health, safety, and sanitation facilities. The coastal communities are supported by a tourist economy, which they cannot afford to lose, and their expansion would provide fuller employment and greater revenues. As the demand for recreation gradually increases, it is expected that State and local efforts would be made to satisfy these needs. Because of this, noise and air quality levels would similarly degrade through personal activity and auto utilization. They will not however, become a significant problem. Various indicators of the presence and/or level of Corps activity in beachfront communities generally have no statistically significant relation to development in those areas. Thus, the statistical evidence indicates that the effect of the Corps on induced development is, at most, insignificant, compared to the general forces of economic growth which are stimulating development in these areas, many of which are induced through other municipal infrastructure developments such as roads, wastewater treatment facilities, etc. (USACE, 1995c).

The utilization of Borrow Area B would be beneficial in that it would significantly reduce project costs to transport sand to Rehoboth Beach and Dewey Beach. (Figures 5-1 and 5-2), which currently uses the Fenwick Island Borrow Area over 15 miles away. In contrast, Area B North transport distances are 3 to 5 miles away.

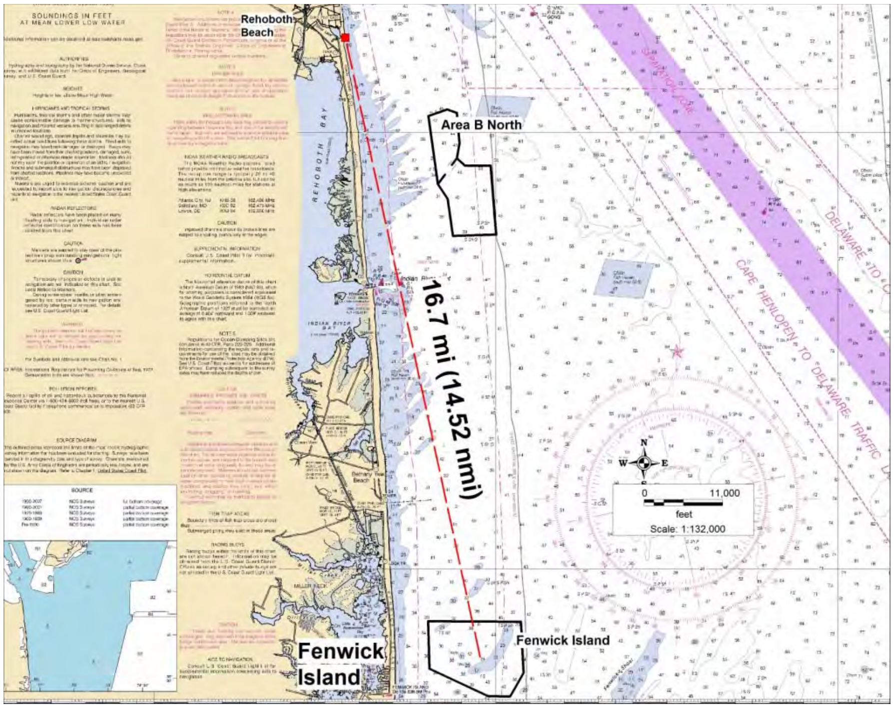

Figure 5-1. General Transport Distance to Rehoboth Beach and Dewey Beach Project Area from the Fenwick Island Borrow Area.

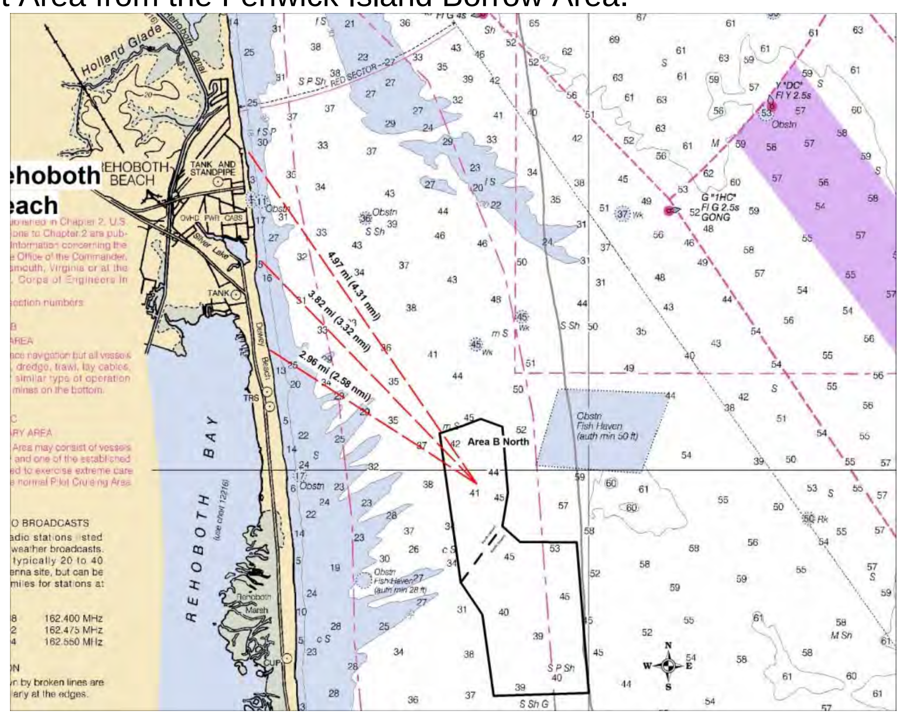

Figure 5-2. General Transport Distance to Rehoboth Beach and Dewey Beach Project Area from Borrow Area B North.

5.3.3 Environmental Justice

All of the alternatives identified in this document including the preferred use of Borrow Area B are expected to comply with Executive Order 12989- Environmental Justice in Minority Populations and Low-Income Populations, dated February 11, 1994. The affected areas are not located in close proximity to a minority or low-income community, and no adverse impacts are expected to occur to any minority or low-income communities in the area.

5.3.4 Recreation

Direct adverse impacts on recreation are temporary and localized in nature. Project construction during warm season months may temporarily displace beachgoers such as bathers and others enjoying the beach within the immediate impact area. Recreational beachgoers engaged in sunbathing, surf fishing, surfing, skim boarding, bathing, etc. will be temporarily affected by the project, since the public will not be permitted to enter the actual work segments. However, since the project will be constructed in segments (approximately 1,000 feet long at a time), only the segment actually under construction will be closed to the public, which would typically last a few days to a week. Therefore, impacts to beach and fishing access will be localized and relatively short-lived. This impact would be further minimized if beach nourishment activities were considered from late fall to early spring when beach recreation activities are minimal.

In the long-term, beach nourishment will not impede public access to the beach. Public access to the beaches in the affected areas will be maintained by the maintenance of existing dune walkovers and existing vehicle access ramps for authorized vehicles.

Boating and offshore fishing may be temporarily displaced in the vicinity of the dredging operations within the sand borrow areas for safety reasons. This impact is temporary and localized, and boaters will be allowed to return to the borrow area(s) after construction ceases. Recreational fishing may be temporarily reduced in portions of the borrow area after dredging due to the temporary loss of benthic prey organisms, which provide a food source for some target species such as summer flounder or as a food source for other prey species.

It is generally regarded that shoreline areas with structure produce the best fishing spots and are frequently targeted for surf fishing. Structured areas can be natural or man-made. Natural structure along the Delaware Atlantic shoreline is formed by waves and currents in the form of cuts and sloughs with nearshore sand bars that can attract and hold fish. These areas are most pronounced where rip currents are present. Man-made structures that attract fish are in the forms of groins and jetties. These structures (man-made or natural) initially become buried during beach nourishment activities. After initial profile adjustment, portions of the groins may become uncovered, but the degree of their exposure is variable. A complete exposure would return these structures (groins) to a pre-project state, but would likely signify that the beach is in need of periodic nourishment to perform its storm damage reduction purpose. Natural structure can also reform, but this would be dependent on post-fill profile adjustment and the formation of new cuts, sloughs and nearshore bars, particularly after storm events. Although fishing structure would initially be affected, targeted fish species may return to the filled areas within hours or days after a beachfill is completed (USACE, 2001). It should be noted that the most intensive surf fishing areas are in Cape Henlopen State Park, Delaware Seashore State Park, and Fenwick Island State Park, which generally allow for year-long drive-on access. With the exception of the beach immediately north of Indian River Inlet, these beaches are not directly affected by beach nourishment, and do not receive periodic nourishment to maintain a specified berm and dune.

Based on benthic investigations, Area B North does not contain any significant bottom structure in the form of reefs and shoals, and does not contain any unique bottom habitat that is more attractive to targeted fish species for recreational fishing. Area B South, however, does contain some pockets of hard bottom cobble and pebble deposits that may be more attractive to reef fish, but these areas would be avoided to the maximum extent practicable. Because dredging initially removes the benthic community in the affected portions of the borrow area, these areas would not provide a food source to fish until they recover within 1-2 years after dredging. Therefore, a temporary loss in fishing productivity could be expected at the locations affected by dredging.

5.4 Cumulative Impacts

Since 2004, approximately 10.83 million cubic yards of sand has been placed on the Federal project beaches at Rehoboth Beach/Dewey Beach, Indian River Inlet North, Bethany Beach/South Bethany, and Fenwick Island. Most of the sand for these projects was obtained from offshore sand sources. Table 5-5 provides the total estimated quantities and acreages from the Federal project offshore sand sources since 2005 and the proposed Area B quantities.

Table 5-5. Existing Sand Borrow Areas and Proposed Area B Sand Quantities and Area Affected by the Federal Beach Nourishment Projects along the Delaware Atlantic Coast.

Existing Borrow Areas	**Destination Beach**	**Quantity of Sand Used (cubic yards)**	**Estimated Area Affected within Borrow Area (acres)**
Area G (discontinued)	Rehoboth Beach and Dewey Beach	1,690,000	1,274
Area E	Bethany Beach and South Bethany	3,428,000	762
Fenwick Island	Fenwick Island	1,533,000	2,279
	Rehoboth Beach and Dewey Beach	1,781,000	
	Bethany Beach and South Bethany	1,877,000	
TOTAL		**10,309,000**	**4,315**
Proposed Borrow Area	**Destination Beach**	**Quantity of Available Sand Estimated (based on a 10-foot deepening)**	**Estimated Area to be Affected within Borrow Area (acres)**
Area B North	Rehoboth Beach and Dewey Beach	11,000,000	684
	Alternate for other projects		
Area B South	Rehoboth Beach and Dewey Beach	9,260,000	574*
	Alternate for other projects		

*Acreage assumes ½ of the total acreage is suitable for use as a sand source

The existing sand borrow areas occupy approximately 4,315 acres of marine bottom along the Delaware Atlantic Coast. These areas are generally 30 to 60 feet in depth and are all within State waters (within 3 nautical miles of the coast). Within this depth range (30 ft. to 60 ft.), these areas occupy approximately 10.5% of the marine bottom along the Delaware Atlantic Coast. The addition of Area B (north and south) would increase this acreage to approximately 5,573 acres, which would also increase the use of marine habitat in the 30 to 60 foot depth range to 12.3% of Delaware's Atlantic Coastal waters. These sites have little bathymetric features and prominent shoal features are avoided. Also, unique bottom habitats such as pebble/cobble bottoms are being avoided to the maximum extent practicable. Therefore, it is concluded that cumulative impacts within the sand sources are minor regarding benthic and fisheries resources (including EFH).

Cumulative impacts involving marine intertidal and nearshore benthic organisms were assessed in USACE (2000) for the proposed Federal actions along Delaware’s Atlantic coast. Beachfill is placed for a 13,500 linear foot segment of beach for the Rehoboth Beach/Dewey Beach project, 14,950 linear feet for Bethany Beach/South Bethany and approximately 6,500 linear feet of shoreline for Fenwick Island. Combining these projects, approximately 35,050 linear feet (6.6 miles) of shoreline is directly affected by beach nourishment projects. This represents approximately 27.5% of Delaware’s Atlantic coastline. Although the sand bypass plant at Indian River Inlet affects a small portion of shoreline on the north side, a 5,200 foot long beachfill was placed there in 2013 to restore the beaches following Hurricane Sandy. With this segment added in, approximately 7.6 miles of Delaware’s coast has recently received beach nourishment, which represents approximately 31.7% of Delaware’s Atlantic Coastal beaches. From a regional perspective, a significant amount of intertidal and subtidal nearshore benthic habitat would be impacted by beach replenishment. The existing Federal project for Ocean City, MD extends from Fenwick Island (MD – DE border) to Fourth Street in Ocean City, MD, which is approximately 7.5 miles long. This project combined with the other proposed Federal projects in Delaware (including Fenwick Island) represents nearly 45% of the total Atlantic coastline from Cape Henlopen to Ocean City Inlet. These areas or smaller segments would undergo periodic disturbances from beach replenishment activities, as needed. However, as discussed previously, the intertidal and nearshore zones are characteristic of naturally high disturbance from pounding waves and shifting sands encountered along the beaches. The adaptive measures utilized by the organisms that inhabit these areas involve high mobility and rapid reproduction, which makes them more resilient to environmental changes such as beachfill placement. Therefore, any impact involving beachfill is expected to be temporary and minor on the benthic community within these zones. Because of these reasons, the cumulative impacts resulting from periodic disturbances utilizing beachfill on intertidal and nearshore organisms is not expected to be significant.

Communities along the Delaware Atlantic Coast that are not part of the aforementioned Federal projects may undertake their own beach replenishment projects. If these communities pursue beach replenishment they would be required to seek Federal and State permits outside of the existing Federal projects. These actions, if implemented, could affect the existing borrow areas and coastline incrementally more than the known proposed Federal projects. However, the demand for these projects may be less due to the introduction of sand into the entire littoral system from the existing Federal projects.

5.5 Mitigation Measures

Mitigation measures are discussed in USACE (1996)(1998)(2000)(2002)(2005) and (2013), and are incorporated by reference. Several generalized measures have already been adopted in plan formulation to minimize the impacts on aquatic resources. These measures include the selection of the beach nourishment alternative (berm and dune restoration). This alternative offers a more naturalistic and softer approach for storm damage reduction. Selection of this alternative is based on its relatively low ecological impacts and its cost effectiveness. Another measure is the utilization of an offshore sand borrow area. Offshore areas are characterized by high energy and would not produce adverse effects as associated with borrow sites from the inland bay areas. Therefore, ecological impacts are expected to be lower. Another measure is the selected use of suitable sand grain sizes for beach nourishment. The selection of the borrow area is based on compatibility studies for sand grain sizes. The utilization of beach nourishment quality sands will minimize impacts on water quality at the dredging site and discharge (placement) site. General measures considered to minimize adverse effects on benthic communities include dredging shallow pits (less than ten feet), avoiding previously impacted areas to allow for recruitment and recovery, and utilizing a pipeline delivery system to the discharge location. Dredging at times of lowest biological activity (winter months) would minimize impacts on biological reproduction. However, this measure may not be practicable considering dangers associated with offshore dredging and winter storms.

Mitigation measures were adopted for alternative borrow site selection. To minimize impacts to benthic resources and fisheries, hard bottom areas consisting of gravels, cobbles, blue mussel beds and hard bottoms associated with encrusting bryozoans or relic corals within Areas B would be avoided to the maximum extent practicable. Only areas composed of sands with lesser amounts of gravels and shell material would be targeted based on habitat characterization maps. Also, the use of Area B represents bottom habitats with little vertical bathymetric relief, therefore, dredging would not degrade areas of high bathymetric relief such as shoals/lumps that are generally regarded by fisheries agencies and recreational and commercial fishermen as attractive to fish.

6.0 COORDINATION

The draft EA was circulated to Federal, State, and local resource agencies with particular jurisdiction and interest over the affected resources and applicable statutes. This includes the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Environmental Protection Agency, the Delaware Department of Natural Resources and Environmental Control and the Delaware State Historic Preservation Office. In addition, the public was notified of the availability of this document for public review on the Philadelphia District's website (http://www.nap.usace.army.mil/) via an e-mailed public notice, which was sent to interested individuals, organizations, stakeholders and media outlets listed on the Philadelphia District's Regulatory mailing list.

7.0 COMPLIANCE WITH ENVIRONMENTAL STATUTES

Compliance with applicable Federal Statutes, Executive Orders, and Executive Memoranda, was originally discussed in USACE (1996) (1998) (2000) (2002) (2005) and (2013). Table 7-1 is a complete listing of compliance status relative to environmental quality protection statutes and other environmental review requirements for the proposed action.

Table 7-1. Compliance with Environmental Quality Protection Statutes and Other Environmental Review Requirements.

FEDERAL STATUTES	**COMPLIANCE W/PROPOSED PLAN**
Archeological - Resources Protection Act of 1979, as amended	Full
Clean Air Act, as amended	Full
Clean Water Act of 1977	Partial
Coastal Barrier Resources Act	Full
Coastal Zone Management Act of 1972, as amended	Partial
Endangered Species Act of 1973, as amended	Full
Estuary Protection Act	Full
Federal Water Project Recreation Act, as amended	N/A
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act, as amended	N/A
Marine Protection, Research and Sanctuaries Act	Full
Magnuson-Stevens Fishery Conservation and Management Act	Full
National Historic Preservation Act of 1966, as amended	Partial
National Environmental Policy Act, as amended	Partial
Rivers and Harbors Act	Full
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic River Act	N/A
Executive Orders, Memorandums, etc.	
EO 11988, Floodplain Management	Full
EO 11990, Protection of Wetlands	Full
EO12114, Environmental Effects of Major Federal Actions	Full
EO 12989, Environmental Justice in Minority Populations and Low-Income Populations	Full

Table 7-1. Compliance with Environmental Quality Protection Statutes and Other Environmental Review Requirements.	
FEDERAL STATUTES	**COMPLIANCE W/PROPOSED PLAN**
County Land Use Plan	Full
Full Compliance - Requirements of the statute, EO, or other environmental requirements are met for the current stage of review. **Partial Compliance** - Some requirements and permits of the statute, E.O., or other policy and related regulations remain to be met. **Noncompliance** - None of the requirements of the statute, E.O., or other policy and related regulations have been met. **N/A** - Statute, E.O. or other policy and related regulations are not applicable.	

- **National Environmental Policy Act (NEPA)**: Table 1-1 provides a list of previous NEPA documents incorporated by reference. This EA evaluates a proposed new sand borrow area (Area B), which would be used primarily for the Rehoboth Beach and Dewey Beach project, but could be used interchangeably with the other Federal storm damage reduction project borrow areas and beaches. Full compliance with NEPA for these changes will be achieved following the full consideration of public and agency comments and a determination that a Finding of No Significant Impact (FONSI) is appropriate. A Draft FONSI is presented in the front of this document.
- **Endangered Species Act (ESA):** A programmatic BO was completed by the National Marine Fisheries Service in 1996 to address hopper dredging activities and their effects on threatened and endangered sea turtles and marine mammals. In 2012, the New York Bight Distinct Population Segment of the Atlantic sturgeon was listed as endangered by the NMFS. The Philadelphia District reinitiated formal consultation in accordance with Section 7 of the Endangered Species Act with NMFS, which resulted in the issuance of a Biological Opinion from NMFS in 2014. The existing Federal beach projects and their sand borrow areas (including the proposed Area B) were evaluated in this document. NMFS concluded "that the proposed actions may adversely affect but are not likely to jeopardize the continued existence of the Gulf of Maine, New York Bight, Chesapeake Bay and South Atlantic DPS of Atlantic sturgeon, Kemp's ridley or green sea turtles or the Northwest Atlantic DPS of loggerhead sea turtles and is not likely to adversely affect leatherback sea turtles, the Carolina DPS of Atlantic sturgeon, right, fin or humpback whales. Because no critical habitat is designated in the action area, none will be affected by the proposed action."
- **Fish and Wildlife Coordination Act (FWCA):** Coordination was previously undertaken on all of the Delaware Atlantic Coast Federal storm damage reduction projects in accordance with the FWCA. This document is being provided to USFWS and NMFS to address the project changes in accordance with the FWCA.
- **Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (Essential Fish Habitat)**. Evaluations of Essential Fish

Habitat (EFH) pursuant to the MFSCMA were previously performed on all of the Federal storm damage reduction projects along the Delaware Atlantic Coast. An updated evaluation to address the Borrow Area B is provided in Sections 4.0 and 5.0 of this document. A copy of the draft EA was provided to NMFS for review in accordance with the MSFCMA

- **Clean Water Act Section 404(b)(1) Evaluation**. Evaluations were previously performed on all of the Federal storm damage reduction projects along the Delaware Atlantic Coast in accordance with the Section 404(b)(1) guidelines. A new Section 404(b)(1) evaluation to address the discharges associated with Area B is provided in Appendix A.
- **Clean Water Act Section 401 Water Quality Certification (WQC).** The initial construction and periodic nourishment for the Federal projects were previously provided Section 401 WQC's for each individual project by the Delaware DNREC. These WQCs included periodic nourishment for a period of 10 years following issuance. All, but Bethany Beach/South Bethany, have expired WQCs and will require new WQCs. Bethany Beach/South Bethany will expire 4/24/2016, and will require a new WQC prior to any beachfill placement. A Section 401 WQC is being requested from DNREC for the use of Area B as a primary sand borrow area for Rehoboth Beach and Dewey Beach and as an alternate borrow area for the other Federal coastal storm damage reduction projects along the Delaware Atlantic Coast. Since WQC has or will expire for the existing sand sources and their projects, new WQCs will be requested from DNREC, as needed.
- **Coastal Zone Management Act - Federal Consistency Determination.** The use of Area B as a primary sand source for the Rehoboth Beach and Dewey Beach project and as an alternate for the other Delaware Atlantic Coast Federal storm damage reduction projects requires a new Federal consistency review. A Federal Consistency Certification request will be submitted to the Delaware Coastal Management Program upon submittal of the Draft EA for public review. Compliance will be achieved after the DECMP concurs with the Corps' Federal Consistency determination.
- **Coastal Barrier Resources Act (CBRA).** One unit, DE-06, is designated within the Coastal Barrier Resources System, and occurs along the Silver Lake area between Rehoboth Beach and Dewey Beach. Although DE-06 is within the project template, no fill placement or any other project activities would occur within the unit. The North Shore Indian River Inlet is within an "Otherwise Protected Area" (OPA), which is part of DE-07P in Delaware Seashore State Park. Another OPA exists in Fenwick Island State Park (DE-08P). Both, South Bethany and Fenwick Island projects have tapers into DE-08P. OPAs only prohibit Federal funding for flood insurance. Project activities are not restricted in OPAs.
- **Section 106 National Historic Preservation Act**. By letter dated October 23, 2015, the Delaware Division of Cultural affairs determined

that the proposed undertaking (use of Area B) cannot have an effect on properties eligible for, or listed in, the National Register of Historic Places…

- **Clean Air Act (CAA)**. The proposed use of Area B and Fenwick Island Sand Borrow Areas are not expected to exceed thresholds for NOx and VOCs based on analyses that assumed a fixed quantity of sand (400,000 cubic yards). A draft CAA statement of conformity is provided in Appendix D with supporting analysis.

8.0 CONCLUSIONS

This EA evaluated the environmental impacts of the utilization of a proposed sand borrow area (Area B) to support the berm and dune restoration plan as presented in the 1996 Environmental Impact Statement (USACE, 1996) for storm damage reduction in Rehoboth Beach and Dewey Beach and as an alternate sand source for Indian River Inlet North Shore, Bethany Beach/South Bethany, and Fenwick Island Federal Storm Damage Reduction Projects. Based on the information available to date, Area B North has been identified as the preferred sand source based on its closer transport distance to Rehoboth Beach/Dewey Beach, sand quality, quantity, and its fewer impacts on marine biota. Impacts associated with dredging in Area B North are considered to be temporary and minor on marine biota. Supplemental investigations would be undertaken to identify suitable portions of Area B South, if necessary. The evaluation for the potential use of Area B North establishes the fact that environmental impacts associated with the proposed action are similar in nature to those previously investigated. The use of Area B North is consistent with the project actions previously detailed and documented, and does not result in any new or significant impacts to the project area.

Based on the data presented and continuing coordination with State and Federal resource agencies, no significant adverse environmental impacts are expected to occur as a result of the proposed action. Since the potential impacts identified have been determined to be minor, localized and temporary, the preparation of a new or Supplemental Environmental Impact Statement is not warranted and a Finding of No Significant Impact (FONSI) for the proposed action is appropriate.

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APPENDIX-A

CLEAN WATER ACT SECTION 404(B)(1) EVALUATION

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EVALUATION OF 404 (b)(1) GUIDELINES

* This evaluation involves the aquatic placement of sandy material dredged from the proposed offshore borrow Area B on Rehoboth Beach and Dewey Beach and as an alternate sand source for the Federal storm damage reduction project areas at Indian River Inlet North, Bethany Beach/South Bethany and Fenwick Island for the purpose of beach replenishment. A previous 404(b)(1) evaluation for the placement of sand at these areas are presented in USACE (1996) (1998) (2000) (2002) (2005) and (2013).

I. PROJECT DESCRIPTION

A. Location

The proposed project discharge site is in the vicinity of Rehoboth Beach and Dewey Beach and other Federal storm damage reduction project areas at Indian River Inlet North, Bethany Beach/South Bethany and Fenwick Island, Sussex County, Delaware. The specific areas involved are Area B (proposed dredge site), and the upper beach, intertidal zones and nearshore areas of Rehoboth Beach and Dewey Beach.

B. General Description

The proposed project involves the use of sand from Borrow Area B to provide periodic nourishment sand and emergency sand as beachfill to maintain and restore the previously authorized project templates for the existing Federal storm damage reduction projects at Rehoboth Beach/Dewey Beach (primary), North Shore of Indian River Inlet (alternate to sand bypass southern fillet), Bethany Beach/South Bethany (alternate) and Fenwick Island (alternate). This is accomplished through dredging within Borrow Area B and the subsequent discharge/placement of dredged material (sand) into waters of the United States on the beachfront areas of these communities. The authorized templates are provided in Section 1.0 of the Environmental Assessment. Beachfill and extents will vary depending on conditions and needs at the time of each nourishment cycle and emergency storm repairs. Table A-1 summarizes the projected average periodic nourishment quantities, lengths of affected beaches, and maximum aquatic intertidal and nearshore habitat impacts.

Table A-1. Project Sand Needs and Affected Areas					
Federal Project	Area B Use	Total Project Length (linear ft.)	Max. Area Affected (below MHW)	Estimated Avg. Periodic Nourishment Quantity	Periodic Nourishment Interval
Rehoboth Beach/ Dewey Beach	Primary source	13,500	111 acres	360,000 CY	3 years
North Shore Indian River Inlet	Alternate to IRI South Fillet	5,200	30 acres	520,000 CY	As needed for emergency repairs
Bethany Beach/South Bethany	Alternate to Area E or Fenwick BA	14,950	146 acres	480,000 CY	3
Fenwick Island	Alternate to Fenwick BA	8,000	60 acres	320,000 CY	4

Sand Borrow Area B is divided into two subareas: Area B North (684 acres) and Area B South (1,148 acres) in depths ranging from 34 feet to 53 feet.

C. <u>Authority and Purpose</u>

The authority for the proposed project is the resolution of the Committee on Environment and Public Works of the United States Senate dated 23 June 1988. This resolution reads as follows:

> "RESOLVED BY THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS OF THE UNITED STATES SENATE, 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 the report on the Delaware Coast from Kitts Hummock to Fenwick Island, Delaware, published as House Document Number 85-216, and other reports, with a view to determining the advisability of providing improvements in the interest of beach erosion control, hurricane protection, and related purposes, along the Delaware Coast from Cape Henlopen to Fenwick Island. Included in this study will be the

development of a physical and engineering data base on coastal area changes and processes, including appropriate monitoring during development of the data base, as the basis for actions to prevent the harmful effects of shoreline erosion and storm damage."

The purpose of these projects is to reduce hurricane and storm damages for the communities of Rehoboth Beach/Dewey Beach, Bethany Beach/South Bethany, Town of Fenwick Island and to protect the important infrastructure State Route 1 and approach to the Charles Cullen Bridge along the North Shore of Indian River Inlet, Sussex County, Delaware.

D. General Description of Dredged or Fill Material

1. General Characteristics of Material.
The material present in Northern Borrow Area B consists predominately of a gray to tan, fine to medium, poorly graded sand, from a depth of approximately 0 to 10 feet below ground surface. The Mean Grain Size, for the upper interval (0-10') was calculated to be 1.694 phi (0.309 mm) with a standard deviation of 0.926 phi (0.526 mm).

The material present in Southern Borrow Area B consisted predominately of a gray to tan, medium, poorly graded sand, from a depth of approximately 0 to 10 feet below ground surface. The Mean Grain Size, for the upper interval (0-10') was calculated to be 0.589 phi (0.665 mm) with a standard deviation of 1.866 phi (0.274 mm).

2. Quantity of Material. The quantity of material required to be dredged and discharged is variable because fill needs will be determined based on pre-nourishment surveys. Table A-1 provides an estimated quantity averaged for each nourishment cycle interval. However, emergency storm repairs will also be highly variable.

3. Source of Material.

Area B: Area B lies approximately 2 –3 nautical miles offshore of Delaware Seashore State Park between Dewey Beach and Indian River Inlet.

E. Description of the Proposed Discharge Site

1. Location. The proposed discharge locations include the upper beach and dunes, lower beach intertidal areas and nearshore areas of Rehoboth Beach/Dewey Beach, North Shore Indian River Inlet, Bethany Beach/South Bethany, and Fenwick Island. Additionally, discharges would occur within the sand borrow area if a hopper dredge is used and pumped to overflow for economic loading.

2. Size. The proposed beachfill discharge areas are composed of eroding beach berm and dunes. Areas affected by discharges below MHW will vary depending on needs, but the maximum estimated affected areas are presented in Table A-1.

3. Type of Site. The proposed beachfill discharge area is composed of a high energy Atlantic Coast sandy beach. The proposed discharge sites are unconfined with placement to occur on beach areas including intertidal sandy marine habitat, nearshore surf zone and open water (dredge site).

4. Type(s) of Habitat. The type of habitat present at the proposed discharge locations are marine sandy beach (upper beach and dune), marine intertidal and subtidal nearshore habitats and marine open water.

5. Timing and Duration of Discharge. There are no seasonal restrictions for beachfill placement and associated discharges. It is anticipated that winter months would be avoided due to potential hazardous working conditions caused by winter storms. However, this does not rule out the possibility of winter construction. Discharges associated with periodic nourishment would occur over a duration of approximately 2 to 3 months every 3 to 4 years during the 50-year project life, but this could vary depending on size and scope of beachfill based on current conditions.

F. <u>Description of Discharge Method</u>

A hydraulic dredge (cutter-suction or trailing suction hopper dredge) would be used to excavate the sandy material from the borrow area. The material would be transported using a hopper/barge with a pump-out and/or pipeline delivery system to the beachfill placement site. Sandy material would be pumped through a 1 ¼ inch munitions and explosives of concern (MEC) screen on the dredge, and discharged through a basket screen on the beach, which would retain objects larger than ¾ inches in diameter. The sand will flow through the screens, and will be retained by temporary training berms that will maximize sand retention, but will drain freely back into the nearshore ocean to dewater the sand. Subsequently, final grading would be accomplished using standard construction equipment such as bulldozers and graders.

A trailing suction hopper dredge may pump to overflow conditions to maximize quantity of sand in the hopper to employ a technique called “economic loading". This overflow will discharge suspended materials into the surface waters within the borrow area.

II. FACTUAL DETERMINATION

A. Physical Substrate Determinations

1. **Substrate Elevation and Slope.** For Rehoboth Beach and Dewey Beach, the design elevation of the beach substrate after fill placement is +7.2 feet NAVD at the top of the berm, and the top of dune elevation is +13.2 ft. The proposed profile would have a foreshore slope of 10H:1V initially to 15H:1V, after fill adjustment occurs. The underwater slope parallels the existing bottom to the depth of closure. Other project dimensions are provided in Table A-2.

Table A-2. Delaware Atlantic Coast Federal Project Berm and Dune Dimensions

Federal Project	Berm Elevation (NAVD)	Dune Crest Elevation (NAVD)	Design Berm Width (minimum)	Construction Berm Width (maximum)	Foreshore Slope(s)
Rehoboth Beach/ Dewey Beach	+7.2 ft.	+13.2 ft.	125 ft. (Rehoboth) 150 ft. (Dewey)	210 ft.	10H:1V to 15H:1V
North Shore Indian River Inlet	+9.2 ft.	+16.0 ft.	Varies	Varies	10H:1V to 15H:1V
Bethany Beach/South Bethany	+7.0 ft.	+16.0 ft.	150 ft.	220 ft.	10H:1V to 15H:1V
Fenwick Island	+7.7 ft.	+17.7	75 ft.	285 ft.	10H:1V to 15H:1V

Mean High Water Elevation: +1.6 ft. NAVD
Mean Low Water Elevation: +2.4 ft. NAVD

2. **Sediment Type.** The sediment type involved would be sandy beachfill material (generally consists of 90% or greater of fine, medium and coarse sands and gravels) obtained from Area B.

3. **Dredged/Fill Material Movement.** The planned construction would establish an initial construction template, which is wider than the final intended design template or profile. It is expected that

compaction and erosion and sorting would be the primary processes resulting in the change to the design template. The loss or winnowing of fine grain materials into the water column would occur during the initial settlement. These materials may become re-deposited within subtidal nearshore waters.

4. **Physical Effects on Benthos.** The proposed construction and discharges would result in initial burial of the existing beach and nearshore benthic communities when this material is discharged during berm construction. Substrate is expected to be composed of material that is similar to existing substrate, which is expected to become recolonized by the same type of benthos that previously existed at the location.

5. **Other Effects.** Other effects would include a temporary increase in suspended sediment load and a change in the beach profile, particularly in reference to elevation. Bathymetric changes in the placement sites would raise the bottom several feet, which would be offset seaward.

6. **Actions Taken to Minimize Impacts.** Actions taken to minimize impacts include selection of fill material that is similar in nature to the pre-existing substrate.

B. **<u>Water Circulation, Fluctuation, and Salinity Determinations</u>**

1. **Water. Consider effects on:**

- **a.** **Salinity** - No effect. Area B sand is from a polyhaline salinity regime, which is similar to beach area and nearshore.
- **b.** **Water chemistry** - No significant effect.
- **c.** **Clarity** - Minor short-term increase in turbidity during construction.
- **d.** **Color** - No effect.
- **e.** **Odor** - No significant effect.
- **f.** **Taste** - No effect.
- **g.** **Dissolved gas levels** - No significant effect.
- **h.** **Nutrients** - Minor effect.
- **i.** **Eutrophication** - No effect.
- **j.** **Others as appropriate** - None.

2. **Current patterns and circulation**

   a. **Current patterns and flow** – Minor impacts to circulation patterns and flow in the beach zone and nearshore where the existing circulation pattern and flow would be offset seaward the width of the beachfill placement. Minor circulation differences are expected within the immediate vicinity of the borrow area.

   b. **Velocity** - No effects on tidal velocity and longshore current velocity regimes.

   c. **Stratification** - Thermal stratification normally occurs beyond the mixing region created by the surf zone. The normal pattern should continue after construction of the proposed project.

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

3. **Normal water level fluctuations** - The tides are semidiurnal. The mean tide range for the Delaware Coast Area is 3.9 feet (1.2 m). The spring tide range is reported as 4.7 feet (1.4 m). Construction of the proposed plan would not affect the tidal regime. Mean High Water occurs at +1.6 ft. NAVD and Mean Low Water occurs at -2.4 ft. NAVD.

4. **Salinity gradients** - There should be no significant effect on the existing salinity gradients.

5. **Actions that will be taken to minimize impacts**- None are required; however, utilization of sand from clean high energy, marine (Area B) environment and its excavation with either a hopper dredge or cutter-suction dredge and discharges with a pipeline delivery system would minimize water chemistry impacts.

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

1. **Expected Changes in Suspended Particulates and Turbidity Levels in the Vicinity of the Disposal (Beachfill Placement) Site** - There would be a short-term elevation of suspended particulate concentrations during construction phases in the immediate vicinity of the dredging and the discharge locations. Elevated levels of particulate concentrations at the discharge locations may also result from "washout" after beachfill is placed.

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

a. **Light penetration** - Short-term, limited reductions would be expected at the discharge sites from dredge activity and berm washout, respectively.

b. **Dissolved oxygen** - There is a potential for a decrease in dissolved oxygen levels but the anticipated low levels of organics in the borrow material should not generate a high, if any, oxygen demand.

c. **Toxic metals and organics** - Because sand sources (Area B) are generally 90% or more sand, are located in a well-mixed marine environment. Several vibracore composites obtained from within Area B did not reveal any significant contamination of the sediments; although several metals and organic compounds were detected at lower levels (see Appendix B).

d. **Pathogens** - Pathogenic organisms are not known or expected to be a problem in the sand borrow area. However, temporary increases in indicator bacteria levels may occur during beachfill discharges as bottom sediments become stirred-up during the discharge.

e. **Aesthetics** - Construction activities and the initial construction template associated with the fill placement site would result in a minor, short-term degradation of aesthetics. This is due to the temporary impacts to noise, sight, and smell associated with the discharges and beach de-watering during construction and periodic nourishment. Newly deposited sand may initially appear dark and produce a sulfurous odor; however, this is expected to be short-term as the new sands undergo “bleaching” by becoming oxidized to air and sunlight.

3. **Effects on Biota**

   a. **Primary production, photosynthesis** - Minor, short-term effects related to turbidity.

   b. **Suspension/filter feeders** - Minor, short-term effects related to suspended particulates outside the immediate deposition zone. Sessile organisms would be subject to burial if within the deposition area.

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

4. **Actions taken to minimize impacts** include the selection of clean sand with a small fine grain component and a low organic content. Standard construction practices would also be employed to minimize turbidity and erosion.

D. Contaminant Determinations

The discharge material is not expected to significantly introduce, relocate, or increase contaminant levels at the placement sites. Area B is within a historic artillery firing range fan, and may contain Munitions and Explosives of Concern (MEC's), therefore, MEC screens are required on the intake and discharge points of the dredge equipment that would screen out any potential MEC objects. Although a number of organic and inorganic constituents were detected, contaminant sampling did not identify any high levels of metal or organic constituents (see Appendix B). Nickel slightly exceeded the DNREC – SIRS screening level for sediments at one sample, and thallium exceeded the DNREC-SIRS screening level for soils in three samples. Additionally, the pesticides: dieldrin and gamma chlordane exceeded their Effects Range-Low values established by Long et. al (1995) in three samples, but did not exceed Effects Range-Median values.

E. Aquatic Ecosystem and Organism Determinations

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

2. **Effects on Benthos** – Initially, sand placement would result in the burial of benthos within the discharge (beachfill) location. The losses of benthic organisms are somewhat offset by the expected rapid opportunistic recolonization from adjacent areas that would

occur following cessation of construction activities. Recolonization is expected to occur rapidly in the discharge (beachfill placement) area through horizontal and in some cases vertical migrations of benthos. Some minor losses of benthos associated with rocky intertidal habitat are expected, as portions of rock groins would become temporarily covered with beachfill material.

3. **Effects on Nekton** - Only a temporary displacement is expected, as the nekton would probably avoid the active work area. The proposed action is not expected to have significant adverse impacts on essential fish habitat (EFH) for the species and their life stages identified within the impact area provided that hard-bottomed areas are avoided in the borrow site.

4. **Effects on Aquatic Food Web** – Localized significant impacts in the affected areas due to loss of benthos as a food source through burial at the beachfill placement site. This is expected to be short-term as the beachfill placement sites could become recolonized by benthos within a few days or weeks.

5. **Effects on Special Aquatic Sites** - No special aquatic sites such as sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs and riffle and pool complexes are present at the discharge site.

6. **Threatened and Endangered Species** - The piping plover (*Charadrius melodus*), a Federal and State threatened species, utilizes sandy beach habitat in Delaware. This bird nests on the beach, however, no nesting sites have been reported within the project impact area. The sea beach amaranth (*Amaranthus pumilus*) is a Federally threatened plant that can be found on the upper beach and lower dunes in along the Atlantic Coast Beaches of Delaware. However, this plant has not been identified recently within the project impact areas. Several species of threatened and endangered sea turtles may be migrating through the sand borrow area depending on the time of year. Sea turtles have been known to become entrained and subsequently destroyed by suction hopper dredges. Use of a hopper dredge during a time of high likely presence (June – November) in the area could potentially entrain and destroy a sea turtle(s). The threatened Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*) uses the Delaware Atlantic Coast as a migratory route and could be within the sand borrow area or beach nearshore. Project compliance for these

species is addressed in the Biological Opinion prepared by the National Marine Fisheries Service (NMFS 2014).

7. **Other Wildlife** - The proposed plan would not significantly affect other wildlife.

8. **Actions to minimize impacts** – None required. The utilization of suitable sand as beachfill minimizes impacts to benthic and pelagic organisms at the discharge locations.

F. <u>Proposed Disposal/Discharge (Beachfill Placement) Site Determinations</u>

1. **Mixing Zone Determination**

- **a.** **Depth of water** - 0 to-25 feet (-7.6 m) mean low water
- **b.** **Current velocity** - Generally less than 3 feet per second
- **c.** **Degree of turbulence** - Moderate to high
- **d.** **Stratification** - None
- **e.** **Discharge vessel speed and direction** - Not applicable
- **f.** **Rate of discharge** - Typically this is estimated to be 780 cubic yards (597 cubic meters) per hour
- **g.** **Dredged material characteristics** - Medium-fine sand and gravels with low silts, clays and organics
- **h.** **Number of discharge actions per unit time** - Continuous over the construction period

2. **Determination of Compliance with Applicable Water Quality Standards** - Prior to construction, a Section 401 Water Quality Certificate will be obtained from the State of Delaware.

3. **Potential Effects on Human Use Characteristics** -

- **a.** **Municipal and private water supply** - No effect
- **b.** **Recreational and commercial fisheries** - Short-term effect during construction; there would be a temporary disruption to fisheries at the placement locations where finfish may avoid construction area. Burial of benthos would result in temporary loss of food source for finfish. Beach access for recreational fisherman may be temporarily restricted in segments during construction.
- **c.** **Water related recreation** - Short-term effect during construction where potential beachgoers, bathers, and surf-

fishermen would be prohibited from accessing active construction locations.

d. **Aesthetics** - Short-term adverse effects to noise sight and smell during construction are anticipated.

e. **Parks, national and historic monuments, national seashores, wilderness areas, research sites and similar preserves** – No effects.

G. <u>Determination of Cumulative Effects on the Aquatic Ecosystem</u>- Impacts on benthos and the aquatic ecosystem in general are considered to be temporary and do not represent a significant loss of habitat. This action in concert with other existing or proposed similar actions, may produce measurable temporary cumulative impacts to benthic resources. However these impacts are short-term.

H. <u>Determination of Secondary Effects on the Aquatic Ecosystem</u> – Secondary impacts such as turbidity on aquatic organisms or temporary loss of food sources through the burial of benthos are considered to be of short duration.

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

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

B. Evaluation of Availability of Practicable Alternatives to the Proposed Discharge Site, Which Would Have Less Adverse Impact on the Aquatic Ecosystem. The alternative measures considered for accomplishing the project objectives were previously evaluated in USACE (1996)(1998)(2002)(2005)(2013) and Section 3.0 of the Environmental Assessment. Several alternatives including No Action, Permanent Evacuation and Regulation of Future Development would likely have less adverse impacts on the aquatic ecosystem. An evaluation of alternative sand sources was conducted in the EA.

C. Compliance with Applicable State Water Quality Standards. This action is not expected to violate State of Delaware Water Quality Standards. A Section 401 water quality certificate will be obtained from the Delaware Department of Natural Resources and Environmental Control prior to initiation of discharges associated with this project.

D. Compliance with Applicable Toxic Effluent Standards or Prohibition Under Section 307 of the Clean Water Act. The proposed action is not expected to violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

E. Compliance with Endangered Species Act. Formal Section 7 consultation has been concluded with the issuance of a Biological Opinion (BO) from the National Marine Fisheries Service (NMFS, 2014) for protected marine species within the project impact areas. Compliance will be met through adherence with the terms and conditions in the BO. The Federally listed threatened piping plover and seabeach amaranth have not occurred within the project impact areas. If this condition changes, the Philadelphia District would consult with the U.S. Fish and Wildlife Service.

F. Compliance with Specified Protection Measures for Marine Sanctuaries Designated by the Marine Protection, Research, and Sanctuaries Act of 1972. The proposed action will not violate the protective measures for any Marine Sanctuaries designated by the Marine Protection, Research, and Sanctuaries Act of 1972.

G. Evaluation of Extent of Degradation of the Waters of the United States. The proposed action is not expected to result in permanent 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 of aquatic life and other wildlife dependent on aquatic ecosystems; aquatic ecosystem diversity, productivity, and stability; and recreational, aesthetic, and economic values is not expected to occur or have long-term effects on impacted resources.

H. Appropriate and Practicable Steps Taken to Minimize Potential Adverse Impacts of the Discharge on the Aquatic Ecosystem. Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems include selection of borrow material that is low in silt content, has little organic material, and is expected to be uncontaminated.

I. On the basis of the guidelines, the proposed discharge sites for the dredged 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.

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APPENDIX-B

DELAWARE ENVIRONMENTAL NAVIGATOR (DEN) MAPS ALONG THE DELAWARE ATLANTIC COAST

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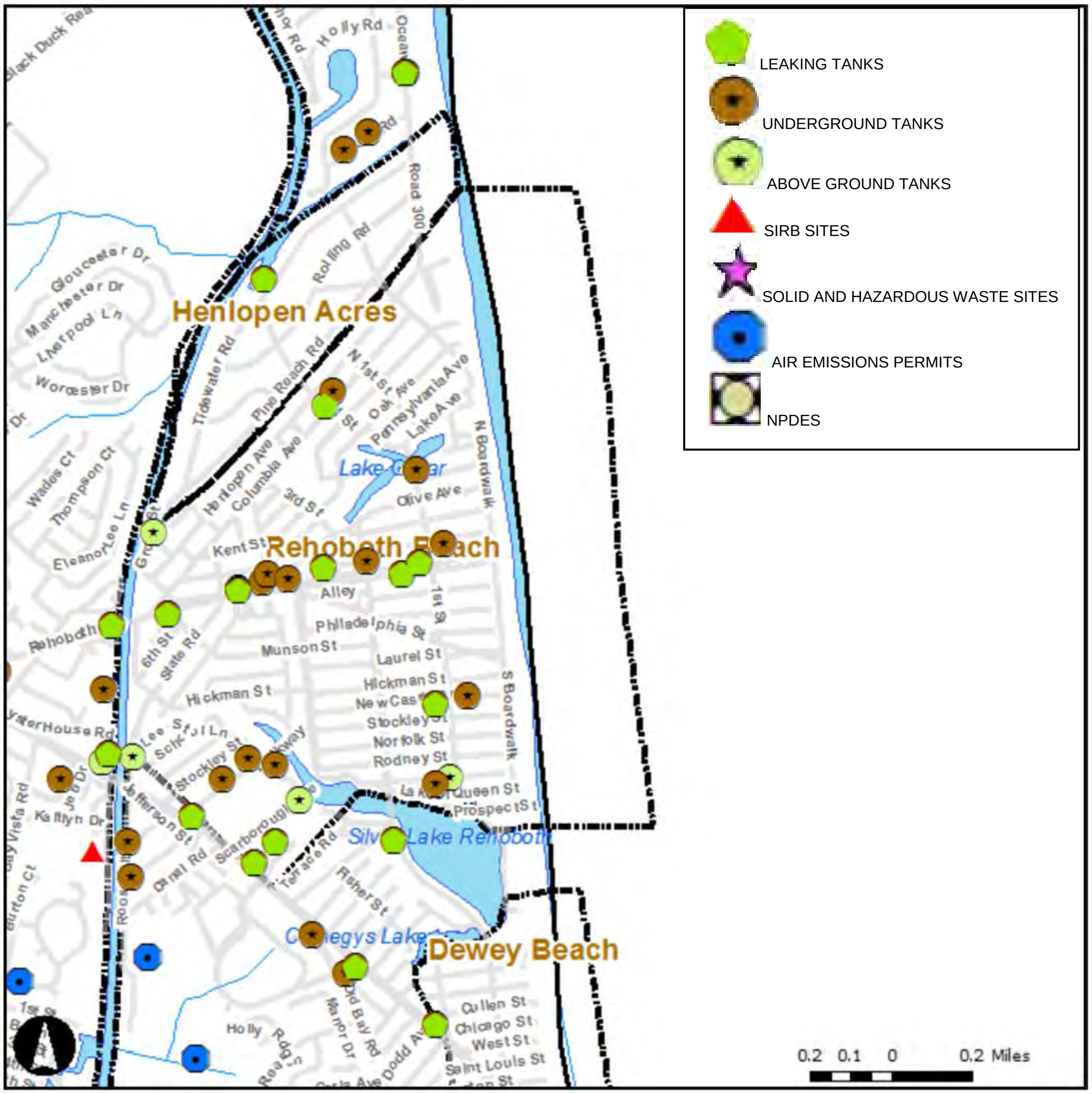
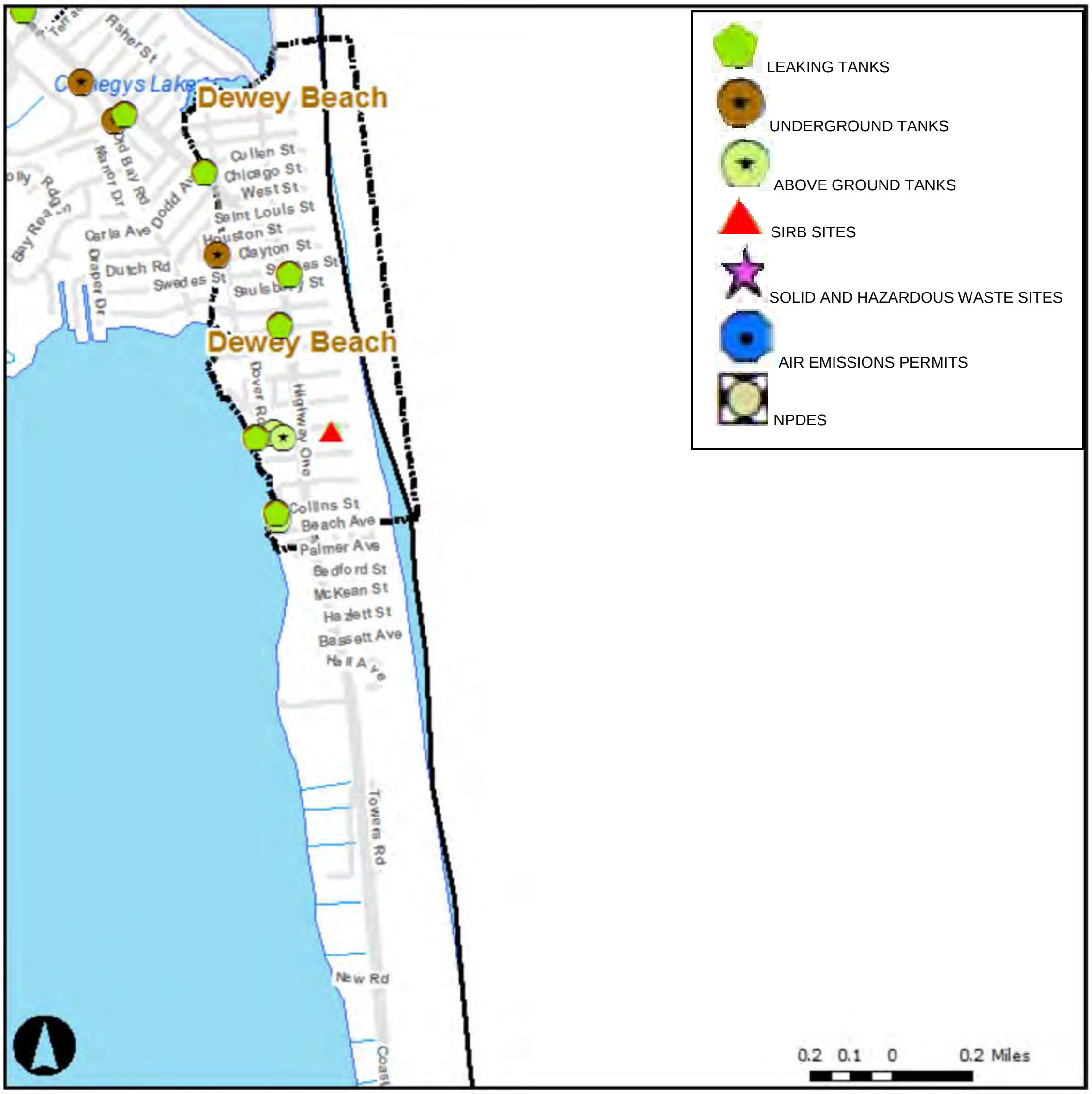

LEAKING TANKS
UNDERGROUND TANKS
ABOVE GROUND TANKS
SIRB SITES
SOLID AND HAZARDOUS WASTE SITES
AIR EMISSIONS PERMITS
NPDES
Henlopen Acres
Rehoboth Beach
Dewey Beach
Lake Gerar
Silver Lake Rehoboth
0.2 0.1 0 0.2 Miles

Watersheds

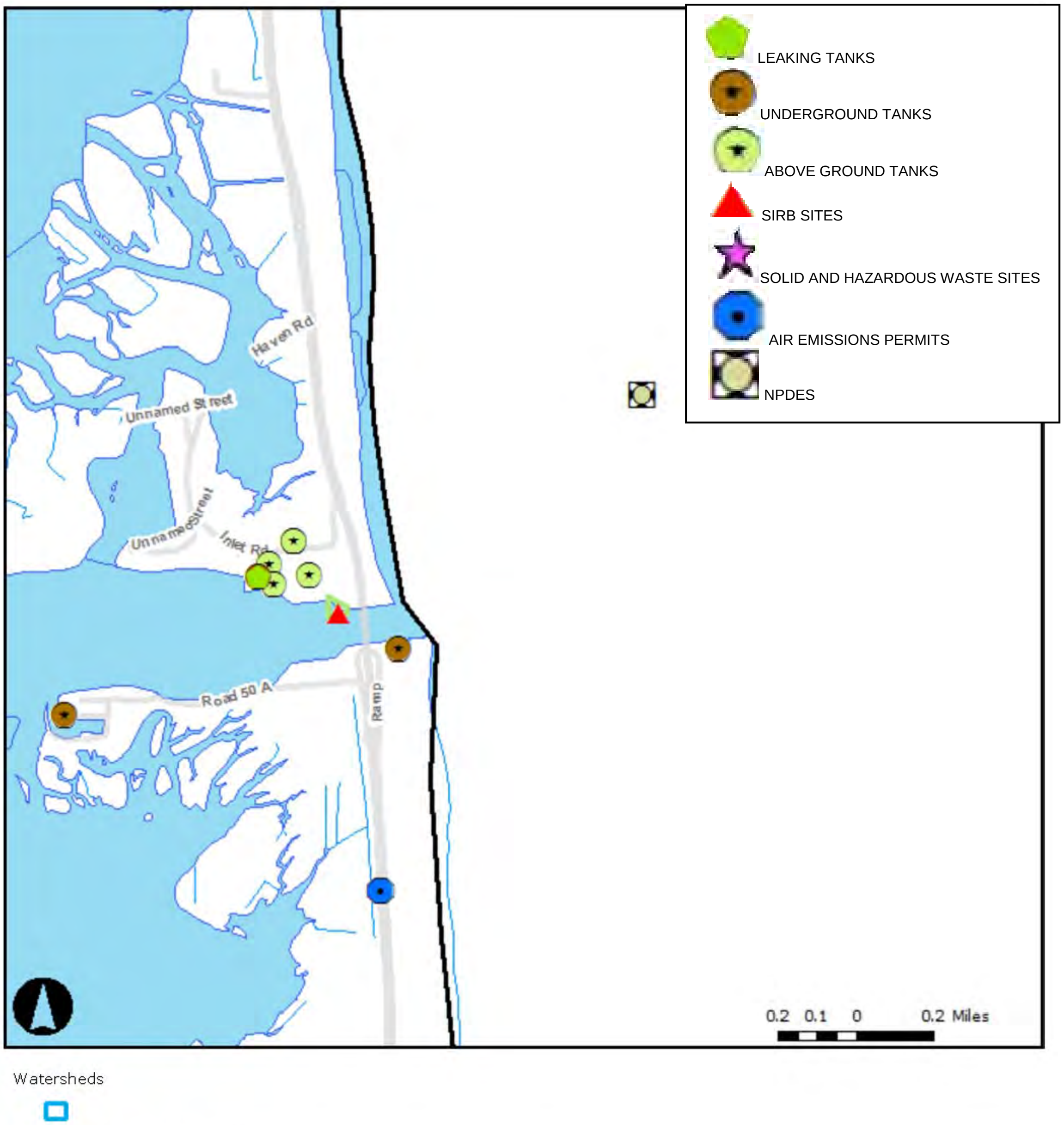


Watersheds

Copyright DNREC 2009

Watersheds

Copyright DNREC 2009



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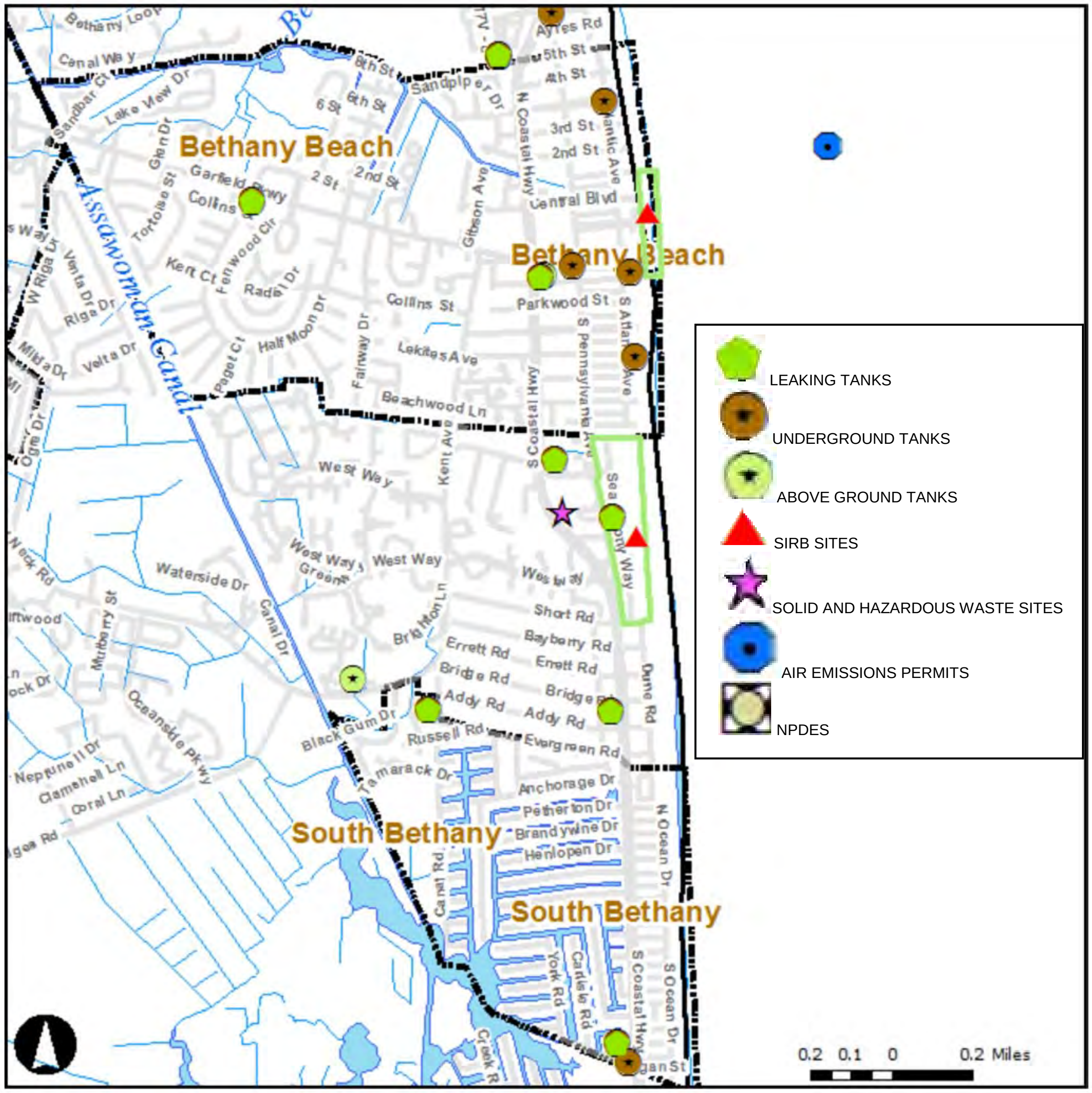
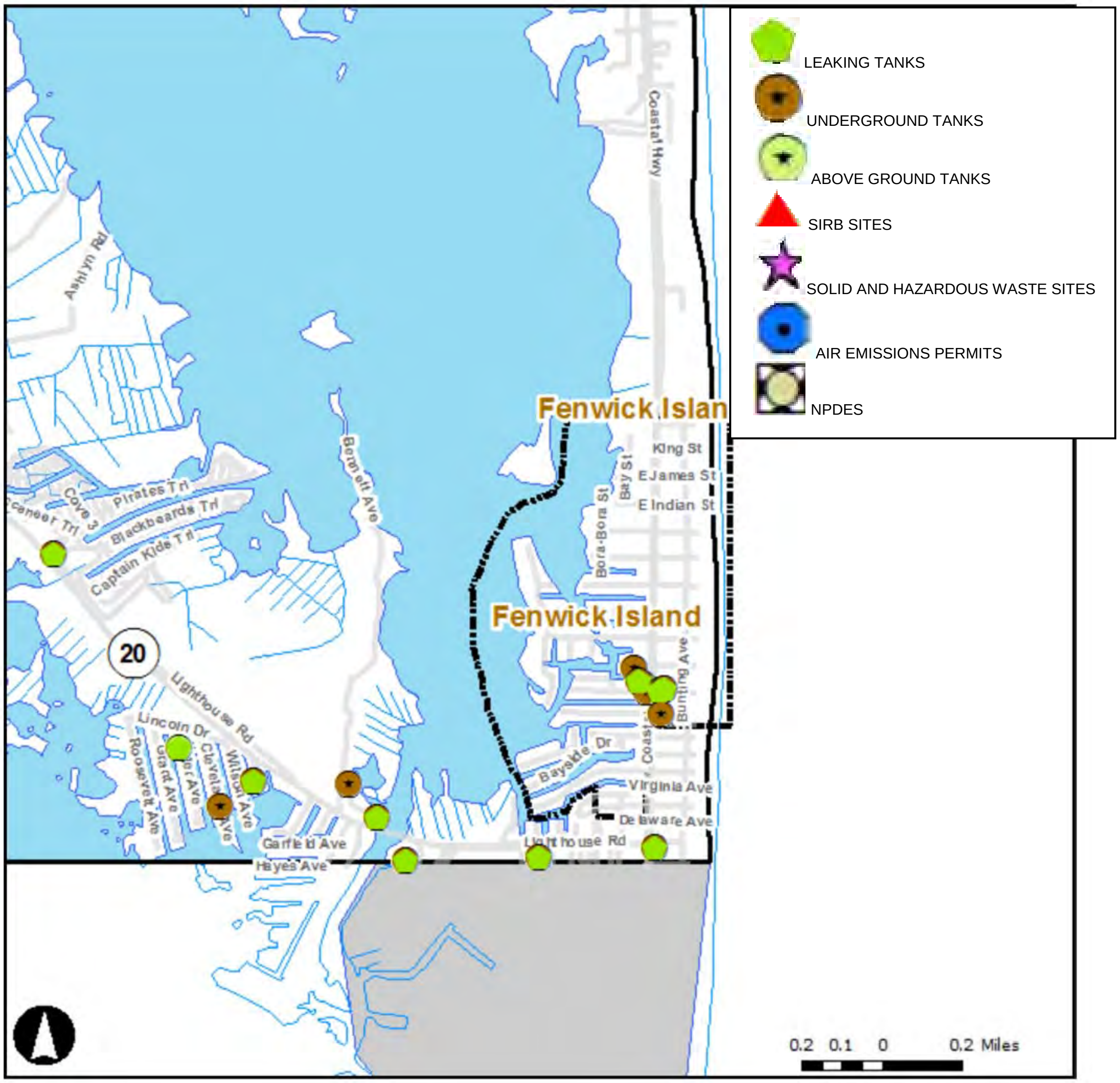

Bethany Beach
Bethany Beach
South Bethany
South Bethany
Assawoman Canal
LEAKING TANKS
UNDERGROUND TANKS
ABOVE GROUND TANKS
SIRB SITES
SOLID AND HAZARDOUS WASTE SITES
AIR EMISSIONS PERMITS
NPDES
0.2 0.1 0 0.2 Miles

Watersheds



LEAKING TANKS
UNDERGROUND TANKS
ABOVE GROUND TANKS
SIRB SITES
SOLID AND HAZARDOUS WASTE SITES
AIR EMISSIONS PERMITS
NPDES
Fenwick Islan
Fenwick Island
Coastal Hwy
King St
E James St
E Indian St
Bay St
Bora-Bora St
Bunting Ave
Bayside Dr
Virginia Ave
Delaware Ave
Lighthouse Rd
Garfield Ave
Hayes Ave
Lincoln Dr
Roosevelt Ave
Grant Ave
Wilson Ave
Bennett Ave
Ashlyn Rd
Pirates Trl
Blackbeards Trl
Captain Kidd Trl
Cove 3
20
0.2 0.1 0 0.2 Miles

Watersheds

APPENDIX-C

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS IN AREA B

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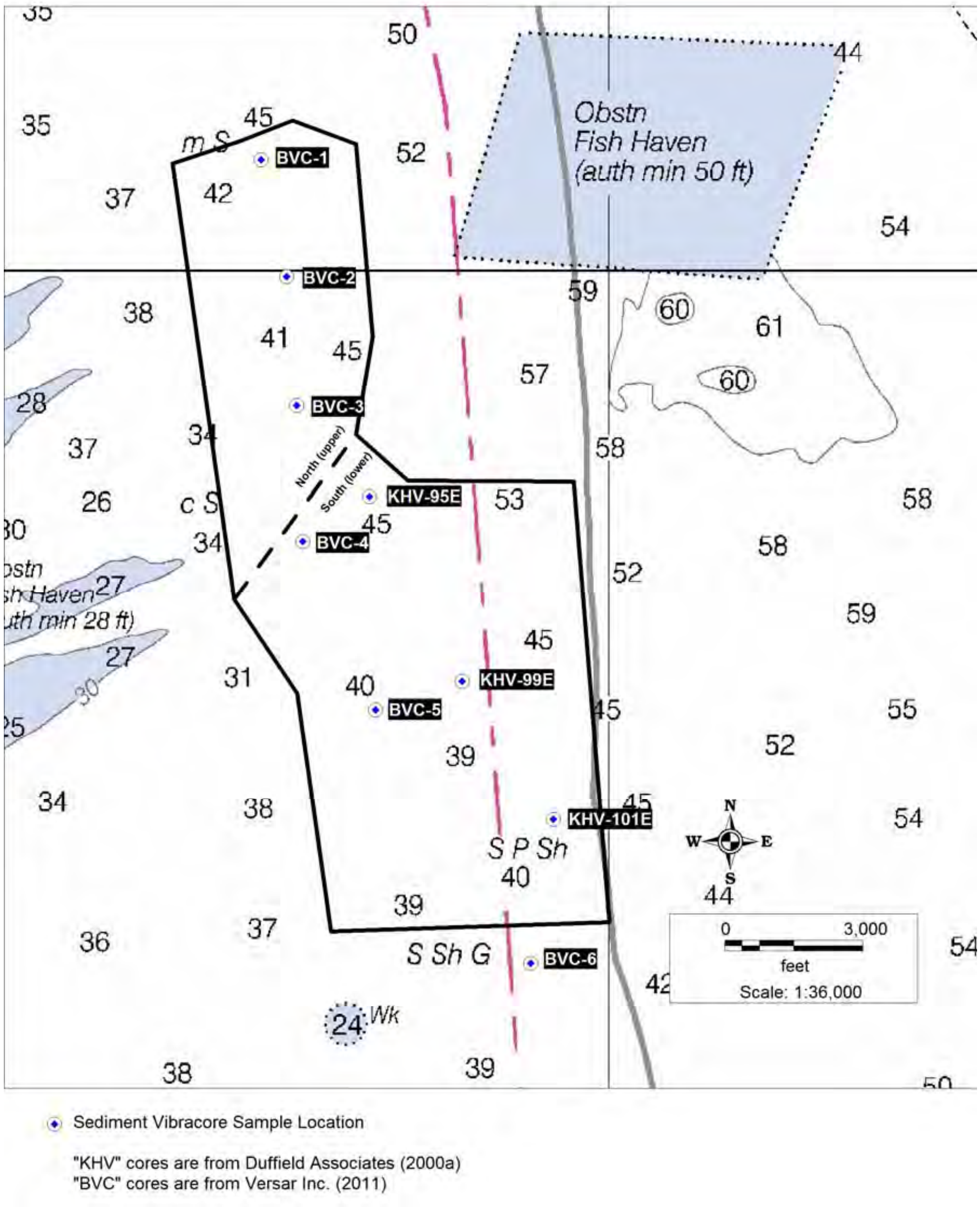

Figure C-1. Area B Sediment Quality Vibracore Locations

Table C-1. Results of grain size and Total Organic Carbon (TOC) analysis for composite samples taken from Area B in 2000 (Duffield Associates, 2000a) and 2011 (Versar Inc., 2011).

	KHV-95E (0-7.0 ft.)	**KHV-99E (0-8.0 ft.)**	**KHV-101E (0-8.6 ft.)**			
TOC (%)	0.025	0.017	0.0077			
Silt/Clay (%)	3.5	2.7	4.1			
Gravel (%)	5.7	38.3	3.6			
Sand (%)	90.8	59	92.3			
	BVC-1 (0-3 ft.)	**BVC-1 (3-10 ft.)**	**BVC-2 (0-3 ft.)**	**BVC-2 (3-10 ft.)**	**BVC-3 (0-3 ft.)**	**BVC-3 (3-10 ft.)**
TOC (%)	0.47	0.40	0.56	0.57	0.86	0.61
Silt/Clay (%)	4.80	5.29	5.18	4.57	11.28	11.70
Gravel (%)	0.02	0.82	0.67	13.97	13.76	0.83
Sand (%)	95.19	93.89	94.15	81.46	74.96	87.47
	BVC-4 (0-3 ft.)	**BVC-4 (3-10 ft.)**	**BVC-5 (0-3 ft.)**	**BVC-5 (3-10 ft.)**	**BVC-6 (0-3 ft.)**	**BVC-6 (3-10 ft.)**
TOC (%)	0.66	2.54	0.39	0.69	1.67	2.46
Silt/Clay (%)	23.18	96.26	3.36	6.42	77.11	91.90
Gravel (%)	45.85	0.00	20.41	3.41	2.52	0.00
Sand (%)	30.97	3.74	76.23	90.17	20.37	8.10

Table C-2. Concentrations Of Metals And Miscellaneous Parameters Measured In Composites Vibracores Collected From Area B in 2000 (Duffield Associates, 2000a)

Parameter	KHV-95E (mg/kg)	KHV-99E (mg/kg)	KHV-101E (mg/kg)	DNREC-SIRS Screening Level for Soil (mg/kg)	DNREC- SIRS Ecological Marine Sediment (mg/kg)	Effects Range Low (Long and Morgan, 1995) (mg/kg)
Aluminum	793	1930	8400	51,200	NL	NL
Antimony	ND	ND	ND	3.1	2	2
Arsenic	ND	0.40 J	ND	11	7.24	8.2
Barium	1.84 J	2.14 J	14	1500	NL	NL
Beryllium	ND	ND	0.15 J	16	NL	NL
Cadmium	ND	ND	ND	7	0.68	1.2
Calcium	195	246	208	NL	NL	NL
Chromium	2.26 J	4.46 J	7.0	214	52.3	81
Cobalt	ND	0.88 J	1.29 J	34	NL	NL
Copper	0.67 J	1.53 J	2.02 J	310	18.7	34
Iron	1070	2710	1730	74,767	NL	NL
Lead	ND	1.02 J	1.9	400	30.2	46.7
Magnesium	450	330	525	NL	NL	NL
Manganese	9	6.6	12.2	2100	NL	NL
Mercury	ND	ND	ND	1.0	0.13	0.15
Nickel	ND	ND	4.4 J	150	15.9	20.9
Potassium	213	159	279	NL	NL	NL
Selenium	ND	ND	ND	39	NL	NL
Silver	ND	ND	ND	39	0.73	1
Sodium	1530	1440	1740	NL	NL	NL
Thallium	ND	ND	ND	0.078	NL	NL
Vanadium	2.5	8.6	1.65 J	134	NL	NL
Zinc	3.4 J	8.6 J	9.7 J	2300	124	150
Cyanide	ND	ND	ND	4.7	NL	NL
Moisture Content (% by weight)	12.1	11.4	13.4			
pH	7.86	8.32	7.67			
Total Organic Carbon (mg/kg)	251	169	77			
Oil & Grease (mg/kg)	ND	ND	ND			

Table C-3. Inorganic results of bulk sediment analysis (dry weight) for composite samples taken from Area B in 2011 (Versar, 2011). Shaded values are over DNREC SIRS Screening Levels.

Boring ID:		**BVC-1**	**BVC-1**	**BVC-2**	**BVC-2**	**BVC-3**	**BVC-3**	**DNREC-SIRS Screening Level for Soil (mg/Kg)**	**DNREC- SIRS Ecological Marine Sediment (mg/kg)**	**Effects Range Low (Long and Morgan, 1995) (mg/kg)**
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**			
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID			
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011			
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL			
MET										
Aluminum	mg/kg	1770	1440	1820	1130	3030	2440	51,200	NL	NL
Antimony	mg/kg	0.084	0.036	0.026	0.013	0.049	0.015	3.1	2	2
Arsenic	mg/kg	2.1	1.1	2.2	0.63	2.6	1.2	11	7.24	8.2
Barium	mg/kg	3.1	3.2	6.9	2.6	7.1	4.9	1500	NL	NL
Beryllium	mg/kg	0.12	0.074	0.11	0.056	0.16	0.1	16	NL	NL
Cadmium	mg/kg	0.042	0.029	0.049	0.021	0.14	0.053	7	0.68	1.2
Calcium	mg/kg	525	441	619	389	2260	3720	NL	NL	NL
Chromium	mg/kg	5.9	4	5.9	3.2	10.2	5.7	214	52.3	81
Cobalt	mg/kg	2	1.1	1.8	0.69	2.2	1.6	34	NL	NL
Copper	mg/kg	1.1	0.97	1.2	0.71	3.9	1.6	310	18.7	34
Iron	mg/kg	6680	3160	6050	2040	6140	3860	74,767	NL	NL
Lead	mg/kg	3.4	1.4	3.1	1.3	7.4	2	400	30.2	46.7
Magnesium	mg/kg	1210	907	1220	705	1790	1360	NL	NL	NL
Manganese	mg/kg	37.7	20.7	38.9	15.5	63	45.3	2100	NL	NL
Mercury	mg/kg	0.0044	0.0014	0.0036	0.0012	0.021	0.0028	1.0	0.13	0.15
Nickel	mg/kg	2.6	2.2	2.7	1.6	4.9	3.5	150	15.9	20.9
Potassium	mg/kg	502	385	494	321	761	548	NL	NL	NL
Selenium	mg/kg	0.18	0.13	0.18	<0.29	0.33	0.19	39	NL	NL
Silver	mg/kg	0.011	<0.062	0.0087	<0.058	0.061	0.009	39	0.73	1
Sodium	mg/kg	2090	2060	1990	1540	2720	2320	NL	NL	NL
Thallium	mg/kg	0.019	0.031	0.026	0.017	0.048	0.036	0.078	NL	NL
Vanadium	mg/kg	11.8	5.8	10.2	4	11.8	6.3	134	NL	NL
Zinc	mg/kg	11.1	6	12.3	4	30.5	8.4	2300	124	150
Cyanide, Total	mg/kg	<0.30	<0.31	<0.30	<0.29	<0.32	<0.31	4.7	NL	NL

Table C-3. Continued										
Boring ID:		**BVC-4**	**BVC-4**	**BVC-5**	**BVC-5**	**BVC-6**	**BVC-6**	**DNREC-SIRS Screening Level for Soil (mg/Kg)**	**DNREC- SIRS Ecological Marine Sediment (mg/kg)**	**Effects Range Low (Long and Morgan, 1995) (mg/kg)**
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**			
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID			
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011			
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL			
MET										
Aluminum	mg/kg	5890	14500	1530	3180	9230	12300	51,200	NL	NL
Antimony	mg/kg	0.023	0.081	0.042	0.019	0.024	0.022	3.1	2	2
Arsenic	mg/kg	2.9	5.5	1.5	0.42	4.1	5.5	11	7.24	8.2
Barium	mg/kg	12.1	32.9	2.3	3.8	19.1	23.3	1500	NL	NL
Beryllium	mg/kg	0.26	0.67	0.069	0.14	0.45	0.64	16	NL	NL
Cadmium	mg/kg	0.15	0.29	0.052	0.031	0.29	0.3	7	0.68	1.2
Calcium	mg/kg	2190	4340	1510	187	923	1160	NL	NL	NL
Chromium	mg/kg	13.9	34.4	3.9	3.8	19.8	25.7	214	52.3	81
Cobalt	mg/kg	3.6	8.6	0.75	0.6	6	8	34	NL	NL
Copper	mg/kg	4	9.2	1.6	1.4	6.7	9	310	18.7	34
Iron	mg/kg	9850	23300	2040	1360	16500	18900	74,767	NL	NL
Lead	mg/kg	4.2	9.8	3.9	1.7	7.5	10	400	30.2	46.7
Magnesium	mg/kg	3130	8600	590	489	3630	4630	NL	NL	NL
Manganese	mg/kg	108	267	14.6	7.3	118	138	2100	NL	NL
Mercury	mg/kg	0.0082	0.0109	0.0081	0.0009	0.0185	0.0171	1.0	0.13	0.15
Nickel	mg/kg	8.5	**20.9**	2	2.7	11.8	15.5	150	15.9	20.9
Potassium	mg/kg	1260	3130	269	257	1710	2110	NL	NL	NL
Selenium	mg/kg	0.34	0.64	0.15	0.15	0.56	0.67	39	NL	NL
Silver	mg/kg	0.025	0.046	0.019	<0.059	0.042	0.05	39	0.73	1
Sodium	mg/kg	2980	5280	1610	1670	4240	4900	NL	NL	NL
Thallium	mg/kg	0.072	**0.16**	0.02	0.017	**0.11**	**0.14**	0.078	NL	NL
Vanadium	mg/kg	16.6	36.3	5.9	5	21.8	26.1	134	NL	NL
Zinc	mg/kg	21	47.1	11	6	31.7	41.6	2300	124	150
Cyanide, Total	mg/kg	<0.31	<0.36	<0.29	<0.29	<0.35	<0.37	4.7	NL	NL

Table C-4. Summary of Analytic Testing Results for Target Compound List Volatile Organic Compounds Composite Sediment Samples						
Parameters	**Area B (Duffield Associates, 2000a)**				**DE SIRS SCREENING**	
	MDL (µg/kg)	**KHV-95E (µg/kg)**	**KHV-99E (µg/kg)**	**KHV-101E (µg/kg)**	**SOIL (µg/kg)**	**MARINE SEDIMENT (µg/kg)**
DEPTH:		0-7.0 ft.	0-8.0 ft.	0-8.6 ft.		
Acetone	7	**13 J**	**37**	ND	6,100,000	NL
Benzene	1	ND	ND	ND	1,100	137
Bromodichloromethane	2	ND	ND	ND	270	NL
Bromoform	1	ND	ND	ND	62,000	1,310
Bromomethane	3	ND	ND	ND	730	NL
2-Butanone (MEK)	7	ND	ND	ND	2,800,000	NL
Carbon disulfide	3	ND	ND	ND	82,000	NL
Carbon tetrachloride	1	ND	ND	ND	610	7,240
Chlorobenzene	1	ND	ND	ND	29,000	162
Chloroethane	3	ND	ND	ND	1,500,000	NL
Chloroform	1	ND	ND	ND	290	NL
Chloromethane	2	ND	ND	ND	12,000	NL
Dibromochloromethane	1	ND	ND	ND	680	NL
1,1-Dichloroethane	1	ND	ND	ND	3,300	NL
1,2-Dichloroethane	2	ND	ND	ND	430	NL
1,1-Dichloroethene	2	ND	ND	ND	24,000	NL
cis-1,2-Dichloroethene	2	ND	ND	ND	16,000	NL
trans-1,2-Dichloroethene	2	ND	ND	ND	15,000	NL
1,2-Dichloropropane	3	ND	ND	ND	940	NL
cis-1,3-Dichloropropene	1	ND	ND	ND	1,700	7.31
TRANS-1, 3-Dichloropropene	1	ND	ND	ND	1,700	7.31
Ethylbenzene	1	ND	ND	ND	12,000,000	305
2-Hexanone	3	ND	ND	ND	21,000	NL
Methylene chloride	2	ND	ND	ND	36,000	NL
4-Methyl-2-pentanone (MIBK)	3	ND	ND	ND	530,000	NL
Styrene	1	ND	ND	ND	630,000	7,070
1,1,2,2-Tetrachloroethane	1	ND	ND	ND	1,900	NL
Tetrachloroethene	1	**4 J**	**4 J**	**4 J**	8,600	190
Toluene	1	ND	ND	ND	500,000	109
1,1,1-Trichloroethane	1	ND	ND	ND	870,000	856
1,1,2-Trichloroethane	2	ND	ND	ND	160	570
Trichloroethene	1	ND	ND	ND	440	8,950
Vinyl chloride	2	ND	ND	ND	60	20
Xylenes (total)	1	ND	ND	ND	420,000	30

Table C-5. Summary of Analytic Testing Results for Target Compound List Semi-Volatile Organic Compounds Composite Sediment Samples (Duffield Associates, 2000a)

	MDL (μg/kg)	KHV-95E (μg/kg)	KHV-99E (μg/kg)	KHV-101E (μg/kg)	DELAWARE SIRS SCREENING LEVELS		ER-L SEDIMENT (μg/kg)	ER-M SEDIMENT (μg/kg)
					SOIL (μg/kg)	MARINE SEDIMENT (μg/kg)		
DEPTH:		0-7.0 ft.	0-8.0 ft.	0-8.6 ft.				
Acenapthene	33	ND	ND	ND	270,000	6.71	16	500
Acenapthylene	33	ND	ND	ND	NL	NL	44	640
Anthracene	33	ND	ND	ND	1,000,000	46.9	85.3	1,100
Benzo(a)anthracene	33	ND	ND	ND	900	74.8	261	1,600
Benzo(a)pyrene	33	ND	ND	ND	90	88.8	430	1600
Benzo(b)fluoranthene	33	ND	ND	ND	900	NL	NL	NL
Benzo(k)fluoranthene	33	ND	ND	ND	9,000	NL	NL	NL
Benzo(g,h,i)perylene	33	ND	ND	ND	NL	NL	NL	NL
bis-(2-Chlorethyl)ether	33	ND	ND	ND	210	NL	NL	NL
bis(2-Chloroethoxy)methane	67	ND	ND	ND	18,000	NL	NL	NL
bis(2-Ethylhexyl)phthalate	67	ND	ND	ND	35,000	182	NL	NL
4-Bromophenyl-phenylether	33	ND	ND	ND	NL	NL	NL	NL
Butylbenzylphthalate	67	ND	ND	ND	260,000	16,800	NL	NL
Carbazole	67	ND	ND	ND	NL	NL	NL	NL
4-Chloroaniline	67	ND	ND	ND	2,400	NL	NL	NL
4-Chloro-3-methylphenol	67	ND	ND	ND	610,000	NS	NL	NL
2-Chlorophenol	33	ND	ND	ND	390,000	344	NL	NL
4-Chlorophenyl-phenyl ether	33	ND	ND	ND	NL	NL	NL	NL
Chrysene	33	ND	ND	ND	87,000	108	384	2800
Dibenzo(a,h)anthracene	33	ND	ND	ND	90	6.2	63.4	260
Dibenzofuran	33	ND	ND	ND	7,800	7,300	NL	NL
1,2-Dichlorobenzene	33	ND	ND	ND	190,000	989	NL	NL
1,3-Dichlorobenzene	67	ND	ND	ND	NL	NL	NL	NL
1,4-Dichlorobenzene	67	ND	ND	ND	2,400	460	NL	NL
3,3'-Dichlorobenzidine	67	ND	ND	ND	1,100	2,060	NL	NL
2,4-Dichlorophenol	67	ND	ND	ND	18,000	NL	NL	NL
Diethylphthalate	67	ND	ND	ND	4,900,000	218	NL	NL
Dimethylphthalate	67	ND	ND	ND	NL	NL	NL	NL
2,4-Dimethylphenol	67	ND	ND	ND	120,000	NL	NL	NL
Di-n-butylphthalate	67	ND	ND	ND	610,000	1,160	NL	NL
4,6-Dinitro-2-methylphenol	170	ND	ND	ND	490	NL	NL	NL
2,4-Dinitrophenol	670	ND	ND	ND	12,000	NL	NL	NL
2,4-Dinitrotoluene	33	ND	ND	ND	1,600	NL	NL	NL
2,6-Dinitrotoluene	33	ND	ND	ND	330	NL	NL	NL
Di-n-octylphthalate	67	ND	ND	ND	61,000	NL	NL	NL
Fluoranthene	33	ND	ND	ND	310,000	133	600	5,100
Fluorene	33	ND	ND	ND	300,000	21.2	19	540
Hexachlorobenzene	33	ND	ND	ND	300	NS	NL	NL
Hexachlorobutadiene	67	ND	ND	ND	6,100	NS	NL	NL
Hexachlorocyclopentadiene	170	ND	ND	ND	37,000	139	NL	NL
Hexachloroethane	33	ND	ND	ND	4,300	804	NL	NL
Indeno(1,2,3-cd)pyrene	33	ND	ND	ND	900	NL	NL	NL
Isophorone	33	ND	ND	ND	510,000	NL	NL	NL

Table C-5. Summary of Analytic Testing Results for Target Compound List Semi-Volatile Organic Compounds Composite Sediment Samples (cont.)

	MDL (µg/kg)	KHV-95E (µg/kg)	KHV-99E (µg/kg)	KHV-101E (µg/kg)	DELAWARE SIRS SCREENING LEVELS SOIL (µg/kg)	DELAWARE SIRS SCREENING LEVELS MARINE SEDIMENT (µg/kg)	ER-L SEDIMENT (µg/kg)	ER-M SEDIMENT (µg/kg)
DEPTH:		0-7.0 ft.	0-8.0 ft.	0-8.6 ft.				
2-Methylnapthalene	33	ND	ND	ND	1,000	20.2	70	670
2-Methylphenol(o-cresol)	33	ND	ND	ND	310,000	NL	NL	NL
4-Methylphenol (p-cresol)	67	ND	ND	ND	610,000	NL	NL	NL
Napthalene	33	ND	ND	ND	5,000	34.6	160	2,100
2-Nitroaniline	67	ND	ND	ND	61,000	NS	NL	NL
3-Nitroaniline	67	ND	ND	ND	NL	NL	NL	NL
4-Nitroaniline	67	ND	ND	ND	24,000	NL	NL	NL
Nitrobenzene	33	ND	ND	ND	4,800	NS	NL	NL
2-Nitrophenol	67	ND	ND	ND	NL	NL	NL	NL
4-Nitrophenol	170	ND	ND	ND	NL	NS	NL	NL
N-Nitroso-di-n-propylamine	33	ND	ND	ND	69	NS	NL	NL
N-nitroso-diphenylamine	33	ND	ND	ND	99,000	422,000	NL	NL
2,2'-oxybis(1-Chloropropane)	33	ND	ND	ND	NL	NL	NL	NL
Pentachlorophenol	170	ND	ND	ND	890	NL	NL	NL
Phenanthrene	33	ND	ND	ND	1,000,000	86.7	240	1,500
Phenol	67	ND	ND	ND	1,800,000	NL	NL	NL
Pyrene	33	ND	ND	ND	230,000	153	665	2,600
1,2,4-Trichlorobenzene	33	ND	ND	ND	6,200	473	NL	NL
2,4,5-Trichlorophenol	67	ND	ND	ND	610,000	819	NL	NL
2,4,6-Trichlorophenol	67	ND	ND	ND	6,100	2,650	NL	NL
Lindane	0.067	ND	ND	ND	520	0.32	NL	NL
Dicofol	NM	NM	NM	NM	NL	NL	NL	NL
Heptachlor	0.067	ND	ND	ND	110	NL	NL	NL
Heptachlor Epoxide	0.067	ND	ND	ND	53	0.6	NL	NL
Methoxychlor	0.67	ND	ND	ND	3,100	29.6	NL	NL
Oxychlordane	NM	NM	NM	NM	NL	NL	NL	NL
Chlordane (g)	0.067	ND	ND	ND	1,600	NL	0.5	6
Chlordane (a)	0.067	ND	ND	ND	1,600	NL	0.5	6
o,p-DDE	0.13	ND	ND	ND	NL	NL	2	15
p,p-DDE	0.13	ND	ND	ND	1,400	1.2	2	15
o,p-DDD	0.13	ND	ND	ND	2,000	1.2	2	20
p,p-DDD	0.13	ND	ND	ND	2,000	1.2	2	20
o,p-DDT	0.13	ND	ND	ND	1,700	1.19	1.58	46.1
p,p-DDT	0.13	ND	ND	ND	1,700	1.19	1.58	46.1
Endosulfan I	0.067	ND	ND	ND	37,000	0.107	NL	NL
cis Nonachlor	NM	NM	NM	NM				
trans Nonachlor	NM	NM	NM	NM				
Dieldrin	0.13	ND	ND	ND	30	0.72	0.02	8
Endrin	0.13	ND	ND	ND	1,800	2.67	0.02	45
Endrin Aldehyde	0.13	ND	ND	ND	NL	NL	NL	NL
Endrin Ketone	0.13	ND	ND	ND	NL	NL	NL	NL
Endosulfan II	0.13	ND	ND	ND	NL	NL	NL	NL
Endosulfan sulfate	0.13	ND	ND	ND	NL	NL	NL	NL

Table C-5. Summary of Analytic Testing Results for Target Compound List Semi-Volatile Organic Compounds Composite Sediment Samples (cont.)

	MDL (µg/kg)	KHV-95E (µg/kg)	KHV-99E (µg/kg)	KHV-101E (µg/kg)	DELAWARE SIRS SCREENING LEVELS		ER-L SEDIMENT (µg/kg)	ER-M SEDIMENT (µg/kg)
					SOIL (µg/kg)	MARINE SEDIMENT (µg/kg)		
DEPTH:		0-7.0 ft.	0-8.0 ft.	0-8.6 ft.				
Mirex	NM	NM	NM	NM	27	NL	NL	NL
Aldrin	0.067	ND	ND	ND	29	NL	NL	NL
Alpha BHC	0.067	ND	ND	**0.101 J**	77	1,360	NL	NL
Beta BHC	0.067	ND	ND	ND	270	NL	NL	NL
Delta BHC (HCH-technical)	0.067	ND	ND	ND	270	NL	NL	NL
Toxaphene	6.7	ND	ND	ND	440	536	NL	NL
PCB-1016	3.3	ND	ND	ND	390	NL	NL	NL
PCB-1221	7.8	ND	ND	ND	140	NL	NL	NL
PCB-1232	3.3	ND	ND	ND	140	NL	NL	NL
PCB-1242	3.3	ND	ND	ND	220	NL	NL	NL
PCB-1248	3.3	ND	ND	ND	220	NL	NL	NL
PCB-1254	3.3	ND	ND	ND	110	63.3	NL	NL
PCB-1260	3.3	ND	ND	ND	220	NL	NL	NL

MDL – Method Detection Limit
ND- Not Detected During Analysis
NL- Not listed
NM- Not measured/parameter not analyzed
ER-L, ER-M – Effects Range-Low and Effects Range-Median, respectively, in sediment per "Incidents of Adverse Biological Effects Within Ranges of Chemical Concentrations in Marine and Estuarine Sediments," Long, MacDonald, Smith and Calder (1995).

Table C-6. Results of MS Semi-volatile organics bulk sediment analysis (dry weight) for composite samples taken from Area B April 2011. (Versar Inc., 2011)

Boring ID:		BVC-1	BVC-1	BVC-2	BVC-2	BVC-3	BVC-3	DE SIRS SCREENING LEVELS FOR SOIL (µg/kg)	DE SIRS SCREENING LEVEL FOR SEDIMENT (µg/kg)	ER-L SEDIMENT (µg/kg)	ER-M SEDIMENT (µg/kg)
Depth:		(0-3 ft.)	(3-10 ft.)	(0-3 ft.)	(3-10 ft.)	(0-3 ft.)	(3-10 ft.)				
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID				
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011				
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL				
MSSEMI											
1,1-Biphenyl	µg/kg	<40	<40	<40	<38	<100	<41	5,100	NL	NL	NL
1,2,4-Trichlorobenzene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	6,200	473	NL	NL
1,2-Dichlorobenzene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	190,000	989	NL	NL
1,2-Diphenylhydrazine	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	610	NL	NL	NL
1,3-Dichlorobenzene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	NL	NL	NL	NL
1,4-Dichlorobenzene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	2,400	460	NL	NL
2,4,5-Trichlorophenol	µg/kg	<40	<40	<40	<38	<100	<41	610,000	819	NL	NL
2,4,6-Trichlorophenol	µg/kg	<40	<40	<40	<38	<100	<41	6,100	2,650	NL	NL
2,4-Dichlorophenol	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	18,000	NL	NL	NL
2,4-Dimethylphenol	µg/kg	<40	<40	<40	<38	<100	<41	120,000	NL	NL	NL
2,4-Dinitrophenol	µg/kg	<200	<210	<200	<200	<540	<210	12,000	NL	NL	NL
2,4-Dinitrotoluene	µg/kg	<40	<40	<40	<38	<100	<41	1,600	NL	NL	NL
2,6-Dinitrotoluene	µg/kg	<40	<40	<40	<38	<100	<41	330	NL	NL	NL
2-Chloronaphthalene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	630,000	NL	NL	NL
2-Chlorophenol	µg/kg	<40	<40	<40	<38	<100	<41	39,000	344	NL	NL
2-Methylnaphthalene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	1,000	20.2	70	670
2-Methylphenol	µg/kg	<40	<40	<40	<38	<100	<41	310,000	NL	NL	NL
2-Nitroaniline	µg/kg	<200	<210	<200	<200	<540	<210	61,000	NL	NL	NL
2-Nitrophenol	µg/kg	<40	<40	<40	<38	<100	<41	NL	NL	NL	NL
3,3-Dichlorobenzidine	µg/kg	<40	<40	<40	<38	<100	<41	1,100	2,060	NL	NL
3-Nitroaniline	µg/kg	<200	<210	<200	<200	<540	<210	NL	NL	NL	NL
4,6-Dinitro-2-methylphenol	µg/kg	<200	<210	<200	<200	<540	<210	490	NL	NL	NL
4-Bromophenyl phenyl ether	µg/kg	<40	<40	<40	<38	<100	<41	NL	NL	NL	NL
4-Chloro-3-methylphenol	µg/kg	<40	<40	<40	<38	<100	<41	610,000	NL	NL	NL
4-Chloroaniline	µg/kg	<40	<40	<40	<38	<100	<41	2,400	NL	NL	NL

Table C-6. Results of MS Semi-volatile organics bulk sediment analysis (dry weight) for composite samples taken from Area B April 2011. (Versar Inc., 2011)

Boring ID:		BVC-1	BVC-1	BVC-2	BVC-2	BVC-3	BVC-3	DE SIRS SCREENING LEVELS FOR SOIL (µg/kg)	DE SIRS SCREENING LEVEL FOR SEDIMENT (µg/kg)	ER-L SEDIMENT (µg/kg)	ER-M SEDIMENT (µg/kg)
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**				
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID				
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011				
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL				
4-Chlorophenyl phenyl ether	µg/kg	<40	<40	<40	<38	<100	<41	NL	NL	NL	NL
4-Methylphenol	µg/kg	<40	<40	<40	<38	<100	<41	610,000	NL	NL	NL
4-Nitroaniline	µg/kg	<200	<210	<200	<200	<540	<210	24,000	NL	NL	NL
4-Nitrophenol	µg/kg	<200	<210	<200	<200	<540	<210	NL	NL	NL	NL
Acenaphthene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	270,000	6.71	16	500
Acenaphthylene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	NL	NL	44	640
Acetophenone	µg/kg	<40	<40	<40	<38	<100	<41	780,000	NL	NL	NL
Anthracene	µg/kg	<8.0	<8.2	<8.0	<7.8	2.1	<8.3	1,000,000	46.9	85.3	1,100
Atrazine	µg/kg	<40	<40	<40	<38	<100	<41	2,100	NL	NL	NL
Benzaldehyde	µg/kg	<40	<40	<40	<38	<100	<41	780,000	NL	NL	NL
Benzidine	µg/kg	<800	<820	<800	<780	<2100	<830	0.5	NL	NL	NL
Benzo(a)anthracene	µg/kg	<8.0	<8.2	<8.0	<7.8	**5.9**	<8.3	900	74.8	261	1,600
Benzo(a)pyrene	µg/kg	<8.0	<8.2	<8.0	<7.8	**5.9**	<8.3	90	88.8	430	1,600
Benzo(b)fluoranthene	µg/kg	<8.0	<8.2	<8.0	<7.8	**7**	<8.3	900	NL	NL	NL
Benzo(ghi)perylene	µg/kg	<8.0	<8.2	<8.0	<7.8	**12**	<8.3	NL	NL	NL	NL
Benzo(k)fluoranthene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	9,000	NL	NL	NL
bis(2-Chloroethoxy)methane	µg/kg	<40	<40	<40	<38	<100	<41	18,000	NL	NL	NL
bis(2-Chloroethyl) ether	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	210	NL	NL	NL
bis(2-Chloroisopropyl) ether	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	NL	NL	NL	NL
bis(2-Ethylhexyl) phthalate	µg/kg	<40	<40	<40	<38	<100	<41	35,000	182	NL	NL
Butyl benzyl phthalate	µg/kg	<40	<40	<40	<38	<100	<41	260,000	16,800	NL	NL
Caprolactam	µg/kg	<200	<210	<200	<200	<540	<210	3,000,000	NL	NL	NL
Carbazole	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	NL	NL	NL	NL
Chrysene	µg/kg	<8.0	<8.2	<8.0	<7.8	4.4	<8.3	87,000	108	384	2,800
Di-n-butyl phthalate	µg/kg	<40	<40	<40	<38	<100	<41	610,000	1,160	NL	NL
Di-n-octyl phthalate	µg/kg	<40	<40	<40	<38	<100	**18**	61,000	NL	NL	NL

Table C-6. Results of MS Semi-volatile organics bulk sediment analysis (dry weight) for composite samples taken from Area B April 2011. (Versar Inc., 2011)

Boring ID:		BVC-1	BVC-1	BVC-2	BVC-2	BVC-3	BVC-3	DE SIRS SCREENING LEVELS FOR SOIL (µg/kg)	DE SIRS SCREENING LEVEL FOR SEDIMENT (µg/kg)	ER-L SEDIMENT (µg/kg)	ER-M SEDIMENT (µg/kg)
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**				
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID				
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011				
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL				
Dibenz(a,h)anthracene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	90	6.22	63.4	260
Dibenzofuran	µg/kg	<40	<40	<40	<38	<100	<41	7,800	7,300	NL	NL
Diethyl phthalate	µg/kg	<40	<40	<40	<38	<100	<41	4,900,000	218	NL	NL
Dimethyl phthalate	µg/kg	<40	<40	<40	<38	<100	<41	NL	6,000	NL	NL
Fluoranthene	µg/kg	<8.0	<8.2	<8.0	<7.8	**8.7**	<8.3	310,000	133	600	5,100
Fluorene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	300,000	21.2	19	540
Hexachlorobenzene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	300	NL	NL	NL
Hexachlorobutadiene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	6,100	NL	NL	NL
Hexachlorocyclopentadiene	µg/kg	<40	<40	<40	<38	<100	<41	37,000	139	NL	NL
Hexachloroethane	µg/kg	<40	<40	<40	<38	<100	<41	4,300	804	NL	NL
Indeno(1,2,3-cd)pyrene	µg/kg	<8.0	<8.2	<8.0	<7.8	**16**	<8.3	900	NL	NL	NL
Isophorone	µg/kg	<40	<40	<40	<38	<100	<41	510,000	NL	NL	NL
N-Nitrosodi-n-propylamine	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	69	NL	NL	NL
N-Nitrosodimethylamine	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	99,000	422,000	NL	NL
N-Nitrosodiphenylamine	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	99,000	422,000	NL	NL
Naphthalene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	5,000	34.6	160	2,100
Nitrobenzene	µg/kg	<8.0	<8.2	<8.0	<7.8	<21	<8.3	4,800	NL	NL	NL
Pentachlorophenol	µg/kg	<40	<40	<40	<38	<100	<41	890	NL	NL	NL
Phenanthrene	µg/kg	<8.0	<8.2	<8.0	<7.8	5.1	<8.3	1,000,000	86.7	240	1,500
Phenol	µg/kg	**29**	**27**	<8.0	**47**	**63**	<8.3	1,800,000	NL	NL	NL
Pyrene	µg/kg	<8.0	<8.2	<8.0	<7.8	7.2	<8.3	230,000	153	665	2,600

Table C-6. (continued). Results of MS Semi-volatile organics bulk sediment analysis (dry weight) for composite samples taken from Area B April 2011. (Versar Inc., 2011)

Boring ID:		**BVC-4**	**BVC-4**	**BVC-5**	**BVC-5**	**BVC-6**	**BVC-6**	**DE SIRS SCREENING LEVELS FOR SOIL (µg/kg)**	**DE SIRS SCREENING LEVELS FOR SEDIMENT (µg/kg)**	**ER-L SEDIMENT (µg/kg)**	**ER-M SEDIMENT (µg/kg)**
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**				
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID				
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011				
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL				
MSSEMI											
1,1-Biphenyl	µg/kg	<100	<50	<38	<38	<46	<49	5,100	NL	NL	NL
1,2,4-Trichlorobenzene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	6,200	473	NL	NL
1,2-Dichlorobenzene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	190,000	989	NL	NL
1,2-Diphenylhydrazine	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	610	NL	NL	NL
1,3-Dichlorobenzene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	NL	NL	NL	NL
1,4-Dichlorobenzene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	2,400	460	NL	NL
2,4,5-Trichlorophenol	µg/kg	<100	<50	<38	<38	<46	<49	610,000	819	NL	NL
2,4,6-Trichlorophenol	µg/kg	<100	<50	<38	<38	<46	<49	6,100	2,650	NL	NL
2,4-Dichlorophenol	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	18,000	NL	NL	NL
2,4-Dimethylphenol	µg/kg	<100	<50	<38	<38	<46	<49	120,000	NL	NL	NL
2,4-Dinitrophenol	µg/kg	<530	<260	<190	<200	<240	<250	12,000	NL	NL	NL
2,4-Dinitrotoluene	µg/kg	<100	<50	<38	<38	<46	<49	1,600	NL	NL	NL
2,6-Dinitrotoluene	µg/kg	<100	<50	<38	<38	<46	<49	330	NL	NL	NL
2-Chloronaphthalene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	630,000	NL	NL	NL
2-Chlorophenol	µg/kg	<100	<50	<38	<38	<46	<49	39,000	344	NL	NL
2-Methylnaphthalene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	1,000	20.2	70	670
2-Methylphenol	µg/kg	<100	<50	<38	<38	<46	<49	310,000	NL	NL	NL
2-Nitroaniline	µg/kg	<530	<260	<190	<200	<240	<250	61,000	NL	NL	NL
2-Nitrophenol	µg/kg	<100	<50	<38	<38	<46	<49	NL	NL	NL	NL
3,3-Dichlorobenzidine	µg/kg	<100	<50	<38	<38	<46	<49	1,100	2,060	NL	NL
3-Nitroaniline	µg/kg	<530	<260	<190	<200	<240	<250	NL	NL	NL	NL
4,6-Dinitro-2-methylphenol	µg/kg	<530	<260	<190	<200	<240	<250	490	NL	NL	NL
4-Bromophenyl phenyl ether	µg/kg	<100	<50	<38	<38	<46	<49	NL	NL	NL	NL
4-Chloro-3-methylphenol	µg/kg	<100	<50	<38	<38	<46	<49	610,000	NL	NL	NL

Table C-6. (continued). Results of MS Semi-volatile organics bulk sediment analysis (dry weight) for composite samples taken from Area B April 2011. (Versar Inc., 2011)

Boring ID:		**BVC-4**	**BVC-4**	**BVC-5**	**BVC-5**	**BVC-6**	**BVC-6**	**DE SIRS SCREENING LEVELS FOR SOIL (µg/kg)**	**DE SIRS SCREENING LEVELS FOR SEDIMENT (µg/kg)**	**ER-L SEDIMENT (µg/kg)**	**ER-M SEDIMENT (µg/kg)**
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**				
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID				
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011				
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL				
4-Chloroaniline	µg/kg	<100	<50	<38	<38	<46	<49	2,400	NL	NL	NL
4-Chlorophenyl phenyl ether	µg/kg	<100	<50	<38	<38	<46	<49	NL	NL	NL	NL
4-Methylphenol	µg/kg	<100	<50	<38	<38	<46	<49	610,000	NL	NL	NL
4-Nitroaniline	µg/kg	<530	<260	<190	<200	<240	<250	24,000	NL	NL	NL
4-Nitrophenol	µg/kg	<530	<260	<190	<200	<240	<250	NL	NL	NL	NL
Acenaphthene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	270,000	6.71	16	500
Acenaphthylene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	NL	NL	44	640
Acetophenone	µg/kg	<100	<50	<38	<38	<46	<49	780,000	NL	NL	NL
Anthracene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	1,000,000	46.9	85.3	1,100
Atrazine	µg/kg	<100	<50	<38	<38	<46	<49	2,100	NL	NL	NL
Benzaldehyde	µg/kg	<100	<50	<38	<38	<46	<49	780,000	NL	NL	NL
Benzidine	µg/kg	<2100	<1000	<770	<780	<940	<990	0.5	NL	NL	NL
Benzo(a)anthracene	µg/kg	<21	<10	**1.8**	<7.8	<9.4	<9.9	900	74.8	261	1,600
Benzo(a)pyrene	µg/kg	**15**	<10	**1.4**	<7.8	<9.4	<9.9	90	88.8	430	1,600
Benzo(b)fluoranthene	µg/kg	<21	<10	**2.1**	<7.8	<9.4	<9.9	900	NL	NL	NL
Benzo(ghi)perylene	µg/kg	<21	<10	**4.3**	<7.8	<9.4	<9.9	NL	NL	NL	NL
Benzo(k)fluoranthene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	9,000	NL	NL	NL
bis(2-Chloroethoxy)methane	µg/kg	<100	<50	<38	<38	<46	<49	18,000	NL	NL	NL
bis(2-Chloroethyl) ether	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	210	NL	NL	NL
bis(2-Chloroisopropyl) ether	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	NL	NL	NL	NL
bis(2-Ethylhexyl) phthalate	µg/kg	<100	<50	<38	<38	<46	<49	35,000	182	NL	NL
Butyl benzyl phthalate	µg/kg	<100	<50	<38	<38	**11**	**8.7**	260,000	16,800	NL	NL
Caprolactam	µg/kg	<530	<260	<190	<200	<240	<250	3,000,000	NL	NL	NL
Carbazole	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	NL	NL	NL	NL
Chrysene	µg/kg	<21	<10	**1.6**	<7.8	<9.4	<9.9	87,000	108	384	2,800

Table C-6. (continued). Results of MS Semi-volatile organics bulk sediment analysis (dry weight) for composite samples taken from Area B April 2011. (Versar Inc., 2011)

Boring ID:		**BVC-4**	**BVC-4**	**BVC-5**	**BVC-5**	**BVC-6**	**BVC-6**	**DE SIRS SCREENING LEVELS FOR SOIL (µg/kg)**	**DE SIRS SCREENING LEVELS FOR SEDIMENT (µg/kg)**	**ER-L SEDIMENT (µg/kg)**	**ER-M SEDIMENT (µg/kg)**
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**				
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID				
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011				
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL				
Di-n-butyl phthalate	µg/kg	<100	<50	<38	<38	<46	<49	610,000	1,160	NL	NL
Di-n-octyl phthalate	µg/kg	**59**	**44**	**53**	**40**	**55**	**24**	61,000	NL	NL	NL
Dibenz(a,h)anthracene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	90	6.22	63.4	260
Dibenzofuran	µg/kg	<100	<50	<38	<38	<46	<49	7,800	7,300	NL	NL
Diethyl phthalate	µg/kg	<100	<50	<38	<38	<46	<49	4,900,000	218	NL	NL
Dimethyl phthalate	µg/kg	<100	<50	<38	<38	<46	<49	NL	6,000	NL	NL
Fluoranthene	µg/kg	<21	**1.1**	**2.8**	<7.8	<9.4	<9.9	310,000	133	600	5,100
Fluorene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	300,000	21.2	19	540
Hexachlorobenzene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	300	NL	NL	NL
Hexachlorobutadiene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	6,100	NL	NL	NL
Hexachlorocyclopentadiene	µg/kg	<100	<50	<38	<38	<46	<49	37,000	139	NL	NL
Hexachloroethane	µg/kg	<100	<50	<38	<38	<46	<49	4,300	804	NL	NL
Indeno(1,2,3-cd)pyrene	µg/kg	<21	<10	**5.5**	<7.8	<9.4	<9.9	900	NL	NL	NL
Isophorone	µg/kg	<100	<50	<38	<38	<46	<49	510,000	NL	NL	NL
N-Nitrosodi-n-propylamine	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	69	NL	NL	NL
N-Nitrosodimethylamine	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	99,000	422,000	NL	NL
N-Nitrosodiphenylamine	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	99,000	422,000	NL	NL
Naphthalene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	5,000	34.6	160	2,100
Nitrobenzene	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	4,800	NL	NL	NL
Pentachlorophenol	µg/kg	<100	<50	<38	<38	<46	<49	890	NL	NL	NL
Phenanthrene	µg/kg	<21	<10	**2.3**	<7.8	<9.4	<9.9	1,000,000	86.7	240	1,500
Phenol	µg/kg	<21	<10	<7.7	<7.8	<9.4	<9.9	1,800,000	NL	NL	NL
Pyrene	µg/kg	<21	<10	**2.4**	<7.8	<9.4	<9.9	230,000	153	665	2,600

Table C-7. Results of GC Semivolatile organics (pesticides) bulk sediment analysis (dry weight) for composite samples taken from Area B in April 2011. (Versar Inc., 2011)

Boring ID:		**BVC-1**	**BVC-1**	**BVC-2**	**BVC-2**	**BVC-3**	**BVC-3**	**DE SIRS SCREENING LEVELS FOR SOIL (µg/kg)**	**DE SIRS SCREENING LEVELS FOR SEDIMENT (µg/kg)**	**ER-L SEDIMENT (µg/kg)**	**ER-M SEDIMENT (µg/kg)**
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**				
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID				
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011				
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL				
GCSEMI											
4,4-DDD	µg/kg	<1.0	**0.18**	**0.18**	<0.96	**0.25**	**0.16**	2,000	1.2	2	20
4,4-DDE	µg/kg	<1.0	<1.0	<1.0	<0.96	**0.69**	**0.95**	1,400	1.2	2	15
4,4-DDT	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	1,700	1.19	1.58	46.1
NL Aldrin	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	29	NL	NL	NL
alpha-BHC	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	77	1,360	NL	NL
alpha-Chlordane	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	1,600	NL	0.5	6
Aroclor 1016	µg/kg	<5.0	<5.1	<5.0	<4.8	<5.3	<5.2	390	NL	NL	NL
Aroclor 1221	µg/kg	<5.0	<5.1	<5.0	<4.8	<5.3	<5.2	140	NL	NL	NL
Aroclor 1232	µg/kg	<5.0	<5.1	<5.0	<4.8	<5.3	<5.2	140	NL	NL	NL
Aroclor 1242	µg/kg	<5.0	<5.1	<5.0	<4.8	<5.3	<5.2	220	NL	NL	NL
Aroclor 1248	µg/kg	<5.0	<5.1	<5.0	<4.8	<5.3	<5.2	220	NL	NL	NL
Aroclor 1254	µg/kg	<5.0	<5.1	<5.0	<4.8	<5.3	<5.2	110	63.3	NL	NL
Aroclor 1260	µg/kg	<5.0	<5.1	<5.0	<4.8	<5.3	<5.2	220	NL	NL	NL
beta-BHC	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	270	NL	NL	NL
Chlordane (technical)	µg/kg	<10	<10	<10	<9.6	<10	<10	NL	NL	NL	NL
delta-BHC	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	270	NL	NL	NL
Dieldrin	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	**0.24**	30	0.72	0.02	8
Endosulfan I	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	37,000	0.107	NL	NL
Endosulfan II	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	NL	NL	NL	NL
Endosulfan sulfate	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	NL	NL	NL	NL
Endrin	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	1,800	2.67	0.02	45
Endrin aldehyde	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	NL	NL	NL	NL
Endrin ketone	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	NL	NL	NL	NL
gamma-BHC (Lindane)	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	520	0.32	NL	NL
gamma-Chlordane	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	**0.54**	1,600	NL	0.5	6
Heptachlor	µg/kg	<1.0	<1.0	**0.34**	<0.96	<1.0	<1.0	110	NL	NL	NL
Heptachlor epoxide	µg/kg	<1.0	<1.0	<1.0	<0.96	<1.0	<1.0	53	0.6	NL	NL
Methoxychlor	µg/kg	<2.0	<2.0	**0.4**	<1.9	<2.1	<2.1	3,100	29.6	NL	NL
Toxaphene	µg/kg	<40	<41	<40	<38	<42	<42	440	536	NL	NL

Table C-7 (cont.)											
Boring ID:		**BVC-4**	**BVC-4**	**BVC-5**	**BVC-5**	**BVC-6**	**BVC-6**	**DE SIRS SCREENING LEVELS FOR SOIL (µg/kg)**	**DE SIRS SCREENING LEVELS FOR SEDIMENT (µg/kg)**	**ER-L SEDIMENT (µg/kg)**	**ER-M SEDIMENT (µg/kg)**
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**				
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID				
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011				
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL				
GCSEMI											
4,4-DDD	µg/kg	**0.3**	**0.35**	**0.12**	**0.15**	**0.22**	**0.24**	2,000	1.2	2	20
4,4-DDE	µg/kg	**0.24**	**0.57**	**0.19**	<0.97	**0.29**	**0.38**	1,400	1.2	2	15
4,4-DDT	µg/kg	<1.0	3.6	<0.95	<0.97	<1.2	<1.2	1,700	1.19	1.58	46.1
Aldrin	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	29	NL	NL	NL
alpha-BHC	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	77	1,360	NL	NL
alpha-Chlordane	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	1,600	NL	0.5	6
Aroclor 1016	µg/kg	<5.2	<6.3	<4.7	<4.9	<5.9	<6.1	390	NL	NL	NL
Aroclor 1221	µg/kg	<5.2	<6.3	<4.7	<4.9	<5.9	<6.1	140	NL	NL	NL
Aroclor 1232	µg/kg	<5.2	<6.3	<4.7	<4.9	<5.9	<6.1	140	NL	NL	NL
Aroclor 1242	µg/kg	<5.2	<6.3	<4.7	<4.9	<5.9	<6.1	220	NL	NL	NL
Aroclor 1248	µg/kg	<5.2	<6.3	<4.7	<4.9	<5.9	<6.1	220	NL	NL	NL
Aroclor 1254	µg/kg	<5.2	<6.3	<4.7	<4.9	<5.9	<6.1	110	63.3	NL	NL
Aroclor 1260	µg/kg	<5.2	<6.3	<4.7	<4.9	<5.9	<6.1	220	NL	NL	NL
beta-BHC	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	270	NL	NL	NL
Chlordane (technical)	µg/kg	<10	<13	<9.5	<9.7	<12	<12	NL	NL	NL	NL
delta-BHC	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	270	NL	NL	NL
Dieldrin	µg/kg	**0.23**	**0.29**	<0.95	<0.97	<1.2	<1.2	30	0.72	0.02	8
Endosulfan I	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	37,000	0.107	NL	NL
Endosulfan II	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	NL	NL	NL	NL
Endosulfan sulfate	µg/kg	<1.0	0.14	<0.95	<0.97	<1.2	<1.2	NL	NL	NL	NL
Endrin	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	1,800	2.67	0.02	45
Endrin aldehyde	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	NL	NL	NL	NL
Endrin ketone	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	NL	NL	NL	NL
gamma-BHC (Lindane)	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	520	0.32	NL	NL
gamma-Chlordane	µg/kg	**0.28**	**0.26**	<0.95	<0.97	<1.2	<1.2	1,600	NL	0.5	6
Heptachlor	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	110	NL	NL	NL
Heptachlor epoxide	µg/kg	<1.0	<1.3	<0.95	<0.97	<1.2	<1.2	53	0.6	NL	NL
Methoxychlor	µg/kg	<2.1	<2.5	<1.9	<1.9	<2.4	<2.5	3,100	29.6	NL	NL
Toxaphene	µg/kg	<41	<51	<38	<39	<47	<49	440	536	NL	NL

Table C-8. Results of high resolution PCB, Dioxin, and Furan sediment analysis (dry weight) for composite samples taken from Area B in April 2011. (Versar Inc., 2011)

Boring ID:		**BVC-2**	**BVC-2**	**BVC-5**	**BVC-5**
Depth:		**(0-3 ft.)**	**(3-10 ft.)**	**(0-3 ft.)**	**(3-10 ft.)**
Sample Matrix:		SOLID	SOLID	SOLID	SOLID
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011
Analyte:	Unit	LDL	LDL	LDL	LDL
Total HpCDD	pg/g	24	14	15	12
Total HpCDF	pg/g	0.18	0.17	1.5	0.24
Total HxCDD	pg/g	9	6.1	5.7	5.2
Total HxCDF	pg/g	<3.0	<2.9	0.92	0.22
Total PeCDD	pg/g	1.2	0.91	0.42	0.65
Total PeCDF	pg/g	<3.0	<2.9	0.81	<2.9
Total TCDD	pg/g	0.9	0.5	0.31	0.62
Total TCDF	pg/g	<0.60	<0.58	1.2	0.12
OCDD	pg/g	95	59	74	55
OCDF	pg/g	<6.0	0.35	1.9	0.51
Sum of Dioxin and Furan Homologs	**pg/g**	**130.28**	**81.03**	**101.76**	**74.56**
Monochlorobiphenyl (total)	ng/g	0.0018	0.00021	0.0036	0.0018
Dichlorobiphenyl (total)	ng/g	0.018	0.0049	0.033	0.021
Trichlorobiphenyl (total)	ng/g	0.029	0.0033	0.07	0.036
Tetrachlorobiphenyl (total)	ng/g	0.034	0.0039	0.12	0.044
Pentachlorobiphenyl (total)	ng/g	0.034	0.0044	0.14	0.04
Hexachlorobiphenyl (total)	ng/g	0.035	0.0037	0.15	0.041
Heptachlorobiphenyl (total)	ng/g	0.016	0.0012	0.088	0.021
Octachlorobiphenyl (total)	ng/g	0.0072	<0.0058	0.054	0.013
Nonachlorobiphenyl (total)	ng/g	0.0081	0.0015	0.074	0.017
Decachlorobiphenyl (total)	ng/g	0.0096	0.0019	0.088	0.021
Sum of PCB Congeners	**ng/g**	**0.1927**	**0.02501**	**0.8206**	**0.2558**

Table C-9. Results of Dioxin and Furan Toxicity Equivalency analysis for composite samples taken from Area B in April 2011 (Versar, Inc., 2011, Van den Berg et.al. 2006)

			BVC-2 (0-3 ft.)		**BVC-2 (3-10 ft.)**		**BVC-5 (0-3 ft.)**		**BVC-5 (3-10 ft.)**	
Analyte:	**TEF (WHO/2005)**	**Unit**	**LDL**	**TEQ**	**LDL**	**TEQ**	**LDL**	**TEQ**	**LDL**	**TEQ**
DIOXIN										
2,3,7,8-TCDD	1	pg/g	0	0	0	0	0	0	0	0
1,2,3,7,8-PeCDD	1	pg/g	0	0	0	0	0	0	0	0
1,2,3,4,7,8-HxCDD	0.1	pg/g	0	0	0.096	0.0096	0.07	0.007	0	0
1,2,3,7,8,9-HxCDD	0.1	pg/g	0	0	0.13	0.013	0	0	0	0
1,2,3,6,7,8-HxCDD	0.1	pg/g	0.2	0.02	0.14	0.014	0.2	0.02	0	0
1,2,3,4,6,7,8-HpCDD	0.01	pg/g	5.5	0.055	3.3	0.033	4.3	0.043	3.1	0.031
OCDD	0.0003	pg/g	95	0.0285	59	0.0177	74	0.0222	55	0.0165
Sum of Dioxin TEQs		**pg/g**		**0.1035**		**0.0873**		**0.0922**		**0.0475**
FURANS										
2,3,7,8-TCDF	0.1	pg/g	0	0	0	0	0.23	0.023	0	0
1,2,3,7,8-PeCDF	0.03	pg/g	0	0	0	0	0.077	0.00231	0	0
2,3,4,7,8-PeCDF	0.3	pg/g	0	0	0	0	0	0	0	0
1,2,3,4,7,8-HxCDF	0.1	pg/g	0	0	0	0	0.18	0.018	0.069	0.0069
1,2,3,7,8,9-HxCDF	0.1	pg/g	0	0	0	0	0	0	0	0
1,2,3,6,7,8-HxCDF	0.1	pg/g	0	0	0	0	0.08	0.008	0	0
2,3,4,6,7,8-HxCDF	0.1	pg/g	0	0	0	0	0	0	0	0
1,2,3,4,6,7,8-HpCDF	0.01	pg/g	0.18	0.0018	0.088	0.00088	1	0.01	0.24	0.0024
1,2,3,4,7,8,9-HpCDF	0.01	pg/g	0	0	0.085	0.00085	0	0	0	0
OCDF	0.0003	pg/g	0	0	0.35	0.000105	1.9	0.00057	0.51	0.000153
Sum of Furans TEQs		pg/g		**0.0018**		**0.001835**		**0.06188**		**0.009453**
Total TEQs (parts per trillion)		pg/g		**0.1053**		**0.089135**		**0.15408**		**0.056953**

EPA Res Soil Criterion 1,000 parts per trillion TEQ
EPA Non-Res Soil Criterion 5,000 parts per trillion TEQ

Table C-10. Results of PCB Toxicity Equivalency analysis for composite samples taken from Area B in April 2011 (Versar Inc., 2011 Van den Berg et.al. 2006)										
			BVC-2 (0-3 ft.)		**BVC-2 (3-10 ft.)**		**BVC-5 (0-3 ft.)**		**BVC-5 (3-10 ft.)**	
Analyte:	**TEF (WHO/2005)**	**Unit**	**LDL**	**TEQ**	**LDL**	**TEQ**	**LDL**	**TEQ**	**LDL**	**TEQ**
PCB 77 (BZ)	0.0001	ng/g	0.0012	0.00000012	0	0	0.005	0.002	0.002	0.0000002
PCB 81 (BZ)	0.0003	ng/g	0	0	0	0	0	0	0	0
PCB 126 (BZ)	0.1	ng/g	0		0		0	0	0	
PCB 169 (BZ)	0.03	ng/g	0		0		0	0	0	
PCB 105 (BZ)	0.00003	ng/g	0.0023	0.000000069	0.00029	8.7E-09	0.0069	0.002	0.002	0.00000006
PCB 114 (BZ)	0.00003	ng/g	0	0	0	0	0.00037	0	0	0
PCB 118 (BZ)	0.00003	ng/g	0.0074	0.000000222	0.00089	2.67E-08	0.024	0.0079	0.0079	0.000000237
PCB 123 (BZ)	0.00003	ng/g	0	0	0	0	0.00026	0	0	0
PCB 156 (BZ)	0.00003	ng/g	0.00056	1.68E-08	0	0	0.0021	0.00049	0.00049	1.47E-08
PCB 157 (BZ)	0.00003	ng/g	0.00056	1.68E-08	0	0	0.0021	0.00049	0.00049	1.47E-08
PCB 167 (BZ)	0.00003	ng/g	0	0	0	0	0.00095	0	0	0
PCB 189 (BZ)	0.00003	ng/g	0	0	0	0	0.00029	0	0	0
Sum of PCB TEQs (parts per billion)		ng/g		**4.446E-07**		**3.54E-08**		**0.01288**		**5.264E-07**
EPA Res Soil Criterion 1 part per billion TEQ **EPA Non-Res Soil Criterion 5 parts per billion TEQ**										

Table C-11. Summary of PCB congener concentrations observed in sediment collected from Area B sediments (Duffield Associates, 2000). All units in pg/g (parts per trillion)						
Proposed Sand Source	**Core Composite**	Sum of PCB Congeners (pg/g)	**DE SIRS SCREENING LEVELS FOR SOIL** (pg/g)	**DE SIRS SCREENING LEVELS FOR SEDIMENT** (pg/g)	**ER-L** (pg/g)	**ER-M** (pg/g)
			220,000 (high risk)	40,000 (high risk)	22,700	180,000
Area B	KHV-95E	352.7				
	KHV-99E	666.3				
	KHV-101E	582.4				

Table C-12 . Summary of Analytic Testing Results for Polychlorinated Dibenzo Dioxins and Furans Composite Sediment Samples (Duffield Associates, 2000).				
Parameters	**Area B (Duffield Associates, 2000)**			
	Method Blank (pg/g)	**KHV-95E (pg/g)**	**KHV-99E (pg/g)**	**KHV-101E (pg/g)**
2,3,7,8-TCDD	0.101	0.122 U	0.159 U	0.0941 U
1,2,3,7,8-PeCDD	0.344	0.32 B	0.171 B	0.215 U/ EMPC
1,2,3,4,7,8-HxCDD	0.289	0.312	0.199	0.174
1,2,3,6,7,8 –HxCDD	0.089	0.135	0.13	0.0805 U
1,2,3,7,8,9-HxCDD	0.0697	0.185	0.123 U/EMPC	0.0772 U
1,2,3,4,6,7,8-HpCDD	0.526	2.82	2.25	0.591 B
OCDD	3.34	46.8	28.5	5.72 B
Total HxCDD	**0**	**0.632**	**0.329**	**0.174**
Total Dioxins w/blank masked values	**4.21**	**50.572**	**31.25**	**6.485**
Total Dioxins w/o blank masked values	**N/A**	**50.252**	**31.079**	**0.174**
2,3,7,8-TCDF	0.101	0.108 U	0.167 U/EMPC	0.122
1,2,3,7,8-PeCDF	0.110	0.122 U/EMPC	0.136	0.0733
2,3,4,7,8-PeCDF	0.0887	0.0684 U/EMPC	0.097 U/EMPC	0.0707 U
1,2,3,4,7,8-HxCDF	0.0767	0.08	0.092	0.147
1,2,3,6,7,8 –HxCDF	0.204	0.171 B	0.169 B	0.153 B
1,2,3,7,8,9-HxCDF	0.576	0.461 U/EMPC	0.372 B	0.436 B
2,3,4,6,7,8-HxCDF	0.186	0.145 B	0.137 U/EMPC	0.109 U/EMPC
1,2,3,4,6,7,8-HpCDF	0.141	0.2 B	0.493	0.0785 B
1,2,3,4,7,8,9-HpCDF	0.099	0.0578 B	0.128 U/EMPC	0.0788 U
OCDF	0.248	0.287 B	1.04	0.179 U/EMPC
Total Furans w/blank masked values	**1.4540**	**0.9408**	**2.302**	**1.0090**
Total Furans w/o blank masked values	**N/A**	**0.08**	**1.761**	**0.3423**

Table C-13. Toxicity Equivalent Value of Dioxins and Furans observed in sediment collected from HCS, Area B and Area G sediments (Duffield Associates, 2000a). All units in pg/g (parts per trillion).					
Core Composite	Total Toxicity Equivalent (TEQ) as 2,3,7,8-TCDD for Dioxins and Furans (pg/g)	Total Toxicity Equivalent (TEQ) as 2,3,7,8 – TCDD for Coplanar PCBs (pg/g)	Total Toxicity Equivalent (TEQ) as 2,3,7,8 – TCDD (pg/g)(combined)	**DNREC SIRS Screening Level for Soil 2,3,7,8 – TCDD (pg/g)**	**EPA Region III Residential Soil RBC 2,3,7,8 - TCDD**
				4.5	4.3
KHV-95E	0.146	0.027	0.174		
KHV-99E	0.106	0.089	0.195		
KHV-101E	0.048	0.017	0.065		

Table C-14. Results of Radio Chemical analysis for composite samples taken from Area B in April 2011 (Versar Inc., 2011).

Boring ID:		**BVC-1 (0-3 ft.)**	**BVC-1 (3-10 ft.)**	**BVC-2 (0-3 ft.)**	**BVC-2 (3-10 ft.)**	**BVC-3 (0-3 ft.)**	**BVC-3 (3-10 ft.)**
Depth:							
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL
Gross Alpha	Pci/g	8.8	10.7	<10	<10	8.9	9.9
Gross Beta	Pci/g	18.8	14.3	13.5	9.1	14.7	15.9
Radium 226	Pci/g	0.12	<1	0.19	0.146	0.24	0.22
Radium 227	Pci/g	7.9	<1	<1	<1	<1	<1
Boring ID:		**BVC-4 (0-3 ft.)**	**BVC-4 (3-10 ft.)**	**BVC-5 (0-3 ft.)**	**BVC-5 (3-10 ft.)**	**BVC-6 (0-3 ft.)**	**BVC-6 (3-10 ft.)**
Depth:							
Sample Matrix:		SOLID	SOLID	SOLID	SOLID	SOLID	SOLID
Sample Date:		4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011	4/21/2011
Analyte:	Unit	LDL	LDL	LDL	LDL	LDL	LDL
Gross Alpha	Pci/g	16.9	15.4	11	7.7	24.7	17.9
Gross Beta	Pci/g	20.8	25.5	13.5	22.2	20.4	28.1
Radium 226	Pci/g	0.42	0.83	<1	0.143	0.72	0.88
Radium 227	Pci/g	<1	1.03	<1	<1	<1	<1

Abbreviations and Notes

J =	Estimated concentration – Substance was detected during the analysis at a concentration below the practical limit of quantitation, but above the method detection limit.
MDL =	Method Detection Limit – Lower limit of detection for the analysis. Values shown ae not adjusted for sample moisture content
ND =	Not Detected by during the analysis
NL =	Not Listed
NS =	No standard – substance is listed, but a standard has not been set.
NM =	Not measured – substance was not analyzed
ng/kg =	dry weight concentration - nanograms per kilogram or parts per trillion
pg/g =	dry weight concentration – picograms per gram or parts per trillion
ug/kg =	dry weight concentration - micrograms per kilogram or parts per billion
mg/kg =	dry weight concentration - milligrams per kilogram or parts per million
mg/l =	liquid concentration - milligrams per liter or parts per million
DNREC Screening Levels for Soil =	Delaware Department of Natural Resources and Environmental Control Uniform Risk-Based Standards, unrestricted Use in Critical Water Resource Area, December 1999
EPA III RBC-Res. Soil =	US EPA Region III Risk-Based Concentration for Residential Soil, April 2000
ER-L, ER-M =	Effects Range-Low and Effects Range-Median, respectively, Long et. al. 1995.
U =	Undetected with a noise based detection
EMPC =	A peak was detected that did not meet ion ration criteria. The peaks were summed to calculate an Estimated Maximum Possible Concentration given as the detection limit in pg/g
B =	Substance detected at less than three times the concentration detected in the method blank analyzed by MRI. MRI dismissed these concentrations as “analytic background”, meaning that MRI’s analysis does not believe that the substance is present in the sample.

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APPENDIX-D

AIR EMISSIONS ESTIMATES

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CLEAN AIR ACT
STATEMENT OF CONFORMITY
DELAWARE ATLANTIC COAST CAPE HENLOPEN TO FENWICK ISLAND
STORM DMAGE REDUCTION PROJECT PERIODIC NOURISHMENT
SUSSEX COUNTY, DELAWARE

Based on the conformity analysis in the subject report, I have determined that the proposed action conforms to the applicable State Implementation Plan (SIP). The conformity analysis provided a detailed accounting of the emissions resulting from the project construction utilizing two scenarios: the existing Fenwick Island Borrow Area, which is the furthest from Rehoboth and Dewey Beach and the proposed Area B, which is the closest. These emissions were estimated to be below the General Conformity trigger levels of 100 tons per year of NOx and 50 tons per year of VOCs for a marginal nonattainment area. All other Delaware Atlantic Coast project locations and distances are intermediate to these two scenarios. Therefore, all dredging options that utilize the existing borrow areas (Fenwick Island and Area E) and/or the proposed borrow area B with a sand quantity of 400,000 cubic yards or less would be below these thresholds.

General Conformity under the Clean Air Act, Section 176 has been evaluated for the project according to the requirements of 40 CFR 93, Subpart B. The requirements of this rule are not applicable to this project because the total emissions from the project are below the conformity threshold values established at 40 CFR 93.153(b) for ozone (NOx and VOCs) in a marginal nonattainment area (100 tons of NOx and 50 tons of VOCs per year).

____
Date

____
Michael A. Bliss
Lieutenant Colonel, Corps of Engineers
District Engineer

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DEWEY BEACH & REHOBOTH BEACH
Borrow Area: AREA "B"
TABLE 1 - PROJECT EMISSION SOURCES AND ESTIMATED POWER

								NOx		VOC	
17 BEACH REPLENISHMENT	**# of Engines**	**HP**	**Load Factor (LF)**	**EQ Hours**	**Hrs/Day**	**days of operation***	**hp-hr**	**Emission Factors (g/hp-hr)**	**Emissions (tons)** 907200	**Emission Factors (g/hp-hr)**	**Emissions (tons)**
INITIAL NOURISHMENT, YEAR 1											
170001 Mobilization, Demobilization Preparatory Work											
TRUCK, HIGHWAY, CONVENTIONAL, 8,600 LBS (3,901KG)GVW, 4X2, 2 AXLE, 3/4 TON -PICKUP	1	130	0.570	296.00	8.00	37.00	21,933.6	9.200	0.222	1.300	0.031
TRUCK, HIGHWAY, 55,000 LBS (24,948KG) GVW, 6X4, 3 AXLE, (ADD ACCESSORIES)	5	310	0.570	192.00	8.00	24.00	169,632.0	9.200	1.720	1.300	0.243
HOPPER, PROPULSION*	1	9,000	0.400	19.20	24.00	0.80	69,120.0	9.700	0.739	0.370	0.028
HOPPER, AUXILIARY*	1	1,000	0.400	19.20	24.00	0.80	7,680.0	7.500	0.063	0.200	0.002
WORK TUG, PRIMARY	1	4,000	0.690	19.20	24.00	0.80	52,992.0	9.700	0.567	0.370	0.022
WORK TUG, SECONDARY Electric	1	50	0.400	19.20	24.00	0.80	384.0	7.500	0.003	0.200	0.000
SUVEY BOAT, SHORE	1	100	0.500	19.20	24.00	0.80	960.0	9.700	0.010	0.370	0.000
SUVEY BOAT, SHORE, SECONDARY Electric	1	40	0.400	19.20	24.00	0.80	307.2	7.500	0.003	0.200	0.000
DERRICK, PRIMARY	1	200	0.400	19.20	24.00	0.80	1,536.0	7.500	0.013	0.200	0.000
DERRICK, SECONDARY Electric	1	40	0.400	19.20	24.00	0.80	307.2	7.500	0.003	0.200	0.000
SUVEY BOAT, OFFSHORE	1	500	0.690	19.20	24.00	0.80	6,624.0	9.700	0.071	0.370	0.003
SUVEY BOAT, OFFSHORE, SECONDARY Electric	1	40	0.430	19.20	24.00	0.80	330.2	7.500	0.003	0.200	0.000
170017 Hopper Dredging											
TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	1	135	0.570	408.00	15.60	26.20	31,451.0	9.200	0.319	1.300	0.045
TRACTOR, CRAWLER (DOZER), 410 HP, POWERSHIFT, W/17.7 CY SEMI-U BLADE (ADD ATTACHMENTS)	4	410	0.590	715.52	15.60	45.90	692,840.3	9.500	7.255	1.300	0.993
LOADER, FRONT END, WHEEL, INTEGRATED TOOL CARRIER, 1.75 CY (1.3 M3) LOADER; 6,303 LB (2,859 KG) @ 12.17' (3.7 M) HIGH, FORK LIFT, OR 1,841 LB (835 KG) @ 22.42' (6.8 M) HIGH, MATERIAL HANDLING ARM	1	90	0.590	178.88	15.60	11.50	9,526.1	9.500	0.100	1.300	0.014
HOPPER, PROPULSION*	1	9,000	0.400	408.07	15.60	26.20	1,471,392.0	9.700	15.732	0.370	0.600
HOPPER, DREDGE*	1	3,000	0.400	408.07	15.60	26.20	490,464.0	7.500	4.055	0.200	0.108
HOPPER, AUXILIARY*	1	1,000	0.400	408.07	15.60	26.20	163,488.0	7.500	1.352	0.200	0.036
WORK TUG, PRIMARY	1	1,000	0.690	408.07	15.60	26.20	282,016.8	9.700	3.015	0.370	0.115
WORK TUG, SECONDARY Electric	1	50	0.400	408.07	15.60	26.20	8,174.4	7.500	0.068	0.200	0.002
SUVEY BOAT, SHORE	1	100	0.500	408.07	15.60	26.20	20,436.0	9.700	0.219	0.370	0.008
SUVEY BOAT, SHORE, SECONDARY Electric	1	40	0.400	408.07	15.60	26.20	6,539.5	7.500	0.054	0.200	0.001
DERRICK, PRIMARY	1	200	0.400	408.07	15.60	26.20	32,697.6	7.500	0.270	0.200	0.007
DERRICK, SECONDARY Electric	1	40	0.400	408.07	15.60	26.20	6,539.5	7.500	0.054	0.200	0.001
FLOATING BOOSTER, PRIMARY	1	5,200	0.430	408.07	15.60	26.20	913,897.9	9.500	9.570	0.200	0.201
FLOATING BOOSTER, SECONDARY	1	200	0.430	408.07	15.60	26.20	35,149.9	7.500	0.291	0.200	0.008
SUVEY BOAT, OFFSHORE	1	500	0.690	408.07	15.60	26.20	141,008.4	9.700	1.508	0.370	0.058
SUVEY BOAT, OFFSHORE, SECONDARY Electric	1	40	0.430	408.07	15.60	26.20	7,030.0	7.500	0.058	0.200	0.002
								NOx Emissions (tons) =	47.3		
										VOCs Emissions (tons) =	2.5

*Load Factors Obtained from ENVIRON International Corp. and Woods Hole Group (2013).

Dredge Duration Time = 0.86 Months 0.86 Total Duration
Effective Work Time = 474.5 Hrs/Month
Effective Work Time = 15.6 Hrs/Day
Effective Work Time = 16 Hrs/Day, Rounded
Time Efficiency = 65%
Daily Shift = 8 Hrs/Day
hp-hr = # of engines*hp*LF*hrs/day*days of operation
Load Factor (LF) represents the average percentage of rated horsepower used during a source's operational profile.
Emissions (g) = Power Demand (hp-hr) * Emission Factor (g/hp-hr)
Emissions (tons) = Emissions (g) * (1 ton/907200 g)

One way travel time Mobilization in DE = 0.4 days

One way travel time demobilization in DE = 0.4 days

Table 2 : Pollutant Emissions from Employee Vehicles For Borrow Area B

Assumptions:

Average trip distance (1 way) is 30 miles.
Every member of the work crew drives their own vehicle.
Mob/demob Dredge Crew: Crew of 28 will travel to work 3.28 days. Crew of 28 will travel from work 4 days.
Mob/demob Shore Crew: Crew of 13 will travel to work 46 days. Crew of 13 will travel from work 46 days.
Beachfill Crew: Crew of 28 will travel to work 46 days. Crew of 28 will travel from work 46 days.
Shore Crew: Crew of 13 will travel to work 46 days. Crew of 13 will travel from work 46 days.
Average NOx vehicle emission factor is 0.96 g/mile.
Average VOC vehicle emission factor is 0.84 g/mile.

NOx

Construction Stage	# Workers	Trips/day	#days	miles/trip	0.96 g of Nox/mile		Total Nox
Mob/demob Dredge Crew	28	2	3.28	30	0.96		0.005831
Mob/demob Shore Crew	13	2	3.28	30	0.96		0.002707
Beachfill Crew	28	2	30	30	0.96		0.053333
Shore Crew	13	2	30	30	0.96		0.024762
				TOTAL NOx (Tons):			**0.09**

VOC

Construction Stage	# Workers	Trips/day	#days	miles/trip	0.84 g of VOC/mile		Total VOC
Mob/demob Dredge Crew	28	2	3.28	30	0.84		0.005102
Mob/demob Shore Crew	13	2	3.28	30	0.84		0.002369
Beachfill Crew	28	2	30	30	0.84		0.046667
Shore Crew	13	2	30	30	0.84		0.021667
				TOTAL VOCs (Tons):			**0.075804**

DEWEY BEACH & REHOBOTH BEACH
Borrow Area: FENWICK ISLAND
TABLE 1 - PROJECT EMISSION SOURCES AND ESTIMATED POWER

17 BEACH REPLENISHMENT	**# of Engines**	**HP**	**Load Factor (LF)**	**EQ Hours**	**Hrs/Day**	**days of operation***	**hp-hr**	**NOx Emission Factors (g/hp-hr)**	**NOx Emissions (tons)** 907200	**VOC Emission Factors (g/hp-hr)**	**VOC Emissions (tons)**
INITIAL NOURISHMENT, YEAR 1											
170001 Mobilization, Demobilization Preparatory Work											
TRUCK, HIGHWAY, CONVENTIONAL, 8,600 LBS (3,901KG)GVW, 4X2, 2 AXLE, 3/4 TON -PICKUP	1	130	0.570	296.00	8.00	37.00	21,933.6	9.200	0.222	1.300	0.031
TRUCK, HIGHWAY, 55,000 LBS (24,948KG) GVW, 6X4, 3 AXLE, (ADD ACCESSORIES)	5	310	0.570	192.00	8.00	24.00	169,632.0	9.200	1.720	1.300	0.243
HOPPER, PROPULSION	1	9,000	0.400	19.20	24.00	0.80	69,120.0	9.700	0.739	0.370	0.028
HOPPER, AUXILIARY	1	1,000	0.400	19.20	24.00	0.80	7,680.0	7.500	0.063	0.200	0.002
WORK TUG, PRIMARY	1	4,000	0.690	19.20	24.00	0.80	52,992.0	9.700	0.567	0.370	0.022
WORK TUG, SECONDARY Electric	1	50	0.400	19.20	24.00	0.80	384.0	7.500	0.003	0.200	0.000
SUVEY BOAT, SHORE	1	100	0.500	19.20	24.00	0.80	960.0	9.700	0.010	0.370	0.000
SUVEY BOAT, SHORE, SECONDARY Electric	1	40	0.400	19.20	24.00	0.80	307.2	7.500	0.003	0.200	0.000
DERRICK, PRIMARY	1	200	0.400	19.20	24.00	0.80	1,536.0	7.500	0.013	0.200	0.000
DERRICK, SECONDARY Electric	1	40	0.400	19.20	24.00	0.80	307.2	7.500	0.003	0.200	0.000
SUVEY BOAT, OFFSHORE	1	500	0.690	19.20	24.00	0.80	6,624.0	9.700	0.071	0.370	0.003
SUVEY BOAT, OFFSHORE, SECONDARY Electric	1	40	0.430	19.20	24.00	0.80	330.2	7.500	0.003	0.200	0.000
170017 Hopper Dredging											
TRUCK, HIGHWAY, 8,600 GVW, 4X4 (SUBURBAN)	1	135	0.570	408.00	15.60	26.20	31,451.0	9.200	0.319	1.300	0.045
TRACTOR, CRAWLER (DOZER), 410 HP, POWERSHIFT, W/17.7 CY SEMI-U BLADE (ADD ATTACHMENTS)	4	410	0.590	1,189.76	15.60	76.30	1,151,714.9	9.500	12.061	1.300	1.650
LOADER, FRONT END, WHEEL, INTEGRATED TOOL CARRIER, 1.75 CY (1.3 M3) LOADER; 6,303 LB (2,859 KG) @ 12.17' (3.7 M) HIGH, FORK LIFT, OR 1,841 LB (835 KG) @ 22.42' (6.8 M) HIGH, MATERIAL HANDLING ARM	1	90	0.590	297.44	15.60	19.10	15,821.7	9.500	0.166	1.300	0.023
HOPPER, PROPULSION	1	9,000	0.400	678.54	15.60	43.50	2,442,960.0	9.700	26.121	0.370	0.996
HOPPER, DREDGE	1	3,000	0.400	678.54	15.60	43.50	814,320.0	7.500	6.732	0.200	0.180
HOPPER, AUXILIARY	1	1,000	0.400	678.54	15.60	43.50	271,440.0	7.500	2.244	0.200	0.060
WORK TUG, PRIMARY	1	1,000	0.690	678.54	15.60	43.50	468,234.0	9.700	5.006	0.370	0.191
WORK TUG, SECONDARY Electric	1	50	0.400	678.54	15.60	43.50	13,572.0	7.500	0.112	0.200	0.003
SUVEY BOAT, SHORE	1	100	0.500	678.54	15.60	43.50	33,930.0	9.700	0.363	0.370	0.014
SUVEY BOAT, SHORE, SECONDARY Electric	1	40	0.400	678.54	15.60	43.50	10,857.6	7.500	0.090	0.200	0.002
DERRICK, PRIMARY	1	200	0.400	678.54	15.60	43.50	54,288.0	7.500	0.449	0.200	0.012
DERRICK, SECONDARY Electric	1	40	0.400	678.54	15.60	43.50	10,857.6	7.500	0.090	0.200	0.002
FLOATING BOOSTER, PRIMARY	1	5,200	0.430	678.54	15.60	43.50	1,517,349.6	9.500	15.889	0.200	0.335
FLOATING BOOSTER, SECONDARY	1	200	0.430	678.54	15.60	43.50	58,359.6	7.500	0.482	0.200	0.013
SUVEY BOAT, OFFSHORE	1	500	0.690	678.54	15.60	43.50	234,117.0	9.700	2.503	0.370	0.095
SUVEY BOAT, OFFSHORE, SECONDARY Electric	1	40	0.430	678.54	15.60	43.50	11,671.9	7.500	0.096	0.200	0.003
								NOx Emissions (tons) =	76.1		
										VOCs Emissions (tons) =	4.0

*Load Factors Obtained from ENVIRON International Corp. and Woods Hole Group (2013).

Dredge Duration Time = 1.43 Months 1.43 Total Duration
Effective Work Time = 474.5 Hrs/Month
Effective Work Time = 15.6 Hrs/Day
Effective Work Time = 16 Hrs/Day, Rounded
Time Efficiency = 65%
Daily Shift = 8 Hrs/Day
hp-hr = # of engines*hp*LF*hrs/day*days of operation
Load Factor (LF) represents the average percentage of rated horsepower used during a source's operational profile.
Emissions (g) = Power Demand (hp-hr) * Emission Factor (g/hp-hr)
Emissions (tons) = Emissions (g) * (1 ton/907200 g)

One way travel time Mobilization in DE = 0.4 days

One way travel time demobilization in DE 0.4 days

Table 2: Pollutant Emissions from Employee Vehicles For Fenwick Borrow Area

Assumptions:

Average trip distance (1 way) is 30 miles.
Every member of the work crew drives their own vehicle.
Mob/demob Dredge Crew: Crew of 28 will travel to work 3.28 days. Crew of 28 will travel from work 4 days.
Mob/demob Shore Crew: Crew of 13 will travel to work 46 days. Crew of 13 will travel from work 46 days.
Beachfill Crew: Crew of 28 will travel to work 46 days. Crew of 28 will travel from work 46 days.
Shore Crew: Crew of 13 will travel to work 46 days. Crew of 13 will travel from work 46 days.
Average NOx vehicle emission factor is 0.96 g/mile.
Average VOC vehicle emission factor is 0.84 g/mile.

NOx

Construction Stage	# Workers	Trips/day	#days	miles/trip	0.96 g of Nox/mile		Total Nox
Mob/demob Dredge Crew	28	2	3.28	30	0.96		0.005831
Mob/demob Shore Crew	13	2	3.28	30	0.96		0.002707
Beachfill Crew	28	2	46	30	0.96		0.081778
Shore Crew	13	2	46	30	0.96		0.037968
				TOTAL NOx (Tons):			**0.13**

VOC

Construction Stage	# Workers	Trips/day	#days	miles/trip	0.84 g of VOC/mile		Total VOC
Mob/demob Dredge Crew	28	2	3.28	30	0.84		0.005102
Mob/demob Shore Crew	13	2	3.28	30	0.84		0.002369
Beachfill Crew	28	2	46	30	0.84		0.071556
Shore Crew	13	2	46	30	0.84		0.033222
				TOTAL VOCs (Tons):			**0.112249**

APPENDIX E

PERTINENT CORRESPONDENCE

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STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
& ENVIRONMENTAL CONTROL
DIVISION OF FISH & WILDLIFE
89 Kings Highway
Dover, Delaware 19901

OFFICE OF THE
DIRECTOR

Phone: (302) 739-9910
Fax: (302) 739-6157

December 9, 2014

Steven D. Allen
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107

Re: USACE 2014 Atlantic Coast Sand Sources and Beach Replenishment

Dear Mr. Allen:

Thank you for contacting the Wildlife Species Conservation and Research Program (WSCRP) about information on rare, threatened and endangered species, unique natural communities, and other significant natural resources as they relate to the above referenced project.

The following are comments regarding the Rehoboth, Dewey, Indian River, Bethany, South Bethany and Fenwick Island Beachfill Projects:

The information provided to WSCRP regarding these beachfill projects do not delineate staging areas. If any land-based staging for this project will be off of paved roads or parking areas or will cross onto the beach outside of established vehicle crossovers, the Army Corps of Engineers (USACE) should contact WSCRP regarding potential impacts to rare species and vegetation communities that may be present in these areas.

A review of our database indicates that the following state rare, federally listed or Species of Greatest Conservation Need (SGCN) occur at or adjacent to the project site:

Scientific Name	Common Name	Taxon	State Rank	State Status	SGCN Tier	Federal Status
Charadrius melodus	Piping Plover	Bird	S1	E	1	T
Haematopus palliates	American Oystercatcher	Bird	S1B	E	1	--
Photuris bethaniesis	Bethany Beach Firefly	Insect	S1	E	1	--
Amaranthus pumilis	Seabeach Amaranth	Plant	S1	--	--	T
Dicanthelium dichotonum	Witch Grass	Plant	S2	--	--	--
Fimbristylis caroliniana	Carolina Fimbry	Plant	S1	--	--	--

Sabatia campnulata	Slender Marsh Pink	Plant	S1	--	--	--
Spiranthes vernalis	Twisted Ladies' Tresses	Plant	S2	--	--	--

State Rank: **S1**- extremely rare within the state (typically 5 or fewer occurrences); **S2**- very rare within the state (6 to 20 occurrences); **S3**-rare to uncommon in Delaware, **B** - Breeding; **N** - Nonbreeding; **SX**-Extirpated or presumed extirpated from the state. All historical locations and/or potential habitat have been surveyed; **SH**- Historically known, but not verified for an extended period (usually 15+ years); there are expectations that the species may be rediscovered; **SE**-Non-native in the state (introduced through human influence); not a part of the native flora or fauna., **SNR**-not yet ranked in Delaware, **SNA**-occurrences in DE of limited conservation value, **of concern due to a restricted range; **SU-**Status uncertain within the state. Usually an uncommon species which is believed to be of conservation concern, but there is inadequate data to determine the degree of rarity.

State Status: E – endangered, i.e. designated by the Delaware Division of Fish and Wildlife as seriously threatened with extinction in the state pursuant to State of Delaware Code (7 Del. §601 *et seq.*) and implementing regulation (Title 7, 3900, 16.0 Endangered Species) ; n/a-plants are not included in Title 7.

Federal Status: E – endangered, i.e. designated by the U.S. Fish and Wildlife Service as being in danger of extinction throughout its range; **T** – threatened, i.e. designated by USFWS as being likely to become endangered in the foreseeable future throughout all or a significant portion of its range; C-candidate – Taxa for which the U.S. Fish and Wildlife Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species. NOAA Managed Candidate: **SC-Species of Concern** are those species about which NOAA's National Marine Fisheries Service (NMFS) has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act (ESA).

SGCN Tiers: Tier 1 Species of Greatest Conservation Need (SGCN) are those that are most in need of conservation action on order to sustain or restore their populations. They are the focus of the Delaware Wildlife Action Plan (DEWAP), which is based on analyzing threats to their populations and their habitats, and on developing conservation actions to eliminate, minimize or compensate for these threats. **Tier 2** SGCN are also in need of conservation action, although not with the urgency of Tier 1 species. Their distribution across the landscape will help determine where DEWAP conservation actions will be implemented on the ground. Plants are not addressed in DEWAP.

Piping Plover

During migration, piping plover may be present on the beach in all of deposition zones listed by the USACE. Migration times for piping plover in Delaware is from March 1 through June 15 and from August 1 through September 15. No sand should be deposited in the deposition zones during this time without a qualified shorebird biologist being present. If the biologist observes piping plovers, work should stop at that site until the plovers leave the area.

Additionally, sand deposition has the potential to create new piping plover habitat. Piping plovers are federally protected beach nesting birds that require monitoring and protection. This is not an issue at present because plovers have not nested in the areas in question for over a decade. However, nesting could become an issue once beach replenishment takes place. If piping plover breeding activities are observed after the replenishment project is completed, USACE should coordinate with WSCRP to ensure that the breeding plovers are adequately protected.

American Oystercatcher

For the past two seasons, American Oystercatchers have been observed nesting within the proposed sand deposition zone immediately north of Indian River Inlet. Oystercatchers are likely to continue nesting in this area. Nesting times for oystercatchers in Delaware start by March 15 and continue to mid-September. USACE should not plan on depositing sand in the Indian River Inlet area during this time of year. In any case, work should not occur within 300 meters of oystercatcher nests or broods.

Seabeach Amaranth

During the summer of 2014, seabeach amaranth was observed growing 1.4 miles north of the Indian River Inlet. Additionally, amaranth had been observed growing with the proposed deposition area north of Indian River Inlet in 2002. In order to avoid potential take of seabeach amaranth, work should not be conducted in the Indian River Inlet area from June 15 through October 31.

Interdunal Swale Dependent Species

Numerous rare plant and animal species have been observed in interdunal swales in the vicinity of the proposed sand deposition zones. Plant species include: twisted ladies' tresses, slender marsh pink, carolinafimbry and witch grass. Additionally, the Bethany Beach firefly has also been observed in nearby interdunal swales. The Bethany Beach firefly is known to inhabit only seven interdunal swales in the world. All are in Delaware. USACE should take great care to not impact wetlands that exist to the landward side of dunes during the proposed project. In the interest of ensuring no impacts will occur, no staging or work should occur within 100 feet of an interdunal wetland.

State Natural Area

The replenishment site north of Indian River is within Delaware's Natural Areas Inventory. State Natural Areas are composed of areas of land and/or water, whether in public or private ownership, which have retained or reestablished its natural character (although it need not be undisturbed), has unusual flora or fauna, or has biotic, geological, scenic or archaeological features of scientific or educational value. Please contact Eileen Butler, Natural Areas Program Manager, at (302) 739-9235 for further information about this area for your planning.

The following are comments regarding the existing (Area E and Fenwick Island) and proposed (Area B) sand source areas:

Marine Birds

Sand mining shoals, such as Fenwick Island Shoal, could affect marine bird species of regional conservation concern, including several species of high conservation concern (e.g. Common Loon, Northern Gannet, White-winged Scoter). These shoals are important to draw in forage fish for these species during the fall, winter and spring, but also provide important forage for other bird species during other times of year (e.g. Common terns in the summer, and Forster's terns throughout the year). As such, we recommend that sand mining operations in shoals be avoided to the greatest extent practicable, particularly in the fall, winter and spring.

Fish and Surf Clam Habitat

Sand resource areas that have been historically harvested in Delaware's nearshore Atlantic Coast have included relic shoals that provided ideal surf clam habitat and rocky habitat to that support important commercial and recreational species (e.g. black sea bass and summer flounder). To ensure that these habitats are avoided, DFW recommends that USACE contracts a commercial fisherman to conduct a survey of the site to determine if there is a commercial surf clam resource on the site. In addition, any benthic characterization of the site should include quantitative grab samples and any juvenile surf clams should be noted. DFW also recommends that an Epibenthic Sled Video Survey (or equivalent) is conducted to determine whether there is any coarse sediment on the surface sufficient to support a unique epibenthic community important to fish such as summer flounder and black sea bass. Areas with this community should be avoided in dredging borrow material.

Atlantic Sturgeon
We have coordinated with Dr. Dewayne Fox of Delaware State University, who has been monitoring Atlantic sturgeon in Delaware's coastal Atlantic Ocean since 2009. Dr. Fox's telemetry data suggests a strong seasonal pattern of arrival and departure of Atlantic Sturgeon along Delaware's coast, with marine-phase Atlantic Sturgeon returning to Delaware's coastal waters in mid-late March through mid-May and departing between early September and mid-December. During the summer months, these animals will either return to Delaware River to spawn (mature adults), occupy river/upper estuary foraging areas (primarily sub-adults), or remain in the lower estuary mouth/Cape Henlopen region. During the period mid-December through mid-March telemetry arrays have detected few, if any, telemetered Atlantic Sturgeon in Delaware's coastal region. It is important to note that unlike some areas which are known to harbor Atlantic Sturgeon year-round (e.g. NY Harbor Mouth/Sandy Hook, NJ) research off the coast of Delaware suggests an absence of individuals during the winter months.

Sea Turtles
The mortality of sea turtles in dredging operations (most notably hopper dredges) is well documented; Therefore, if sea turtles forage in or near the borrow site or are migrating through, this project could result in the mortality of sea turtles. If hopper dredges are to be used, it would be best if it dredging did not begin until November and was completed prior to May. This is especially important if NMFS approved observers are not required during 100% of the dredging cycle as the observed takes may not be representative of all the turtles killed during dredge operations[1]. Other prudent measures, such as deflectors (although there is some disagreement on effectiveness) should be considered as well.

Sharks
The Delaware Bay and its nearby coastal waters are used extensively by sandbar (*Carcharhinus plumbeus*) and sand tiger (*Carcharias Taurus*) sharks, which are listed as a NOAA Species of Concern. Delaware's coastal waters provide important summer habitat to juvenile sand tigers from June to October and migratory habitat as they move to and from overwinter grounds in the spring and fall/early winter[2]. Extensive utilization of the Delaware coast by large juvenile and adult sand tigers regardless of size or sex has also been documented in the summer and fall[3]. Delaware Bay also serves as one of the largest nursery habitat for young-of-year and juvenile sandbar sharks along the Atlantic coast. Like sand tigers, juvenile sandbar sharks have been documented in Delaware's coastal waters as they migrate to and from their wintering grounds in the south, typically in the spring and fall[4]. These species do not overwinter in Delaware's coastal waters. As such, to avoid impacts to important shark species, winter (December-March) may be the best time to conduct this work, although a time of year restriction may be discussed with our fisheries section as the project moves forward. Additionally, if a cutterhead is used to complete this project, caging should be considered.

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[1] National Marine Fisheries Service. 2009. Biological opinion for ACOE NAP DE River Main Channel Deepening. FfNERJ2009/00615.
[2] Kneebone, Jeff, J. Chisholm and G. Skomal 2014. Movement patterns of juvenile sand tigers (*Carcharias taurus*) along the east coast of the USA. Marine Biology.
[3] Kilfoi, James P. 2014. Post-release mortality and fine-scale movement patterns of sand tigers (*Carcharias taurus*) caught in Delaware's shore-based recreational fishery: A Thesis. Delaware State University, Dover, Delaware.
[4] McCandless, Camilla T, HL Pratt Jr, NE Kohler 2007. Distribution, localized abundance, movements, and migrations of juvenile sandbar sharks tagged in Delaware Bay. American Fisheries Society Symposium 50.

Overall, to minimize impacts to several shark species, the federally protected Atlantic sturgeon, and several federally protected sea turtle species, we recommend that dredging activity take place between December 15 to March 15th.

We are continually updating our records on Delaware's rare, threatened and endangered species, unique natural communities and other significant natural resources. Once details of this project are determined please contact us again for the latest information.

Feel free to contact me if you have any questions or require additional information.

Sincerely,

Kate Fleming
Wildlife Biologist/Environmental Review Coordinator
(302) 735-8658
(302) 653-3431 fax
Kate.Fleming@state.de.us

State of Delaware
Historical and Cultural Affairs

21 The Green
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Phone: (302) 736.7400 Fax: (302) 739.5660

October 23, 2015 Review Code: 2015.10.16.02

Nikki Minnichbach
Cultural Resource Specialist
Philadelphia District
U.S. Army Corps of Engineers
Regulatory Branch
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Project: Underwater Archaeological Investigations Delaware Atlantic Coast Expanded Borrow Area B, Dewey and Rehoboth Beaches.

Dear Ms. Minnichbach:

The staff of the State Historic Preservation Office has reviewed *Phase I Underwater Archaeological Investigations Delaware Atlantic Coast Expanded Borrow Area B, Atlantic Ocean, Sussex County, and Delaware* by J. Lee Cox. This report meets our standards of documentation when no sites are observed. Please send us a digital copy.

We concur with the Area of Potential Effect being the footprint of the borrow area. This investigation recorded 16 targets, and found none of them to be probable archaeological resources. We concur with these findings. The implementation of the MEC baskets and monitors will ensure no archaeological sites will be impacted. Based on this review, we have made the determination that the undertaking cannot have an effect on properties eligible for, or listed in, the National Register of Historic Places, given the findings and preventative procedures to be used with the MEC baskets.

If you have any questions, I can be reached at craig.lukezic@state.de.us

Craig Lukezic
Archaeologist

cc: Gwen Davis, Deputy SHPO, Division of Historical and Cultural Affairs

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