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US Army Corps of Engineers ®
Wilmington District

CAROLINA BEACH, NC

BEACH RENOURISHMENT EVALUATION REPORT

June 2019

Wilmington District – U.S. Army Corps of Engineers

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Executive Summary

Carolina Beach, NC

Beach Renourishment Evaluation Report

The purpose of this action is to determine Federal interest for continued coastal storm risk management (CSRM) through periodic renourishment in the Carolina Beach portion of the Carolina Beach and Vicinity, NC CSRM project. Under the current authority, the last renourishment interval was completed in 2019, and Federal participation will end after 2020. With a determination of Federal interest, obtaining authorization in the Water Resources Development Act (WRDA) of 2020 would facilitate the uninterrupted continuation of cost-shared periodic renourishment cycles scheduled for construction initiation in fall 2021. Continuation of this project allows the opportunity for Federal participation in periodic renourishment through 2036 (see Figure A for illustration of authorization history). This Beach Renourishment Evaluation Report (BRER), conducted under Section 1037 of the Water Resources Reform and Development Act of 2014, as amended, is a cost-shared effort with the Town of Carolina Beach as the non-Federal study sponsor. Project Delivery Team (PDT) representatives included members of the Wilmington, Jacksonville and Savannah Districts with the participation of the Town of Carolina Beach (sponsor), New Hanover County and other Federal and State government agencies.

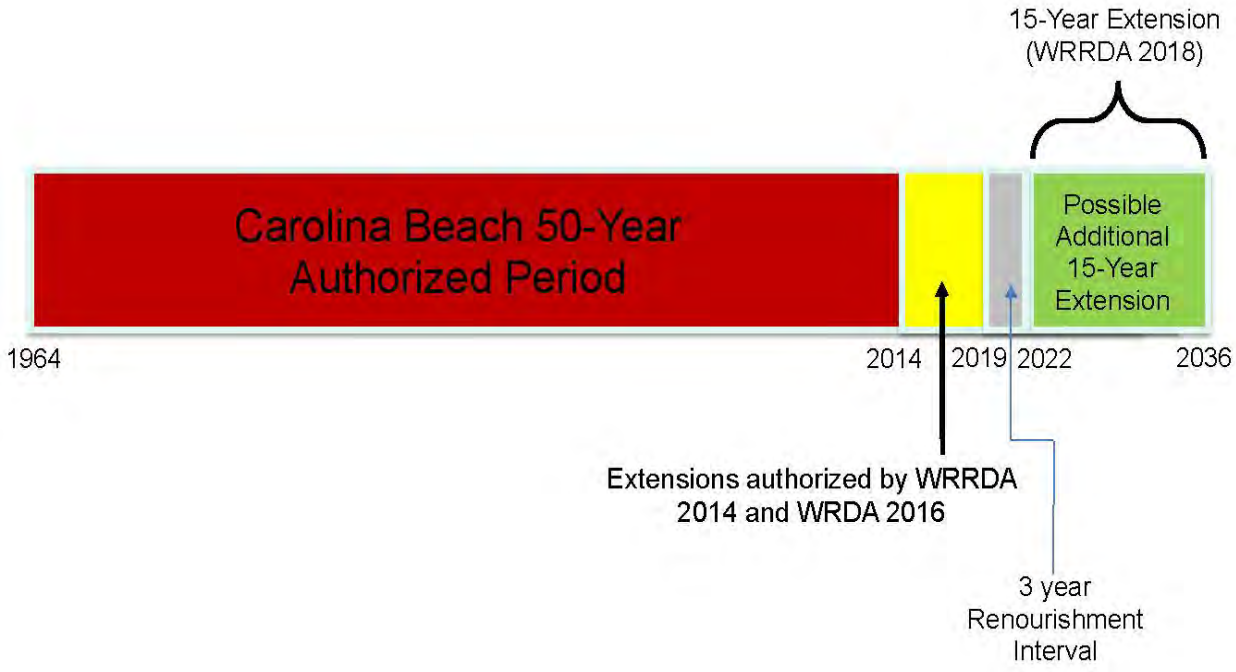

Figure A. Carolina Beach CSRM Authorization History

The project is located in southeastern North Carolina in the Town of Carolina Beach, within New Hanover County. The area along the shoreline within the project footprint is approximately 2.7 miles in length and is fully developed with a mix of cottages, condominiums, motels, hotels and various commercial establishments.

The Implementation Guidance applicable to this study authority directs that only an extension of periodic renourishment will be considered, and, in general, no reformulation of the existing project is required. Therefore, no plan formulation was incorporated into the study process to develop new alternatives beyond reaffirmation of the existing project. However, the sand borrow area of Carolina Beach Inlet, the historic borrow source for Carolina Beach since 1967, is located within Coastal Barrier Resources System (CBRS) unit (L09), subsequently established under the provisions of the Coastal Resources Barrier Act of 1982, for undeveloped coastal barriers, within which Federal spending is restricted.

Due to this identified risk, the PDT evaluated an offshore borrow source (Borrow Area B), not located within a CBRS. Borrow Area B could be utilized if the sand borrow area of Carolina Beach Inlet is unavailable for this project in the future. Borrow Area B has been used since 1999 as the primary sand source for the Area South CSRM project, also part of the Carolina Beach and Vicinity project, which is located just south of the Carolina Beach CSRM project. Analysis has concluded that either Carolina Beach Inlet or Borrow Area B, even with considering the quantity requirements for the Area South CSRM project through 2049, has sufficient sand quality and quantity to support the Carolina Beach CSRM project over the recommended 15-year continuation of Federal participation in periodic renourishment.

The Recommended Plan is the NED plan, which is a continuation of the existing Carolina Beach CSRM project. The Recommended Plan consists of approximately 14,000 feet of ocean shoreline fronting the majority of the Town of Carolina Beach, a dune having a crown width of 25 feet at 12.5 feet North American Vertical Datum of 1988 (NAVD88), together with a storm berm, having a crown width of 50 feet at 9.5 feet NAVD88. The dune and berm extend about 14,000 feet along the beachfront from the northern to the southern limits of Carolina Beach. Included in the existing project is a 2,050 foot long rock revetment located on the far northeast segment of the project. To compensate for higher erosion rates in the northern segment, the construction berm width increases from 40 feet to 100 feet. Material for the beach fill would be transported via a pipeline connected to a cutterhead dredge from Carolina Beach Inlet to the Carolina Beach shoreline. The renourishment interval for the project remains at three years.

There is explicit understanding that the financial restrictions of CBRA would affect the ability to utilize federal funds to use Carolina Beach Inlet as a borrow source. Consequently, continued use of the Carolina Beach Inlet would require an exemption from the provisions of CBRA in the project's final Congressional authorization. A Congressional re-authorization of the project would need to include specific statutory language allowing use of Federal funds to work within this borrow area notwithstanding the provisions of CBRA.

Utilizing existing information about the inlet borrow source and information gathered about the offshore borrow source, the use of the Carolina Beach Inlet as the primary borrow source is environmentally preferable to only using the offshore borrow source, and would conserve Federal and non-Federal funds.

While USACE does not typically consider alternatives that are outside the scope of current Congressional authority, the National Environmental Policy Act specifically allows for this type of consideration. Given the environmental benefits associated with continued use of the inlet borrow source, the Recommended Plan includes the Carolina Beach Inlet as the primary borrow source for this project notwithstanding the provisions of CBRA.

As noted above, the Recommended Plan is the environmentally preferred plan. Coordination with resource agency representatives was initiated early in the study and appropriate avoidance and minimization measures (i.e. environmental windows, beach placement activities, borrow site selection and use, etc.) were developed and integrated into project alternatives during the plan formulation process in this study in order to reduce project impacts. These measures reduced significant direct impacts; however, incidental impacts were still documented with respect to specific species and their associated habitat requirements, including listed species such as piping plovers and sea turtles.

This report is a fully Integrated Beach Renourishment Evaluation Report and Environmental Assessment that complies with the National Environmental Policy Act (NEPA) and the USACE's water resources planning process. The Recommended Plan would not result in any significant impacts to federally-listed threatened or endangered species or their designated critical habitat, would have no significant impact to sites listed on or eligible for inclusion on the National Register of Historic Places, and would not significantly affect any wetlands or waters of the U.S., nor any important wildlife habitat. Therefore, no compensatory mitigation is required. Informal Section 7 coordination was successfully completed with the US Fish and Wildlife Service (FWS). The FWS and the National Marine Fisheries Service (NMFS) have been actively involved throughout this evaluation and will have an additional opportunity to review and comment on the report during the 30-day state and agency review period. The Recommended Plan is covered under the North Carolina Division of Water Quality's March 19, 2017, Water Quality Certification (WQC) No. 4099: General Certification for Projects Eligible for U.S. Army Corps of Engineers Regional General Permit 198000048. All conditions of WQC #4099 will be met. The project will also be in compliance with Section 404 of the Clean Water Act as documented in the Section 404(b)(1) analysis that is included as an appendix to this report.

The estimated First Cost of the Recommended Plan is $45,300,000 with October 2018 (FY 2019) price levels or an average of approximately $9,060,000 per periodic renourishment event. Continuation of Federal participation in the project would be anticipated to be cost-shared 50 percent Federal ($22,650,000) and 50 percent non-Federal ($22,650,000). Cost sharing for periodic renourishments is based on Section 215 of the Water Resources Development Act of 1999. Operations and maintenance costs between scheduled periodic renourishment cycles are estimated at $95,000 a year and would be a 100 percent non-Federal responsibility. The project includes a 3-year renourishment cycle (5 total renourishments). The preliminary benefit cost ratio for the Recommended Plan is 3.9 to 1.

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1 STUDY OVERVIEW AND PURPOSE

The integrated Beach Renourishment Evaluation Report (BRER) and Environmental Assessment (EA) presents the results of analyses to continue coastal storm risk management (CSRM) through periodic renourishment on the Carolina Beach, NC CSRM project for an additional 15-year period through FY 2036. The Town of Carolina Beach is the project sponsor. The USACE is the lead Federal agency for this report, and the Bureau of Ocean Energy Management (BOEM) is a cooperating agency.

1.1 Purpose and Need for Action

The purpose of the Carolina Beach and Vicinity, NC Coastal Storm Risk Management (CSRM) Project – Carolina Beach Portion – Beach Renourishment Evaluation Report (Carolina Beach BRER) is to determine Federal interest for continued CSRM through periodic renourishment in the Carolina Beach project area from 2022 through 2036. Current Federal participation will end after 2020 with the last renourishment interval of the current authorization occurring in 2019.

1.2 Study Authority and Scope

The Carolina Beach BRER will determine the feasibility of extending the period of renourishment for a period not to exceed 15 additional years, beginning on the date of initiation of construction of Congressionally-authorized renourishment. The 50-year project at Carolina Beach, which was authorized in the Flood Control Act of 1962, completed the period of Federal participation in cost sharing in December 2014. Two three-year extensions were authorized in the Water Resources Reform and Development Act (WRRDA) of 2014 and the Water Resources Development Act (WRDA) of 2016, respectively, that extended Federal renourishment through the 2019 cycle; therefore, the project is eligible for continued construction of periodic renourishments from the 2022 construction cycle through 2036. This timeline is illustrated below in Figure 1.1.

This study was authorized in WRRDA 2014 under Section 1037(a)--- Hurricane and Storm Damage Reduction, with amendments in WRDA 2018 under Section 1158. Under current guidance, a BRER will be prepared and cost shared 50 percent Federal and 50 percent non-Federal. Funding to complete the Carolina Beach BRER was provided in January 2017, and included a Federal funding limit of $375,000 for all BRER activities. After completion and approval of the Carolina Beach BRER, Congressional authorization will be needed to extend Federal participation in periodic renourishments through FY 2036.

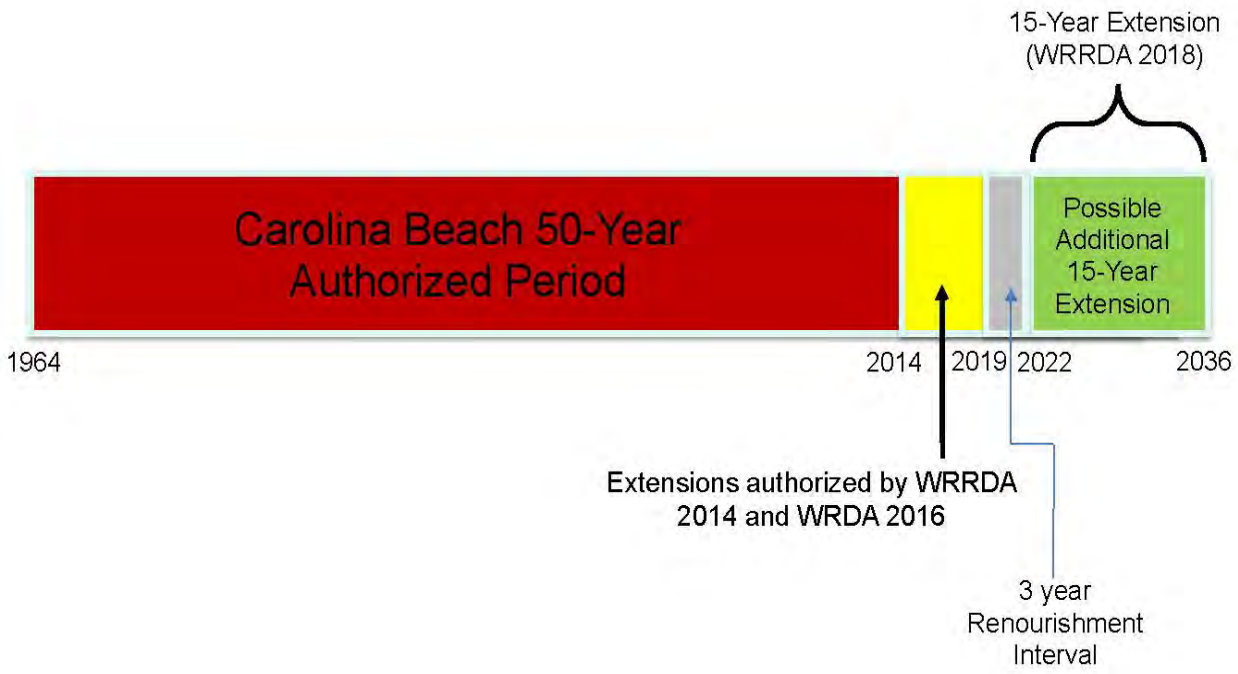


Figure 1.1 Carolina Beach CSRM Authorization

1.3 Study Area

The Carolina Beach CSRM project is located in the Town of Carolina Beach, in southeastern North Carolina. The area is comprised of a peninsula which separates the lower Cape Fear River from the Atlantic Ocean. Running just west of the Town is the Atlantic Intracoastal Waterway (AIWW) which connects to the Cape Fear River via the U.S. Army Corps of Engineers (USACE) constructed Snow's Cut canal. The shoreline in the study area is a continuous strip of beach with a north-northeast to south-southwest alignment. The area along the shoreline within the project footprint is fully developed with cottages, duplexes, condominiums, motels, hotels and various commercial establishments. The study area also includes the historical borrow source of Carolina Beach Inlet, which is located north of the terminus of the authorized project. Additionally, an alternative borrow source, referred to as Borrow Area B, is located offshore of the northern reach of the project. Borrow Area B is currently being utilized for the Area South portion of the Carolina Beach and Vicinity CSRM project. A map of the study area is provided as Figure 1.2.

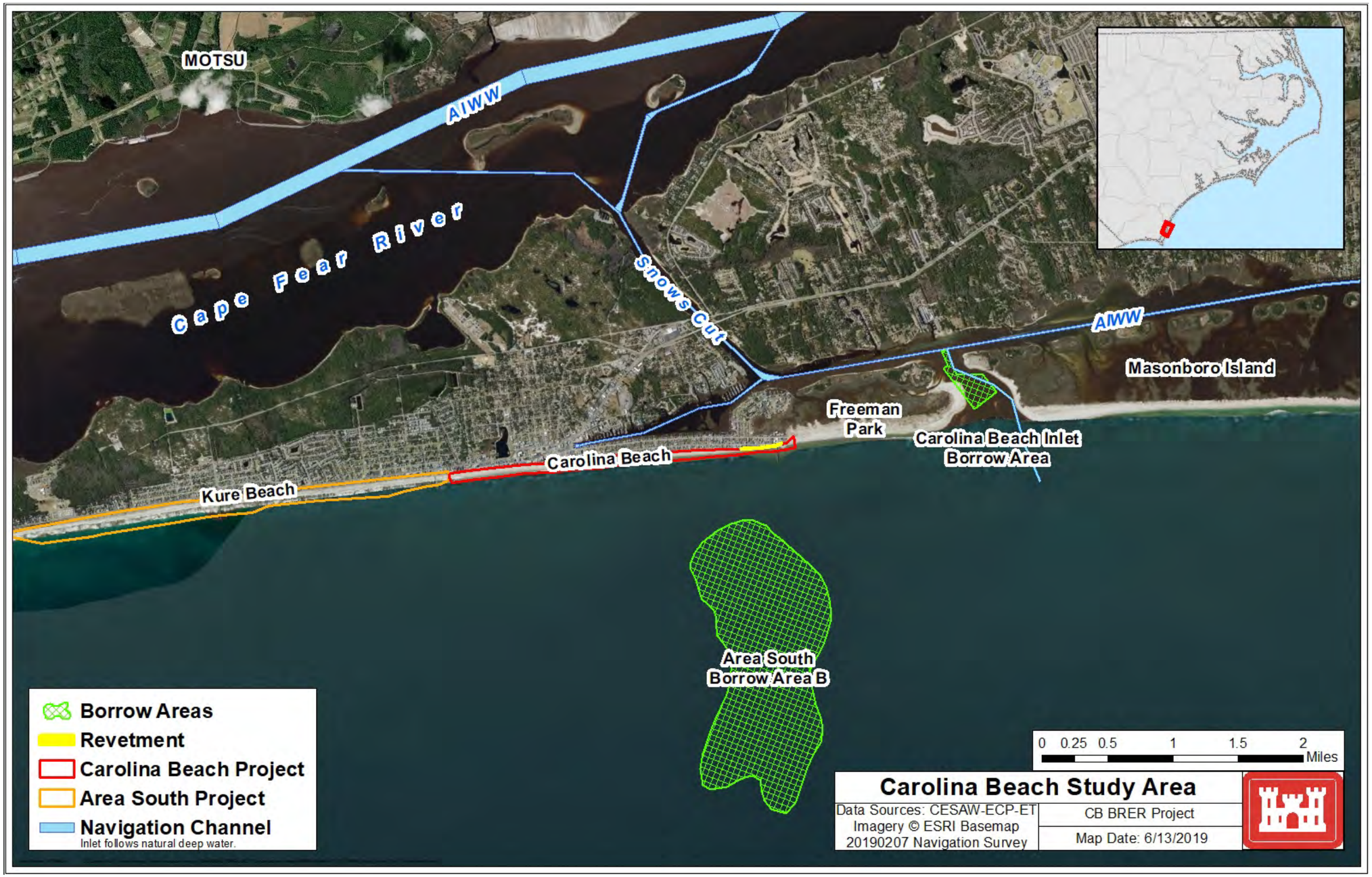


Figure 1.2. Map of the Study Area

1.4 Study Process

Per coordinated guidance from the South Atlantic Division (SAD) Regional Integration Team (RIT) (memo dated 20 November 2017), the Carolina Beach BRER will follow the Implementation Guidance for Section 1037(a) of WRRDA 2014 (memos dated 16 July 2015 and 18 April 1019).

In accordance with the Implementation Guidance for Section 1037(a), the following requirements were incorporated into the study process:

1) Perform cost update to appropriate price level
2) Reaffirm economic justification of the project design template
3) Validate project parking and access
4) Confirm adequacy of existing borrow source
5) Discuss sea level rise considerations (in accordance with ER 1100-2-8162)
6) Confirm environmental compliance

The Implementation Guidance for Section 1037 (a) directs that "Only an extension of periodic renourishment will be considered, and, in general, no reformulation of the existing project is required." Therefore, no additional plan formulation was conducted. The one exception to this approach was the inclusion of an alternative in addition to No Action and Recommended Plan, which exclusively uses an offshore borrow source (Borrow Area B) rather than the historical borrow source (Carolina Beach Inlet). This approach was taken based upon the risk of unavailability of the historical borrow source due to the provisions of the Coastal Barrier Resources Act (CBRA) (see section 9.3 for details).

In accordance with Engineering Circular 1165-2-217, this study will undergo District Quality Control (DQC) and Agency Technical Review (ATR), but will be excluded from Independent External Peer Review (IEPR). This beach renourishment evaluation report is excluded from IEPR per Paragraph 4.d. of the implementation guidance for Section 1037(a) of WRRDA 2014, which states, "Decision documents developed under this authority are excluded from independent external peer review unless one of the mandatory triggers contained in Section 2034(a)(3)(A)(i) of the Water Resources Development Act of 2007, as amended (33 U.S.C. 2343(a)(3)(A)(i)), is involved." As described in the approved Review Plan, the Carolina Beach BRER does not contain any of the mandatory triggers described in EC 1165-2-217, 11d, and a risk-informed decision concerning the timing and the appropriate level of reviews for the project implementation phase will be prepared and submitted for approval in an updated Review Plan prior to initiation of the design/implementation phase of this project.

The study was conducted in compliance with SMART Planning guidance. In this regard, the Carolina Beach BRER project delivery team (PDT) has applied vertical team engagement throughout the study process, and has maintained a focus on identifying and reducing key areas of uncertainty. The following SMART Planning milestones are being used as part of the study process:

I. Alternatives Milestone Meeting (AMM)
II. Tentatively Selected Plan (TSP) Milestone
III. Agency Decision Milestone (ADM)

2 HISTORY OF THE PROJECT

Carolina Beach, located in New Hanover County in southeastern North Carolina, experienced 21 hurricanes and 29 tropical storms within a 50-mile radius prior to 1964, including the devastating Hurricane Hazel in 1954, a Category Four event. The significant damage resulting from Hurricane Hazel was a key factor in the authorization and construction of the Federal project. In recognition of the need to manage storm risk to Carolina Beach, a partnership was undertaken between the Town of Carolina Beach and USACE to construct a berm and dune project, and to provide periodic renourishment. Initial construction of the Federal project started in 1964. Remedial work included partial restoration in 1967 and 1971. Emergency work was required in 1967, 1970, 1973, and 1980 following severe storms. Emergency work included construction of a 1,100-foot stone seawall in 1970 and extensions there to 500 feet north and 450 feet south in 1973, totaling 2,050 feet.

Since initiation of construction of the project in 1964, there have been 10 hurricanes and 14 tropical storms whose centers have passed within 50 miles of Carolina Beach, averaging a storm every 2.4 years (source: NOAA). Since 1993, renourishment cycles have been on a regular 3-year interval. Key authorization changes which have affected this project are as follows:

- 1993 – Completion of 934 Report (extended project life through 2014)
- 2014 – End of Carolina Beach 50-Year Project (3-year extension authorized to 2017 in WRRDA 2014)
- 2016 – 3-year extension expanded to a total of 6 years to 2020 (WRDA 2016)
- 2018 – Modification of Section 1037 so that 15-year extension would begin on the date of initiation of construction of Congressionally-authorized renourishment (WRDA 2018)

Figure 2.1. Carolina Beach pre-1964 construction

Figure 2.2. Carolina Beach post construction (1965)

Figure 2.3. Carolina Beach present day

2.1 Project Description

The authorized project is located in New Hanover County, in southeastern North Carolina. The study area starts a few hundred feet south of Carolina Sands Drive and runs northward approximately 14,000 feet to the end of First Avenue southward of Carolina Beach Inlet. The project area consists of a continuous strip of beach with a north-northeast to south-southwest alignment. The average width of the project area, from the dune line inland, is 700 feet, and consists of a sacrificial berm and dune. The dune crown has a width of 25 feet at an elevation of 12.5 feet North American Vertical Datum 88 (NAVD88) and is integrated with a shoreline berm that has a crown width of 50 feet at elevation 9.5 feet NAVD88 and beach fill extending approximately 14,000 feet from the northern to the southern limits of Carolina Beach. Included with this project is a 2,050-foot long rock revetment located on the far northeast segment of the project. The historical borrow area associated with the project is located within Carolina Beach Inlet, located 1.4 miles north of the northern terminus of the project. The renourishment cycle has been performed on a regular 3-year interval since 1993. Historic volumes for each renourishment cycle have averaged 880,000 cubic yards (cy) over the life of the project. Typical renourishments focus on reconstruction of the berm portion of the template. While the dune system has not been overtopped since initial construction, some dune reconstruction has been required to repair erosion damage to the toe of the dune. A map of the project area is located at Figure 2.4.

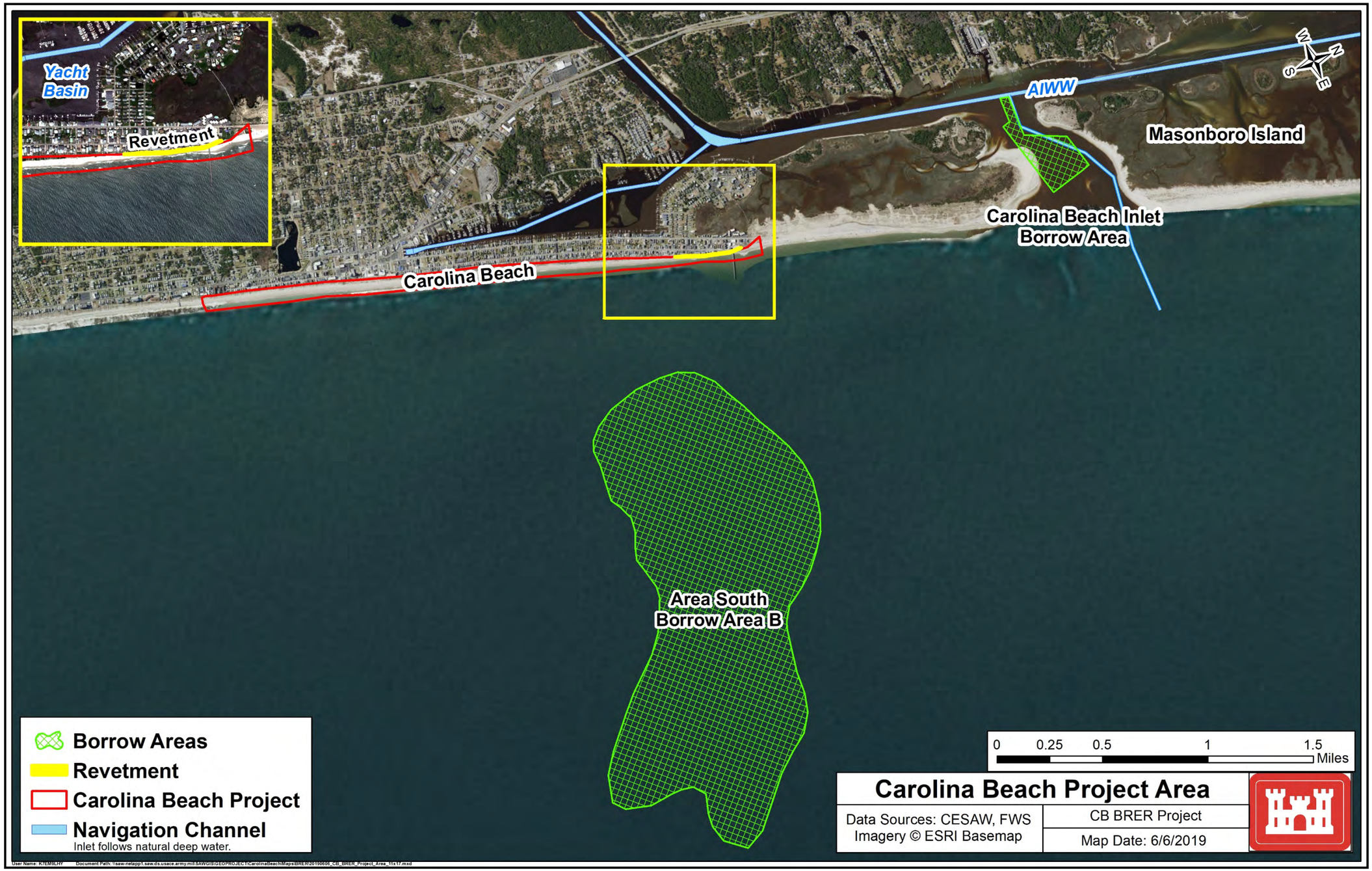


Figure 2.4. Map of the Project Area

2.2 Prior Studies and Reports

Since 1964, the pertinent studies and reports related to the project are as follows:

Reanalysis – Carolina Beach, NC. USACE 1973

This report was a reanalysis of the Carolina Beach Restoration Project after the installment of the 2,050 foot rock revetment at the north end of the project. This report provides details on the rock revetment of which construction was completed in 1973 to address accelerated erosion along that section of the project.

Section 934 Reevalution Report and Environmental Assessment. Carolina Beach & Vicinity – Carolina Beach Portion, Carolina Beach, North Carolina. USACE 1993.

This report found the Carolina Beach portion of the Federal project to be eligible for continued Federal participation through 2014, which increased the overall project life to a 50-year period of Federal participation.

Project Information Report For the Hurricane Rehabilitation Effort – Carolina-Kure Beach, North Carolina Shore Protection Project. USACE 1998.

This report evaluated damage from Subtropical Storm Andrea to the Federal Project in both Carolina and Kure (also known as "Area South") beaches. The report recommended rehabilitation from storm damages using emergency funds under Public Law (PL) 84-99.

Project Information Report – Rehabilitation of Storm Damaged Carolina Beach Portion of the Carolina Beach and Vicinity, North Carolina Coastal Storm Risk Management Project. USACE 2017.

This report evaluated damage from Hurricane Matthew to the Carolina Beach portion of the Federal Project and recommended eligibility for rehabilitation under PL 84-99.

Additional Data Sources – A large volume of vibracore and survey data from 1997 – 2017 exists for the Carolina Beach Inlet borrow source, and for Offshore Borrow Area B (data from 2012 – 2018). This data and resulting analyses are discussed in detail in Appendix A.

2.3 Existing Federal Projects in New Hanover County

2.3.1 Coastal Storm Risk Management Projects

The Carolina Beach CSRM project, is not the only existing federal coastal storm risk management projects in New Hanover County in southeastern North Carolina. The Area South portion of the Carolina Beach and Vicinity CSRM is immediately adjacent on the south side of the Carolina Beach portion of the project. The Area South portion was authorized along with the entirety of the Carolina Beach and Vicinity CSRM by the Flood

Control Act of 1962. The Area South portion called for protecting 18,000 feet of shoreline within the town limits of Kure Beach and a very small portion of the southern part of Carolina Beach. Initial construction was completed in 1998. Since initial construction, Area South has shared the same three-year renourishment intervals with Carolina Beach. The sand source that Area South utilizes, referred to as Borrow Area B, has also been evaluated as an alternative borrow source in the Carolina Beach BRER analysis. The analysis has indicated there is sufficient quality and quantity of material for both projects over their respective periods of analyses (see Section 6.2.4 for details).

The Wrightsville Beach CSRM Project, located approximately 10 miles north of Carolina Beach, was authorized by the Flood Control Act of 1962. The project was re-evaluated in 1982 with a recommendation for continued Federal participation in project renourishment for 50 years, which was authorized in WRDA 1986. Wrightsville Beach uses a separate sand borrow source from the Carolina Beach and Vicinity CSRM Project.

A map showing locations of the New Hanover County CSRM projects is located in Figure 2.5.

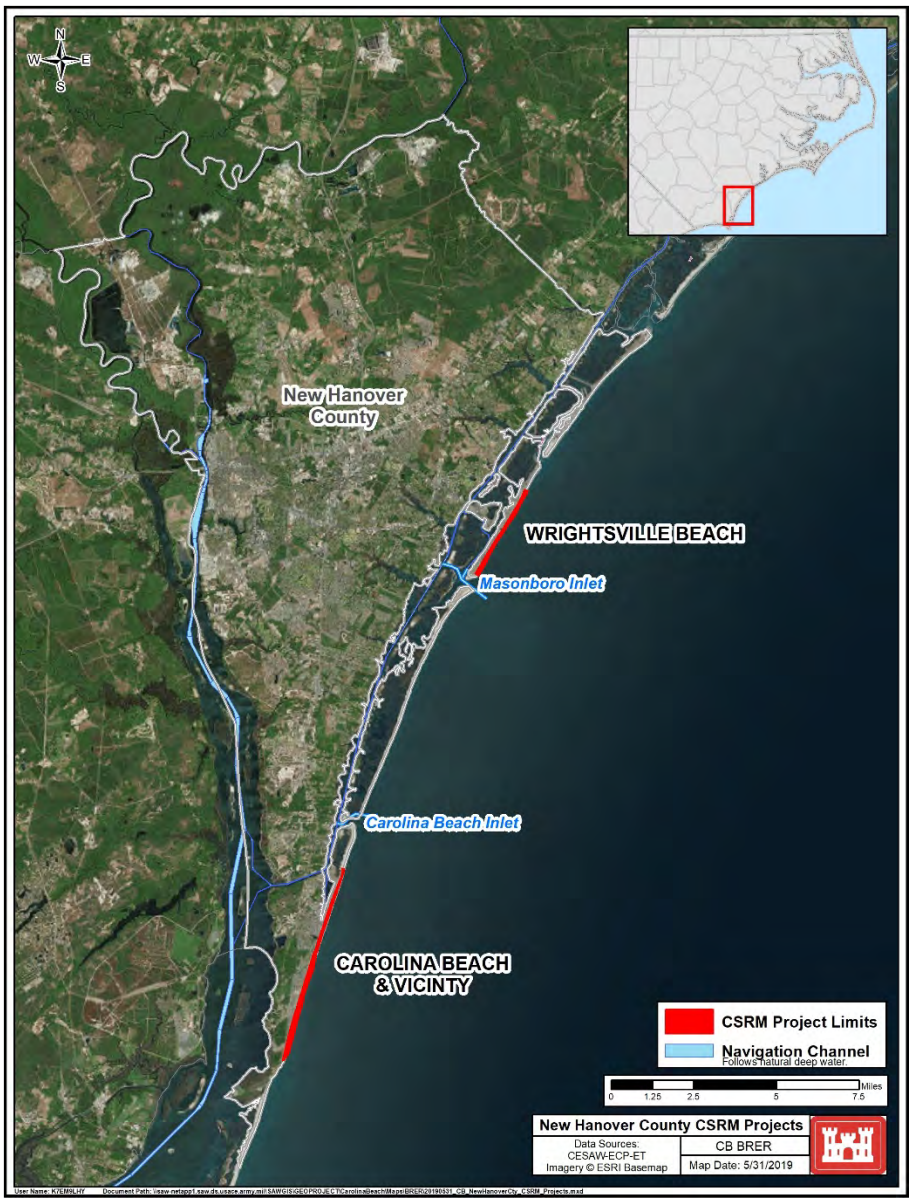


Figure 2.5. New Hanover County CSRM Projects

2.3.2 Atlantic Intracoastal Waterway (AIWW)

The AIWW provides an important inland navigation route from Norfolk, Virginia, to the St. Johns River, Florida. The 308-mile-long North Carolina portion is the state's only north-south commercial navigation thoroughfare. The authorized project includes a navigation channel with a depth of 12 feet and widths varying from 90 feet inland to 300 feet in open waters; side channels and basins at a number of locations; and five highway bridges. The Beaufort to Cape Fear River section was authorized by House Document No. 450, 69th Congress, *Inland Waterway, Beaufort – Cape Fear River*. The main channel of the AIWW in North Carolina was completed in 1940, and it has since been maintained by dredging to remove shoals that develop periodically. Some of the dredged material

removed during maintenance activities is beach-quality sand. That material is placed directly on nearby ocean beaches, when practicable; otherwise, it is stockpiled in confined disposal areas near the shoreline of the AIWW. The sand serves as a viable source of beach fill where it exists in sufficiently large volumes and in proximity to beaches. Within the Carolina Beach BRER study area, beneficial use of dredged material is made by taking beach quality sand from the AIWW inlet crossing at Carolina Beach Inlet and placing it at Freeman Park at Carolina Beach via pipeline dredge. Freeman Park is located immediately north of the Carolina Beach CSRM project. This beneficial use of dredged material occurs about every two years.

2.3.3 Carolina Beach Inlet Navigation Project and CBRA Zone

Carolina Beach Inlet is located approximately 1.4 miles north of the Town of Carolina Beach. The man-made inlet, opened in 1952 by local interests, became a USACE navigation improvement project by record of decision in 1982 following a Detailed Project Report. The inlet has been dredged periodically by USACE since the 1960's, and has also served as the primary borrow source for the Carolina Beach portion of the Carolina Beach and Vicinity CSRM Project since 1967.

Although Carolina Beach Inlet has been the only source of placement material since 1967, it is located within a Coastal Barrier Resources System (CBRS) unit and is therefore subject to the CBRA's restrictions on the expenditure of Federal funds. Due to the identified risk that the inlet may not be available as a borrow source, the PDT evaluated an offshore borrow source option, not located within a CBRA zone, which could be utilized if the sand borrow area of Carolina Beach Inlet is unavailable for this project in the future For more details on CBRA, see section 9.3 of the main report.

2.3.4 Masonboro Inlet Navigation Channel

The Masonboro Inlet navigation project is an authorized feature of the AIWW and was authorized by the River and Harbor Act of 1950. This project includes a channel across the ocean bar at Masonboro Inlet and a channel through Banks and Motts Channel to the AIWW, a deposition basin and dual jetties providing a connection between the AIWW and the Atlantic Ocean.

Construction of the Masonboro Inlet jetty on the north side of Masonboro Inlet took place between July 1965 and June 1966, partly due to a lack of funds for constructing jetties on both sides of the inlet**.** By the late 1970s, the navigation channel (and northern end of Masonboro Island) had shifted significantly to the north. As a result, the previously authorized southern jetty was constructed in 1980 and the navigation channel was dredged to -14 feet and centered between the two jetties**.** This project configuration remains unchanged as of today.

2.3.5 Wilmington Harbor Navigation Project

Wilmington Harbor is a high use deep draft navigation project located on the southeastern coast of North Carolina in Brunswick and New Hanover counties. The project extends from the Atlantic Ocean to a point just beyond downtown Wilmington, NC, a distance of about 35 miles. The project includes a channel 44 feet deep through the Ocean Bar and 42 feet deep to 800 feet south of the Cape Fear Memorial Bridge in downtown Wilmington. Upstream of this point, the project is 38 feet deep to the Highway 133 bridge; 32 feet deep to the Hilton Railroad Bridge over the Northeast Cape Fear River; and 25 feet deep from the Hilton Railroad Bridge to a point 1-2/3 miles above the bridge. The project also includes a northwestward connecting channel, 12 feet deep, from the Atlantic Intracoastal Waterway at Snow's Cut to the main river channel.

The project mitigation features include a 30 acre tidal embayment and acquisition of about 700 acres of existing tidal swamp and upland area for habitat preservation to offset losses of wetlands and primary nursery areas. Also, a rock ramp for fish passage at Lock and Dam No. 1 on the Cape Fear River constructed to address the impacts to anadromous fish and the endangered short-nose sturgeon from rock removal by blasting during the harbor deepening.

3 PROBLEMS AND OPPORTUNITIES, OBJECTIVES AND CONSTRAINTS

3.1 Problems and Opportunities

A problem is an existing undesirable condition to be changed. An opportunity is a chance to create a future condition that is desirable.

Problems and opportunities have been identified by the Project Delivery Team (PDT) as follows:

Problems

- There is a continuing threat to existing residential and commercial structures and property, and local infrastructure, with future without project average annual damages of approximately $7,592,000.

Opportunities

- There is an opportunity to significantly reduce risk of coastal storm damage by investigating structural and non-structural measures for residential and commercial structures and property in the town of Carolina Beach, NC.

3.2 Goals and Objectives

As described in Engineering Regulation 1105-2-100 and as outlined in the 1983 *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, planning objectives are statements that describe the desired results of the planning process by solving the problems and taking advantage of the opportunities identified. The planning objectives must be directly related to the problems and opportunities identified for the study and are used for the formulation and evaluation of plans. For the Carolina Beach BRER as directed by Section 1037(a), objectives will be used for consideration of the project as constructed and authorized, and for a No Action alternative. For this study there will also be evaluation of an alternative borrow source. Objectives must be clearly defined and provide information on the effect desired (quantified, if possible), the subject of the objective (what will be changed by accomplishing the objective), the location where the expected result will occur, the timing of the effect (when would the effect occur) and the duration of the effect.

Goal: Evaluate continued Federal participation in the existing Carolina Beach CSRM project.

Identifying and considering the problems, needs, and opportunities of the study area in the context of Federal authorities, policies, and guidelines resulted in the establishment of the following specific objective:

Objective: The objective of the Carolina Beach BRER is to determine if extending Federal participation in periodic beach renourishment for the Carolina Beach & Vicinity, NC Coastal Storm Risk Management (CSRM) Project – Carolina Beach Portion is technically feasible, economically justified, and environmentally acceptable for the 15-year period of analysis from 2022 to 2036.

3.3 Constraints

As described in Engineering Regulation 1105-2-100, constraints are restrictions that limit the planning process. Constraints, like objectives, are unique to each planning study. Some general types of constraints that need to be considered are resource constraints and legal and policy constraints. Resource constraints are those associated with limits on knowledge, expertise, experience, ability, data, information, money and time. Legal and policy constraints are those defined by law, Corps policy and guidance. Plans should be formulated to meet the study objectives and to avoid violating the constraints.

The following constraints were identified for the study:

Planning Constraints

1. Only an extension of periodic renourishment will be considered, and no reformulation of the existing project is required.
2. Continued use of the historical borrow source (Carolina Beach Inlet) would require an exemption from the provisions of CBRA in the Congressional Authorization.

3.4 Key Assumptions

The following are key assumptions made for this study:

1) The future without project (FWOP) condition will use the 2015 shoreline (pre-2016 renourishment) conditions to reflect the 2021 shoreline (pre-2022 renourishment), and analyze from that point moving forward with erosion occurring through 2036.
2) No new real estate is required for the CSRM placement area. However, the non-Federal sponsor will work to acquire a permanent easement across Freeman Park (Figure 1.2) to allow future placement of the pipeline from Carolina Beach Inlet to the northern end of the Carolina Beach CSRM project.

3) Project details in the Carolina Beach BRER only consider the project as constructed and authorized; no reformulation is required under this study authorization. An alternative borrow source (Borrow Area B) was evaluated due to the risk of unavailability of the Carolina Beach Inlet historic borrow source. This risk is associated with the historic borrow source being located within a CBRS Unit (see section 9.3 for details).
4) All environmental clearances will be current following completion of the NEPA process.

4 DESCRIPTION OF EXISTING CONDITIONS AND FUTURE WITHOUT PROJECT CONDITIONS

The existing condition of significant environmental resources in the area are described in Section 7 of this report. This section focuses on further quantifying the existing and Future Without Project (FWOP) physical shoreline and economic conditions, which form the primary basis for the comparison of benefits of project alternatives. The FWOP refers to the most likely future that would occur without continued Federal participation in periodic renourishments over the 15-year period of analysis from 2022-2036.

4.1 Existing Conditions

4.1.1 Existing Coastal Storm Damage Conditions

Carolina Beach is located in an area of significant hurricane activity. The shoreline of Carolina Beach is influenced predominantly by tropical systems that occur during the summer and fall. Northeasters during the late fall, winter and spring contribute to shoreline erosion, but to a lesser degree than hurricanes, due to shielding effects of coastal geography north of the project site. Based on records from the National Hurricane Center, 74 hurricanes and tropical storms have passed within a 50-nautical mile radius of the project site over the 164-year period of record. In recent years, a number of named storms passing within the 50-mile radius have significantly impacted the project area, including Florence (2018), Colin (2016), Hermine (2016), Matthew (2016), Arthur (2014), and Beryl (2012). Damages from these storms, as well as from more distant storms causing indirect impacts, included substantial erosion and damage from winds, waves, and elevated water levels. However, structural damage to buildings from these storms was minimal. Assessments indicate that the project berm and dune absorb many of the impacts.

4.1.2 Existing Beach Erosion Conditions

Major erosion in the project area is caused by northeasters that frequently occur along Carolina Beach during the colder months, as well as tropical cyclones and hurricanes occurring in the warmer months. Erosion rates vary by reach, but average between 7 and 15 feet per year over the majority of the project. Erosion is accelerated in the most northern extent of the project in the vicinity of the revetment. Here erosion rates are between 33 and 40 feet per year. Erosion in the project area has been managed by planned periodic renourishments on a 3-year interval. More detail on erosion rates is located in Appendix B.

4.1.3 Existing Recreation Conditions

The study area has a robust tourist-oriented commercial industry. Visitors come to enjoy both the developed beach areas and to take advantage of other ocean-based recreational opportunities (Figure 4.1).

Figure 4.1. Carolina Beach in Summer of 2017.

4.1.4 Existing Environmental Conditions

The existing environmental conditions of the area are detailed in Section 7 of this report.

4.1.5 Existing Socioeconomic Conditions

Over the past 35 years Carolina Beach has developed rapidly as a family ocean resort community for outdoor recreation. Land use is primarily recreational, residential with a few commercial properties, with the highest density along the oceanfront and Inlet. Based on the 2010 census, the permanent, off-season population is about 5,700 residents, but increases vastly in the summer. During the summer months a large portion of the homes within the study area are available as summer rentals to vacationers primarily from inland North Carolina and other locations around the Eastern United States. The current beach plays a large role in the significant revenues generated from tourist-oriented businesses (Figure 4.2).

Figure 4.2. The boardwalk at Carolina Beach.

4.1.6 Existing Public Parking and Access Requirements and Conditions

The important function of this analysis is to address the adequacy of public access at Carolina Beach and determine whether the spirit and intent of the Project Cooperation Agreement (PCA) is being met. According to Article II, Paragraph i, "The town shall provide and maintain necessary access roads, parking areas and other public use facilities open and available to all on equal terms." With regards to the term "necessary," the project must continue to conform to USACE regulations to be eligible for expenditure of Federal funds. The regulations regarding public access and parking are ER 1165-2-130, dated 15 June 1989, and ER 1105-2-100, dated 22 April 2000. These regulations stipulate that the beaches receiving the material must be open to the public and provide reasonable access. The USACE regulations require that in order to be deemed "public" beaches, the sponsor must provide public access points every one-half mile with sufficient public parking within one-quarter mile. The regulations also refer to sufficient parking in terms of accommodating "projected use demands," and are further defined as sufficient to accommodate the lesser of the peak hour demand or the beach capacity. Finally, in computing parking requirements, the number of beach users not requiring parking is to be deducted from the projected use demand. There are 44 Coastal Area Management Act (CAMA) public access points on Carolina Beach that range from simple walkovers to handicap accessible dune walkover structures. Each of these access points are clearly marked with signs. The number of marked parking spaces has increased slightly from 2002.

Along with the 44 CAMA access points, there are a total of 763 parking spots on Carolina Beach. No parking or access deficiencies were identified for the Carolina Beach BRER.

Additional details on Parking and Access can be found in Appendix C.

4.2 Future Without Project (FWOP) Condition

4.2.1 Future Without Project Coastal Storm Damage Conditions

For purposes of economic analysis, the study area was divided into smaller economic reaches. An economic reach contains one or more similar, adjacent damageable elements. Economic reaches in the study area vary in length but average approximately 1,000 ft long. Average annual coastal storm damages to the study area were estimated using the Beach-*fx* model.

The estimated average total without project damages over 50 years for each of the economic reaches, based on 300 life-cycles, are illustrated in Figure 4.3. Damages are fairly comparable across reaches, although there are several notable exceptions. The total without project damages (structure and contents) in the study area over 50 years, in present value, is $200,077,000. At the fiscal year (FY) 2019 discount rate of 2.875%, total average annual without project structure and content damages are estimated at $6,257,000 per year. Average annual without project damages resulting from land loss (which are calculated based on the erosion rates presented in Appendix B) are estimated at $1,335,000. Thus, the total average annual damages in the study area in the Future Without-Project condition are $7,592,000. Appendix F contains more details on the calculation of land loss value and the determination of structure and content value.

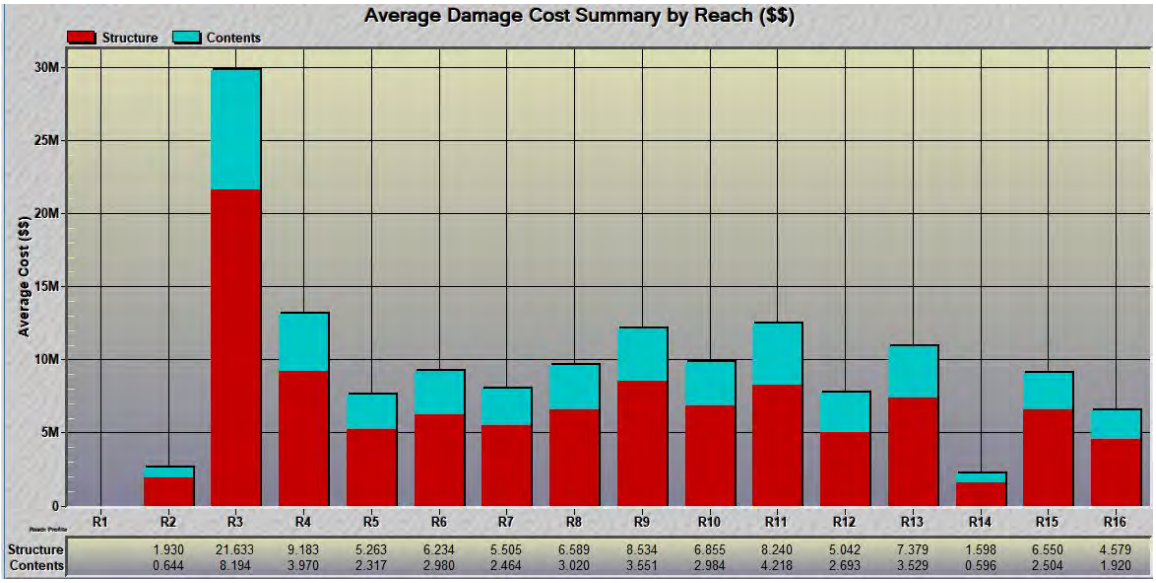


Figure 4.3. Total future without project damages (contents plus structures plus land loss) over 50 years by economic reach.

4.2.2 Future Without Project Beach Erosion Conditions

Based on the calculated average erosion rate per year, it is anticipated that without continued federal participation in the project a good portion of the beach will erode from the existing shoreline back into the dune. Once the beach has eroded back into the dune, escarpments will occur, resulting in wave reflection off the escarpment with subsequent increased erosion, scouring, and loss of intertidal beach habitat. The intertidal beach habitat and benthic invertebrate community is a significant resource for feeding shorebirds and surf zone fishes. As the beach and dune complex erode, important habitat for a variety of plants and animals would be endangered, including loss of the dune grasses and associated fauna. Additionally, beach habitat for loafing and nesting shorebirds, as well as nesting sea turtles would be degraded or lost as the beach and dune are eroded into the coastal infrastructure. Recreational opportunities associated with the beach would also be greatly diminished.

4.2.3 Future Without Project Recreation Conditions

Carolina Beach will likely continue to serve as a popular tourist destination in the future, although in the FWOP condition the recreational value of the area will decline as the beach continues to erode and the beach width available for typical beach-going activities is reduced or eliminated.

4.2.4 Future Without Project Environmental Conditions

The future without project environmental conditions of the area are detailed in Section 7 of this report.

4.2.5 Future Without Project Socioeconomic Conditions

The population of New Hanover County, along with that of the rest of the State of North Carolina, is predicted to increase over the next 15 years. However, in a future without project condition where the beach is allowed to erode away, a large economic impact would likely be felt by the community on the island, as many commercial businesses are dependent upon the income generated by year-round tourists. Should beach utility drop below a critical level associated with shoreline erosion, these significant revenues gained from tourist-oriented business could be expected to markedly decrease as recreational opportunities and environmental quality diminish.

4.2.6 Future Without Project – Sea Level Rise Assumptions

Engineering Regulation (ER) 1100-2-8162 and Engineer Technical Letter (ETL) 1100-2-1 (USACE 2013, 2014) provide USACE both a methodology and a procedure for determining a range of sea level change estimates. This guidance is used for incorporating the potential direct and indirect physical effects of projected future sea level change in the engineering, planning, design and management of USACE projects.

Three estimates are required by the guidance, a Low (Baseline) estimate representing the minimum expected sea level change, an Intermediate estimate, and a High estimate representing the maximum expected sea level change. These estimates are referenced to the midpoint of the latest National Tidal Datum epoch, 1992.

Based on historical sea level measurements taken from NOS gage 8659084 at Southport, North Carolina, the historic sea level change rate was determined using the *updated published* guidance extracted from *http://www.corpsclimate.us/ccaceslcurves.cfm*. The economic analysis period for this study begins with a Beach-fx model start date of 2021 (economic base year of 2022) and extends to the proposed end of the 15-year Federal participation in periodic nourishment in 2036.

Relative vulnerability to flooding during extreme events is consistent between both the With and Without project conditions. However, adaptation in the form of additional sand volume may be required to maintain project performance. For this analysis, the Intermediate sea level rise rate curve was used to compare with and without project conditions.

Details of this study's sea level rise analysis are located in Appendix B. A discussion on risk and uncertainty in sea level rise analysis is located in section 6.9.5 of the main report.

5 PLAN FORMULATION AND EVALUATION OF ALTERNATIVES

This section describes the plan formulation process. Typically, a number of alternatives are identified early in the planning process, and their number is reduced by screening, evaluation, and comparison in an iterative sequence in increasing levels of detail to finally identify the selected plan.

The Implementation Guidance for Section 1037 (a) directs that "Only an extension of periodic renourishment will be considered, and, in general, no reformulation of the existing project is required."

Therefore, plan formulation for this study consisted of the following: (1) establishing criteria by which alternatives would be evaluated; (2) identifying alternative plans; and (3) evaluating alternative plans.

In conformity with the 1037 guidance, initial plan formulation resulted in the identification and evaluation of two preliminary alternatives:

1. The No Action Plan
2. Continuation of Federal participation for periodic renourishments consistent with the currently authorized project for a 15-year period of analysis from 2022 to 2036.

During the study, the PDT identified a study risk concerning the future availability of the historical sand borrow source (Carolina Beach inlet). This risk is associated with the historical sand borrow source being situated within a Coastal Barrier Resources System (CBRS) unit, and therefore subject to restrictions on the expenditure of Federal funds. Due to this identified risk, the PDT evaluated an additional alternative that uses an offshore borrow source (Borrow Area B) not located within a CBRA zone. Both borrow sources were evaluated in this study. Continued use of Carolina Beach Inlet as the borrow source would require a legislative exemption from the provisions of CBRA in the project's final Congressional authorization. Use of offshore Borrow Area B would not require a legislative exemption from the provisions of CBRA. Details on both borrow source alternatives are located in Appendix A. **The following is the final array of alternatives:**

1. The No Action Plan
2. Continuation of Federal Participation for Periodic Renourishments consistent with the currently authorized project using the inlet borrow source, for a 15-year period from 2022 to 2036 (requires an exemption from the provisions of CBRA)

3. Continuation of Federal Participation for Periodic Renourishments consistent with the currently authorized project using an offshore borrow source, for a 15-year period from 2022-2036 (does not require an exemption from the provisions of CBRA)

5.1 No Action Plan

The No Action Plan is an alternative with no Federal action. Under the No Action Plan, the USACE would not participate in future cost-shared periodic renourishments of Carolina Beach.

5.2 Formulation and Evaluation Criteria

Alternative plans were evaluated by applying numerous, rigorous criteria. Four general planning and guidance (P&G) criteria are considered during alternative plan screening: completeness, effectiveness, efficiency, and acceptability. Analysis of alternatives using the P&G criteria, as well as their definitions are located in section 5.6.2, Tables 5.6 and 5.7.

There are also categories of specific technical criteria related to (1) engineering, (2) economic, (3) environmental, and (4) institutional items. They are as follows:

Engineering Criteria

- The plan must represent a sound, acceptable, and safe engineering solution.

Economic Criteria

- The plan must contribute benefits to National Economic Development (NED).
- Tangible benefits of a plan must exceed economic costs.
- Each separable unit of improvement must provide benefits at least equal to costs.
- Recreation benefits may not be more than 50 percent of the total benefits required for economic justification.

Environmental Criteria

- The plan would fully comply with all relevant environmental laws, regulations, policies, executive orders.
- The plan would represent an appropriate balance between economic benefits and environmental sustainability.
- The plan would be developed in a manner that is consistent with the Corps' Environmental Operating Principles (EOPs).
- Adverse impacts to the environment would be avoided. In cases where adverse effects cannot be avoided, mitigation must be provided to minimize impacts to at least a level of insignificance.

Institutional Criteria

- The plan must satisfactorily address the identified needs and concerns of the public.
- The plan must be implementable with respect to financial and institutional capabilities.
- The plan must be implementable with regard to public support.

5.3 Environmental Operating Principles

The USACE Environmental Operating Principles (Principles) were developed to ensure that Corps of Engineers missions include totally integrated sustainable environmental practices. The Principles provided corporate direction to ensure the workforce recognized the Corps of Engineers' role in, and responsibility for, sustainable use, stewardship, and restoration of natural resources across the Nation and, through the international reach of its support missions. More information on the Principles can be found here:

http://www.usace.army.mil/Missions/Environmental/EnvironmentalOperatingPrinciples.aspx

Specifically for this project, these Principles were adhered to during the planning process with regards to the screening of potential borrow sources, and the proposed timing of construction activities to avoid impacts to listed species to the maximum extent practicable.

5.4 Identification, Examination and Screening of Measures

A variety of potential measures can be considered and combined when formulating alternative plans for reducing coastal storm damages. These measures generally are categorized as either structural or non-structural. Structural measures are those that directly affect the conditions that cause storm damage – in this case erosion, wave attack and/or flooding. Non-structural measures are those taken to reduce damages without directly affecting those conditions driving project area damages. A No Action Alternative is developed to provide a baseline condition against which to measure comparative plan effectiveness. Under the No Action alternative, FWOP conditions remain in place without implementation of a Federal project.

In accordance with Section 1037(a) guidance, the study evaluated the existing project as authorized. The structural and non-structural measures associated with the existing project are as follows:

Structural Measures

- ***Beach Fill.*** Beach fill measures consist of berms, dunes, and terminal sections. Measures generally involve variations in dune width, dune height, and berm width. Beach fill measures are considered some of the most appropriate and effective measures, as they mimic the natural environment and can be designed to optimize storm risk management outputs. Although incidental to formulation efforts for this project, beach fill measures that widen the existing berm also provide more recreational benefits than hard structures, and expand the area available for sea turtle nesting and shorebird nesting and foraging. Additionally, a beach fill alternative is naturally adaptable to various sea-level rise scenarios. However, in order to fully realize project outputs, the beach fill template may need to be periodically renourished throughout the life of the project. Figure 5.1 shows an example of a beach fill being constructed.

- ***Vegetation and sand fencing.*** Vegetation and sand fencing help retain windblown sand but do not provide adequate storm damage reduction for moderate to severe storms, and hence are not adequate as a stand-alone measure. However, any dune construction measure would also include appropriate vegetation planting.

Figure 5.1. Example of beach fill being constructed (Carolina Beach, 2019).

Non-Structural Measures

- ***Floodplain and Building Code Regulations.*** Management of the floodplain is a non-Federal responsibility. Regulatory measures include coastal building codes, building construction setbacks, and floodplain regulations. Most regulatory measures have already been instituted at the local level. These regulations

provide indirect benefit to storm damage reduction, primarily to new and future construction. They are considered as part of the existing and future without project conditions, and are an integral part of any final project alternatives.

- ***Evacuation, Routing and Signage***. Elements of this measure include State evacuation route signage, reverse 911 phone systems, low frequency AM Stations, hurricane risk education and upgrading critical infrastructure and services.

5.5 Identification of Alternative Plans

In conformity with the Section 1037 (a) guidance of WRRDA 2014, as amended, plan formulation resulted in the identification and evaluation of three alternatives:

5.5.1 Alternative 1: No Action

The No Action Plan describes an alternative scenario with no federal action. Under the No Action Plan, USACE would not participate in future periodic renourishments. The period of analysis for this study is from 2022-2036.

5.5.2 Alternative 2: Continuation of Federal Participation for Periodic Renourishments consistent with the currently authorized project using the inlet borrow source, for a 15 year period from 2022 to 2036 (requires an exemption from the provisions of CBRA).

This alternative would determine Federal interest in continuing periodic renourishments for the Carolina Beach CSRM project through 2036. This alternative would be the same as the current Carolina Beach CSRM project with the Carolina Beach Inlet borrow source.

5.5.3 Alternative 3: Continuation of Federal Participation for Periodic Renourishment consistent with the currently authorized project using an offshore borrow source (does not require an exemption from the provisions of CBRA).

This alternative would determine Federal interest in continuing periodic renourishments for the Carolina Beach CSRM project through 2036. This alternative would be the same as the current Carolina Beach CSRM project, but would only use an offshore borrow source.

5.5.4 Application of CBRA in using Carolina Beach Inlet Borrow Source

Utilizing existing information about the inlet borrow source and information gathered about the offshore borrow source, the use of the Carolina Beach Inlet as the primary borrow source is environmentally preferable to only using the offshore borrow source (see Section 7.1), and would conserve Federal and non-Federal funds. Consequently, there is the explicit understanding that CBRA would prohibit the use of the inlet as a borrow source unless the Congressional re-authorization of the project included specific

statutory language allowing use of Federal funds to work within this borrow area notwithstanding the financial restrictions of CBRA.

While USACE does not typically consider alternatives that are outside the scope of current Congressional authority, the National Environmental Policy Act specifically allows for this type of consideration. Given the environmental benefits associated with continued use of the inlet borrow source, the Recommended Plan is the environmentally preferred plan and includes the Carolina Beach Inlet as the primary borrow source for this project notwithstanding the restrictions of CBRA. For additional information on the application of CBRA on both alternatives, see Section 9.3 of this report.

5.6 Evaluation of Alternative Plans

This section discusses the second-tier evaluation of alternative plans.

5.6.1 Beach Fill Alternatives Evaluation

The Beach-fx model was used to produce the benefits and borrow volumes needed for each alternative; however, it should be noted that the costs produced by the model and presented at this stage were for comparative purposes only, and only factored in borrow placement costs, but not other associated costs such as mobilization/de-mobilization, monitoring, tilling, walkway replacement, vegetation planting, real estate, administration, and pre-construction, engineering and design. The associated costs are proportional to the magnitude/size of the alternative, and thus, their exclusion did not affect the comparison of alternatives and determination of the NED Plan. Fully detailed project costs were ultimately developed, independent of the Beach-fx model, for Alternatives 2 and 3. A three-year renourishment cycle was specified for the screening runs.

5.6.2 System of Accounts Analysis

The system of accounts is one method to organize and track the effects of alternative plans. It is essentially a set of effect categories. The four primary categories considered for impacts in this study are as follows:

1) National Economic Development (NED)

Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units.

2) Regional Economic Development (RED)

Contributions to RED are changes in the distribution of regional economic activity that result from the alternative plan.

3) Environmental Quality (EQ)

EQ is captured as both beneficial effects and adverse effects. Beneficial effects are favorable changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources. Adverse effects are unfavorable changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources.

4) Other Social Effects (OSE)

The OSE account displays impacts that would not be reflected in the other 3 accounts (NED, RED and EQ). These additional impacts could include the following: Community impacts; life, health and safety factors; displacement; and long-term productivity.

The average annual NED costs, benefits, and net benefits of each of the alternatives are shown in Table 5.1. The alternative with the highest net benefit is to continue the project as authorized.

Table 5.1. Comparison of alternative average annual (AA) costs and benefits, October 2018 (FY 2019) price level, FY 2019 interest rate (2.875 percent). The interest rate used was current at time of analysis.

		Continue Project as Authorized (Interest @ 2.875 percent)	
Item	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Damage Reduction Benefits	$0	$4,606,000	$4,606,000
Land Loss Benefits	$0	$1,309,000	$1,309,000
Primary Benefits	$0	$5,915,000	$5,915,000
Primary BCR (No Recreation)	0	3.4	3.0
Recreational Benefits	$0	$834,000	$834,000
Total Benefits	$0	$6,749,000	$6,749,000
Total Costs	$0	$1,718,000	$1,954,000
Preliminary BCR	0	3.9	3.4

The following table displays the System of Accounts Evaluation:

Table 5.2. NED comparison of alternatives

Account: NED			
Item	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
a. Beneficial Impacts			
Average Annual Damages Prevented	$0	$5,915,000	$5,915,000
Emergency Costs Avoided	$0	n/a	n/a
Recreation	$0	$834,000	$834,000
Total Beneficial Impacts	$0	$6,749,000	$6,749,000
b. Adverse Impacts			
Total Project Cost, Including Real Estate	$0	$45,300,000	$51,479,000
Interest During Construction	$0	n/a	n/a
Economic Costs for BCR	$0	$45,300,000	$51,479,000
Average Annual First Cost	$0	$1,718,000	$1,954,000
Annual O&M	$0	n/a	n/a
Total Average Annual Costs	$0	$1,718,000	$1,954,000
Benefit-Cost Ratio	n/a	3.9:1	3.4:1
Average Annual Net Benefits	n/a	$5,031,000	$4,795,000

Table 5.3. RED comparison of alternatives

Account: RED			
Item	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Sales Volume	Reduced rental market and tourism.	Rental sales and tourism sales preserved or increased.	Same as Alternative 2
Income	Decreased recreation visitation may reduce the income of service industries and rental properties.	Increased recreation visitation may improve the income of service industries and rental properties.	Same as Alternative 2
Employment	Seasonal employment may decrease due to decreased recreation visitation.	Seasonal employment may increase recreation visitation. Temporary increase in employment related to construction activities.	Same as Alternative 2
Tax Changes	Loss of tax base if properties are destroyed and cannot be rebuilt.	Tax base and property values preserved or increased.	Same as Alternative 2

Table 5.4. EQ comparison of alternatives (Part 1 of 5)

Account: EQ				
Item		**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Physical Resources	**Air Quality**	No effect.	Temporary pollutant increase associated with dredging and heavy equipment during renourishment events.	Temporary pollutant increase associated with dredging and heavy equipment during renourishment events. Slightly greater increase as compared to Alternative 2 due to longer dredging time and transit time to and from borrow area.
	Geology and Sediment	Increased quantity of sediment in Carolina Beach Inlet, reducing the impact to the natural sediment bypassing process. Long-term erosion of Carolina Beach shoreline.	No significant change to the natural geology. Short-term reduction of beach quality sediment in the inlet, continuing the impact to the natural sediment bypassing process, recharged through littoral transport and navigation material placement. Continued erosion on south end of Masonboro Island due to a lack of inlet management plan that includes sand bypassing.	No significant change to the natural geology. Reduction of beach quality sediment in Borrow Area B; more sediment would remain in CB Inlet, reducing the impact to the natural sediment bypassing process. Increased Littoral drift from Carolina Beach may increase shoaling in the inlet.
	Climate Change	No effect to climate change. Likely increased storm events and sea level rise would cause increased erosion rates.	No effect to climate change. Likely increased storm events and sea level rise would cause increased erosion rates.	Same as Alternative 2
	Sea Level Rise	No effect to sea level rise. Accelerated sea level rise rates would lead to higher storm surges and increased erosion rates.	No effect to sea level rise. Accelerated sea level rise rates would lead to higher storm surges and increased erosion rates.	Same as Alternative 2

Table 5.4. EQ comparison of alternatives (Part 2 of 5)

Account: EQ				
Item	**Factor**	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Water Quality		No effect.	Short-term and localized elevated turbidity and suspended solid levels in the inlet and in the surf zone environments associated with dredging and beach placement.	Increased short-term and localized elevated turbidity and suspended solid levels offshore and in the surf zone environments associated with dredging and beach placement due to longer project duration.
Marine Resources	**Benthic Resources**	Long term reduction in benthic macro-invertebrate abundance in the beach environment due to erosion of beach habitat	Short-term and localized impact to benthic macro-invertebrate community from direct burial and turbidity associated with beach placement. Short-term and localized impact to macro-invertebrate community associated with dredging.	Short-term and localized impact to benthic macro-invertebrate community from direct burial and turbidity associated with beach placement. Increase over Alternative 2 in short-term and localized impact to macro-invertebrate community associated with dredging duration and greater extent of borrow area impacts.
	Inlet and Surf Zone Fishes and Nekton	No effect.	Short-term effects due to construction turbidity. Negligible entrainment impacts due to use of cutterhead dredge.	Increased short-term turbidity effects over Alternative 2 due to construction duration. Increased impacts to oceanic nekton (offshore borrow) and greater entrainment impacts due to longer duration for construction
	Hard Bottoms	No effect.	No effect.	No effect.
	EFH-HAPC	No effect.	No significant adverse impacts to EFH or HAPC. Physical and biological impacts to EFH would be short-term and localized on an individual and cumulative effects basis.	No significant adverse impacts to EFH or HAPC. Physical and biological impacts to EFH would be slightly greater than Alternative 2, but would be short-term and localized on an individual and cumulative effects basis.

Table 5.4. EQ comparison of alternatives (Part 3 of 5)

Account: EQ				
Item	**Factor**	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Wetlands and Floodplains		No effect.	No effect.	No effect.
	Vegetation	Long term loss of vegetation habitat areas as beach erodes.	Disturbance of some existing vegetation, minimized by post-construction dune planting if the dune requires renourishment.	Same as Alternative 2
Terrestrial Resources	**Wildlife**	Long term loss of roosting, foraging, breeding and nesting habitat for mammals, reptiles, amphibians and birds.	Short-term effects to transient species. Temporary effect to roosting and foraging shorebird habitat.	Increased duration of short-term effects to transient species and temporary effects to roosting and foraging shorebird habitat due to longer construction duration.
	Whales and Manatees	No effect.	Short-term impacts to foraging habitat and slight chance of vessel strikes to whales and manatees. No effect to NARW critical habitat and manatees.	Increased risk of short-term impacts to foraging habitat and increased chance of vessel strikes offshore and during transit due to increase in distance and construction duration to whales and manatees. No effect to NARW critical habitat.
Endangered Species	**Sea Turtles**	Long term decrease in sea turtle nesting habitat success due to beach erosion, scarping and scouring of the dune.	Negligible risk to benthic oriented sea turtles due to entrainment. Long term sustainability of sea turtle nesting habitat due to preservation of the beach berm. No effect to loggerhead critical habitat.	Same as Alternative 2

Table 5.4. EQ comparison of alternatives (Part 4 of 5)

Account: EQ				
Item	**Factor**	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Endangered Species	**Atlantic and Shortnose Sturgeon**	No effect to sturgeon or critical habitat.	No effect to Shortnose Sturgeon. Minor risk of Atlantic sturgeon (AS) impacts from dredging. Short-term impacts to benthic foraging and refuge habitat and disruption of migratory pathway. No effect to AS critical habitat.	No effect to Shortnose Sturgeon. Minor risk of Atlantic sturgeon (AS) impacts from dredging. Increase in construction duration increases short-term disruption of migratory pathway. No effect to AS critical habitat.
	Seabeach Amaranth	Long term loss of seabeach amaranth habitat as beach erodes.	Deep burial of seeds during construction may slow germination and population recovery over the short-term. Long term benefits of increased available seabeach amaranth habitat.	Same as Alternative 2
	Piping Plover and Red Knot	Long term loss of habitat areas as beach erodes.	Short-term impact to bird foraging, sheltering and roosting areas. Long term enhancement of these areas with beach renourishment.	Increased short-term impacts to bird foraging, sheltering and roosting areas. Long term enhancement of these areas with beach renourishment.
Socio-economics	**Demographics, Economics and Income**	Increased potential adverse impacts to the existing tax base and to commercial and public entities.	Continue economic growth. Minimized damages to residential, public and commercial structures, as well as reduction of damages to critical infrastructure.	Continue economic growth. Minimized damages to residential, public and commercial structures, as well as reduction of damages to critical infrastructure.
	Aesthetic Recreational and Resources	Adverse long term detrimental effect due to beach erosion.	Short-term minor adverse impacts due to beach placement activities. Long term benefits to beach renourishment and stabilization.	Increased short-term impacts to bird foraging, sheltering and roosting areas. Long term enhancement of these areas with beach renourishment.

Table 5.4. EQ comparison of alternatives (Part 5 of 5)

Account: EQ				
Item	**Factor**	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Socio-economics	**Commercial and Recreational Fishing**	No effect.	Potential temporary delays to boat traffic through the inlet during construction.	No effect.
Cultural Resources		Potential resources would continue to be vulnerable to natural processes.	Slight risk of encountering resources associated with beach placement and borrow area dredging, although risk in dredging areas is minimal since area has been surveyed. Long term protection of potential beach resources that would be affected by natural processes.	Slight risk of encountering resources associated with beach placement and borrow area dredging, although risk in dredging area is minimal since area will be surveyed prior to use. Long term protection of potential beach resources that would be affected by natural processes.
Noise		No effect.	Minor short-term increase in noise during construction.	Greater short-term increase in noise during beach construction over Alternative 2; somewhat mitigated by Borrow Area B distance dissipation.
HTRW		No effect.	No effect.	No effect.

Table 5.5. OSE comparison of alternatives

Account: OSE			
Item	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Life, Health and Safety	No change. Continued stress during damaging storms. Evacuation would still be required before storm landfall.	Significant reduction in stress related to concern of amount of damage and recovery during and after storms. Evacuation would still be required before storm landfall.	Same as Alternative 2
Community Cohesion	Increased displacements of all permanent residents and visitors.	Periodic displacement of all permanent residents and visitors.	Same as Alternative 2
Community Growth	Recreation visitation would likely decrease as the beachfront erodes away. Permanent population would likely decrease as lots are abandoned.	Growth trends in population and recreation visitation would continue.	Same as Alternative 2
Traffic and Transportation	Increased risk to streets and highways as the beachfront erodes.	Reduces damages to streets and highways. Minor, short-term increase in boat traffic due to dredging operations during renourishments.	Same as Alternative 2
Environmental Justice	No Effect.	No Effect.	Same as Alternative 2
Socioeconomics	In absence of a project, the probability of damages to existing structures increases, potential adverse impacts to existing tax base and impacts to commercial and public entities.	Continued economic growth in the presence of an authorized project. Minimize damage to residential, public and commercial structures, as well as reduction of damages to critical infrastructure.	Same as Alternative 2

USACE Planning Criteria Evaluation

Alternatives were also evaluated based on the planning criteria of acceptability, completeness, effectiveness, efficiency and with consideration of the planning constraints. General planning criteria definitions are located in table 5.6 below, with the comparative evaluation following in table 5.7.

TABLE 5.6 GENERAL PLANNING CRITERIA DEFINITIONS FOR ALTERNATIVES SCREENING

Completeness	Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities. Completeness also includes consideration of real estate issues, operations and maintenance (O&M), monitoring, and sponsorship factors.
Effectiveness	Effectiveness is the extent to which the alternative plans contribute to achieve the planning objectives. The plan must make a significant contribution to the problem or opportunity being addressed.
Efficiency	Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the objectives. The plan outputs cannot be produced more cost-effectively by another plan.
Acceptability	Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations and public policies. Appropriate mitigation of adverse effects shall be an integral component of each alternative plan. The project should have evidence of broad-based public support and be acceptable to the non-Federal cost sharing partner.

Table 5.7. Planning and Guidance (P&G) criteria comparison of alternatives

Account: P & G Criteria			
Item	**Alternative 1 (No Action)**	**Alternative 2 (Inlet Borrow Source)**	**Alternative 3 (Offshore Borrow Source)**
Acceptability	Would be objectionable to some state and local entities, and will not meet the planning objective, but is compliant with existing laws, regulations and policies.	Utilization of this sand borrow source would conflict with the provisions of the Coastal Barrier Resources Act (CBRA). Utilizing this option would require added language in the Congressional authorization providing an exemption from the provisions of CBRA for this project.	Would be acceptable to state and local entities and is compliant with existing laws, regulations and policies
Completeness	Not a complete solution because it would not meet the planning objective.	Complete solution.	Complete solution.
Effectiveness	Not effective in achieving the planning objective.	An effective solution because it meets the planning objective.	An effective solution because it meets the planning objective.
Efficiency	Not efficient because it does not contribute to planning objective.	Most efficient alternative for meeting the planning objective.	Meets the planning objective, but not the most efficient alternative due to increased construction costs.

5.7 Plan Selection

5.7.1 Identification of NED Plan

Based on the results of the analyses presented in Section 5, Alternative 2 is identified as the NED Plan, as it is the alternative with the highest net benefits. The dimensions of the NED plan, as is the Recommended Plan, are summarized in Section 6.

5.7.2 Identification of a Locally Preferred Plan (LPP)

No Locally Preferred Plan has been identified, as the non-Federal sponsor is in support of moving forward with the NED Plan as the Recommended Plan.

5.8 Value Engineering

Value engineering was not conducted during this Section 1037(a) study. However, a programmatic study was completed in June 2018 regarding dredging in the South Atlantic region. That study will be referenced for application on each individual renourishment cycle.

5.9 Independent External Peer Review (IEPR)

IEPR may be required for decision documents under certain circumstances. IEPR is the most independent level of review, and is applied in cases that meet certain criteria where the risk and magnitude of the proposed project are such that a critical examination by a qualified team outside of USACE is warranted. A risk-informed decision, as described in EC 1165-2-217, is made as to whether IEPR is appropriate. IEPR panels will consist of independent, recognized experts from outside of USACE in the appropriate disciplines, representing a balance of areas of expertise suitable for the review being conducted. There are two types of IEPR:

- Type I IEPR. Type I IEPR reviews are managed outside USACE and are conducted on project studies. Type I IEPR panels assess the adequacy and acceptability of the economic and environmental assumptions and projections, project evaluation data, economic analysis, environmental analyses, engineering analyses, formulation of alternative plans, methods for integrating risk and uncertainty, models used in the evaluation of environmental impacts of proposed projects, and biological opinions of the project study. Type I IEPR will cover the entire decision document or action and will address all underlying engineering, economics, and environmental work, not just one aspect of the study. For decision documents where a Type II IEPR (Safety Assurance Review) is anticipated during project implementation, safety assurance shall also be addressed during the Type I IEPR per EC 1165-2-217.

- Type II IEPR. Type II IEPR, or Safety Assurance Review (SAR), are managed outside USACE and are conducted on design and construction activities for hurricane, storm, and flood risk management projects or other projects where existing and potential hazards pose a significant threat to human life. Type II IEPR panels will conduct reviews of the design and construction activities prior to initiation of physical construction and, until construction activities are completed, periodically thereafter on a regular schedule. The reviews shall consider the adequacy, appropriateness, and acceptability of the design and construction activities in assuring public health safety and welfare.

a. Decision on Type I IEPR. As documented in the Review Plan approved by the South Atlantic Division Commander in January 2018, this beach renourishment evaluation report is excluded from IEPR per Paragraph 4.d. of the implementation guidance for Section 1037(a) of the Water Resources Reform and Development Act of 2014, which

states, “Decision documents developed under this authority are excluded from independent external peer review unless one of the mandatory triggers contained in Section 2034(a)(3)(A)(i) of the Water Resources Development Act of 2007, as amended (33 U.S.C. 2343(a)(3)(A)(i)), is involved.”

PDT review determined that this proposed continuation of an existing project does not meet nor is expected to involve any of the following mandatory triggers described in EC 1165-2-217, paragraph 11.d:

A. There is no public safety component of the project.
B. The total project cost is less than $200 million.
C. We do not expect the governor to request IEPR.
D. We do not expect the Director of Civil Works or the Chief of Engineers to determine this project is controversial due to significant public dispute over the size, nature, or effects of the project or the economic or environmental costs or benefits of the project.

Therefore, this project is excluded from Type I IEPR.

b. **Decision on Type II IEPR.** Based on the project as currently envisioned, the Wilmington District Chief of Engineering, as the Engineer-In-Responsible-Charge, does not recommend a Type II IEPR Safety Assurance Review of this project at this time. A risk-informed decision concerning the timing and the appropriate level of reviews for the project implementation phase will be prepared and submitted for approval in an updated Review Plan prior to initiation of the design/implementation phase of this project.

Products to Undergo Type I IEPR. Not applicable

Required Type I IEPR Panel Expertise. Not applicable

Documentation of Type I IEPR. Not applicable

6 RECOMMENDED PLAN

The purpose of this report section is to centralize information concerning the Recommended Plan. The Recommended Plan is discussed in terms of features, construction, maintenance, monitoring requirements, real estate requirements, economics, accomplishments, and risk and uncertainty.

6.1 Plan Description and Components

The Recommended Plan is alternative #2 – Continuation of Federal Participation for Periodic Renourishments consistent with the currently authorized project using the inlet borrow source, for a 15 year period from 2022 to 2036. This alternative would result in an additional 15 years of Federal participation beginning at initiation of construction of the congressionally authorized renourishment. This alternative includes approximately 14,000 feet of ocean shoreline and fronts the Town of Carolina Beach. The project includes the following: Dune having a crown width of 25 feet at 12.5 feet North American Vertical Datum of 1988 (NAVD88), together with a storm berm, having a crown width of 50 feet at 9.5 feet NAVD88. The dune and berm extend about 14,000 feet along the beachfront from the northern to the southern limits of Carolina Beach. Included with this project is a 2,050 foot long rock revetment located on the far northeast segment of the project (from Station 116+00 to 137+.15). Historically the project renourishment extends from Station 0+00 to 120+00 with a 2,000-foot transition to station 140+00. To compensate for higher erosion rates in the northern segment, the construction berm width increases from 40 feet at station 90+00 to 100 feet at station 120+00. Material for the beach fill would be obtained from Carolina Beach Inlet and would require an exemption from CBRA for this project in the final Congressional authorization. Typical project plan views and template profiles are illustrated in Figures 6.1 and 6.2.

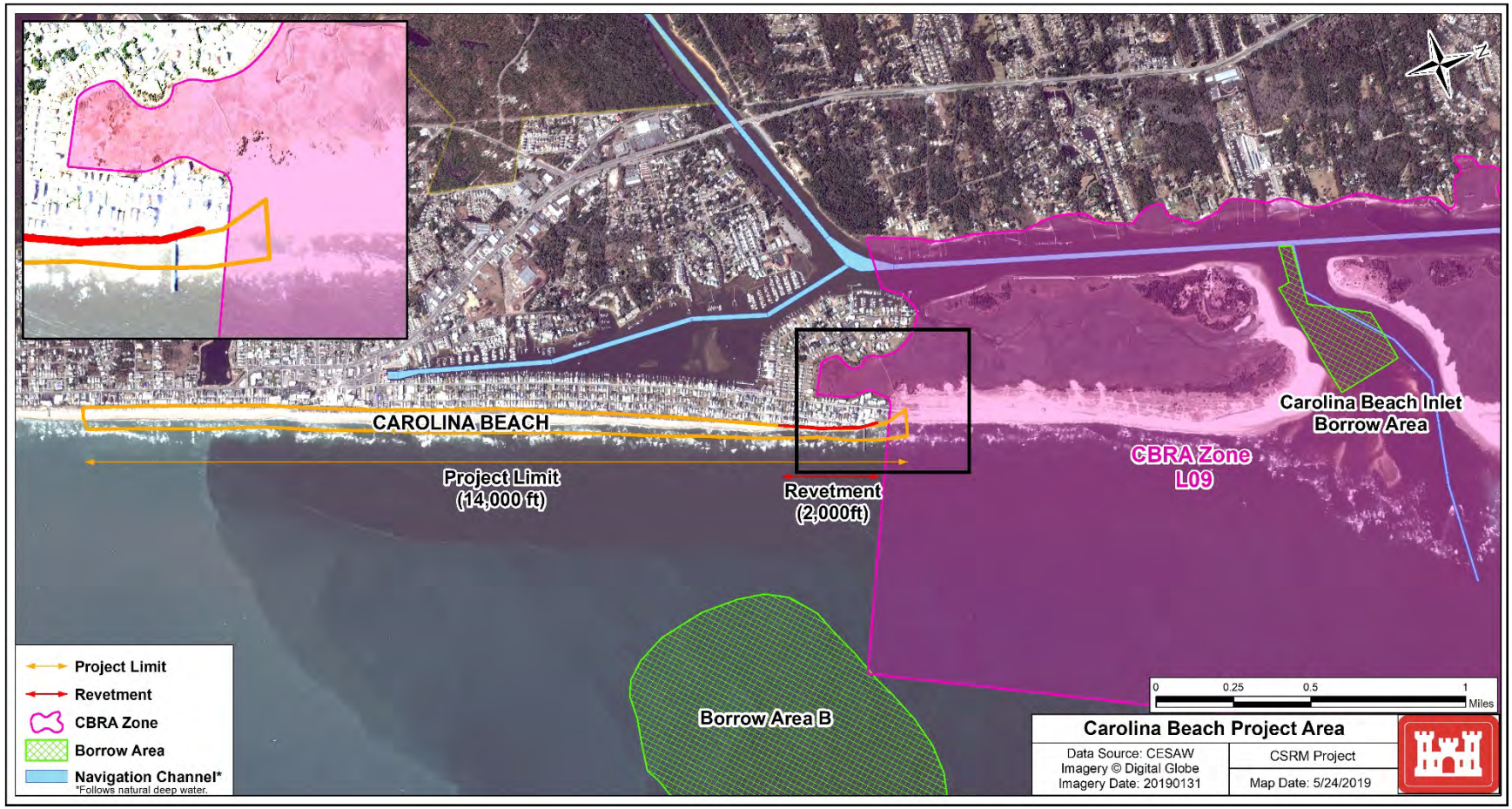
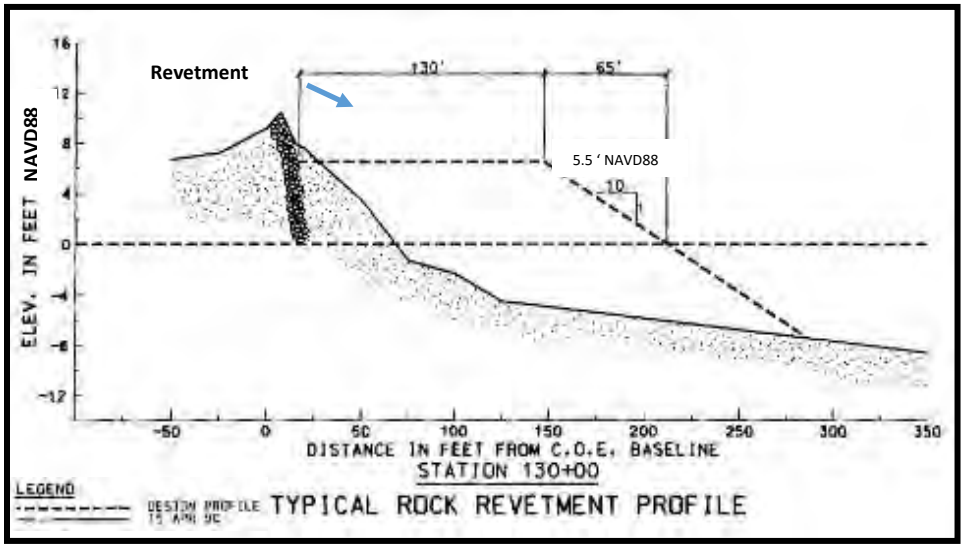


Figure 6.1. Plan view of the Recommended Plan.

Northern reach with rock revetments (rock revetment added in 1973) about 2,050 feet in length.



Southern reach without rock revetment. About 12,000 feet in length.

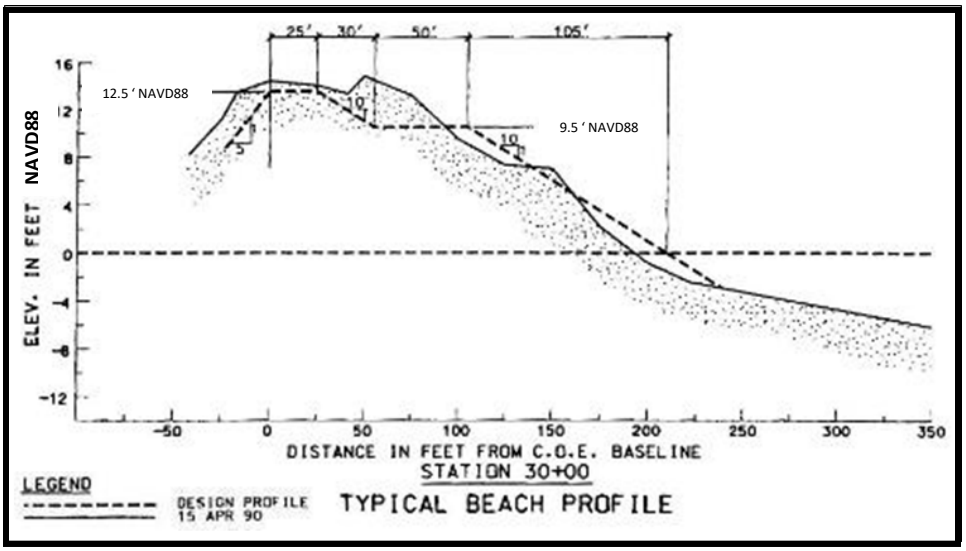


Figure 6.2. Carolina Beach Authorized Template – Typical Beach Profiles

6.1.1 Beach Fill

The Recommended Plan has a main fill length of 14,000 feet. The southernmost 11,950 lineal feet of the project consists of a 25' wide crested dune at an elevation of 12.5' NAVD88 fronted by a 50' wide berm at elevation 9.5' NAVD88. The northernmost 2,050 linear feet of the project is a 130' berm only project at elevation 5.5' NAVD88 that fronts an existing rock revetment The dimensions listed for the Recommended Plan integrate, and are based on, the existing idealized dune dimensions for those reaches, and represent the maximum size of the construction template.

6.2 Design and Construction Considerations

6.2.1 Renourishment

The Recommended Plan will require an estimated 800,000 cubic yards of material for each renourishment cycle (every 3 years). During the 15 year project life, 5 renourishment events would require a total volume of 4 million cubic yards of material.

The renourishment material would most likely be pumped to the beach from pipeline dredges (although other types of dredges could potentially be used) and shaped on the beach by earth-moving equipment. During renourishment, material between the toe of dune and the mean high water line would be tilled to prevent compaction, if needed. Due to limitations in the ability of equipment to shape material underwater, the berm would not be constructed in the shape of the design berm profile. Instead, the volume of material necessary to create the design berm would be pumped out into an initial construction profile (see Figure 6.2). The initial construction profile would extend seaward of the final design berm profile by a variable distance (approximately 100-150 ft) to cover anticipated sand movement during and immediately after construction. Once sand distribution along the foreshore occurs (about 6 months), the adjusted profile should resemble the design berm profile. The first renourishment of this reauthorization, and all subsequent events would use a single dredge and is anticipated to take 30 days.

For hydraulic pipeline operations that include the placement of dredged material on the beach, a pipeline route would be extended from the dredge plant to the beach fill placement location. Before each renourishment event, pipeline placement will be coordinated with the appropriate resource agencies. Renourishments would utilize a pipeline route from Carolina Beach Inlet, through Freeman Park, to the southernmost portion of the project. Prior to the commencement of dredging, shoreline pipe would be mobilized to the beach in segments of varying sizes in length and diameter. The mobilization process usually requires the use of heavy equipment to transport and connect pipe segments from the beach access point to the designated placement area. Except for the Freeman Park section of the pipeline route, which runs along the toe of the dune, the placement of shore pipe is generally on the upper beach, away from existing dune vegetation and seaward of the toe of the primary dune.

The width of disturbance area required to construct the pipeline route varies depending on the size of pipe used for the project. Site context and environmental features are considered for each project so that construction activities are confined to areas with minimal impact to the environment. Once the heavy equipment and pipe is on the beach and the pipes are connected, heavy equipment operation is generally confined to the vicinity of the mean high water line, away from dune vegetation on the upper beach. Within the active placement area, heavy equipment operates throughout the width of the beach in order to manage the outflow of sediment and construct target elevations for the appropriate beach profile.

6.2.2 Dune Vegetation

The dune portions of the project are stabilized against wind losses by planting appropriate native beach grasses. Sand fencing is not needed since the existing dune is at an appropriate height to provide stabilization without fencing. If the dune is under design template height or if the dredging contractor damages the dune during a periodic renourishment event, stabilization will be accomplished by planting vegetation during the optimum planting season following dune construction. If planting is accomplished by machine, all equipment must be off the beach by close of the environmental window of April 30 to the maximum extent practicable. Planting stocks would consist of a variety of native dune plants including sea oats (*Uniola paniculata*), American beachgrass (*Ammophila breviligulata*), panic grass (*Panicum amarum*), and seaside little bluestem (*Littoralis variety*). The vegetative cover would extend from the landward toe of the dune to the seaward intersection with the berm for the length of the dune. Plant spacing guidelines will follow the recommendations provided by the North Carolina Sea Grant, *The Dune Book* (Nash and Rogers, 2003). Sea oats would be the predominant plant with American beach grass and panic grass as supplemental plants. Seaside little bluestem would be planted on the backside of the dune away from the most extreme environment.

6.2.3 Construction Access

Construction access to the project is currently available by public roads and rights-of-way. There are sufficient access areas along the beach at the ends of public streets and at public access areas for contractors to move pipe and construction equipment to the beach as demonstrated by the multiple periodic renourishment events completed since 1967.

6.2.4 Borrow Areas

This study evaluated two potential borrow sources for suitability – **1) Carolina Beach Inlet**, and **2) offshore Borrow Area B**. Analysis indicates that Carolina Beach inlet is economically efficient and environmentally preferable with regard to impacts. However, both sources contain suitable sand resources in both quality and quantity for future renourishments.

Carolina Beach Inlet

Carolina Beach Inlet was constructed in 1952 by local interests and has been used as the historic borrow source for the federally authorized project since 1967, with renourishment cycles occurring every three years. Located immediately north of the project site, Carolina

Beach Inlet receives and retains suitable sand via longshore current, which would otherwise help recharge the Carolina Beach shoreline. As a result, Carolina Beach Inlet has historically served as a reliable sand source for the authorized project and could continue to do so for the Section 1037 period of analysis.

USACE formally established borrow area limits within Carolina Beach Inlet as part of its implementation of Section 934 of the Water Resources Development Act of 1986. Respective borrow area limits constitute a polygonal area of around 41 acres, which ranges in width from 200 ft. to 1,100 ft. with a length of about 1,900 ft. Water depths and sediment volumes vary, in accordance with dredging, beach renourishment operations, and naturally-occurring sediment entrainment and deposition. For example, bathymetric surveys performed immediately after borrow area use and respective beach renourishment indicate that the borrow area reaches a maximum depth of around -40 ft. MLLW. However, subsequent condition surveys show that the area becomes shallower over time due to sedimentary recharge. For comparison, the Carolina Beach Inlet navigation channel is about 6,000 ft. long, 150 ft. wide, and is typically maintained to a target depth of -10 ft. MLLW, except in areas where it intersects the borrow area, where it is generally deeper. However, due to the Coastal Barrier Resources Act, continued use of the Carolina Beach Inlet borrow area (Recommended Plan) would require an exemption from CBRA in the project's final Congressional authorization.

Utilizing existing information about the inlet borrow source and information gathered about the offshore borrow source, the use of the Carolina Beach Inlet as the primary borrow source is environmentally preferable to only using the offshore borrow source (see Section 7.1), and would conserve Federal and non-Federal funds. Consequently, there is the explicit understanding that the provisions of CBRA would prohibit the use of the inlet as a borrow source unless the Congressional re-authorization of the project includes specific statutory language allowing use of Federal funds to work within this borrow source notwithstanding the financial restrictions of CBRA.

While USACE does not typically consider alternatives that are outside the scope of current Congressional authority, the National Environmental Policy Act specifically allows for this type of consideration. Given the environmental benefits associated with continued use of the inlet borrow source, the Recommended Plan includes the Carolina Beach Inlet as the primary borrow source for this project notwithstanding the restrictions of CBRA. For additional information on the application of CBRA on both alternatives, see Section 9.3 of this report.

Borrow Area B

As a result of potential CBRA restrictions for use of the historic borrow area at Carolina Beach Inlet, another alternative borrow site, known as "Borrow Area B", was evaluated. Borrow Area B is located about 0.5 to 2.5 miles east of the Federally-authorized project and has a surface area of approximately 1,040 acres. Borrow Area B has been used since 1999 as the primary sand source for the Area South CSRM project, also part of the Carolina Beach and Vicinity

project, which is located just south of the Carolina Beach CSRM project. Analysis in 2012 and 2018 concluded that either Carolina Beach Inlet or Borrow Area B, even with the quantity requirements for the Area South CSRM project through 2049, has sufficient sand quality and quantity to support the Carolina Beach CSRM project over the recommended 15-year continuation of Federal participation in periodic renourishment, if required to be used as a borrow source in lieu of Carolina Beach Inlet. Although Borrow Area B is not expected to be utilized under the Recommended Plan in the event that its use be required due to potential shortfalls in volume in the inlet or if other issues arise in the future.

For further details on the evaluation of these borrow areas, please see Geotechnical Appendix A.

6.2.5 Dredging Production

Dredging production refers to the average volume transported per day and relates to factors such as plant, material, distance, and weather. This information is used to estimate project cost and construction time. With the use of Carolina Beach Inlet, production rates are estimated to average about 20,000 cubic yards/day by pipeline dredge for periodic renourishment (dependent on placement location and weather conditions).

6.2.6 Environmental Window

Cutterhead dredging operations and project-related activity on the oceanfront beach involving construction equipment, equipment stockpiling, or sand movement will be restricted to the environmental window of November 16 to April 30.

6.2.7 Recommended Construction Plan

Periodic renourishment would occur every 3 years and would typically consist of using a cutterhead (pipeline) dredge. Renourishment would begin as early as November 16 for each cycle and proceed until completion, which is anticipated to be prior to April 30 the following year. The plan would require separate contracts for each periodic renourishment cycle.

6.3 Monitoring Requirements

6.3.1 Beach Fill Monitoring

A comprehensive monitoring program in accordance with USACE guidance (EM 1110-2-1100, Part V, Chapter 4) has been, and would be followed, when not budgetarily constrained, for the Carolina Beach project to assess and ensure project functionality throughout its design lifetime. Such monitoring supports the design efforts for periodic renourishment and is cost-shared 50 percent Federal and 50 percent non-Federal. Beach fill monitoring would include semiannual beach profile surveys, aerial photography, and an annual monitoring report. This beach fill monitoring is required for post-construction survey to confirm the final constructed beach profile after equilibration. Profile equilibration occurs about 6 months after completion of renourishment. If budgetary constraints lengthen the renourishment interval beyond the three years identified in the Recommended Plan, any subsequent beach fill monitoring prior to pre-

construction surveys conducted for the next renourishment cycle would be considered a local responsibility.

Beach profile surveys would not only allow assessment of anticipated beach fill performance, but also allow determination of renourishment volume requirements. An aerial photographic record of the project would further facilitate assessment of the beach fill performance. The annual monitoring report would present the data collected and the corresponding analysis of project performance, including recommendations on renourishment requirements.

6.3.2 Environmental Monitoring and other Commitments

The environmental goal of the project is to avoid and minimize adverse impacts to the environment to the maximum extent practicable. Costs related to the measures that will be taken to minimize impacts are factored into the total project construction costs. As part of the *North Carolina Sea Turtle Protection Project*, and with the help of Federal and local agencies and volunteer groups, annual surveys of sea turtle activity have and continue to occur along Carolina Beach. These surveys likely would continue, with or without a project in place.

The placement of material on Carolina Beach may affect but is unlikely to adversely affect the Federally-listed, threatened Seabeach amaranth (Amaranthus pumilus). Generally, Seabeach amaranth populations in North Carolina are concentrated towards inlet complexes and the extents of beach islands, should they exist. Beginning in 1991, the USACE conducted annual Seabeach amaranth surveys at beaches on which USACE beach renourishment / coastal storm damage reduction projects have been constructed. At Carolina Beach, specifically, no Seabeach amaranth has been observed since 2006. Regardless, the proposed project limits avoid the inlet complexes at both the northern and southern ends of Carolina Beach. Along the beachfront and within the project limits, high erosion rates and inundation from storm events have reduced and deteriorated available Seabeach amaranth habitat between the base of the dune and the wrack line. Beach renourishment has the potential to bury existing seeds in the project area, and it is unknown if the dredged material from an offshore borrow area would introduce seed stock capable of producing viable Seabeach amaranth plants. Although none are currently known to exist at Carolina Beach, any plants in the project area would not be expected to be directly impacted by material placement as this annual plant is typically emergent, spanning July through October (https://www.fws.gov/raleigh/species/es_seabeach_amaranth.html), which is outside of the proposed construction window. The proposed project may restore and expand available habitat area for Seabeach amaranth at Carolina Beach.

Seabeach amaranth monitoring, in areas of Carolina Beach receiving sand placed by USACE, will include five annual monitoring events following the placement event. In accordance with a 1993 Biological Opinion (USFWS 1993), "The Corps should commit to monitoring the beach

disposal areas for at least five years following beach disposal to determine the status of the seabeach amaranth populations in the project areas and the effects that beach disposal has on this species." Given this obligation, and should the Corps continue to place sand on Carolina Beach every five years or sooner, annual Seabeach monitoring may be expected to occur in relative perpetuity. Annual Seabeach amaranth monitoring cost is estimated to be approximately $2,600. Annual monitoring cost includes survey of favorable habitat areas by two individuals to record presence and number of plants, and data recording, compilation, and analysis.

Contractors will be required to monitor and assess the pipeline numerous times each day and night during construction to avoid leaking of dredged material from the pipeline and its couplings that may result in sediment plumes, siltation and/or elevated turbidity levels, as well as erosion of the beach. In the event a leak is discovered, the contractor will be required to either repair the leak immediately or cease dredging and pumping until the leak is repaired.

6.4 Real Estate Considerations

Except for a pipeline easement across Freeman Park, lands required for the Carolina Beach and Vicinity, NC CSRM project were in place prior to the 1964 initial construction for the project. A town building line, located along the ocean shoreline, was established in 1963. All land seaward of this building line is public property. WRRDA 2014 and WRDA 2016 extended the project life to a total of 56 years through 2020. The Town of Carolina Beach is the project sponsor for the project, signing amendments to the Project Cooperation Agreement on 6 July 2015 and 27 December 2017, respectively.

No new real estate is required for the CSRM placement area. However, the non-Federal sponsor will work to acquire a permanent easement across Freeman Park (Figure 1.2) to allow future placement of the pipeline from Carolina Beach Inlet to the northern end of the Carolina Beach CSRM project.

All construction will be within the non-Federal sponsor’s owned lands provided by the Town of Carolina Beach for the original project. The proposed borrow site for the project is located at Carolina Beach Inlet. If Carolina Beach Inlet is utilized as the sand borrow source, then it is recommended that the sponsor secure perpetual easements for running the pipeline across nine privately owned parcels at the northern limits of the Carolina Beach Project area. Refer to Appendix D for more details on real estate considerations.

6.5 Operations and Maintenance Considerations

Operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) requirements of the sponsor would consist of project inspections and maintenance. The beach fill monitoring actions are different from the non-Federal sponsor’s OMRR&R project inspections and surveillance, which consist of assessing dune vegetation, access facilities, dune crest erosion, trash and debris, and unusual conditions such as escarpment formation or excessive erosion.

Periodic renourishment and beach fill monitoring (including the semiannual beach profile surveys) are classified as continuing construction, not as OMRR&R. Dune vegetation maintenance includes watering, fertilizing, and replacing dune plantings as needed. Other maintenance is reshaping of any minor dune damage, repairs to walkover structures and vehicle accesses, and grading any large escarpments. Estimated OMRR&R annual costs are $95,000.

6.6 Public Parking and Access Requirements

ER 1165-2-130 (Federal Participation in Shore Protection) requires reasonable public parking and access to the beach to be provided by the non-Federal sponsor. These requirements ensure that all portions of the project shoreline are available for public use as defined by adequate parking and access facilities. Per ER 1165-2-130, paragraph 6.h.: "Parking should be sufficient to accommodate the lesser of the peak hour demand or the beach capacity", and "public use is construed to be effectively limited to within one-quarter mile from available points of public access to any particular shore. In the event public access points are not within one-half mile of each other, either an item of local cooperation specifying such a requirement and public use throughout the project life must be included in the project recommendations or the cost sharing must be based on private use." The USACE Wilmington District has further interpreted the policy for adequate parking and access to mean that for participation in coastal storm risk management projects, a minimum of 10 public parking spaces need to be located at each access point.

There are 44 public access points on Carolina Beach that range from simple walkovers to accessible dune walkover structures. Each of these access points are clearly marked with signs. Four of the access sites include public parking as well as shower and changing facilities. The estimates of public parking spaces were provided by the Town of Carolina Beach Planning and Inspections Department and verified by USACE District staff in December 2018, indicating 44 CAMA access points and 763 parking spaces. The number of marked parking spaces has increased slightly from 2002.

No parking or access deficiencies were identified for the Carolina Beach CSRM project. Appendix C contains an inventory of existing parking facilities and access points along Carolina Beach.

6.7 Economics of the Recommended Plan

6.7.1 Recommended Plan – CSRM Benefits

Table 6.1 presents the applicable economic results at the October 2018 (FY 2019) price level for the Recommended Plan at the interest rate of 2.875 percent, resulting in a benefit cost ratio of 3.9 to 1.

Table 6.1. Economics of the Recommended Plan

Recommended Plan – Alternative 2 (I @ 2.875 percent)	
Damage Reduction Benefits	$4,606,000
Land Loss Benefits	$1,309,000
Primary Benefits	$5,915,000
Primary BCR (No Recreation)	3.4
Recreational Benefits	$834,000
Total Benefits	$6,749,000
Total Costs	$1,718,000
Preliminary BCR	3.9

6.7.2 Recommended Plan – Recreation Benefits

Per ER 1105-2-100, the USACE policy on the application of recreation benefits is that "recreation must be incidental in the formulation process and may not be more than 50 percent of the total benefits required for justification. If the criterion for participation is met, then all recreation benefits are included in the benefit to cost analysis." The Recommended Plan is justified based solely on CSRM benefits, therefore all incidental recreation benefits are being claimed for the project.

In order to determine the recreation benefits of the Recommended Plan, an economic value must be placed on the recreation experience at Carolina Beach. By applying a unit day value to estimated use, an approximation is obtained that will be used to estimate project recreation benefits. For this analysis, general unit day values (UDV) are used to determine the economic value of recreation at Carolina Beach. UDV are administratively determined values which represent the NED recreation values for typical types of recreation. Guidance for their use is provided by Engineering Regulation 1105-2-100.

The average annual recreation benefit for the Recommended Plan (at 2.875 percent interest rate) is $834,000.

6.7.3 Recommended Plan – Total Benefits

Combining the CSRM benefits and the recreation benefits yields a total average annual benefit of $6,749,000.

6.7.4 Recommended Plan – Costs

Determining the economic costs of the Recommended Plan consists of four basic steps. First, project First Costs are computed. First Costs include expenditures for project design and initial

construction and related costs of supervision and administration. First Costs also typically include the lands, easements, and all rights-of-way, but are not applicable in this report. Total First Costs are estimated to be $45,300,000 at October 2018 (FY 2019) price levels. Details regarding this preliminary cost are contained in Appendix E (Cost Engineering).

Second, Interest during Construction is typically added to the project First Cost, but is not applicable to this report given that initial construction has already occurred.

Third, Scheduled Renourishment Costs are computed. Those costs are incurred in the future for each of the five planned renourishments. As detailed in Appendix E, the estimated cost is $9,060,000 for each renourishment. Note that this cost includes the cost of the annual beach fill monitoring (see Section 6.4).

Fourth, Expected Annual Costs are computed. Those costs consist of interest and amortization of the Total Investment Cost and the equivalent annual cost of beach fill monitoring and project OMRR&R (see sections 6.3 and 6.5). The Expected Annual Costs provide a basis for comparing project costs to expected annual benefits. Expected Annual Costs for the Recommended Plan are estimated to be $1,718,000.

6.7.5 Recommended Plan Benefit to Cost Ratio

For Alternative 2, with the expected annual benefits of $6,749,000 and average annual costs of $1,718,000, the benefit to cost ratio is 3.9 to 1. See Appendix F for an explanation of the calculations.

6.8 Summary of Recommended Plan Accomplishments

The Recommended Plan will reduce coastal storm damages to homes, businesses and critical infrastructure along approximately 2.7 miles of beachfront. Additionally, the plan would mitigate future land loss over much of the same area. The Recommended Plan would also maintain the recreational value and demand of the beach. The Recommended Plan would also potentially reduce future emergency response costs (although these have not been quantified for this study), and preserve or expand the amount of beach habitat available for sea turtle and shorebird utilization. Finally, the Recommended Plan will benefit the regional economy by maintaining the area as a popular year-round destination and supporting the jobs and businesses associated with that industry.

6.9 Evaluation of Risk and Uncertainty

6.9.1 Residual Risks

Residual risk is the risk that remains after the Recommended Plan is implemented.

Beach-fx estimates that average annual residual damages in the Future With-Project condition will be $1,677,000. This estimate represents a significant reduction in Future Without Project damages of $7,592,000 and indicates a robust reduction in coastal storm risk throughout Carolina Beach.

The proposed project would greatly reduce, but not completely eliminate future storm damages. Coastal storm damages are reduced by approximately 78 percent over the 50-year period of analysis; therefore, the residual damages would be 22 percent. The project is designed to reduce damages from storm waves, direct flooding, and erosion, but would not prevent any damage from back bay flooding; therefore, any ground-level floors of structures, ground-level floor contents, vehicles, landscaping, and property stored outdoors on the ground would still be subject to saltwater flooding that flows in through the inlets and the back bay channels. Back-bay flooding is a relatively minor issue in the first three rows of the island which is where the benefits of the project are being realized and those damages were not claimed as a project benefit. As the project is also not claiming any benefits beyond the third row of the island, damages from flooding to structures past the third row were not calculated. Structures would also continue to be subject to damage from hurricane winds and windblown debris. Even new construction is not immune to damage, especially from these processes.

The proposed beach fill would reduce damages but does not have a specific design level. In other words, the project is not designed to fully withstand a certain category of hurricane or a certain frequency storm event. The project purpose is reduce coastal storm risk, and the berm-and-dune is not designed to prevent loss of life. Loss of life is prevented by the existing procedures of evacuating the barrier island completely, well before expected hurricane landfall and removing the residents from harm's way. The erratic nature and unpredictability of hurricane path and intensity require early and safe evacuation. That policy should be continued either with or without the coastal storm risk management project.

6.9.2 Risk and Uncertainty in Economics

The Beach-fx model accounts for uncertainty in the economic evaluations through the use of Monte-Carlo simulations to model future damages. The average annual damages reported in this study are based on the damages averaged across 300 life cycles, with each life cycle experiencing a different suite of storms during the period of analysis. Additionally, uncertainty is accounted for in the damage functions that are used to determine the amount of damage incurred to a structure and its contents from a given storm. Each structure type is assigned a minimum, maximum, and most likely damage function, meaning that the amount of damage experienced by a structure due to a specific amount of erosion or water depth can vary between life cycles. An example of one of these damage functions is shown in Figure 6.3 below, the entire suite of damage functions used in this study are contained in Appendix F.

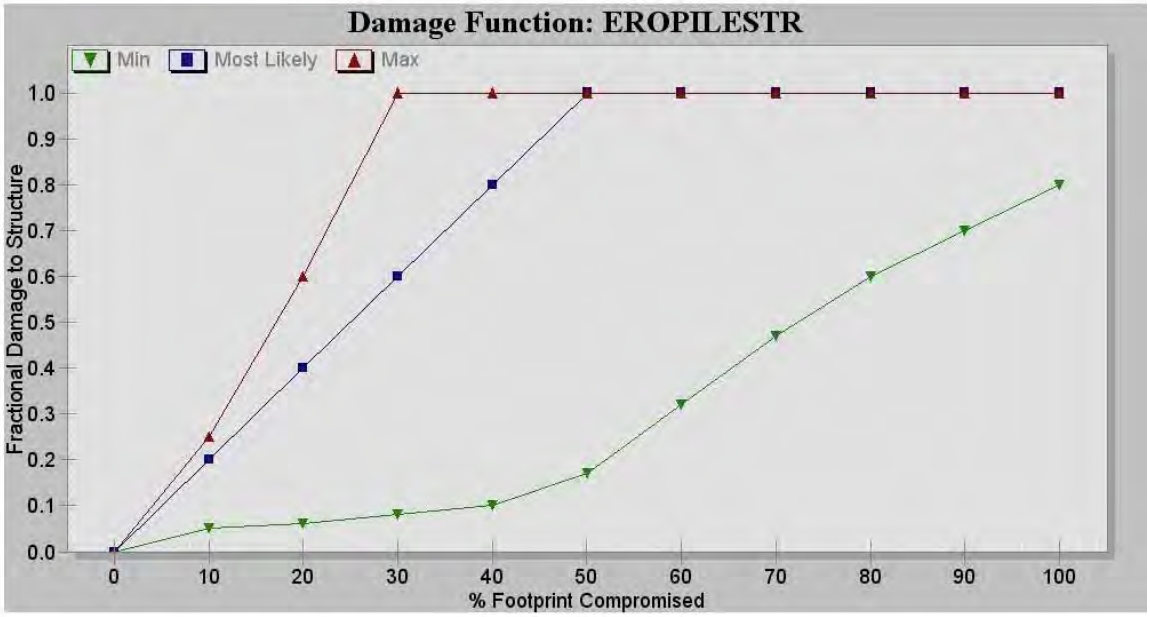


Figure 6.3. Damage Functions used to Measure Erosion Damage to Structures on 8-ft Pile.

6.9.3 Risk and Uncertainty in Costs

In order to account for uncertainties in the final project costs, which could result from a variety of factors, all costs include an appropriate contingency on top of the actual estimated costs. Preliminary cost schedule risk analyses were completed for the Recommended Plan and Alternative 3 using an offshore borrow source (Borrow Area B). Details are included in Appendix E. Final cost certification will be completed for the Final Report.

6.9.4 Risk and Uncertainty in Borrow Availability

An estimated 4 million cubic yards (CY) of borrow material would be needed for this project over the 15 year period of analysis – all of which would come from Carolina Beach Inlet. Carolina Beach Inlet has served as the primary source of borrow material for the project since 1967. Carolina Beach Inlet, based on historical recharging, is assumed to continue to have adequate volumes of material for the project. The inclusion of Carolina Beach Inlet in CBRS Unit L09 means that continued use of this historical source of fill material for the project will require an exemption from the provisions of CBRA in the project's final Congressional authorization. Details on CBRS Unit L09 in the Recommended Plan are located in section 9.3. Alternative 3 in Carolina Beach BRER utilizes an offshore borrow source outside of the CBRA zone (Borrow Area B).

6.9.5 Risk and Uncertainty in Sea Level Rise Assumptions

Per ER 1100-2-8162, a sensitivity analysis on the economics of the Recommended Plan was performed using low and high accelerated sea level rise rates. A full discussion of the accelerated sea level rise rates and how they were calculated for the project area is contained in Appendix B.

The net benefits reported for the Recommended Plan in section 6.7.1 are based on the intermediate sea level rise rate (.0128 ft/yr) being applied to both the future with and without project conditions. The Recommended Plan was rerun in Beach-fx using both the historic (.0066 ft/yr) and high (.0325 ft/yr) sea level rise rates for both the future with and without project conditions. In the future without project condition, damages increase under accelerated sea level rise scenarios. Under accelerated sea level rise, damages also increase in the with-project conditions, but to a lesser degree. Table 6.2 shows a comparison of with and without project damages under the various scenarios.

Table 6.2. Comparison of with and without project damages and benefits under historical, intermediate accelerated and high accelerated sea level rise scenarios. Benefits include land loss.

	FWOP Damages (AA)	With Project Damages (AA)	AA Benefit
Historical (low)	$6,773,000	$1,557,000	$5,216,000
Intermediate Rate	$7,592,000	$1,677,000	$5,915,000
High Rate	$9,184,000	$2,011,000	$7,173,000

The increases in project costs are relatively minimal under the accelerated sea level rise scenarios. Under assumptions of accelerated sea level rise, project net benefits actually increase and the project remains economically justified. This conclusion supports the concept of beach fill as naturally adaptable to sea level rise fluctuations.

6.9.6 Risk and Uncertainty with Future Beach Placement Activities

There is low risk associated with continuation of future beach placement activities for the Carolina Beach and Vicinity, NC CSRM project. There are adequate staging areas available and sufficient access points for construction. To date, temporary easements have been acquired every 3 years for each periodic renourishment cycle by the non-Federal sponsor for placement of a pipeline across Freeman Park from Carolina Beach Inlet to discharge dredged sand to the northern end of the Carolina Beach CSRM project. The non-Federal sponsor is currently working to acquire a permanent easement for this pipeline placement in advance of the next scheduled periodic renourishment event in 2022 as described in this report through 2036, if authorized.

6.9.7 Risk and Uncertainty in Coastal Storms

Uncertainty regarding the number and intensity of future storms in the area is handled through the Beach-*fx* Monte Carlo simulation, whereby each lifecycle randomly selects (based on actual probabilities of storm occurrence) a suite of storms that will hit the project area over a given lifecycle. The storm suite is selected from a group of 696 plausible storms. However, while the storms are randomly selected, the effect of any given storm on a given shore profile is determined by the SBEACH software, and is fixed.

7 AFFECTED ENVIRONMENT AND ENVIRONMENTAL EFFECTS

This section describes the existing conditions and probable consequences (impacts and effects) on significant environmental resources within the proposed beach placement locations and within the borrow areas of Alternative 1 (No Action), Alternative 2 (Recommended Plan) and Alternative 3 (Borrow Area B).

7.1 Proposed Action

The Recommended Plan will renourish the existing authorized project, which has a main fill length of 14,000 feet. The southernmost 11,950 lineal feet of the project consists of a 25' wide crested dune at an elevation of 12.5' NAVD88 fronted by a 50' wide berm at elevation 9.5' NAVD88. The northernmost 2,050 lineal feet of the project is a 130' berm only project at elevation 5.5' NAVD88 that fronts an existing rock revetment. The Recommended Plan would extend the project life for 15 more years to 2036. Every three years, each renourishment will require an estimated 800,000 cubic yards. A total of five renourishment events would require a total volume of 4.0 million cubic yards.

Renourishment material would be pumped from the Carolina Beach Inlet borrow area to the beach from a cutterhead dredge and shaped on the beach by earth-moving equipment. The pipeline would run from Carolina Beach Inlet, through Freeman Park to Carolina Beach. Each renourishment event will require approximately 30 cutterhead dredging days. Beach placement will be restricted to the environmental window of November 16 to April 30.

The Recommended Plan is the environmentally preferred plan because of the overall impacts are smaller than Alternative 3. These impacts include the following:

- Fewer dredging days with a cutterhead dredge as opposed to two hopper dredges which reduces air emissions, noise, endangered species vessel strikes and entrainment, recreation, aesthetics and other impacts
- Smaller acreage of benthic and water quality impacts and in the same, previously dredged area as opposed to larger and new impacts each dredging event

7.2 Physical Resources

7.2.1 Air Quality

Ozone is North Carolina's most widespread air quality problem, particularly during the warmer months. High ozone levels generally occur on hot sunny days with little wind, when pollutants such as nitrogen oxides and hydrocarbons react in the air. High levels of fine particles are more of a problem in the western Piedmont region but can occur throughout the year, particularly during episodes of stagnant air and wildfires. The project would be constructed outside the ozone season. The air quality in New Hanover County, North Carolina, is designated as an attainment area. North Carolina has a State Implementation Plan approved or promulgated

under Section 110 of the Clean Air Act. A conformity determination is not required for this project because it is located in an attainment area,

The ambient air quality for New Hanover County has been determined to be in compliance with the National Ambient Air Quality Standards, and is designated as an attainment area for ozone, fine particulate matter and carbon monoxide and sulfur dioxide is meeting the 75 parts per billion 2010 1-hour standard (www.deq.nc.gov).

Greenhouse gases absorb infrared radiation, thereby trapping heat and making the planet warmer. The most important greenhouse gases directly emitted by humans include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and several other fluorine-containing halogenated substances. Although CO2, CH4, and N2O occur naturally in the atmosphere, human activities have changed their atmospheric concentrations. From the pre-industrial era (i.e., ending about 1750) to 2017, concentrations of these greenhouse gases have increased globally by 45, 164, and 22 percent, respectively.

Gases in the atmosphere can contribute to climate change both directly and indirectly. Direct effects occur when the gas itself absorbs radiation. Indirect radiative forcing occurs when chemical transformations of the substance produce other greenhouse gases, when a gas influences the atmospheric lifetimes of other gases, and/or when a gas affects atmospheric processes that alter the radiative balance of the earth.

In 2017, total gross U.S. greenhouse gas emissions were 6,472.3 MMT, or million metric tons, carbon dioxide. Total U.S. emissions have increased by 1.6 percent from 1990 to 2017, and emissions decreased from 2016 to 2017 by 0.3 percent. (Draft Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2017)

Alternative 1 (No Action): This alternative would have no effect on air quality.

Alternative 2 (Recommended Plan): Temporary increases in exhaust emissions from the cutterhead dredge and other construction equipment are expected, however, the emissions produced would be similar to that produced by other large pieces of machinery and should be readily dispersed. Each renourishment is expected to take approximately 30 days and would occur during cold weather months. All dredges must comply with the applicable EPA standards. The direct and indirect emissions from this option fall below the prescribed de minimis levels.

Alternative 3 (Borrow Area B): Use of the offshore Borrow Area B would likely require a cutterhead dredge and a total of approximately 44 dredging days. If a hopper dredge is used, it would require a total of about 82 dredging days. All dredges must comply with the applicable EPA standards and work would occur during cold weather months. The direct and indirect emissions from this option fall below the prescribed de minimis levels.

7.2.2 Geology and Sediment

Carolina Beach Inlet separates Masonboro Island and Carolina Beach. These barrier islands flank the western edge of the Onslow Bay, which is bound by Cape Lookout to the north and

Cape Fear to the south. The islands consist of unlithified sediment and unconformably overlie lithified and semi-indurated Oligocene and Eocene sandy, molluscan-mold and bryozoan-echinoid limestone. Thus, Onslow Bay is limited in naturally-occurring offshore sand supply and subsequent sand recharge onto barrier beaches.

Carolina Beach Inlet receives and retains sand-sized sediment grains via longshore current. Although the direction of littoral sediment transport is generally in a north-to-south direction, seasonal variations exist which temporarily reverse this trend. Tidal currents have resulted in a well-formed ebb tidal delta just seaward of the inlet, but flood tidal delta development, which is common in other barrier island inlets is curtailed due to frequent channel dredging. Ultimately, sand that would naturally recharge the Carolina Beach shoreline is deposited into and retained within Carolina Beach Inlet. As a result, the inlet has historically served as a reliable sand resource, holding material comparable to sand remaining on and eroding from Carolina Beach.

Historical vibracore logs and respective laboratory data indicate that well-distributed, suitable sand has consistently occurred within the inlet. Historical bathymetric surveys, as well as measured volumes of dredged sand have consistently accumulated enough material to support beach renourishment once every three years. While the inlet is naturally recharged by sand through littoral transport, the area is also being used as a repository for material which has been dredged from the nearby Carolina Beach Inlet channel. This combination of natural and anthropogenic deposition will continue to recharge sand into the borrow area between renourishment cycles.

Similar to Carolina Beach Inlet, Borrow Area B is near the western edge of Onslow Bay. The USCS classifies the sediment within Borrow Area B as widely ranging from CH (inorganic clays of high plasticity) to SW (well-graded sands). The average fines content for the suitable material within Borrow Area B is 3.6 percent. Average shell content for all sampled material within the borrow area is 2.2 percent, while average shell content within the suitable material is 3.0 percent. Median and mean grain sizes for the suitable material within Borrow Area B are 0.36 mm and 0.51 mm, respectively, with a standard deviation of 0.30 mm, based on $n = 224$ samples.

Borrow Area B has been used as a sand borrow site to support triennial renourishment activities on Kure Beach twice since 2013. Vibracore logs from 2012 and 2018 show that approximately 12.6 million cubic yards of suitable sand exists and is well-distributed inside the borrow area, with the most voluminous sand resources occurring in the northwestern portion of the site. However, this borrow site does not receive a regularly-occurring sedimentary recharge and therefore, constitutes a finite resource.

Typical USACE contract specifications for renourishment projects generally recognize suitable beach material as Poorly Graded Sand (SP), or Poorly Graded Sand with Silt (SP-SM) per the Unified Soil Classification System (USCS), as long as the portion of material meets these criteria:

- Less than 10 percent, by weight, material passing #200 sieve over weighted average.
- Less than 10 percent, by weight, material retained on the #4 sieve over weighted average.
- Material retained on the 3/4 inch sieve does not exceed, by percentage or size that found on the native beach.
- Contains no construction debris, toxic material, or other foreign matter.
- Contains no clasts of lithified rock.

The USACE guideline for beach placement is no more than 10 percent of the material passing the # 200 sieve, i. e., dredged material must be ≥90 percent sand (coarse-grained). All dredged material that will be placed on Carolina Beach meets the USACE guideline and is dredged from the same inlet that has been placed on Carolina Beach in the past. A larger discussion of geology and sediments can be found in Appendix A.

Alternative 1 (No Action): This alternative likely would result in a larger quantity of sediment in Carolina Beach Inlet, reducing the impact to the natural sediment bypassing process. This alternative would also result in the long-term erosion of the Carolina Beach shoreline. Freeman Park may accrete toward the inlet, increasing the need for navigation maintenance dredging and may result in the eventual closure of the inlet.

Alternative 2 (Recommended Plan): This alternative would reduce the amount of sediment in the inlet with each renourishment event, continuing the impact to the natural sediment bypassing process. Due to a lack of inlet management plan that includes sand bypassing, the south end of Masonboro Island will continue to erode. The sediment that will be utilized from the inlet borrow area is beach quality (≥ 90 percent sand) and will be recharged through littoral transport and through placement of maintenance dredged navigation material on Carolina Beach.

Alternative 3 (Borrow Area B): This alternative likely would result in a larger quantity of sediment in Carolina Beach Inlet, reducing the impact to the natural sediment bypassing process. Material placed on Carolina Beach may increase shoaling in Carolina Beach Inlet due to littoral drift. Freeman Park may accrete toward the inlet increasing the need for navigation dredging and may result in closure of the inlet. Alternative 3 would reduce the amount of sediment in Borrow Area B with each renourishment event, but should not result in any significant changes to the natural geology of the study area.

7.2.3 Climate Change

The global average temperature has increased by more than 1.5°F since the late 1800s. Many factors, both natural and human, can cause changes in Earth's energy balance, including:

- Variations in the sun's energy reaching Earth
- Changes in the reflectivity of Earth's atmosphere and surface
- Changes in the greenhouse effect, which affects the amount of heat retained by Earth's atmosphere

Greenhouse gases come from a variety of human activities, including: burning fossil fuels for heat and energy, clearing forests, fertilizing crops, storing waste in landfills, raising livestock, and producing some kinds of industrial products (www.epa.gov). Greenhouse gasses are discussed in detail in Section 7.2.1.

A review of the U.S. Environmental Protection Agency's analysis for climate change for North Carolina titled *What Climate Change Means for North Carolina* (https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-nc.pdf) states:

- Most of North Carolina has warmed 0.5-1.0 degrees Fahrenheit in the last 100 years. The southeastern United States has warmed less than most of the nation.
- Tropical storms and hurricanes have become more intense during the past 20 years. Hurricane wind speeds and rainfall rates are likely to increase as the climate continues to warm.
- Increased rainfall may further exacerbate flooding in some coastal areas. Since 1958, the amount of precipitation during heavy rainstorms has increased by 27 percent in the Southeast, and the trend toward increasingly heavy rainstorms is likely to continue.

Alternative 1 (No Action): This alternative would have no effect on climate change. Climate change would increase the frequency and intensity of storm events, which will likely increase erosion rates and the effects of storm surge.

Alternative 2 (Recommended Plan): This alternative will not increase the effects of climate change in the project area; however, it is likely to be affected by climate change in the future due to the proximity of the project area being on the coast where effects of climate change, such as increased storm events and sea level rise, will likely be more dramatic than inland portions of the State. Increased frequency and intensity of storm events will likely increase erosion rates which may increase the need for larger, or more frequent renourishments to maintain coastal storm risk management benefits.

Alternative 3 (Borrow Area B): Impacts of this alternative would be similar to impacts of the Recommended Plan.

7.2.4 Sea Level Rise

Relative sea level refers to local elevation of the sea with respect to land, including the lowering or rising of land through geologic processes such as subsidence and glacial rebound. It is anticipated that sea level will rise within the next 100 years. To incorporate the direct and indirect physical effects of projected future sea-level change on design, construction, operation, and maintenance of coastal projects, the USACE has provided guidance in EC 1165-2-212 (USACE, 2012) which has been superseded by ER 1100-2-8162 and Engineer Technical Letter 1100-2-1 (USACE 2013, 2014).

In accordance with ER 1100-2-8162, dated 31 December 2013, potential relative sea level change must be considered in every USACE coastal activity as far inland as the extent of estimated tidal influence. Based on historical sea level measurements taken from NOS gage 8659084 at Southport, North Carolina, the historic sea level change rate was determined using the *updated published* seal level change fetched from http://www.corpsclimate.us/ccaceslcurves.cfm. The economic analysis period for this study begins with a Beach-fx model start date of 2021 (economic base year of 2022) and extends to the end of the project life in 2036. At Gauge 8659084, the mean sea level trend is 2.01 mm/year (0.00659 feet/year) with a 95 percent confidence interval of +/- 0.41 mm/year (0.00134 feet/year) based on monthly mean sea level data over a 74 year record (Figure 7.1) which is equivalent to a change of 0.11 feet over the remaining life of the project (2036). The Intermediate rate was determined to be 3.91 mm/year (0.0128 feet/year). The High rate was determined to be 9.92mm/year (0.0325 feet/year). This results in an Intermediate and High change in sea level between the start year (2021) and the end of the project life (2036) of 0.21 feet and 0.54 feet, respectively. Relative sea level change between 2021 and 2036 is shown graphically in Figure 7.2.

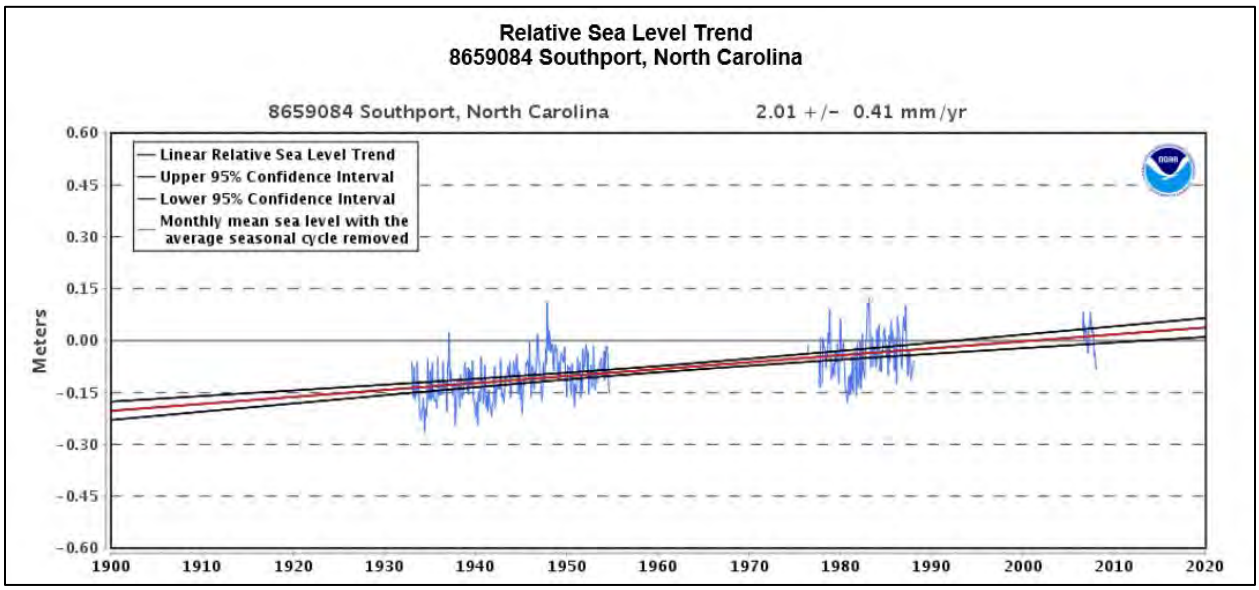


Figure 7.1. Relative Sea Level Trend, NOAA Gauge 8659084

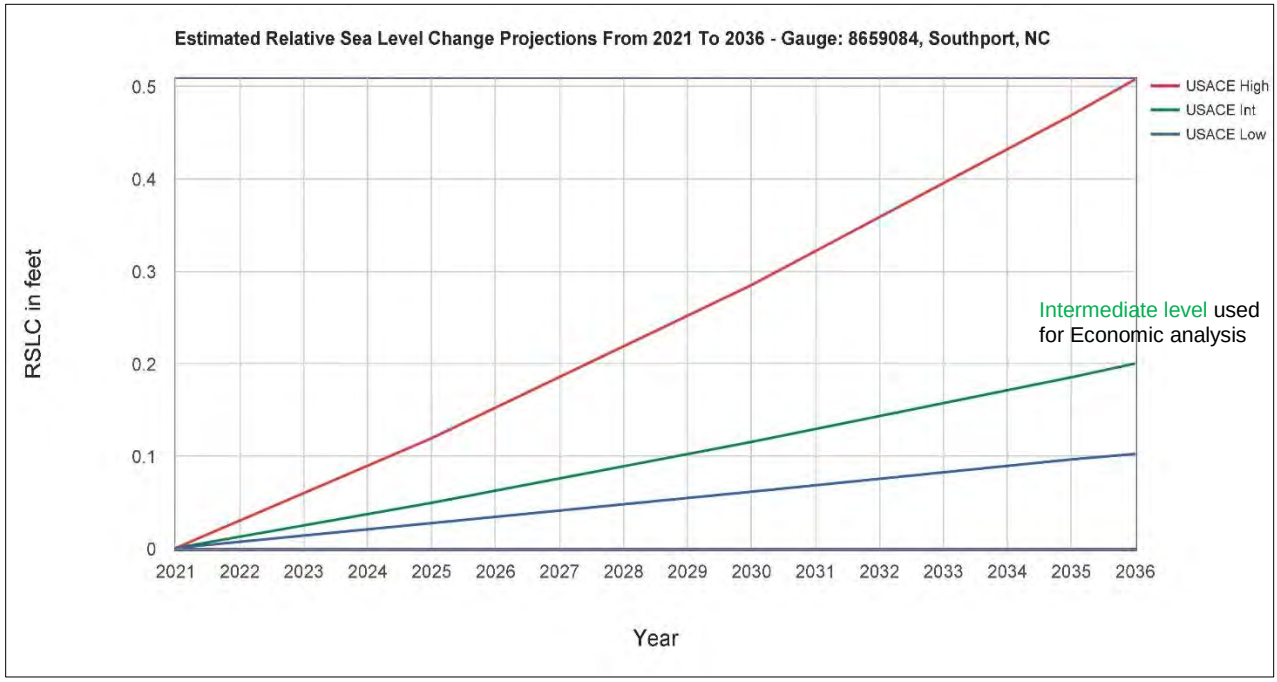


Figure 7.2. Projected Sea Level Change, Start Year (2021) to End of Project Life (2036)

Potential impacts of rising sea level on total water levels experienced at the site include overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas. In general, relative sea level change (Baseline, Intermediate, and High) will not affect the overall function of the project. Relative vulnerability to flooding during extreme events is consistent between both the With and Without Project conditions. However, adaptation in the form of additional sand volume will be required to maintain project performance.

Alternative 1 (No Action): The No Action analysis assumes that sea level rise will be 0.20 feet over the remaining life of the project. Accelerated sea level rise rates would lead to higher storm surges and increased erosion rates, resulting in increased damages. The No Action alternative would not affect sea level rise.

Alternative 2 (Recommended Plan): Potential impacts of rising sea level on total water levels experienced at the site include overtopping of waterside structures, increased shoreline erosion, and flooding of low lying areas. In general, relative sea level change (Baseline, Intermediate, and High) will not affect the overall function of the project. Relative vulnerability to flooding during extreme events is consistent between both the With and Without project conditions. However, adaptation in the form of additional sand volume will be required to maintain project performance.

Alternative 3 (Borrow Area B): Impacts associated with implementation of this alternative would be similar to impacts of the Recommended Plan.

7.3 Water Quality

Water quality standards are State regulations or rules that protect lakes, rivers, streams and other surface water bodies from pollution. These standards are used to determine if the designated uses of a water body are being protected. Those uses are defined by the classifications assigned to the water body. Surface Water Classifications are designations applied to surface water bodies, such as streams, rivers and lakes, which define the best uses to be protected within these waters (for example swimming, fishing, drinking water supply) and carry with them an associated set of water quality standards to protect those uses.

All surface waters in North Carolina are assigned a primary classification by the North Carolina Division of Water Resources (NCDWR) (15A NC Administrative Code 02B .0301 to .0317). Waters in the vicinity of the study area fall into two classifications. Waters of Carolina Beach Inlet are classified as SC and High Quality Waters (HQW). SC waters are suitable for secondary recreation such as fishing, boating, and other activities involving minimal skin contact, aquatic life propagation and survival, and wildlife. HQW are waters which are rated excellent based on biological and physical/chemical characteristics through NCDWR monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and other functional nursery areas designated by the Marine Fisheries Commission. Waters of the Atlantic Ocean, including Carolina Beach are classified as SB and are tidal salt waters protected for all Class SC uses in addition to primary recreation. Primary recreational activities include swimming, skin diving, water skiing, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis.

Inlets are highly dynamic, resulting from ocean longshore currents, waves and tidal influences. Storms and maintenance dredging of the navigation channel all add to the levels of turbidity and suspended solids in the inlet.

The proposed action complies with Section 404(b)(1) (P.L. 95-2017) of the Clean Water Act. The Section 404(b)(1) evaluation is included in Appendix G. Dredged material consisting of ≥90 percent sand would be placed in the authorized placement areas under either the recommended plan or Alternative 3; therefore, renourishment events would be covered under the North Carolina Division of Water Resources' March 19, 2017, Water Quality Certification No. 4099: General Certification for Projects Eligible for U.S. Army Corps of Engineers Regional General Permit 198000048 (Emergency Activities on Ocean Beaches). It should be noted that although WQC #4099 is titled "Emergency Activities on Ocean Beaches," based on coordination with NCDWR, WQC #4099 is applicable to the Carolina Beach CSRM project. All conditions of WQC #4099 will be met. The proposed action complies with Sections 404 and 401 of the Clean Water Act.

Alternative 1 (No Action): This alternative would have no effect on water quality.

Alternative 2 (Recommended Plan): Dredging in the inlet borrow area would involve mechanical disturbance of the bottom substrate and subsequent redeposition of suspended

sediment and turbidity generated during the estimated 30 days of dredging for each renourishment event. Factors that are known to influence sediment spread and turbidities are grain size, water currents and depths.

During renourishment, there would be elevated levels of turbidity and suspended solids in the inlet borrow area and the immediate area of sand deposition when compared to the existing non-storm conditions of the surf zone. Significant increases in turbidity are not expected to occur outside the immediate dredging and renourishment area (turbidity increases of 25 nephelometric turbidity units [NTUs]) or less are not considered significant). Turbid waters (increased turbidity relative to background levels but not necessarily above 25 NTUs) would stay close to shore and be transported with waves either up-drift or down-drift depending on wind conditions. Because of the low percentage of silt and clay in the borrow areas (10 percent), turbidity impacts would not be expected to be greater than the natural increase in turbidity and suspended material that occurs during storm events. Any increases in turbidity in the borrow area during renourishment would be expected to be temporary and limited to the area surrounding the dredging. Turbidity levels would be expected to return to background levels in the borrow area and surf zone when dredging ends.

Overall water quality impacts of this alternative would be expected to be short-term and minor. Living marine resources dependent on good water quality should not experience significant adverse effects from water quality changes.

Alternative 3 (Borrow Area B): Offshore borrow areas typically are less disturbed and have less turbidity than inlets. Dredging at Borrow Area B would result in increased turbidity and would be expected to be limited to the area surrounding the dredging during the 44 days if a cutter head dredge is used and 82 days if using a hopper dredge. Turbidity levels would be expected to return to background levels in the benthic zone and water column when dredging ends. Overall water quality impacts of this alternative would be expected to be short-term and minor. Living marine resources dependent on good water quality should not experience significant adverse effects from water quality changes.

Pursuant to Section 404 of the Clean Water Act, the effects associated with the discharge of beach fill material into waters of the United States are discussed in the Section 404(b)(1) (P.L. 95-217) Analysis in Appendix G. If a hopper dredge is used, incidental fallback associated with hopper dredging operations in the offshore borrow area is anticipated. Resultant water column impacts associated with sedimentation and turbidity are discussed in Section 7.4.4; however, no measureable increase in bottom elevation is expected from the fallback of sediment during the dredging operations and the activity would not destroy or degrade waters of the United States (33 CFR Section 323.2(d)(4)(i)). Therefore, incidental fallback from hopper dredging in the borrow area is not considered a discharge addressed under the Section 404 (b)(1) Analysis.

7.4 Marine Resources

7.4.1 Benthic Resources

Aquatic organisms that live in close association with the bottom, or substrate, of a body of water, are collectively called the benthos. Benthic communities provide a link between planktonic and benthic production and commercially important fish species (Posey, 1991). Benthic communities of the project area exhibit a wide range of organism composition and density, and community structure may vary considerably depending on substrate type, salinity regime, proximity to structural habitat, and the like. Benthic substrate type and structural habitat within the project area range between fine- to coarse-grained sand; gravel and shell hash; and low-, moderate-, and high-relief hard bottom.

Offshore sand bottom communities along the North Carolina coast are relatively diverse habitats containing over a hundred polychaete taxa. Tube dwellers and permanent burrow dwellers are important benthic prey for fish and epibenthic invertebrates. These species are also most susceptible to sediment deposition, turbidity, erosion, or changes in sediment structure associated with sand mining activities, compared to other more mobile polychaetes. On ebb tide deltas, polychaetes, crustaceans (primarily amphipods), and mollusks (primarily bivalves) were the most abundant infauna, while decapod crustaceans and echinoderms (sand dollars) dominated the epifauna. Because periodic storms can affect benthic communities along the Atlantic coast to a depth of about 115 feet (35 m), the soft bottom community tends to be dominated by opportunistic taxa that are adapted to recover relatively quickly from disturbance. Many faunal species documented on the ebb tide delta are important food sources for demersal predatory fishes and mobile crustaceans, including spot, croaker, weakfish, red drum, and penaeid shrimp. These fish species congregate in and around inlets during various times of the year, presumably to enhance successful prey acquisition and reproduction (Deaton et al. 2010).

The surf zone of the beach shoreface is extremely dynamic and is characterized as the area from mean low tide landward to the high tide mark. The area serves as habitat for invertebrate communities adapted to the high-energy, sandy-beach environment. Important invertebrates of the surf zone and beach/dune community include the mole crab (*Emerita talpoida*), coquina clams (*Donax variabilis*), polychaete worms, amphipods, and ghost crabs (*Ocypode quadrata*). Mole crabs and coquinas represent the largest component of the total macrofaunal biomass of North Carolina intertidal beaches, and they are consumed in large numbers by important fish species such as flounders, pompanos, silversides, mullets, and kingfish (Reilly and Bellis 1978). Beach intertidal macrofauna are also a seasonally important food source for numerous shorebird species.

Similar to the surf zone, inlets are also highly dynamic. Typical inlet invertebrate infauna that have evolved to survive in high energy, disruptive habitat include the mole crab (*Emerita talpolida*), haustorid amphipods (*Haustorius* spp.), coquina clam (*Donax variablilis*), and spionid worm (*Scolelepis squamata*). The epifaunal blue crab (*Callinectes sapidus*), and lady crab

(*Ovalipes ocellatus*) are also found in the intertidal zone. These invertebrates are prey to various shore birds and nearshore fishes.

Carolina Beach Inlet borrow area has a total maximum area of 41 acres. When the inlet was dredged in 2007, 2010, 2013, and 2016; 24 acres of benthic habitat were directly impacted with each renourishment event.

Borrow Area B has a total maximum area of 1040 acres. The amount of sand needed to complete each renourishment event using Borrow Area B would directly impact approximately 123 acres of benthic habitat.

Alternative 1 (No Action): This alternative would result in the long term reduction of the surf zone habitat and benthic macro invertebrate abundance due to erosion and scour of beach habitat towards existing homes and infrastructure. This alternative would have no effect on benthos associated with dredging.

Alternative 2 (Recommended Plan): Beach placement may have negative effects on intertidal macrofauna through direct burial or increased turbidity in the surf zone; such effects would be expected to be localized, short-term, and reversible. Any reduction in the numbers or biomass (or both) of intertidal macrofauna present immediately after beach placement may have localized limiting effects on surf-feeding fishes and shorebirds because of a reduced food supply. In such instances, those animals may be temporarily displaced to other locations, but would be expected to return following placement.

About 41 acres of benthic habitat and benthic organisms in the Inlet borrow area would be lost during each renourishment event. Each renourishment would dredge the same 41 acres impacting the same area with each renourishment. However, recolonization by opportunistic species would be expected to begin soon after the dredging activity stops. Because of the opportunistic nature of the species that inhabit the soft-bottom benthic habitats, recovery would be expected to occur within 1–2 years. Effects on estuarine-dependent organisms are not expected to be significant because construction-related activities would be localized. Demersal fish may incur a slight risk due to entrainment by dredging activities.

Alternative 3 (Borrow Area B): Effects to intertidal macrofauna as a result of discharging of material on the beach would be similar to the Recommended Plan. Borrow Area B does not recharge with sand and therefore, each renourishment event would impact a 123 acres of previously undisturbed habitat. Benthic organisms in the impacted area of the borrow site would be lost; however, these areas would be recolonized by opportunistic species soon after the dredging activity stops. Because of the opportunistic nature of the species that inhabit the soft-bottom benthic habitats, recovery would be expected to occur within 1–2 years. Effects on estuarine-dependent organisms are not expected to be significant because construction-related activities in the offshore borrow area and on beach would be localized. However, recolonization on the beach by opportunistic species would be short-term and expected to

begin soon after the dredging activity stops. Demersal fish may have a slight risk due to entrainment by dredging activities.

7.4.2 Inlet and Surf Zone Fishes and Nekton

The surf zone along the area beaches provides important fishery habitat on which some species are dependent. Surf zone fisheries are typically diverse, and 47 species have been identified from North Carolina; however, the actual species richness of fishes using the North Carolina surf area for at least part of their life history is much higher (Ross, 1996; Ross and Lancaster, 1996). According to Ross (1996), the most common species in the South Atlantic Bight surf zone are Atlantic menhaden (*Brevoortia tyrannus*), striped anchovy (*Anchoa hepsetus*), bay anchovy (*A. mitchilli*), rough silverside (*Membras martinica*), Atlantic silverside (*Menidia menidia*), Florida pompano (*Trachinotus carolinus*), spot (*Leiostomus xanthurus*), Gulf kingfish (*Menticirrhus littoralis*), and striped mullet (*Mugil cephalus*). Two species in particular, the Florida pompano and gulf kingfish (*M. littoralis*) seem to use the surf zone exclusively as a juvenile nursery area and are rarely found elsewhere. The South Atlantic Bight marine region extends southward from Virginia's James River to the Florida Keys. It encompasses the southern Virginia Shoreline and the entire Atlantic shoreline of North Carolina, South Carolina, Georgia and Florida. Seaward the Bight reaches to 5,000 meters below sea level. The major recruitment time for juvenile fishes to surf zone nurseries is late spring through early summer (Hackney et al., 1996). Major surf zone species consume a variety of benthic and planktonic invertebrates, with most of the prey coming from the water column. The dominant benthic prey are coquina clams; however, that is not the dominant food item throughout the South Atlantic Bight. Furthermore, many surf zone fishes exhibit prey switching in relation to prey availability, which could minimize potential adverse effects of beach renourishment.

Carolina Beach Inlet is an important passageway for the larvae of many species of commercially or ecologically important fish. Spawning grounds for many marine fishes are believed to occur on the continental shelf with immigration to estuaries during the juvenile stage. The shelter provided by the marsh and creek systems within the sound serves as nursery habitat where young fish undergo rapid growth before returning to the offshore environment. Transport from offshore shelves to estuarine nursery habitats occurs in three stages: offshore spawning grounds to nearshore, nearshore to the locality of an inlet or estuary mouth, and from the mouth into the estuary (Boehlert and Mundy, 1988).

In North Carolina, the majority of invertebrate species recruit between May and September and surf zone fish species recruit from March through September. The anticipated construction time frame for the project is from November 16 to April 30 (December 1 to March 31 if using a hopper dredge) and would avoid a majority of the peak recruitment and abundance periods of surf zone fishes and their benthic invertebrate prey source.

Oceanic nekton are active swimmers, not at the mercy of the currents, and are distributed in the relatively shallow oceanic zone. They are composed of three phyla-chordates, mollusks, and arthropods, with chordates (i.e., fish species) forming the largest portion.

Alternative 1 (No Action): This alternative would have no effect on inlet and surf zone fishes and nekton.

Alternative 2 (Recommended Plan): Beach placement and subsequent turbidity increases may result in short-term effects on surf zone fishes and prey availability. The approximate 30 days of dredging in the inlet will result in increased turbidity during that time. However, the opportunistic behavior of the organisms within the dynamic inlet environment enables them to adapt to short-term disturbances. Because of the adaptive ability of representative organisms in the area and the avoidance of peak recruitment and abundance time frames, such effects would be expected to be temporary and minor. Due to nekton's ability to avoid the disturbed areas and the use of a cutterhead dredge, entrainment impacts during dredging are expected to be minor.

Alternative 3 (Borrow Area B): Beach placement impacts resulting from use of Borrow Area B would be similar to the Recommended Plan. Although entrainment of benthic oriented organisms could occur from the proposed dredging activities, a hydraulic dredge operating in the open ocean would pump such a small amount of water in proportion to the surrounding water volume that any entrainment effects associated with dredging of borrow material for the project are not expected to adversely affect species at the population level. Though entrainment rates for both cutterhead and hopper dredges are expected to be low, the mobile and surficial dredging nature of hopper dredges would likely incur a higher risk of entrainment than cutterhead suction dredges since cutterhead dredges are not mobile and operate most effectively while buried within a small surface area.

Dredging Borrow Area B with a cutterhead dredge will take about 44 days, 82 days if a hopper is used. The longer dredging duration could have a larger impact to fishes and nekton as compared to the Recommended Plan. Any entrainment of adult fish, and other motile animals in the vicinity of Borrow Area B during dredging would be expected to be minor because of their ability to actively avoid the disturbed areas. Fish species would be expected to leave the area temporarily during the dredging operations and return when dredging ceases.

7.4.3 Hard Bottoms

There are no hard bottoms in the project area so there would be no impacts to hard bottoms.

7.4.4 Essential Fish Habitat

The 1996 Congressional amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (PL 94-265) set forth new requirements for the National Marine Fisheries Service (NMFS), regional fishery management councils (FMC), and other Federal agencies to identify and protect important marine and anadromous fish habitat. These amendments established procedures for the identification of Essential Fish Habitat (EFH) and a requirement for interagency coordination to further the conservation of Federally managed fisheries. Table 7.1 shows the categories of EFH and Habitat Areas of Particular Concern (HAPC) for managed species which were identified in the Fishery Management Plan Amendments

affecting the South Atlantic area. Table 7.2 lists the Federally managed fish species of North Carolina for which Fishery Management Plans have been developed by the South Atlantic Fishery Management Council (SAFMC), Mid-Atlantic Fishery Management Council (MAFMC), and National Marine Fisheries Service (NMFS).

Table 7.1 Categories of Essential Fish Habitat and Habitat Areas of Particular Concern identified in Fishery Management Plan Amendments affecting the South Atlantic Area.

ESSENTIAL FISH HABITAT	GEOGRAPHICALLY DEFINED HABITAT AREAS OF PARTICULAR CONCERN
Estuarine Areas	**Area - Wide**
Estuarine Emergent Wetlands	Council-designated Artificial Reef Special Management Zones
Estuarine Scrub / Shrub Mangroves	Hermatypic (reef-forming) Coral Habitat & Reefs
Submerged Aquatic Vegetation (SAV)	Hard Bottoms
Oyster Reefs & Shell Banks Intertidal Flats	Hoyt Hills
Palustrine Emergent & Forested Wetlands	Sargassum Habitat
Aquatic Beds	State-designated Areas of Importance of Managed Species
Estuarine Water Column Seagrass	Submerged Aquatic Vegetation
Creeks	
Mud Bottom	**North Carolina**
	Big Rock
Marine Areas	Bogue Sound
Live / Hard Bottoms	Pamlico Sound at Hatteras / Ocracoke Islands
Coral & Coral Reefs	Capes Fear, Lookout, & Hatteras (sandy shoals)
Artificial / Manmade Reefs	New River
Sargassum	The Ten Fathom Ledge
Water Column	The Point

Table 7.2. Essential Fish Habitat (EFH) Species for Coastal NC

E-EGGS L-LARVAL J-JUVENILE A-ADULT N/A-NOT FOUND	Carolina Beach Inlet	AIWW Inlet Crossing	Atlantic Ocean South of Cape Hatteras
COASTAL DEMERSALS			
Red Drum	E L J A	E L J A	J A
Bluefish	J A	J A	E L J A
Summer Flounder	L J A	L J A	E L J A
INVERTEBRATES			
Brown Shrimp	E L J A	L J A	E L J A
Pink Shrimp	E L J A	L J A	E L J A
White Shrimp	E L J A	L J A	E L J A

Calico Shrimp	N/A	N/A	E L J A
COASTAL PELAGICS			
Dolphinfish	J A	N/A	E L J A
Cobia	L J A	J A	E L J A
King Mackerel	J A	J A	E L J A
Spanish Mackerel	L J A	L J A	E L J A
HIGHLY MIGRATORY			
Bigeye Tuna	N/A	N/A	E L J A
Bluefin Tuna	N/A	N/A	J A
Skip Jack Tuna	N/A	N/A	J A
Yellowfin Tuna	N/A	N/A	E L J A
Swordfish	N/A	N/A	E L J A
Blue Marlin	N/A	N/A	E L J A
White Marlin	N/A	N/A	E L J A
Sailfish	N/A	N/A	E L J A
Little Tunny	N/A	N/A	E L J A
SHARKS			
Spiny Dogfish	J A	N/A	J A
Smooth Dogfish	J A	J	J A
Small Coastal Sharks	J A	J A	J A
Large Coastal Sharks	J A	N/A	J A
Pelagic Sharks	N/A	N/A	J A
Prohibited/Research Sharks	J A	N/A	J A
SNAPPER/GROUPER			
Black Sea Bass	L J A	L J A	E L J A
Bank Sea Bass	N/A	N/A	E L J A
Rock Sea Bass	J	J	E L J A
Gag	J A	J	E L J A
Graysby	N/A	N/A	E L J A
Speckled Hind	N/A	N/A	E L J A
Yellowedge Grouper	N/A	N/A	E L J A
Coney	N/A	N/A	E L J A
Red Hind	N/A	N/A	E L J A
Goliath Grouper	N/A	N/A	E L J A
Red Grouper	N/A	N/A	E L J A
Misty Grouper	N/A	N/A	E L J A
Warsaw Grouper	N/A	N/A	E L J A
Snowy Grouper	N/A	N/A	E L J A
Yellowmouth Grouper	N/A	N/A	E L J A
Black Grouper	J	J	E L J A
Scamp	N/A	N/A	E L J A
Blackfin Snapper	N/A	N/A	E L J A
Red Snapper	N/A	N/A	E L J A

Cubera Snapper	N/A	N/A	E L J A	
Lane Snapper	N/A	N/A	E L J A	
Silk Snapper	N/A	N/A	E L J A	
Vermillion Snapper	N/A	N/A	E L J A	
Mutton Snapper	N/A	N/A	E L J A	
Gray Snapper	J	J	E L J A	
Gray Triggerfish	N/A	N/A	E L J A	
Yellow Jack	J	J	E L J A	
Blue Runner	J	J	E L J A	
Crevalle Jack	J	J	E L J A	
Bar Jack	J	J	E L J A	
Greater Amberjack	N/A	N/A	E L J A	
Almaco Jack	N/A	N/A	E L J A	
Banded Rudderfish	N/A	N/A	E L J A	
Atlantic Spadefish	N/A	N/A	E L J A	
White Grunt	N/A	N/A	E L J A	
Tomtate	N/A	N/A	E L J A	
Hogfish	N/A	N/A	E L J A	
Puddingwife	N/A	N/A	E L J A	
Sheepshead	J A	J A	E L J A	
Red Porgy	N/A	N/A	E L J A	
Longspine Porgy	N/A	N/A	E L J A	
Sculp	N/A	N/A	E L J A	
Blueline Tilefish	N/A	N/A	E L J A	
Sand Tilefish	N/A	N/A	E L J A	
SMALL COASTAL SHARKS	**LARGE COASTAL SHARKS**	**PELAGIC SHARKS**	**PROHIBITED SHARKS**	
Atlantic Sharpnose Shark	Silky Shark	Shortfin Mako	Sand Tiger	Reef Shark
Finetooth Shark	Tiger Shark	Porbeagle	Bigeye Sand Tiger	Narrowtooth Shark
Blacknose Shark	Blacktip Shark	Thresher Shark	Whale Shark	Smalltail Shark
	Spinner Shark	Ocean Whitetip Shark	Basking Shark	Atlantic Angel Shark
RESEARCH SHARKS	Bull Shark	Blue Shark	White Shark	Longfin Mako
Sandbar Shark	Lemon Shark		Dusky Shark	Bigeye Thresher
	Nurse Shark		Bignose Shark	Sharpnose Sevengill Shark
	Scalloped Hammerhead		Galapagos Shark	Bluntnose Sixgill Shark
	Great Hammerhead		Night Shark	Bigeye Sixgill Shark
	Smooth Hammerhead			

Alternative 1 (No Action): This alternative would have no effects on EFH or HAPC.

Alternative 2 (Recommended Plan): This alternative would directly affect the estuarine water column in Carolina Beach Inlet and may have a short-term minor effect to estuarine life cycle requirements of managed species in the South Atlantic Region. Short-term, elevated turbidity levels could also occur during the renourishment operations and could be transported outside the immediate placement area via longshore and tidal currents. Turbidity associated with beach fill placement operations could extend into Carolina Beach inlet and the estuarine water column from longshore currents and tidal influx, however these effects are expected to be minimal. This alternative would not be expected to cause any significant adverse impacts to EFH or HAPC for managed species identified in the Fisheries Management Plan Amendments affecting South Atlantic Area. Physical and biological impacts to EFH would be short-term and localized on an individual and cumulative effects basis.

Alternative 3 (Borrow Area B): Minor and short-term suspended sediment plumes and related turbidity may affect the marine water column during dredging in Borrow Area B. Due to the distance from the inlet, dredging operations would not be expected to directly affect any estuarine water column, and therefore, would not be expected to directly affect estuarine life cycle requirements of managed species in the South Atlantic Region. Turbidity associated with beach fill placement operations could extend into Carolina Beach inlet and the estuarine water column from longshore currents and tidal influx, however these effects are expected to be minor. This alternative would not be expected to cause any significant adverse impacts to EFH or HAPC for managed species identified in the Fisheries Management Plan Amendments affecting South Atlantic Area. Physical and biological impacts to EFH are short-term and localized on an individual and cumulative effects basis.

7.5 Wetlands and Floodplains

7.5.1 Wetlands

Executive Order 11990 directs all Federal agencies to issue or amend existing procedures to ensure consideration of wetlands protection in decision making and to ensure the evaluation of the potential effects of any new construction proposed in a wetland.

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions (33 C.F.R. § 328.3). Wetlands possess three essential characteristics: hydrophytic vegetation, hydric soils, and wetland hydrology.

Although abundant salt marsh and tidal creek wetlands are in the study area, no wetlands are found along the ocean shoreline of the project area. Along Carolina Beach and the proposed borrow areas, there are no Section 404 jurisdictional wetlands (having the three essential

characteristics) that would be impacted by the proposed project. This project is in full compliance with EO 11990.

7.5.2 Floodplains

The 100-year floodplain is established by the Federal Emergency Management Agency (FEMA) and is identified on Federal Insurance Rate Maps. Base flood elevations for flood zones and velocity zones are also identified by FEMA, as are designated floodways. All portions of the project area are within the 100-year floodplain.

Executive Order 11988 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "[e]ach agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities…"

Any placement of material on the beach would occur within the 100-year floodplain and would therefore constitute an alteration of the floodplain, displacing the floodplain seaward. Placement of dredged material on Carolina Beach cannot be accomplished outside the floodplain.

Alternative 1 (No Action): The No Action Plan will result in no changes to wetlands or hydrology, but the continued erosion would cause permanent loss of land area in the floodplain.

Alternative 2 (Recommended Plan): The alternative would not result in filling of wetlands and would not produce changes in hydrology that could affect wetlands.

The Recommended Plan will result in insignificant changes throughout the study area and therefore will not alter existing hydrology in the floodplain. The eight steps discussed in E.O. 11988 are addressed as follows:

1. Floodplain and/or wetland determination.

The project is within the 100-year floodplain. The proposed action will not adversely impact any floodplains or wetlands, upstream, within, or downstream of the project.

2. Public notification.

Public involvement began with scoping and will continue throughout the study process. This report will be provided to the public for comment. All comments received will be addressed and considered during development of the final report.

3. Identify and evaluate practicable alternatives to locating in the base floodplain.

The draft report discusses all practicable alternatives, and illustrates the deliberative process by which the proposed action was selected. Since the project involves beach renourishment, there is no alternative outside the Floodplain.

4. Identify the impacts of the proposed action.

Impacts of the proposed action are fully discussed in the draft report, and are compared side-by-side in the System of Accounts analysis (Table 5.4).

5. Evaluate measures to reduce potential adverse impacts of the proposed action.

The proposed action has the lowest potential to produce adverse impacts of any alternative. Section 7 of this report contains a thorough analysis of all positive and negative impacts, and presents them in a System of Accounts format (Table 5.4).

6. Re-evaluate the alternatives.

All alternatives were thoroughly evaluated and re- evaluated during the deliberative Corps planning process, and are presented in an evaluative, comparative, and screened process, in the report.

7. Make the final determination and present the decision.

The final determination and presentation of the Recommended Plan are contained in the draft report.

8. Implement the action.

Implementation of the Recommended Plan will result in no significant impacts to floodplains or wetlands. The existing hydrology of the floodplain will not be changed. Implementation of the Recommended Plan complies with Executive Order 11988.

Alternative 3 (Borrow Area B): Impacts associated with implementation of this alternative would be similar to impacts of the Recommended Plan. Implementation of Alternative 3 complies with Executive Order 11988.

7.6 Terrestrial Resources

Within the study area, the most significant terrestrial resources occur on Masonboro Island. Masonboro Island is the largest undisturbed barrier island along the southern part of the North Carolina coast. Eighty-seven percent of the 8.4-mile long island is covered with marsh and tidal flats. The remaining portions are composed of beach uplands and dredged material islands. Designated in 1991, Masonboro Island is the largest site, at 5,653 acres, within the North Carolina National Estuarine Research Reserve system. This site is also a Dedicated Nature Preserve, authorized by G.S. 143B-135.250 (deq.nc.gov).

Terrestrial beach and dune communities that may be impacted by the proposed project action occur along most of the Carolina Beach shoreline. Terrestrial habitat types within the areas

include sandy or sparsely vegetated beaches and dune communities. The first line of stable vegetation is outside or landward of the proposed project limits. Utility corridors may have herbaceous or shrub cover. Mammals occurring in this environment are opossums, cottontails, red foxes, gray foxes, raccoons, feral house cats, shrews, moles, voles, and house mice.

7.6.1 Vegetation

When compared to most of North Carolina's upland communities, the beach and dune community in the project area could be considered lacking in species variety in both plants and animals. The environment on the beach is severe because of constant exposure to salt spray, shifting sands, wind, and sterile soils with low water retention capacity. Beach vegetation known from the area includes beach spurge (Euphorbia polygonifolia), sea rocket (Cakile edentula) and pennywort (Hydrocotyle bonariensis). The threatened plant, seabeach amaranth (Amaranthus pumilis) occurs sporadically along the dune faces of Carolina Beach. The dunes along Carolina Beach are more heavily vegetated with American beach grass (Ammophila breviligulata), panic grass (Panicum amarum) sea oats (Uniola paniculata), broom straw (Andropogon virginicus) and salt meadow hay (Spartina patens) being commonly observed.

Alternative 1 (No Action): Long term erosion is expected to destroy habitat for beach vegetation over time.

Alternative 2 (Recommended Plan): If the dune is under the design template height or if the dredging contractor damages the dune during a periodic renourishment event, stabilization will be accomplished by planting vegetation during the optimum planting season following dune construction. Representative native planting stocks may include sea oats (*Uniola paniculata*), American beachgrass (*Ammophila breviligulata*), and panic grass (*Panicum amarum*). The vegetative cover would extend from the landward toe of the dune to the seaward intersection with the storm berm for the length of the dune. Sea oats would be the predominant plant with American beach grass and panic grass as supplemental plants. Planting would be accomplished during the season best suited for the particular plant. Overall, minimal impacts to dune vegetation would be expected to occur due to replanting and placing material away from the vegetation along the berm.

Alternative 3 (Borrow Area B): Impacts associated with implementation of this alternative would be similar to impacts of the Recommended Plan.

7.6.2 Wildlife

Mammals occurring in this environment are opossums, cottontails, red foxes, gray foxes, raccoons, feral house cats, shrews, moles, voles, and house mice.

Reptile and amphibian species observed include southern leopard frog, green tree frog, black rat snake, eastern cottonmouth, yellow-bellied turtle, and snapping turtle.

Birds common to the nearshore ocean in the project area are loons, grebes, gannets, cormorants, scoters, red-breasted mergansers, gulls, and terns (LeGrand, 1983; USACE 2007b;

Sauer et al., 2008). The habitat and food source of such seabirds is the marine environment, whether coastal, offshore or pelagic. They can be divided into four groups by their feeding strategies, which are reflected in their anatomy, physiology, and habitat niche: surface feeders, surface swimmers/pursuit divers, plunge-divers, and scavengers and pirates (i.e., steal from other birds).

The beaches and inlets of the project vicinity are heavily used by migrating shorebirds. However, dense development and high public use of project area ocean front beaches may reduce their value to shorebirds. Along the ocean beach, black-bellied plovers, ruddy turnstones, whimbrels, willets, red knots, semi-palmated sandpipers, and sanderlings may be found (LeGrand, 1983; USACE 2007b; Sauer et al., 2008). Table 7.3 provides a more complete list of waterbirds found in the project area. The dunes of the project area support fewer numbers of birds but can be very important habitats for resident species and for other species of songbirds during periods of migration. Other birds occurring in the area are mourning doves, swallows, fish crows, starlings, meadowlarks, redwinged blackbirds, boat tailed grackles, and savannah sparrows (Douglas and Dechant-Shaffer, 2002; Sauer et al., 2008).

The black skimmer, least tern, gull-billed tern, common tern and American oystercatcher are state-listed species of concern for New Hanover County, North Carolina, and are found on Carolina Beach year round during both the breeding season and during migration, with peak abundance occurring in the summer months. Terns feed by diving from the air on insects and small fish, the black skimmer feeds on shrimp or small fish by flying just above the water with the tip of the long lower mandible shearing the surface and the American Oystercatcher forages by walking in the shallow water searching for shellfish and marine worms by sight. All these bird species may use Carolina Beach for roosting, foraging, breeding, and nesting (Potter et al., 1980).

Although it is possible that shorebird nesting could occur in the project area during the spring and summer months (April 1–August 31), most of the bird species have been displaced by development pressures and heavy recreational use along the beach, thus, traditional nesting areas on the project beach have been lost. Many of the bird species have retreated to the relatively undisturbed dredged material disposal islands that border the navigation channels in the area. Nonetheless, it is possible that shorebird species would still attempt to nest in the project area. To protect bird nesting, the NCWRC discourages beach work between April 1 and August 31.

Table 7.3 Waterbirds Surveyed in the Project Area by National Audubon Society 2009-2018.

Black-bellied Plover	American Kestrel	Fish Crow	Osprey
Piping Plover	Barn Swallow	Forster's Tern	Pied-billed Grebe
Semipalmated Plover	Belted Kingfisher	Great Black-backed Gull	Purple Martin
Wilson's Plover	Black Scoter	Great Blue Heron	Purple Sandpiper
Killdeer	Black Skimmer	Great Egret	Razorbill
American Oystercatcher	Black Tern	Green Heron	Red-breasted Merganser
Greater Yellowlegs	Black-legged Kittiwake	Gull-billed Tern	Red-tailed Hawk
Willet	Boat-tailed Grackle	Herring Gull	Red-throated Loon
Spotted Sandpiper	Bonaparte's Gull	Hooded Merganser	Red-winged Blackbird
Whimbrel	Brown Pelican	Horned Grebe	Ring-billed Gull
Marbled Godwit	Bufflehead	House Finch	Rock Dove
Ruddy Turnstone	Canada Goose	House Sparrow	Royal Tern
Red Knot	Caspian Tern	Laughing Gull	Sandwich Tern
Sanderling	Common Loon	Least Tern	Snowy Egret
Dunlin	Common Nighthawk	Lesser Black-backed Gull	Tree Swallow
Western Sandpiper	Common Tern	Mourning Dove	Turkey Vulture
Least Sandpiper	Cooper's Hawk	Northern Gannet	White Ibis
Short-billed Dowitcher	Surf Scoter	Northern Harrier	
American Crow	Double-crested Cormorant	Northern Mockingbird	

Table 7.4 State-listed Species of Concern Nesting at Carolina Beach Inlet (NC Wildlife Resources Commission)

Year	Black Skimmer	Common Tern	Least Tern
1988	0	0	13
1993	24	14	242
1995	8	6	461
2017	0	0	0

Alternative 1 (No Action): Beach erosion would result in the loss of roosting, foraging, breeding, and nesting habitat for mammals, reptiles, amphibians and birds.

Alternative 2 (Recommended Plan): Periodic renourishment would not be expected to have an adverse effect on wildlife found along the beach. However, short-term transient effects could occur to mammalian species using the dune and foredune habitat, but those species are mobile and would be expected to move to other, undisturbed areas of habitat during the 30-day periodic renourishment events.

Although the project area is heavily developed and sustains heavy recreational use, migratory shorebirds could still use the project area for foraging and roosting habitat. A cutterhead dredge is proposed for dredging within Carolina Beach Inlet, pumping the dredged material

directly to the designated beach fill area. The pipeline route would run from the inlet area (Freeman Park) to the southernmost portion of the project. The pipeline could temporarily obstruct roosting, feeding and nesting activities. Prior to each renourishment event, the pipeline route would be coordinated with appropriate resource agencies to avoid impacts to the greatest extent practicable. Bulldozers would be used to construct seaward shore parallel dikes to contain the material on the beach, and to shape the beach to the appropriate construction cross-section template. Beach renourishment activities could temporarily affect the roosting and intertidal macro-fauna foraging habitat, however, recovery often occurs within one year due to the fact that renourishment material will consist of beach quality sand.

Birds that use the inlet as feeding grounds would be temporarily impacted during dredging activities. To the greatest extent practicable, periodic renourishment will occur from November 16 to April 30. This alternative would not be expected to significantly affect breeding and nesting shorebirds or colonial waterbirds in the project area.

Alternative 3 (Borrow Area B): Renourishment activities with a cutterhead dredge are expected to last about 44 days, a relatively significant increase in construction duration and associated disturbance over cutterhead renourishments with the Recommended Plan. If a hopper dredge is used, dredging would not start before December 1, but would last about 82 days, which is a substantial increase in construction duration and associated disturbance over cutterhead renourishments with the Recommended Plan. Since the borrow area is offshore, the pipeline route would run from the dredge directly onto the beach and would be moved as the beach is filled. Because the pipeline would not run through Freeman Park, impacts to roosting, feeding and nesting birds are reduced as compared to the Recommend Plan. Birds that use Borrow Area B as feeding grounds may be temporarily impacted during dredging activities, but would quickly return when the dredge leaves. Other impacts would be similar to those of the Recommended Plan.

7.7 Endangered and Threatened Species

The Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531–1543), provides a program for the conservation of threatened and endangered (T&E) plants and animals and the habitats in which they are found. The lead Federal agencies for implementing the ESA are the USFWS (http://www.fws.gov/) and the NOAA Fisheries Service (http://www.nmfs.noaa.gov/). In accordance with Section 7 of the ESA, the USACE has been coordinating with the USFWS and NMFS since beginning this study.

A list of threatened and endangered (T&E) species for the project area was obtained from and the USFWS IPAC website (https://ecos.fws.gov/ipac/). Table 7.5 includes T&E species that could be present in the area based upon their historical occurrence or potential geographic range. However, the actual occurrence of a species in the area depends upon the availability of suitable habitat, the season of the year relative to a species' temperature tolerance, migratory habits, and other factors.

Table 7.5. Federally Threatened and Endangered Species Potentially Present In Project Area.

Species	Status	Effect Determination
Mammals		
West Indian Manatee */Trichechus manatus*	Threatened	No effect
Blue, Finback, Sei and Sperm Whales	Endangered	No effect
Humpback Whale */Megaptera novaeangliae*	Endangered	MANLAA*
North Atlantic Right Whale */Eubaleana glacialis*	Endangered	MANLAA
Fish		
Atlantic Sturgeon */cipenser oxyrhynchus oxyrhynchus*	Endangered	MANLAA
Shortnose Sturgeon */Acipenser brevirostrum*	Endangered	No effect
Birds		
Piping Plover */Charadrius melodus*	Threatened	MANLAA
Red Knot */Calidris canutus rufa*	Threatened	MANLAA
Reptiles		
Green Sea Turtle */Chelonia mydas*	Threatened	MANLAA
Hawksbill Sea Turtle */Eretmochelys imbricata*	Endangered	MANLAA
Kemp's Ridley Sea Turtle */Lepidochelys kempii*	Endangered	MANLAA
Leatherback Sea Turtle */Dermochelys coriacea*	Endangered	MANLAA
Loggerhead Sea Turtle */Caretta caretta*	Threatened	MANLAA
Flowering Plants		
Seabeach Amaranth */Amaranthus pumilus*	Threatened	MANLAA
Critical Habitats		
Loggerhead Sea Turtle		No effect
Atlantic Sturgeon		No effect
North Atlantic Right Whale		No effect

*May Affect Not Likely to Adversely Affect

7.7.1 Large Whales—Blue Whale, Finback Whale, Humpback Whale, North Atlantic Right Whale (NARW), Sei Whale, and Sperm Whale

Source: https://www.fisheries.noaa.gov/species/north-atlantic-right-whale

Blue whale, finback whale, humpback, North Atlantic right, sei whale, and sperm whales all occur infrequently in the ocean off the coast of North Carolina. Of these, only the NARW and the humpback whale routinely come close enough inshore to encounter the project area. Humpback whales were listed as “endangered” throughout their range on June 2, 1970 under

the Endangered Species Act and are considered “depleted” under the Marine Mammal Protection Act. Humpbacks are often found in protected waters over shallow banks and shelf waters for breeding and feeding. They migrate toward the poles in summer and toward the tropics in winter and are in the vicinity of the North Carolina coast during seasonal migrations, especially between December and April. Since 1991, humpback whales have been seen in nearshore waters of North Carolina with peak abundance in January through March. In the Western North Atlantic, humpback feeding grounds encompass the eastern coast of the United States, the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland. Major prey species include small schooling fishes (herring, sand lance, capelin, mackerel, small Pollock, and haddock) and large zooplankton, mainly krill (up to 1.5 tons per day) (http://www.nmfs.noaa.gov).

The NARW continues to be one of the most critically endangered populations of large whales in the world as revealed by the most recent review of the photo-ID recapture database in 2009 indicating that, at a minimum, 361 individually recognized whales in the catalog were known to be alive during 2005 (NMFS, 2010a). There are 6 major habitats or congregation areas for the western NARW; these are the coastal waters of the southeastern United States, the Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf. However, the frequency with which NARWs occur in offshore waters in the southeastern U.S. remains unclear. While it usually winters in the waters between Georgia and Florida, the NARW can, on occasion, be found in the waters off North Carolina. The occurrence of NARWs in the State's waters is usually associated with spring or fall migrations.

When defining critical habitat for right whales, the NMFS considered the physical and/or biological features of foraging and calving habitats. The physical and biological features of right whale calving habitat that are essential to the conservation of the North Atlantic right whale are: (1) Calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale; (2) sea surface temperatures from a minimum of 7 °C, and never more than 17 °C; and (3) water depths of 6 to 28 meters, where these features simultaneously co-occur over contiguous areas of at least 231 nm^2 of ocean waters during the months of November through April. When these features are available, they are selected by right whale cows and calves in dynamic combinations that are suitable for calving, nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves.

The NMFS’s Unit 2 contains the essential features for calving right whales in the southeastern U.S (Figure 7.1). This area comprises waters of Brunswick County, North Carolina; Horry, Georgetown, Charleston, Colleton, Beaufort, and Jasper Counties, South Carolina; Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden Counties, Georgia; and Nassau, Duval, St. John's, Flagler, Volusia, and Brevard Counties, Florida.

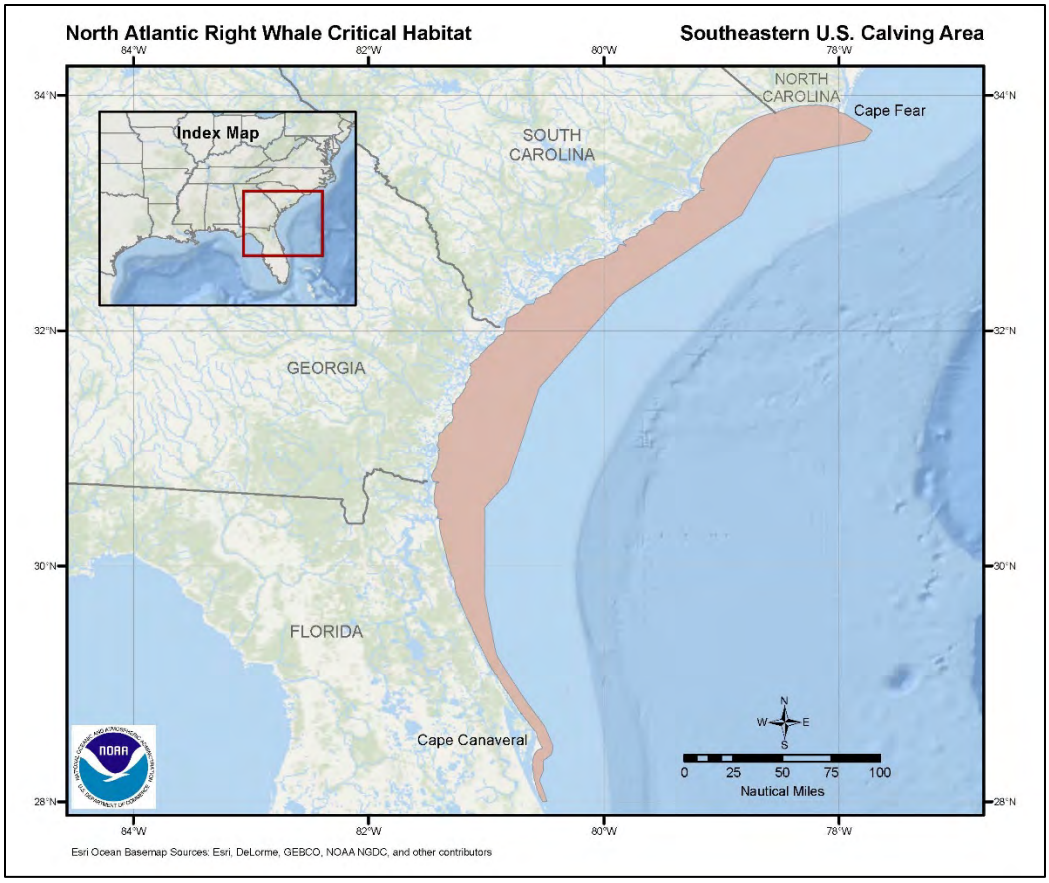


Figure 7.3. North Atlantic Right Whale Critical Habitat

Alternative 1 (No Action): This alternative would have no effect on the six species of whales potentially in the project area.

Alternative 2 (Recommended Plan): Of the six species of whales being considered, only the NARW and humpback whale would normally be expected to occur within the project area during a periodic renourishment event. Therefore, this alternative is not likely to adversely affect the blue whale, finback whale, sei whale, and sperm whale. Humpback whales are most abundant in the project area January through March, coinciding closely with the dredging window of November 16 to April 30, while NARW abundance times are much less known. Conditions outlined in previous consultations in order to reduce the potential for accidental collision (i.e. contractor pre-project briefings, large whale observers, slow down and course alteration procedures, etc.) will be implemented as a component of this project. Based on the implementation of these conditions, the proposed project may affect, but is not likely to adversely affect the NARW and humpback whale species. There is no NARW critical habitat in the project area, therefore the project will have no effect on NARW critical habitat.

Alternative 3 (Borrow Area B): This alternative takes about 44 days with a cutterhead dredge or 82 days with a hopper dredge. Also, vessel strikes to Humpback and NARW are more likely to occur farther from the coastline, near Borrow Area B, versus the inlet. Due to the offshore

borrow area and the associated increase in construction time as compared with the Recommended Plan, this alternative has a moderate increased chance of vessel strikes to Humpback and NARW with a cutterhead.

The transport of hopper dredges to and from the offshore borrow area, as compared to a cutterhead that pumps directly from the borrow area, increases the chance of an encounter with humpback and NARW species. Conditions outlined in previous consultations in order to reduce the potential for accidental collision (i.e. contractor pre-project briefings, large whale observers, slow down and course alteration procedures, etc.) will be implemented as a component of this project.

Overall, based on the implementation of conditions to reduce collision, this alternative may affect, but is not likely to adversely affect the NARW and humpback whale species. There is no NARW critical habitat in the project area, therefore the project will have no effect on NARW critical habitat.

7.7.2 West Indian Manatee

Source: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=4469

Manatees are a sub-tropical species with little tolerance for cold. Though they are generally restricted to warm inland and coastal waters of Florida, in warmer months they may be found throughout the United States. North Carolina is one location along the Southeast coast where the manatee is an occasional summer resident. The species can be found in shallow (5 feet to usually <20 feet), slow-moving rivers, estuaries, saltwater bays, canals, and coastal areas. The West Indian manatee is herbivorous and eats aquatic plants such as hydrilla, eelgrass, and water lettuce. Manatees are thermally stressed at water temperatures below 18ºC (64.4ºF); therefore, during winter months, when ambient water temperatures approach 20ºC (68ºF), the U.S. manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. During the summer months, sightings drop off rapidly north of Georgia and are rare north of Cape Hatteras. However, they are sighted infrequently in southeastern North Carolina with most records occurring in July, August, and September, as they migrate up and down the coast. The Species is considered a seasonal inhabitant of North Carolina with most occurrences reported from June through October.

Alternative 1 (No Action): This alternative would have no effect on manatees.

Alternative 2 (Recommended Plan): All dredging will occur in the inlet environment in the winter months when overall occurrence of manatees in the project vicinity is infrequent. Guidelines for Avoiding Impacts to the West Indian Manatee (USFWS, 2017) precautionary measures will be implemented for transiting vessels associated with the project. The habitat and food supply of the manatee will not be significantly impacted. This alternative may affect, but is not likely to adversely affect the manatee.

Alternative 3 (Borrow Area B): This alternative takes about 44 days with a cutterhead dredge or 82 days with a hopper dredge. The transport of hopper dredges to and from the offshore borrow area, as compared to a cutterhead that pumps directly from the borrow area, increases the chance of an encounter with manatees. All dredging will occur in the winter months when overall occurrence of manatees in the project vicinity is infrequent. Guidelines for Avoiding Impacts to the West Indian Manatee (USFWS, 2017) precautionary measures will be implemented for transiting vessels associated with the project. The habitat and food supply of the manatee will not be significantly impacted. This alternative may affect, but is not likely to adversely affect the manatee.

7.7.3 Sea Turtles

Source: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=6199

All five species of sea turtles identified above are known to occur in both the estuarine and oceanic waters of North Carolina. Loggerhead, green, and Kemp's ridley sea turtles are known to frequently use coastal waters offshore of North Carolina as migratory travel corridors and commonly occur at the edge of the continental shelf when they forage around coral reefs, artificial reefs, and boat wrecks.

Results from satellite tracking survey of male loggerhead sea turtles aggregated for mating in the Port Canaveral, FL, shipping entrance channel suggest that residents and transients co-occurred in near shore waters during April and mid-May, after which time residents moved offshore to deeper waters (>26m) and transients dispersed to multiple locations along the U.S. East Coast, including Cape Hatteras, NC. These results are consistent with other studies tracking male loggerhead sea turtles suggesting that that Cape Hatteras, NC may represent a seasonally important landmark for adult male loggerheads. Male turtles appear to migrate to

Cape Hatteras in the fall before over-wintering near the edge of the continental shelf to the east/southeast of Cape Fear, NC.

Of the five species of sea turtles considered for this project, only the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*), and the leatherback sea turtle (*Dermochelys coriacea*) nest regularly on North Carolina beaches and have the potential to nest within the project area.

With a few exceptions, the entire Kemp's ridley population nests on the approximately 15 miles of beach in Mexico between the months of April and June. The hawksbill sea turtle nests primarily in tropical waters in south Florida and the Caribbean. Considering the infrequency of Kemp's ridley nesting occurrence throughout North Carolina and the lack of historical nesting of hawksbill sea turtles, these species are not anticipated to nest within the project area. The loggerhead is considered to be a regular nester in the state, while green sea turtle nesting is infrequent and primarily limited to Florida's east coast (300 to 1,000 nests reported annually).

Carolina Beach consists of approximately 3 linear miles of available nesting habitat. Table 7.6, shows the total number of recorded nesting activity on this beach from 2009 to 2018. A total of 85 nests have been laid within the project area since 2009.

Table 7.6 North Carolina Wildlife Resources Commission's Historic Data of Turtle Nests on Carolina Beach

Year	Number of Nests
2009	13
2010	1
2011	9
2012	7
2013	11
2014	2
2015	16
2016	9
2017	7
2018	10

In order to avoid periods of peak sea turtle abundance during warm water months and minimize impacts to sea turtles in the offshore environment, the proposed dredging window for this project using a cutterhead is November 16 through April 30 and December 1 to March 31 for a hopper dredge. Also, during all hopper dredging activities, the use of turtle deflecting dragheads, inflow and/or overflow screening, and NMFS certified turtle observers will also be implemented. By adhering to these environmental windows to the maximum extent practicable, all subsequent beach placement of sediment will occur outside of the North

Carolina sea turtle nesting season of May 1 through November 15. The limits of the nesting season window are based on the known nesting sea turtle species within the state and the earliest and latest documented nesting events for those species.

Critical Habitat: The NMFS identified physical biological features (PBF)s of habitat essential for the conservation of the loggerhead sea turtle, the Primary Constituent Elements (PCE)s that support the PBFs, and the specific areas identified using these PBFs and PCEs. A description of the means used to identify PBFs, PCEs and specific areas can be found in the proposed rule (78 FR 18000, March 25, 2013).

Of the five categories of habitat identified in Loggerhead critical habitat, only Nearshore Reproductive Habitat is in the project area (Figure 7.2). Nearshore Reproductive Habitat is described as the PBFs of nearshore reproductive habitat as a portion of the nearshore waters adjacent to nesting beaches that are used by hatchlings to egress to the open-water environment as well as by nesting females to transit between beach and open water during the nesting season.

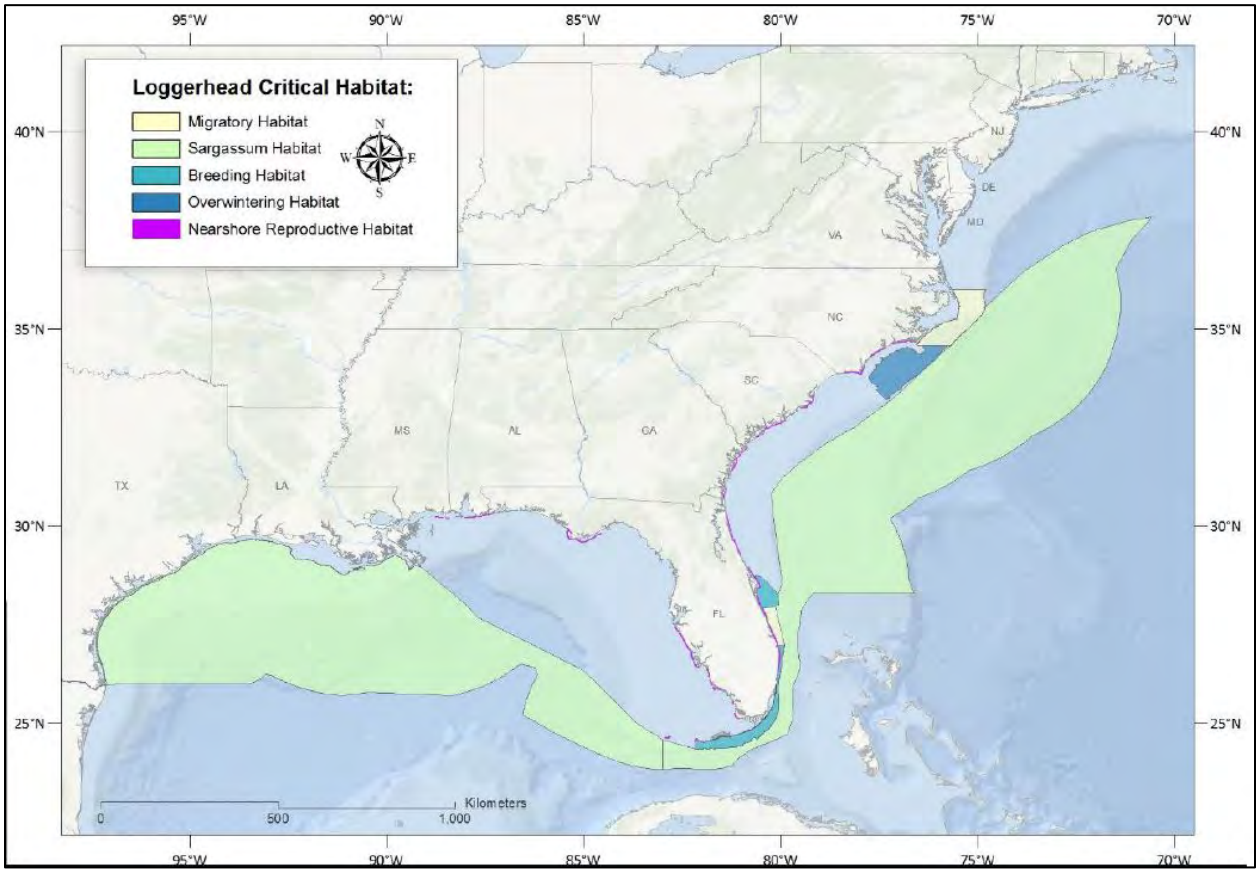


Figure 7.4. NMFS Loggerhead Critical Habitat

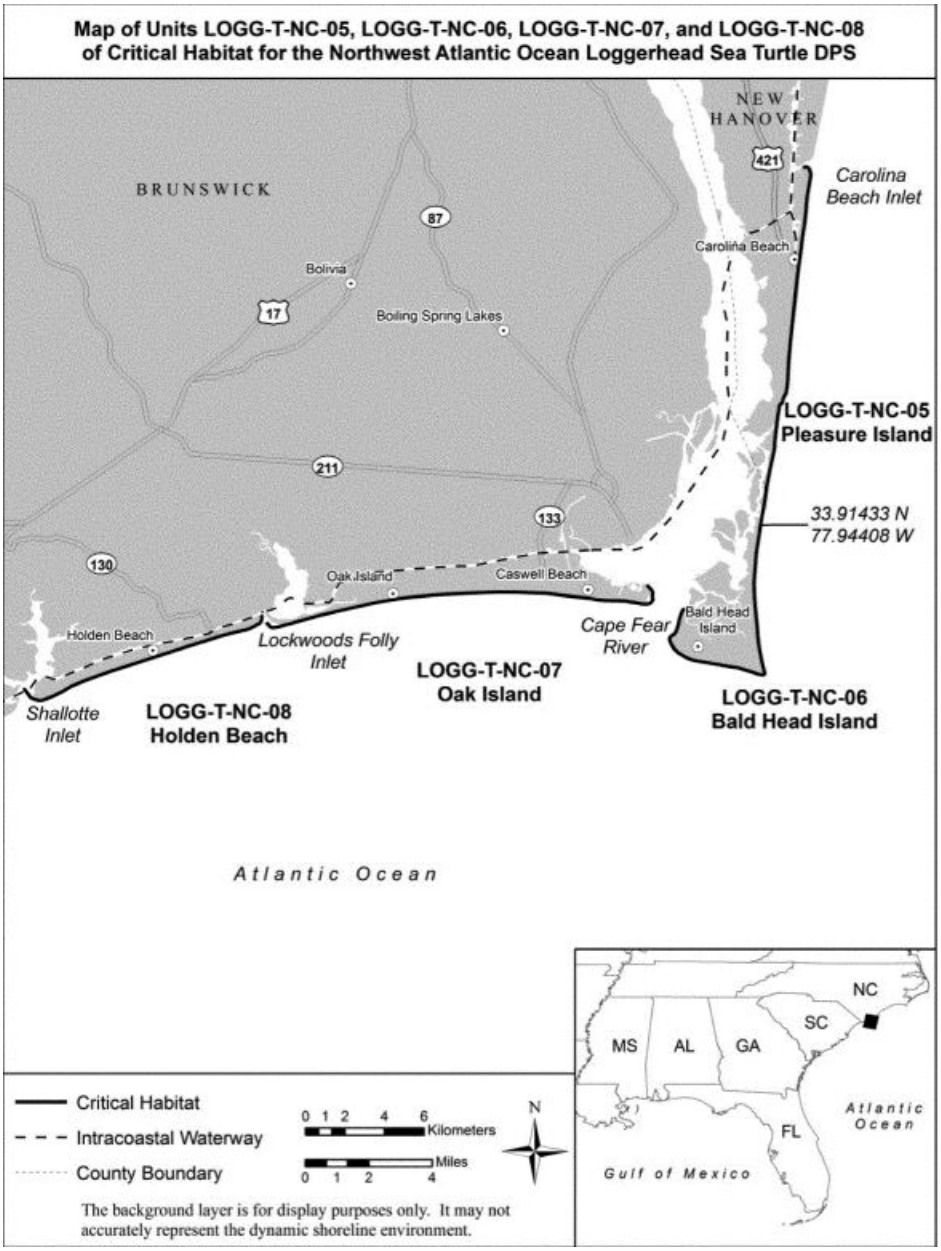


Figure 7.5. USFWS Loggerhead Critical Habitat

The USFWS designated areas in terrestrial environment as critical habitat for the Northwest Atlantic Ocean DPS of the loggerhead sea turtle (Figure 7.3). This critical habitat is defined as the specific areas within the geographical area occupied by the species on which are found those physical or biological features essential to conservation of the species and which may require special management considerations or protection and specific areas outside the geographical area determined to be essential for the conservation of the species. Recovery Unit LOGG-T-NC-05 consists of 11.5 miles of island shoreline along the Atlantic Ocean and starting from Carolina Beach Inlet.

Alternative 1 (No Action): This alternative would have no effect on sea turtles from dredging, but would result in the long term reduction of available nesting habitat due to erosion.

Alternative 2 (Recommended Plan): Based on post-renourishment monitoring, in most cases, nesting success decreases during the year following renourishment as a result of escarpments obstructing beach accessibility, altered beach profiles, and increased compaction.

There are inherent changes in beach characteristics as a result of mechanically placing sediment on a beach from alternate sources. The change in beach characteristics often results in short-term decreases in nest success and/or alterations in nesting processes. However, when done properly, beach renourishment projects may mitigate the loss of nesting beach when the alternative is severely degraded or non-existent habitat. Though significant alterations in beach substrate properties may occur with the input of sediment types from other sources, re-establishment of a berm and dune system with a gradual slope can enhance nesting success of sea turtles by expanding the available nesting habitat beyond erosion and inundation prone areas.

Considering that the proposed dredging window will avoid the sea turtle nesting season to the maximum extent practicable, the use of turtle deflecting dragheads, inflow and/or overflow screening, and NMFS certified turtle and whale observers the proposed project may affect but is not likely to adversely affect nesting loggerhead, green, and leatherback sea turtles by altering nesting habitat.

Due to depth restrictions for hopper dredges, it is likely a cutterhead suction dredge would be used in the inlet. The proposed dredging activities for each three year renourishment interval may occur in areas used by migrating turtles. Therefore, the proposed project may affect, but is not likely to adversely affect loggerhead, leatherback, green, hawksbill, and Kemp's ridley sea turtles.

Loggerhead Critical Habitat - The proposed project will not result in an adverse modification of critical habitat for the threatened loggerhead sea turtle.

Alternative 3 (Borrow Area B): Impacts associated with beach placement and associated impacts to loggerhead critical habitat would be similar to the Recommended Plan.

This alternative takes about 44 days with a cutterhead dredge or 82 days with a hopper dredge, due to the offshore borrow area and the associated increase in construction time as compared with the Recommended Plan, increasing the risk to sea turtles from dredging.

The dredging activities for each renourishment event may occur in areas used by migrating turtles. Although cutterhead suction dredges do not pose risks to benthic oriented sea turtles through physical injury or death by entrainment, the risk of lethal impacts still exists as some sea turtle species may be found year-round in the offshore area. Therefore, Alternative 3, using a cutterhead dredge may affect, but is not likely to adversely affect loggerhead, leatherback, green, hawksbill, and Kemp's ridley sea turtles.

Hopper dredges pose risks to benthic oriented sea turtles through physical injury or death by entrainment. Though limiting hopper dredge activities, to the maximum extent practicable, to the December 1 to March 31 dredging window will avoid periods of peak turtle abundance during the warm water months, the risk of lethal impacts still exists as some sea turtle species may be found year-round in the offshore borrow area. Therefore, Alternative 3 using a hopper dredge may affect, but is not likely to adversely affect loggerhead, green, hawksbill, and Kemp's ridley sea turtles. Based on historic hopper dredging take data, Alternative 3 using a hopper dredge may affect, but is not likely to adversely affect leatherback sea turtles.

7.7.4 Sturgeon

Source: https://www.fisheries.noaa.gov/species/atlantic-sturgeon

Shortnose Sturgeon- Populations of shortnose sturgeon range along the Atlantic seaboard from the Saint John River in New Brunswick, Canada to the Saint Johns River, Florida. It is apparent from historical accounts that this species may have once been fairly abundant throughout North Carolina's waters; however, many of these early records are unreliable due to confusion between this species and the Atlantic sturgeon (*Acipenser oxyrhynchus*). The shortnose sturgeon is principally a riverine species and is known to use three distinct portions of river systems: (1) non-tidal freshwater areas for spawning and occasional over wintering; (2) tidal areas in the vicinity of the fresh/saltwater mixing zone, year-round as juveniles and during the summer months as adults; and (3) high salinity estuarine areas (15 parts per thousand (ppt.) salinity or greater) as adults during the winter.

Atlantic Sturgeon - The general life history pattern of Atlantic sturgeon is that of a long lived, late maturing, estuarine dependent, anadromous species. The species' historic range included major estuarine and riverine systems that spanned from Hamilton Inlet on the coast of Labrador to the Saint Johns River in Florida. Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February-March in southern systems, April-May in mid-Atlantic systems, and May-July in Canadian systems. Comprehensive information on current or historic abundance of Atlantic sturgeon is lacking for most river systems; however, use of the Cape Fear

River, NC for spawning and nursery habitat is well documented. Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers, where optimal flows are 46-76 cm/s and deep depths of 11-27 meters. Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces. Juveniles spend several years in the freshwater or tidal portions of rivers prior to migrating to sea. Upon reaching a size of approximately 76-92 cm, the subadults may move to coastal waters, where populations may undertake long range migrations.

Effective September 18, 2017, the NMFS designated critical habitat for the distinct population segment of Atlantic sturgeon. Specific occupied areas designated as critical habitat for the Carolina distinct population segment of Atlantic sturgeon contain approximately 1,939 km (1,205 miles) of aquatic habitat in the following rivers of North Carolina and South Carolina: Roanoke, Tar-Pamlico, Neuse, Cape Fear, Northeast Cape Fear, Waccamaw, Pee Dee, Black, Santee, North Santee, South Santee, and Cooper, and the following other water body: Bull Creek. Unit C4 (Cape Fear River, NC/Northeast Cape Fear River, NC) is the closest critical habitat river to the proposed project.

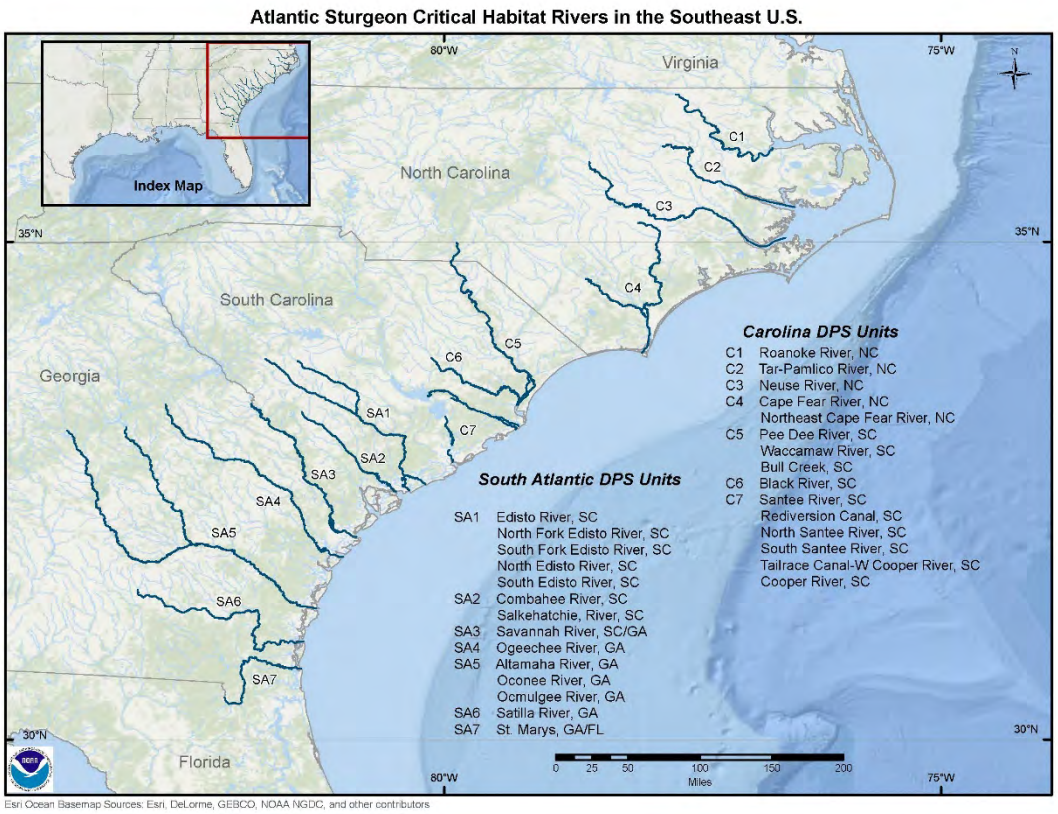


Figure 7.6 Atlantic Sturgeon Critical Habitat

Alternative 1 (No Action): This alternative would have no effect on sturgeon species and no effect on Atlantic sturgeon critical habitat.

Alternative 2 (Recommended Plan): As it is not likely that shortnose sturgeon would be present in the beach or inlet area, the proposed project will have no effect on the shortnose sturgeon.

Though no site specific data pertaining to Atlantic sturgeon distribution within the inlet borrow area is available, based on documented migratory pathways using existing tagging data, it is likely that sturgeon may be migrating through or spending time in or near the inlet.

Although cutterhead suction dredges do not pose risks to benthic oriented sturgeons through physical injury or death by entrainment, the risk of lethal impacts still exists. Hydraulic dredging techniques may also indirectly impact Atlantic sturgeon through (1) short-term impacts to benthic foraging and refuge habitat, (2) short-term impacts to water and sediment quality from re-suspension of sediment and subsequent increase in turbidity/siltation, and (3) disruption of spawning migratory pathways. Therefore, the proposed dredging activities, may affect, but are not likely to adversely affect the Atlantic sturgeon species. Beach placement activities would have no effect on Atlantic sturgeon.

There is no designated critical habitat in the project area, therefor this alternative will not result in an adverse modification of Atlantic sturgeon critical habitat.

Alternative 3 (Borrow Area B): As it is not likely that shortnose sturgeon would be present in the beach area and as dredging will occur in the offshore environment, it has been determined that the actions of the proposed project will have no effect on the shortnose sturgeon.

Though no site specific data pertaining to Atlantic sturgeon distribution within the offshore borrow area is available, based on documented migratory pathways using existing tagging data, it is likely that sturgeon may be migrating through or spending time in or near the borrow area.

Although cutterhead suction dredges do not pose risks to benthic oriented sturgeons through physical injury or death by entrainment, the risk of lethal impacts still exists. Hydraulic dredging techniques may also indirectly impact Atlantic sturgeon through (1) short-term impacts to benthic foraging and refuge habitat, (2) short-term impacts to water and sediment quality from re-suspension of sediment and subsequent increase in turbidity/siltation, and (3) disruption of spawning migratory pathways. Therefore, the proposed dredging activities, may affect, but are not likely to adversely affect the Atlantic sturgeon species. Beach placement activities would have no effect on Atlantic sturgeon.

Hopper dredges pose risks to Atlantic sturgeon through physical injury or death by entrainment. Atlantic sturgeon are covered by the Section 7(a)(2) and 7(d) Endangered Species Act Jeopardy Analysis, April 2014. Endangered species observers on board hopper dredges will be responsible for monitoring for incidental take of Atlantic sturgeon. For hopper dredging operations, dragheads as well as all inflow and overflow screening will be inspected for

sturgeon species following the same ESO protocol for sea turtles. Hopper dredge activities, to the maximum extent practicable, will use the 1 December to 31 March dredging window. Though no site specific data pertaining to Atlantic sturgeon distribution within the borrow areas is available, based on their documented migratory pathways using existing tagging data, it is likely that sturgeon may be migrating through or spending time on or near the borrow area and may be adversely impacted.

Due to the hopper dredge protection measures and the likelihood of migrating sturgeon, this alternative may affect, but is not likely to adversely affect Atlantic sturgeon.

7.7.5 Seabeach Amaranth

Source: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=8549

Seabeach amaranth is an annual or sometimes perennial plant that usually grows between the seaward toe of the dune and the limit of the wave uprush zone occupying elevations ranging from 0.2 to 1.5 m above mean high tide. Greatest concentrations of seabeach amaranth occur near inlet areas of barrier islands, but in favorable years many plants may occur away from inlet areas. Seabeach amaranth is considered a pioneer species of accreting shorelines, stable foredune areas, and overwash fans. Seed dispersal of seabeach amaranth is achieved in a number of ways, including water and wind dispersal.

Historically, seabeach amaranth was found from Massachusetts to South Carolina, but according to recent surveys, its distribution is now restricted to North and South Carolina with several populations on Long Island, New York. The decline of this species is caused mainly by development of its habitat, such as inlet areas and barrier islands, and increased off-road vehicle and human traffic, which tramples individual plants.

Seabeach amaranth surveys have been performed along all of Carolina Beach, NC since 1992. Based on the available data, a total of 819 plants have been recorded along the beaches of Carolina Beach (Table 7.7). Shoreline erosion and accretion processes associated natural storm events and beach dynamics likely play an important role in explaining the random spatial and temporal abundance patterns since 1992.

Since seabeach amaranth seeds are fairly resilient and germination is dependent on critical physical conditions, populations of seabeach amaranth are very dynamic with numbers of plants fluctuating dramatically from year to year. Germination begins in April as temperatures reach about 25ºC (77ºF) and continues at least through July with greatest germination occurring at 35ºC (95ºF). Seed production begins in July or August, peaks in September, and continues until the plant dies. Seabeach amaranth is physically controlled (salt water inundation, temperature, emergence at depth, etc.) rather than biologically controlled (web worm). Furthermore, seedlings are unable to emerge from depths greater than 1cm; however, seabeach amaranth seeds are resilient, and century–old seeds of some species of amaranth are capable of successful germination and growth.

Table 7.7. Total Amaranthus Count by Year on Carolina Beach

Year	Total	Year	Total
1992	9	2005	0
1993	33	2006	1
1994	103	2007	0
1995	579	2008	0
1996	93	2009	0
1997	1	2010	0
1998	0	2011	0
1999	0	2012	0
2000	0	2013	0
2001	0	2014	0
2002	0	2015	0
2003	0	2016	0
2004	0	2017	0
		2018	0
		Total	**819**

Alternative 1 (No Action): This alternative would have a long term negative effect on seabeach amaranth due to loss of habitat from erosion.

Alternative 2 (Recommended Plan): Beach renourishment will restore much of the existing habitat lost to erosion and is expected to provide long-term benefits to seabeach amaranth; however, renourishment every three years and the resulting deep burial of seeds on a portion of the beach may slow germination and population recovery over the short-term. Therefore, the project may affect, but is not likely to adversely affect seabeach amaranth.

Alternative 3 (Borrow Area B): Impacts associated with implementation of this alternative would be similar to the impacts of the Recommended Plan.

7.7.6 Piping Plover

Source: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=6039

The Atlantic Coast piping plover population breeds on coastal beaches from Newfoundland to North Carolina (and occasionally in South Carolina) and winters along the Atlantic Coast (from North Carolina south), the Gulf Coast, and in the Caribbean where they spend a majority of their time foraging. Since being listed as threatened in 1986, only 800 pairs were known to exist in the three major populations combined and by 1995 the number of detected breeding pairs increased to 1,350. This population increase can most likely be attributed to increased survey efforts and implementation of recovery plans.

The species typically nests in sand depressions on unvegetated portions of the beach above the high tide line on sand flats at the ends of sand spits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, sparsely vegetated dunes, and washover areas cut into or between dunes. Piping plovers head to their breeding grounds in late March or early April and nesting usually begins in late April; however, nests have been found as late as July. The largest reported nesting concentration of the species in the State appears to be on Portsmouth Island where 19 nests were discovered in 1983. The southernmost nesting record for the state was one nest located in Sunset Beach by in 1983. Feeding areas include intertidal portions of ocean beaches, washover areas, mud flats, sand flats, wrack lines, and shorelines of coastal ponds, lagoons, or salt marshes. Prey consist of worms, fly larvae, beetles, crustaceans, mollusks, and other invertebrates.

The piping plover is a fairly common winter resident along the beaches of North Carolina. On 10 July 2001, the USFWS designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population of the piping plover where they spend up to 10 months of each year on the wintering grounds. Constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The USFWS has defined textual unit descriptions to designate areas within the critical habitat boundary. These units describe the geography of the area using reference points, include the areas from the landward boundaries

to the MLLW, and may describe other areas within the unit that are utilized by the piping plover and contain the primary constituent elements.

NC-14 is a USFWS designated piping plover critical habitat unit within the vicinity of the project. NC-14 is located in Carolina Beach Inlet. It includes the contiguous shoreline from MLLW to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur along the Atlantic Ocean and either inlet. Though the limits of critical habitat are constantly evolving based on the presence or absence of constituent elements, this approximation facilitated a more detailed and site specific impact analysis relative to the proposed action.

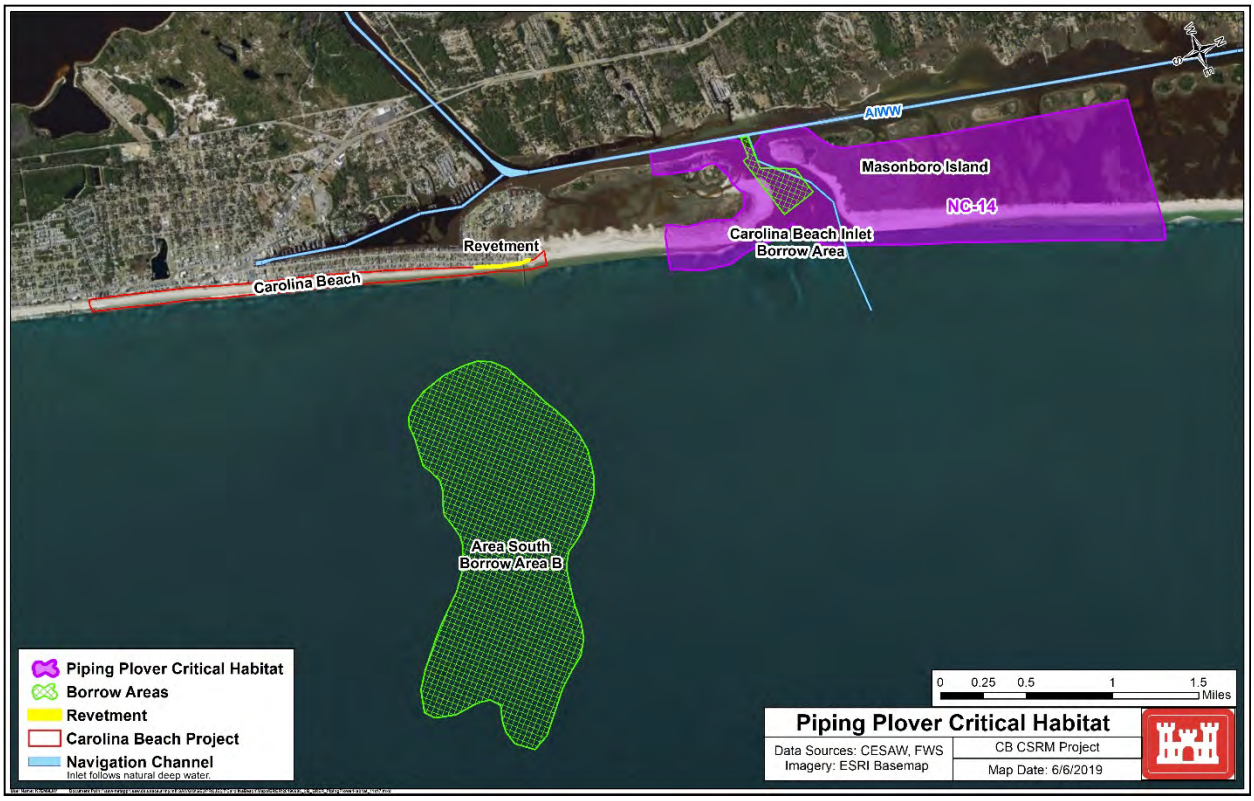


Figure 7.7. Piping Plover Critical Habitat

Alternative 1 (No Action): Beach erosion would result in the loss of roosting, foraging, breeding, and nesting habitat for the piping plover.

Alternative 2 (Recommended Plan): The long-term effects of the project may restore lost roosting and nesting habitat through the addition of beach fill; however, short-term impacts to foraging, sheltering and roosting habitat may occur during renourishment events. Therefore, the project may affect, but is not likely to adversely affect the piping plover. A cutterhead dredge would pump the dredged material directly to the designated beach fill area, requiring a pipeline route that would run from the inlet to the southernmost portion of the project. The pipeline could temporarily obstruct piping plover activities; however, prior to the start of each

renourishment event, the USACE will coordinate with appropriate resource agencies to identify a pipeline route that will minimize impacts to the greatest extent practicable. Considering that the project construction limits and associated activities will avoid the designated piping plover critical wintering habitat and associated constituent element at NC-14, the proposed project is not likely to adversely modify critical habitat.

Alternative 3 (Borrow Area B): Although renourishment activities will only take place in the winter months , total dredging time will be about 44 days for a cutterhead, 82 days for a hopper, increasing short-term impacts to foraging, feeding, sheltering, and roosting habitat over the Recommended Plan (about 30 days). Other impacts of this alternative would be similar to the Recommended Plan.

7.7.7 Red Knot

Source: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=1864

The Red Knot (*Calidris canutus rufa)* is a medium-sized shorebird that undertakes an annual 30,000 km hemispheric migration, one of the longest among shorebirds. Their migration route extends from overwintering sites in the southernmost tip of South America at Tierra del Fuego, up the Eastern coast of the Americas through the Delaware Bay, and ultimately to breeding sites in the central Canadian Arctic. Red Knots break their migration into strategically timed and selected non-stop segments, of approximately 1,500 miles, throughout the entire Atlantic coast, including North Carolina. These staging areas consist of highly productive foraging locations which are repeatedly used year to year. As the Red Knot moves towards the northern extent of its migration route, the timing of departures becomes increasingly synchronized. One critical foraging stop for Red Knots occurs in the Delaware Bay where they feed almost exclusively on horseshoe crab eggs, due to their high fat content and ease of digestion, in order to reach threshold departure masses (180-200 grams) prior to heading for the Arctic breeding grounds. The arrival of the Red Knot in the Delaware Bay coincides with the spawning of the horseshoe crabs, which peaks in May and June. Birds arrive emaciated and can nearly double their mass (~4.6 grams/day) prior to departure if foraging conditions are favorable, eating an estimated 18,000 fat rich horseshoe crab eggs per day. This critical foraging stopover enables Red Knots to achieve the nutrient store levels necessary for migration, survival, and maximizing the reproductive potential of the population. In order to increase their body mass at such a

rapid rate during their refueling stopover in the Delaware Bay, Red Knots morph their guts during their migration route from South America to Delaware.

Red Knots feed extensively in the intertidal zone and on small coquina clams and horseshoe crab eggs. So they are either seen feeding voraciously or resting. Once they build up adequate fat reserves, they fly to their next stopover site. Some Red Knots have geo-locators on their leg bands and such data demonstrate that they can fly 100s of miles without stopping if they have adequate fat stores.

The best places for them to feed and rest are large intertidal areas for foraging, with foredunes in which to rest. No disturbance at these sites from pedestrians, dogs, or vehicles would be tolerated by the birds; thus, busy sites are not used.

Aerial survey observations of Carolina Beach counted 11 red knots in 2009 and 0 in 2010. There are no other reports after 2010 (https://www.ncpaws.org/PAWS/Wildlife/Shorebird/Shorebird.aspx and USFWS August 2014).

Alternative 1 (No Action): Beach erosion would result in the loss of roosting and foraging habitat for red knots.

Alternative 2 (Recommended Plan): Short-term impacts of the proposed action on the Red Knot would result from the placement of sediment on Carolina Beach every 3 years. This activity would restore beach and intertidal area for this species. The long-term effects of the project may restore lost roosting and foraging habitat through the addition of beach placement activities within Carolina Beach; however, short-term impacts to roosting and foraging habitat may occur during project construction. Considering that construction activities will (1) avoid large scale disturbance within the entire range limits of Red Knot foraging distribution and allow for areas of unimpacted or recovered foraging habitat within a given year, (2) avoid roosting timeframes or provide appropriate buffers around existing roosting habitat identified during shorebird surveys and construction operations, and (3) beach placement on Carolina Beach will only take place from November 16 to April 30 once every 3 years, the placement of beach quality sediment on Carolina Beach may affect, but is not likely to adversely affect the Red Knot.

Alternative 3 (Borrow Area B): Beach placement on Carolina Beach will only take place from November 16 to April 30, or December 1 to March 31 if a hopper dredge is used. As compared to the Recommended Plan (30 days), total work time will be longer, about 44 days, 82 if a hopper dredge is used, increasing short-term impacts to roosting and foraging habitat. Other impacts of this alternative would be similar to the Recommended Plan.

7.8 Socioeconomic Resources

Demographics

According to the US Census Bureau, the 2010 population of Carolina Beach was 5,706, and 202,607 for New Hanover County, making it the 9th most populous county in North Carolina. In the past several years, the county has seen strong population growth. In fact, between 2000 and 2010, the county grew by over 26 percent. According to reports by the North Carolina State office of Budget and Management, New Hanover County is expected to increase in size to over 270,000 persons by 2029. The ethnic makeup of New Hanover County is 79.9 percent white, 16.9 percent African American, less than 1 percent Native American, less than 1 percent Asian, less than 1 percent Pacific Islander, and less than 1 percent from other races. 2.1 percent of the population were Hispanic or Latino of any race. Carolina Beach's racial makeup was 98.4 percent white, with less than 1 percent of each additional race represented. The Hispanic population in Carolina Beach represents less than 1 percent of the total population.

Economics

New Hanover County has a service based economy that has benefited from an influx of permanent residents, and a thriving tourism industry. The service sector includes banking/finance, real estate, insurance, healthcare, and related commercial businesses. The percentage of the workforce employed in social services (defined as educational services, healthcare, or social assistance) is 13percent, with the highest percentage of individuals working in the Finance-Insurance-Real Estate industry (24 percent), followed by Construction (15 percent).

With numerous notable attractions located in its borders and nearby, tourism is a critical component of the New Hanover County and Carolina Beach economy. In addition to miles of beaches, the county possesses numerous access points to the Intercostal Waterway, which is popular for recreational fishing and boating related activities.

Income

On average, the socioeconomic composition of New Hanover County and Carolina Beach is higher than the remainder of North Carolina. The median household income are $51,232 and $37,662 respectively for the county and town, while the State average is $48,256. The per capita income in New Hanover County and Carolina Beach are $31,708 and $24,182 respectively, the State average being $25,774.

Executive Order 12898 states that the Federal Government would review the effects of its proposed actions on low income communities. Federal agencies are "to the greatest extent practicable and permitted by law" identify and address "as appropriate, disproportionately high and adverse human health and environmental effects of its programs, policies and activities on minority populations and low-income populations in the United States."

The USACE evaluated potential project impacts of the proposed project and found that any of the three alternatives would not cause disproportionately high and adverse impacts on minority populations or low income populations. No impacts to either minority/low-income populations or low income communities are anticipated as a result of the Proposed Action; therefore the action would comply with EO 12898.

Alternative 1 (No Action): In absence of a project, the probability of damages to existing structures increases, increasing potential adverse impacts to the existing tax base and impacts to commercial and public entities.

Alternative 2 (Recommended Plan): This alternative would continue economic growth. Also, this alternative will minimized damages to residential, public and commercial structures, as well as reduction of damages to critical infrastructure.

Alternative 3 (Borrow Area B): This alternative would continue economic growth. Also, this alternative will minimized damages to residential, public and commercial structures, as well as reduction of damages to critical infrastructure.

7.8.1 Aesthetic and Recreational Resources

All project area beaches are available for a multitude of recreation activities—swimming, surfing, wading, walking, sightseeing, picnicking, sunbathing, surf fishing, jogging, and so on. The total environment of barrier islands, beaches, ocean, estuaries, and inlets attract many residents and visitors to the area to enjoy the total aesthetic experience created by the sights, sounds, winds and ocean sprays. The Carolina Beach Fishing Pier is located in the project area and are considered important recreational facilities. During fall months, recreational surf fishing is a popular activity. These ocean piers, private recreational vessels, and charter boats that use the near-shore waters also contribute to the local economy.

A scenic setting is provided by the ocean and sound, coastal beaches, and the numerous vessels common to these waters, including commercial and recreational boats. The marine environment provides opportunities for boating and fishing.

Alternative 1 (No Action): This alternative would have an adverse, long-term detrimental effect on aesthetic and recreational resources due to beach erosion.

Alternative 2 (Recommended Plan): Renourishments are planned to be completed between November 16 and April 30, thereby avoiding the peak summer tourist season. When work activities in any area are completed, aesthetic values and recreational opportunities would be restored or enhanced as construction equipment is moved away.

Placement of beach fill would result in temporary use of a dredge pipeline, bulldozers, and other equipment on the beach. These objects would detract from the normal appearance of

the beach as well as create elevated levels of noise, vibration, lighting, etc. within the construction area. Also, recreational activities on beaches, including Freeman Park (pipeline route), may experience some interruption or interference during work periods, but the degenerated, eroded conditions of the beaches already present recreational constraints. After work is completed on a beach and the heavy equipment is removed, the resulting wider beach would be expected to represent an aesthetic enhancement and an improvement for recreation.

The inlet navigability would be significantly affected in the short term when the dredge, barge, tug and crew boats associated with the work would be on-site during renourishment events. As a result, recreational boating navigability would be impacted.

This alternative would result in an overall, short-term minor adverse and long-term beneficial effects on aesthetic and recreational resources. Implementing the Recommended Plan could cause temporary reduction of aesthetic appeal and interference with recreational activities in the areas of work.

Alternative 3 (Borrow Area B): Renourishments are planned to be completed between November 16 and April 30 if a cutterhead is used, December 1 to April 30 if by hopper dredge, thereby avoiding the peak summer tourist season. As compared to the Recommended Plan, total work time will be longer, about 44 days (versus 30 days with Recommended Plan), 82 days if a hopper dredge is used, increasing short-term impacts to aesthetic and recreational resources. Also, since the pipeline would not be running through Freeman Park, impacts to aesthetic and recreational resources would be less than the Recommended Plan. Other impacts of this alternative would be similar to the Recommended Plan. This alternative would result in overall, short-term minor adverse and long-term beneficial effects on aesthetic and recreational resources.

7.8.2 Commercial and Recreational Fishing

Commercial and recreational fishermen extensively utilize the nearshore marine and estuarine waters of North Carolina's northeast coast on a year-round basis. The USACE maintains navigation channels in Pamlico Sound and Hatteras Inlet that are actively fished, or provide passage to other waters, including the Atlantic Ocean. In addition, recreational surf fishermen frequently utilize area beaches.

Recreational fishing includes fishing from head boats, charter boats, private boats, piers, and the surf. Fishing from head boats is best in the winter months for snapper and grouper. Fishing from charter boats is excellent for king mackerel and bottomfish during the winter. Offshore, gulfstream species, like yellowfin tuna and wahoo are available. Inside fishing has been successful for inshore species such as red drum, speckled trout, and flounder.

Private boat anglers can find bluefin tuna in the nearshore area, king mackerel, and other bottomfish species in the offshore, and other species such as speckled trout, red drum, and flounder can be found in the inside areas of the creeks and AIWW.

Alternative 1 (No Action): As the inlet naturally shoals in, navigation may be restricted to shallower draft fishing boats. Boats not able to safely navigate may have to access the ocean through Masonboro Inlet. Impacts from shoaling may be reduced through maintenance of the Carolina Beach Inlet Federal navigation project, as federal funding allows. This alternative may result in long-term moderate negative effects to commercial and recreational fishing.

Alternative 2 (Recommended Plan): During inlet dredging, fishing boat traffic would be temporarily delayed; however during past dredging work in the inlet, boat traffic has been allowed to periodically navigate through the work area. Once dredging is completed, area mariners would benefit from the restored safe navigation conditions in the channel. Because each renourishment is expected to have a short duration (30 days), impacts to fishing should be minimal.

Alternative 3 (Borrow Area B): This alternative would not impede any boat traffic through the inlet. Because each renourishment is expected to be of relatively short duration (about 44 days for a cutterhead or 82 days for a hopper dredge), impacts to commercial and recreational fishing should be minimal.

7.9 Cultural Resources

The lower Cape Fear region was explored by the French and Spanish in the 16th century and by the English in the 17th century. The first permanent settlement of the area was made by the English in 1664 on the west bank of the river near Town Creek. This site was deserted three years later. In 1725 Brunswick Town was founded on the west bank of the river, and in 1732 Wilmington was established. Wilmington rapidly developed into a shipping center for lumber, naval stores, and rice. By 1800 it was the largest city in North Carolina, and it soon became one of the major world port for shipping tar and turpentine. The lower Cape Fear region played an active and important part in the Civil War, primarily because of the strategic value to the Confederacy of the port facilities at Wilmington. Fort Fisher, located at the southern tip of the peninsula between the Atlantic Ocean and the Cape Fear River, was developed beginning in 1861 to fortify the approach to Wilmington for the Confederacy. The fort was captured during the battle on 15 January 1965.

Because of its rich cultural history, the lower Cape Fear region today holds significant remnants of the past. Both Brunswick Town and Fort Fisher are State Historic Sites and are listed on the National Register of Historic Places. Artifacts from the area are displayed at the Fort Fisher Museum, and many others are found by relic collectors.

In order to assure that cultural resources are adequately documented and that potential project impacts are adequately assessed, cultural resource reconnaissance and surveys have been conducted in areas of potential project impact. Survey work has primarily consisted of magnetic remote sensing surveys which have identified target areas to be avoided. The Cape Fear Civil War Shipwreck District occurs in and near the project area. The District's Carolina

Beach Unit, consists of four blockade-runners (Venus, Lynx, Hebe, and Duoro) lost along the beach halfway between New Inlet and Masonboro Inlet. The District's New Inlet Unit consists of seven wrecks with located at the mouth of the inlet off Fort Fisher with an eighth found on the inside of the inlet where it meets the Cape Fear River Channel (Modern Greece, CSS Raleigh, Condor, Louisiana, Arabian, USS Aster, Stormy Petrel, and an Unknown Vessel). Between these two Units and north of Fort Fisher, an isolated wreck (General Beauregard) exists.

Previously completed upland surveys in the project area have documented occupations ranging from prehistoric Indian settlements through modern recreational use. Unfortunately, wind, water, and human induced erosion have destroyed most sites, reducing them to collections of scattered artifacts of negligible value.

All identified shipwrecks and archaeological sites eligible or potentially eligible for listing on the National Register of Historic Places will not be affected by the proposed project. In order to achieve full compliance with Section 106 of the National Historic Preservation Act of 1966 and the Abandoned Shipwreck Act of 1987, the proposed action will be coordinated with the North Carolina State Historic Preservation Office.

Alternative 1 (No Action): No known archeological resources are above MHW in the project area that could be exposed due to beach erosion; however, potential, currently unidentified resources would continue to be vulnerable to natural processes.

Alternative 2 (Recommended Plan): Construction activities have the potential to encounter buried shipwrecks during dredging, but all known sites near the borrow area have been documented and will be avoided. All locations identified as acceptable options for beach access for pipeline, pipe staging areas, location of pipeline routes, and offshore anchoring will be coordinated with the NC Office of State Archaeology. Contractors shall be made aware that in the event unknown resources are encountered, work in that area shall cease until assessment and consultation by the USACE and North Carolina Office of State Archeology has been completed. No effect to historic properties is anticipated for renourishment activities.

Alternative 3 (Borrow Area B): The placement of sand on beaches and the use of sand from underwater borrow sites are typically subjected to archaeological investigations in order to locate potentially significant resources. Since the proposed action would not impact any new submerged borrow areas or terrestrial placement areas, only areas that have been previously coordinated with the North Carolina State Historic Preservation Office (SHPO), the proposed beach renourishment action would have no effect on cultural resources. National Historic Preservation Act Section 106 coordination for the project area was initially completed under the 1981 *Final Environmental Impact Statement, Beach Erosion Control and Hurricane Wave Protection, Carolina Beach and Vicinity, New Hanover County, North Carolina*. Revisions to borrow areas were addressed in the 1992 Environmental Assessment and Finding of No

Significant Impact for the project of the same name. The SHPO concurred that these borrow area revisions would have no effect on cultural resources.

7.10 Noise

Noise is a prominent feature in the study area because of the sound of the breakers and at times, tourists and traffic on the beach. The sounds of breakers are tranquil and add to the pleasure experienced by visitors. No large manufacturing, industrial, or mining-type operations are located nearby. There are no airports or other area establishments or entities that produce unbearable noise levels on the community.

Any harbor or open-water coastal environment has a number of underwater ambient noise sources such as commercial and recreational vessel traffic, dredges, wharf/dock construction (e.g., pile driving), natural sounds (e.g., storms, biological), and so on. To better assess potential species effects (i.e., disturbance of communication among marine mammals) associated with dredge specific noise from navigation maintenance, deepening, or borrow area dredging operations, Clarke et al. (2002) performed underwater field investigations to characterize sounds emitted by bucket, hydraulic cutterhead, and hopper dredge operations. A summary of results from the study are presented below and are a first step toward developing a dredge sounds database that will encompass a range of dredge plant sizes and operational features:

Cutterhead Suction Dredge

Noise generated by a cutterhead suction dredge is continuous and muted and results from the cutterhead rotating within the bottom sediment and from the pumps used to transport the effluent to the placement area. The majority of the sound generated was from 70 to 1,000 hertz (Hz) and peaked at 100 to 110 decibel (dB) range. Although attenuation calculations were not completed, reported field observations indicate that the cutterhead suction dredge became almost inaudible at about 500 meters (Clarke et al., 2002).

Hopper Dredge

The noise generated from a hopper dredge is similar to a cutterhead suction dredge except there is no rotating cutterhead. The majority of the noise is generated from the dragarm sliding along the bottom, the pumps filling the hopper, and operation of the ship engine/propeller. Similar to the cutterhead suction dredge, most of the produced sound energy fell within the 70- to 1,000-Hz range; however peak pressure levels were at 120 to 140 dB (Clarke et al., 2002).

Alternative 1 (No Action): This alternative would have no effect on noise.

Alternative 2 (Recommended Plan): This alternative would renourish Carolina Beach approximately every three years, taking about 30 days for each event. Noise in the outside environment associated with beach renourishment activities would be expected to minimally exceed normal ambient noise in the project area, however, construction noise would be

attenuated by background sounds from wind and surf. Though in-water noise would be expected in association with the dredging activities for this project, no injurious effects would be expected because, as discussed above, the significance of the noise generated by the dredging equipment is relatively low and would dissipate with an increasing distance from the noise source.

Alternative 3 (Borrow Area B): Although the noise impacts for renourishment events would last about 44 days, 82 if a hopper dredge is used, the distance to Borrow Area B from Carolina Beach would dissipate noise generated by the dredging equipment to a greater extent as compared with the Recommended Plan. The effects of in-water noise associated with Alternative 3 would be similar to the Recommended Plan. No injurious noise effects would be expected with implementation of this alternative.

7.11 Hazardous, Toxic and Radioactive Wastes (HTRW)

A review of the EPA Superfund National Priorities List identified three sites in New Hanover County. All three were over five miles inland.

USACE standard tiered approach for analyzing the potential for encountering contaminated sediment in the potential borrow areas was used to assess the potential borrow areas for HTRW. According to that analysis, before any chemical or physical testing of sediment would be conducted, a reason to believe that the sediment could be contaminated must be established. The sources of the sediment in the selected borrow areas are derived from sediment transport and deposition by ocean currents. The probability of the areas being contaminated by pollutants is low.

The bottom sediment that would be dredged from the borrow areas and placed on the beach would consist of predominately fine- to medium-grain size sand with some shell. Therefore, no further analyses or physical and chemical testing of the sediment is recommended. It would not be expected that any hazardous and toxic waste sites would be encountered during construction or periodic renourishment. However, if any hazardous and toxic waste sites are identified, response plans and remedial actions would be the responsibility of the local sponsor.

Alternative 1 (No Action): This alternative would have no effect to HTRW.

Alternative 2 (Recommended Plan): Since no HTRW exists in the project area, this alternative would have no effect on HTRW and no HTRW would be produced with implementation of the Recommended Plan.

Alternative 3 (Borrow Area B): Impacts are the same as the Recommended Plan.

7.12 Summary of Notable Environmental Differences

The table below is a summary of the environmental resources with the greatest impact differences of the Recommended Plan and Alternative 3.

Table 7.8. Summary of Notable Environmental Differences

	Alternative 1 (No Action)	Alternative 2 (Inlet Borrow Source)	Alternative 3 (Offshore Borrow Source)
Dredging Days	0 dredging days	1 Cutterhead: 30 dredging days	1 Cutterhead: 44 dredging days 1 Hopper: 82 dredging days
Benthic Impacts	No impacts	Same 41 acres each renourishment	▪ 123 acres each renourishment ▪ Cumulative impacts to borrow area due to dual use with Area South project
Threatened and Endangered Species	Erosion causing impacts to sea turtle nesting critical habitat, piping plover and red knot foraging, sheltering, roosting and nesting habitat and seabeach amaranth habitat.	No impacts from pipeline dredging operations. Beach nourishment reduces erosion and protects habitat for sea turtle nesting, piping plover nesting and red knot foraging and seabeach amaranth.	Use of hopper dredge results in increased chance of collision with NARW and other marine mammals and increased chance of sea turtle and sturgeon entrainment. Beach nourishment reduces erosion and protects habitat for sea turtle nesting, piping plover nesting and red knot foraging and seabeach amaranth.
Dredging Noise	No impacts	30 days of dredging noise per renourishment	44 - 82 days of dredging noise per renourishment

7.13 Cumulative Impacts

The Council on Environmental Quality (CEQ) defines cumulative impact as:

*The impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (*40 CFR 1508.7).

For the purposes of this analysis, proposed projects, as well as potential navigation dredged material placements, were considered in order to make full disclosure of potential impacts. Many of these projects may never occur for lack of permitting, funding, environmental clearances, or other factors. The assessment of cumulative effects focused on effects of the following on important coastal shoreline resources.

1) existing Beach Renourishment projects
2) proposed future Beach Renourishment continued maintenance
3) Federal (USACE) Navigation Beach Placement (placing navigation maintenance sediment on beaches)
4) existing and potential offshore borrow sites

Alternative 1 (No Action): The No Action Alternative is where no Federal participation in renourishment occurs. This alternative would cause erosion of the beach and dunes, and increase the risk of coastal storm damage to homes, businesses and infrastructure of Carolina Beach. Significant impacts to NED, RED, EQ and OSE would be expected.

Actions Affecting Beach Resources: Sources of beach impacts include local beach maintenance activities (i.e. beach renourishment, beach scraping, sand bags, etc.), placement of dredged material from maintenance of navigation channels, and beach renourishment (berm and dune construction with long-term periodic maintenance).

Local Maintenance Activity: Under the existing condition the project area may be subjected to repeated and frequent maintenance disturbance by individual homeowners and local communities following storm events. These efforts are primarily made to protect adjacent shoreline property. Such repairs consist of dune rebuilding using sand from beach scraping and/or upland fill. Limited fill and sandbags are generally used to the extent allowable by Coastal Area Management Act permits. These maintenance efforts could keep the natural resources of the barrier island ecosystems from re-establishing a natural equilibrium with the dynamic coastal forces in some limited areas.

7.13.1 Non-Federal Beach Renourishment

Several local beach renourishment efforts have been conducted or are in the permitting process throughout NC (Table 7.9). The number of locally funded beach renourishment

activities has increased substantially in the last 20 years as local communities continue to seek avenues for restoring severely eroding shorelines. Though non-Federal beach renourishment efforts continue to increase, many of these projects are being pursued as one-time interim efforts until the Federal beach renourishment projects can be implemented. Therefore, this increase in permitted non-Federal projects does not necessarily reflect a subsequent increase in resource acreage impacts. Many of the non-Federal projects occur within the limits of Federal projects which are already authorized but un-funded (i.e. Dare County Beaches) or projects which are under study (i.e. Carolina Beach). Beaches that have been nourished pursuant to State and Federal permits, or have submitted a permit application to be nourished, are provided in Table 7.8. Individually, these projects total approximately 97 miles of beach or 32 percent of North Carolina beaches.

7.13.2 Federal (USACE) Beach Renourishment

Federal beach renourishment activities typically include the construction and long-term (50-year) maintenance of a berm and dune. The degree of cumulative impact would increase proportionally with the total length of beach renourishment project constructed. The first Federal North Carolina beach renourishment projects were constructed at Carolina and Wrightsville Beaches in 1965, and totaled approximately 6.4 miles. An additional 3.8 miles of Federal beach renourishment project was constructed in 1998 at Kure Beach. In 2004, a coastal storm risk management project along 14 miles of Dare County Beaches was authorized, but has not yet been constructed. Topsail, Surf City and North Topsail Beaches, as well as Bogue Banks have authorized federal CSRM projects, but have not been funded for construction. Funding has been provided for planning, engineering and design (PED) of the Bogue Banks project. Only Carolina Beach and Wrightsville Beach are currently under study by the Wilmington District (Table 7.10). Considering all existing and proposed Federal and non-Federal renourishment projects, and recognizing that some of the projects are overlapping or represent the same project area, approximately 112 miles or 37 percent of the North Carolina coast could eventually have private or Federal beach renourishment projects.

Table 7.9. Summary of non-Federal beach renourishment projects in North Carolina that have recently occurred, are currently underway, or will occur in the reasonably foreseeable future. This list does not include small scale beach fill activities.

Federal/ Non-Federal	Project	Source of Sand for Renourishment	Beachfront Nourished	Approximate Length of Shoreline (miles)	Approximate Straight-line Distance From the Project Area (miles)
Non-Federal	*Town of Kill Devil Hills – Beach Renourishment Project	Offshore Borrow Areas	Kill Devil Hills	4	179.6
	*Town of Nags Head – Beach Renourishment Project	Offshore Borrow Areas	Nags Head	10	177.4
	Emergency Highway 12 Mirlo Beach in Rodanthe NC	Offshore Borrow Area	Southern Pea Island to Mirlo Beach	2	162.4**
	*Bogue Banks FEMA Project	USACE ODMDS-Morehead City Port Shipping Channel	Emerald Isle (2 segments), Indian Beach, Salter Path, Pine Knoll Shores	13	64.7**
	*Bogue Banks Restoration Project - Phase I- Pine knoll Shores and Indian Beach Joint Restoration	Offshore Borrow Areas	Pine Knoll Shores and Indian Beach	7	69.1**
	*Bogue Banks Restoration Project- Phase II – Eastern Emerald Isle	Offshore Borrow Areas	Indian Beach and Emerald Isle	6	62.7**
	*Emerald Isle FEMA Project	USACE ODMDS-Morehead City Port Shipping Channel	Emerald Isle	4	61
	*Emerald Isle “Hotspots” FEMA Project	USACE ODMDS-Morehead City Port Shipping Channel	Emerald Isle	7	61

*Projects which may utilize the same borrow sources and/or overlap beach placement locations.

**Distance measured from midpoint between the projects.

Table 7.9 continued. Summary of non-Federal beach renourishment projects in North Carolina that have recently occurred, are currently underway, or will occur in the reasonably foreseeable future. This list does not include small scale beach fill activities.

Federal/ Non-Federal	Project	Source of Sand for Renourishment	Beachfront Nourished	Approximate Length of Shoreline (miles)	Approximate Straight-line Distance From the Project Area (miles)
Non-Federal	*Bogue Banks Restoration Project - Phase III- Bogue Inlet Channel Realignment Project	Bogue Inlet Channel	Western Emerald Isle	5	55.9
	*North Topsail Dune Restoration (Town Of North Topsail Beach)	Upland borrow source near Town of Wallace, NC	North Topsail Beach	NA	29.5
	*North Topsail Beach Shoreline Protection Project	New River Inlet Realignment and Offshore Borrow Area	North Topsail Beach	11	29.5
	*Topsail Beach – Beach Renourishment Project	Disposal Island	Topsail Beach	6	18.2
	*Topsail Beach – Beach Renourishment Project	New Topsail Inlet	Topsail Beach	6	18.2
	Rich Inlet Management Project	Relocation of Rich Inlet	Figure Eight Island	NA	14.2
	Figure Eight Island	Banks Channel and Nixon Channel	North & South Sections of Figure Eight Island	3	11.7

*Projects which may utilize the same borrow sources and/or overlap beach placement locations.

**Distance measured from midpoint between the projects.

Table 7.9 continued. Summary of non-Federal beach renourishment projects in North Carolina that have recently occurred, are currently underway, or will occur in the reasonably foreseeable future. This list does not include small scale beach fill activities.

Federal/ Non-Federal	Project	Source of Sand for Renourishment	Beachfront Nourished	Approximate Length of Shoreline (miles)	Approximate Straight-line Distance From the Project Area (miles)
Non-Federal	Masons Inlet Relocation Project	Masons Inlet (new channel) and Masons Creek	North end of Wrightsville Beach and south end of Figure Eight Island	2	9.4
	*New Hanover County Beaches- Beach Renourishment	TBD	Wrightsville Beach, Carolina Beach, Kure Beach	TBD	1.3**
	Bald Head Island Creek Project	Bald Head Creek	South Beach	0.4	20
	Bald Head Island – Beach Renourishment	Offshore Borrow Area (Jay Bird Shoals)	West and South Beach of Bald Head Island	4	20
	Bald Head Island- Terminal Groin and Beach Renourishment	Offshore Borrow Area (Jay Bird Shoals)	Terminal Groin Fillet	NA	20
	*Holden Beach- Terminal Groin and Beach Renourishment	Unconstructed	Holden Beach w/in vicinity of Lockwoods Folly Inlet	TBD	26.9
	*Holden Beach Interim Beach Renourishment	Offshore Borrow Area	Holden Beach	4	29.3
	*Holden Beach East & West	Upland Borrow Source (Truck Haul)	Extension of 933 Project	3	29.3
	*Ocean Isle- Terminal Groin and Beach Renourishment	Unconstructed	Ocean Isle Beach w/in vicinity of Shallotte Inlet	TBD	34.9

*Projects which may utilize the same borrow sources and/or overlap beach placement locations.

**Distance measured from midpoint between the projects.

Table 7.10. Summary of Federal beach renourishment projects in North Carolina that have recently occurred, are currently underway, or will occur in the reasonably foreseeable future. This list does not include small scale beach fill activities.

Federal/Non-Federal	Project	Constructed?	Source of Sand for Renourishment	Beachfront Nourished	Approximate Length of Shoreline (miles)	Approximate Straight Line Distance From the Project Area (miles)
Federal	*Dare County Beaches, NC Bodie Island (CSRM)	No	Offshore Borrow Areas	Kitty Hawk and Nags Head Beaches	14	179**
	*Dare County Beaches, NC Hatteras to Ocracoke Portion	No	NA	Hatteras and Ocracoke Island (Hot Spots)	10	131.4
	*Cape Lookout National Seashore-East Side of Cape Lookout Lighthouse	Yes	Channel	East Side of Cape Lookout Lighthouse	1	83.9
	Beaufort Inlet Dredging-Section 933 Project (Outer Harbor)	Yes	Beaufort Inlet Outer Harbor	Indian Beach, Salter Path, and Portions of Pine Knoll Shores	7	78.6**
	*Morehead City Harbor, NC Deep Draft Navigation Project	Yes	Cutoff Channel	Atlantic Beach	1.1	77.5

*Projects which may utilize the same borrow sources and/or overlap beach placement locations.

**Distance measured from midpoint between the projects.

Table 7.10 continued. Summary of Federal beach renourishment projects in North Carolina that have recently occurred, are currently underway, or will occur in the reasonably foreseeable future. This list does not include small scale beach fill activities.

Federal/Non-Federal	Project	Constructed?	Source of Sand for Renourishment	Beachfront Nourished	Approximate Length of Shoreline (miles)	Approximate Straight Line Distance From the Project Area (miles)
Federal	Beaufort Inlet and Brandt Island Pumpout- Section 933 (Dredged Material Placed on Eastern Bogue Banks)	Yes	Beaufort Inlet Inner Harbor and Brandt Island Pumpout	Fort Macon and Atlantic Beach	4	76.2**
	*Bogue Banks, NC (CSRM)	No	Offshore Borrow Areas	Communities of Bogue Banks	24	73
	*Surf City and North Topsail Beach- (CSRM)	No	Offshore Borrow Areas	Surf City and North Topsail Beach	10	38.8
	*West Onslow Beach New River Inlet (Topsail Beach) (CSRM)	No	Offshore Borrow Areas	Topsail Beach	6	29.2
	*Wrightsville Beach (CSRM)	Yes	Masonboro Inlet and Banks Channel	Wrightsville Beach	3	6.5

*Projects which may utilize the same borrow sources and/or overlap beach placement locations.

**Distance measured from midpoint between the projects.

Table 7.10 continued. Summary of Federal beach renourishment projects in North Carolina that have recently occurred, are currently underway, or will occur in the reasonably foreseeable future. This list does not include small scale beach fill activities.

Federal/ Non-Federal	Project	Constructed?	Source of Sand for Renourishment	Beachfront Nourished	Approximate Length of Shoreline (miles)	Approximate Straight Line Distance From the Project Area (miles)
Federal	*Carolina Beach and Vicinity, NC Carolina Beach Portion (CSRM)	Yes	Carolina Beach Inlet	Carolina Beach	2	6.5
	*Carolina Beach and Vicinity, NC Area South Portion (CSRM)	Yes	Wilmington Harbor Confined Disposal Area 4 and an Offshore Borrow Area	Kure Beach	2	9.2
	*Wilmington Harbor, NC	Yes	Inner Ocean Bar – Smith Island and Bald Head-1 and 2	Bald Head Island – West and South Beach	2.8	20
	*Wilmington Harbor, NC	Yes	Inner Ocean Bar – Smith Island and Bald Head-2	Caswell Beach and Oak Island	4.4	21.6**
	Wilmington Harbor Deepening (Section 933 Project) – Sand Management Plan	Yes	Wilmington Harbor Ocean Entrance Channels	Bald Head Island, Caswell Beach, Oak Island	4	20.6**

*Projects which may utilize the same borrow sources and/or overlap beach placement locations.

**Distance measured from midpoint between the projects.

Table 7.10 continued. Summary of Federal beach renourishment projects in North Carolina that have recently occurred, are currently underway, or will occur in the reasonably foreseeable future. This list does not include small scale beach fill activities.

Federal/Non-Federal	Project	Constructed?	Source of Sand for Renourishment	Beachfront Nourished	Approximate Length of Shoreline (miles)	Approximate Straight Line Distance From the Project Area (miles)
Federal	Oak Island Section 1135- Sea Turtle Habitat Restoration	Yes	Upland Borrow Area- Yellow Banks	Oak Island	2	23
	*Brunswick County Beaches, NC - Oak Island Caswell, and Holden Beaches (CSRM)	No	Offshore Borrow Areas – Frying Pan Shoals	Caswell Beach, Oak Island, Holden Beach	30	24.7**
	Holden Beach (Section 933 Project)	Yes	Wilmington Harbor Ocean Entrance Channels	Holden Beach	2	29.3
	*Ocean Isle Beach, NC (CSRM)	Yes	Shallotte Inlet	Ocean Isle Beach	2	35.8

*Projects which may utilize the same borrow sources and/or overlap beach placement locations.

**Distance measured from midpoint between the projects.

7.13.3 Federal (USACE) Navigation Channels - Beach Placement

Maintenance material from dredging the AIWW, inlets, and connecting channels in the vicinity of the study area has historically been disposed within approved disposal limits along the beach (Table 7.11). Throughout North Carolina, a total of approximately 41 miles of beach (~14 percent of North Carolina beaches) are approved for disposal of beach quality dredged material from maintenance dredging of navigation channels. However, not all of these projects are routinely dredged and a majority of the authorized disposal limits are not fully utilized. Additionally, many of the approved disposal limits overlap with existing Federal or non-Federal renourishment projects. Therefore, without double counting for overlapping beach projects, navigation dredged material is placed along approximately 19 miles, or 6 percent of North Carolina beaches (Table 7.12). The Wilmington District currently uses about 50 percent of the length of beach in North Carolina that is approved for this purpose and does not anticipate significant increases in beach disposal in the foreseeable future.

Beach quality sand is a valuable resource that is highly sought by beach communities. When beach quality sand is dredged from navigation projects, it has become common practice of USACE to make this resource available to beach communities when applicable laws, regulations, funding and other considerations allow. Placement of this sand on beaches represents return of sediment to the littoral system.

Table 7.11. Summary of dredged material placement activities on the oceanfront beach associated with dredging of Federal Navigation Channels. Projects listed and associated placement locations and quantities may not be all encompassing and represent an estimate of navigation placement activities for the purposes of this cumulative impacts assessment. (Part 1 of 3).

PROJECT		PLACEMENT LOCATION	APPROVED PLACEMENT LIMITS	ESTIMATED ACTUAL PLACEMENT LIMITS	ESTIMATED QUANTITY (CY)
Outer Banks	Avon	Begins at a point 1.15 miles south of Avon Harbor and extends north 3.1 miles	3.1 miles (16,368 lf)	0.4 miles or 2,000 linear feet	<50,000 every 6 years
	Rodanthe	Extends from road to Rodanthe Harbor south 700' to south end of beach placement area (straight out from existing dirt road). North end at Wildlife Refuge Boundary (PINWR)	.91 miles (4,800 lf)	0.4 miles or 2,000 linear feet	<100,000 every 6 years
	Ocracoke Island	Begins at a point 5,000 linear feet south of Hatteras Inlet and extends southward about 3,000 linear feet	0.6 miles (3,000 lf)	0.4 miles or 2,000 linear feet	<100,000 every 2 to 3 years
	Rollinson (Hatteras)	Begins at a point 0.85 miles south of Hatteras Harbor and extends north 5.85 miles to a point north of Frisco, NC	5.85 miles (30,888 lf)	0.4 miles or 2,000 linear feet	<60,000 every 2 years
	Silver Lake (Teaches Holes/Ocracoke)	From a point 2,000' NE of inlet and extending approximately 2,000 linear feet (0.4 miles-Ocracoke Island)	0.4 miles (2,000 lf)	0.4 miles or 2,000 linear feet	<50,000 every 2 years
	Oregon Inlet	Pea Island National Wildlife Refuge (PINWR)	3 miles (15,840 lf)	1.5 miles or 7.920 linear feet	300,000 as needed
	Drum Inlet	Core Banks. From a point 2,000 feet on either side of inlet extending for 1 mile in either direction	2 miles (10,560 lf)	1 miles or 5,280 linear feet	298,000 initial, 100,000 for maintenance (Assume 8 year cycle)
Beaufort	*Morehead City (Brandt Island)	2,000 feet west of inlet, Fort Macon and Atlantic Beach to Coral Bay Club, Pine Knoll Shores	7.3 miles (38,300 lf)	5.2 miles or 27,800 linear feet	3.5 million every 8 years
	*AIWW Section I, Tangent B	Pine Knoll Shores, vicinity of Coral Bay	2 miles (10,560 lf)	0.4 miles or 2,000 linear feet	<50,000 every 5 years

* Navigation beneficial use of dredged material placement sites which may overlap with existing Federal or non-Federal beach renourishment projects.

Table 7.11 continued. Summary of dredged material placement activities on the oceanfront beach associated with dredging of Federal Navigation Channels. Projects listed and associated placement locations and quantities may not be all encompassing, but represent an estimate of navigation placement activities for the purposes of this cumulative impacts assessment. (Part 2 of 3).

PROJECT		PLACEMENT LOCATION	APPROVED PLACEMENT LIMITS	ESTIMATED ACTUAL PLACEMENT LIMITS	ESTIMATED QUANTITY (CY)
Swansboro	*AIWW Bogue Inlet Crossing Section I, Tangent H through F	Approx. 2,000 feet from inlet going east to Emerald Point Villas, Emerald Isle (Bogue Banks)	1 mile (5,280 lf)	0.4 miles or 2,000 linear feet	<100,000 every 2 years
Browns Inlet	AIWW Section II, Tangents F, G, H	Camp Lejeune, 3,000 feet west of Browns Inlet extending westward	1.58 miles (8,300 lf)	1 miles or 5,280 linear feet	<200,000 every 2 years
New River Inlet	*AIWW New River Inlet Crossing Section II, Tangents I & J, Channel to Jacksonville. Section III, tangents 1 & 2	N. Topsail Beach, 3,000 feet west of inlet extending westward to Maritime Way (Galleon Bay area)	1.5 miles (8,000 lf)	0.8 miles or 4,000 linear feet	<200,000 every 2 years
New Topsail Inlet (Hampstead)	*AIWW, Sect. III	Topsail Island, Queens Grant	0.5 miles (2,500 lf)	0.5iles or 2,500 linear feet	<50,000 every 6 years
	*AIWW, Topsail Inlet Crossing & Topsail Creek	Topsail Beach, from a point 2,000 feet north of Topsail Inlet	1 mile (5,280 lf)	0.4 mi or 2,000 linear feet	<75,000 every 2 years
Wrightsville Beach	AIWW Sect. III, Tang 11 & 12 Mason Inlet Crossing	Shell Island (north end of Wrightsville Beach) from a point 2,000 feet from Mason Inlet	0.4 miles (2,000 lf)	0.4 mi or 2,000 linear feet	<100,000
	*Masonboro Inlet Sand Bypassing	At a point 9,000 feet from jetty extending southward midway of island	1.2 miles (6,000 lf)	1 mile or 5,280 linear feet	500,000 every 4 years

* Navigation beneficial use of dredged material placement sites which may overlap with existing Federal or non-Federal beach renourishment projects.

Table 7.11 continued. Summary of dredged material placement activities on the oceanfront beach associated with dredging of Federal Navigation Channels. Projects listed and associated placement locations and quantities may not be all encompassing, but represent an estimate of navigation placement activities for the purposes of this cumulative impacts assessment. (Part 3 of 3).

PROJECT		PLACEMENT LOCATION	APPROVED PLACEMENT LIMITS	ESTIMATED ACTUAL PLACEMENT LIMITS	ESTIMATED QUANTITY (CY)
Carolina Beach	AIWW, Section IV, Tangent 1	Southern end of Masonboro Island at a point 2,000 linear feet from Carolina Beach Inlet extending northward to Johns Bay area	1.3 miles (7,000 lf)	0.4 miles or2,000 linear feet	<50,000 as needed
	AIWW, Section IV, Tangent 1	North end of Carolina Beach at Freeman Park	0.6 miles (3,000 lf)	0.6 miles or 3,000 linear feet	<50,000 every 2 years
Caswell Beach	*Caswell Beach	Beachfront on eastern end of island	4.7 miles (25,000 lf)	4.7 miles or 25,000 linear feet	1.1 million every 6 years
Bald Head Island	*Bald Head Island	Beachfront on eastern and western shoreline	3.0 miles (16,000 lf)	3.0 miles or 16,000 linear feet	1.1 million every 2 years (except every 6th when it goes to Caswell)
Oak Island	AIWW	Beachfront on eastern end of the shoreline	0.5 miles (2,500 lf)	0.5 miles or 2,500 linear feet	<50,000 every 2 years
Holden Beach	AIWW	Beachfront on eastern end of the shoreline	0.4 miles (2,000 lf)	0.4 miles or 2,000 linear feet	<50,000 every 2 years
Ocean Isle	AIWW	Beachfront on eastern end of the island within the vicinity of Shallotte Blvd	0.3 miles (1,600 lf)	0.3 miles or 1,600 linear feet	<50,000 every 2 years

* Navigation beneficial use of dredged material placement sites which may overlap with existing Federal or non-Federal beach renourishment projects.

Table 7.12. Summary of cumulative mileage of North Carolina Ocean beach that could be impacted by beach renourishment and/or navigation disposal activities.

Project Type	Total Miles Impacted (*w/o double counting for overlapping projects)	Percent NC Beach
Federal and Non-Federal Beach Renourishment	112	37
Federal Authorized Maintenance Beach Placement	19	6
TOTAL	**131**	**43**

7.13.4 Offshore Borrow Areas

The Recommended Plan for the Carolina Beach BRER borrow area is the Carolina Beach Inlet, Alternative 3 would use Borrow Area B. There are many possible sequences and methods for dredging and placing available material on the beach for the project and a site specific borrow area use plan has yet to be defined. Each renourishment interval will utilize varying components of the borrow site with a sequence of temporary impacts to benthic resources over the life of the project. Subsequent intervals of dredging within the borrow area may occur in portions not previously been dredged. This cyclic use of the borrow area would result in cumulative effects from space crowded perturbations on a local scale.

7.13.5 Statewide Impacts

Beach quality sediment identified for all Federal and non-Federal renourishment projects throughout North Carolina is most often identified from: upland sites, maintenance or deepening of navigation channels, inlets and/or offshore borrow areas (Tables 7.9 and 7.10). For the purposes of this impact assessment, only inlets and offshore borrow areas are evaluated for cumulative marine resource impacts considering that upland sources are outside of the marine environment and navigation channels are repeatedly dredged already in order to maintain navigability. This assessment also addresses both the impacts to the borrow site and to the beaches where the material is placed. Of all the projects listed with offshore borrow areas in Tables 7.9 and 7.10, there is currently only one Federal (Carolina Beach and Vicinity, NC Kure Beach portion) and four non-Federal (Bogue Banks FEMA, Bogue Banks Restoration Project – Phases 1&2, Bald Head Island Beach Renourishment, and Nags Head Beach Renourishment) offshore borrow sites that have received permits and/or authorizations and funding. Other offshore borrow areas identified for projects are either under study and have not been permitted and/or authorized or have received permits and/or authorizations but have not been funded or constructed. Considering only the projects that are currently in use, significant cumulative impacts associated with time and space crowded perturbations are not expected considering that these borrow areas are spread throughout the state and the acreage

of impact for these borrow areas relative to the available un-impacted sites throughout the state is relatively minimal.

The degree of cumulative impact would increase proportionally with the total length of beach impacted. The most likely projects to increase the length of North Carolina beach placement are beach renourishment projects.

Recognizing that many of the existing or proposed Federal and non-Federal beach renourishment project limits overlap and that some portions of the Federal approved beach disposal limits are within these project areas as well, Table 7.12 provides an estimate of total mileage of North Carolina ocean beach that could cumulatively be impacted by beach renourishment or navigation disposal activities without double counting the overlapping projects. Considering all proposed and existing disposal and renourishment impacts throughout the ocean beaches of North Carolina, a significant portion of the shoreline may have beach placement activities in the foreseeable future, likely resulting in time and space crowded perturbations. However, recognizing the funding constraints to complete all authorized and/or permitted activities, the availability of dredging equipment, etc; it is very unlikely that all of these proposed projects would ever be constructed all at once. Therefore, though time and space crowded perturbations are expected in the reasonably foreseeable future, assuming each project adheres to project related impact avoidance measures, it is likely that adjacent un-impacted and/or recovered portions of beach will be available to support dependent species (i.e. surf zone fish, shore birds, etc.) and facilitate recovery of individual project sites to pre-project conditions. Neither potential impacts to borrow sites nor to beaches on which the material is placed are likely to result in unacceptable Statewide impacts.

7.13.6 Conclusion

Historically, the extent of beach renourishment activities on North Carolina beaches was limited to a few authorized Federal projects including: Wrightsville Beach, Carolina and Kure Beaches, and Ocean Isle Beach. However, in the past 20 years, a significant number of Federal and non-Federal beach renourishment efforts were pursued to provide coastal storm risk management along the increasingly developed North Carolina shoreline. Additionally, the number of non-Federal beach renourishment projects has increased in recent years in efforts to initiate coastal storm risk management measures while awaiting authorization and funding of Federal projects (i.e. Bogue Banks, Dare County, North Topsail Beach, and Topsail Beach). Considering the extent of coastal development and subsequent vulnerability to long and short-term erosion throughout the North Carolina shoreline, it is possible that either the proposed Federal or non-Federal beach renourishment projects may be constructed in the future. Furthermore, the frequency of beach placement activities for protection of infrastructure will continue throughout the state resulting in cumulative time and space crowded perturbations.

Assuming projects continue to adhere to environmental commitments for the reduction of environmental impacts, and undeveloped beaches throughout the state continue to remain undisturbed, it is likely that adjacent unimpacted and/or recovered portions of beach will be

available to support dependent species (i.e. surf zone fish, shore birds, etc.) and facilitate recovery of individual project sites to pre-project conditions. Assuming recovery of impacted beaches and the sustainability of undeveloped protected beaches (i.e. National/Federal and State Parks and Estuarine Reserves) the potential impact area from the proposed and existing actions is small relative to the area of available similar habitat on a vicinity and statewide basis. Additionally, due to the widespread distribution and small acreage relative to the available unimpacted sites, the cumulative impacts to the borrow areas would be minimal.

8 PLAN IMPLEMENTATION

8.1 Project Schedule

Table 8.1 shows the current project schedule following an assumed December 2020 project authorization (WRDA) of the project. The schedule assumes expeditious review and approval of the project through all steps, including authorization and funding, and as such is subject to change.

Table 8.1. Carolina Beach CSRM Project, Current Project Schedule to First Renourishment

Activity	Date
Sign Amended Project Partnership Agreement	FEB 2021
Complete Real Estate Acquisition	JUN 2021
Complete Final Plans and Specs	JUN 2021
Award Construction Contract	AUG 2021
Begin First Renourishment	NOV 2021
Complete First Renourishment	APR 2022

8.2 Division of Plan Responsibilities

8.2.1 General

Federal policy requires that costs for water resources projects be assigned to the various purposes served by the project. These costs are then apportioned between the Federal Government and the non-Federal sponsor according to percentages specified in section 103 of the Water Resources Development Act (WRDA) of 1986 (P.L. 99-662). For projects that provide damage reduction to publicly owned shores, the purposes are usually (1) coastal storm damage reduction and (2) separable recreation. For the Carolina Beach & Vicinity, NC Coastal Storm Risk Management (CSRM) Project, there is no separable recreation component.

8.2.2 Cost Sharing

The Recommended Plan is to continue historic Federal participation in periodic renourishment using Carolina Beach Inlet. Continued use of the Carolina Beach Inlet would require an exemption from the provisions of CBRA for this project in the project's final Congressional authorization.

All project costs for the Recommended Plan are allocated to the purpose of hurricane and storm damage reduction. Cost sharing for initial construction would be 50 percent Federal/50 percent non-Federal consistent with requirements specified in Section 103(c)(5) of WRDA 1986 as amended by WRDA 1996. The Recommended Plan is only a continuation of Federal participation in periodic renourishment for a previously constructed project. As such, there are no initial project construction costs. Non-Federal interests are required to provide all lands,

easements, rights-of-way, relocations and disposal (LERRDs) necessary for placement of sand on the project. There is no value of the non-Federal portion of the LERRD because these requirements were satisfied when the project was initially constructed. This value will be adjusted in the final report subject to ongoing actions by the non-Federal sponsor to acquire a permanent easements across Freeman Park properties to place the dredge pipeline from the Carolina Beach Inlet to the northern end of the Carolina Beach CSRM project.

Cost sharing for periodic renourishment (continuing construction) would be consistent with Section 215 of WRDA 99, which requires that such costs be shared 50 percent Federal and 50 percent non-Federal. Annual beach fill monitoring is also considered part of continuing construction and would be cost-shared 50/50 as well.

Annual OMRR&R costs, such as inspection costs and dune vegetation maintenance costs, are 100 percent non-Federal responsibility. The Federal Government will prepare and provide an updated OMRR&R manual to the sponsor, if required.

As noted previously, current Federal policy requires, unless there are other overriding considerations, the NED plan would be the plan recommended for implementation. However, the non-Federal sponsor can request recommendation of a Locally Preferred Plan (LPP) that differs from the NED Plan if they are willing to pay 100 percent of the cost differential between the two plans. In this case, the non-Federal sponsor has not elected to pursue a LPP, therefore the Recommended Plan is the NED plan. Cost sharing for the Recommended Plan is shown in Table 8.2 at October 2018 (FY 2019) price levels.

As discussed in section 4.1.6, the non-Federal sponsor has already provided the required additional public accesses and parking requirements needed to support the determination of Federal interest in a CSRM project. The existing public accesses and parking areas have been validated as meeting USACE requirements.

All of these requirements may affect the cost sharing percentages of Federal and non-Federal partners. This issue is also re-visited prior to each renourishment, and cost sharing may be adjusted accordingly. Continued maintenance (of access for the public by both access corridors and public parking) is an especially important factor in ensuring funding of the project. The non-Federal sponsor for the Carolina Beach project is fully aware of all the factors potentially affecting cost sharing, and is wholly committed to meeting and maintaining these requirements in the future.

Table 8.2. Cost allocation and apportionment, First Costs, October 2018 (FY 2019) price levels.

Initial Project Construction Costs					
Project Purpose	Project First Cost	Apportionment (Percent)		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
Coastal storm risk management	N/A	N/A	N/A	N/A	N/A
LERRD credit	N/A	N/A	N/A	N/A	
Cash portion	N/A	N/A	N/A	N/A	N/A
Total Financial Initial Project Construction Costs					
Project Purpose	Project First Cost	Apportionment (Percent)		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
Coastal storm risk management	N/A	N/A	N/A	N/A	N/A
Total financial cost	N/A	N/A	N/A	N/A	N/A
Total Renourishment Costs					
Project Purpose	Total Cost (5 Renourish-ments)	Apportionment (Percent)		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
Coastal storm risk management	$45,300,000	50	50	$22,650,000	$22,650,000
	Cost Per Year	Apportionment (Percent)		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
Beach fill	$6,000	50	50	$3,000	$3,000
Annual OMRR&R Costs					
	Cost per year	Apportionment (Percent)		Apportionment $	
		Non-Federal	Federal	Non-Federal	Federal
General repair, maintenance, inspection	$95,000	100	0	$95,000	$0

8.2.3 Financial Analysis

To date, the non-Federal sponsor has demonstrated their ability to provide for any and all cost sharing requirements since this project was originally constructed in FY 1965. Cost sharing requirements are provided by the state of North Carolina and a hotel occupancy tax which is managed by New Hanover County. A non-Federal statement of financial capability will be provided to the USACE and included in the Integrated Final Report and Environmental Assessment.

8.2.4 Project Partnership Agreement

A model Project Partnership Agreement (PPA) establishes the responsibilities for project execution between the Federal Government and the non-Federal sponsor. The terms of local cooperation to be required in the PPA are described in Section 11, Recommendations. A Letter of Intent acknowledging this process and stating their intent to support project implementation will be obtained from Carolina Beach and included in the Integrated Final Report and Environmental Assessment.

Federal commitments regarding a construction schedule or specific provisions of the PPA cannot be made to the non-Federal sponsors on any aspect of the Recommended Plan or separable element until the following are true:

- The Recommended Plan is authorized in a Water Resources Development Act (WRDA) or similar legislation.

- Construction funds are appropriated, apportioned by the OMB, and their allocation is approved by the Assistant Secretary of the Army for Civil Works (ASA-CW)

- An draft amendment to the existing PPA has been reviewed and approved by the Assistant Secretary of the Army – Civil Works (ASA-CW)

In no case would the PPA be executed or construction initiated on the project until the Final EIS has been fully coordinated and a Record of Decision has been signed.

8.3 Views of the Non-Federal Sponsor

The non-Federal sponsor, the Town of Carolina Beach, fully supports the Recommended Plan. A letter of support is included in this draft Integrated Beach Renourishment Evaluation Report and Environmental Assessment.

9 STATUS OF ENVIRONMENTAL COMPLIANCE

9.1 National Environmental Policy Act (NEPA)

Prior to circulation of the Carolina Beach, Beach Renourishment Evaluation Report and Integrated Environmental Assessment, a scoping letter was sent out to local governments, State and federal resource agencies and stakeholders requesting comments to identify significant resources and issues of concern. Comments received were considered in the development of this report. A formal scoping meeting was conducted at the Carolina Beach Town Hall on March 6, 2018.

The Wilmington District will circulate the draft integrated report for a 30-day Public Review. All comments received will be addressed and will be considered in the development of the final report.

9.2 North Carolina Coastal Zone Management Program

The action addressed in this report will take place in the designated coastal zone of the State of North Carolina. Pursuant to the Federal Coastal Zone Management Act (CZMA) of 1972, as amended (P.L. 92-583), federal activities are required to be consistent to the maximum extent practicable with the federally approved coastal management program of the state in which their activities would be occurring.

Along with a copy of the draft integrated report/EA for Carolina Beach, the USACE will submit a separate consistency determination to the N.C. Division of Coastal Management (CAMA) in accordance with Section 307 (c) (l) of the Federal Coastal Zone Management Act of 1972, as amended.

Section 1102 (a) states that "clean, beach quality material from navigation channels within the active nearshore, beach, or inlet shoal systems must not be removed permanently from the active nearshore, beach or inlet shoal system unless no practicable alternative exists. Preferably, this dredged material will be disposed of on the ocean beach or shallow active nearshore area where environmentally acceptable and compatible with other uses of the beach." When considering a project's compliance with Section 1102, the NC Division of Coastal Management (NCDCM) has stated that the section should be read in concert with NCAC 7H.0208 (2)(G), which provides some flexibility for publicly funded projects, allowing them to be considered by review agencies on a case by case basis with respect to dredged material placement. Placement of dredged material associated with the proposed action will be done in accordance with this regulation with the majority of the clean, beach quality material (i.e., ≥90 percent sand) being placed on approved beach areas.

The Coastal Resources Commission designates areas as Areas of Environmental Concern to protect them from uncontrolled development, which may cause irreversible damage to

property, public health or the environment, thereby diminishing their value to the entire state. The following determinations have been made regarding the consistency of the proposed action with the State's management objective for each of the areas affected:

- **Public Trust Areas –** These areas include waters of the Atlantic Ocean and the lands there under from the mean high water mark to the 3-mile limit of state jurisdiction.

  Carolina Beach Inlet is located within these Public Trust Areas. Acceptable uses include those that are consistent with protection of the public rights for navigation and recreation, as well as conservation and management to safeguard and perpetuate the biological, economic, and aesthetic value of these areas. The activities that comprise the proposed action are not intended to adversely impact the public's right for navigation and recreation, and are consistent with conservation of the biological, physical, and aesthetic values of public trust areas.

- **Estuarine Waters –** Estuarine Waters are the state's oceans, sounds, tidal rivers and their tributaries, which stretch across coastal North Carolina and link to the other parts of the estuarine system: public trust areas, coastal wetlands and coastal shorelines.

  For regulatory purposes, the inland, or upstream, boundary of estuarine waters is the same line used to separate the jurisdictions of the Division of Marine Fisheries and the NC Wildlife Resources Commission. However, many of the fish and shellfish that spend part of their lives in estuaries move between the "official" estuarine and inland waters.

  Since the proposed project would dredge in the Carolina Beach Inlet, short-term adverse impacts to the estuarine and ocean system will take place.

- **Ocean Erodible –** The Ocean Erodible AEC covers North Carolina's beaches and any other oceanfront lands that are subject to long-term erosion and significant shoreline changes. The seaward boundary of this AEC is the mean low water line. The landward limit of the AEC is measured from the first line of stable natural vegetation and is determined by adding: a distance equal to 60 times the long-term, average annual erosion rate for that stretch of shoreline to the distance of erosion expected during a major storm. The width of the AEC varies from about 145 feet to more than 700 feet.

  The proposed action would not adversely affect oceanfront lands at Carolina Beach. In fact, the disposal of beach quality sand from the Carolina Beach Inlet onto Carolina Beach will reduce the erosion and storm damage potential.

- **Inlet Hazard –** This AEC covers the lands next to ocean inlets. Inlet shorelines are especially vulnerable to erosion and flooding and can shift suddenly and dramatically. For each inlet along the coast, the NC Division of Coastal Management prepares a hazard area map that is reviewed and approved by the NC Coastal Resources Commission. Each area is mapped based on a statistical analysis of inlet migration,

previous inlet locations, narrow or low lands near the inlet, and the influence of man-made features, such as jetties and channelization projects.

The lands adjacent are not part of the project area and are not inhabited, but the proposed project would help maintain and stabilize an open inlet.

9.3 Coastal Barrier Resources Act (CBRA)

This Beach Renourishment Evaluation Report (BRER) includes an evaluation of the use of the Carolina Beach Inlet as a borrow source, in addition to an evaluation of an offshore borrow source. Although the inlet borrow source cannot currently be used, the BRER and associated NEPA document may serve as the basis for obtaining Congressional authorization to use the inlet borrow source. Therefore, as explained in more detail below, this alternative is reasonable and should be evaluated.

The Carolina Beach Inlet is a man-made waterway opened in 1952, anecdotally by local fishermen using dynamite. Federal maintenance of the inlet for navigation purposes began in February 1982, and utilization of the inlet as a borrow source for coastal storm risk management projects began in 1967 and has continued to the present day.

The Coastal Barrier Resources Act (CBRA), enacted in October 1982, established resource units on undeveloped coastal barriers within which federal spending is restricted. Coastal Barrier Resources System (CBRS) Unit L09, established subsequent to the passage of the Act, includes the entirety of Carolina Beach Inlet. The Act includes exceptions that, if applicable, allow for federal expenditures within CBRS units. Utilization of the exceptions found at 16 U.S.C. § 3505(a)(6) requires consultation with the applicable resource agency, in this case the U.S. Fish and Wildlife Service of the Department of the Interior (DOI).

When environmental review and long-term cost sharing agreements were established for this project in 1993, the Wilmington District, U.S. Army Corps of Engineers, understood that the exception found at 16 U.S.C. § 3505(a)(6)(G) (nonstructural projects for shoreline stabilization that are designed to mimic, enhance, or restore a natural stabilization system) applied to the use of the borrow source for this project. Subsequently, the USFWS clarified that the DOI does not interpret this exception to be applicable in cases where sand is being removed from a CBRS unit and placed outside of the CBRS unit to perform shoreline stabilization functions. In order to align this project with DOI's current position, the Wilmington District has formulated an alternative that avoids use of the traditional inlet borrow source for all subsequent nourishments.

Initial environmental analyses, utilizing existing information about the inlet borrow source and new information gathered about the alternate borrow source, indicates that use of the inlet borrow source is environmentally preferable to the alternate (offshore) source and, furthermore, would conserve federal and non-federal funds. Therefore, the Wilmington District

will evaluate the inlet source as one of the potential borrow sources for the project, with the caveat that the use of this borrow source is not permitted unless the Congressional re-authorization of the Project allows for the use of federal funds to work within this borrow area notwithstanding the financial restrictions of CBRA. Without such Congressional authorization, the offshore borrow source alternative would be used for all future project re-nourishments.

While USACE does not typically consider alternatives that are outside the scope of current Congressional authority, it is reasonable to do so for the use of the Carolina Beach Inlet as a borrow source and the National Environmental Policy Act specifically allows for this type of consideration. In its *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations*, the Council on Environmental Quality (CEQ) explains that:

> An alternative that is outside the legal jurisdiction of the lead agency must still be analyzed in the [applicable NEPA document] if it is reasonable. A potential conflict with local or federal law does not necessarily render an alternative unreasonable, although such conflicts must be considered. *Section 1506.2(d)*. Alternatives that are outside the scope of what Congress has approved or funded must still be evaluated in the [NEPA document] if they are reasonable, because the [NEPA document] may serve as the basis for modifying the Congressional approval or funding in light of NEPA's goals and policies. *Section 1500.1(a)*.

The environmental benefits and cost savings associated with use of the inlet borrow source may be the basis for obtaining Congressional authorization to continue its use, notwithstanding the restrictions of CBRA. Consequently, the use of both the Carolina Beach Inlet and offshore borrow sources will be evaluated.

Designated map showing the Coastal Barrier Resources System in North Carolina indicates Unit L09 is located in the project area (Figure 9.1).

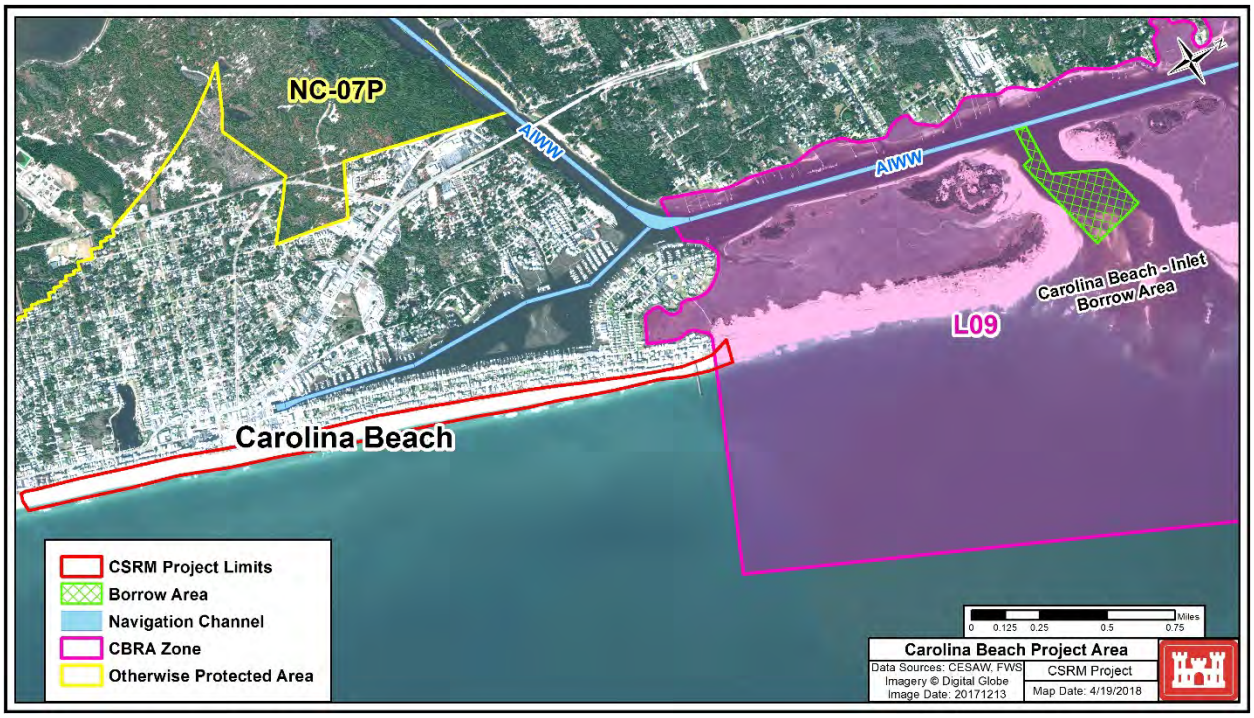


Figure 9.1. Project Area with CBRA Zone

10 CONCLUSIONS

The Recommended Plan is feasible on the basis of engineering and economic criteria and is acceptable by environmental, cultural and social laws and standards.

Based on findings described in this draft report, it is in the Federal interest to implement the proposed action. Continued use of the Carolina Beach Inlet would require an exemption from the provisions of CBRA for this project in the project's final Congressional authorization.

The Recommended Plan is supported by the non-Federal sponsor, the Town of Carolina Beach. The sponsor has the capability to provide the necessary non-Federal requirements identified and described in this report.

11 RECOMMENDATIONS

This study has addressed the needs for continued coastal storm risk reduction for the Town of Carolina Beach. The following recommendations include items for implementation by Federal, State of North Carolina, and local governments and agencies, including continuation of Federal participation of periodic renourishments for the Carolina Beach and Vicinity, NC CSRM Project, Carolina Beach Portion.

Hurricane Risk Education

Numerous people die each year as a result of hurricanes, primarily due to the failure to evacuate to an area of safety. Any loss of life is tragic, and any number of those deaths may have been prevented. Even one death prevented is sufficient reason to improve our methods of educating the public on hurricane and storm threats, and to ensure that all is done to warn all those residents or visitors to the coastline of North Carolina as to the dual hazards of wind and surge/waves. It is particularly vital to inform the public as to the potential for hurricane occurrence, particularly within the dangerous hurricane season, so they pay continued attention to media reports on weather. Education needs to include articulation of effects related to the potential magnitude of the threat, the urgency to heed potential calls to evacuate, and providing the means by which to make wise choices on evacuation methods and route (see recommendations given below under "Hurricane Evacuation Planning"). The following are suggested guidelines for implementation by state and local government, in the interests of good education on hurricane storm threats:

- Provide good science and information to the residents and visitors to coastal North Carolina, so they can understand the nature of the threat, and its possibility of happening at any time within the hurricane season. This information should be provided in both written form, and as an initial "page" on televisions provided in visitor's housing, and also in a variety of venues, including:
    - Posting and televised education in supermarkets, libraries, and public buildings;
    - Teacher-provided, posted and televised education in schools and at public meetings and gatherings, at intervals not to exceed 1 year;
    - Publically-posted and visitor-housing-posted information on evacuation routes, and procedures, on publicly-accessible websites, updated regularly (minimum 1 yr.).

There is nothing humanly possible to maintain the lives and safety of coastal North Carolina residents and visitors, if they do not have sufficient warning, and if they then do not use that knowledge to evacuate in a timely manner.

Education of hurricane risks is an on-going effort of multiple agencies and educational institutions, and not a funded program under existing USACE authorities. Updating of websites

containing evacuation routes and procedures should be done under existing programs implemented by the state and local governments.

Hurricane and Storm Warning

Residents and visitors to the coast of North Carolina need to recognize that they live in, or visit, a high-hazard area. Although certain times of the year pose less risk than others, each year's hurricane season provides a strong possibility of hurricane impact somewhere along the coast of North Carolina. All residents and visitors need to be made aware of the current hurricane threat, but first meteorological conditions must be evaluated, and any threat must be assessed and characterized by experts with the National Oceanic and Atmospheric Administration's National Weather Service, and that interpretation passed to national and local media for dissemination. Continued support of NOAA's program, and the following supportive activities is critical to an adequate warning process:

- On-going efforts to upgrade the existing system of NOAA buoys, transmission capabilities, and advanced warning measures that provide data on the location and nature of weather conditions.
- Efforts directed at the interpretation of that data and its dissemination to the media and public, through the National Weather Service.
- Public appreciation for the need to be aware at all times of, and the need to listen to weather reports and advice given on various media. Television weather reports, radio, and the internet all provide excellent up-to-date information on weather conditions, and the development of threatening situations. Simply living in or visiting the barrier islands of North Carolina should be sufficient to create a consistent and on-going process of being exceptionally aware of the weather, and its potential consequences. The vital importance of heeding the advice of experts. One should know what needs to be done in the event of an approaching storm. Family members should conduct evacuation drills, keep needed phone numbers and travel supplies on hand, and be prepared to leave on short notice. One should be aware of evacuation routes, keeping a full tank of gas during the hurricane season, and having a plan for where one should go, how to maintain contact with other family members, and where one will re-locate temporarily, particularly if this turns out to be longer than expected.

Hurricane Evacuation Planning Upgrading

The critical need for adequate evacuation planning was borne out by Hurricanes Bertha, Fran, and Floyd, of the late 1990's, and brought even more to the forefront by the monumental impacts of Hurricane Katrina in 2005. An evacuation plan is an essential component of a comprehensive plan for ensuring the safety of residents of, and visitors, to the coast of North Carolina. The preservation of life is the single most important goal and objective of the recommendations. Joint Federal Emergency Management Agency (FEMA)/ NOAA/Corps/State of North Carolina studies of evacuation routes and populations along the coastline has provided a tremendous amount of value to-date in aiding local government, individual and family

readiness, in the face of approaching events. Support for this program is a critical element of the recommendations for the Town of Carolina Beach, in support of its residents and visitors. The following are important recommendations in support of efforts to support Hurricane Evacuation Planning:

- There is still much that can be done to update this on-going effort, and to provide new, and more widely-disseminated data and tools for evacuation planning by the State and the Town of Carolina Beach, and also for use by individuals and families in their preparation for an impending event.
- Evacuation route signage is an important part of a successful evacuation campaign. Maintenance of hurricane evacuation route signage is viewed as a vital link in ensuring the safety of residents and visitors alike.
- The provision of additional signage illustrating surge height achieved during past events would be an added and continual link to on-going education efforts. This could take the form of signs placed in locations in which there is significant traffic, such as major thoroughfares, where pedestrians walk, and particularly in those highest hazard zones based on elevation/depth data.

Evacuation Planning is an on-going effort of multiple agencies, including USACE, but its implementation is not a funded program under existing USACE authorities. Updating of websites containing evacuation routes and procedures should be periodically updated under existing programs implemented by the State of North Carolina.

Floodplain Management

Management of the floodplain is a non-Federal responsibility, yet is considered a key component of all plans for hurricane and coastal storm risk management. The Town of Carolina Beach participates in the National Flood Insurance Program, which requires the Town to engage in active and responsible floodplain management. Since so much of the Town of Carolina Beach are within a recognized floodplain, the Town continues to engage in activities that reduce threats to existing and potential future development, including structure setbacks, building code and construction monitoring, and flood zone management. The Town is encouraged to continue to update building codes, and encourage strong pursuit of activities such as first-floor elevation and building code upgrading, in the effort to reduce the potential for future structural and content damage.

Building Codes

The Town of Carolina Beach has adopted the International Building Code (IBC) to guide the design and construction of residential and commercial structures in the study area. In order to assure that the latest design and construction techniques are being used that apply to hurricane-resistant construction, all future construction is encouraged to follow the latest version of the IBC (2007) and ensure enforcement of the codes through diligent building permit processing and on-site inspections of construction. Annual training classes on the use and

enforcement of the new IBC should be encouraged. In addition, the Town of Carolina Beach should consider adopting the document "FEMA 550 Guidelines for Elevating Residential Structures on the Gulf Coast" as a part of their updated building codes for construction, due to the possibility of surge inundation associated with hurricane events.

Long-term Critical Infrastructure and Services Upgrading

The upgrading of critical infrastructure and services, such as Fire and Police services, is considered a vital recommendation in the reduction of threats to lives and property. The need to bring these services up to immediate restoration in the wake of a hurricane is of vital importance to the community. The methodical upgrading of the Town's Fire and Police services facilities as part of their Capital Improvement Programs will provide long-term savings in capital outlay, and potentially save lives and residential and commercial property damage. This program may be instituted under a modified Capital Improvement Program, where structures reaching the end of their economic life are successively replaced by upgraded structures, locating vital communications and power supplies above the elevation of a Maximum Probable Surge event, and capable of surviving the ravages of wind and/or surge, as funds become available.

Upgrading or replacement of services is primarily a local charge, implemented through Capital Improvement Plans, with funding from a variety of Federal, state, and local resources, and will take many years to accomplish, due to the varying age and condition of each facility.

Structural Risk Management Features

Based on the conclusions of this study, I recommend the implementation of the Recommended Plan, identified as Alternative #2, which is the continuation of the Carolina Beach portion of the existing CSRM project, as authorized, for a 15-year period beginning at initial construction of Congressionally-authorized renourishment. The project consists of a 14,000-foot long shoreline system with a dune having a crown width of 25 feet at 12.5 feet North American Vertical Datum of 1988 (NAVD88), together with a storm berm, having a crown width of 50 feet at 9.5 feet NAVD88. Included with this project is a 2,050 foot long rock revetment located on the far northeast segment of the project. Material for the beach fill would be transported via a pipeline connected to a cutterhead dredge from Carolina Beach Inlet to the Carolina Beach shoreline. Continued use of the Carolina Beach Inlet would require an exemption from the provisions of CBRA in the project's final Congressional authorization. The renourishment interval for the project is three years.

As a result of the Beach Renourishment Evaluation Report and EA, I recommend that the project be authorized and implemented in accordance with the findings of this report.

I further recommend that construction of the proposed project be contingent on the project sponsor giving written assurances satisfactory to the Secretary of the Army that it will:

a. Provide 50 percent periodic renourishment costs assigned to hurricane and coastal storm risk management plus 100 percent of periodic renourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits and as further specified below:

(1). Provide all lands, easements, and rights-of-way, and perform or ensure the performance of all relocations determined by the Federal Government to be necessary for periodic renourishment, operation, and maintenance of the project;

(2). Provide, during construction, any additional amounts as are necessary to make its total contribution equal to 50 percent of periodic renourishment costs assigned to hurricane and coastal storm risk management plus 100 percent of periodic renourishment costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. Operate, maintain, replace and rehabilitate the completed project, or functional portion of the project between periodic renourishment events, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

c. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor, now or hereafter, owns or controls for access to the project for the purpose of inspecting, operating, maintaining, repairing, replacing, rehabilitating, or completing the project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Federal Government shall relieve the non-Federal sponsor of responsibility to meet the non-Federal sponsor's obligations, or to preclude the Federal Government from pursuing any other remedy at law or equity to ensure faithful performance;

d. Hold and save the United States free from all damages arising from periodic renourishment, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

e. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence is required, to the extent and in such detail as will properly reflect total costs of construction of the Project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

f. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for periodic renourishment, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

g. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for periodic renourishment, operation, or maintenance of the project;

h. Agree that, as between the Federal Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

i. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by (42 U.S.C. 4601 – 4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way, required for periodic renourishment, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable Federal labor standards and requirements, including but not limited to, 40 U./S.C. 3141 – 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying, and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S. C. 276c et seq.);

k. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires the non-Federal interest to participate in and

comply with applicable Federal floodplain management and flood insurance programs, prepare a floodplain management plan within one year after the date of signing a Project Cooperation Agreement, and implement the plan not later than one year after completion of construction of the project;

l. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project, in accordance with the cost sharing provisions of the agreement;

m. Participate in and comply with applicable Federal floodplain management and flood insurance programs;

n. Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

o. Prevent obstructions of or encroachment on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) which might reduce the level of protection it affords, hinder operation and maintenance or future periodic renourishment, or interfere with its proper function, such as any new developments on project lands or the addition of facilities which would degrade the benefits of the project;

p. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

q. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain, and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

r. For so long as the project remains authorized, the non-Federal sponsor shall ensure continued conditions of public ownership, access, and use of the shore upon which the amount of Federal participation is based;

s. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

t. At least twice annually and after storm events, perform surveillance of the beach to determine losses of renourishment material from the project design section and provide the results of such surveillance to the Federal Government; and

u. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 22130, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable

element thereof, until the Non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

The non-Federal sponsor has indicated that they have available the necessary funds to provide the non-Federal share of the project first costs and periodic renourishment costs. I am confident that the non-Federal sponsor will provide their share.

This recommendation is subject to the cost sharing policies as outlined in this report and is endorsed, provided that, prior to construction, the non-Federal sponsor enters into a written PPA, as required by Section 221 of Public Law 91-611, as amended.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for implementation funding. However, prior to transmittal to the Congress, the sponsor, the states, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

The Administration's projections of future inflation are 2.785 percent annually. Based on these data, the total inflation adjusted (fully funded) project costs are estimated to be $59,830,000 over the 15-year period of Federal participation for the Recommended Plan of improvement. The Federal share of the fully funded project costs is currently estimated at $29,915,000. The non-Federal share of the fully funded costs is currently estimated at $29,915,000. Given the Administration's declared budgetary concerns, potential long-term costs associated with the proposed project may be vital to decision making. As previously indicated, the total project benefit-cost ratio is 3.9, which means that for every dollar spent for the project there are $3.90 realized in National Economic Development (NED) benefits from the project.

These recommendations comply with Section 215 of the Water Resources Development Act of 1999, which sets cost sharing for periodic renourishment at 50 percent Federal and 50 percent non-Federal. In recent years the Federal share of periodic renourishment costs of new coastal storm damage reduction projects has been limited by the availability of funds. However, I recommend that this Beach Renourishment Evaluation Report, prepared under Section 1037 of the Water Resources Reform and Development Act of 2014, as amended, be approved.

In conclusion, I recommend continuation of Federal participation for periodic renourishment of the Carolina Beach, NC Coastal Storm Risk Management in accordance with the Recommended Plan described within this report, notwithstanding the provisions of the Coastal Barrier Resources Act of 1982.

Robert J. Clark
Colonel, U.S. Army
District Commander

12 POINT OF CONTACT

Questions or comments regarding this draft Integrated Beach Renourishment Evaluation Report and Environmental Assessment and the proposed action should be directed to:

US Army Corps of Engineers, Wilmington District
Environmental Resources Section
Attn: Mr. Eric Gasch
69 Darlington Avenue
Wilmington, NC 28403

Telephone: (910) 251-4553

Email: Eric.K.Gasch@usace.army.mil

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Attachment 1 - Sponsor Letter of Support

Town of Carolina Beach
1121 N. Lake Park Boulevard
Carolina Beach, North Carolina 28428
TEL: (910) 458-2999
FAX: (910) 458-2997

Colonel Landers
US Army Corps of Engineers
Wilmington District
69 Darlington Ave
Wilmington, NC
28403

March 9, 2017

Dear Colonel Landers,

The Town of Carolina Beach, New Hanover County, North Carolina (the "Town") seeks to enter into an Agreement with the United States Army Corps of Engineers (the "Corps") to provide funds for the purpose of completing a Beach Renourishment Evaluation Study to determine the feasibility of extending the period of nourishment for the Carolina Beach & Vicinity, NC Hurricane Wave and Shore Protection Project – Carolina Beach Portion a period not to exceed 15 additional years. It is the intent of the Town to provide a plan for reducing risks to people and property associated with erosion of the beach within the limits of the Town.

The Town understands the cost-sharing requirements of this undertaking, and agrees that it shall contribute 50 percent of the shared study costs in accordance with the provisions of the agreement that will be executed by the Corps and the Town. The Town also understands that it will be required to initially provide funds in the amount of $25,000, for the Corps to initiate the Study. In the event more funds are needed to develop the Project Management Plan, the Town agrees to provide the necessary funds. Thereafter, the Town will provide funds sufficient to meet its share of the estimated shared study costs for each fiscal year of the Study.

The Town will not ask to be reimbursed for these expenses at a later date. However, the Town understands that, if any of these funds remain unspent after the study is complete, the unspent funds will be returned to the Town.

Although the Town has entered into separate agreements with the State and County for the purpose of providing funding assistance to the Town for this study, the State and County will not be parties to the agreement between the Corps and the Town. Therefore, all funding obligations involved with this study are ultimately the responsibility of the Town.

The Town is making this voluntary contribution of funds with the clear understanding that this contribution will not have any effect on the findings and conclusions of the study.

Sincerely,

Michael Cramer
Town Manager

Attachment 2 - Draft Finding of No Significant Impact