CAPE COD CANAL & SANDWICH BEACHES

SHORE DAMAGE MITIGATION STUDY

APPENDIX D

ENGINEERING & DESIGN

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Cape Cod Canal and Sandwich Beaches
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1. Introduction

1.1. Study Area and Overview

The study is focused on shore damage prevention measures due to impacts from the Cape Cod Canal, Federal Navigation Project (FNP). Since it was constructed, the Federal Navigation Project has been contributing to coastal erosion of area beaches, in particular Town Neck Beach and Springhill Beach in Sandwich, Massachusetts. By analyzing historical and existing conditions, erosional rates and other sources of data, various alternatives were developed and considered with the objective of arriving at a readily implementable solution to mitigate further coastal erosion.

As shown in Figure D1, the study area encompasses the shoreline from Scusset Beach to Springhill Beach. The shoreline which is experiencing the most coastal erosion is Town Neck Beach and consists of town and private property. The land adjacent to the south jetty is owned by an area utility provider (Genon Holdco 10 Inc.) and the land adjacent to the north jetty is federal property. The study area consists of nearly 2.5 miles of shoreline.

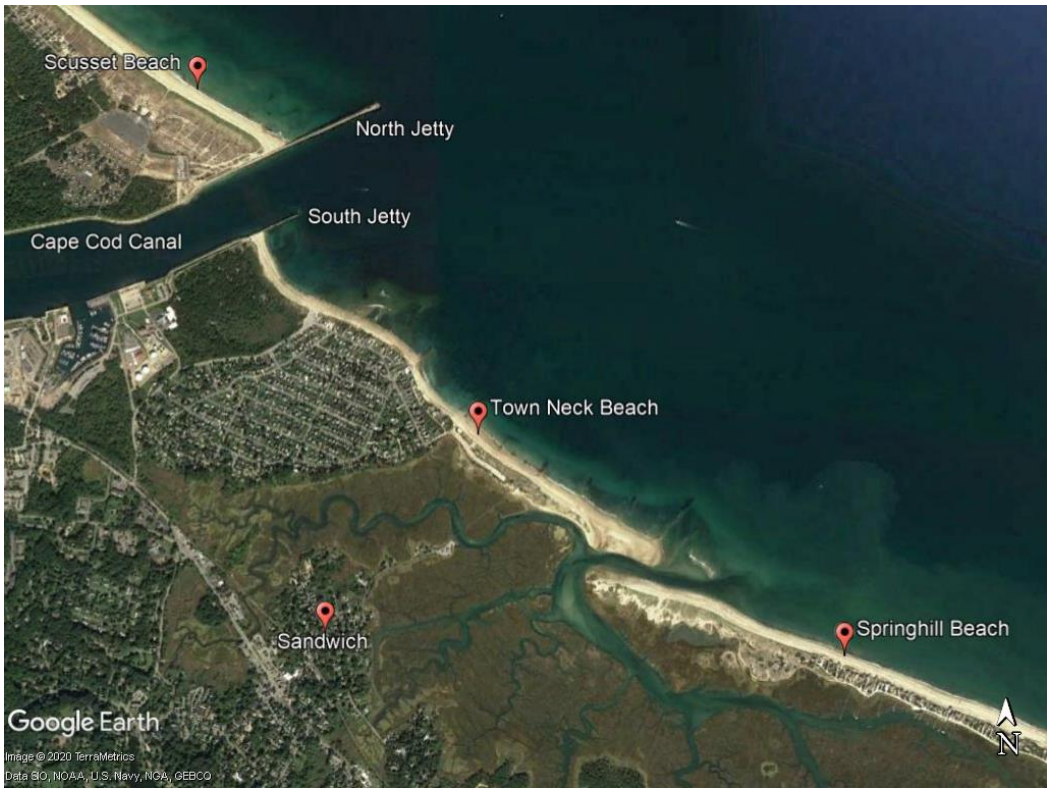

Figure D1: Study Area

2. Existing Conditions

2.1. Topographic Data

Elevation measurements and topography (contours) for civil & site design activities were established from land survey data collected by Woods Hole Group and others between 2012 and 2018. In addition to, topographic and bathymetric data collected via aerial survey was used to supplement the data set. Aerial surveys were conducted by USACE National Coastal Mapping Program in 2015 and also the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) in 2018. All survey data sets were referenced to the same coordinate system for horizontal coordinates which is NAD83 Massachusetts State Plane, Mainland Zone, US Foot. All vertical coordinates and values are referenced to NAVD 1988 Vertical Datum, US Foot.

2.2. Public Records

Parcel mapping data which includes property lines and property ownership was collected from the MassGIS standardized assessor's database, as well as, the Town of Sandwich GIS database. GIS data (i.e. .SHP files) were imported into the civil design model for determination of real estate impacts and development of a real estate plan. Additional GIS features that were incorporated into the model include storm drainage structures and street lights to identify any potential interferences and/or obstructions during the development of alternatives.

2.3. CAD & GIS

A three-dimensional CAD model of the existing site was created by compiling topographic data, public records data, and external referencing of CAD files. As part of the analysis conducted by Woods Hole Group, an AutoCAD model of the Town Neck Beach project area was created which was the primary file referenced into the civil design model. Examples of features that were referenced into the model include: environmental delineations, vegetation boundaries, dune extents, property structures, and various beach features. Using MicroStation the civil design model also included ortho-imagery from October 2018 of the entire project area.

3. Design Process

As part of the alternatives development and analysis, the project delivery team (PDT) considered various alternatives to mitigate coastal erosion within the project area. This section describes all the alternatives considered for the project area and the activities performed during the civil engineering process.

3.1. No Action

Analysis performed by USACE and Woods Hole Group considered the option of not deploying any type of implementable alternative and the impacts which would result. Models were developed to project shoreline change and concluded that the barrier beach is likely to be gone in approximately 50 years and the usable beach gone even sooner if no action is taken. No civil design input was considered as this alternative implies no change to the present conditions.

3.2. Beach Nourishment

One of the primary reasons for the coastal erosion of Town Neck Beach was determined to be the lack of sediment transport within the coastal littoral cell due the presence of the Federal Navigation Project. Therefore, in order to offset the starvation of new sand being deposited onto Town Neck Beach, beach nourishment brings in additional compatible sand from an off-site source to widen the beach.

The Town of Sandwich recently obtained permits for a 388,000 cubic yard engineered dune and berm beach that served as the basis for beach nourishment alternatives developed for this study. Coastal modeling and analysis was used to design a project that would increase beach width, added storm protection, increased recreational area, and added habitat areas. Design activities were then conducted to determine various engineering and construction plans for implementing such a project.

The project footprint covers 41.15 Acres of land (includes land under the ocean), primarily place on the town-owned beach at Town Neck Beach. An outline of the beach nourishment project area was incorporated into the civil design model and used to determine the projected impacts and design requirements:

Real Estate Requirements

By layering the project footprint with the parcel mapping data, real estate impacts were determined by identifying the interferences with private and publically owned land parcels. GIS files (.SHP) were obtained from the MassGIS standardized assessor's database which included the property lines and structure footprint for each parcel within the project area. This data was verified with the Town of Sandwich GIS database which provided the parcel ID and lot number's as depicted on the Real Estate Plan (See Sheet RE-001). Based off the interferences identified, in order to implement beach nourishment, construction easements would be required on private (1.29 AC) and public property (21.41 AC). A total of seven (7) privately-owned parcels would be affected. The remaining project footprint encompasses land which is federally owned.

Areas were also identified on the project site plan for construction access and staging which would take place on public (Town of Sandwich) property.

Construction Plans

The primary sediment source for beach nourishment is a borrow area located off the shoreline of Scusset Beach. In contrast to Town Neck Beach, sand accretion has occurred on the north side of the FNP and has resulted in a growing shoreline for Scusset Beach. Due to the surplus of sediment being collected in this nearshore area, the total volume of sediment (388,000 CY) needed for beach nourishment will be dredged from the Scusset Beach nearshore area and deposited onto Town Neck Beach for a one-time construction of an engineered dune and berm beach.

In 2019 the Town of Sandwich obtained permits to dredge material from the nearshore area off of Scusset Beach for beach nourishment purposes at Town Neck Beach. Those permits included a footprint that would allow for approximately 224,000 cubic yards to be dredged and placed on Town Neck Beach. In order to dredge 388,000 cubic yards of material, the near shore borrow area footprint would need to be increased from what is currently permitted. Based off the permitted area footprint which measures 1,700 Ft. along the shore line and 630 Ft. landward-seaward, the average excavation depth was calculated to be approximately 5.7 Ft. In order to increase the total dredge volume to 388,000 CY, modifying the permitted borrow area footprint would best be served by extending the shoreline dimension from 1,700 Ft. to 1,890 Ft which would enable the average excavation depth (5.7 Ft.) to remain the same while being able to provide the total sediment budget. Material would be dredged utilizing either a mechanical or hydraulic dredge from the near shore borrow site and then pumped via rainbow placement onto Town Neck Beach.

Heavy equipment would be positioned land-side and provide support once the dredged sediment has been pumped onto the beach. Dozers and other miscellaneous heavy equipment would access the beach at designated construction access points. One of the access points is the parking area adjacent to the Drunken Seal restaurant (Parcel ID 93-013) and enables sufficient space for construction equipment to drive onto the beach, as well as, storage during non-work hours. The other area identified for construction access and staging includes the public parking area at the end of Wood Ave. Personnel would be able to access the beach area via the various walkways, however, construction equipment would utilize walkways at the far east end of the parking lot which would require widening to allow heavy equipment to access the beach. Both areas identified for access would allow for sufficient construction access and staging no matter the time of implementation, with the proper coordination and

administration. In addition, any disturbed areas resulting from construction access or staging would be returned to pre-project conditions, which would include re-grading, stabilization, and planting of vegetation. Working around the tide cycles would be required for land-based construction activities as the following values identify the placement amounts within specific tidal regions: below mean low water (12.93 AC), between MLW and mean high water (12.72 AC), between mean high water and high tide line (2.10 AC), and above the high tide line (13.40 AC).

3.3. Beach Nourishment with Dune Coir Envelopes

Supplementing the beach nourishment alternative with dune coir envelopes would add an extra layer of protection during a storm event. The project footprint and volume of beach nourishment would remain the same, however, dune coir envelopes would be installed along the entire length of Town Neck Beach.

Construction Plans

Dune coir envelopes consist of biodegradable sand filled logs which are placed length-wise within the dune or can be placed at the toe of the dune. During storm events, the bank of the dune has increased stability and is more likely to stay intact. The configuration of these features would consist of three (3) coir envelopes stacked on top of each other while vertically aligned with the slope of the dune. Based off the assumption that each log would be approximately 1 Ft. in height and cover 4,870 linear feet of the beach, the total amount of biodegradable material needed for coir envelope construction is 28,000 Square Yards. Service would be required after every storm which breaches the dune to ensure the integrity of the structures. Regardless of storm event, dune coir envelopes need to be inspected and/or serviced every 5 to 7 years. The installation of the coir envelopes falls within the project footprint of beach nourishment and would utilize the same construction access points.

3.4. North Jetty Modification

Designed to minimize wave energy in the canal and also to prevent infilling of the navigation channel, the north jetty which currently measures approximately 3,000 Ft. in length, has been the main factor in the accretion of sediment along Scusset Beach. Sand is blocked from its natural littoral transport and the majority of sediment that does make it around or through the north jetty is either deposited within in the canal or flows offshore.

Construction Plans

Modifying the jetty would include shortening the current length by 550 Ft. which would allow additional sediment to be transported past the jetty. The jetty was constructed during the early 1900's and based off historical drawings contains an

average crest width of 25 Ft. and contains a 1V:2H side slope of armor stone. Armor stone along most of the ocean and channel sides consist of a minimum stone size of 6 Tons and the head consists of a minimum stone size of 12 Tons. Demolition of the jetty would begin at the nose and extend back 550 Ft. along the trunk. Since the jetty contains a crest width large enough for an all-terrain excavator and/or dump truck to access the jetty nose, hauling off of material could be accomplished using land-based equipment wherever possible. Removal and hauling off of core stones would require a floating crane or similar setup to reach submerged material.

Using historical drawings as a reference, jetty cross sections were developed and material quantities to be removed were determined. In addition, elevations of the ocean floor were determined from bathymetric data collected by JALBTCX. An estimated 80,000 to 90,000 Tons of stone would need to be removed and hauled off in order to decrease the length of the current jetty by 550 Ft. This alternative is assumed to be implemented separately from beach nourishment.

3.5. South Jetty Modification

Coastal modeling showed that the north and south jetties combine to create a reversal in local sediment transport. The natural sediment transport for Town Neck Beach is to the southeast, however, from the canal to approximately Knott Ave. a reversal occurs and sand transports to the northwest. Even though the magnitude of sand accumulation is relatively small on the south side of the South Jetty, lengthening of the south jetty could take advantage of this and increase sediment retention down drift of the Canal.

Construction Plans

The south jetty is approximately 700 Ft. in length with 1V:1.5H side slopes on the channel and ocean sides. Modifications of the jetty would include maintaining the current crest width (20 Ft.) for the trunk and extending the length by 900 Ft. Historical drawings indicated the armor stone on the side slopes is a minimum stone size of 2.5 Tons and the nose consists of 5 to 7 Ton stone sizes. Placement of additional stone will include demolition of the existing nose in order to transition the existing trunk width and begin constructing a 900 Ft. extension. Stones from the existing nose would be reused in the construction of a new south jetty nose. The crest width is sufficient to enable land-based heavy equipment to haul materials and also place excavators for stone placement, however, due to the large volume of stone required (85,000 to 95,000 Tons) a barge would be best suited to deliver materials. In areas were the ocean depth is sufficient, jetty extension work could also utilize a water plant construction setup. This alternative is assumed to be implemented separately from the beach nourishment alternative.

3.6. Town Neck Beach Groin and Old Harbor Inlet Modifications

Nine (9) groin structures of varying size are currently located along Town Neck Beach and two (2) jetties associated with Old Harbor Inlet are located at the easternmost end of the beach. The groin structures range in condition and effectiveness in trapping sand on Town Neck Beach. Modifications of the existing structures would look to maximize the effectiveness in sand retention, without further impacting natural sediment transport along both beaches, as a supplement to beach nourishment.

Construction Plans

Some of the existing beach groin structures have had stone loss and/or become detached from the shoreline and have very little impact on trapping sediment on Town Neck Beach, whereas, a select few are intact and effective. Modifications to the existing groin field would include demolition of both jetties at the Old Harbor Inlet and also demolition of five (5) groins located at the eastern most end of Town Neck Beach. The four (4) groins located nearest to the South Jetty on the west side of the beach would not be modified as they are stable and effective in trapping sand. During demolition of the jetties and groins, the stones would be harvested and re-used in the construction of four (4) new notched groins. The new groins would measure approximately 250 Ft. in length and include a 50 Ft. notch (1/5 of overall length) to allow continued sediment transport. Based off surveys of the existing groins and jetties, a total of 1,800 Ft. of materials (varied stone sizes) could be salvaged. Due to the specialized construction and requirements for larger stones, 33% of the existing groin materials (600 Ft.) would be anticipated for re-use in the construction of the new notched groins totaling 1,000 Ft. The existing groins and jetties would be dismantled prior to beach nourishment and stock piled. Once beach nourishment has been completed then the new groins could be properly aligned with the new shoreline. The groins would be constructed within the intertidal zone and work would require coordination with tidal cycles, however, it was assumed that all construction would take place via land-based heavy equipment.

Modification of the existing groin field would only be implemented as a supplement to beach nourishment and construction activities would be included in those plans.

4. Design Summary

The most readily implementable alternative to mitigate coastal erosion from the Federal Navigation Project was determined to be beach nourishment. This would include the one-time construction of a 388,000 cubic yard engineered dune and berm beach at Town Neck Beach..

Sand would be dredged from a near-shore borrow site located off the shoreline of Scusset Beach on the north side of the North Jetty. Dredged material would be pumped onto Town Neck Beach upon which grading equipment and excavators would be utilized on the land to construct the engineered beach profile. Heavy equipment would access Town Neck Beach from designated construction access points located in public parking lots at the east and west entrances to the beach. As part of the engineered beach profile, new plantings and habitat areas would also be incorporated.