TOWN OF KILL DEVIL HILLS

Land Where Flight Began

MEMORANDUM September 12, 2022

TO: Mayor and Board of Commissioners

FROM: Debora P. Diáz, Town Manager D. Diáz/CA

REF: New Business

2. Shore Protection Project – Beach Maintenance Plan (Attached NB-2)

The most recent beach nourishment project for the Town's Beach Erosion Control and Flood and Hurricane Protection Works successfully concluded in August 2022. This renourishment project followed the Town's initial 2017 construction project to protect the Town's infrastructure and shoreline. Planning Director Meredith Guns' attached memorandum highlights the updated Beach Maintenance Plan, submitted by Coastal Protection Engineering of North Carolina, Inc. The Plan, which is also included in the meeting materials, details the project design (initial and most recent), maintenance cost and schedules, and monitoring protocols. This information is required for the Town's eligibility to participate in the FEMA Public Assistance (PA) program. Additionally, justification that the maintenance plan has been implemented must be provided to be eligible to receive federal aid in a presidentially declared disaster. Staff recommends adoption of the Town of Kill Devil Hills updated Shore Protection Project – Beach Maintenance Plan.

A motion will be in order to adopt the Shore Protection Project – Beach Maintenance Plan as presented.

Director of
Planning and Inspections
MEREDITH GUNS

Building Inspector
MARTY SHAW
CHARLES THUMAN

Code Enforcement Officer
JORDAN BLYTHE

THE TOWN OF KILL DEVIL HILLS
NORTH CAROLINA

PLANNING DEPARTMENT

Assistant Director of
Planning and Inspections
CAMERON RAY

Senior Planner
RYAN LANG

Zoning Administrator
DONNA ELLIOTT

September 12, 2022

Memorandum

To: Debbie Diaz, Town Manager

From: Meredith Guns, Planning Director

Subject: Shore Protection Project Beach Maintenance Plan

In August 2022, the Town completed the five-year reconstruction cycle the shore protection project, the initial project being completed in 2017. Attached to this memorandum is an updated Beach Maintenance Plan.

The Maintenance Plan includes a description of the project design, construction activities to date, anticipated volume and cost for maintenance, schedule of maintenance and the monitoring protocols being employed by the Town. The plan will be updated regularly to reflect results of monitoring; construction of additional projects, maintenance events and changes is schedules. The maintenance program will monitor the performance of the Shore Project and determine when periodic re-nourishment is needed to maintain the project. This information is required for eligibility under the Public Assistance (PA) program administered by FEMA. If the project is impacted by a presidentially declared disaster or emergency, justification that the maintenance plan has been implemented must be provided to receive federal aid.

Staff recommends adoption of the Town of Kill Devil Hills Updated Shore Protection Project Maintenance Plan.

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Staff recommends adoption of the Town of Kill Devil Hills Updated Shore Protection Project Maintenance Plan.

Town of Kill Devil Hills
North Carolina

Town of Kill Devil Hills Shore Protection Project

Photograph obtained by Coastal Protection Engineering of North Carolina, Inc. (July 4, 2022)

Beach Maintenance Plan

Original August 2017
Last Update August 2022

Prepared By:
Coastal Protection Engineering of North Carolina, Inc.
Engineering License Certificate #: C-2331
4038 Masonboro Loop Road
Wilmington, NC 28409

TOWN OF KILL DEVIL HILLS
SHORE PROTECTION PROJECT MAINTENANCE PLAN

EXECUTIVE SUMMARY

The Town of Kill Devil Hills has initiated a shore protection project aimed at sustaining the beaches that support a significant portion of their local economy, maintaining the tax base of the Town, retaining existing recreational resources, and protecting existing natural resources. The project has and will continue to provide increased protection to the Town's economy and coastal development. A key aspect to the long-term success of the project is the implementation of a maintenance program to document construction achievements and project performance. This document details the maintenance program established by the Town.

The Town successfully completed the initial construction of the Shore Protection Project in July 2017. Periodic maintenance or renourishment is included in the Town's maintenance plan for the Shore Protection Project. The first periodic maintenance project was completed in July 2022. The project placed approximately 550,000 cy of beach fill material (payment quantity) in Kill Devil Hills. All material used in the sand placement came from Borrow Area A located offshore of Kill Devil Hills and Nags Head. While post-construction surveys of Borrow Area A will not be completed until the fall of 2022 when dredging is completed for construction of other beach nourishment projects utilizing the same source, a sufficient quantity of sand is anticipated to be available for future maintenance events. That said, Dare County, in cooperation with the Towns of Kill Devil Hills, Duck, Southern Shores, and Kitty Hawk, recently submitted a grant request to conduct a regional sand investigation survey aimed at identifying up to 30-years of additional sand resources to support their programs.

Project monitoring has been implemented to track performance of the placed material and is used to update nourishment requirements. The initial baseline monitoring event was conducted in December 2017 after the initial construction of the project. Annual monitoring was conducted each year between 2018 and 2022. Additional post-storm monitoring was conducted in December 2019 to determine volumetric losses due to Hurricane Dorian, which impacted the project in September 2019.

Following completion of the first maintenance event (re-nourishment) in 2022, a baseline survey was conducted in July 2022 to track volumetric changes. The baseline survey includes beach profile surveys at approximate 1,000 foot intervals as well as shore parallel bathymetric surveys to assist in the tracking of nearshore depressions or troughs located offshore of the project area. The surveys are conducted along the entire length of the project as well as approximately 4,500 feet south of the project area. Additional data north of the project area, available from the neighboring Town of Kitty Hawk, are also incorporated into the monitoring. The beach profile surveys, and supplemental shore-parallel bathymetric surveys have been designed and are conducted to capture changes along the active profile of the beach both within and adjacent to the project area.

This Maintenance Plan serves as documentation that the Town of Kill Devil Hill's Shore Protection Project meets the criteria established by 44 CFR 206.226(j)(2). The Maintenance Plan has been developed in a way consistent with the Public Assistance Program and Policy Guide (Version 4). This Maintenance Plan will be updated regularly to reflect results of monitoring, construction of additional projects, maintenance events and changes in schedules.

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INTRODUCTION

The Town of Kill Devil Hills has implemented a long-term shoreline management program. The Town's stated purpose for implementing this program was to sustain the beaches that support a significant portion of their local economy, maintain the tax base of the Town, retain existing recreational resources, and protect existing natural resources. In order to accomplish these stated goals, the Town has taken steps to maintain its oceanfront beach and dune to a configuration that provides a reasonable level of storm damage reduction to public and private development and mitigates long-term erosion impacts.

Extensive engineering analysis conducted between 2012 and 2015 (CPE-NC, 2012 and CPE-NC, 2015a) resulted in a recommendation that a beach nourishment project be constructed along an approximate 2.6-mile section of the Town of Kill Devil Hills that was vulnerable to impacts of a design storm with wave and water level characteristics matching Hurricane Isabel, which impacted the coast in 2003. The project was also designed to include 5 years of advanced fill to account for predicted background erosion of the project during the maintenance interval. The project included the construction of a beach fill design along 12,505 ft. of the Town of Kill Devil Hills between baseline station 189+87 (northern Town Boundary) and 314+92 (Windsong Way). In addition to the design fill section, the project also included a 1,074-foot long taper on the south end from baseline station 314+92 to 325+66, which is located near the Prospect Avenue public beach access.

Initial construction of the project was completed in July 2017. The project included placement of 817,359 cy of beach compatible sand, which equates to an average fill density of approximately 60 cy/lf, along 13,579 feet or approximately 2.6 miles. Sand used to construct the project was dredged from an offshore borrow source. Following the construction of the project, the Town implemented a maintenance program to monitor the performance of the Shore Protection Project and determine when periodic renourishment is needed to maintain the project.

The Town of Kill Devil Hills completed an Erosion and Shoreline Management Design report in March 2022, which evaluated potential management options for the oceanfront shoreline and provided recommendations for the design of 2022 renourishment event (CPE, 2022). The recommendation for the 2022 renourishment project was to place 505,000 cy of material along the Kill Devil Hills project area. The design includes 5 years of advanced fill to account for predicted background erosion of the project during the maintenance interval.

Placement of beach fill for the first periodic maintenance event of the shore protection project was completed in July 2022. The project included placement of approximately 550,000 cy of beach compatible sand, which equates to an average fill density of approximately 41 cy/lf, along 13,579 feet or approximately 2.6 miles. Sand used to construct the project was dredged from the same offshore borrow source (Borrow Area A) as the initial project.

Documentation of the construction and subsequent monitoring events has been archived as evidence of the Town's commitment towards maintaining the Shore Protection Project. This information is required for eligibility under the Public Assistance (PA) program administered by FEMA. If the project is impacted by a presidentially declared disaster or emergency, justification

that the maintenance plan has been implemented must be provided to receive federal aid. This stipulation is mandated by 44 CFR 206.226(j)(2), which states:

> *Work on an improved beach may be eligible under the following conditions:*
> *(i) The beach was constructed by the placement of sand (of proper grain size) to a designed elevation, width, and slope; and,*
> *(ii) A maintenance program involving periodic renourishment of sand must have been established and adhered to by the applicant.*

The amount of sand replacement eligible for FEMA funding is limited to the material volume lost as a result of the declared disaster or emergency. Pre- and post-storm profiles, when available, are used to determine the eligible volume of sand. If pre-storm profiles are not available, the estimated erosion from the design study and renourishment history can be used to determine a pre-storm condition. Surveys collected during the monitoring can also be used to determine the pre-storm condition.

This Maintenance Plan serves as documentation that the Town of Kill Devil Hills' Shore Protection Project meets the criteria established by 44 CFR 206.226(j)(2). The Maintenance Plan has been developed in a way consistent with FEMA's Public Assistance Program and Policy Guide (Version 4). The Maintenance Plan includes a description of the project design, construction activities to date, anticipated volume and cost for maintenance, schedule of maintenance and the monitoring protocols being employed by the Town of Kill Devil Hills. This Maintenance Plan will be updated regularly to reflect results of monitoring, construction of additional projects, maintenance events, and changes in schedules.

CONSTRUCTION EVENTS

Beach Fill

Initial Construction (2017): The initial construction of the Town of Kill Devil Hills Shore Protection Project was completed in July 2017. The project included the establishment of a dune and berm beach fill design along 12,505 feet of the Town of Kill Devil Hills between stations 189+87 and 314+92. In addition to the 12,505 ft. design fill section, the project also included a 1,074-foot long taper on the south end. North of Kill Devil Hills, the Town of Kitty Hawk constructed a beach nourishment project along the entirety of their shoreline negating the need for a taper on the north end of the Kill Devil Hills project. In total, the Kill Devil Hills project placed sand from baseline station 189+87 (near the northern Town boundary) to 325+66 (Prospect Ave. Public Access). Figure 1 shows the extent of the 2017 project including the main fill construction template, the southern taper, and the construction baseline. Sand used to construct the 2017 project was dredged from the permitted offshore borrow area referred to as Borrow Area A, using trailing suction hopper dredges (Figure 2).

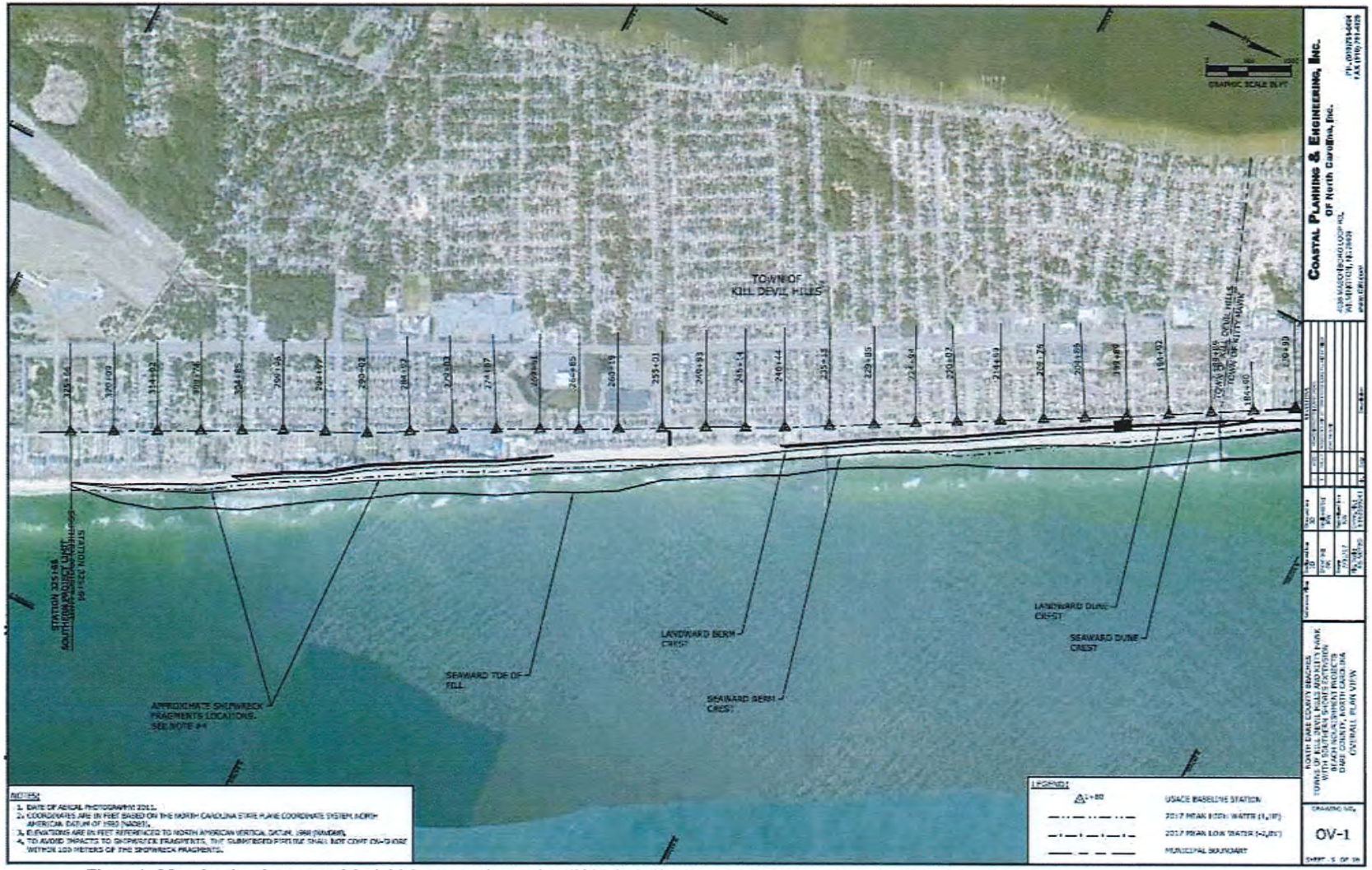

Figure 1. Map showing the extent of the initial construction project (2017) including the main fill construction template, the southern taper, and the construction baseline.

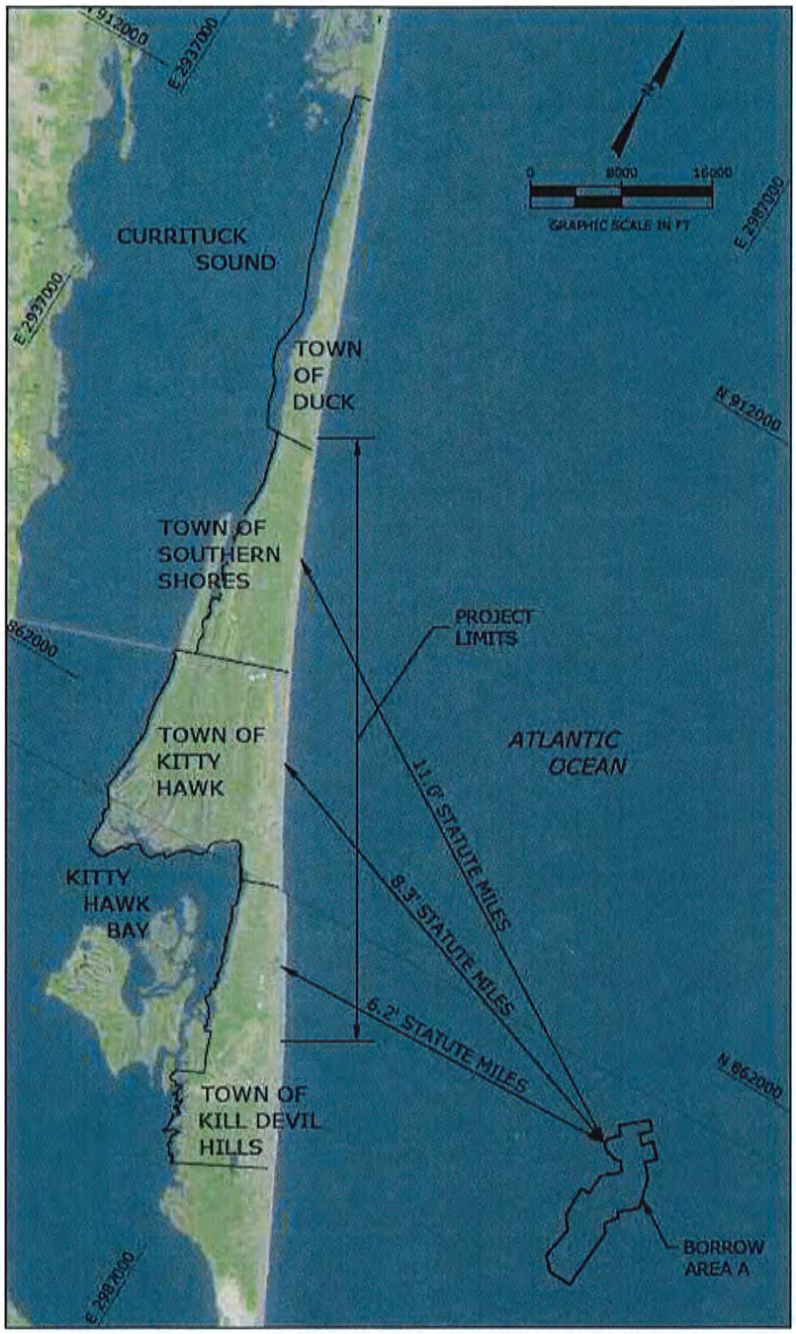

Figure 2. Map showing the location of offshore borrow area used for the construction of the June/July 2022 Kill Devil Hills Shore Protection Project.

The beach fill constructed in July 2017 included placement of 817,359 cy of beach compatible sand, which equates to an average fill density of approximately 60 cy/lf, along 13,579 feet of beach (approximately 2.6 miles). The volume placed included both the volume necessary to construct the designed dune and berm as well as the volume needed for advanced fill. Advanced fill is the

sacrificial portion of the fill required to protect the design section from anticipated sediment losses during the time between subsequent maintenance cycles. The volume of advanced fill needed was based on background erosion rates, anticipated diffusion losses and a five (5) year maintenance cycle. Ultimately, the performance of the beach fill dictates when constructed sections require maintenance, which is referred to as renourishment.

1st Maintenance Event (2022): Placement of beach fill associated with the first periodic maintenance of the Town of Kill Devil Hills Shore Protection Project was completed in July 2022. The overall goal of the project focused on providing a reasonable level of storm damage reduction to public and private development, mitigating long-term erosion impacts, and optimizing project performance (CPE, 2022). The project included the construction of a beach fill design along the same portion of Kill Devil Hills that was constructed in 2017. Figure 3 shows the extent of the project including the main fill construction template, the southern taper, and the construction baseline. Sand used to construct the project was dredged from the permitted offshore borrow area referred to as Borrow Area A, using trailing suction hopper dredges (Figure 2).

The design for the 2022 renourishment aimed to maintain an equal level of protection throughout the Project Area. Given the beach fill project constructed in 2017 did not erode uniformly, the project was designed to re-establish the 40-foot-wide design berm. In addition to re-establishing the design berm, the project also restored a small section of dune along approximately 100 feet of the northern end of Kill Devil Hills to the 2017 post-construction condition. The project also included the uniform distribution of approximately 24 cy/ft. along the entire design section of the project to account for anticipated background erosion and diffusion. The design also included additional fill to mitigate the potential for hot spot erosion along the central 4,000 feet of the project area between station 220+00 (Near E Hayman Blvd) and station 260+17 (Near Drifting Sands Motel).

The beach fill constructed in July 2022 included placement of approximately 550,000 cy of beach compatible sand, which equates to an average fill density of approximately 41 cy/lf, along 13,579 feet of beach (approximately 2.6 miles). The overall beach fill volume incorporated the volume required to repair the project following Hurricane Dorian, which resulted in the loss of 311,900 cy. The project volume anticipated a five (5) year maintenance cycle. Ultimately, the performance of the beach fill dictates when constructed sections require maintenance, which is referred to as renourishment.

Sand Fencing

As part of the initial construction of the project, the Town installed two rows of 10-foot sand fencing sections staggered along the landward and seaward edge of the dune crest oriented at 45-degree angles from the shoreline. The sand fence was installed along the entire length of the beach nourishment project, a distance of approximately 2.6 miles. Sand fence was evenly spaced thin wooden vertical slats connected with twisted wire. The sections were four feet in height and supported by three wooden stakes or posts per 10-foot section, one stake at each end and one in the middle. The sand fencing was untreated, unfinished, biodegradable, and neutral in color (beige. tan, natural wood finish).

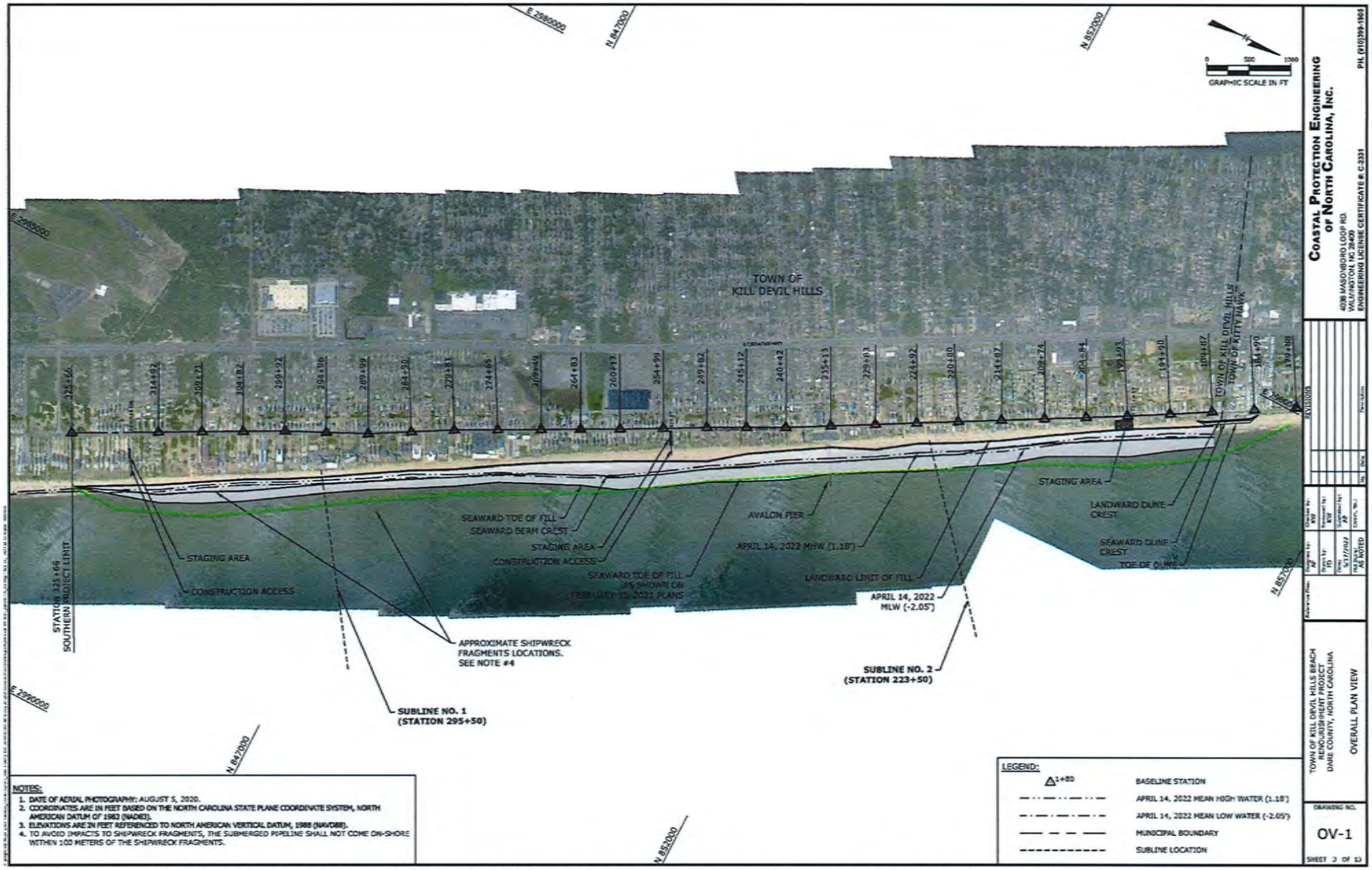

Figure 3. Map showing the extent of the project (2022) including the main fill construction template, the southern taper, and the construction baseline.

Impacts of Hurricane Dorian resulted in the loss or damaging of sections of sand fence along the project. Furthermore, subsequent storms following Dorian also damaged sections of sand fence along the project area. As part of the 2022 project, approximately 1,250 sections of sand fence will be installed along the project area as needed to replace damaged fencing and to help control landward sand migration by catching wind blown sand on the seaward face of the dune. The 10-foot sections of sand fencing will be installed at an approximate 45-degree angle to the dune, with a gap between sections of approximately 10 feet. The fencing will be placed on the crest of the dune, on the face of the dune, and/or at the toe of the dune.

Dune Vegetation

The Town planted American Beach Grass in the nourishment area to promote trapping of wind-blown sand. American Beach Grass was planted at 18-inch intervals along both the crest of the dune and the seaward face of the dune. Plants were fertilized at the time of planting. The planting of the American Beach Grass occurred in late fall and winter of 2017.

The Town also planted Sea Oats in the nourishment area to promote trapping of wind-blown sand. Sea Oats were planted on 18-inch intervals along both the crest of the dune and the seaward face of the dune. Plants were fertilized at the time of planting. The planting of the Sea Oats occurred in August and September of 2017 and in Spring 2018.

Once sand fencing has been installed associated with the 2022 project, the Town has plans to install additional dune vegetation in areas where the seaward slope of the dune is unvegetated. Initial estimates suggest approximately 5,050 feet of dune will require vegetation.

Funding

Both the initial construction and the first maintenance event were funded through revenue derived from the Dare County Beach Nourishment Fund and the Town of Kill Devil Hills. The Town of Kill Devil Hills portion of the project was raised through a combination of General Fund appropriation and Municipal Service Districts (MSDs). In essence, the Town of Kill Devil Hills portion of the cost of the project was funded by an increase in the ad valorem tax rate on all properties within the Town of Kill Devil Hills with additional funding provided at a higher rate through the MSDs by oceanfront property owners in the project area.

MAINTENANCE REQUIREMENTS

During the design of the 2022 Kill Devil Hills Shore Protection Project, Coastal Protection Engineering of North Carolina, Inc. (CPE, formerly Coastal Planning & Engineering of North Carolina, Inc. and Aptim Coastal Planning & Engineering of North Carolina, Inc.) conducted an analysis of background erosion losses and diffusion losses to determine the volume of advanced fill to include in the project design. The 2022 project was designed using an assumed rate of loss of 4 cy/ft/yr. (CPE, 2022). The design also called for an additional 75,000 cy placed in the central portion of the project to mitigate for hot spot erosion (CPE, 2022). Assuming a 5-year nourishment cycle, the Kill Devil Hills project would require approximately 340,700 cy of sand in 2027.

CPE has estimated that the cost to conduct maintenance of the Kill Devil Hills Shore Protection project in 2027 would be $6,086,700. This cost estimate accounts for the construction cost to place 340,700 cy of sand, design and permitting, construction soft costs, environmental monitoring, and a 5% contingency. The cost estimate assumes renourishment of the Kill Devil Hills Project would occur simultaneously with the Kitty Hawk, Southern Shores, and Duck renourishment projects and that the mobilization and demobilization costs were allocated based on the percentage of the total renourishment volumes.

For planning purposes, CPE has also estimated costs to conduct maintenance of the Kill Devil Hills Shore Protection project in 2027 assuming the 2027 maintenance project would be designed for a 6-year and 7-year maintenance cycle. These estimates assume that the 2027 project would place the equivalent volume to last 6 years or 7 years, respectively. Initial estimates suggest increasing the maintenance cycle from 5-years to 6-years, for the 2027 project, could save approximately $100,000 per year in future maintenance costs, starting in 2027. Furthermore, increasing the maintenance cycle from 5-years to 7-years could save approximately $175,000 per year in future maintenance costs. These estimates are based on transitioning all four northern Dare County Town projects (Duck, Southern Shores, Kitty Hawk, and Kill Devil Hills) to 6-year and 7-year maintenance cycles in 2027. However, it has not yet been determined whether all four projects could be extended to a 6-year or 7-year maintenance cycle. However, in the event that the 2027 project could be designed to include a 7-year maintenance cycle, the estimated cost would be $7,294,400. Constructing a project in 2027, assuming a 6-year maintenance cycle, is estimated to cost $6,689,200. These estimated costs are provided as preliminary planning numbers for comparison to the previously stated cost of $6,086,700, which reflects a volume that assumes a 5-year nourishment cycle.

During the permitting of the 2017 Kill Devil Hills Shore Protection Project, CPE conducted a comprehensive marine sand search and borrow area design (CPE-NC, 2015B). Two borrow sites, referred to as Borrow Areas A and C, were designed during the investigation. Borrow Area A, shown in Figure 2, is located on the Outer Continental Shelf (OCS) between 5.0 and 6.5 miles offshore of the Towns of Kill Devil Hills and Nags Head in water depths between 50 and 60 ft. (NAVD88). The borrow area covers 1,173 acres and initially contained approximately 16,335,000 cy of sand. The mean grain size of the sand was found to be 0.36 mm with a sorting value of 0.90. The sand in the borrow area was characterized as fine to medium grained quartz sand with trace silt, shell hash, and shell fragments. The average wet Munsell color value was determined to be 5 and dry color value 6. The borrow area was broken up into 6 different cuts with cut depths ranging from -58.5 to -68.0 ft. NAVD88.

A marine sand search investigation was conducted in October 2020 to locate another source of beach compatible material other than Borrow Area A (CPE, 2021A). The investigation concluded that there was material in the reconnaissance area, however, the material was determined to have a finer grain size than the material in Borrow Area A. Based on multi-beam data collected in May 2021, Borrow Area A contained 12,563,700 cy of beach compatible sand, prior to the construction of the 2022 project (CPE, 2021B).

The Dept. of the Army (USACE) and North Carolina Division of Coastal Management issued permits for the Town of Kill Devil Hills to use Borrow Area A for the initial construction of the Kill Devil Hills Shore Protection Project and for the 2022 project. Furthermore, since the borrow area is located in Outer Continental Shelf (OCS) waters, the Town was required to obtain a lease from the Bureau of Ocean Energy Management (BOEM) to use the sand in the permitted borrow area. Individual leases were issued by BOEM for both projects (2017 and 2022).

Post-construction surveys of Borrow Area A are expected to be completed in fall 2022, following construction of other beach nourishment projects utilizing the same source. However, a sufficient quantity of sand is anticipated to be available for the 2027 maintenance event, following completion of the various 2022 projects. That said, Dare County, in cooperation with the Towns of Kill Devil Hills, Duck, Southern Shores, and Kitty Hawk, recently submitted a grant request to conduct a regional sand investigation survey aimed at identifying up to 30-years of sand resources to support their programs.

MONITORING PROTOCOL

A monitoring plan has been designed and implemented for the Kill Devil Hills Shore Protection Project. The first post-construction survey of the 2022 project was conducted in July 2022, which establish baseline conditions. Topographic and hydrographic surveys of the beach profiles are conducted to monitor project performance and potential impacts. Annual monitoring surveys are conducted along beach profiles at approximately 1,000-foot intervals along the fill area and adjacent shoreline within a minimum distance of 4,000 feet. Figure 4 shows the location of these beach profiles.

The ocean floor offshore of the Kill Devil Hills project area is characterized by nearshore depressions or troughs. The presence of these troughs were evident based on data plotted from a 2009 multibeam survey conducted by the US Army Corps of Engineers Field Research Facility (USACE-FRF). The features were also present on a plot of the data collected by Aptim Coastal Planning & Engineering of North Carolina, Inc. (APTIM) during a single-beam bathymetric survey conducted in December 2017/February 2018. Comparison of the 2009 USACE-FRF survey with the 2017/2018 APTIM survey indicated the troughs were mobile, i.e., they appeared to migrate north to south along the coast. Given the potential influence of the troughs on the volume change results computed using beach profile surveys only, the Town of Kill Devil Hills has incorporated a supplemental bathymetric survey into their annual monitoring protocol. This survey was conducted as part of the post-construction survey (July 2022) and is conducted annually with the beach profile surveys. The supplemental bathymetric survey includes a series of shore parallel survey lines spaced approximately 200 feet apart. The survey area generally covers the offshore bottom from about the -10-foot NAVD88 contour seaward for a distance of about 3,000 feet.

The first annual monitoring event (Year-1) is scheduled for spring 2023. Annual monitoring is used to assess the volume of sand in place, compared to the initial beach fill design configuration. The analysis of the monitoring data also provides rates of volume change that can be used to update maintenance frequency or maintenance volume based on existing conditions.

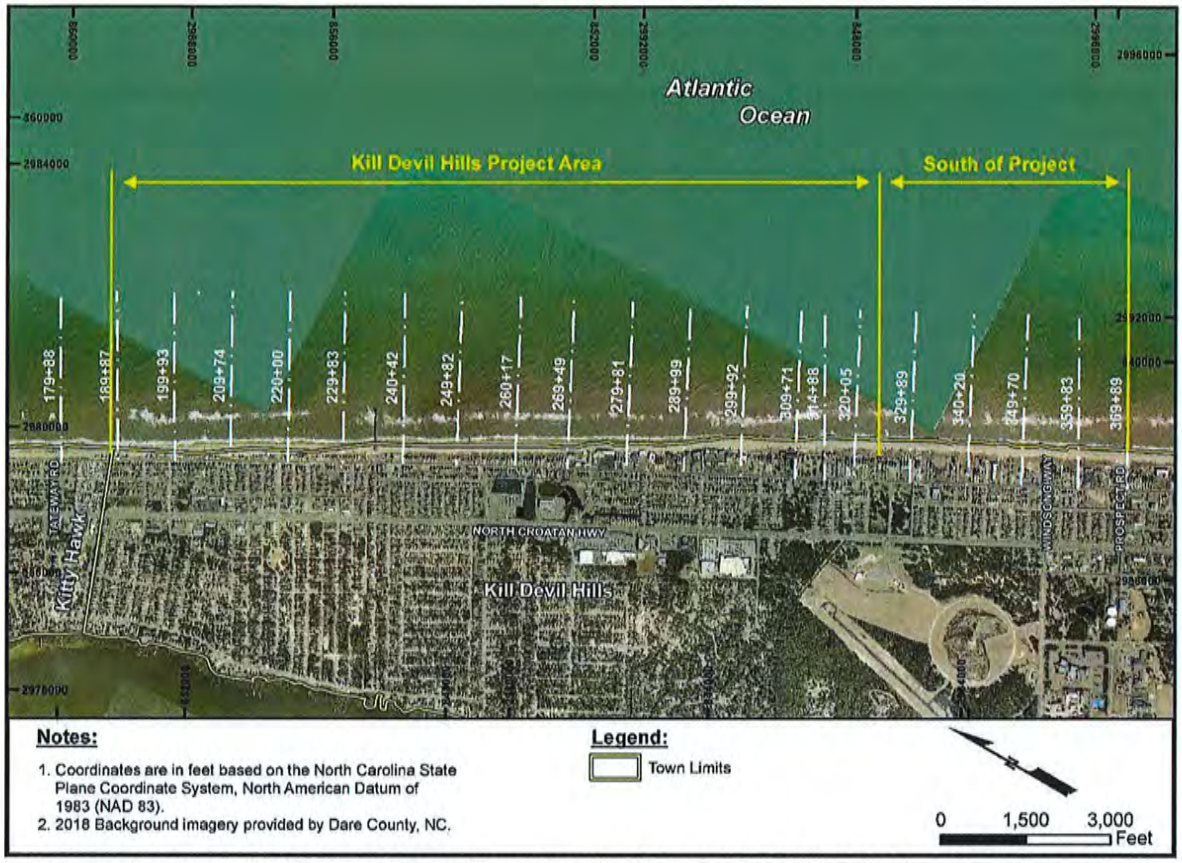

Figure 4. Map of Kill Devil Hills Shore Protection Project Monitoring Beach Profiles.

Supplemental beach profile surveys may also be required following significant storm events as were conducted in 2019 following the impact of Hurricane Dorian. Reports for each monitoring event are archived by the Town. The reports contain volumetric and shoreline change calculations to describe how the project is performing. Erosion rates and shoreline change rates along the beach are also documented throughout the monitoring process. The monitoring results are also used to identify erosion 'hot spots' and to estimate sediment needs for future maintenance events.

CONCLUSION

The Town of Kill Devil Hills has initiated a shore protection project aimed at sustaining the beaches that support a significant portion of their local economy and maintaining the tax base of the Town. The project has and will continue to provide increased protection to the Town's economy and coastal development. Part of the project includes implementing a maintenance program to document construction achievements and project performance. Anticipated future costs have been estimated and are also included in the maintenance plan.

The Town successfully completed the initial construction of the Shore Protection Project in July 2017 and the first periodic renourishment in July 2022. The renourishments are expected to occur

on a 5-year cycle and will involve dredging of Borrow Area A offshore Kill Devil Hills and Nags Head.

Project monitoring has been implemented to track performance of the placed material and is used to update nourishment requirements. The initial baseline monitoring event was conducted in December 2017 after the initial construction of the project. Annual monitoring was conducted each year between 2018 and 2022. The Town of Kill Devil Hills has also incorporated a supplemental bathymetric survey into their monitoring protocol. The beach profile and shore parallel bathymetric surveys were designed and are conducted to capture changes along the active profile of the beach both within the project area and adjacent to the project.

This Maintenance Plan serves as documentation that the Town of Kill Devil Hills' Shore Protection Project meets the criteria established by 44 CFR 206.226(j)(2). The Maintenance Plan has been developed in a way consistent with FEMA's Public Assistance Program and Policy Guide (Version 4). This Maintenance Plan will be updated regularly to reflect results of monitoring, construction of additional projects, maintenance events and changes in schedules.

REFERENCES

CPE (2020) Coastal Protection Engineering of North Carolina, Inc. Post-Storm Design Report: Hurricane Dorian Town of Kitty Hawk and Town of Kill Devil Hills Shore Protection Projects Dare County, NC. Prepared for Towns of Kitty Hawk and Kill Devil Hills. Wilmington, NC.

CPE (2021A) Coastal Protection Engineering of North Carolina, Inc. Borrow Area Investigation and Sediment Compatibility Analysis Report: Town of Duck, Southern Shores, Kitty Hawk, and Kill Devil Hills, North Carolina. Wilmington, NC.

CPE (2021B) Coastal Protection Engineering of North Carolina, Inc. Town of Duck, Southern Shores, Kitty Hawk, and Kill Devil Hills, North Carolina Borrow Area Investigation and Sediment Compatibility Analysis Addendum B – Borrow Area Infilling Assessment, North Carolina, NC.

CPE (2022) Coastal Protection Engineering of North Carolina, Inc. Town of Kill Devil Hills, North Carolina Erosion & Shoreline Management Design Report, North Carolina, NC.

CPE-NC (2015 A) Town of Kill Devil Hills Erosion and Shoreline Management Design Report. Prepared For: The Town of Kill Devil Hills, North Carolina, 77 pgs.

CPE-NC (2015 B) Comprehensive Marine Sand Search and Borrow Area Design Report. Prepared For: The Towns of Duck Kitty Hawk and Kill Devil Hills, North Carolina, 49 pgs.

FEMA (2020) Public Assistance Program and Policy Guide (PAPPG), Version 4, Effective June 1, 2020. (FP 104-009-2).