

EXECUTIVE SUMMARY

The Town of Duck has implemented a long-term beach management program to sustain the beaches that support a significant portion of their local economy and maintains the tax base of the Town. In May and June 2017, the Town constructed its initial beach nourishment project that placed approximately 1.26 million cubic yards of fill along 1.6 miles of shoreline that was shown to be the most vulnerable portion of the Town's oceanfront. Between April and May 2023, the Town constructed its first beach renourishment project along the same area that was nourished in 2017, placing approximately 576,800 cubic yards of fill between Skimmer Way (station D-10) and the northern boundary of the USACE Field Research Facility (FRF) property (station D-19).

As part of its long-term beach management program, the Town has implemented an annual monitoring program to assess both the performance of the beach renourishment project and to track the overall health of the beach along the entire Town. The annual monitoring focuses on analyzing shoreline and volume changes. The beach is divided into three areas designated as the Central Reach Project Area (station D-10 to D-19); the North Monitoring Area (D-01 to D-10), which extends south from the Town limit to Skimmer Way; and the South Monitoring Area (D-19 to D-34), which extends from the northern boundary of the FRF property south to the Town boundary with Southern Shores.

A shoreline change analysis was completed to assess shoreline advance and recession along the monitoring area. The contour used to monitor shoreline change throughout the Town of Duck is the +6.0 ft. NAVD88 contour. The shoreline change analysis compared the position of the +6.0 ft. NAVD88 contour for three different timeframes to update the changes within the Project Area and assess the recent and long-term changes in the North and South Monitoring Areas. Table ES-1 below summarizes the average shoreline changes (ft.) measured from Sept. 2013 to May 2023 (Long-Term Shoreline Change), Dec. 2017 to Jan. 2023, and April 2021 to May 2023 (Post-construction) (Short-term), for the North Monitoring Area, Central Reach Project Area and South Monitoring Area.

Table ES-1
Summary of Average Shoreline Changes (ft.) within the Central Reach Project Area and North and South Monitoring Areas

MONITORING AREAS	Sept. 2013 (Baseline) to May 2023 (2023 Post-Con)	Dec. 2017 (2017 Post-Con) to Jan. 2023 (2023 Pre-Con)	April 2021 to May 2023 (2023 Post-Con)
NORTH MONITORING AREA (D-01 TO D-10)	-11.4	---	-12.5
CENTRAL REACH PROJECT AREA (D-10 TO D-19)	140.1	-88.3	121.0
SOUTH MONITORING AREA (D-19 TO D-34)	-8.9	---	6.2

Similar to the shoreline change analysis, the tracking of long-term volumetric changes within the Central Reach Project Area as well as the North and South Monitoring Areas, are measured by comparing the September 2013 baseline data with the most recent annual monitoring (May 2023 post-construction). Volumetric changes that have occurred subsequent to the 2017 Project are determined by comparing the December 2017 data with the last dataset before the 2023 project (Jan. 2023 pre-construction). The monitoring report also provides short-term volumetric changes that occurred between the most recent

townwide surveys (April 2021 to May 2023). Average volumetric change rates calculated above the -24-foot NAVD88 contour (cubic yards/ft./year) for the Central Reach Project Area and North and South Monitoring Areas are provided in Table ES-2.

Table ES-2
Summary of Average Volume Change Rates (cy/ft./yr.) within the Central Reach Project Area and North and South Monitoring Areas


MONITORING AREAS	Sept. 2013 (Baseline) to May 2023 (2023 Post-Con)	Dec. 2017 (2017 Post-Con) to Jan. 2023 (2023 Pre-Con)	April 2021 to May 2023 (2023 Post-Con)
NORTH MONITORING AREA (D-01 TO D-10)	0.7	---	-0.1
CENTRAL REACH PROJECT AREA (D-10 TO D-19)	12.3	-10.8	24.3
SOUTH MONITORING AREA (D-19 TO D-34)	3.0	---	13.3

The long-term average volumetric change rates indicate a positive trend throughout the Town; however, the Central Reach Project Area rate is clearly being influenced by the beach nourishment projects constructed in 2017 and 2023. Since 2013, the North Monitoring Area has maintained a relatively stable rate of volumetric change (+0.7 cy/ft./yr.), while the South Monitoring Area has experienced a positive trend at a rate of +3.0 cy/ft./yr. over the 9.7-year period.

With the completion of the 2023 beach renourishment project, the entirety of the 2017 project's performance can be analyzed. A comparison of profile surveys conducted in April 2017 (pre-construction) and December 2017 (post-construction) measured the effective volumetric gain to the Project Area was 963,100 cubic yards, due to the 2017 beach nourishment project. Monitoring of the 2017 project over the approximate 5 years between December 2017 and January 2023, indicates a volumetric change rate of -10.8 cy/ft./yr. This rate is considered the most representative rate of volumetric change observed within the Central Reach Project Area between the 2017 initial construction and the 2023 renourishment projects. The volumetric change during this period is equivalent to a loss of approximately 521,800 cubic yards and indicates that approximately 46% of the initial volume placed along the Town of Duck in 2017 remained in the Project Area above the -24-foot NAVD88 contour.

The short-term (April 2021 to May 2023) average volumetric change rates indicate a positive trend throughout the Town; however, the Central Reach Project Area rate is clearly being influenced by the beach nourishment project constructed in 2023. It should also be noted that two surveys were conducted between April 2021 and May 2023, including surveys in October 2022 and January 2023 (Pre-construction). When comparing April 2021 survey to these two surveys the results indicate that the trend along the Project Area, prior to the 2023 project was erosional. In fact, between April 2021 and January 2023 there was an erosional trend and a loss of approximately 107,900 cubic yards. Since April 2021, the North Monitoring Area has maintained a relatively stable rate of volumetric change (-0.1 cy/ft./yr.), while the South Monitoring Area has experienced a positive trend at a rate of +13.3 cy/ft./yr. over the 25-month period.

Using the previously calibrated SBEACH model and the May 2023 beach profile survey data, an updated storm vulnerability analysis was conducted of the oceanfront beach and dune system along the Town of Duck. The updated SBEACH analysis based on May 2023 conditions indicated that within the South Monitoring Area, no structures and 9 pools were identified as vulnerable. This is a decrease in the number



of structures and pools identified as vulnerable based on the 2019 conditions, which was 29 structures and 40 pools. There were no structures or pools identified to be vulnerable within the Central Reach Project Area. Along the North Monitoring Area, within the Town of Duck (stations D-01 to D-10), there were 0 structures or pools identified as vulnerable.

CPE recommends the Town continue to monitor the beach along the entire Town oceanfront in order to assess if shoreline and volume change trends identified in this report persist. For the Central Reach Project Area, the May 2023 survey has been adopted to represent the post-construction conditions. Future annual monitoring reports will reference shoreline and volume changes in the Central Reach Project Area relative to the May 2023 condition to track the performance of the 2023 project and aid in the determination as to when additional nourishment is needed in the Central Reach Project Area. In that regard, data collected in January 2023 indicated that the 2017 project eroded at a rate of -10.8 cy/ft./yr. when compared to the Dec. 2017 Post-construction survey. This erosion rate and rates computed through the continued monitoring of the 2023 project will be used to design the next renourishment event. The continued annual monitoring of the project also provides a pre-storm condition survey that can be used to estimate damages if the project is impacted by a significant storm.

Continued monitoring of the North and South Monitoring Areas is instrumental for the Town to evaluate future areas of concerns and longshore transport trends, and to develop successful shoreline management strategies to deal with issues as they arise. The May 2023 post-construction survey indicates that since 2013, the volumetric trend along the Town's beaches in the North Monitoring Area has been stable. Data collected in May 2023 also indicates a stable volumetric change in the recent period since April 2021. The South Monitoring Area has experienced a positive volumetric change trend (accretion) since 2013. This may be due in part to sand placed during the 2017 project migrating south of the Project Area. Continued monitoring of the areas outside the Central Reach Project Area is vital to achieving the Town's goal of providing a reasonable level of storm damage reduction to public and private development along the entire Town oceanfront.