

## EXECUTIVE SUMMARY

The Town of Duck is located on the Outer Banks of North Carolina, roughly 27 miles south-southeast of the North Carolina and Virginia border. The Town extends along 5.9 miles of Atlantic Ocean shoreline from the Dare County and Currituck County line south to the Town of Southern Shores.

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 a beach nourishment project along 1.6 miles of its oceanfront that was shown to be the most vulnerable portion of the Town’s oceanfront. Approximately 1.26 million cubic yards of fill was distributed between Skimmer Way (station D-10) and the northern USACE Field Research Facility (FRF) property boundary (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 nourishment 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 Project Area (station D-10 to D-19); the area North of the Beach Project (D-01 to D-10), which extends south from the Town limit to Skimmer Way; and the area South of the Beach Project (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 study 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 in September 2013, December 2017, June 2020, and April 2021. The following table summarizes the average shoreline changes (ft.) measured between September 2013 and April 2021 (Long-term), December 2017 and April 2021 (Post-Project), and June 2020 and April 2021 (Short-term), for the Project Area and Areas North and South of the Project.

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

PROFILE	September 2013 (Baseline) to April 2021 (Year-4)	Dec. 2017 (Post-Con to April 2021 (Year-4)	June 2020 (Year-3) to April 2021 (Year-4)
<b>AREA NORTH OF PROJECT</b> (D-01 TO D-10)	1.1	15.7	7.5
<b>PROJECT AREA</b> (D-10 TO D-19)	19.6	-59.1	15.7
<b>AREA SOUTH OF PROJECT</b> (D-19 TO D-34)	-12.0	0.9	-3.7

Similar to the shoreline change analysis, the tracking of long-term volumetric changes within the project area as well as north and south of the project area, are measured by comparing the September 2013 data with the most recent annual monitoring. Volumetric changes that have occurred Post-Project are determined by comparing the December 2017 data with the most recent annual monitoring data. The monitoring report also provides short-term volumetric changes that occurred over the past annual

monitoring cycle (June 2020 to April 2021). Average volumetric change rates above the -24-foot NAVD88 contour (cubic yards/ft./year) for the Project Area and areas North and South of the Project are provided in Table ES-2.


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

<b>MONITORING AREAS</b>	<b>September 2013 (Baseline) to April 2021 (Year-4)</b>	<b>December 2017 (Post-Con) to April 2021 (Year-4)</b>	<b>June 2020 (Year-3) to April 2021 (Year-4)</b>
<b>AREA NORTH OF PROJECT (D-01 TO D-10)</b>	0.7	5.5	-2.9
<b>PROJECT AREA (D-10 TO D-19)</b>	8.7	-14.2	-19.4
<b>AREA SOUTH OF PROJECT (D-19 TO D-34)</b>	-0.1	-3.6	-24.9

The long-term average volumetric change rates indicate a positive trend throughout the Town; however, the Project Area rate is clearly being influenced by the beach nourishment project constructed in 2017. Since the project was completed, the area north of the project experienced a higher rate of positive volumetric change than the long-term rates since 2013. North of the project, the increase in the positive volumetric change rate is nearly 8 times greater than the long-term rate. Since the project was completed, the area south of the project experienced a higher rate of negative volumetric change than the long-term rates since 2013.

With regards to the Project Area, comparison of profile surveys conducted in April 2017 (Pre-Construction) and December 2017 (Post-Construction) suggests the effective volumetric gain to the Project Area due to the 2017 beach nourishment project was 963,100 cubic yards. Monitoring data collected in April 2021 indicate a negative volumetric change within the Project Area of approximately -450,000 cubic yards since December 2017 (Post-construction). This equates to a rate of -14.2 cy/ft./yr. when annualized. As of April 2021, the analysis indicates that approximately 53% of the initial volume placed along the Town of Duck in 2017 remained in the project area above the -24-foot NAVD88 contour.

Monitoring of the project over the first 4 years following construction indicates a volumetric change rate higher than estimated in the initial project design, which may be related to a number of factors. The Town's maintenance plan calls for an estimated renourishment fill density of approximately 30 cy/ft., every 5 years, which translates to an annual average loss of approximately 6 cy/ft./yr. The actual rate of volumetric change measured since 2017, in the first four years post-construction, has been an annual average loss of 14.2 cy/ft./yr., which is more than twice the rate programed in the beach maintenance plan. Given the 2017 project was the initial construction of the Town's project and beach profile data along the Project Area was limited prior to the construction of the 2017 project, the monitoring program is revealing the true erosion rate. The true erosion rate is influenced by the construction of the project itself, recent impacts of storms, alongshore variability, and other factors that may be contributing to the erosion rate beyond the initial estimate. The monitoring data has been used in the design of the 2022 project, both to plan for erosion rates higher than initially anticipated, and through modification of the fill configuration aimed at slowing the volume losses over the next 5-year nourishment interval.



CPE recommends the Town continue to monitor the beach along the entire Town oceanfront in order to assess long-term shoreline and volumetric changes. In that regard, with the re-nourishment scheduled for 2022, pre-construction surveys will be collected by the contractor in 2022, which can serve as the year 5 monitoring surveys for the project area. Furthermore, as part of the construction contract, the dredge contractor will conduct a post-construction survey within 2 weeks following completion of beach fill placement. This survey will serve as the new baseline conditions for the Duck beach nourishment project. Following construction of the beach project in 2022, the continued annual monitoring of the project provides not only a pre-storm condition survey that can be used to estimate storm damages, but also the continued assessment of volume trends, which will be used in the planning of future maintenance events.

Outside the Project Area, continued monitoring 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. In that regard, post-construction surveys, which will be conducted by the dredge contractor within 2-weeks following the 2022 project, will include the Area North and Area South of the Project. Continued monitoring of the areas outside the Project Area is vital to achieving the Town's goal of providing a reasonable level of storm damage reduction to public and private development. In that regard, CPE recommends that given the observed trend of erosion along the Area South of the Project, that the storm vulnerability analysis, last conducted in 2019, be updated using the 2022 monitoring data to be collected following construction of the beach nourishment project. The results of the analysis will be important as the Town transitions from preparation and construction of the 2022 project to planning for the 2027 project.