



COASTAL PROTECTION ENGINEERING OF NORTH CAROLINA, INC
4038 MASONBORO LOOP ROAD
WILMINGTON, NC 28409
910-399-1905

February 9, 2024

Drew Havens
Town Manager
Town of Duck
P.O. Box 8369
Duck, NC 27949

Re: UAS Rapid Beach Assessment Monitoring Program - Event 6 Assessment

Dear Mr. Havens:

This letter and the attachments serve as the deliverables associated with Event 6 of the UAS Rapid Beach Assessment Monitoring Program, which was initiated in the summer of 2019. The program was established to allow Town staff to partner with Coastal Protection Engineering of North Carolina, Inc. (CPE) staff using UAS technology and the ESRI Site Scan for ArcGIS software package (formerly 3DR Site Scan) to perform cost effective beach and dune monitoring. These assessments provide Town staff and CPE engineers with additional information on the condition of the beach and dune as well as an indication of storm impacts to the beach.

Ground Control Points (GCP's)

As part of the program, CPE established a network of Ground Control Points (GCP's) that are used to geo-reference imagery collected during UAS flights. CPE also created UAS flight plans, which were used to conduct rapid assessment UAS flights of the Town's beach and dune, including the beach nourishment project area. Flights were planned to maximize coverage of the beach while maintaining the resolution needed to derive accurate topography of the ground. Upon completion of the UAS flights, the images captured were reviewed and referenced to the existing GCP's using the ESRI Site Scan software. During the GCP geo-referencing, it was noted that several GCP's were either not visible or are no longer in place and as a result were not able to be used to geo-reference the imagery. Table 1 below provides a list of the GCP's that were not visible or obstructed in some manner, a description regarding the current condition, and proposed action to re-establish each GCP. It is recommended that prior to any future flights the vegetation be cut back, and sand be removed to ensure that GCP's are visible during the flight. The remaining 28 permanently installed GCP's were used to geo-reference the images during processing.



Table 1. Ground Control Point Inspection Summary

GCP No.	Location	Description	Proposed Action
DGCP_013*	Cook Dr / Speckle Trout Dr	Faded	Re-paint
DGCP_012*	Marlin Dr.	Faded	Re-paint
DGCP_108*	158 Four Seasons LN	Overgrown Veg	Remove vegetation
DGCP_109	164 Ocean Way	Overgrown Veg	Remove vegetation
DGCP_103	107 Ocean Crest Way	Removed	Replace post
DGCP_101	13th Ave	Missing	Remove from GCP List

* GCPs were visible to be used.

UAS Flights

On May 22, 2023 Post-construction flights were flown by CPE. The Post-construction flights covered the entire beach along the Town of Duck shoreline, including the 2023 Central Reach Project Area. Upon completion of the UAS flights, the imagery was uploaded through the ESRI Site Scan online portal for geo-referencing and processing. Upon completion of processing, the imagery was provided to the Town of Duck in the Event 5 report.

Throughout the months of October, November, and December 2023 periods of high waves and elevated water levels, on the order of 1 to 2 ft. above the predicted levels, impacted the Town of Duck shoreline. Additionally, between January 9th and 11th, 2024 the Town of Duck shoreline was impacted by an unnamed storm with measured wave heights up to 12 feet and wind speeds in excess of 50 mph, according to data obtained from the FRF. The storm created multiple days of high wave conditions and elevated water levels. As a result of this, the Town of Duck contracted with Baldwin Video on January 15, 2024 to perform UAS flights and document the condition of the Duck shoreline, south of the FRF property. Upon completion of the UAS flights, the post-storm imagery was provided to CPE for processing.

Event 6 UAS Assessment

The Event 6 UAS Assessment compares data from the flights conducted on May 22nd, 2023 (Post-nourishment conditions) with the data from the flights conducted on January 15, 2024 (Post-storm conditions). The assessment focuses on the change in position of the +6 ft. NAVD contour locations and calculated volumetric change along the beach between the flights. This letter provides results and a brief discussion of the analysis.

Observations of the orthomosaic imagery plots comparing the flights showed that the position of the +6 ft. NAVD contour in Jan. 2024 was generally further seaward of the position in May 2023 along the portion of the Duck oceanfront shoreline south of the USACE FRF property to Wampum Dr. (Sta. D-24 to D-27). This seaward movement of the +6 ft. NAVD contour generally translates to a wider dry sand beach, however, it appears as though sand lost from the toe of the dune may be influencing the seaward position of the +6 ft. NAVD contour in this area. A seaward movement of the +6 ft. NAVD contour was also observed between Lala Ct. and Plover Dr. (Sta. D-30 to D-31). The position of the +6 ft. NAVD



contour between Wampum Dr. and Lala Ct. (Sta. D-27 to Sta. D-30) showed a landward recession of the +6 ft. NAVD contour position from May 2023 to Jan. 2024. The imagery of this approximate 3,000 ft. stretch of shoreline shows that the dunes were heavily impacted sustaining significant erosion and scarping of the dune as well as a general lowering of the berm height. A landward movement of the +6 ft. NAVD contour was also observed between Plover Dr. and Sea Hawk Dr. (Sta. D-31 to D-32). At the southern end of the Town, between Sea Hawk Dr. and Ocean Crest Way (Sta. D-32 to D-34), the +6 ft. NAVD contour position remained relatively stable (no large swings landward or seaward). The attached maps (Attachment 1) show an upper panel with the orthomosaic imagery for the May 2023 flights and the location of the +6 ft. NAVD contour, whereas the lower panel shows the orthomosaic imagery for January 2024 flights and the associated +6 ft. NAVD contour.

The data obtained from the flights were also used to calculate volumetric change between May 2023 and Jan. 2024. Attachment 2 includes a series of maps showing the differences in elevations measured between the May 2023 (Post-nourishment conditions) and January 2024 (Post-storm conditions) flights conducted along the Town of Duck shoreline south of the USACE FRF property. The volume change analysis was performed independently for each dataset and the calculation was limited to the changes from the backside of the dune extending seaward to the +5 ft. NAVD contour. The Town of Duck oceanfront shoreline, south of the USACE FRF property, covers three flight plan zones; Zone 6 (Sta. D-24 to D-27), which extends from the southern border of the USACE FRF property to Wampum Dr.; Zone 7 (Sta. D-27 to D-31), which extends from Wampum Dr. to Plover Dr.; and Zone 8 (station D-31 to D-34), which extends from Plover Dr. to Ocean Crest Way.

The analysis of the data indicated that between May 2023 and January 2024 flights the Duck oceanfront shoreline south of the USACE FRF property (Sta. D-24 to D-34) experienced an overall volume loss (erosion) of approximately 5,800 cubic yards above the +5 ft. NAVD contour. Similar to the shoreline changes, the northern portion of the beach between Sta. D-24 and D-27 experienced a volume gain, while the largest loss occurred in the central portion of the flight area roughly between Wampum Dr. (Sta. D-27) and Lala Ct. (Sta. D-30). The maps included in Attachment 2 illustrate that the highest losses to the dune occurred along an approximate 1,200-foot segment of dune between 162 Mantoac Ct. and 174 Ocean Way. A summary of the volume changes calculated between the May 2023 and Jan. 2024 flights for each beach zone are included in Table 2. The table includes the volume change per foot of beach in each zone and the net volumetric change in cubic yards. The volumetric changes are not a comparison of pre- and post-storm conditions but rather a comparison of two surveys nearly 8-months apart.

Table 2. Event 6 UAS Assessment Volume Changes above +5 ft. NAVD88

Flight Plan Zones	Station	Volume Change	
		(cy/ft.)	(cy)
Zone 6	D-24 to D-27	2.7	9,300
Zone 7	D-27 to D-31	-3.0	-11,700
Zone 8	D-31 to D-34	-1.2	-3,400
South of USACE FRF property	D-24 to D-34	-0.6	-5,800



Attached to this letter, please find the following:

Attachments

- Attachment 1 – Event 6 – UAS Orthomosaic Imagery Comparison
- Attachment 2 – Event 6 – Elevation Difference Plots

Deliverables

- 2-hard copies and digital PDF copies of maps showing the Event 6 (May 22nd, 2023 (Post-nourishment conditions) vs Jan. 15, 2024 (Post-storm condition)) orthomosaic imagery comparison and the +6.0 ft. NAVD88 contour.
- 2-hard copies and digital PDF copies of maps showing elevation difference plots illustrating the locations and thickness of changes measured between the Event 6 flights (May 22nd, 2023 (Post-nourishment conditions) vs Jan. 15, 2024 (Post-storm condition))
- USB flash drive with georeferenced orthomosaic imagery and elevation difference plots of the Event 6 flights (May 22nd, 2023 (Post-nourishment conditions) vs Jan. 15, 2024 (Post-storm condition))

If you have any questions or comments about the deliverables, please feel free to contact me.

Sincerely,

COASTAL PROTECTION ENGINEERING OF NORTH CAROLINA, INC.

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ATTACHMENT 1

Event 6 - UAS Orthomosaic Imagery Comparison

May 22nd, 2023 (Post-nourishment condition) vs. Jan. 15, 2024 (Post-storm condition)



ATTACHMENT 2

Event 6 - Elevation Difference Plots

May 22nd, 2023 (Post-nourishment condition) vs. Jan. 15, 2024 (Post-storm condition)