

**FINAL REPORT**

Produced for the Town of Nags Head, NC  
October 2025



# 2025 ANNUAL BEACH MONITORING SURVEY EVALUATION

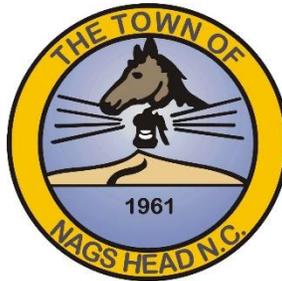
Town of Nags Head, NC



# TOWN OF NAGS HEAD

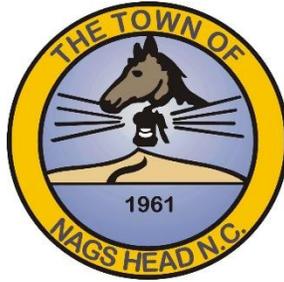
## 2025 ANNUAL MONITORING SURVEY EVALUATION

Prepared for:



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Prepared by:



**TOWN OF NAGS HEAD**

**2025 ANNUAL MONITORING SURVEY  
EVALUATION**

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## EXECUTIVE SUMMARY

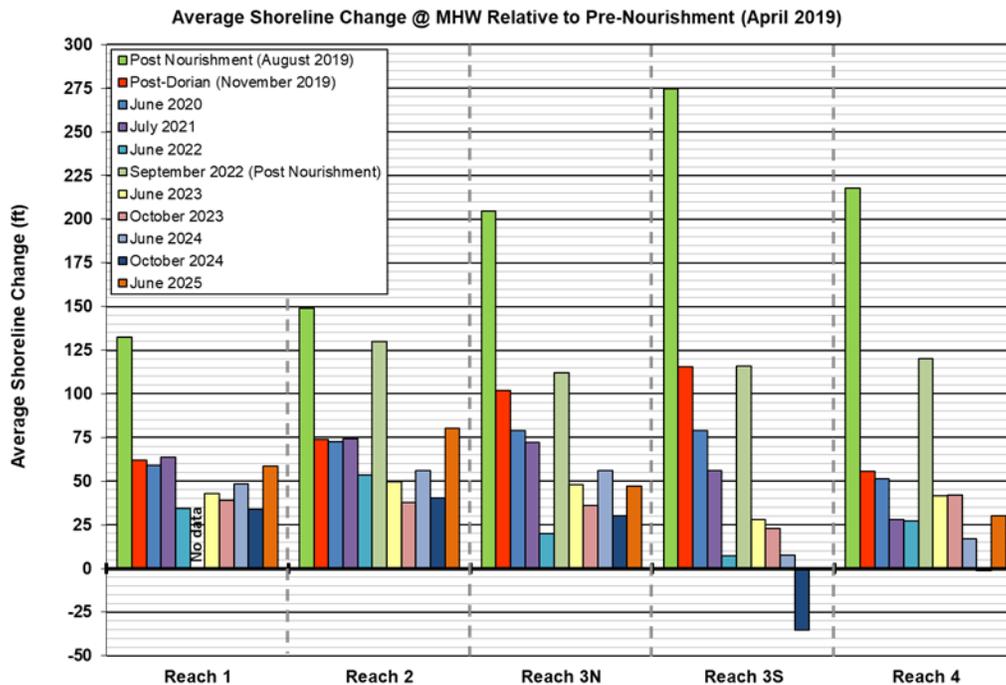
The Town of Nags Head Beach Monitoring and Maintenance Plan is sponsored by the Town of Nags Head (Town) as a continuation of the 2011 monitoring program initiated for assessing beach conditions. The primary purpose of the program is to assess current and historical shoreline conditions, determine shoreline and volumetric changes and evaluate the performance of beach nourishment and other restoration efforts. Evaluating and documenting these changes consistently over successive years provides information necessary to plan for future beach nourishments and to support development of the Town's multi-decadal Beach Nourishment Master Plan.

The latest annual summer survey took place in June 2025 and was carried out by McKim & Creed. Furthermore, a fall survey, prompted by observed scarping along the Town's beachfront, was conducted by McKim & Creed in October 2024, along with another annual survey in June 2024. This report outlines the data sources, methodologies, and findings of a survey evaluation conducted by Moffatt & Nichol. The evaluation compares the June 2025 survey to the data from October 2024 and June 2024 surveys.

The survey data was used to compute shoreline change at Mean High Water (MHW), which is designated as +1.18 ft NAVD88 for Nags Head, and volume change above +6 ft NAVD88 (berm), MHW, -6 ft NAVD88 (wading depth), -14 ft NAVD88 (outer bar), -19 ft NAVD88 (approximate depth of closure), and -30 ft NAVD88 (offshore).

During the 2019 Beach Nourishment Project approximately 4.0 million cy of material was placed along approximately 10 miles of shoreline. The shoreline position and volume changes above six elevations relative to pre-nourishment conditions (April 2019) along the Nourished Oceanfront (Station 495+00 – 1025+00) were also analyzed.

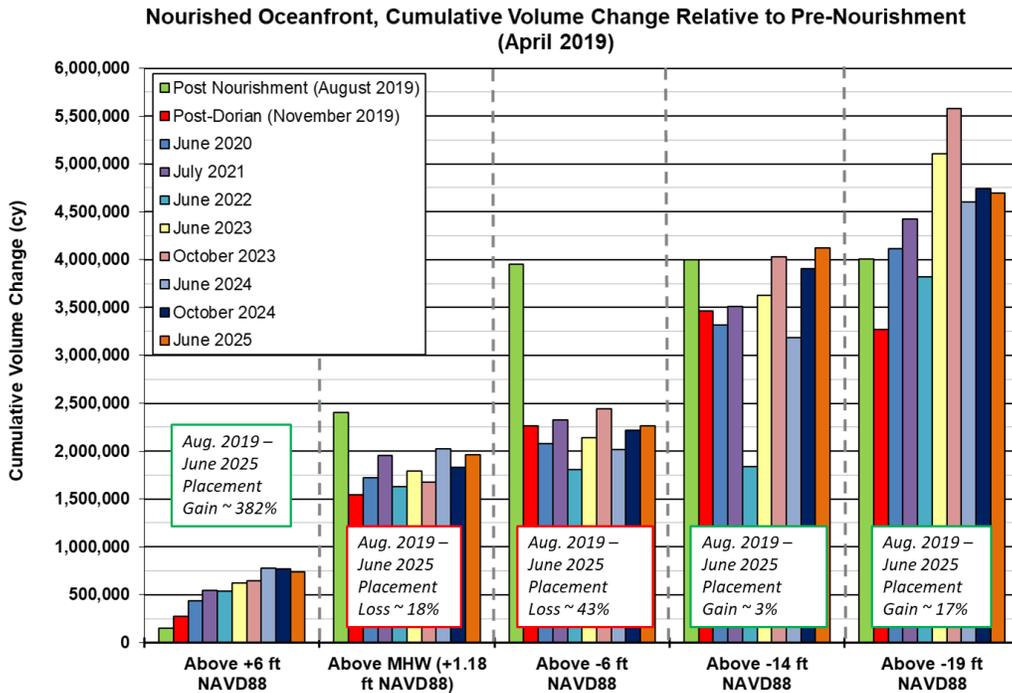
**Figure ES-1** illustrates shoreline changes relative to pre-nourishment conditions (April 2019) along the Nourished Oceanfront. The figure shows a significant landward recession since completion of the 2019 nourishment project. Most of this retreat can be attributed to Hurricane Dorian, with additional losses reflecting natural profile equilibration during stabilization of the nourishment profile. The August 2022 post-Dorian renourishment project mitigated some of this retreat; however, by June 2023 the shoreline had again receded, likely due to ongoing equilibration. Erosion persisted through the June 2023–June 2024 monitoring period, as continuous wave activity limited opportunities for recovery. During the June 2024–June 2025 period, particularly after October 2024, the shoreline showed signs of recovery as calmer wave conditions allowed material to be redeposited onshore.



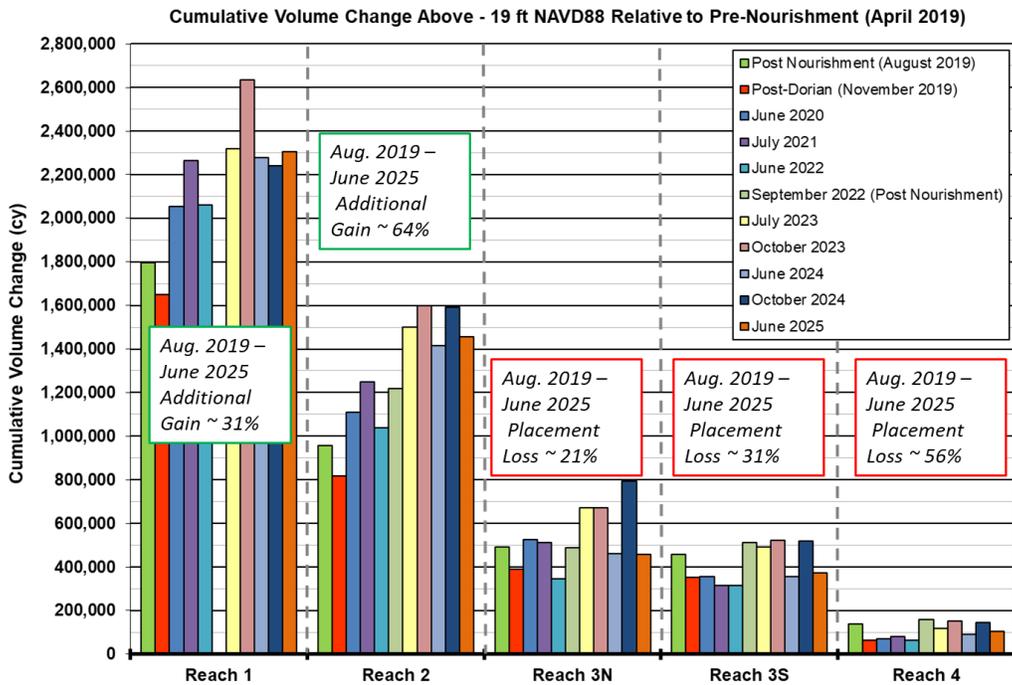
**Figure ES-1. Nourished Oceanfront Average Shoreline Change Relative to Pre-Nourishment Conditions**

**Figure ES-2** presents the volume changes relative to pre-nourishment conditions (April 2019) above six elevations along the Nourished Oceanfront. The results show material losses at MHW and -6 ft NAVD88, reflecting the redistribution of sand to lower elevations. Since the completion of the 2019 nourishment project, approximately 690,045 cy (+13.0 cy/ft) of volume gain has been recorded above -19 ft NAVD88 along the Nourished Oceanfront. It is important to note that 614,106 cy of this total was placed during the 2022 Post-Dorian Renourishment project, indicating that without this effort, net material gains above -19 ft NAVD88 would have been minimal. These results highlight substantial cross-shore sand redistribution across the profile. Much of this material has shifted to lower elevations near the depth of closure, where it remains vulnerable to removal from the system during high-energy wave events.

**Figure ES-3** presents the volume changes above -19 ft NAVD88 relative to pre-nourishment conditions (April 2019) along the Nourished Oceanfront. Reach 1 and Reach 2 show volume gains above -19 ft NAVD88 when compared to pre-nourishment levels. In contrast, the remaining reaches experienced material losses, with Reach 3N and Reach 3S both losing less than 50% of the material placed during the 2019 nourishment. However, Reach 4 has undergone significant material loss, having lost 56% of the nourished material by the end of this monitoring period.



**Figure ES-2. Nourished Oceanfront Cumulative Volume Change Relative to Pre-Nourishment**



**Figure ES-3. Cumulative Volume Change Above -19 ft NAVD88 Relative to Pre-Nourishment**

Volume changes during the monitoring period indicated that the Nourished Oceanfront and Total Monitored Oceanfront both experienced slight gains in material above -19 ft NAVD88 indicating material staying in the Town’s sediment system. Key statistics for reaches along Nags Head along with the entire oceanfront shoreline were as follows:

**Table ES-1. Nags Head Shoreline and Average Unit Volume Change Statistics (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - North	430+00 - 495+00	6,500	15.3	-1.0	1.2	7.3	23.2	8.6	-18.6
Nags Head - Reach 1	495+00 - 790+00	29,500	10.5	-1.2	-1.1	4.7	14.2	0.9	-28.4
Nags Head - Reach 2	790+00 - 920+00	13,000	24.3	0.6	2.6	8.8	25.6	3.1	-22.6
Nags Head - Reach 3N	920+00 - 975+00	5,500	-9.1	-0.4	-6.5	1.1	18.2	-0.9	-26.0
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-8.4	-2.9	-9.4	-1.7	22.6	4.3	-18.5
Nags Head - Reach 4	1010+00 - 1025+00	1,500	13.5	-7.0	-9.2	-3.2	13.6	-4.5	-28.1
National Seashore North	1025+00 - 1200+00	17,500	8.4	1.6	1.7	0.9	26.8	8.1	-15.8
	Transects	Reach Length	weighted avg	weighted avg	weighted avg	weighted avg	weighted avg	weighted avg	weighted avg
<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>53,000</b>	<b>10.7</b>	<b>-1.0</b>	<b>-1.5</b>	<b>4.7</b>	<b>18.0</b>	<b>1.3</b>	<b>-26.1</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>10.5</b>	<b>-0.4</b>	<b>-0.6</b>	<b>4.0</b>	<b>20.4</b>	<b>3.5</b>	<b>-23.1</b>

\*National Seashore South Reach not included in the Total Monitored Oceanfront

**Table ES-2. Nags Head Cumulative Volume Change Statistics (June 2024 – June 2025)**

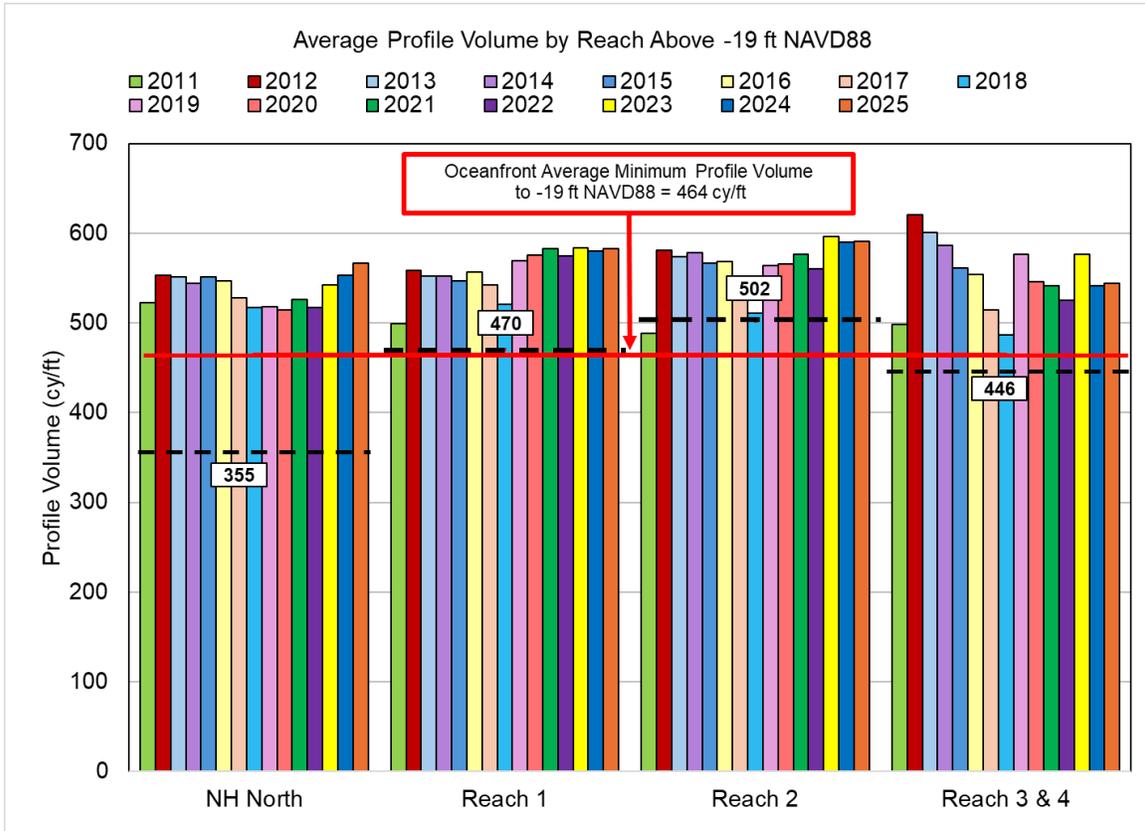
June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - North	430+00 - 495+00	6,500	-6,252	7,453	43,595	139,308	51,694	-111,459
Nags Head - Reach 1	495+00 - 790+00	29,500	-35,310	-32,976	140,064	418,863	26,444	-838,986
Nags Head - Reach 2	790+00 - 920+00	13,000	7,560	34,073	114,009	332,623	40,714	-293,675
Nags Head - Reach 3N	920+00 - 975+00	5,500	-2,328	-37,276	6,150	104,876	-5,007	-149,418
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-10,096	-32,747	-6,001	79,228	15,067	-64,643
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-12,200	-16,082	-5,613	23,818	-7,946	-49,186
National Seashore - North	1025+00 - 1200+00	17,500	28,326	29,343	15,080	468,948	142,184	-276,462
	Transects	Reach Length	total	total	total	total	total	total
<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>53,000</b>	<b>-52,375</b>	<b>-85,007</b>	<b>248,609</b>	<b>959,407</b>	<b>69,271</b>	<b>-1,395,908</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>-30,301</b>	<b>-48,211</b>	<b>307,285</b>	<b>1,567,664</b>	<b>263,149</b>	<b>-1,783,829</b>

\*National Seashore South Reach not included in the Total Monitored Oceanfront

During the June 2024–June 2025 monitoring period, the Nags Head shoreline exhibited an overall seaward advancement, with the nourished oceanfront averaging +10.7 ft at MHW. Reach 2 showed strong shoreline accretion (+24.3 ft), while Reach 3 North and Reach 3 South experienced modest recession (-9.1 ft and -8.4 ft, respectively). All nourished reaches displayed seaward advancement between October 2024 and June 2025, indicating shoreline recovery during the winter–summer portion of the current monitoring period following the erosive conditions of the prior year.

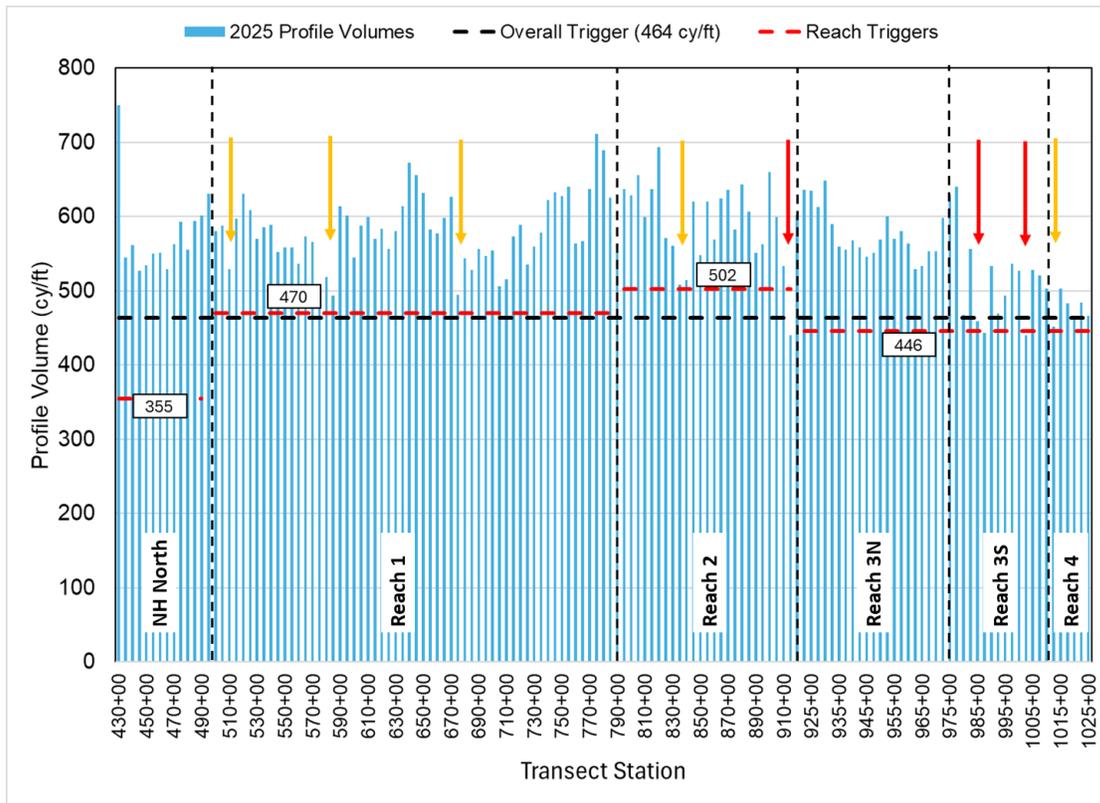
In terms of volume, the nourished oceanfront experienced its largest gains above -14 ft NAVD88 (+959,407 cy, or +18 cy/ft), consistent with widespread sandbar growth across the system. Smaller gains above -19 ft NAVD88 (+69,271 cy) suggest that sediment remained within the system while being redistributed across the profile. Subaerial elevations (+6 ft NAVD88 and MHW) showed net losses, while gains at -6 ft NAVD88 largely reflect profile flattening following the highly erosive June 2023–June 2024 period. Narrow beach conditions during that time allowed waves to reach the dune and berm, redistributing material into the nearshore. The ongoing volume losses below -30 ft NAVD88 across all reaches suggest a system-wide trend of sediment redistribution, likely driven by alongshore transport beyond the depth of closure.

The Town adopted a Multi-Decadal Beach Nourishment Master Plan (Master Plan) in July 2024. This Master Plan included development of volumetric triggers for beach nourishment, based on the profile volume from the landward crest of the primary dune to the outer bar, above the -19 ft NAVD88 elevation. This sand volume was modeled to provide a Level of Protection (LoP) from a 25-year storm. **Figure ES-4** presents the historical and current status of the average profile volumes per reach compared to the volumetric triggers (continuous red and black dashed lines).



**Figure ES-4. Master Plan Nourishment Trigger Volume Comparison**

All management reaches currently contain average profile volumes above the nourishment triggers, however, there have been localized erosion hotspots observed along the Town’s shoreline in the summer of 2025. To more closely examine the current status of the beach, the profile volumes from all transects as of June 2025 are presented in **Figure ES-5**. Localized segments of Reaches 2 and 3 have profiles below the trigger volumes (red arrows), and additional localized segments of Reaches 1, 2 and 4 are close to the triggers (yellow arrows).



**Figure ES-5. 2025 Beach Profile Volumes and Master Plan Trigger Volume Comparison. Red arrows indicate locations that are below the trigger volumes and yellow areas indicate areas that are close to the trigger volumes.**

Additionally, there have been losses of the recreational dry beach as measured by the distance from the MHW line to the +6 ft NAVD88 elevation throughout the Town. Results show gains in recreational beach width during the current monitoring year; however, several sections remain very narrow, particularly in Nags Head North Reach, Reach 1, and Reach 2. The narrowing of the dry beach increases the likelihood that dunes will be impacted by elevated water levels and wave events.

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## **1.0 OBJECTIVE**

The Town of Nags Head Beach Monitoring and Maintenance Plan is sponsored by the Town of Nags Head (Town) as a continuation of the 2011 monitoring program initiated for assessing beach conditions. The primary purpose of the program is to assess current and historical shoreline conditions, determine shoreline and volumetric changes and evaluate the performance of beach nourishment and other restoration efforts. Evaluating and documenting these changes consistently over successive years provides information necessary to plan for future beach nourishments and to support development of the Town's multi-decadal Beach Nourishment Master Plan.

The latest annual summer survey took place in June 2025 and was carried out by McKim & Creed. Furthermore, a fall survey, prompted by observed scarping along the Town's beachfront, was conducted by McKim & Creed in October 2024. This report outlines the data sources, methodologies, and findings of a survey evaluation conducted by Moffatt & Nichol. The evaluation compares the June 2025 survey to the data from October 2024 and June 2024 surveys.

## 2.0 SUMMARY OF PREVIOUS WORK

Moffatt & Nichol began preparing the Town’s annual beach and nearshore monitoring evaluations in 2020. At that time, Moffatt & Nichol reviewed previous beach monitoring studies performed by Coastal Science & Engineering Inc. (CSE) between 2010 and 2018 to gain an understanding of previous survey methods, associated coastal analysis, and observed trends. Shoreline and volume change data for each year was compared to an initial survey performed in 2010, taken before the 2011 beach nourishment project providing for some long-term analysis. **Figure 2-1** presents the extents of each of the monitoring shoreline reaches. **Table 2-1** shows the long-term volume changes from previous studies over the various reaches of shoreline.



**Figure 2-1: Monitoring Reaches Established Before 2020**

**Table 2-1. Long-term Volume Change (Previous Studies: 2010-2018)**

		Nov 2010- Nov 2011	Nov 2010- Jun 2012	Nov 2010- Nov 2012	Nov 2010- Jun 2013	Nov 2010- Jun 2014	Nov 2010- Jun 2015	Nov 2010- Jun 2016	Nov 2010- July 2017	Nov 2010- May 2018
		cy	cy							
<b>Dune to +6 ft NAVD88</b>	Reach 1 (495- 790)	135,789	213,713	124,589	344,963	456,407	466,904	505,144	551,781	526,825
	Reach 2 (790-920)	117,999	164,846	145,705	254,009	287,513	281,663	302,382	328,262	293,650
	Reach 3 (920-1010)	85,345	100,273	144,338	243,163	221,848	211,574	221,481	237,733	227,253
	Reach 4 (1010-1025)	10,824	17,767	13,678	26,771	35,216	18,915	5,486	9,292	2,746
	<b>Project Oceanfront</b>	<b>349,957</b>	<b>496,599</b>	<b>428,310</b>	<b>868,906</b>	<b>1,000,984</b>	<b>979,056</b>	<b>1,034,493</b>	<b>1,127,068</b>	<b>1,050,474</b>
<b>Dune to -6 ft NAVD88</b>	Reach 1 (495- 790)	1,138,026	1,032,425	1,014,648	1,219,411	1,085,981	1,079,356	1,086,961	1,194,858	985,588
	Reach 2 (790-920)	967,742	902,188	883,008	1,002,007	844,702	809,453	783,717	721,915	599,858
	Reach 3 (920-1010)	1,026,681	904,870	789,190	823,748	669,903	658,157	579,130	604,978	420,428
	Reach 4 (1010-1025)	110,880	118,284	93,392	90,268	77,033	31,752	29,024	22,168	-14,344
	<b>Project Oceanfront</b>	<b>3,243,329</b>	<b>2,957,767</b>	<b>2,780,238</b>	<b>3,135,434</b>	<b>2,677,619</b>	<b>2,578,718</b>	<b>2,478,832</b>	<b>2,543,919</b>	<b>1,991,530</b>
<b>Dune to -19 ft NAVD88</b>	Reach 1 (495- 790)	1,700,982	2,101,133	1,713,410	1,911,609	1,908,360	1,790,705	2,088,642	1,699,296	1,053,383
	Reach 2 (790-920)	1,297,082	1,373,586	1,141,685	1,292,398	1,346,691	1,268,412	1,305,026	888,118	573,200
	Reach 3 (920-1010)	1,281,379	1,296,493	1,003,944	1,137,586	1,025,817	799,182	760,191	408,100	157,253
	Reach 4 (1010-1025)	173,344	207,830	176,447	137,614	114,850	61,492	16,051	-59,743	-114,154
	<b>Project Oceanfront</b>	<b>4,452,787</b>	<b>4,979,042</b>	<b>4,035,486</b>	<b>4,479,207</b>	<b>4,395,718</b>	<b>3,919,791</b>	<b>4,169,910</b>	<b>2,935,771</b>	<b>1,669,682</b>

### 3.0 SURVEY PROCEDURES AND DATA PROCESSING

#### 3.1 Survey Transects and Reaches

The present monitoring survey and evaluation continue to use the existing transect lines and origins established by CSE in monitoring periods prior to 2020. Additional monitoring transects were added in 2020 as recommended by Moffatt & Nichol to better understand sand movement and trends at hotspots and along the National Seashore shoreline south of the Town limits. McKim & Creed conducted the summer 2025 survey in June 2025, including both the additional transects and the previously established transect lines. **Figure 3-1** shows the location of the original and additional survey lines and origins applied by McKim & Creed and Moffatt & Nichol. **Figure 3-2** shows the survey lines used in the fall 2024 monitoring survey. As shown, survey transect lines were stationed from north to south along Nags Head. A summary of streets/landmarks present at the start and end of each reach are provided in **Table 3-1**.

**Table 3-1. Reach Start and End Points**

Reach	Stations	Length (ft)	Start Point	End Point
Nags Head - North	430+00-495+00	6,500	E 8 <sup>th</sup> Street	Bonnett Street
Reach 1	495+00-790+00	29,500	Bonnett Street	Governor Street
Reach 2	790+00-920+00	13,000	Governor Street	James Street
Reach 3 - North	920+00-975+00	5,500	James Street	Limulus Drive
Reach 3 - South	975+00-1010+00	3,500	Limulus Drive	Loon Court
Reach 4	1010+00-1025+00	2,000	Loon Court	National Park Shore "ramp one"
National Seashore - North	1025+00-1200+00	17,250	National Park Shore "ramp one"	North of Oregon Inlet Campground
National Seashore - South	1200+00-1290+00	9,000	North of Oregon Inlet Campground	Oregon Inlet

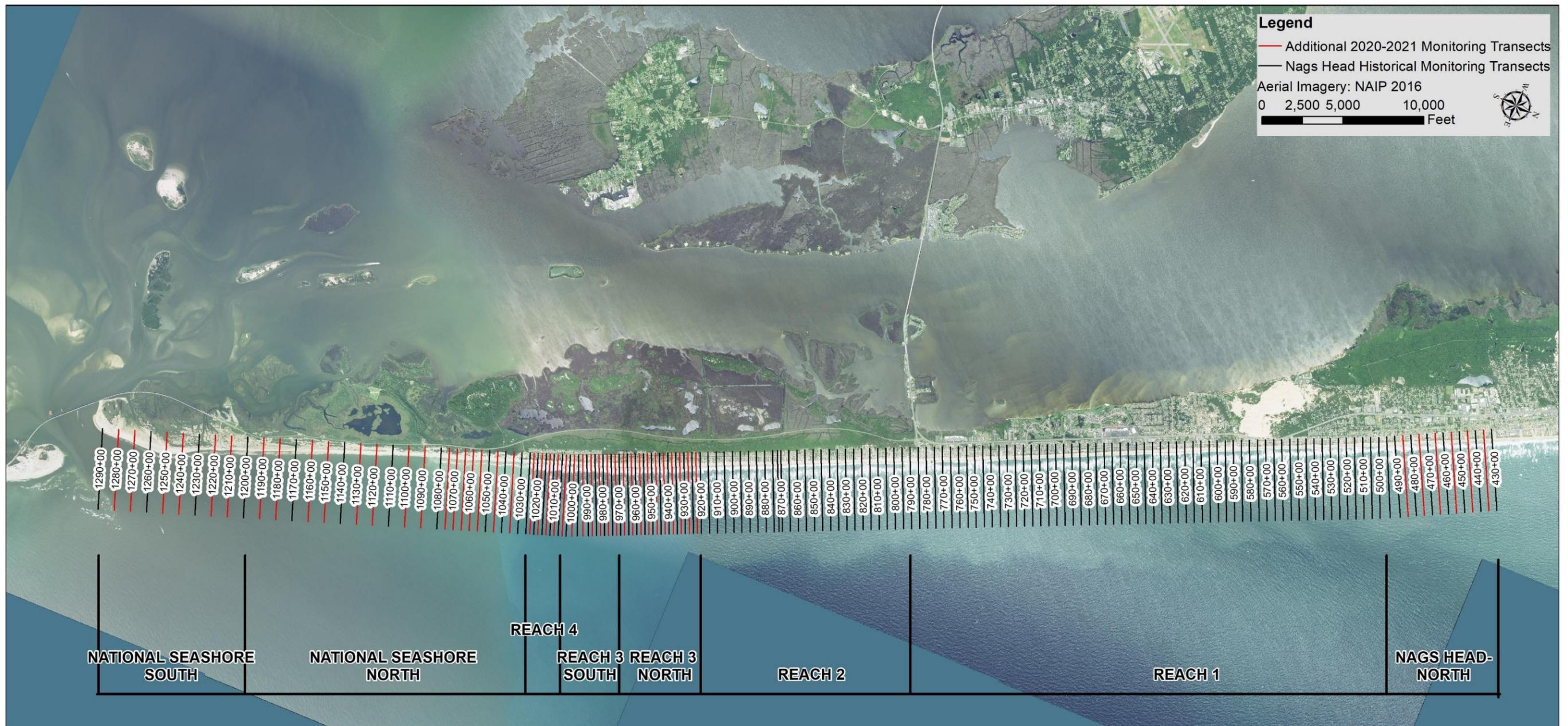


Figure 3-1. Nags Head Annual Monitoring Profile Line Locations

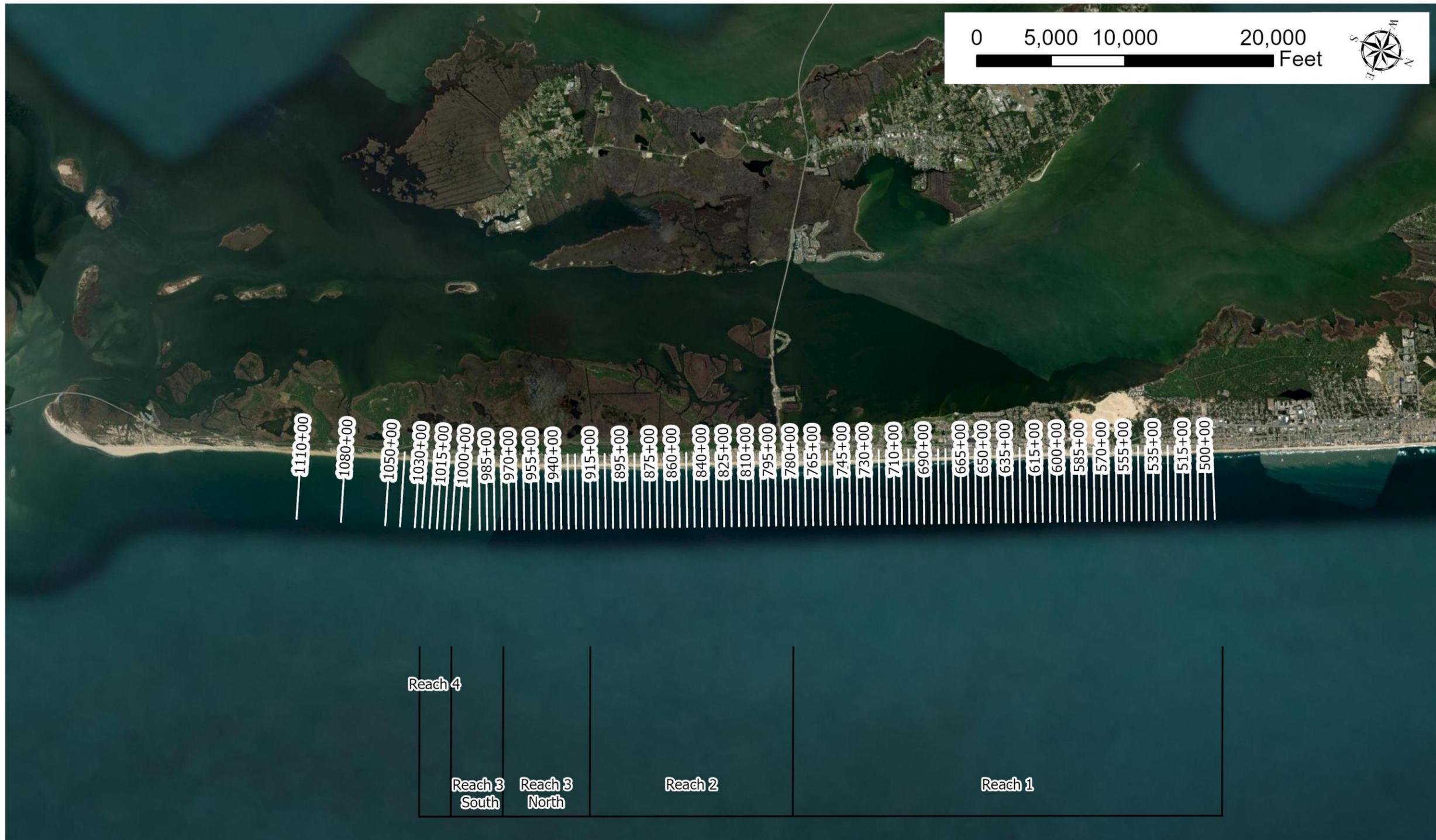


Figure 3-2. Nags Head 2024 Fall Monitoring Profile Line Locations

### 3.2 Survey Data Acquisition

To enable a reproducible and consistent result for the monitoring analysis, the survey events for each shoreline segment are assigned a single date for their completion. Assigning the survey date allows the determination of a consistent timeframe for each monitoring period between survey events for use in calculating shoreline and volumetric change rates. Surveys referenced during the current monitoring analysis include:

#### 2025 Annual Survey

The most recent annual survey data were collected by McKim & Creed between June 16 and June 22, 2025. For this report, June 22, 2025, is used as the representative date for the Nags Head profiles (see **Appendix A** for details).

#### 2024 Fall Survey

The fall 2024 survey was conducted from October 30 to November 1. For reporting purposes, October 31, 2024, was selected as the survey date, as the majority of data collection was completed on that day.

#### 2024 Annual Survey

The summer 2024 survey data was collected by McKim & Creed between June 18 and July 31. Fieldwork was paused on June 26 due to pending permission to survey within Cape Hatteras National Seashore. Once the permit was secured, the crew remobilized on July 29 and completed the 32 survey lines within the park by July 31. For this report, the 2024 Nags Head profile date is recorded as June 26, 2024, since all surveys within the town's boundaries were finished by that time (see **Appendix A** for details).

#### 2022 Post-Dorian Renourishment Project Pre and Post Construction Surveys

The Post-Dorian beach nourishment project was completed between July 2022 and August 2022. During the project, pre- and post-nourishment profiles were surveyed at 100 ft spacing, immediately before and after filling by Gahagan & Bryant Associates. Volume placed during the renourishment effort was determined using these surveys.

#### 2019 Pre – Nourishment Survey

Before the 2019 Beach Nourishment Project, CSE conducted a pre-nourishment survey in April 2019. The date used for the 2019 Nags Head profiles for this report is April 8, 2019.

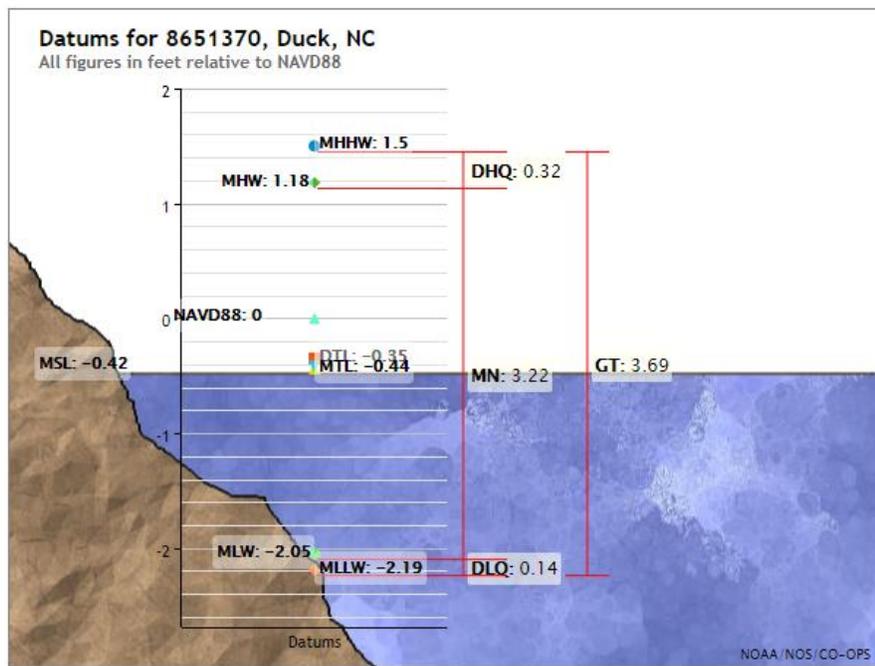
McKim & Creed provided the processed survey data to Moffatt & Nichol in ASCII (xyz), Excel (xyz), BMAP (free format), and GIS (shapefile, grid) formats allowing for compatibility with multiple programs. The data referenced the horizontal North American Datum 1983 (NAD83) State Plane North Carolina (U.S. survey feet) and elevations were provided in feet relative to the North American Vertical Datum of 1988 (NAVD88). A copy of the survey files is provided on the attached USB drive, which also includes photographs taken at each survey transect.

**Appendix A** includes the McKim & Creed 2024 and 2025 Field Reports, which provide detailed documentation of the singlebeam bathymetric and topographic data acquisition. The reports also describe the equipment used and the quality assurance/quality control (QA/QC) procedures implemented during data collection and processing.

## 4.0 SURVEY EVALUATION METHODS

### 4.1 Shoreline Change

Shoreline change designated at the MHW contour, defined as +1.18 ft NAVD88, was calculated at each transect between the June 2024 and June 2025 surveys as well as between the October 2024 and June 2025 surveys. The MHW elevation is based on a National Oceanic and Atmospheric Administration (NOAA) tidal benchmark at Duck, NC shown in **Figure 4-1**. The resulting values represent the shoreline change (ft) over the time between surveys.



**Figure 4-1. Tidal Datum for Duck, NC Station 8651370**

### 4.2 Volume Change

Representative volume changes were calculated at each transect for two time intervals: between the June 2024 and June 2025 surveys, and between the October 2024 and June 2025 surveys. To better assess the processes influencing both the onshore and offshore zones of Nags Head, volume changes were computed across six elevation ranges:

- above +6 ft NAVD88 (berm),
- above +1.18 ft NAVD88 (MHW),
- above -6 ft NAVD88 (wading depth),
- above -14 ft NAVD88 (outer bar),
- above -19 ft NAVD88 (depth of closure), and
- above -30 ft NAVD88.

For profiles that did not extend to -30 ft NAVD88, volume calculations were performed above -30 ft NAVD88 out to the extent of the shortest overlapping survey. **Figure 4-2** presents a graphical display of the various elevations for which volume change calculations were made.

As with the shoreline change analysis, the results represent volume change (cy/ft) over the period between surveys. These unit volume changes were also converted into cumulative changes for each management reach and for the entire shoreline. This was accomplished using the average end area method, whereby the unit volume changes (cy/ft) at each transect were integrated and summed between adjacent transects. The resulting totals represent the net loss or gain of material over the survey intervals, based on the applicable profile extents.

It is important to note that uncertainty in the hydrographic portion of the surveys can introduce significant variation in calculated volumetric change, particularly in offshore areas where the seafloor slope is gradual. For example, applying an uncertainty of  $\pm 0.11$  ft along the portion of the profile between the seaward side of the depth of closure (approximately 2,050 ft offshore) and a depth of -30 ft NAVD88 (approximately 2,950 ft offshore), across the 77,000 ft of oceanfront shoreline, results in a volumetric uncertainty of approximately  $\pm 282,300$  cy. Consequently, greater emphasis is placed on the volume change calculations above -19 ft NAVD88, where results are considered more reliable.

The profile volume calculation lenses (see **Figure 4-2**) were strategically selected to evaluate and track sand movement across both onshore and offshore portions of the profile. Volume changes above +6 ft NAVD88 and above mean high water (MHW; +1.18 ft NAVD88) are representative of material within the dune system and subaerial beach, areas that are highly sensitive to storm activity and critical to the beach and dune's capacity to mitigate storm surge and wave impacts on landward structures and infrastructure. Volume changes calculated above -6 ft NAVD88 (approximate wading depth) reflect changes in the recreational beach, while those above -14 ft NAVD88 track sand movement to and from the outer sand bar—an important consideration in planning future beach nourishment projects. Calculations above -19 ft NAVD88 provide general estimates of total volumetric change along the profile to the depth of closure, and calculations above -30 ft NAVD88 allow for complete assessment of offshore sand transport.

It should be noted that hydrographic survey accuracy can impact offshore volume change results. Nevertheless, this multi-lens approach provides a comprehensive framework to assess storm impacts on the subaerial beach and dune system, track offshore sand movement, and quantify overall sediment gains and losses across the entire profile.

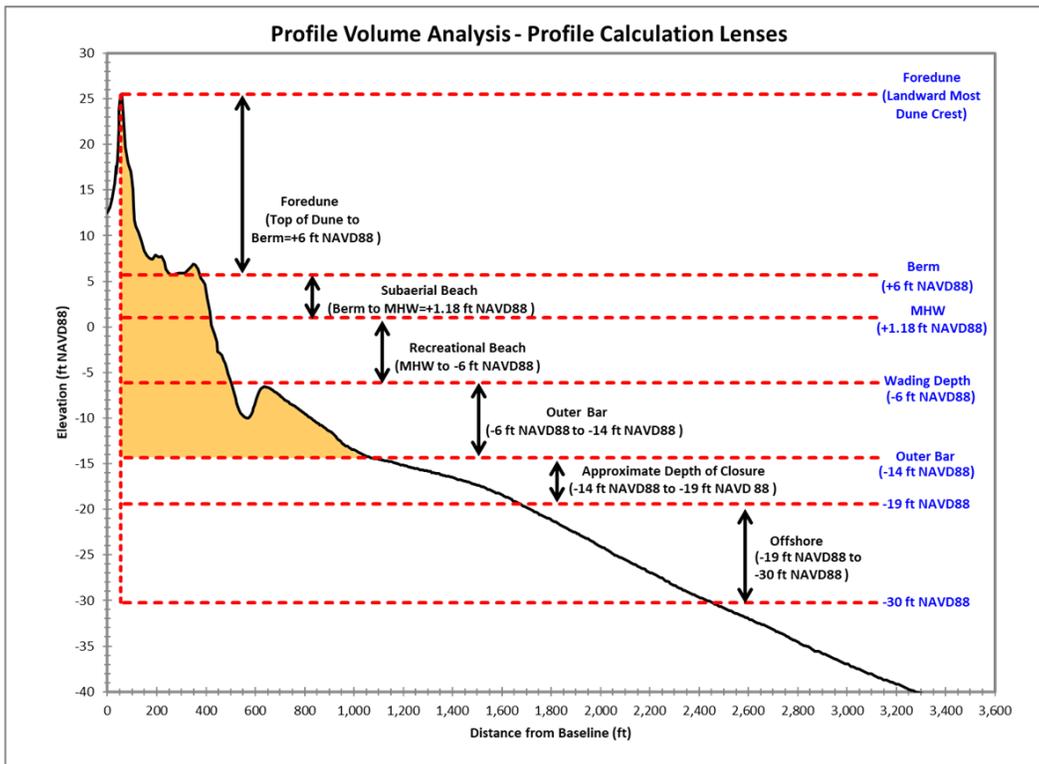


Figure 4-2. Profile Volume Calculation Lenses

## 5.0 DISCUSSION OF ANNUAL SURVEYING EVALUATION

This section covers significant events over the past year that have impacted the annual analysis, such as nourishment projects and storms. It also addresses the development of background erosion rates, trends in annual shoreline and volume changes (June 2024–June 2025), shoreline and volume changes observed between fall 2024 and summer 2025 (October 2024–June 2025), and long-term trends from 2011 through 2025.

### 5.1 Key Events During the Reporting Period

Beach changes are greatly influenced by natural and engineered processes. This section describes key events that occurred during the reporting period that likely had an impact on shoreline change as well as profile volume gains and losses.

#### 5.1.1 Sand Placement Events

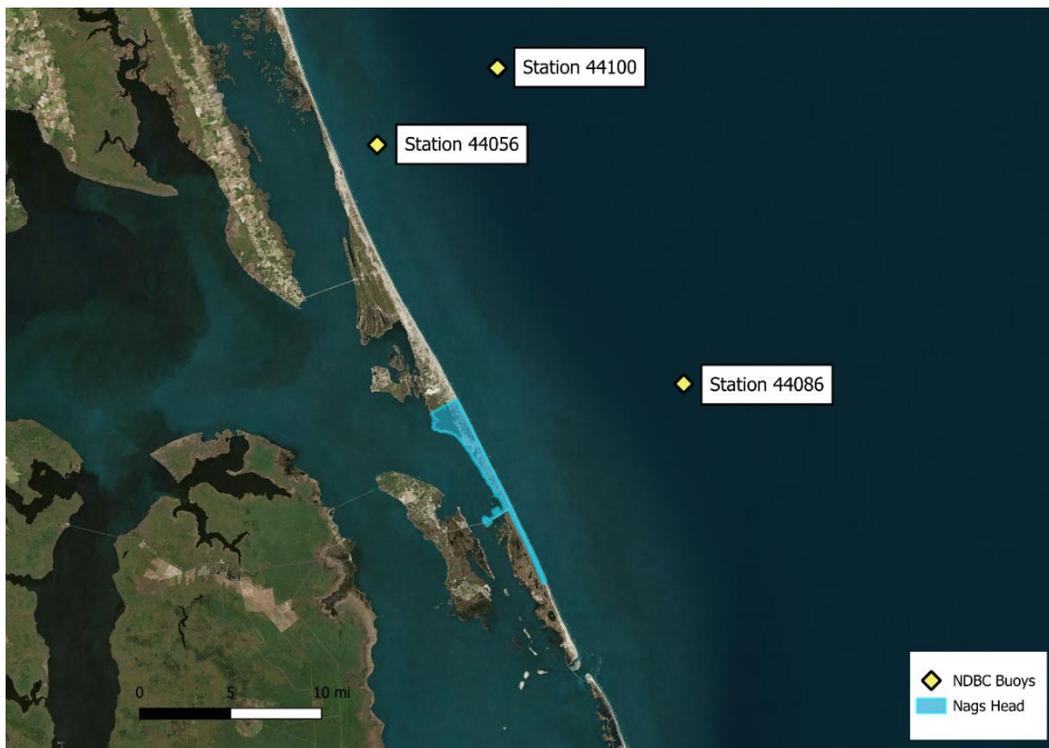
No sand placement events took place during the observation period. The most recent beach nourishment project, 2022 Post-Dorian Project commenced on July 22, 2022, right at the onset of the 2022 - 2023 monitoring period, and was successfully completed by August 29, 2022. During the project a total of 614,106 cy of material was placed along the four reaches of Nags Head. The specific placement volumes are presented in **Table 5-1**.

**Table 5-1. Project Volume Summary**

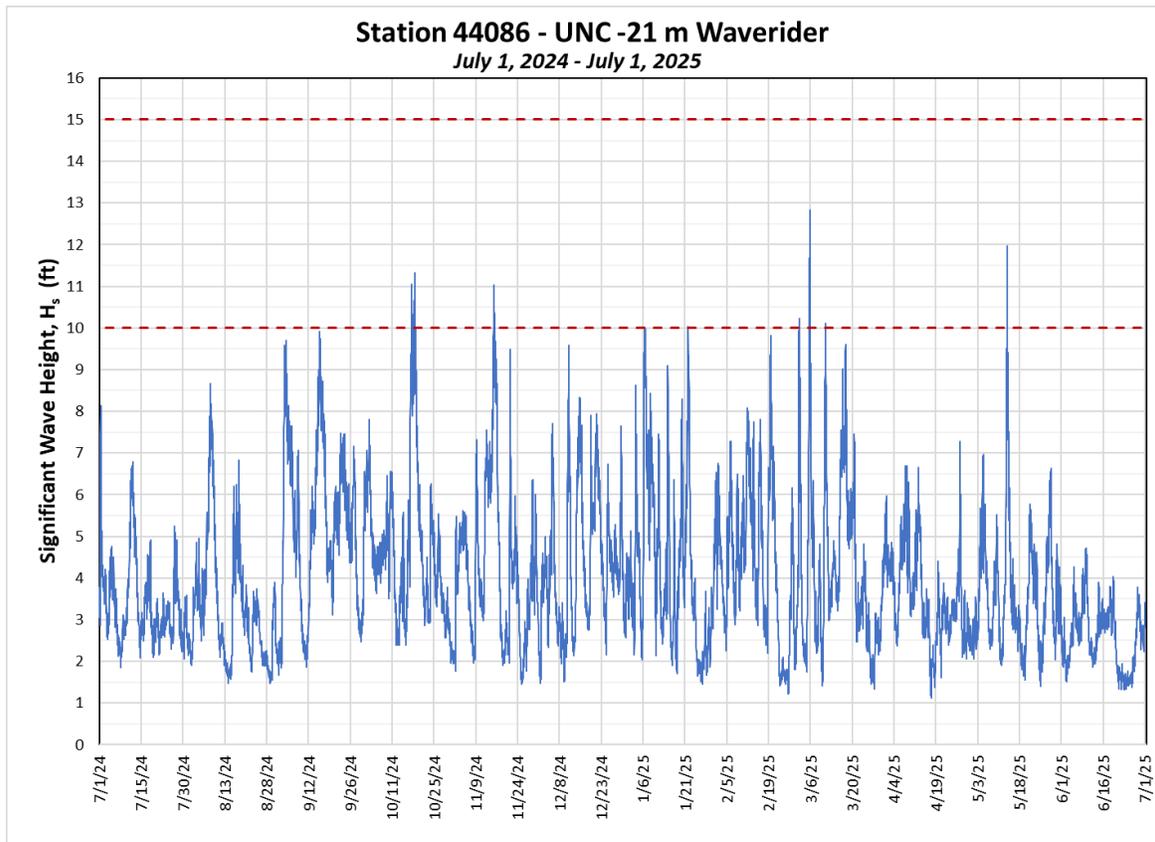
Reach	Length	Final Volume (cy)	Final Density (cy/ft)
Reach 2	13,000	179,355	13.8
Reach 3N	5,500	142,137	25.8
Reach 3S	3,500	198,441	56.7
Reach 4	2,000	94,173	47.1
<b>Total</b>	<b>24,000</b>	<b>614,106</b>	

### 5.1.2 Wave Climate and Storm Events

Nags Head is served by three nearby wave monitoring stations (see **Figure 5-1**). For this analysis, wave data from the National Data Buoy Center (NDBC) Station 44086, operated by the University of North Carolina Coastal Studies Institute and located approximately 10 miles offshore of the Town, were obtained for the period July 2024 through June 2025. The wave data were then plotted to analyze wave activity which may have impacted the Town. **Figure 5-1** shows the location of the buoys while **Figure 5-2** presents a plot of the wave heights during the reporting period.



**Figure 5-1. Wave Buoy Locations**

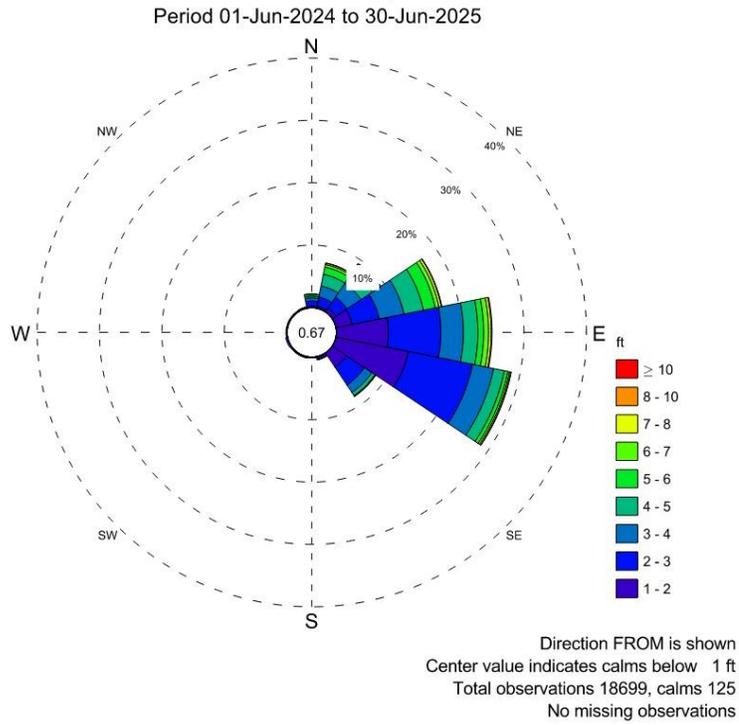


**Figure 5-2. UNC Station 44086 Wave Height**

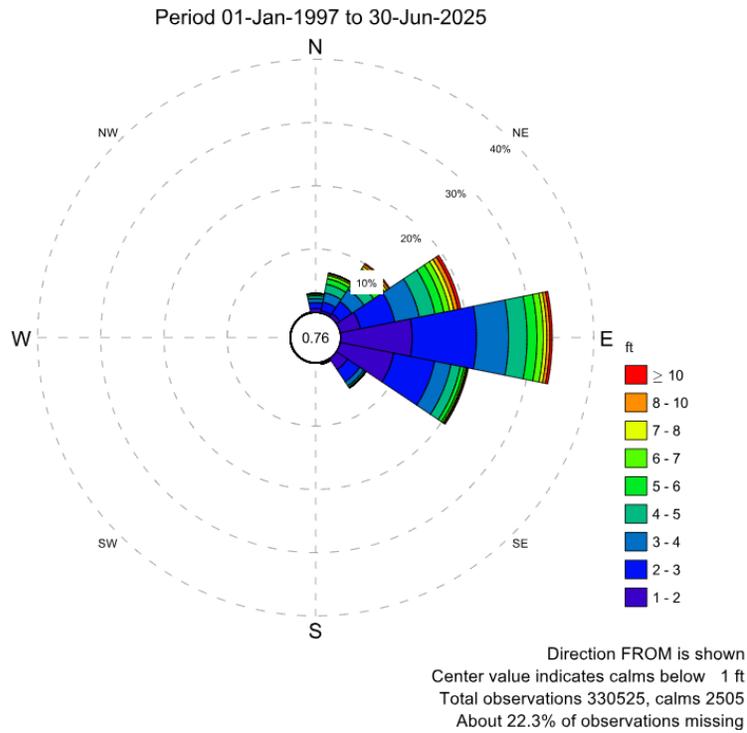
The data indicate a relatively calm wave climate during the monitoring period. In fall/winter 2024 (September–December), two wave events exceeded 10 ft. Potential Tropical Cyclone #8, which occurred in the second week of September, produced a peak significant wave height of 9.8 ft. During the winter storm season (January–May 2025), four events were recorded with wave heights ranging between 10 ft and 13 ft.

**Figure 5-3** and **Figure 5-4** present the directional wave roses for the annual monitoring period (July 2024–June 2025) and the long-term period (January 1997–June 2025), respectively, using data from Station 44056 (see **Figure 5-1**). Station 44056 was selected for directional analysis due to its extensive historical record, beginning in 1997, which provides a stronger basis for evaluating long-term wave trends.

Statistical analysis shows that in both periods, prevailing wave directions range from east-northeast to east-southeast. During the most recent year, however, the proportion of waves arriving from the east-southeast increased by approximately 8%, while waves from the east—typically more erosive—decreased by about 8%. This shift may suggest a recovery phase relative to the previous monitoring period (M&N, 2024).



**Figure 5-3. Station 44056 Significant Wave Height Rose from June 2024 – June 2025**



**Figure 5-4. Station 44056 Significant Wave Height Rose from January 1997 – June 2025**

## 5.2 Determination of Background Erosion Rates for Town of Nags Head (2011 – 2025)

To evaluate long-term trends in volume gains and losses, it is necessary to establish background erosion rates that exclude the influence of nourishment-related volume increases. Since the initiation of the beach monitoring program following the 2011 nourishment project, the Nags Head oceanfront has undergone two additional nourishment events: one in 2019 and another in 2022.

Table 5-2 shows the nourishment volume placed at each reach within the monitoring program since the 2011 nourishment project.

**Table 5-2. Nourishment Volumes Post-2011 by Management Reach**

Reach	Nourishment Volume 2019 (cy)	Nourishment Volume 2022 (cy)	Total Nourishment Volume (cy)
Nags Head - North	0	0	0
Nags Head - Reach 1	1,762,213	0	1,762,213
Nags Head - Reach 2	885,587	179,355	1,064,942
Nags Head - Reach 3N	576,703	142,137	718,840
Nags Head - Reach 3S	540,833	198,441	739,274
Nags Head - Reach 4	239,298	94,173	333,471
National Seashore - North	0	0	0
<b>Total</b>	<b>4,004,634</b>	<b>614,106</b>	<b>4,618,740</b>

Historical volume changes above -19 ft NAVD88 were documented from 2011 through 2025.

Table 5-3 presents the computed volume changes (inclusive of nourishment events) above -19 ft NAVD88 for the defined monitoring reaches during this period.

**Table 5-3. Volume Change by Reach Above -19 ft NAVD88**

Volume Change (cy)	Nags Head - North (430+00 - 495+00)	Nags Head - Reach 1 (495+00 - 790+00)	Nags Head - Reach 2 (790+00 - 920+00)	Nags Head - Reach 3N (920+00 - 975+00)	Nags Head - Reach 3S (975+00 - 1010+00)	Nags Head - Reach 4 (1010+00 - 1025+00)	National Seashore - North (1025+00 - 1200+00)	Nourished Oceanfront (495+00 - 1025+00)	Total Monitored Oceanfront (430+00 - 1200+00)
2011 - 2012	12,512	199,722	117,215	85,381	-32,942	71,930	107,833	441,306	441,306
2012 - 2013	459	-210,804	-195,136	-144,828	-48,873	-105,463	-235,944	-705,102	-705,102
2013 - 2014	-61,997	16,718	54,157	-13,818	-101,531	-14,079	153,705	-58,553	-58,553
2014 - 2015	42,855	-110,558	-81,138	-133,901	-89,412	-33,271	-442,192	-448,280	-448,280
2015 - 2016	-21,464	294,941	33,499	15,540	-54,799	-42,050	3,220	247,132	247,132
2016 - 2017	-107,963	-418,152	-429,523	-252,798	-104,590	-57,636	-470,987	-1,262,698	-1,262,698
2017 - 2018	-76,609	-644,783	-328,626	-168,797	-84,187	-31,569	-520,298	-1,257,961	-1,257,961
2018 - 2019	-273	1,441,871	696,896	423,513	383,465	136,047	-181,579	3,081,792	3,081,792
2019 - 2020	14,451	253,604	156,913	21,457	-106,581	-42,197	-93,041	283,196	283,196
2020 - 2021	82,466	205,765	143,886	10,346	-60,949	-11,624	610,231	287,425	287,425
2021 - 2022	-9,240	-210,748	-206,347	-159,340	-12,855	-8,292	284,283	-597,582	-597,582
2022 - 2023	156,991	259,165	461,067	327,560	179,797	54,562	500,960	1,282,153	1,282,153
2023 - 2024	57,395	-41,313	-85,912	-210,239	-136,136	-13,709	-324,824	-487,309	-487,309
2024 - 2025	51,694	26,444	40,714	-5,007	15,067	-7,946	142,184	69,271	69,271

To calculate the background erosion rate, the documented nourishment volumes were subtracted from total volume changes above -19 ft NAVD88 between 2012 and 2025 and annualized over the 13-year time period. It should be noted that changes from 2011 to 2012 were omitted from the background erosion calculations. This exclusion was necessitated by the delayed survey date of the 2011 survey and the identification of atypical erosion trends during this specific observation period. **Table 5-4** shows the average annual background erosion rates for each management reach of the Nags Head oceanfront. The average background erosion rate for the Town’s Nourished Oceanfront and the Total Monitored Oceanfront shoreline is approximately -6.1 cy/ft/yr and -4.6 cy/ft/yr, respectively. Nags Head Reaches 3N, 3S, and 4 have considerably higher background erosion rates than the remainder of the oceanfront shoreline, signifying these areas need to be monitored closely and taken into special consideration during future planning and nourishment efforts.

**Table 5-4. Average Annual Background Erosion Rates (2012 - 2025)**

Reach (Transects)	Length	Volume Change Above -19 ft NAVD88 (cy) 2012-2025	Nourishment Volume (cy)	Background Erosion (cy)	Average Annual Background Erosion Rates (cy/ft/yr)
Nags Head - North (430+00 - 495+00)	6,500	128,765	0	128,765	1.5
Nags Head - Reach 1 (495+00 - 790+00)	29,500	862,151	1,762,213	-900,062	-2.3
Nags Head - Reach 2 (790+00 - 920+00)	13,000	260,451	1,064,942	-804,491	-4.8
Nags Head - Reach 3N (920+00 - 975+00)	5,500	-290,311	718,840	-1,009,151	-14.1
Nags Head - Reach 3S (975+00 - 1010+00)	3,500	-221,583	739,274	-960,857	-21.1
Nags Head - Reach 4 (1010+00 - 1025+00)	1,500	-177,227	333,471	-510,698	-26.2
National Nearshore - North (1030+00 - 1200+00)	17,500	-574,282	0	-574,282	-2.5
<b>Nourished Oceanfront (495+00 - 1025+00)</b>	<b>53,000</b>	<b>433,482</b>	<b>4,618,740</b>	<b>-4,185,258</b>	<b>-6.1</b>
<b>Total Monitored Oceanfront (430+00 - 1200+00)</b>	<b>77,000</b>	<b>-12,035</b>	<b>4,618,740</b>	<b>-4,630,775</b>	<b>-4.6</b>

### **5.3 Nags Head Annual Shoreline and Volume Change Analysis (June 2024 – June 2025)**

This section discusses the results of the shoreline and volume change analysis for the defined monitoring reaches along Nags Head (see **Figure 3-1**). Key statistics were calculated to quantify average shoreline and volume changes for individual monitoring reaches as well as the entire oceanfront shoreline for Nags Head. The computed statistics include average shoreline change, average unit volume change, and cumulative volume change (e.g. total volume of material lost or gained along a section of shoreline). Evaluation of the computed statistics considers volume changes computed for portions of the profile above the berm (+6 ft NAVD88), above MHW (+1.18 ft NAVD88), above -6 ft NAVD88, above -14 ft NAVD88, above -19 ft NAVD88, and above -30 ft NAVD88 to better understand onshore and offshore processes.

**Appendix B** presents profile comparison plots for individual transects. These plots compare the summer 2024, October 2024 and summer 2025 surveys, alongside the after-dredge (AD) surveys following the 2022 Post-Dorian Renourishment project. **Appendix C** provides the computed shoreline changes and volume changes measured at each transect between the summer 2024 and the summer 2025 surveys in tabular format.

5.3.1 Nags Head - North Reach (June 2024 – June 2025)

The Nags Head – North survey reach extends approximately 6,500 ft between E 8<sup>th</sup> Street and Bonnett Street, containing 13 survey transects (Station 430+00 – 495+00) at approximately 1000 ft spacing (see **Figure 3-1**). A summary of average shoreline and volume changes between June 2024 and June 2025 for Nags Head – North in comparison with the Total Monitored Oceanfront is presented in **Table 5-5** and **Table 5-6**.

**Table 5-5. Average Shoreline and Average Unit Volume Change for Nags Head – North Reach (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - North	430+00 - 495+00	6,500	15.3	-1.0	1.2	7.3	23.2	8.6	-18.6
Total Monitored Oceanfront	430+00 - 1200+00	77,000	10.5	-0.4	-0.6	4.0	20.4	3.5	-23.1

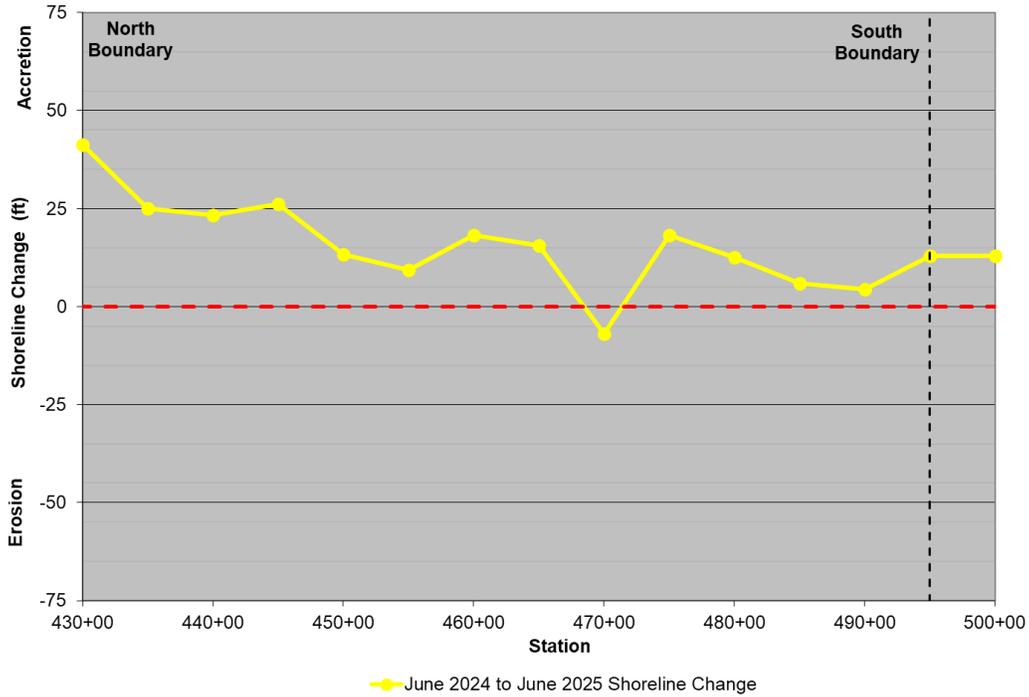
**Table 5-6. Cumulative Volume Change for Nags Head – North Reach (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - North	430+00 - 495+00	6,500	-6,252	7,453	43,595	139,308	51,694	-111,459
Total Monitored Oceanfront	430+00 - 1200+00	77,000	-30,301	-48,211	307,285	1,567,664	263,149	-1,783,829

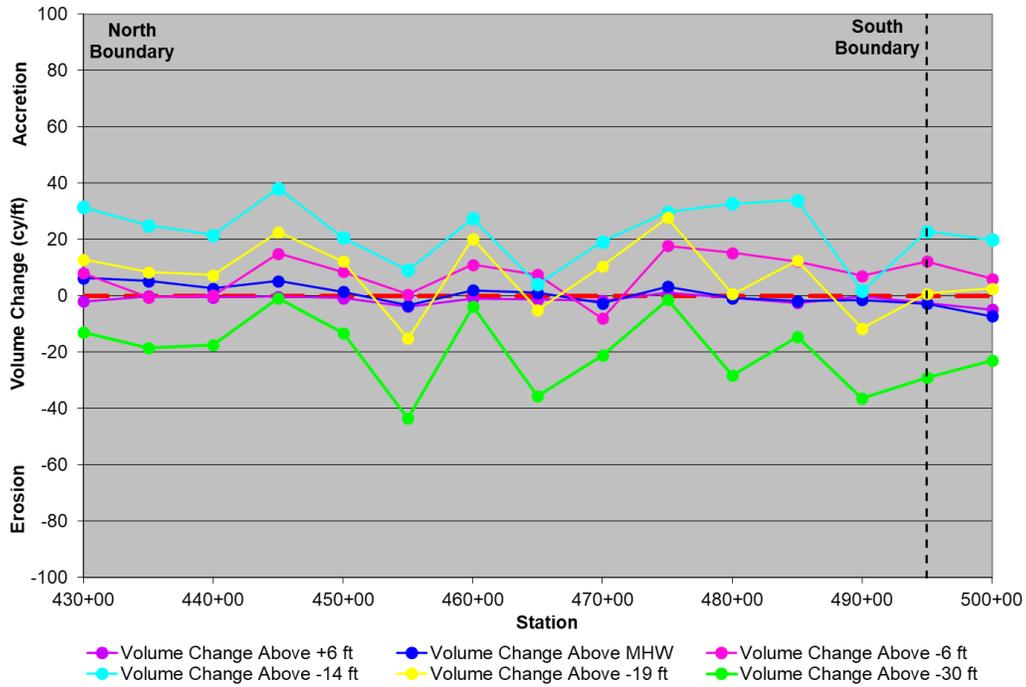
**Table 5-5** indicates that the North Reach experienced an average seaward advancement of 15.3 ft at the MHW shoreline over the past year. **Figure 5-5** shows shoreline change at each transect, with all but one transect advancing seaward.

Both **Table 5-5** and **Table 5-6** demonstrate that the North Reach generally experienced volume gains across most analyzed elevations, with the exception of +6 ft NAVD88 and -30 ft NAVD88. The most significant gains were observed above -14 ft NAVD88 (+139,308 cy, or +23.2 cy/ft). Losses observed between -19 ft NAVD88 and -30 ft NAVD88 may be partly attributed to shifts in wave direction driving alongshore sediment transport. Additionally, small survey uncertainties at depths below -30 ft NAVD88 can translate into disproportionately large volumetric differences due to the gradual seafloor slope.

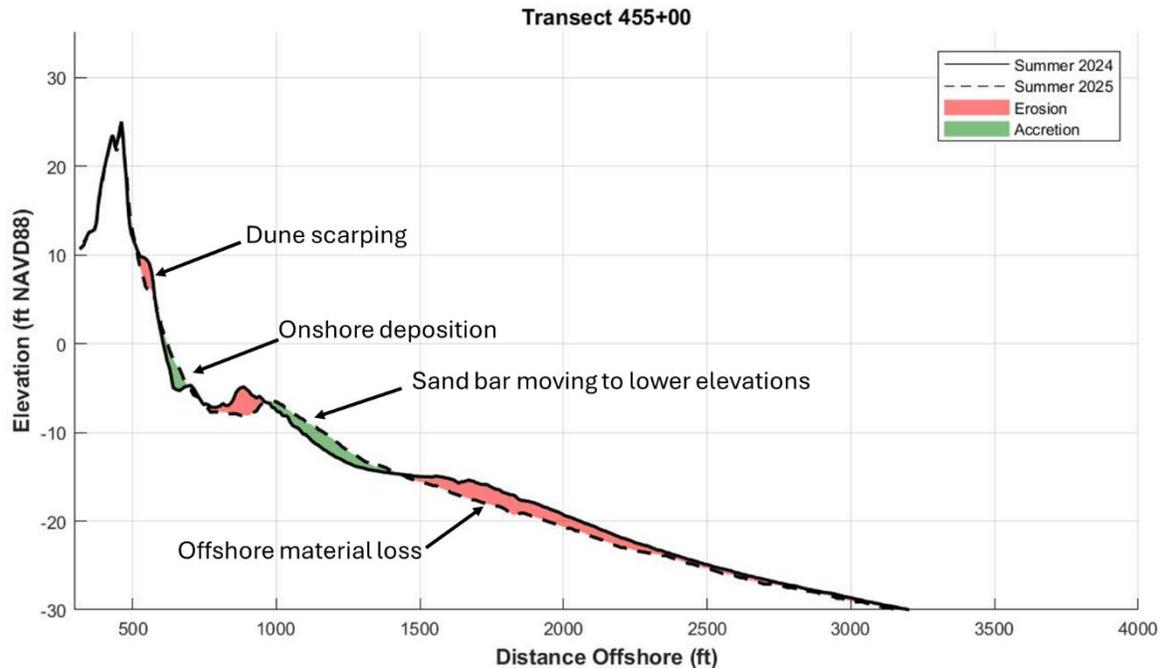
**Figure 5-6** illustrates unit volume changes by transect, showing gains across most monitoring elevations except at -30 ft NAVD88. Profile plots in **Appendix B** depict offshore bar migration and growth through sediment deposition, along with beach profile adjustments that include localized dune scarping, and onshore deposition contributing to shoreline advancement. **Figure 5-7** provides an example of these trends.



**Figure 5-5. Nags Head – North Shoreline Change (June 2024 – June 2025)**



**Figure 5-6. Nags Head – North Unit Volume Change (June 2024 – June 2025)**



**Figure 5-7. Example Nags Head – North Profile, Station 455+00 (E. Gallery Row)**

5.3.2 Nags Head - Reach 1 (June 2024 – June 2025)

The Nags Head – Reach 1 survey reach extends approximately 29,500 ft between Bonnett Street and Governor Street, containing 59 survey transects (Station 495+00 – 790+00), at 500 ft spacing (see **Figure 3-1**). A summary of average shoreline and volume changes between June 2024 and June 2025 for Reach 1 in comparison with the Total Monitored Oceanfront is presented in **Table 5-7** and **Table 5-8**. Additionally, Reach 1 was surveyed in October 2024. The volume and shoreline changes between the October 2024 survey and the June 2025 survey are detailed in **Table 5-9** and **Table 5-10**.

**Table 5-7. Average Shoreline and Average Unit Volume Change for Reach 1 (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 1	495+00 - 790+00	29,500	10.5	-1.2	-1.1	4.7	14.2	0.9	-28.4
Total Monitored Oceanfront	430+00 - 1200+00	77,000	10.5	-0.4	-0.6	4.0	20.4	3.5	-23.1

**Table 5-8. Cumulative Volume Change for Reach 1 (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 1	495+00 - 790+00	29,500	-35,310	-32,976	140,064	418,863	26,444	-838,986
Total Monitored Oceanfront	430+00 - 1200+00	77,000	-30,301	-48,211	307,285	1,567,664	263,149	-1,783,829

**Table 5-9. Average Shoreline and Average Unit Volume Change for Reach 1 (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 1	495+00 - 790+00	29,500	24.5	-0.2	3.1	0.0	4.6	2.2	-14.2
Nourished Oceanfront	495+00 - 1025+00	53,000	27.8	-0.6	2.6	0.9	4.1	-0.7	-15.7

**Table 5-10. Cumulative Volume Change for Reach 1 (October 2024 – June 2025)**

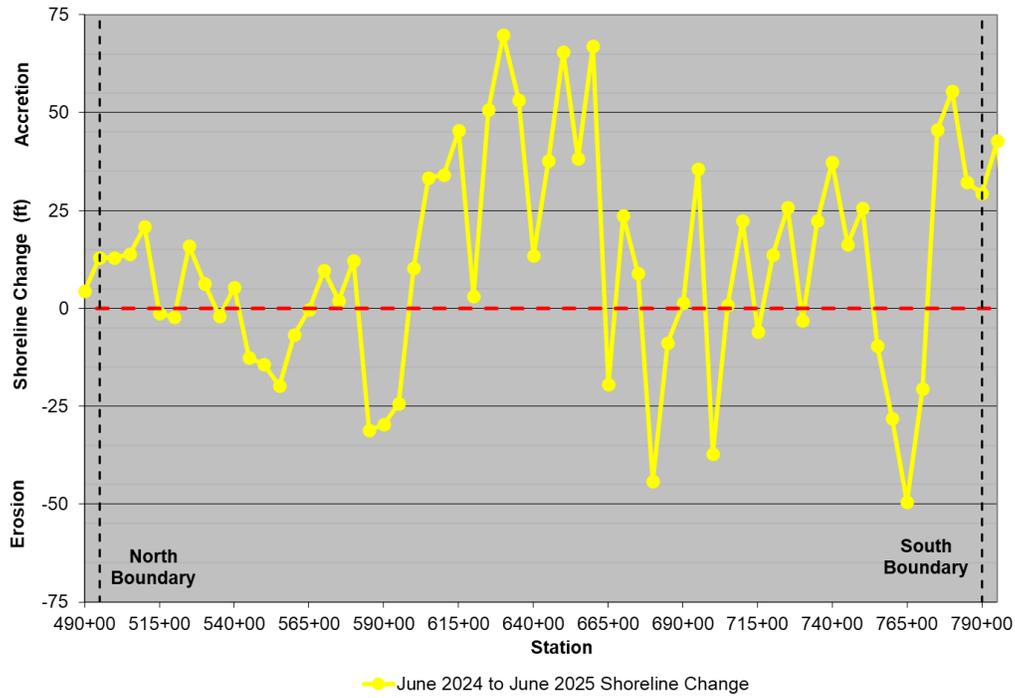
October 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 1	495+00 - 790+00	29,500	-7,010	88,532	2,368	139,635	64,700	-426,205
Nourished Oceanfront	495+00 - 1025+00	53,000	-32,732	132,108	47,115	215,249	-45,561	-857,084

The annual shoreline change at MHW showed an overall seaward advancement of 10.5 ft. The greater shoreline advance observed between October 2024 and June 2025 indicates recovery from the erosion that occurred between June and October 2024. **Figure 5-8** presents the shoreline changes at each transect from June 2024 to June 2025, showing considerable variability across the reach, ranging from -49.4 ft at Station 765+00 to +69.8 ft at Station 630+00.

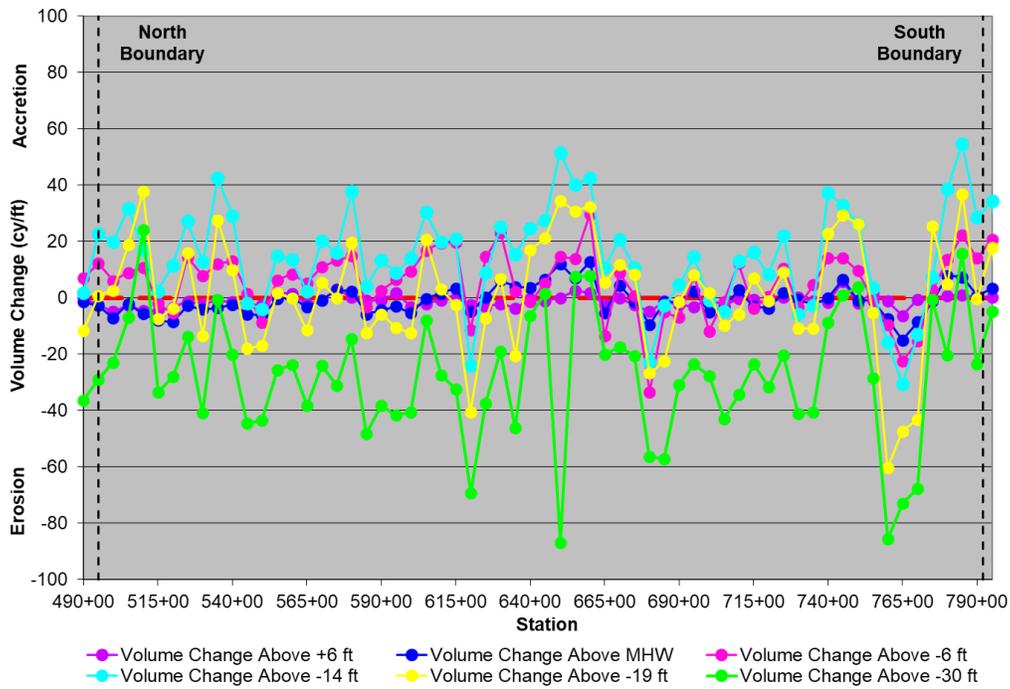
**Table 5-7** and **Table 5-8** indicate that Reach 1 experienced slight volume losses in the subaerial regions (above +6 ft NAVD88 and +1.18 ft NAVD88). At lower elevations, volume gains were recorded across most analyzed extents during the annual monitoring period, with the exception of -30 ft NAVD88, which showed a loss of -838,986 cy (-28.4 cy/ft). This offshore loss, also observed during the October 2024–June 2025 interval, may reflect alongshore sediment transport. The most significant gain occurred above -14 ft NAVD88 (+418,863 cy, or +14.2 cy/ft), with most of this recovery taking place prior to October 2024 during a calmer wave period that followed the unusually active summer of 2024. Smaller gains above -19 ft NAVD88 suggest that the increase above -14 ft NAVD88 is associated with sandbar migration and growth.

**Figure 5-9** illustrates unit volume change at each transect across the six elevation lenses. Results show that in localized areas (e.g., Station 685+00), dune scarping occurred, with material redistributed to the area above MHW. The plots also show consistent material losses between -19 ft NAVD88 and -30 ft NAVD88 across all transects, indicating alongshore sediment transport.

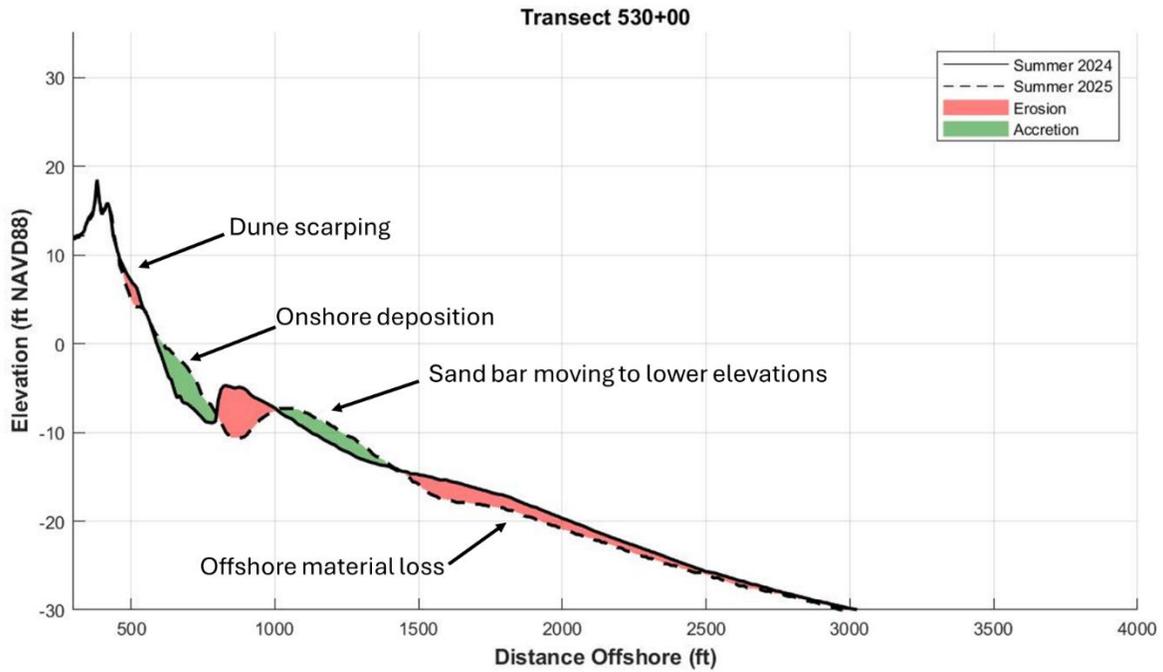
Profile comparisons in **Appendix B** further highlight spatial differences. In the northern portion, nearshore and sandbar material was deposited between MHW and -6 ft NAVD88, while the offshore bar dimensions remained relatively stable. By contrast, profiles in the southern portion show more pronounced sandbar growth, with minimal beachface deposition. **Figure 5-10** presents an example profile from the north of the reach, illustrating beachface deposition and offshore bar adjustments, with the bar migrating seaward to lower elevations. **Figure 5-11** provides an example from the southern reach, showing offshore bar growth and migration, with material contributions from both the nearshore and offshore zones.



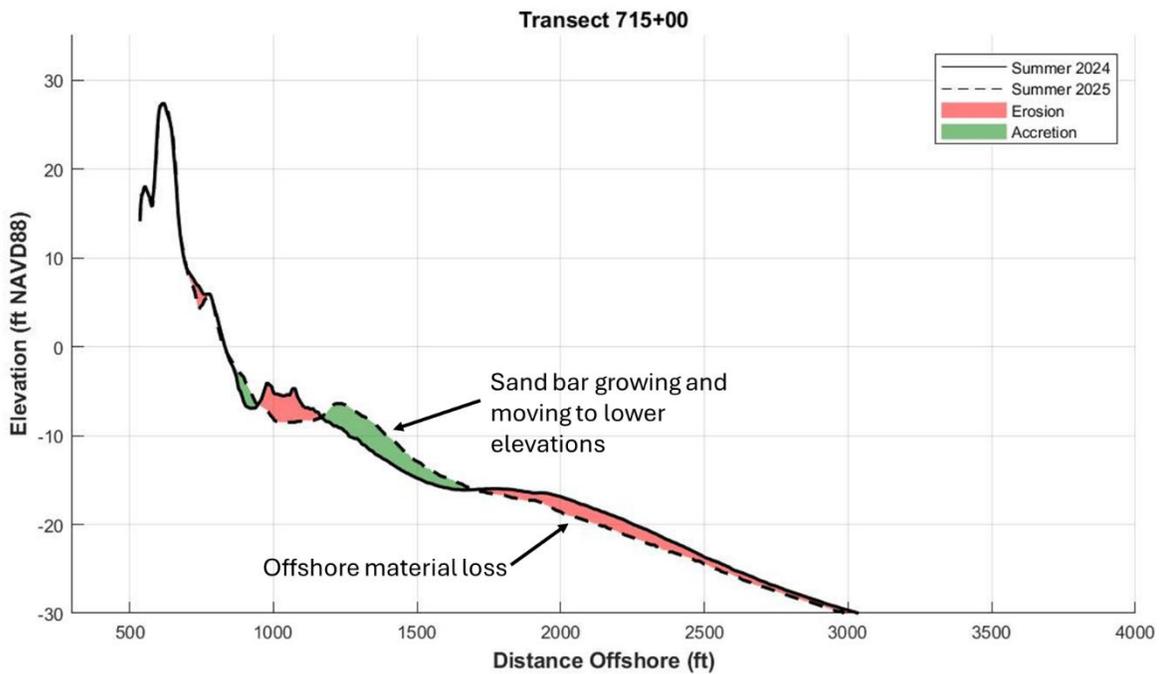
**Figure 5-8. Nags Head – Reach 1 Shoreline Change (June 2024 – June 2025)**



**Figure 5-9. Nags Head – Reach 1 Unit Volume Change (June 2024 – June 2025)**



**Figure 5-10. Example Reach 1 Profile, Station 530+00 (E Curlew St.)**



**Figure 5-11. Example Reach 1 Profile, Station 715+00 (E Sea Holly Ct.)**

5.3.3 Nags Head - Reach 2 (June 2024 – June 2025)

The Nags Head – Reach 2 survey reach extends approximately 13,000 ft between Governor Street and James Street, containing 26 survey transects (Station 790+00 – 920+00), at 500 ft spacing (see **Figure 3-1**). A summary of average shoreline and volume changes between June 2024 and June 2025 for Nags Head – Reach 2 in comparison with the Total Monitored Oceanfront is presented in **Table 5-11** and **Table 5-12**. Reach 2 was also surveyed during the October 2024 survey; the volume and shoreline changes observed between October 2024 survey and June 2025 survey are given in **Table 5-13** and **Table 5-14**.

**Table 5-11. Average Shoreline and Average Unit Volume Change for Reach 2 (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 2	790+00 - 920+00	13,000	24.3	0.6	2.6	8.8	25.6	3.1	-22.6
Total Monitored Oceanfront	430+00 - 1200+00	77,000	10.5	-0.4	-0.6	4.0	20.4	3.5	-23.1

**Table 5-12. Cumulative Volume Change for Reach 2 (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 2	790+00 - 920+00	13,000	7,560	34,073	114,009	332,623	40,714	-293,675
Total Monitored Oceanfront	430+00 - 1200+00	77,000	-30,301	-48,211	307,285	1,567,664	263,149	-1,783,829

**Table 5-13. Average Shoreline and Average Unit Volume Change for Reach 2 (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 2	790+00 - 920+00	13,000	40.0	-1.2	3.5	2.2	8.2	-0.4	-13.3
Nourished Oceanfront	495+00 - 1025+00	53,000	27.8	-0.6	2.6	0.9	4.1	-0.7	-15.7

**Table 5-14. Cumulative Volume Change for Reach 2 (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 2	790+00 - 920+00	13,000	-16,166	46,138	27,982	106,008	-5,174	-173,343
Nourished Oceanfront	495+00 - 1025+00	53,000	-32,732	132,108	47,115	215,249	-45,561	-857,084

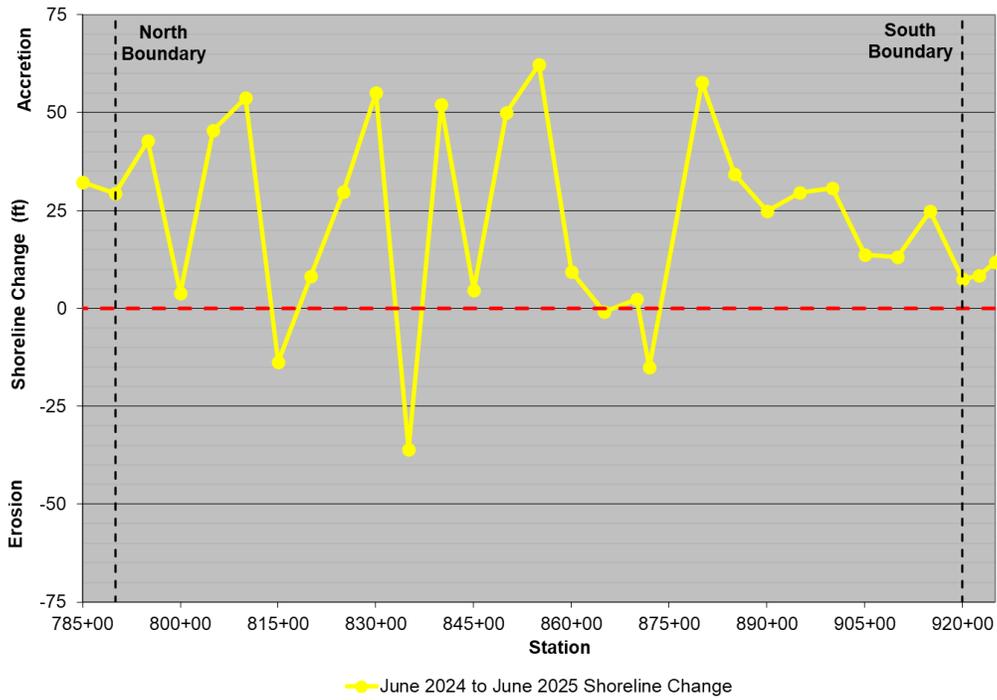
Shoreline change at MHW showed an overall accretion of +24.3 ft. Although the shoreline eroded between June 2024 and October 2024, subsequent shoreline advancement reflects recovery from the active wave climate of the June 2023–June 2024 monitoring period and continued seaward migration through October 2024–June 2025. **Figure 5-12** illustrates shoreline changes at each transect from June 2024 to June 2025, showing that the majority of transects experienced accretion. This seaward advancement is attributed to material transported onshore from lower elevations and deposited along the beachface.

**Table 5-11** and **Table 5-12** show that during the annual monitoring period, Reach 2 experienced volume gains at all elevations except above -30 ft NAVD88. The most significant gains occurred above -14 ft NAVD88 (+332,623 cy, or +25.6 cy/ft), while a smaller gain was observed above -19 ft NAVD88 (+40,714 cy, or +3.1 cy/ft). The combination of modest gains above -19 ft NAVD88 and significant losses below -30 ft NAVD88 suggests sediment movement beyond the depth of closure. This may be linked to shifts in wave direction during the period, driving material transport alongshore.

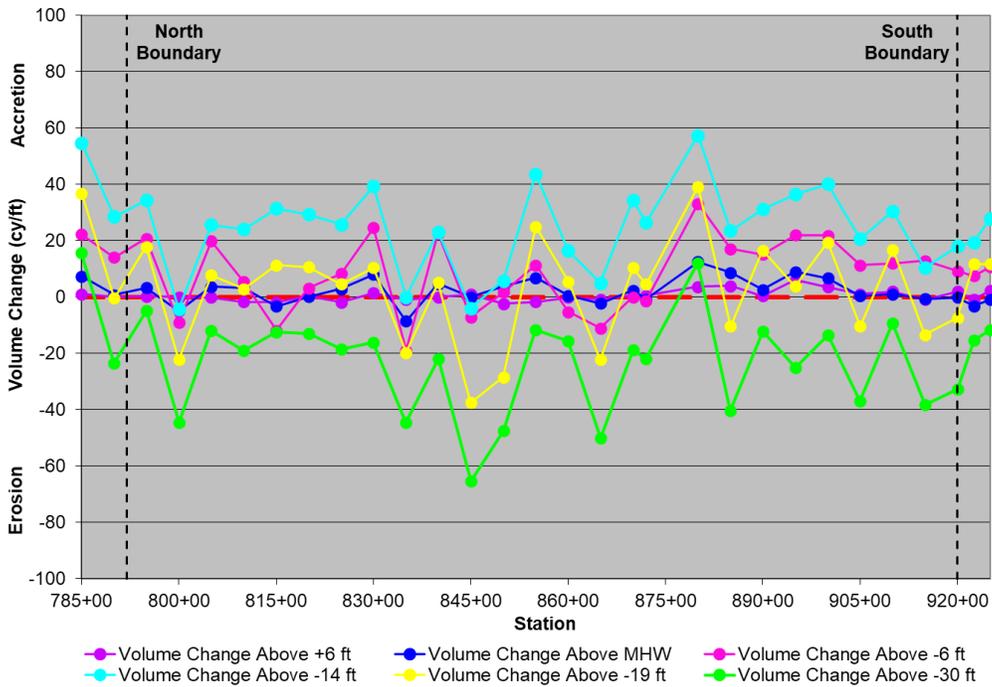
Similar to Reach 1, Reach 2 experienced most of its nearshore volume gains during the fall period, as the shoreline recovered from the active wave conditions of the previous monitoring cycle. Although waves in fall 2024 continued to erode the beachface and transport material to lower elevations, much of this sediment was retained within and above the sandbar. From October 2024 to June 2025, recovery continued, with some of the material lost above MHW during the fall period redeposited onto the beachface.

**Figure 5-13** shows the unit volume change at each transect across the six analyzed elevations. Nearly all transects experienced volume gains above -6 ft NAVD88 and -14 ft NAVD88, while consistent material losses were observed above -30 ft NAVD88 across the entire reach.

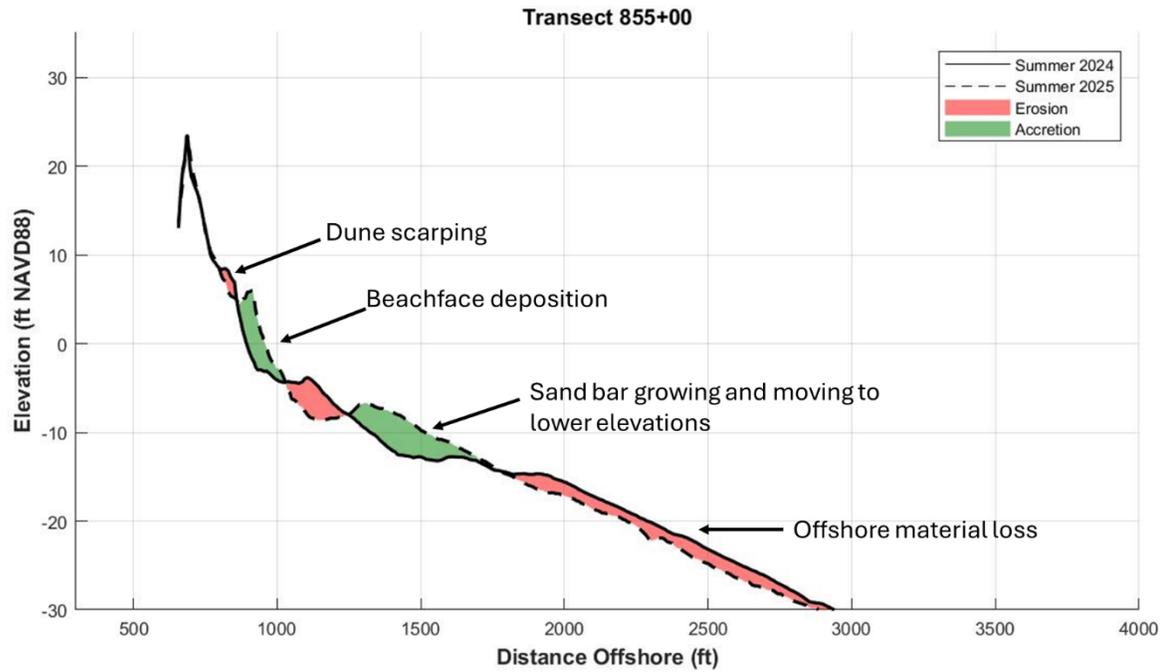
Profile plots in **Appendix B** show multiple instances of material deposition on the berm, contributing to shoreline accretion. At the same time, localized dune scarping is evident in several profiles. Similar to Reach 1, the sandbar migrated offshore and increased in size. **Figure 5-14** presents an example profile showing these trends.



**Figure 5-12. Nags Head – Reach 2 Shoreline Change (June 2024 – June 2025)**



**Figure 5-13. Nags Head – Reach 2 Unit Volume Change (June 2024 – June 2025)**



**Figure 5-14. Example Reach 2 Profile, Station 855+00 (Dunes South Condominium)**

5.3.4 Nags Head - Reach 3 - North (June 2024 - June 2025)

The Nags Head – Reach 3 - North survey reach extends approximately 5,500 ft between James Street and Limulus Drive, containing 22 survey transects (Station 920+00 – 975+00), at 500 ft spacing (see **Figure 3-1**). A summary of average shoreline and volume changes between June 2024 and June 2025 for Nags Head – Reach 3 - North in comparison with the Total Monitored Oceanfront is presented in **Table 5-15** and **Table 5-16**. Additionally, **Table 5-27** and **Table 5-28** summarizes the shoreline and volume changes between October 2024 and June 2025.

**Table 5-15. Average Shoreline and Average Unit Volume Change for Reach 3 - North (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 3 - North	920+00 - 975+00	5,500	-9.1	-0.4	-6.5	1.1	18.2	-0.9	-26.0
Total Monitored Oceanfront	430+00 - 1200+00	77,000	10.5	-0.4	-0.6	4.0	20.4	3.5	-23.1

**Table 5-16. Cumulative Volume Change for Reach 3 - North (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 3 - North	920+00 - 975+00	5,500	-2,328	-37,276	6,150	104,876	-5,007	-149,418
Total Monitored Oceanfront	430+00 - 1200+00	77,000	-30,301	-48,211	307,285	1,567,664	263,149	-1,783,829

**Table 5-17. Average Shoreline and Average Unit Volume Change for Reach 3 - North (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 3 - North	920+00 - 975+00	5,500	17.0	-0.7	-0.3	1.6	-4.8	-12.0	-27.0
Nourished Oceanfront	495+00 - 1025+00	53,000	27.8	-0.6	2.6	0.9	4.1	-0.7	-15.7

**Table 5-18. Cumulative Volume Change for Reach 3 - North (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 3 - North	920+00 - 975+00	5,500	-3,952	-3,293	9,106	-21,880	-66,471	-155,200
Nourished Oceanfront	495+00 - 1025+00	53,000	-32,732	132,108	47,115	215,249	-45,561	-857,084

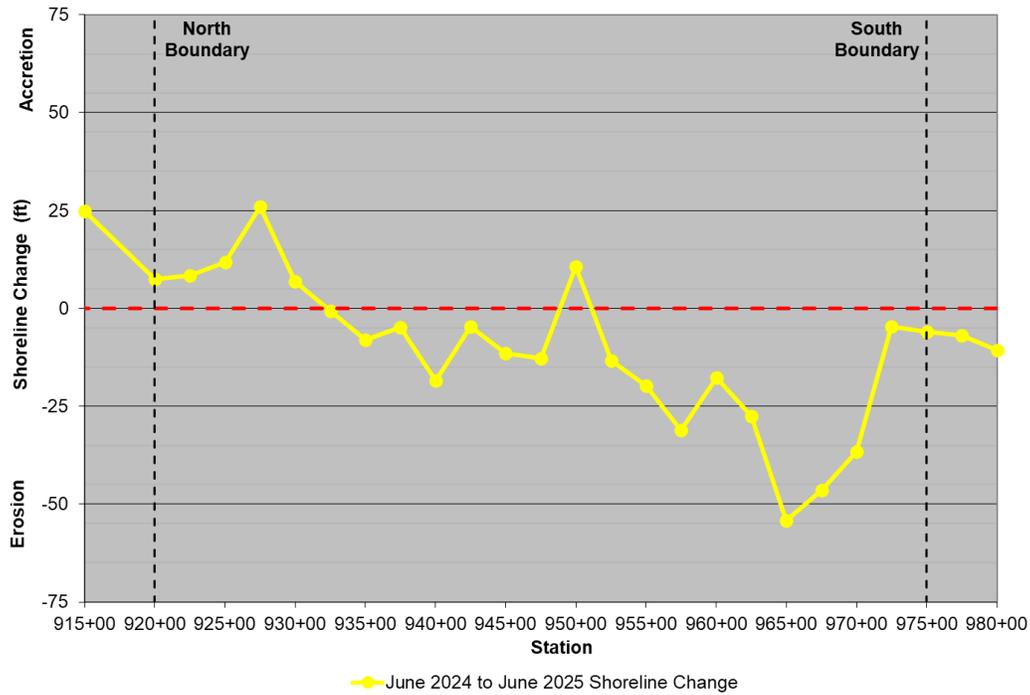
Between June 2024 and October 2024, Reach 3 – North experienced a shoreline recession of -26 ft, as waves continued to move material from the beachface to lower elevations. During the subsequent period (October 2024–June 2025), some of this material was redistributed landward, resulting in an average shoreline advancement of +17 ft. Overall, this equates to a net shoreline recession of -9.1 ft between June 2024 and June 2025. **Figure 5-15** illustrates shoreline changes at each transect during this period, with a primary recession trend evident south of Station 932+50.

**Table 5-15** and **Table 5-16** indicate that during the annual monitoring period, Reach 3 – North experienced minor volume losses at the subaerial elevations (+6 ft NAVD88 and MHW). At lower elevations, volume gains were observed above -6 ft NAVD88 and -14 ft NAVD88, associated with material deposited in the sandbar as it migrated offshore. The most significant gain occurred above -14 ft NAVD88 (+104,876 cy, or +18.2 cy/ft), consistent with trends observed in the previous reaches.

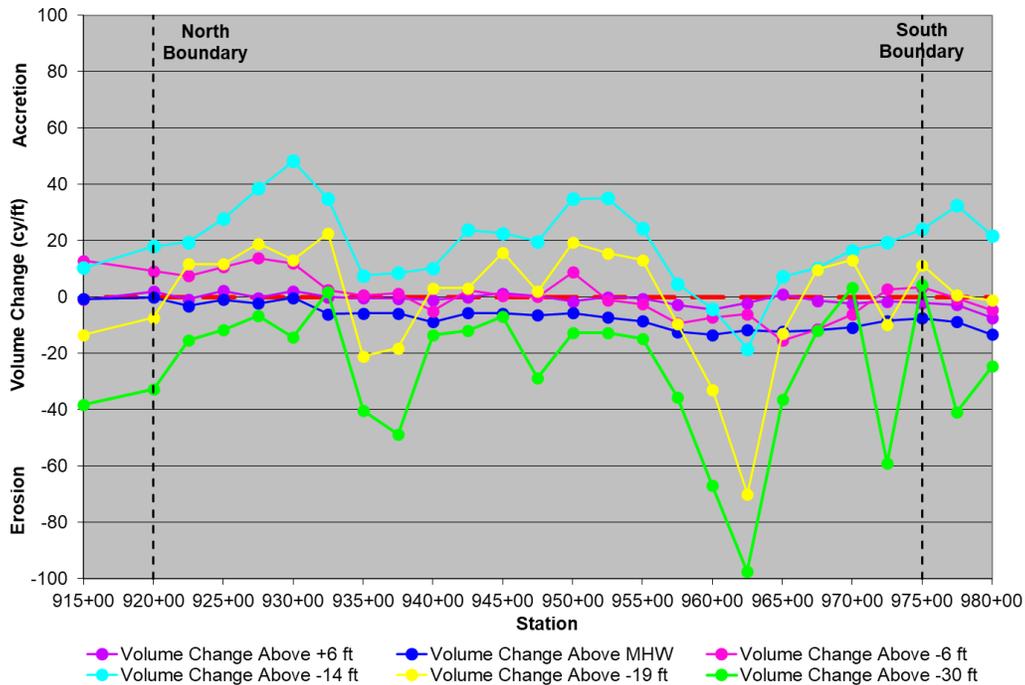
A minor volume loss was recorded above -19 ft NAVD88 during the monitoring period; however, this was substantially less than the average annual background erosion rate for Reach 3 – North (-15.2 cy/ft) (**Table 5-4**). This reduction is likely due to a combination of calmer wave energy conditions and a shift in prevailing wave direction toward the east-southeast. Similar to the other reaches, Reach 3 – North experienced volume losses below -30 ft NAVD88, which may be attributed to alongshore sediment transport.

**Figure 5-16** illustrates unit volume change at each transect across the six analyzed elevations. The majority of transects exhibited volume losses above MHW and above -30 ft NAVD88, while most showed gains above -14 ft NAVD88.

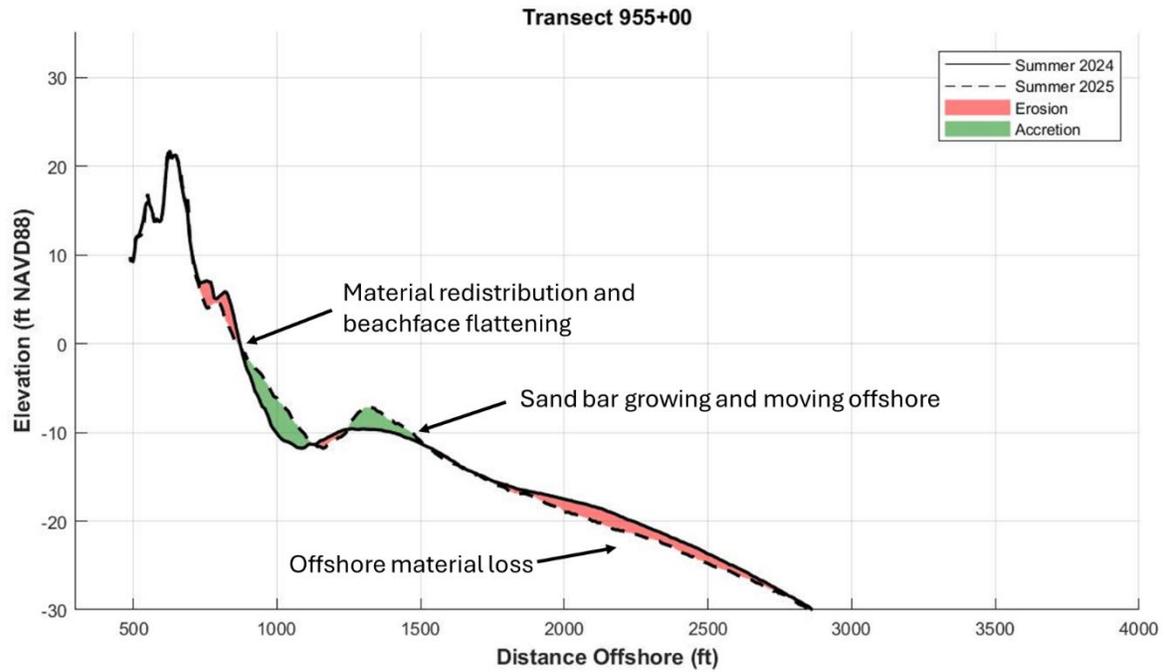
Profile plots in **Appendix B** show several instances of the offshore sandbar migrating seaward and increasing in size, while material from the beachface was redistributed to the nearshore, contributing to shoreline recession. **Figure 5-17** presents an example profile illustrating these trends.



**Figure 5-15. Nags Head – Reach 3 - N Shoreline Change (June 2024 – June 2025)**



**Figure 5-16. Nags Head – Reach 3 - N Unit Volume Change (June 2024 – June 2025)**



**Figure 5-17. Example Reach 3 - North Profile, Station 955+00 (E Surfside Dr.)**

5.3.5 Nags Head - Reach 3 - South (June 2024 – June 2025)

The Nags Head – Reach 3 - South survey reach extends approximately 3,500 ft between Limulus Drive and Loon Court, containing 14 survey transects (Station 975+00 – 1010+00) (see **Figure 3-1**). A summary of average shoreline and volume changes between June 2024 and June 2025 for Reach 3 – South in comparison with the Total Monitored Oceanfront is shown in **Table 5-19** and **Table 5-20**. Additionally, shoreline and volume changes in between October 2024 and June 2025 surveys are presented in **Table 5-21** and **Table 5-22**.

**Table 5-19. Average Shoreline and Average Unit Volume Change for Reach 3 - South (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 3 - South	975+00 - 1010+00	3,500	-8.4	-2.9	-9.4	-1.7	22.6	4.3	-18.5
Total Monitored Oceanfront	430+00 - 1200+00	77,000	10.5	-0.4	-0.6	4.0	20.4	3.5	-23.1

**Table 5-20. Cumulative Volume Change for Reach 3 - South (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 3 - South	975+00 - 1010+00	3,500	-10,096	-32,747	-6,001	79,228	15,067	-64,643
Total Monitored Oceanfront	430+00 - 1200+00	77,000	-30,301	-48,211	307,285	1,567,664	263,149	-1,783,829

**Table 5-21. Average Shoreline and Average Unit Volume Change for Reach 3 - South (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 3 - South	975+00 - 1010+00	3,500	34.6	-0.5	1.5	7.4	8.2	0.7	-13.3
Nourished Oceanfront	495+00 - 1025+00	53,000	27.8	-0.6	2.6	0.9	4.1	-0.7	-15.7

**Table 5-22. Cumulative Volume Change for Reach 3 - South (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 3 - South	975+00 - 1010+00	3,500	-1,890	5,362	25,768	28,652	2,309	-46,540
Nourished Oceanfront	495+00 - 1025+00	53,000	-32,732	132,108	47,115	215,249	-45,561	-857,084

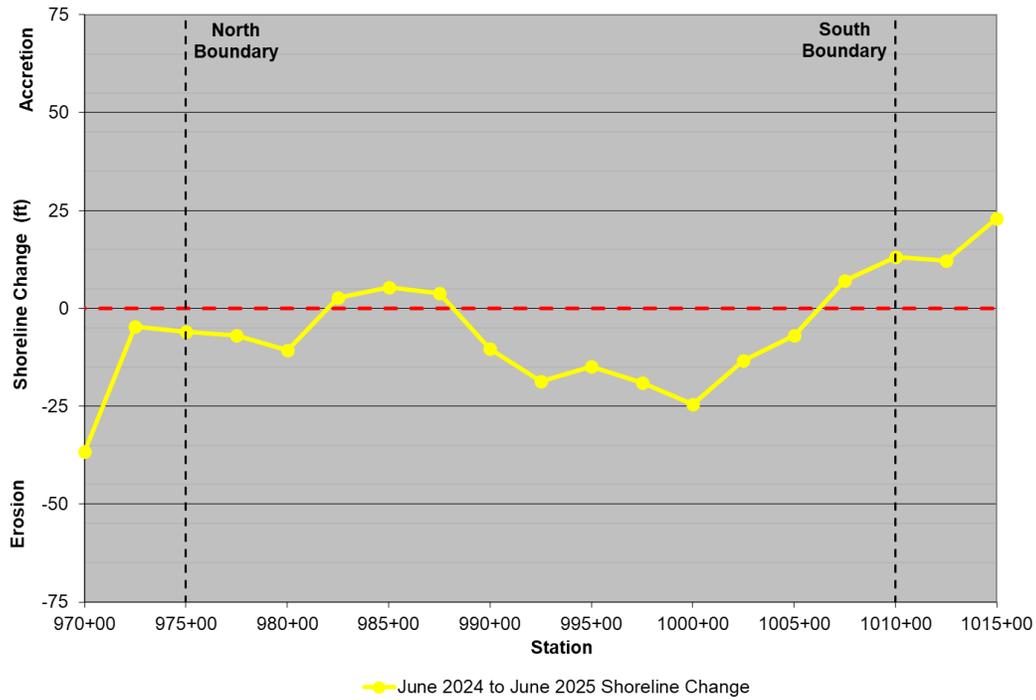
During the annual monitoring period, the shoreline at MHW experienced an overall recession of -8.4 ft. Similar to Reach 3 – North, most of this retreat occurred between June 2024 and October 2024 (-43.1 ft). From October 2024 to June 2025, the shoreline advanced seaward by +34.6 ft, reflecting recovery of material along the beachface. **Figure 5-18** illustrates shoreline changes at each transect from June 2024 to June 2025, showing recession across the majority of transects.

**Table 5-19** and **Table 5-20** indicate that Reach 3 – South experienced volume losses across most analyzed elevations, with the exception of -14 ft NAVD88 and -19 ft NAVD88. The most significant gain was recorded above -14 ft NAVD88 (+79,228 cy, or +22.6 cy/ft). A smaller gain was also observed above -19 ft NAVD88 (+15,067 cy, or +4.3 cy/ft), suggesting that changes within the depth of closure mainly reflect redistribution of material rather than net loss from the system. This trend is likely associated with the relatively calm wave climate during the monitoring period. As with the previous reaches, Reach 3 – South exhibited losses below -30 ft NAVD88, indicating that some material may have been transported alongshore and out of the reach.

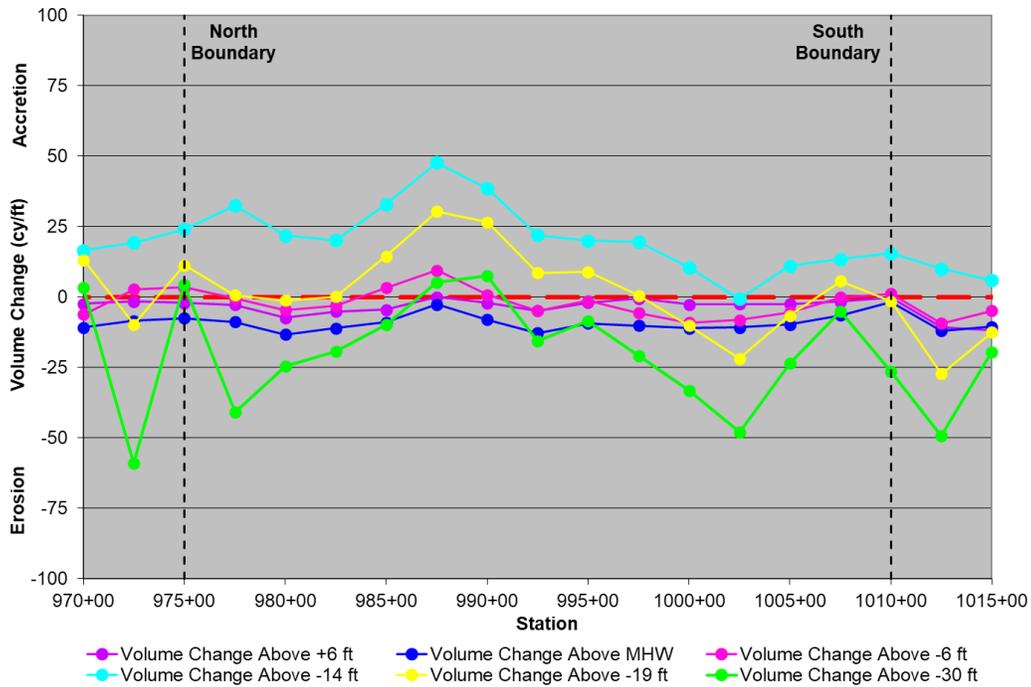
Reach 3 – South experienced volume losses at the subaerial elevations, primarily during June–October 2024, when waves displaced material from the beachface to lower portions of the profile. As sediment shifted offshore, the shoreline receded, and material from the beachface and dunes was redistributed seaward, resulting in localized dune scarping and narrowing of the recreational beach. Some beachface recovery was observed after October 2024; however, the beach face has not returned to June 2024 conditions.

**Figure 5-19** presents the unit volume change at each transect across the six analyzed elevations, showing widespread volume losses along the beachface. In contrast, gains were observed above -14 ft NAVD88 and -19 ft NAVD88. Profile plots in **Appendix B** illustrate material deposition between MHW and -10 ft NAVD88. At the southern transects, the offshore sandbar migrated seaward and increased slightly in size, while concurrent material losses from the dune and berm were also evident.

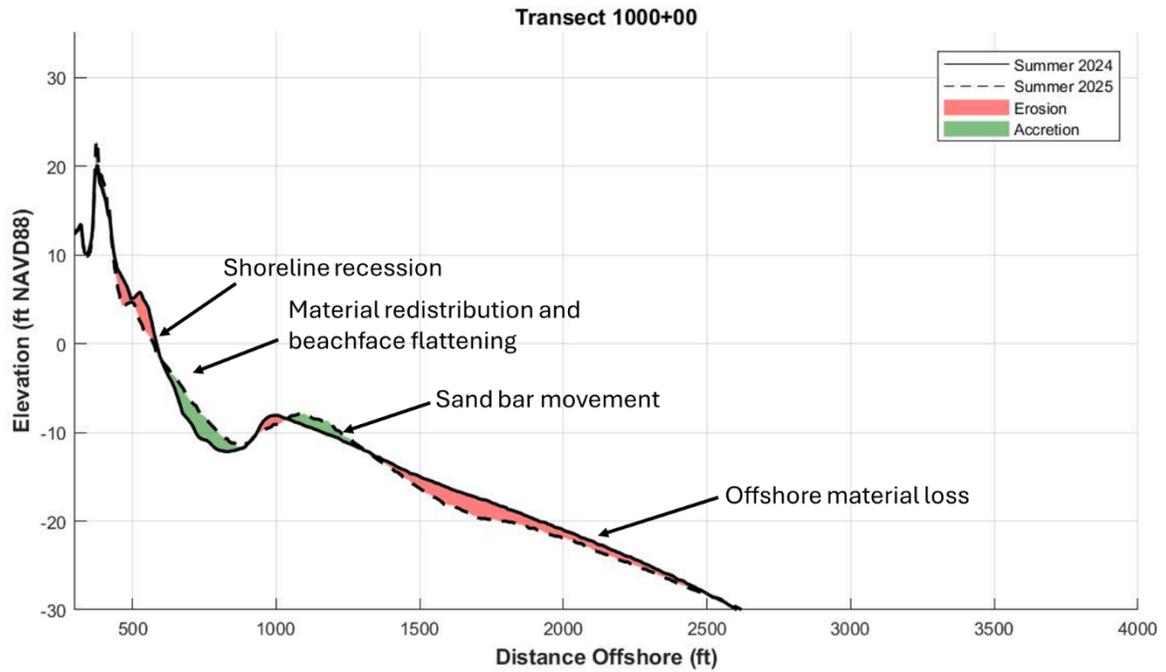
**Figure 5-20** presents an example profile from Reach 3 – South, illustrating material redistribution, offshore sandbar adjustment, and associated shoreline recession.



**Figure 5-18. Nags Head – Reach 3 – S Shoreline Change (June 2024 – June 2025)**



**Figure 5-19. Nags Head – Reach 3 – S Unit Volume Change (June 2024 – June 2025)**



**Figure 5-20. Example Reach 3 - South Profile, Station 1000+00 (E Seagull Dr.)**

5.3.6 Nags Head - Reach 4 (June 2024 – June 2025)

The Nags Head – Reach 4 survey reach extends approximately 1,500 ft between Loon Court and McCall Court, containing seven survey transects (Station 1010+00 – 1025+00), at 500 ft spacing (see **Figure 3-1**). **Table 5-23** and **Table 5-24** summarize the shoreline and volume changes between June 2024 and June 2025 for this reach in comparison with the Total Monitored Oceanfront. Additionally, **Table 5-25** and **Table 5-26** present shoreline and volume changes between the October 2024 and June 2025 surveys.

**Table 5-23. Average Shoreline and Average Unit Volume Change for Reach 4 (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 4	1010+00 - 1025+00	1,500	13.5	-7.0	-9.2	-3.2	13.6	-4.5	-28.1
Total Monitored Oceanfront	430+00 - 1200+00	77,000	10.5	-0.4	-0.6	4.0	20.4	3.5	-23.1

**Table 5-24. Cumulative Volume Change for Reach 4 (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-12,200	-16,082	-5,613	23,818	-7,946	-49,186
Total Monitored Oceanfront	430+00 - 1200+00	77,000	-30,301	-48,211	307,285	1,567,664	263,149	-1,783,829

**Table 5-25. Average Shoreline and Average Unit Volume Change for Reach 4 (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - Reach 4	1010+00 - 1025+00	1,500	11.4	-2.7	-3.5	-9.5	-16.9	-21.0	-28.1
Nourished Oceanfront	495+00 - 1025+00	53,000	27.8	-0.6	2.6	0.9	4.1	-0.7	-15.7

**Table 5-26. Cumulative Volume Change for Reach 4 (October 2024 – June 2025)**

October 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-3,714	-4,631	-18,109	-37,167	-40,925	-55,795
Nourished Oceanfront	495+00 - 1025+00	53,000	-32,732	132,108	47,115	215,249	-45,561	-857,084

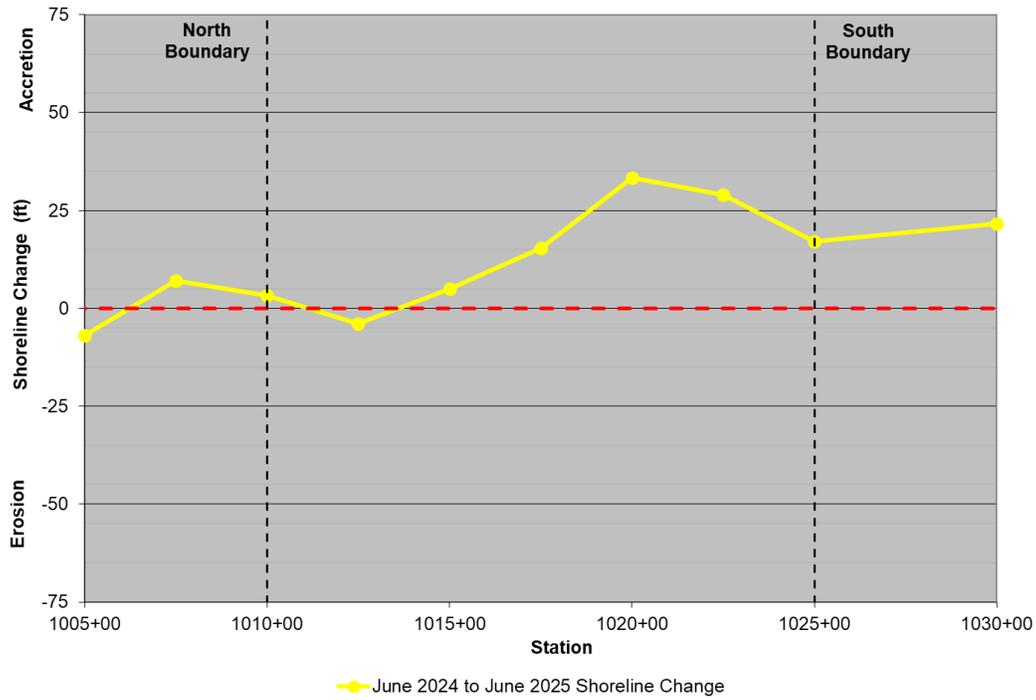
During the annual monitoring period, the shoreline at MHW experienced an overall seaward advancement of 13.5 ft. Similar to Reaches 3 – North and 3 – South, the majority of this accretion occurred between October 2024 and June 2025. **Figure 5-21** illustrates

shoreline changes at each transect from June 2024 to June 2025, showing accretion at majority of transects.

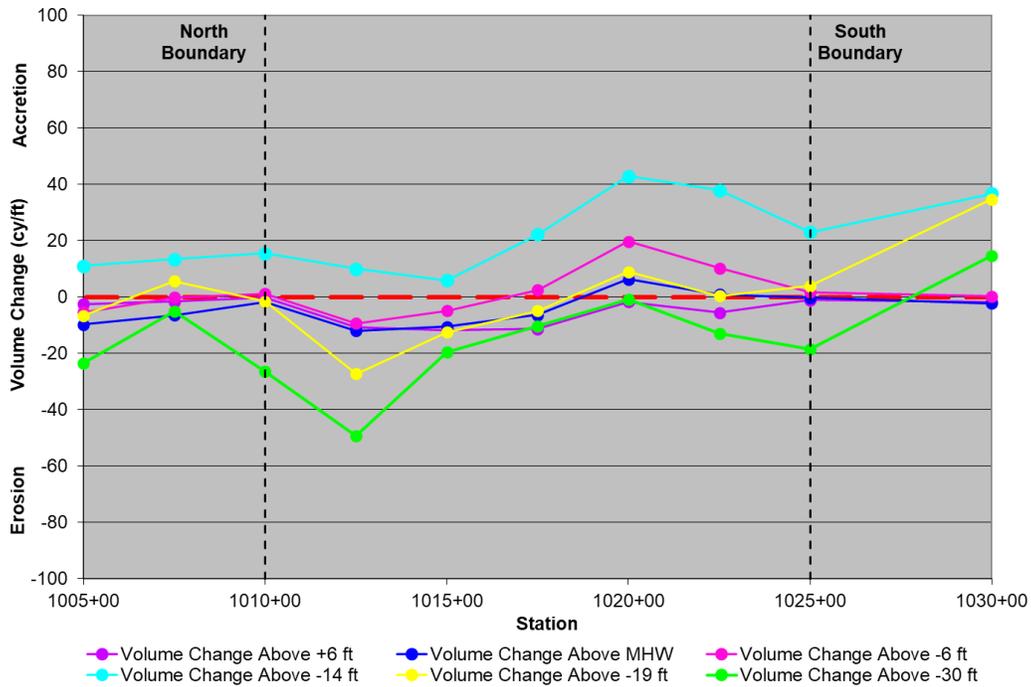
Similar to the Town's other nourished reaches, Reach 4 experienced volume gains above -14 ft NAVD88 (+23,818 cy or +13.6 cy/ft). A minor loss was recorded above -19 ft NAVD88 (-7,946 cy or -4.5 cy/ft); however, this was substantially less than the average annual background erosion rate for Reach 4 (-28.7 cy/ft; see **Table 5-4**). This reduction is likely associated with calmer wave energy conditions and a shift in prevailing wave direction toward the east-southeast. As with the other reaches, Reach 4 also exhibited volume losses below -30 ft NAVD88, suggesting alongshore sediment transport out of the reach.

Consistent with Reach 3 – South, Reach 4 experienced volume losses at the subaerial elevations, particularly within the dune system, during the annual monitoring period. The reach underwent substantial shoreline recession during the June 2023–June 2024 monitoring cycle, which exposed the dunes to direct wave impact and resulted in scarping. Although partial recovery occurred during the most recent monitoring year, the beaches remain relatively narrow, leading to continued dune scarping—most notably between June 2024 and October 2024, when wave activity was elevated.

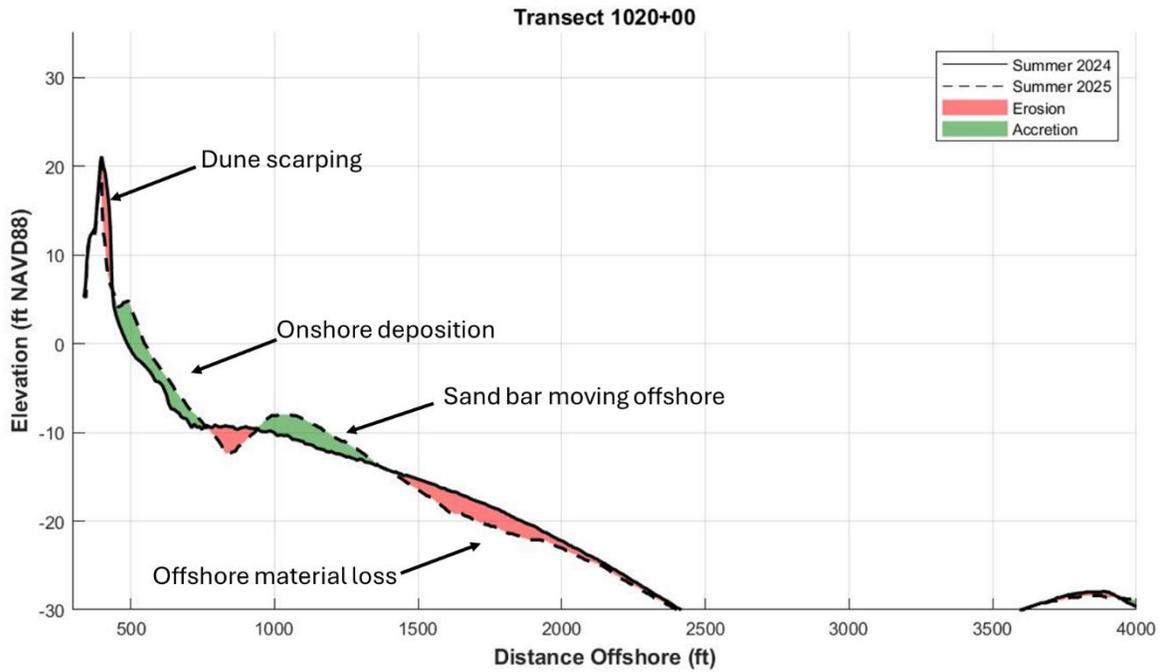
**Figure 5-22** shows unit volume changes at each transect across the six analyzed elevations, indicating volume losses across all transects and elevations except at -14 ft NAVD88, where gains are evident. Profile plots in **Appendix B** illustrate dune scarping along the profiles, accompanied by material deposition on the berm and in the nearshore. The offshore sandbar also migrated seaward and increased in size. **Figure 5-23** presents an example profile illustrating dune scarping, material redistribution along the profile, and offshore sandbar movement.



**Figure 5-21. Nags Head – Reach 4 Shoreline Change (June 2024 – June 2025)**



**Figure 5-22. Nags Head – Reach 4 Unit Volume Change (June 2024 – June 2025)**



**Figure 5-23. Example Reach 4 Profile, Station 1020+00 (McCall Court)**

5.3.7 National Seashore - North (June 2024 – June 2025)

The National Seashore - North survey reach extends approximately 17,500 ft between McCall Court and Oregon Inlet Campground. The National Seashore - North reach contains 23 survey transects (Station 1025+00 – 1200+00), varying in spacing between 500 ft and 1,000 ft (see **Figure 3-1**). A summary of average shoreline and volume changes between June 2024 and June 2025 for the National Seashore - North Reach is presented along with total oceanfront changes in **Table 5-27** and **Table 5-28**.

**Table 5-27. Average Shoreline and Average Unit Volume Change for National Seashore - North (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
National Seashore - North	1025+00 - 1200+00	17,500	8.4	1.6	1.7	0.9	26.8	8.1	-15.8
Total Monitored Oceanfront	430+00 - 1200+00	77,000	10.5	-0.4	-0.6	4.0	20.4	3.5	-23.1

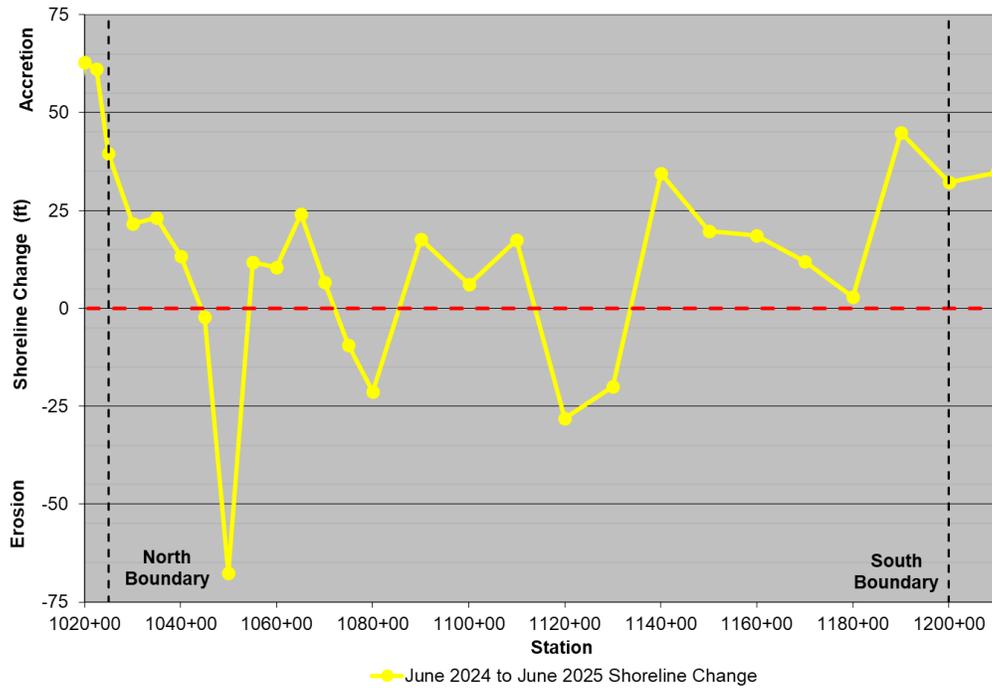
**Table 5-28. Cumulative Volume Change for National Seashore - North (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
National Seashore - North	1025+00 - 1200+00	17,500	28,326	29,343	15,080	468,948	142,184	-276,462
Total Monitored Oceanfront	430+00 - 1200+00	77,000	-30,301	-48,211	307,285	1,567,664	263,149	-1,783,829

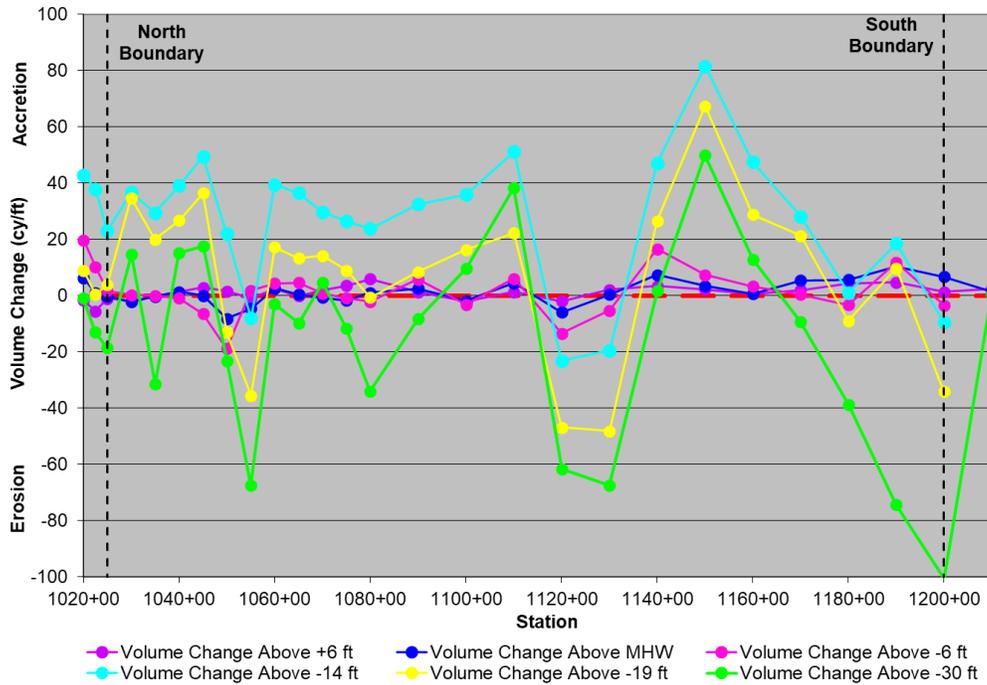
Shoreline change at MHW showed an overall average seaward advancement of +8.4 ft. **Figure 5-24** presents the shoreline changes at each transect, indicating accretion along most transects with some localized areas of erosion.

Overall, the National Seashore – North reach experienced volume gains across all analyzed elevations, except above -30 ft NAVD88. The most significant gains occurred above -14 ft NAVD88 (+468,948 cy, or +26.8 cy/ft) and above -19 ft NAVD88 (+142,184 cy, or +8.1 cy/ft). Similar to the other reaches, losses were observed above -30 ft NAVD88, indicating a system-wide trend of sediment movement beyond the town’s system, likely associated with alongshore transport between the depth of closure and -30 ft NAVD88.

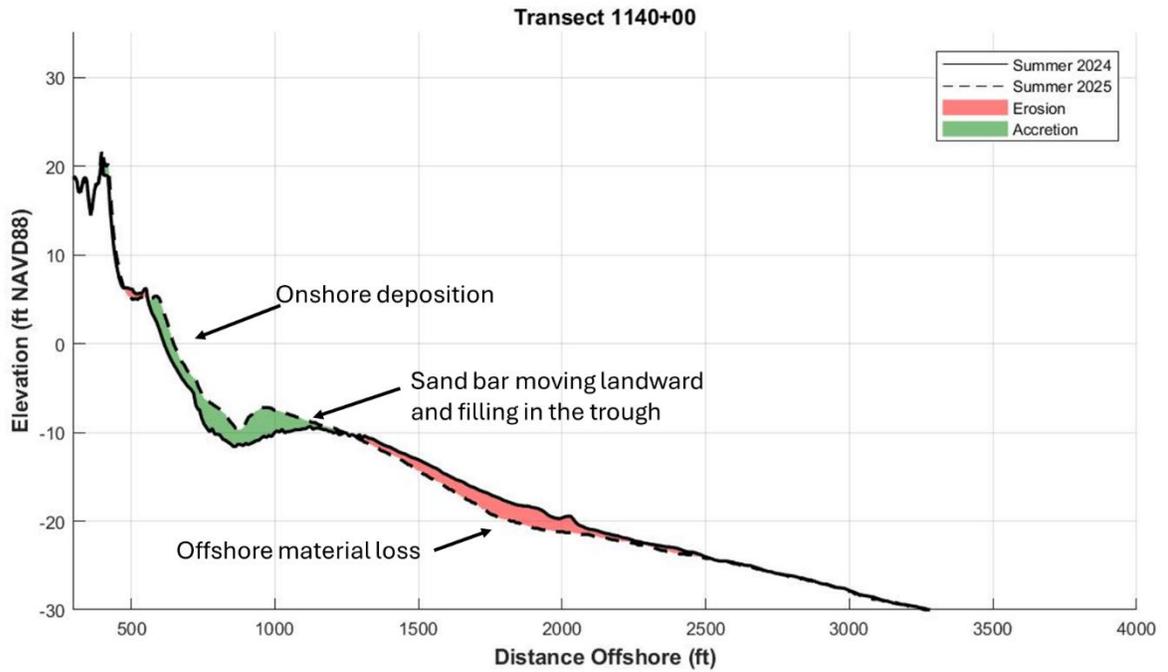
**Figure 5-25** illustrates unit volume changes at each transect across the six analyzed elevations, showing a mix of erosion and accretion trends along the reach. Some transects experienced gains across all elevations, while others showed localized erosion. Profile plots in **Appendix B** indicate that the offshore bar migrated landward to higher elevations, grew in size, and partially filled the trough located seaward of the June 2024 offshore bar. The beachface also steepened, with some material deposited on the berm. **Figure 5-26** provides an example profile illustrating these trends.



**Figure 5-24. National Seashore - North Shoreline Change (June 2024 – June 2025)**



**Figure 5-25. National Seashore - North Unit Volume Change (June 2024 – June 2025)**

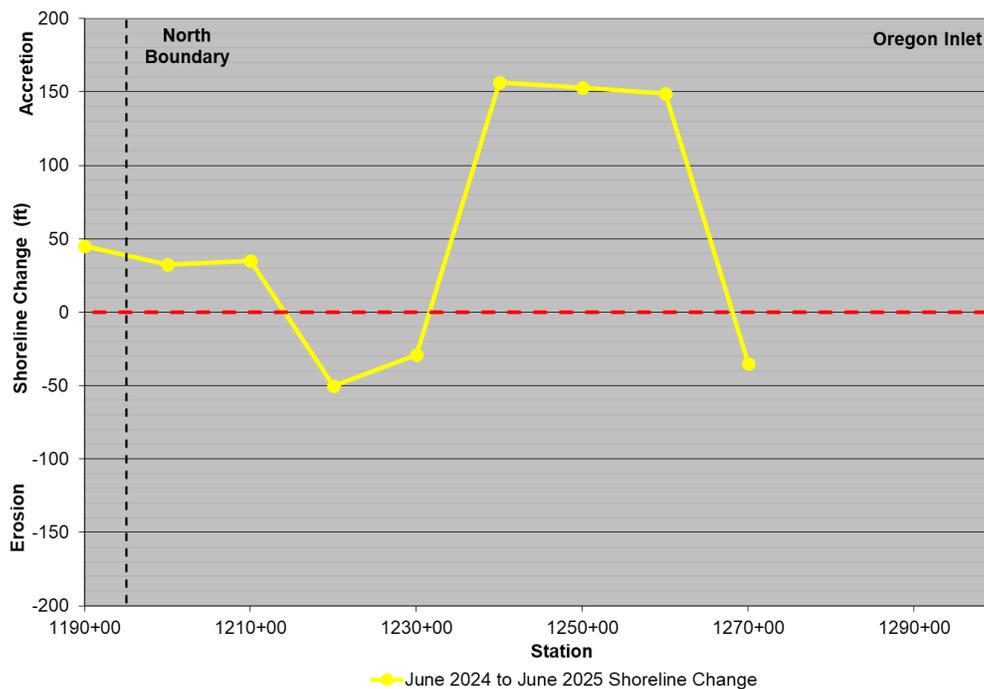


**Figure 5-26. Example National Seashore - North Profile, Station 1140+00**

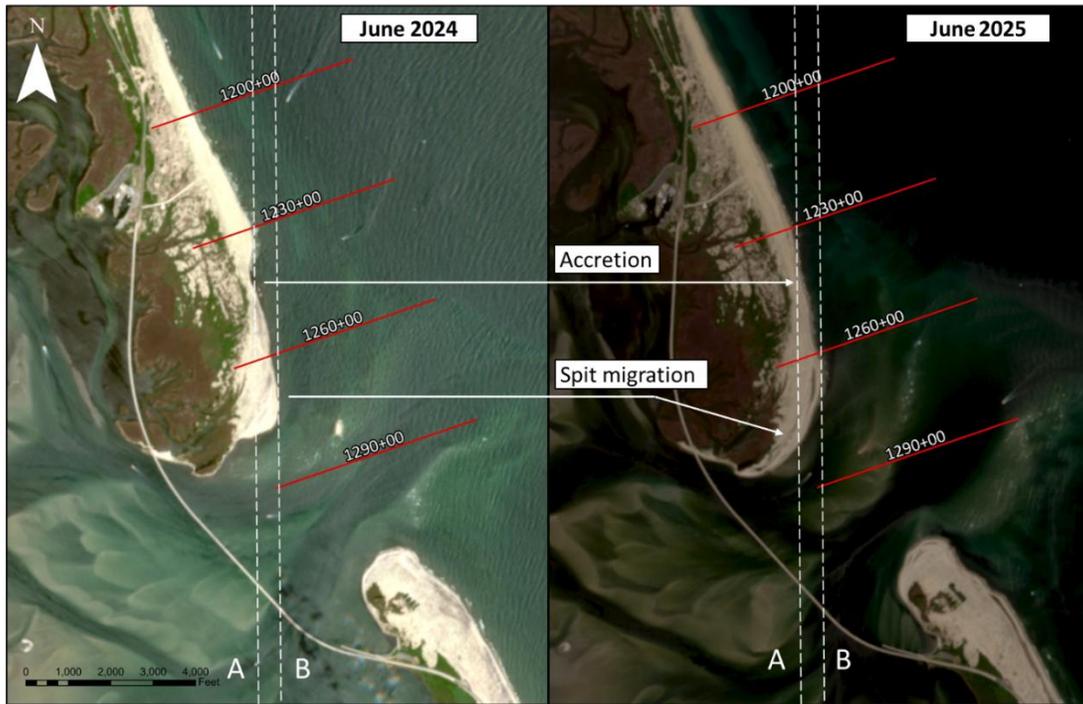
### 5.3.8 National Seashore - South (June 2024 – June 2025)

The National Seashore - South survey reach extends approximately 9,000 ft north of Oregon Inlet, containing eight survey transects (Station 1200+00 – 1290+00), at 1,000 ft spacing (see **Figure 3-1**). Shorelines adjacent to an inlet are typically very active due to more complex hydrodynamics and often greater sediment transport rates, which can lead to more extreme profile changes from year to year. **Figure 5-27** presents shoreline changes at each transect, showing significant seaward advancement between Stations 1240+00 and 1260+00. **Figure 5-28** shows aerial imagery of Oregon Inlet from the beginning and end of the monitoring period. Over this time, material from Bodie Island Spit migrated northward and deposited between Stations 1240+00 and 1260+00, leading to shoreline accretion in this area but contributing to localized erosion at Station 1270+00.

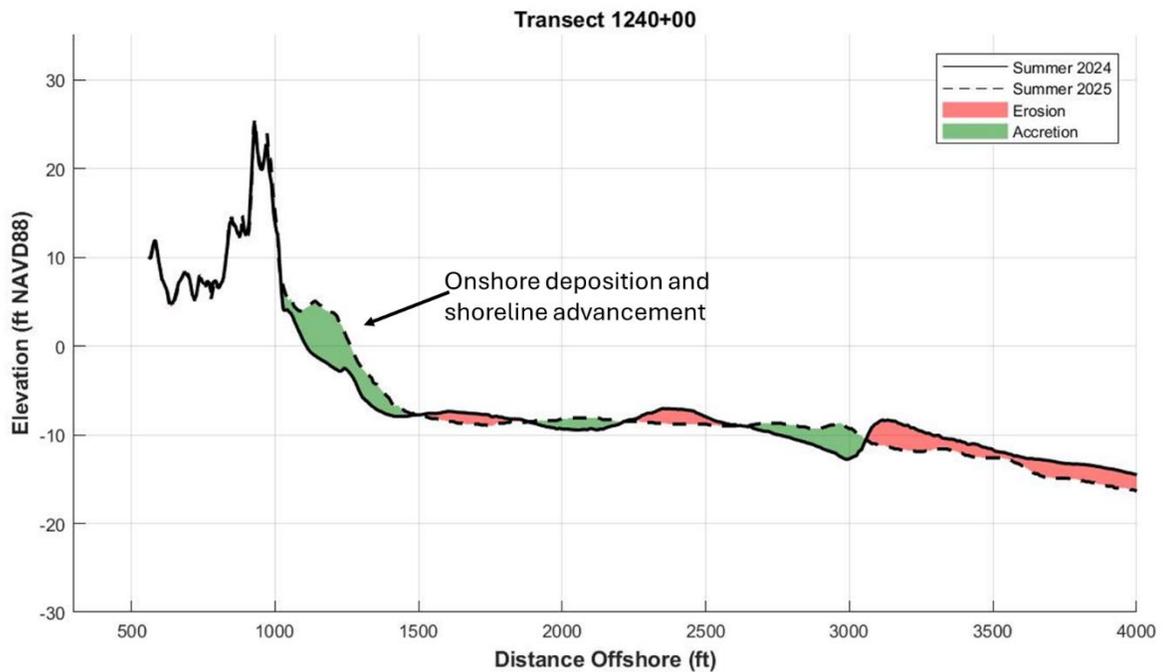
Due to the highly dynamic nature of Oregon Inlet, reliable volume calculations were not feasible. Instead, profile comparisons between June 2024 and June 2025 (see **Appendix B**) were used to identify trends. At the southern transects, material was deposited on the beachface and nearshore, resulting in shoreline accretion, whereas transects from Stations 1220+00 to 1240+00 experienced erosion. **Figure 5-29** provides an example profile illustrating the accretion.



**Figure 5-27. National Seashore - South Shoreline Change (June 2024 – June 2025)**



**Figure 5-28. Oregon Inlet Change (06/25/2024 USGS Sentinel Imagery; 06/25/2025 USGS-Sentinel Imagery)**



**Figure 5-29. Example National Seashore - North Profile, Station 1240 (Bodie Island Spit)**

### 5.3.9 *Oceanfront Trends Summary for All Reaches (June 2024 – June 2025)*

**Table 5-29** and **Table 5-30** provides a summary of the shoreline and volume changes along Nags Head as presented in the previous sections along with average and total oceanfront values. For Nags Head, since each reach consists of a different length of shoreline, the calculations provide a weighted average for unit shoreline change (ft) and unit volume change (cy/ft) along the Nags Head oceanfront. The weighted average also accounts for differences in the shoreline length between each transect. **Appendix D** contains plots of the shoreline and volume changes between the June 2024 and the June 2025 surveys at each transect along Nags Head.

During the June 2024–June 2025 monitoring period, the Nags Head shoreline exhibited an overall seaward advancement, with the nourished oceanfront averaging +10.7 ft at MHW. Reach 2 showed strong shoreline accretion (+24.3 ft), while Reach 3 North and Reach 3 South experienced modest recession (-9.1 ft and -8.4 ft, respectively). All nourished reaches displayed seaward advancement between October 2024 and June 2025, indicating shoreline recovery during the winter–summer portion of the current monitoring period following the erosive conditions of the prior year.

In terms of volume, the nourished oceanfront experienced its largest gains above -14 ft NAVD88 (+959,407 cy, or +18 cy/ft), consistent with widespread sandbar growth across the system. Smaller gains above -19 ft NAVD88 (+69,271 cy) suggest that sediment remained within the system while being redistributed across the profile. Subaerial elevations (+6 ft NAVD88 and MHW) showed net losses, while gains at -6 ft NAVD88 largely reflect profile flattening following the highly erosive June 2023–June 2024 period. Narrow beach conditions during that time allowed waves to reach the dune and berm, redistributing material into the nearshore.

Although net erosion was recorded above MHW, profile plots in **Appendix B** show localized accretion between +3 ft NAVD88 and MHW, consistent with the overall shoreline advancement observed during the monitoring period.

The ongoing volume losses below -30 ft NAVD88 across all reaches suggest a system-wide trend of sediment redistribution, likely driven by alongshore transport beyond the depth of closure.

The Total Monitored Oceanfront, which includes both the Nags Head North and National Seashore–North reaches flanking the Nourished Oceanfront, exhibited a similar pattern—material gains above -14 ft NAVD88 and losses below -19 ft NAVD88.

**Table 5-29. Nags Head Shoreline and Average Unit Volume Change Statistics (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	avg shoreline change @ +1.18 ft NAVD88	avg volume change above +6 ft NAVD88	avg volume change above +1.18 ft NAVD88	avg volume change above -6 ft NAVD88	avg volume change above -14 ft NAVD88	avg volume change above -19 ft NAVD88	avg volume change above -30 ft NAVD88
Reach	#	ft	ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
Nags Head - North	430+00 - 495+00	6,500	15.3	-1.0	1.2	7.3	23.2	8.6	-18.6
Nags Head - Reach 1	495+00 - 790+00	29,500	10.5	-1.2	-1.1	4.7	14.2	0.9	-28.4
Nags Head - Reach 2	790+00 - 920+00	13,000	24.3	0.6	2.6	8.8	25.6	3.1	-22.6
Nags Head - Reach 3N	920+00 - 975+00	5,500	-9.1	-0.4	-6.5	1.1	18.2	-0.9	-26.0
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-8.4	-2.9	-9.4	-1.7	22.6	4.3	-18.5
Nags Head - Reach 4	1010+00 - 1025+00	1,500	13.5	-7.0	-9.2	-3.2	13.6	-4.5	-28.1
National Seashore - North	1025+00 - 1200+00	17,500	8.4	1.6	1.7	0.9	26.8	8.1	-15.8
	Transects	Reach Length	weighted avg	weighted avg	weighted avg	weighted avg	weighted avg	weighted avg	weighted avg
<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>53,000</b>	<b>10.7</b>	<b>-1.0</b>	<b>-1.5</b>	<b>4.7</b>	<b>18.0</b>	<b>1.3</b>	<b>-26.1</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>10.5</b>	<b>-0.4</b>	<b>-0.6</b>	<b>4.0</b>	<b>20.4</b>	<b>3.5</b>	<b>-23.1</b>

\*National Seashore South Reach not included in the Total Monitored Oceanfront

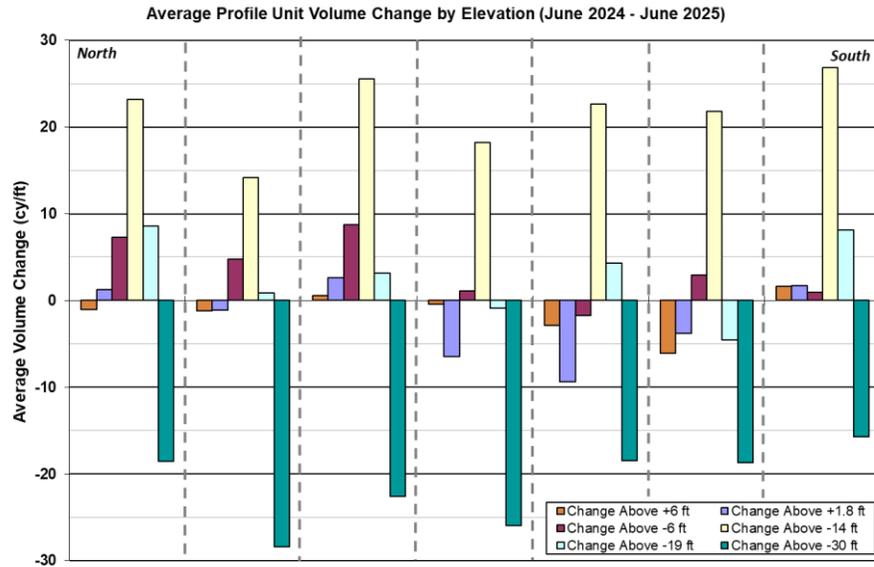
**Table 5-30. Nags Head Cumulative Volume Change Statistics (June 2024 – June 2025)**

June 2024 vs. June 2025	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - North	430+00 - 495+00	6,500	-6,252	7,453	43,595	139,308	51,694	-111,459
Nags Head - Reach 1	495+00 - 790+00	29,500	-35,310	-32,976	140,064	418,863	26,444	-838,986
Nags Head - Reach 2	790+00 - 920+00	13,000	7,560	34,073	114,009	332,623	40,714	-293,675
Nags Head - Reach 3N	920+00 - 975+00	5,500	-2,328	-37,276	6,150	104,876	-5,007	-149,418
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-10,096	-32,747	-6,001	79,228	15,067	-64,643
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-12,200	-16,082	-5,613	23,818	-7,946	-49,186
National Seashore - North	1025+00 - 1200+00	17,500	28,326	29,343	15,080	468,948	142,184	-276,462
	Transects	Reach Length	total	total	total	total	total	total
<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>53,000</b>	<b>-52,375</b>	<b>-85,007</b>	<b>248,609</b>	<b>959,407</b>	<b>69,271</b>	<b>-1,395,908</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>-30,301</b>	<b>-48,211</b>	<b>307,285</b>	<b>1,567,664</b>	<b>263,149</b>	<b>-1,783,829</b>

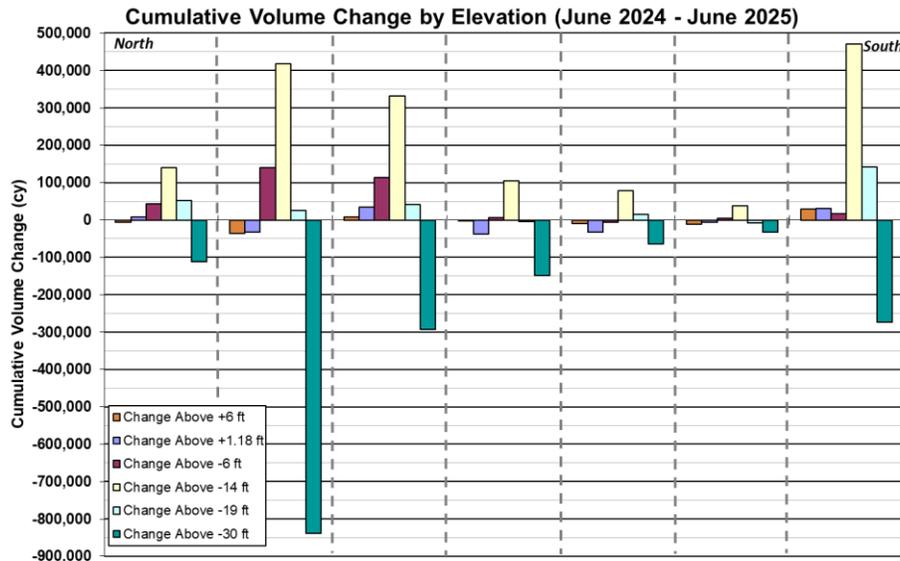
\*National Seashore South Reach not included in the Total Monitored Oceanfront

Figure 5-30 and Figure 5-31 display the trends seen in Table 5-29 and Table 5-30 with bar plots of the average unit volume changes as well as total cumulative volume changes at each sub-reach to help visualize changes that occurred to the Nags Head monitoring area as a whole and how the magnitude of changes compares from one reach to the next. These

figures provide a clear visualization of overall changes within the Nags Head monitoring area and allow for comparison of the magnitude of change between reaches. Both figures highlight significant volume gains above -14 ft NAVD88 and minor changes above -19 ft NAVD88 across all monitored shoreline reaches. Consistent with previous results, all reaches experienced volume losses above -30 ft NAVD88, suggesting that sediment was transported either further offshore or alongshore, leaving the Town's sediment system.



**Figure 5-30. Average Unit Volume Change Within Each Reach (June 2024 – June 2025)**

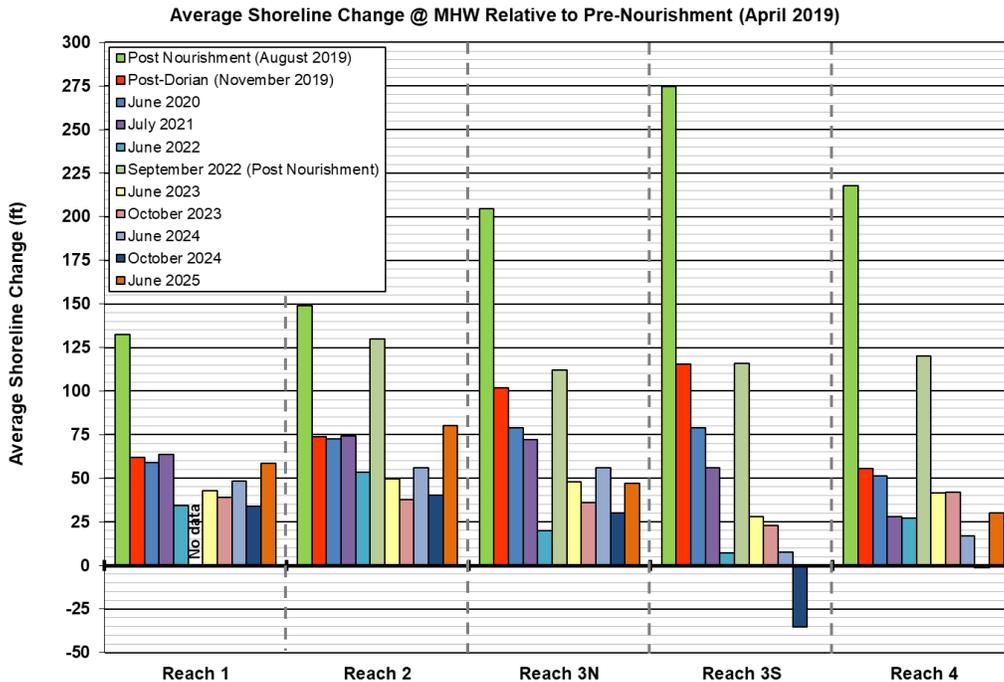


**Figure 5-31. Cumulative Volume Change Within Each Reach (June 2024 – June 2025)**

### 5.4 Nourished Oceanfront Performance Relative to Pre-Nourishment

Construction of the 2019 Nags Head Beach Nourishment Project was carried out between May 1, 2019 and August 18, 2019. During the project, a total of 4 million cy of material was placed along approximately 10 miles of shoreline. CSE conducted a pre-construction survey in April 2019. To quantify the performance of the nourishment project, the volume changes between the pre-nourishment survey and the subsequent monitoring surveys were analyzed.

**Figure 5-32** illustrates shoreline changes relative to pre-nourishment conditions (April 2019) along the Nourished Oceanfront. The figure shows a significant landward recession since completion of the 2019 nourishment project. Most of this retreat can be attributed to Hurricane Dorian, with additional losses reflecting natural profile equilibration during stabilization of the nourishment profile. The August 2022 post-Dorian renourishment project mitigated some of this retreat; however, by June 2023 the shoreline had again receded, likely due to ongoing equilibration. Erosion persisted through the June 2023–June 2024 monitoring period, as continuous wave activity limited opportunities for recovery. During the June 2024–June 2025 period, particularly after October 2024, the shoreline showed signs of recovery as calmer wave conditions allowed material to be redeposited onshore.



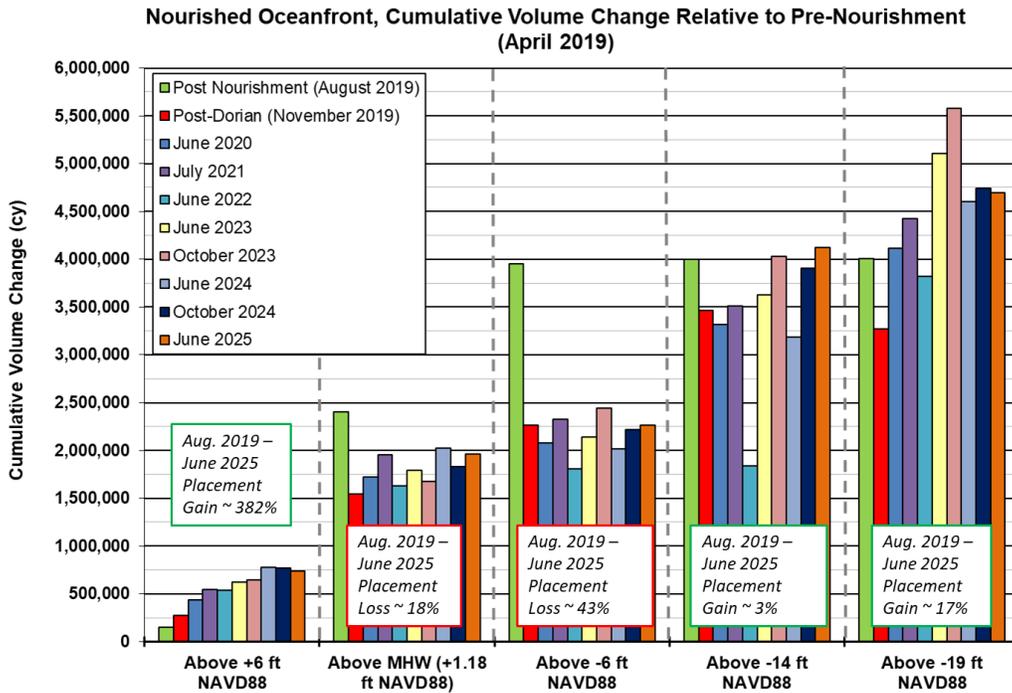
**Figure 5-32. Nourished Oceanfront Average Shoreline Change Relative to Pre-Nourishment Conditions**

**Figure 5-33** and **Table 5-31** present the volume changes relative to pre-nourishment conditions (April 2019) above six elevations along the Nourished Oceanfront. The results

show material losses at MHW and -6 ft NAVD88, reflecting the redistribution of sand to lower elevations. Notably, material from the nourishment remains within the system above -19 ft NAVD88. **Table 5-31** confirms that since the completion of the 2019 nourishment project, approximately 690,045 cy (+13.0 cy/ft) of volume gain has been recorded above -19 ft NAVD88 along the Nourished Oceanfront. It is important to note that 614,106 cy of this total was placed during the 2022 Post-Dorian Renourishment project, indicating that without this effort, net material gains above -19 ft NAVD88 would have been minimal. These results highlight substantial cross-shore sand redistribution across the profile. Much of this material has shifted to lower elevations near the depth of closure, where it remains vulnerable to removal from the system during high-energy wave events.

**Table 5-31. Nourished Oceanfront Cumulative Volume Change Relative to Pre-Nourishment Conditions**

	Reaches	Stations	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88
Pre-Nourishment (April 2019) -Post Nourishment (August 2019)	Reach 1	495+00 - 790+00	47,918	1,258,165	1,693,618	1,755,354	1,762,213
	Reach 2	790+00 - 920+00	15,959	568,190	861,317	883,160	885,587
	Reach 3N	920+00 - 975+00	45,018	447,070	602,835	579,316	576,703
	Reach 3S	975+00 - 1010+00	24,590	94,184	521,783	538,928	540,833
	Reach 4	1010+00 - 1025+00	19,612	37,063	270,325	242,401	239,298
	<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>153,098</b>	<b>2,404,672</b>	<b>3,949,879</b>	<b>3,999,158</b>	<b>4,004,634</b>
Pre-Nourishment (April 2019) -Post Dorian (November 2019)	Reach 1	495+00 - 790+00	122,742	890,211	1,043,259	1,670,583	1,649,959
	Reach 2	790+00 - 920+00	53,589	441,740	550,539	906,718	817,193
	Reach 3N	920+00 - 975+00	53,200	273,200	304,616	414,929	388,407
	Reach 3S	975+00 - 1010+00	29,753	-14,098	295,230	387,901	350,928
	Reach 4	1010+00 - 1025+00	10,924	-47,450	67,788	85,461	62,951
	<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>270,208</b>	<b>1,543,604</b>	<b>2,261,432</b>	<b>3,465,591</b>	<b>3,269,438</b>
Pre-Nourishment (April 2019) - June 2020	Reach 1	495+00 - 790+00	193,057	964,264	991,610	1,633,023	2,052,621
	Reach 2	790+00 - 920+00	110,115	502,260	554,438	935,933	1,109,539
	Reach 3N	920+00 - 975+00	72,432	288,994	261,920	383,133	526,039
	Reach 3S	975+00 - 1010+00	41,649	-4,082	235,215	316,084	354,188
	Reach 4	1010+00 - 1025+00	21,996	-28,740	33,984	45,101	71,796
	<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>439,248</b>	<b>1,722,697</b>	<b>2,077,167</b>	<b>3,313,273</b>	<b>4,114,183</b>
Pre-Nourishment (April 2019) - July 2021	Reach 1	495+00 - 790+00	272,387	1,144,705	1,177,224	1,849,575	2,263,667
	Reach 2	790+00 - 920+00	139,655	559,446	705,370	1,035,767	1,250,047
	Reach 3N	920+00 - 975+00	75,007	303,408	242,005	349,588	511,176
	Reach 3S	975+00 - 1010+00	39,685	-14,715	184,822	252,470	316,292
	Reach 4	1010+00 - 1025+00	18,948	-35,699	15,219	22,910	79,520
	<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>545,682</b>	<b>1,957,146</b>	<b>2,324,639</b>	<b>3,510,310</b>	<b>4,420,702</b>
Pre-Nourishment (April 2019) - June 2022	Reach 1	495+00 - 790+00	326,493	1,076,208	983,159	1,188,310	2,059,260
	Reach 2	790+00 - 920+00	124,552	437,580	512,104	498,138	1,039,949
	Reach 3N	920+00 - 975+00	46,334	206,727	156,733	11,292	344,958
	Reach 3S	975+00 - 1010+00	22,972	-45,066	153,151	142,466	313,583
	Reach 4	1010+00 - 1025+00	14,154	-43,008	-523	-5,248	64,869
	<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>534,504</b>	<b>1,632,442</b>	<b>1,804,624</b>	<b>1,834,958</b>	<b>3,822,618</b>
Pre-Nourishment (April 2019) - June 2023	Reach 1	495+00 - 790+00	335,917	1,059,107	1,006,248	1,713,208	2,318,425
	Reach 2	790+00 - 920+00	164,020	522,559	672,631	1,116,802	1,501,016
	Reach 3N	920+00 - 975+00	69,003	259,624	260,863	445,635	672,518
	Reach 3S	975+00 - 1010+00	39,437	-12,111	198,971	315,891	493,380
	Reach 4	1010+00 - 1025+00	16,489	-39,790	4,174	31,740	119,431
	<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>624,865</b>	<b>1,789,389</b>	<b>2,142,887</b>	<b>3,623,277</b>	<b>5,104,771</b>
Pre-Nourishment (April 2019) - June 2024	Reach 1	495+00 - 790+00	410,557	1,182,465	1,012,650	1,778,061	2,277,112
	Reach 2	790+00 - 920+00	225,530	626,379	669,080	1,017,997	1,415,104
	Reach 3N	920+00 - 975+00	90,033	293,605	203,516	248,145	462,279
	Reach 3S	975+00 - 1010+00	39,087	-23,991	154,556	171,622	357,244
	Reach 4	1010+00 - 1025+00	12,201	-57,924	-27,167	-31,512	91,244
	<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>777,408</b>	<b>2,020,534</b>	<b>2,012,635</b>	<b>3,184,313</b>	<b>4,602,983</b>
Pre-Nourishment (April 2019) - June 2025	Reach 1	495+00 - 790+00	375,246	1,149,489	1,152,714	2,196,923	2,303,556
	Reach 2	790+00 - 920+00	233,090	660,452	783,089	1,350,621	1,455,818
	Reach 3N	920+00 - 975+00	87,705	256,330	209,666	353,021	457,272
	Reach 3S	975+00 - 1010+00	28,991	-56,738	148,555	250,850	372,310
	Reach 4	1010+00 - 1025+00	13,407	-49,051	-27,167	-31,512	105,722
	<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>738,439</b>	<b>1,960,482</b>	<b>2,266,857</b>	<b>4,119,903</b>	<b>4,694,679</b>

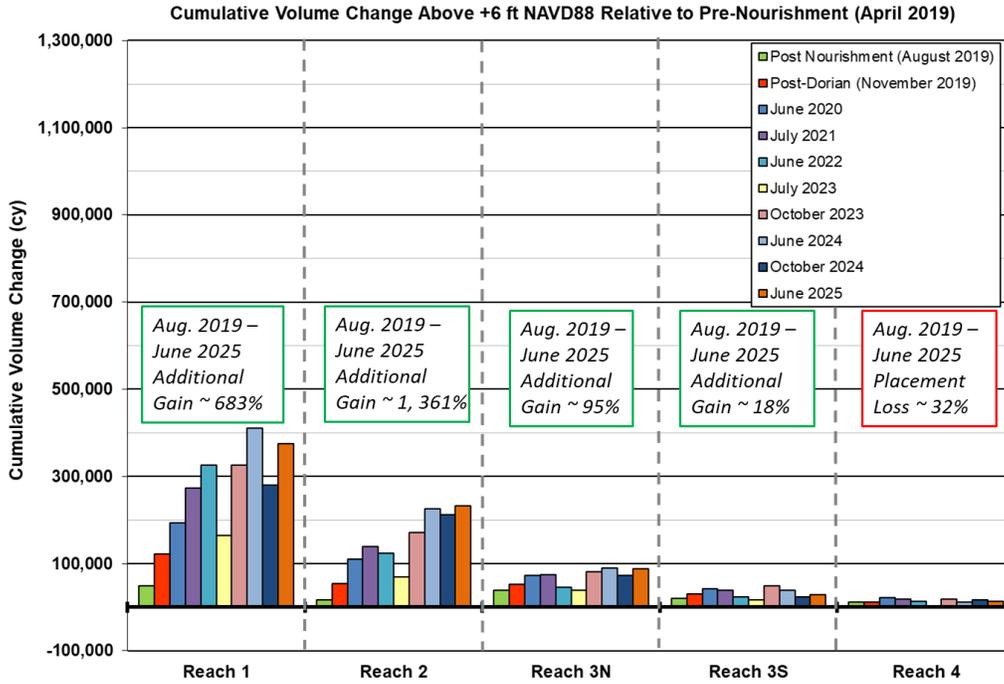


**Figure 5-33. Cumulative Volume Change Relative to Pre-Nourishment**

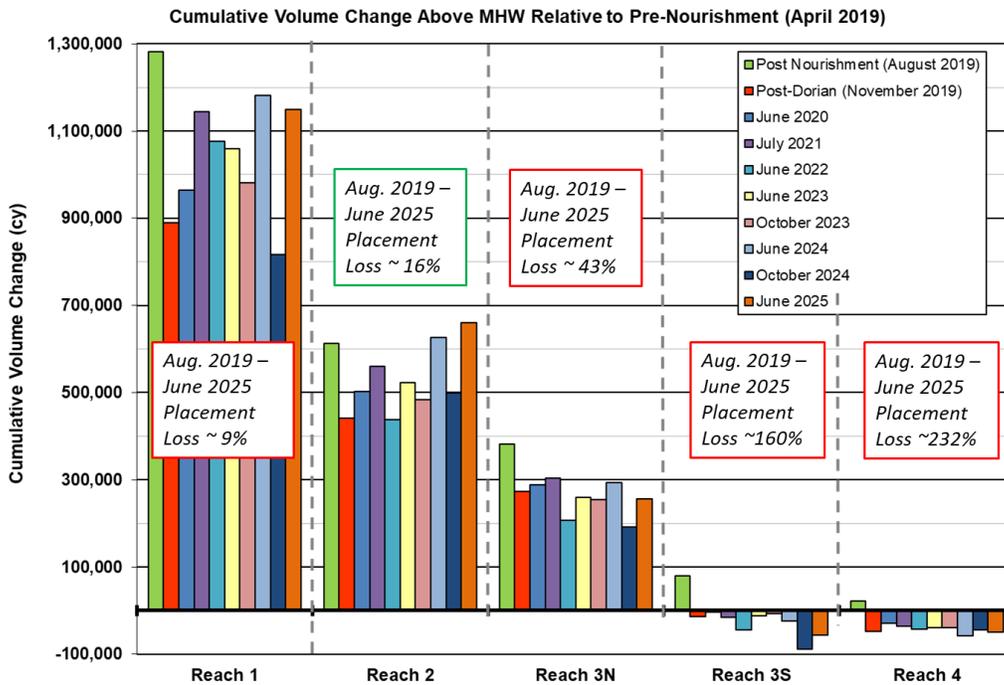
**Figure 5-34** illustrates the volume changes relative to pre-nourishment conditions (April 2019) above +6 ft NAVD88 along the Nourished Oceanfront. All the reaches, excluding Reach 4, experienced a gain in material above +6 ft NAVD88. However, Reach 4 incurred a loss of approximately 32% of the material that was originally placed above +6 ft NAVD88 during the 2019 Nourishment Project. Notably, 31% of this loss occurred between June 2023 and July 2024, driven by substantial shoreline recession that exposed the dunes and resulted in scarping.

**Figure 5-35** shows the volume changes relative to pre-nourishment conditions (April 2019) above MHW along the Nourished Oceanfront. All reaches except Reach 2, experienced material losses above MHW following the completion of the 2019 nourishment project. Consistent with the shoreline changes (see **Figure 5-32**), the majority of these losses occurred during the Post-Dorian survey, reflecting both the direct erosion from Hurricane Dorian and the subsequent adjustment of the nourishment profile toward equilibrium. During the current monitoring period, material above +1.18 ft NAVD88 was redistributed to the nearshore and deposited onto the offshore bar, resulting in losses across all reaches.

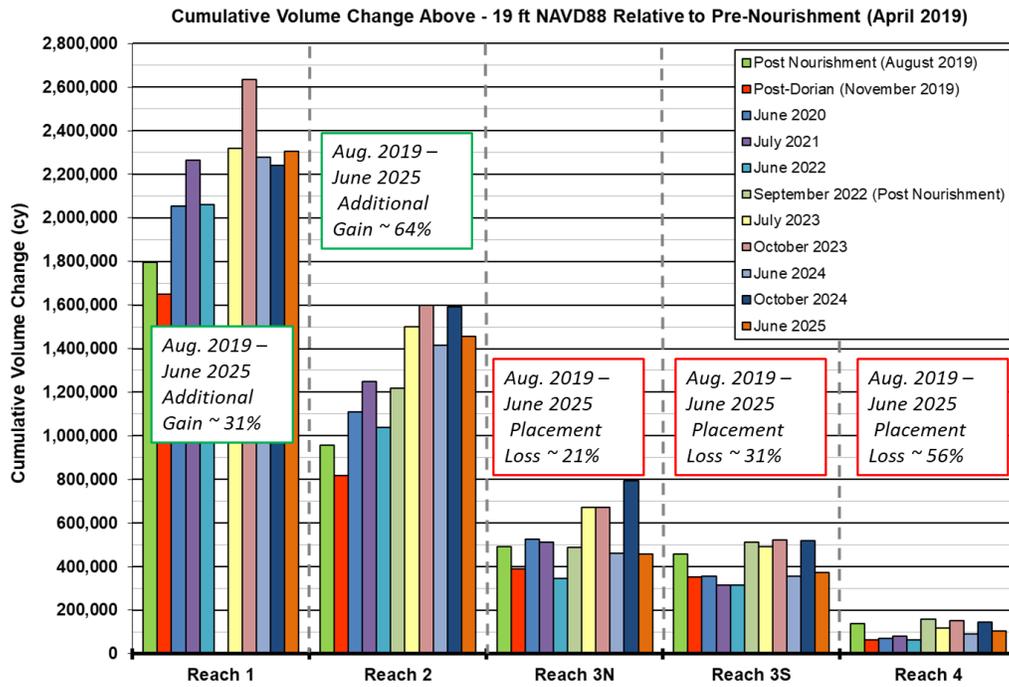
**Figure 5-36** presents the volume changes above -19 ft NAVD88 relative to pre-nourishment conditions (April 2019) along the Nourished Oceanfront. Reach 1 and Reach 2 show volume gains above -19 ft NAVD88 when compared to pre-nourishment levels. In contrast, the remaining reaches experienced material losses, with Reach 3N and Reach 3S both losing less than 50% of the material placed during the 2019 nourishment. However, Reach 4 has undergone significant material loss, having lost 56% of the nourished material by the end of this monitoring period.



**Figure 5-34. Cumulative Volume Change Above +6 ft NAVD88 Relative to Pre-Nourishment**



**Figure 5-35. Cumulative Volume Change Above MHW Relative to Pre-Nourishment**



**Figure 5-36. Cumulative Volume Change Above -19 ft NAVD88 Relative to Pre-Nourishment**

## 5.5 Multi-Decadal Beach Nourishment Master Plan

The Town of Nags Head adopted a Multi-Decadal Beach Nourishment Master Plan (Master Plan) in July 2024 to guide beach maintenance and storm response projects over a 50-year timeframe. The plan provides a framework for permitting, financing, and constructing future nourishment projects more efficiently.

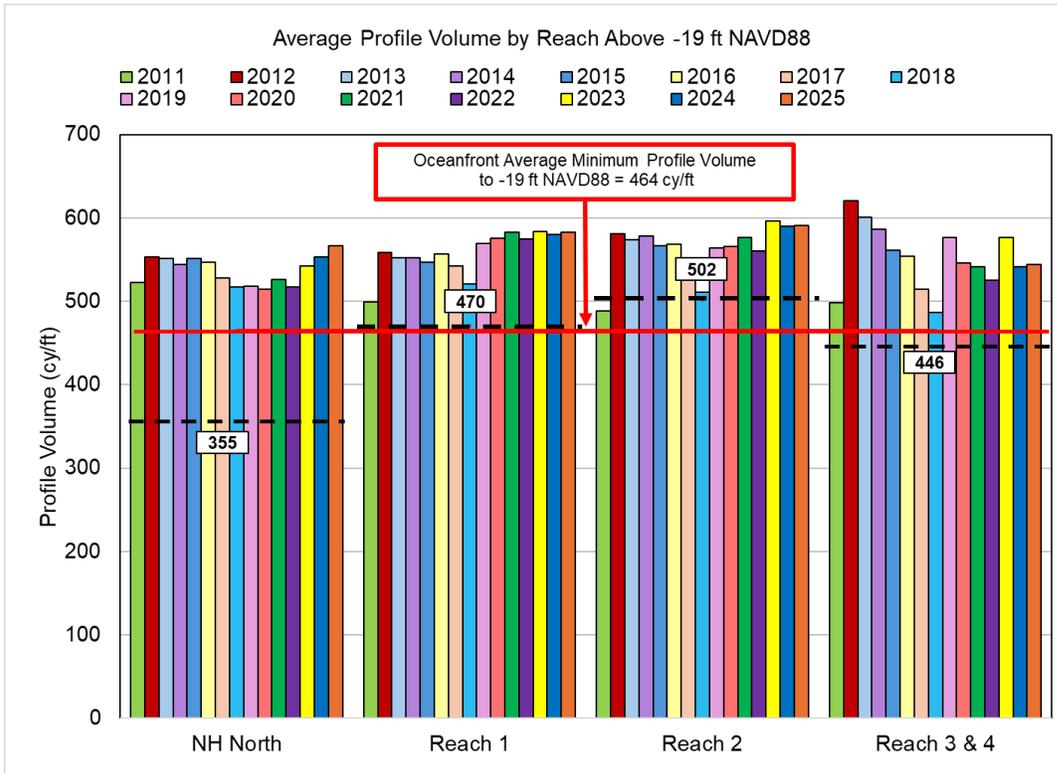
Annual monitoring will determine the timing and extent of projects by tracking average profile volumes in each management reach relative to nourishment triggers, which define the minimum volume needed to maintain equivalent shoreline protection. While volumetric needs are the primary driver, factors such as funding, construction feasibility, and tourism may also influence project design.

The nourishment triggers, developed for the Master Plan, are based on profile volumes from the foredune to the outer bar above -19 ft NAVD88. These thresholds were designed to provide consistent protection across the oceanfront. Engineering analysis and funding expectations indicate that the Town can maintain a Level of Protection (LoP) against a 25-year return period storm. CSHORE modeling was used to determine the sand volume required above -19 ft NAVD88 for each management reach, accounting for dune height, berm width, and other profile features. **Table 5-32** presents the reach-specific triggers, with a Town-wide average of 464 cy/ft.

**Table 5-32. Trigger Volumes Above -19 ft NAVD88 for 25-yr Event**

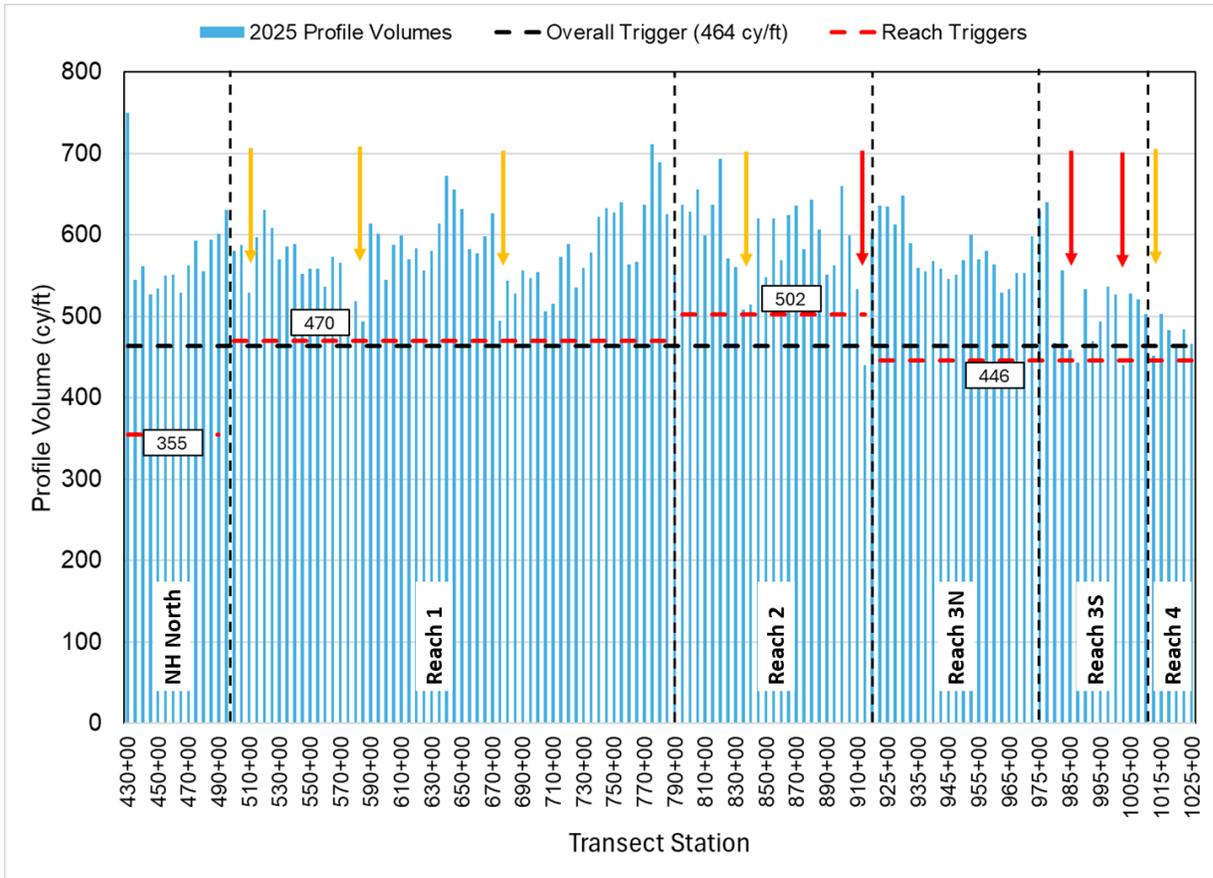
Reach	Stations	Length (ft)	Reach Trigger for 25-yr event (cy/ft)
<b>Nags Head - North</b>	430+00- 495+00	6,500	355
<b>Reach 1</b>	495+00- 790+00	29,500	470
<b>Reach 2</b>	790+00- 920+00	13,000	502
<b>Reach 3 - North</b>	920+00- 975+00	5,500	446
<b>Reach 3 - South</b>	975+00- 1010+00	3,500	
<b>Reach 4</b>	1010+00- 1025+00	1,500	
<b>TOTAL</b>		59,500	464

Because this is a new protocol for evaluating the state of the Town’s beach, all profile data from 2011 to present was re-evaluated considering these volumetric triggers, as shown in **Figure 5-37**. It should be noted that the starting point for these trigger-based volume calculations differs from the *Xon* (computation start) location used in the historical volume change analyses presented in this and previous reports. For the trigger evaluation, volumes are computed from the approximate dune crest to the offshore location of the -19 ft NAVD88 contour.



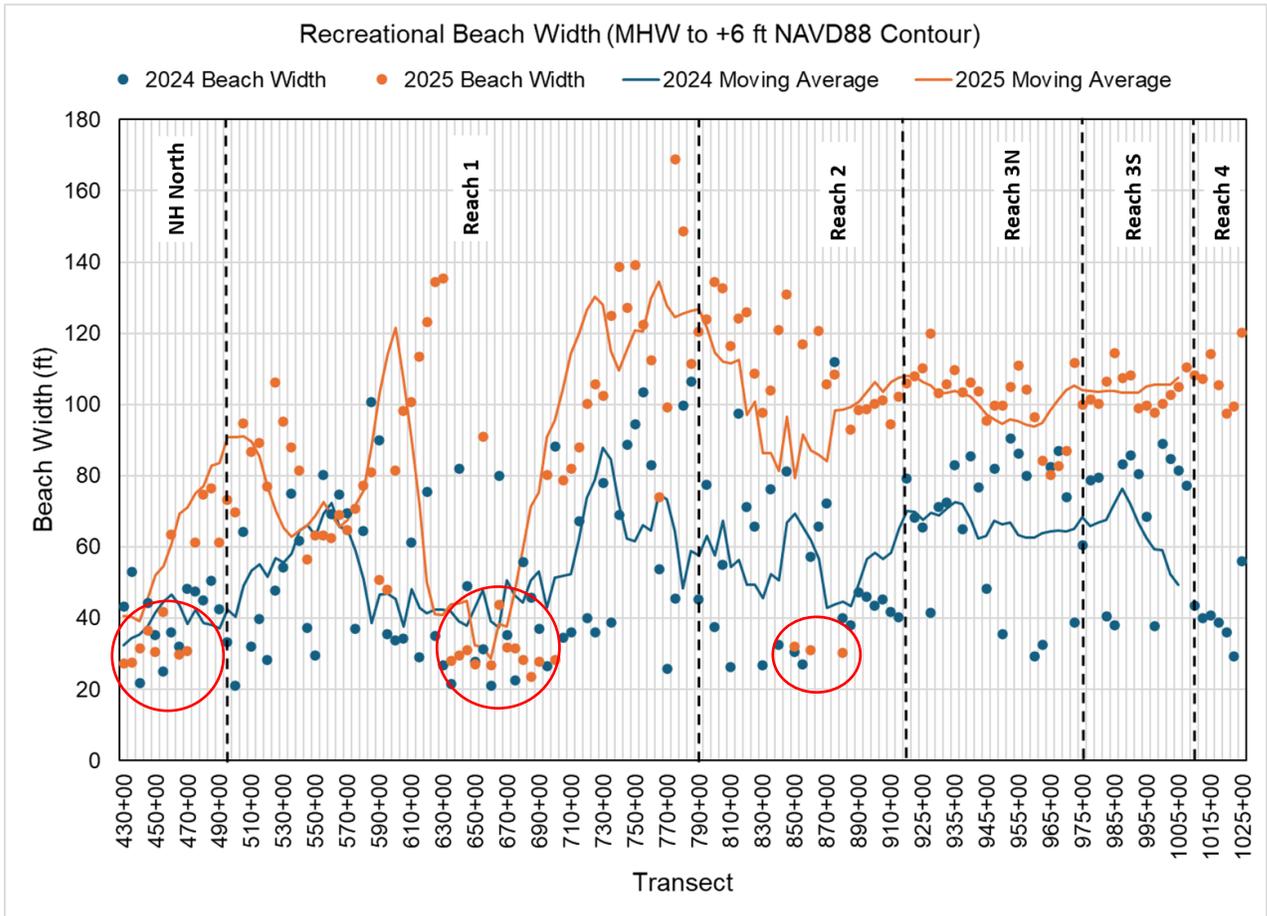
**Figure 5-37. Master Plan Nourishment Trigger Volume Comparison**

All management reaches currently contain average profile volumes above the nourishment triggers, however, there have been localized erosion hotspots observed along the Town’s shoreline in the summer of 2025. To more closely examine the current status of the beach, the profile volumes from all transects as of June 2025 are presented in **Figure 5-38**. Localized segments of Reaches 2 and 3 have profiles below the trigger volumes (red arrows), and additional localized segments of Reaches 1, 2 and 4 are close to the triggers (yellow arrows).



**Figure 5-38. 2025 Beach Profile Volumes and Master Plan Trigger Volume Comparison. Red arrows indicate locations that are below the trigger volumes and yellow areas indicate areas that are close to the trigger volumes.**

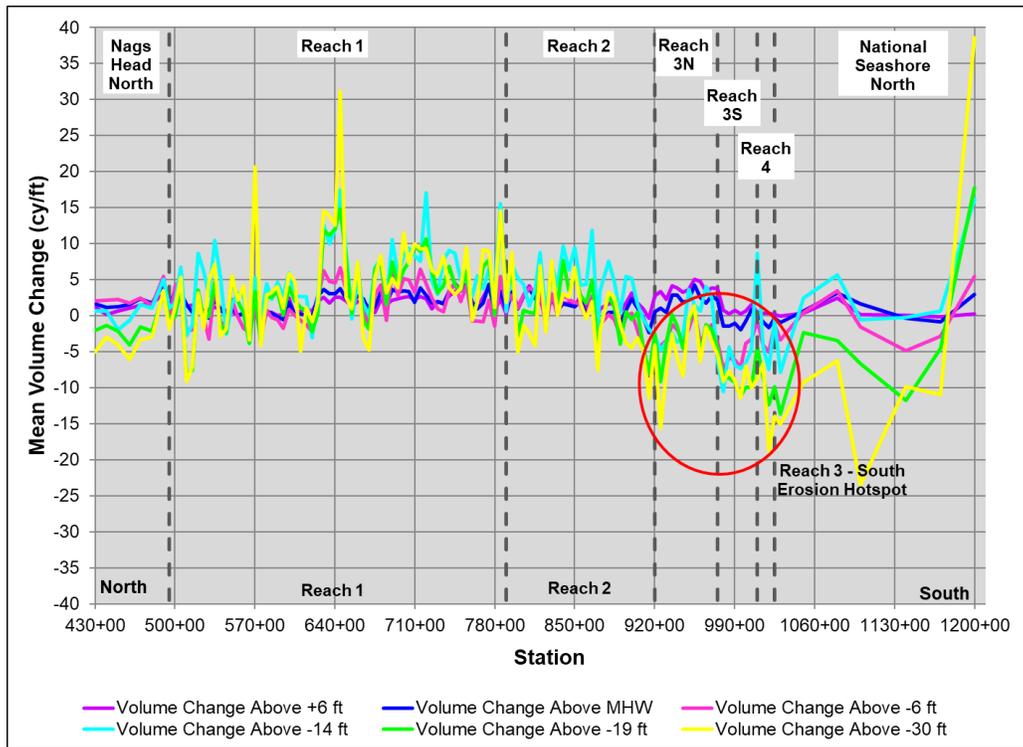
An evaluation of the recreational beach width as approximated by the distance from the MHW contour to the +6 ft NAVD88 contour is also presented in **Figure 5-39**. To reduce scatter in the data, a 2,000-ft moving average was applied to better illustrate overall shoreline trends. Results show gains in recreational beach width during the current monitoring year; however, several sections remain very narrow—particularly in North Reach, Reach 1, and Reach 2 (circled in red in **Figure 5-39**). The narrowing of the dry beach increases the likelihood that dunes will be impacted by elevated water levels and wave events.



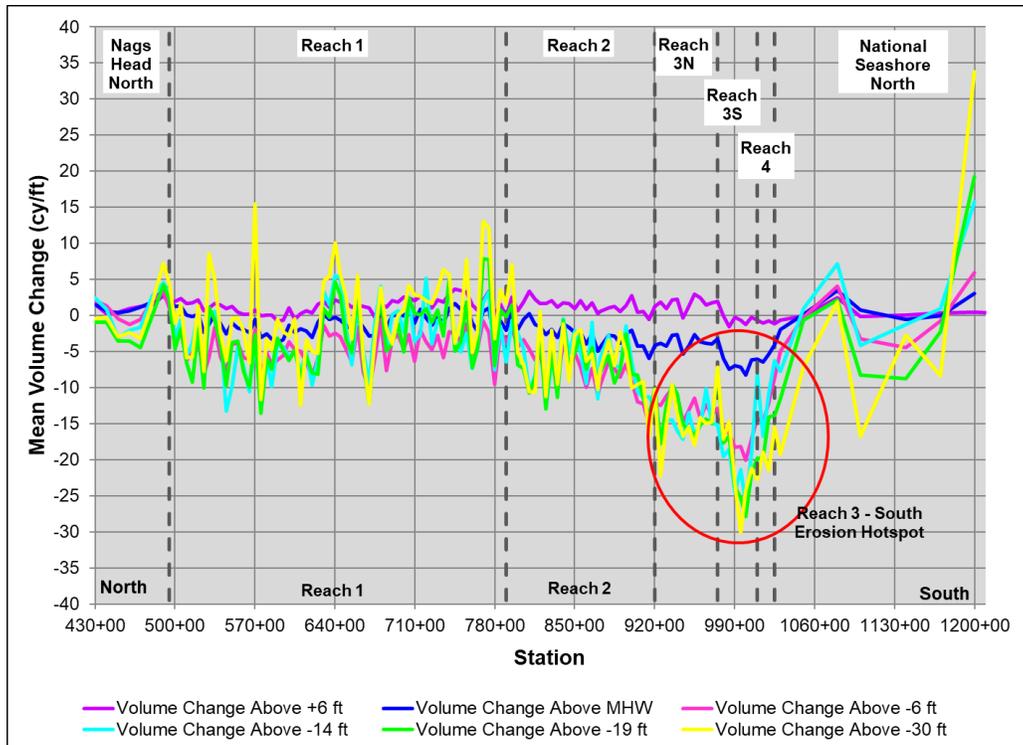
**Figure 5-39. Recreational Beach Width Comparison, 2024 to 2025**

**5.6 Long-Term Volume Change Trends (2011 – 2025)**

To determine the long-term trends along Nags Head, annual volume changes from the present and previous monitoring reports were averaged at each transect. Material placed during the 2019 and 2022 beach nourishment projects was subtracted out of the total volume change at each transect in order to determine the background erosion rate. **Figure 5-40** shows the mean volume change from 2011 to 2025 with nourishment, and **Figure 5-41** shows the mean volume change over the same years with the nourishment subtracted out. In comparison of the two figures, the hotspot at Reach 3-South (in the center of the red circle on each figure) is very visible when nourishment effects are subtracted out. In both figures increases in volume losses from north to south can be observed. The majority of profiles to the south of Reach 2 experience volume losses above all elevations analyzed when the nourishment material is subtracted.



**Figure 5-40. Mean Volume Change per year (2011 – 2025) (With Nourishment)**



**Figure 5-41. Mean Volume Change per year (2011 – 2025) (Without Nourishment)**

## 5.7 Long-Term Dune Volume Trends

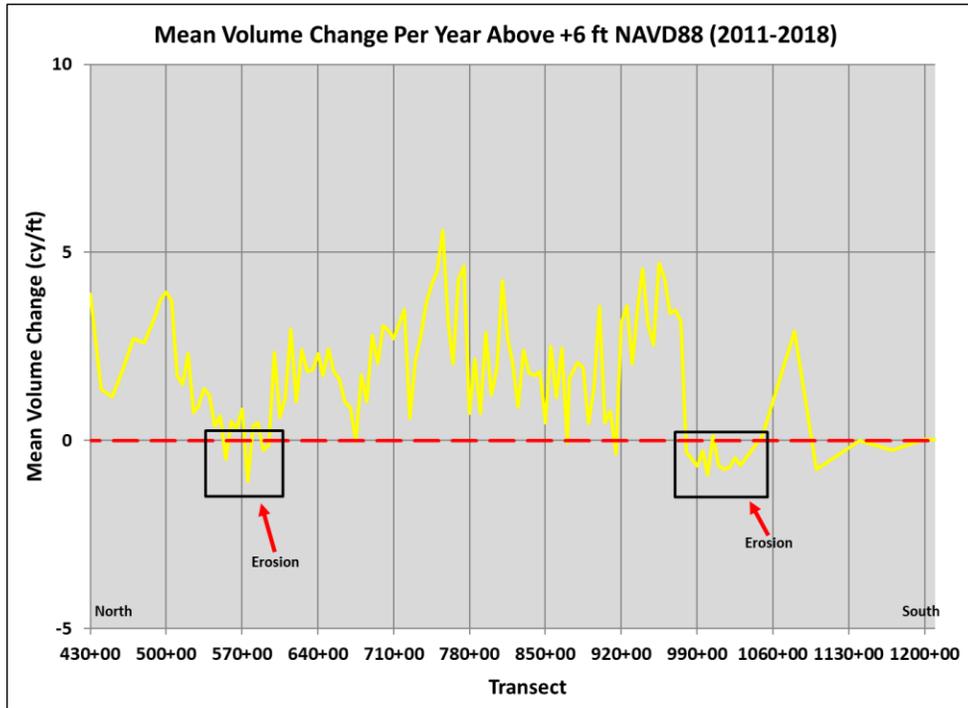
After the 2011 Beach Nourishment study it was noted (CSE 2018) that sand fencing has managed to capture the wind-blown sand and caused steady dune growth until 2014. After 2014, dune growth rates declined as the supply of sand available for aeolian transport decreased. Between 2016 and 2018, shoreline recession and reduced dry beach width further limited aeolian transport, leading to dune losses.

The wider beaches created by the 2019 Beach Nourishment Project restored conditions favorable for aeolian transport, and dune growth was observed above +6 ft NAVD88 during the subsequent four monitoring periods (2019–2023). During the June 2023–June 2024 monitoring period, dune growth continued across Reach 1, Reach 2, and Reach 3N, while Reach 3S and Reach 4 experienced dune scarping due to shoreline recession.

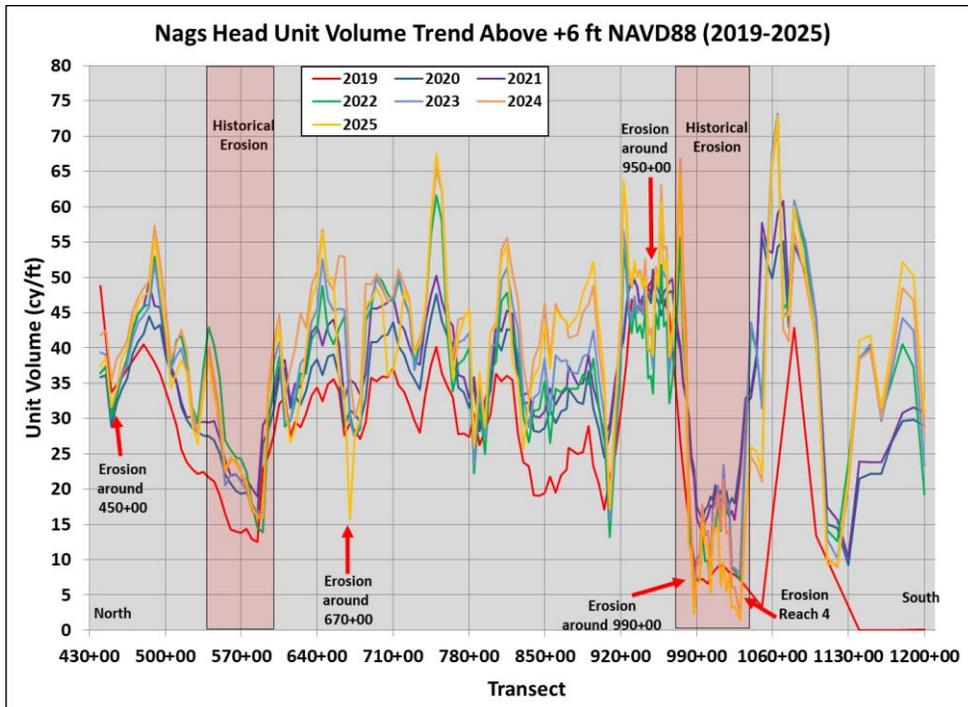
In the current monitoring period, the majority of reaches experienced dune scarping. This trend is tied to narrower dry beach conditions, which increased wave interaction with the dunes while limiting the potential for aeolian transport.

In an attempt to determine the vulnerable locations, the mean volume change above +6 ft NAVD88 in between 2011 and 2019 beach nourishment projects was examined. **Figure 5-42** shows the mean volume change above +6 ft NAVD88, indicating two erosional locations. The first location is observed at Reach 1, in front of the Jockey's Ridge State Park, between E Hollowell Street and E Soundside Road. The second area covers the south part of the monitoring area starting from the hotspot location at Reach 3-South and extending south to National Seashore – North reach. The rest of the dunes across the Nags Head Oceanfront display either volume gain or no overall change.

To investigate how the volume changes occurred over time a moving average analysis was done by averaging the unit volume of a profile with profiles within 1,000 ft distance to it. Using moving average helps visualize the trends by displaying the localized trends while smoothing the instantaneous changes of volume between profiles. **Figure 5-43** presents the moving average analysis of unit volumes above +6 NAVD88 ft along the monitoring shoreline from 2019 to 2025. The analysis reveals dune erosion across Reach 4, as well as other areas where dune erosion has been ongoing.



**Figure 5-42. Unit Dune Volume Change from 2011 to 2018 (Moving Average Trend Above +6 ft NAVD88)**



**Figure 5-43. Unit Dune Volume by Year (Moving Average Trend Above +6 ft NAVD88)**

## 6.0 SUMMARY

This report evaluates shoreline and volume changes along the Town's oceanfront based on surveys collected by McKim & Creed in June 2025, October 2024, and June 2024.

The 2019 Beach Nourishment Project placed approximately 4.0 million cy of material along 10 miles of shoreline. Since then, the shoreline has undergone periods of retreat and recovery. The most significant recession occurred following nourishment, largely from Hurricane Dorian (2019) and natural profile equilibration. The 2022 post-Dorian renourishment mitigated losses, but by June 2023 recession resumed. Continuous wave activity through June 2024 limited recovery, though calmer conditions after October 2024 allowed for shoreline advancement.

During the June 2024–June 2025 monitoring year, the nourished oceanfront advanced an average of +10.7 ft at MHW. Reach 2 showed strong accretion (+24.3 ft), while Reach 3 North and Reach 3 South had modest recession (-9.1 ft and -8.4 ft, respectively). All nourished reaches experienced seaward advancement between October 2024 and June 2025, reflecting post-storm recovery.

Dry beach width, measured from MHW to +6 ft NAVD88, improved overall in 2025 but remains narrow in several areas, particularly in North Reach, Reach 1, and Reach 2. Narrow dry beach segments increase the risk of dune impacts during high water levels and storm events.

Volume analysis highlights cross-shore sand redistribution. The nourished oceanfront gained +959,407 cy (+18 cy/ft) above -14 ft NAVD88, consistent with widespread sandbar growth. Smaller gains above -19 ft NAVD88 (+69,271 cy) indicate sediment remained in the system but shifted across the profile. Subaerial elevations (+6 ft NAVD88 and MHW) experienced losses, while nearshore gains above -6 ft NAVD88 reflected profile flattening after the erosive June 2023–June 2024 season. Ongoing losses below -30 ft NAVD88 across all reaches suggest system-wide sediment transport beyond the depth of closure, likely driven by alongshore processes.

Since 2019, about 690,045 cy (+13 cy/ft) of sand remains above -19 ft NAVD88 along the Nourished Oceanfront, most of it tied to the 2022 renourishment (614,106 cy). Reach 1 and Reach 2 show volume gains above -19 ft NAVD88 relative to pre-nourishment conditions. In contrast, the other reaches experienced material losses: Reach 3-North and Reach 3-South each lost less than 50% of the material placed during the 2019 nourishment, while Reach 4 underwent more substantial losses, with approximately 56% of its nourished material eroded by the end of this monitoring period.

The Town's Master Plan established volumetric triggers based on profile volume from the foredune crest to -19 ft NAVD88, designed to maintain protection from a 25-year storm event. **Figure 5-38** shows that all reaches remain above their triggers on average; however,

localized hotspots in Reaches 2 and 3 are already below threshold values, with additional sections in Reaches 1, 2, and 4 nearing them.

The 2024–2025 monitoring results show shoreline recovery and sandbar growth following the highly erosive 2023–2024 period. However, persistent offshore volume losses and localized erosion hotspots highlight the importance of continued monitoring and proactive management.

## **7.0 REFERENCES**

Coastal Science & Engineering Inc. (CSE), 2018. Monitoring and Analyses of the 2011 Nags Head Beach Nourishment Project. Year 7 (2018) Beach Monitoring Report for Town of Nags Head., NC. Columbia, SC. October 2018.

Moffatt & Nichol (MN), 2024. Town of Nags Head Beach Monitoring Analysis Program. 2024 Summer Annual Monitoring Survey Evaluation. Raleigh, NC. October 2024.



moffatt & nichol

[moffattnichol.com](http://moffattnichol.com)

**Contact:**

Moffatt & Nichol  
4700 Falls of Neuse Road, Suite 300  
Raleigh, NC 27609  
P: (919) 781-4626

101 W. Main Street, Suite 3000  
Norfolk, VA 23510  
P: (757) 628-8222

