

**FINAL REPORT**

Produced for the Town of Nags Head, NC  
October 2024



# 2024 ANNUAL BEACH MONITORING SURVEY EVALUATION

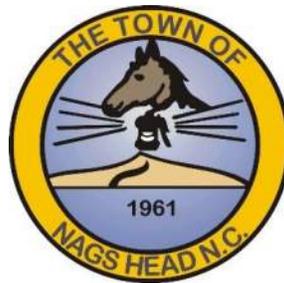
Town of Nags Head, NC



# TOWN OF NAGS HEAD

## 2024 ANNUAL MONITORING SURVEY EVALUATION

Prepared for:



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Checked	NVM	NVM			
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Prepared by:



**TOWN OF NAGS HEAD**

**2024 ANNUAL MONITORING SURVEY  
EVALUATION**

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## EXECUTIVE SUMMARY

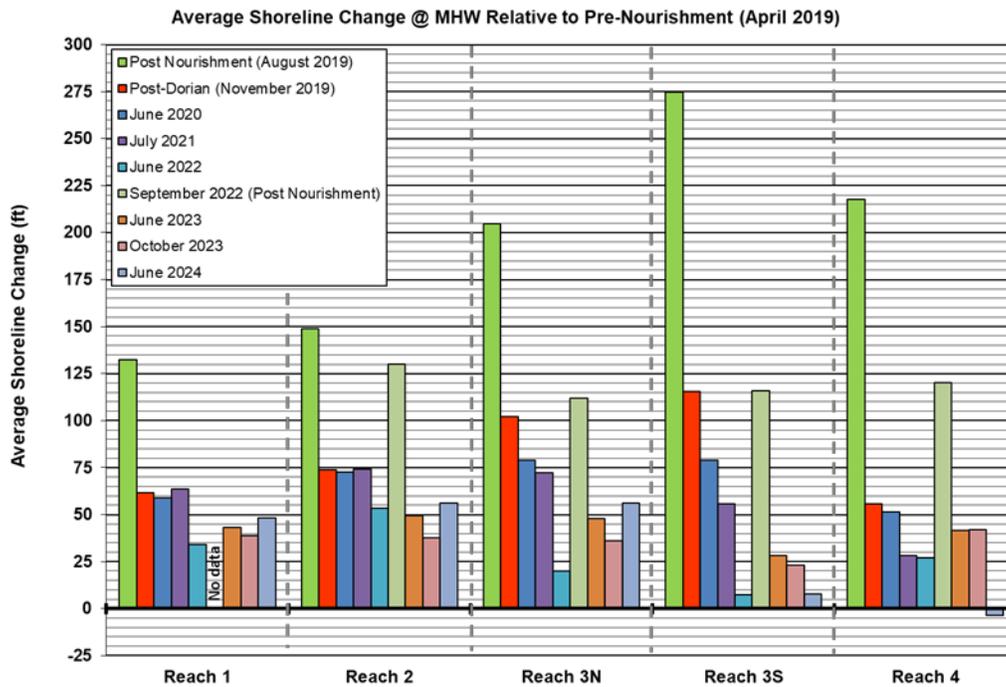
The Town of Nags Head Beach Monitoring and Maintenance Plan is sponsored by the Town of Nags Head (Town) as a continuation of the 2011 monitoring program initiated for assessing beach conditions. The primary purpose of the program is to assess current and historical shoreline conditions, determine shoreline 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 2024 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 2023, along with another annual survey in June 2023. This report outlines the data sources, methodologies, and findings of a survey evaluation conducted by Moffatt & Nichol. The evaluation compares the June 2024 survey to the data from October 2023 and June 2023 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.

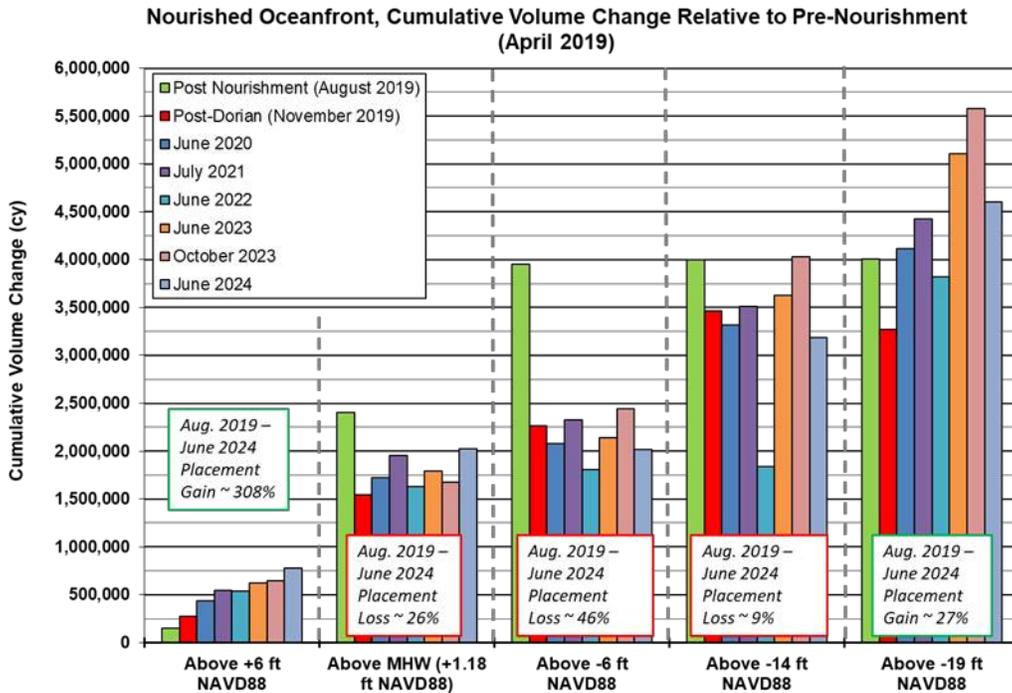
**Figure ES-1** illustrates the shoreline changes relative to pre-nourishment condition (April 2019) along the Nourished Oceanfront. As can be seen from the figure, a significant landward recession occurred along the Nourished Oceanfront since the completion of the 2019 nourishment project. The majority of this recession, noted before the post-Dorian survey, can be attributed to Hurricane Dorian. However, a portion of it was also due to profile equilibration, a natural occurrence during the stabilization of the nourishment profile. Similarly, the August 2022 post-Dorian renourishment project helped mitigate some of the recession. However, by June 2023, the shoreline had receded again, likely due to ongoing profile equilibration. This year, high-energy wave events caused further significant recession, particularly in the southern reaches (3S and Reach 4). In Reach 4, the shoreline has receded beyond the April 2019 pre-nourishment condition.



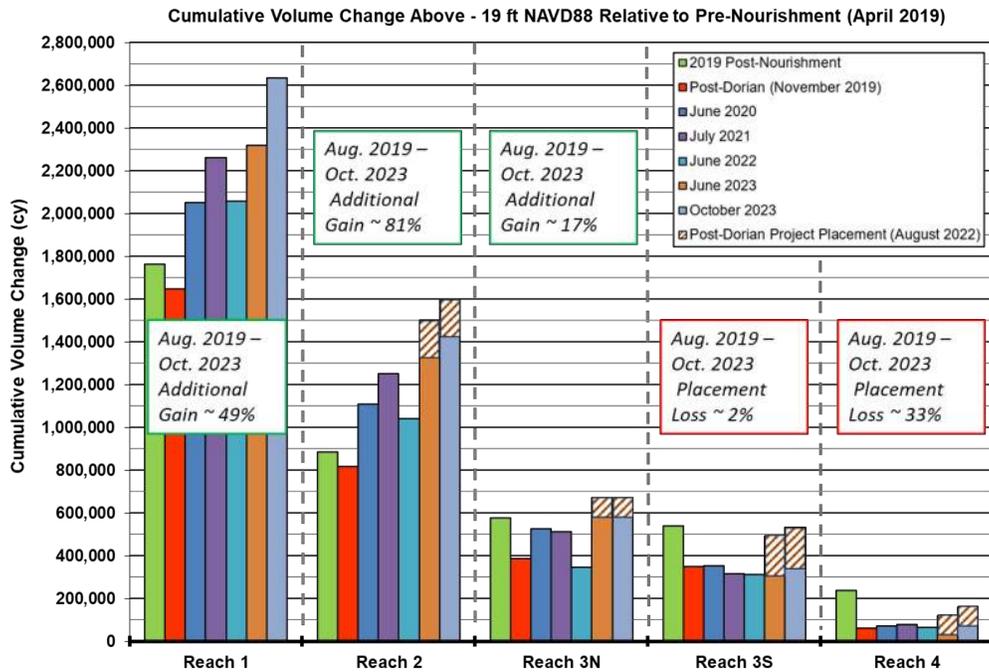
**Figure ES-1. Nourished Oceanfront Average Shoreline Change Relative to Pre-Nourishment Conditions**

**Figure ES-2** illustrates that the overall changes in sand volume vary with the depth above which volumes are assessed. Since the completion of the 2019 nourishment project approximately 598,349 cy (11.3 cy/ft) of volume gain was observed above -19 ft NAVD88 along the Nourished Oceanfront. This indicates that 127% of the volume present in August 2019 above -19 ft NAVD88 has remained within the system through the June 2024 survey. It's important to highlight that 614,106 cubic yards of material were placed during the 2022 Post-Dorian Renourishment project, indicating that without this renourishment, material loss would have likely occurred above -19 ft NAVD88. The results suggest significant cross-shore shifts of sand across various elevations. Notably, much of the sand has moved to lower elevations near the depth of closure, where it becomes vulnerable to being removed 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 62% 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 losses in material above -19 ft NAVD88 indicating material being moved out of 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 2023 – June 2024)**

June 2023 vs. June 2024	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	6.1	3.4	4.5	0.8	11.8	9.6	26.6
Nags Head - Reach 1	495+00 - 790+00	29,500	5.1	2.5	4.2	0.2	2.2	-1.4	14.7
Nags Head - Reach 2	790+00 - 920+00	13,000	6.4	4.7	8.0	-0.3	-7.6	-6.6	5.5
Nags Head - Reach 3N	920+00 - 975+00	5,500	8.2	3.7	5.9	-10.0	-34.3	-36.6	-30.2
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-20.4	-0.1	-3.4	-12.7	-41.2	-38.9	-36.5
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-44.9	-2.5	-10.4	-17.9	-36.1	-16.1	-16.5
National Seashore North	1025+00 - 1200+00	17,500	20.0	-2.4	-0.5	9.2	-26.6	-18.7	-33.3
	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>2.7</b>	<b>2.9</b>	<b>4.4</b>	<b>-2.3</b>	<b>-7.9</b>	<b>-9.2</b>	<b>3.5</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>6.9</b>	<b>1.7</b>	<b>3.3</b>	<b>0.6</b>	<b>-10.5</b>	<b>-9.8</b>	<b>-2.9</b>

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

**Table ES-2. Nags Head Cumulative Volume Change Statistics (June 2023 – June 2024)**

June 2023 vs. June 2024	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	20,432	27,027	4,771	70,965	57,395	159,508
Nags Head - Reach 1	495+00 - 790+00	29,500	74,639	123,358	6,401	64,852	-41,313	433,683
Nags Head - Reach 2	790+00 - 920+00	13,000	61,511	103,820	-3,551	-98,804	-85,912	71,490
Nags Head - Reach 3N	920+00 - 975+00	5,500	21,031	33,981	-57,347	-197,490	-210,239	-173,746
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-350	-11,880	-44,415	-144,269	-136,136	-127,669
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-4,288	-18,134	-31,341	-63,252	-28,187	-28,798
National Seashore - North	1025+00 - 1200+00	17,500	-42,262	-8,788	161,561	-465,228	-326,727	-582,524
	Transects	Reach Length	total	total	total	total	total	total
<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>53,000</b>	<b>152,543</b>	<b>231,146</b>	<b>-130,252</b>	<b>-438,963</b>	<b>-501,787</b>	<b>174,960</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>130,713</b>	<b>249,384</b>	<b>36,080</b>	<b>-833,226</b>	<b>-771,119</b>	<b>-248,056</b>

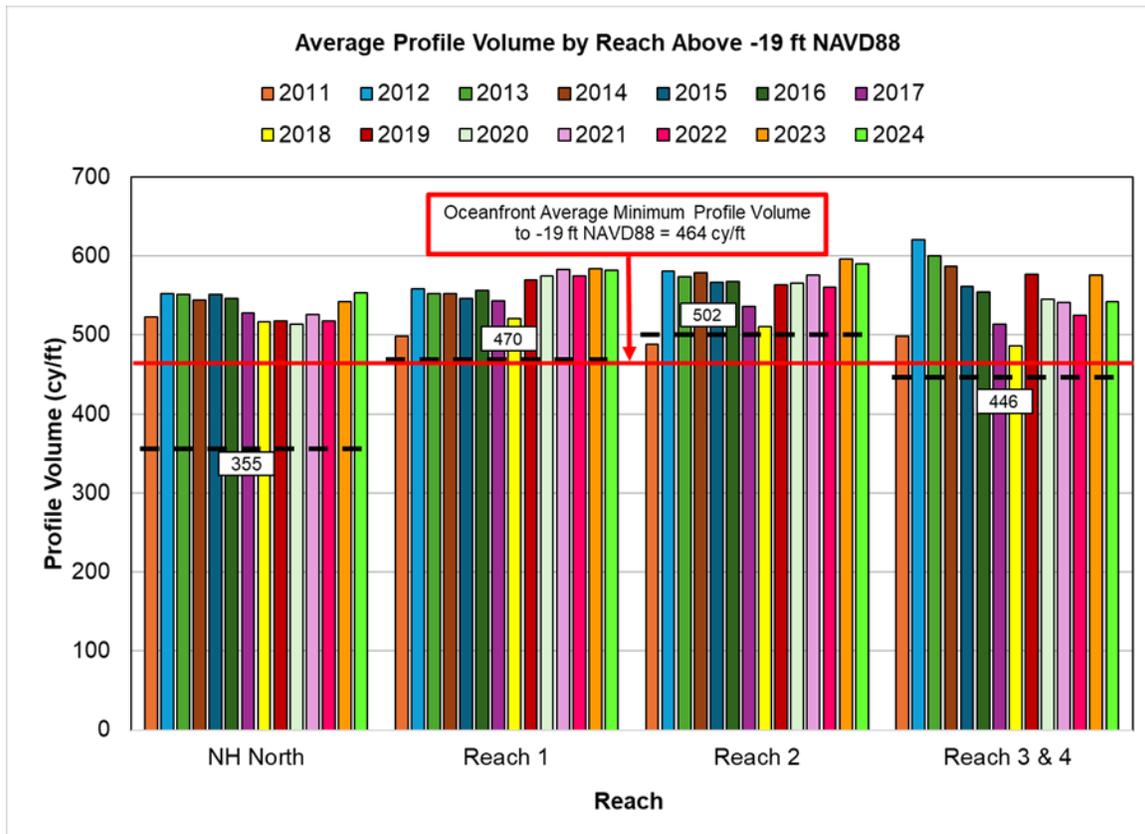
During the June 2023 - June 2024 monitoring period, Reach 3S and Reach 4 experienced significant shoreline recession, eroding much of the recreational beach. This erosion allowed waves to reach the dunes, resulting in dune scarping especially in Reach 4. The remaining reaches showed slight seaward advancement as material from nearshore was deposited to the beachface.

The Nags Head Oceanfront experienced material gains along the subaerial portions of the profiles (+6 ft NAVD88 and MHW). This was mainly due to nearshore material being deposited on the beachface. However, below MHW, volume losses occurred across all analyzed elevations, except above -30 ft NAVD88, where gains were only observed in Reaches 1 and 2. The most significant volume loss was recorded above -19 ft NAVD88 (-501,787 cy or -9.2 cy/ft), exceeding the historical background erosion rate (-6.7 cy/ft). This elevated loss can be attributed to the active 2023-2024 storm season, which brought 17 events with significant wave heights exceeding 8 ft. The frequent storm activity likely prevented the offshore-deposited material from returning to the beach, instead pushing it further offshore to lower elevations. Additionally, material gains at the Town boundaries in the prior monitoring period (June 2022 – June 2023) were attributed to sediment moving south from northern nourishment projects. The ongoing volume losses above -30 ft NAVD88 suggest that sediment may have been transported further south toward Oregon Inlet, moving out of the Town's system.

The Total Monitored Oceanfront, which includes both the Nags Head North and National Seashore-North reaches flanking the Nourished Oceanfront, exhibited a similar trend of material gains at subaerial elevations and losses below MHW. While the Nags Head North reach showed material gains across all analyzed elevations, the National Seashore-North reach experienced material losses above all analyzed elevations, similar to the adjacent areas in the Nourished Oceanfront.

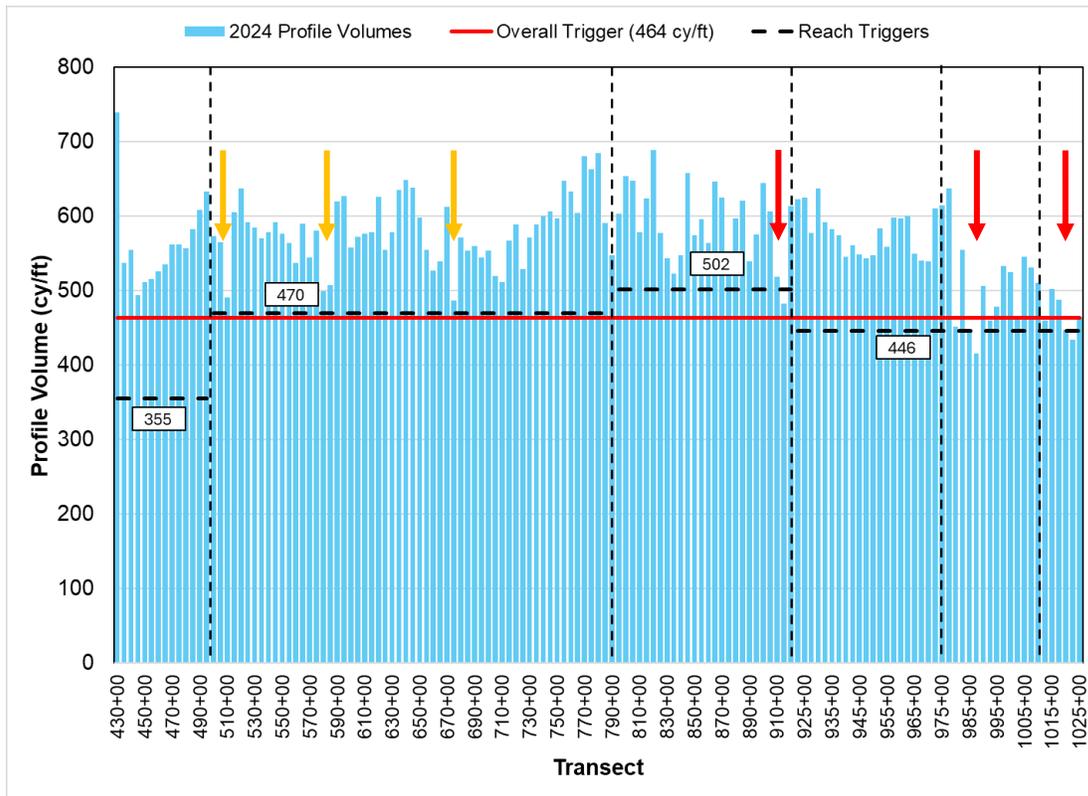
During the June 2023 to June 2024 monitoring period, dune growth continued across Reach 1, Reach 2, and Reach 3N, with the most significant growth occurring in Reach 2, which saw an increase of +65,511 cy (+4.7 cy/ft). In contrast, Reach 3S and Reach 4 experienced dune scarping and shoreline recession. This was particularly significant in Reach 4, where -4,288 cy (-2.5 cy/ft) of material was lost above +6 ft NAVD88.

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 2024. To more closely examine the current status of the beach, the profile volumes from all transects as of June – July 2024 are presented in **Figure ES-5**. Localized segments of Reaches 3 and 4 have profiles below the trigger volumes (red arrows), and additional localized segments of Reaches 1 and 2 are close to the triggers (yellow arrows).



**Figure ES-5. 2024 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. Loss of the dry beach increases the likelihood that the dunes will be further impacted by high water level and wave events. Given these results, the Town may consider accelerating the timeline for the next beach nourishment project, currently planned for Summer 2027.

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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 2024 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 2023. This report outlines the data sources, methodologies, and findings of a survey evaluation conducted by Moffatt & Nichol. The evaluation compares the June 2024 survey to the data from October 2023 and June 2023 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. It should be noted that the monitoring Reach 1 begins from Station 495+00 while the 2011 construction reach began from 497+00. **Table 2-1** shows the long-term volume changes from previous studies over the various reaches of shoreline.



**Figure 2-1: Prior Established Monitoring Reaches**

**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 2024 survey in June 2024, 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 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

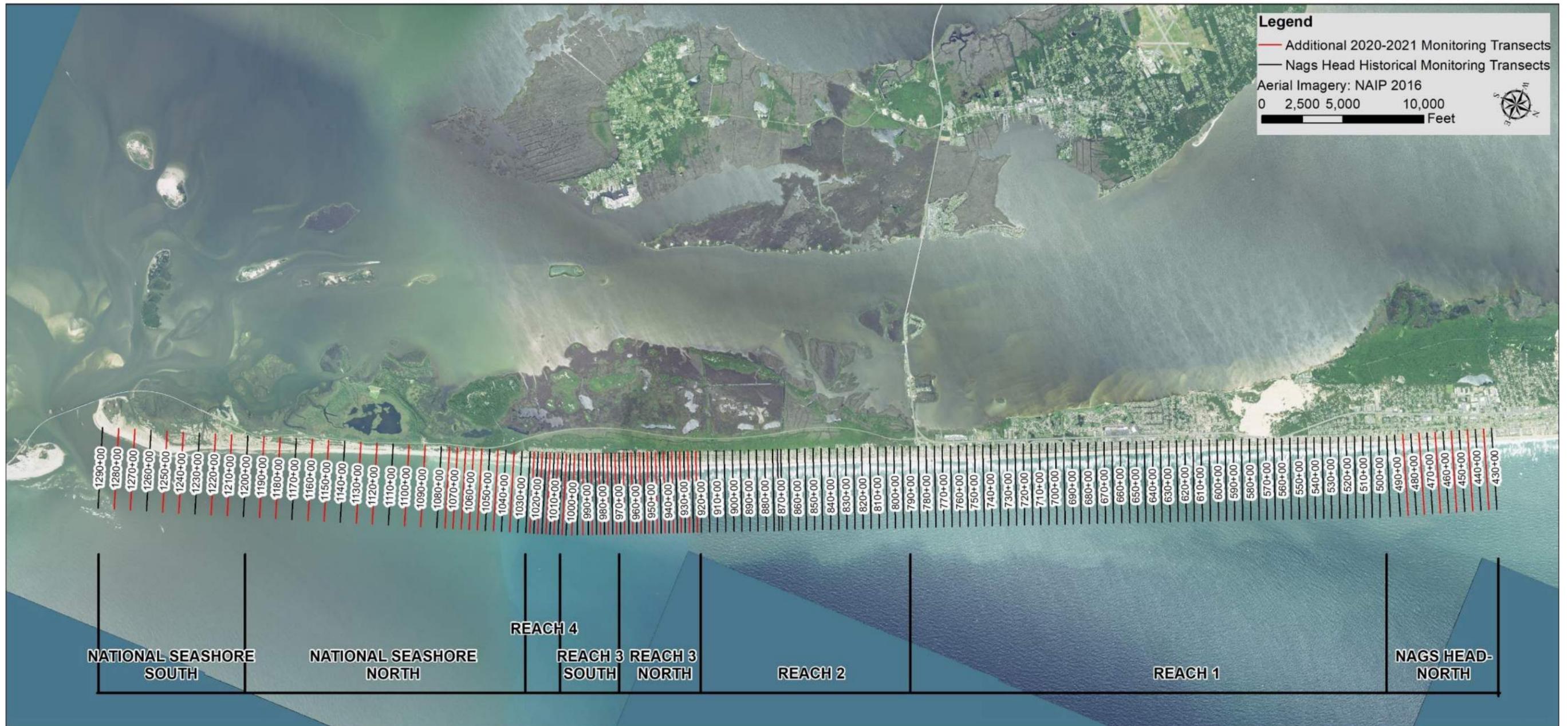


Figure 3-1. Nags Head Annual Monitoring Profile Line Locations

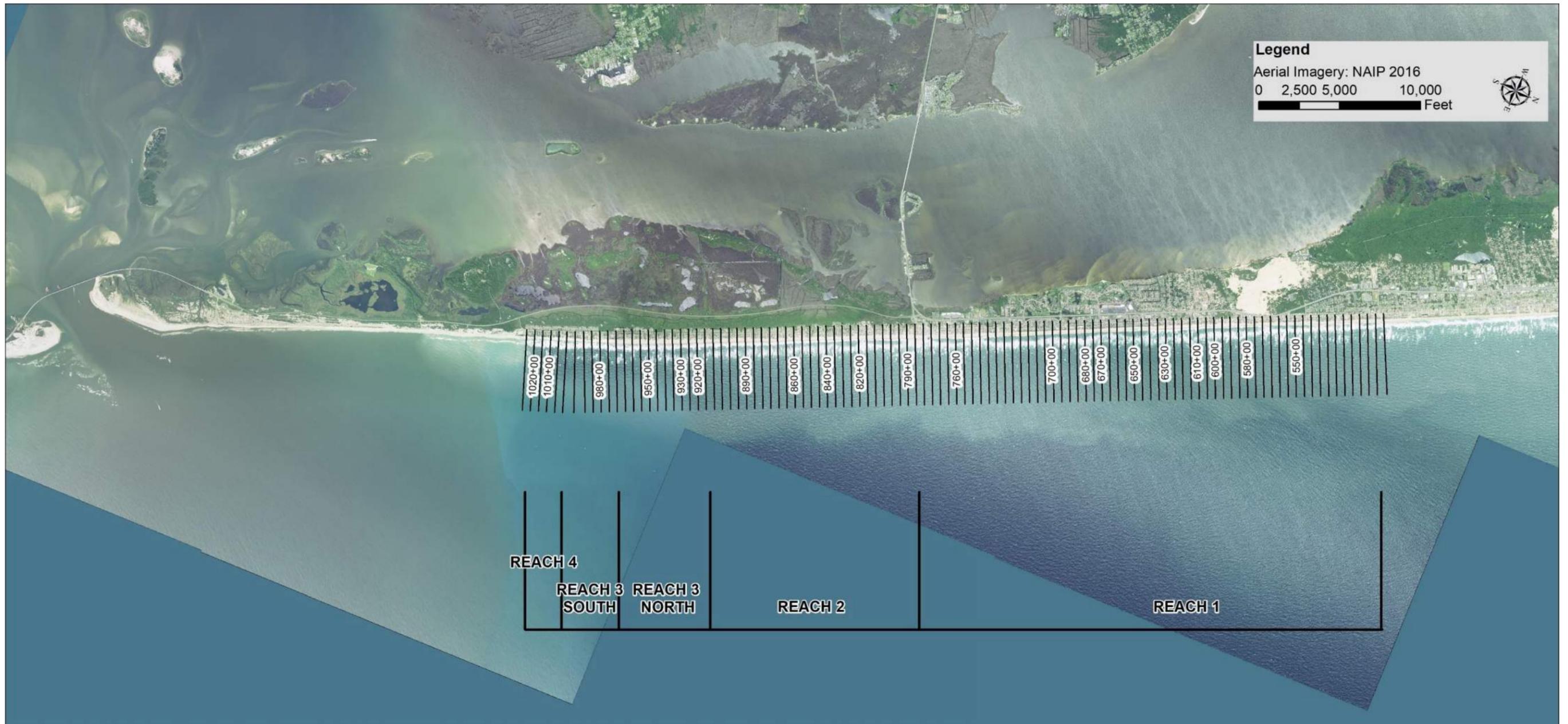


Figure 3-2. Nags Head Fall Monitoring Profile Line Locations

### 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:

#### 2024 Annual Survey

The most recent annual survey data was collected by McKim & Creed between June 18 and July 31, 2024. The crew initially demobilized on June 26 due to a lack of permission to survey within the Cape Hatteras National Seashore. After obtaining the necessary permit, they resumed work on July 29 and completed surveys for the 32 lines within the park, along with re-surveying an additional 7 lines (Reach 4) at the request of the Town of Nags Head by July 31. The date used for the 2024 Nags Head profiles in this report is June 26, 2024, as the majority of the surveys within the town's boundaries were finished by then (see **Appendix A** for details).

#### 2023 Fall Survey

The present fall survey was conducted from October 17-19. The date used for the 2023 Fall survey is October 19, 2023, when the surveying was completed.

#### 2023 Annual Survey

The previous set of annual survey data was collected by McKim & Creed on June 11-July 1. The date used for the 2023 Nags Head profiles for this report is June 30, 2023, when the majority of the surveying was completed.

#### 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.

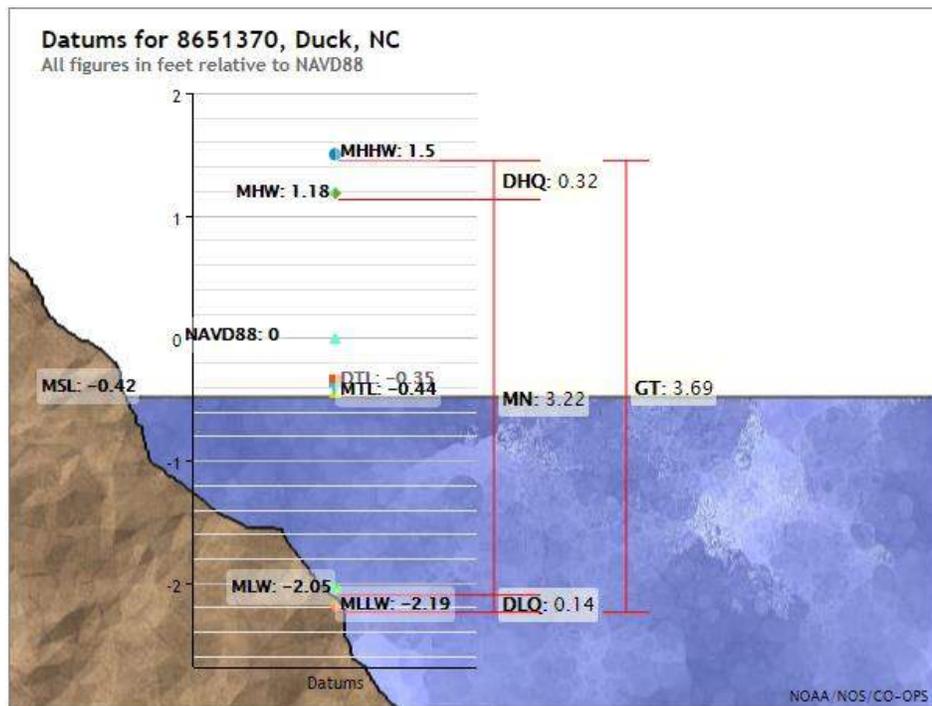
McKim & Creed provided the processed survey data to Moffatt & Nichol in ASCII (xyz), Excel (xyz), BMAP (free format), and GIS (shapefile, grid) formats allowing for compatibility with multiple programs. The data referenced the horizontal North American Datum 1983 (NAD83) State Plane North Carolina (U.S.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

**Appendix A** contains the McKim & Creed 2024 Field Report which discusses, in detail, the singlebeam (bathymetric) and topographic data acquisition. The field report also provides the associated equipment and quality control procedures (QA/QC) utilized in the data collection and processing tasks.

## 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 2023 and June 2024 surveys as well as between the October 2023 and June 2024 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 between the June 2023 and June 2024 surveys as well as between the October 2023 and June 2024 surveys. Volume changes were calculated for six different elevation extents to better understand the processes occurring onshore and offshore of Nags Head. Calculations included volume change above the following elevations:

- above +6 ft NAVD88 (berm),
- above +1.18 ft NAVD88 (MHW),
- above -6 ft NAVD88 (wading depth/recreational beach),
- above -14 ft NAVD88 (outer bar),

- above -19 ft NAVD88 (depth of closure), and
- above -30 ft NAVD88.

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

As with the shoreline change, the results represent volume change (cy/ft) over the period of time between surveys. In addition, the volume changes were converted to cumulative changes over each of the management reaches and for the entire shoreline. This was done by applying the average end area method to the unit volume changes (cy/ft) computed at each transect and summing the total volume changes between each neighboring pair of transects. The resulting value indicated the total loss or gain of material between survey periods based on the applicable profile extents.

It should be noted that the uncertainty in the hydrographic portion of the survey can result in a significant volumetric change in offshore areas where the slope of the seafloor declines gradually. If an uncertainty of  $\pm 0.11$  ft is applied 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) along all 77,000 ft of oceanfront shoreline, this lends itself to an uncertainty of approximately  $\pm 282,300$  cy. For this reason, more attention is given to the volume change calculations at -19 ft NAVD88 and above.

The profile volume calculation lenses (see **Figure 4-2**) were strategically chosen to help understand and track the movement of sand onshore and offshore. Volume changes calculated for portions of the profiles above +6 ft NAVD88 and above MHW are representative of changes in the amount of material in the dune system and on the subaerial beach. These areas of the profile are highly influenced by storm activity, and they are both very significant in the ability of the beach and dune to mitigate storm surge and wave impacts on landward structures and infrastructure. Volume comparisons for portions of the profiles above -6 ft NAVD88, an approximate wading depth, represent changes in the recreational beach area. Volume comparisons above -14 ft NAVD88 help to track sand movement to and from the outer sand bar and are valuable in decision making for future beach nourishment projects. Volume comparisons above -19 ft NAVD88 provide general estimates of the total volumetric change along the respective profile out to the depth of closure. Finally, volume comparisons above -30 ft NAVD88 allow the complete tracking of sand movement offshore. However, hydrographic survey measurement accuracy may impact these calculations. This is a proven, comprehensive way to assess the impact of storm activity on the subaerial beach and dune system as well as track the movement of sand offshore and quantify total gains and losses in the entire system.

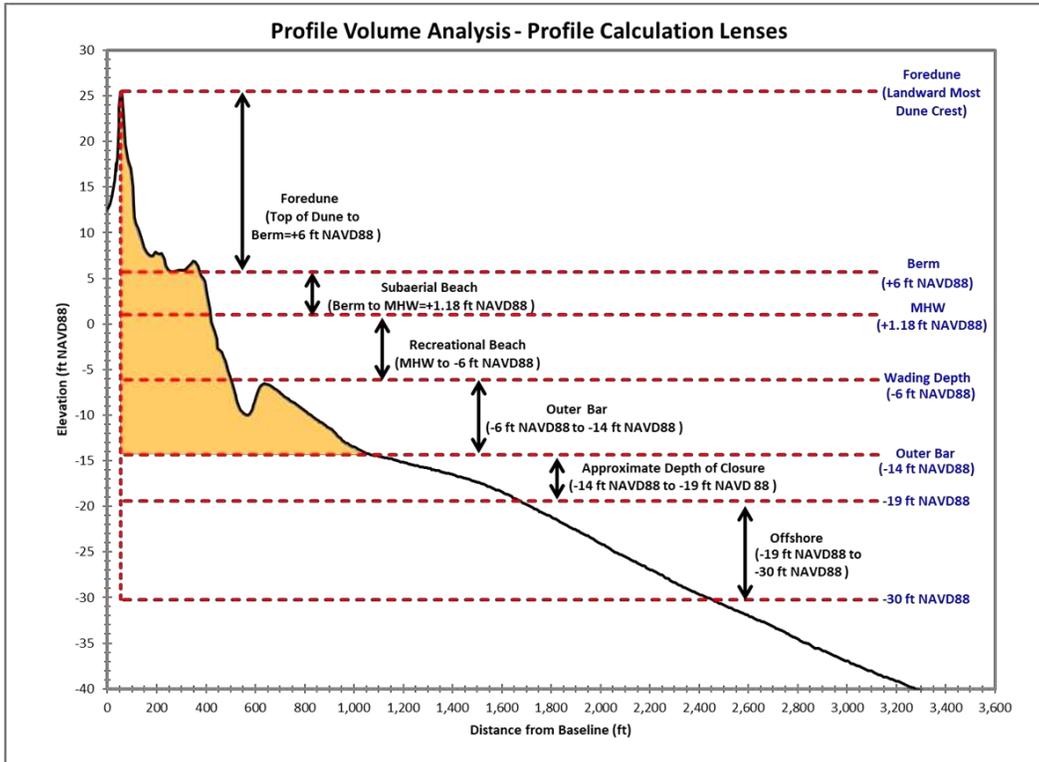


Figure 4-2. Profile Volume Calculation Lenses

## 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 2023 – June 2024), insights into shoreline and volume changes from fall 2023 to summer 2024 (October 2023 – June 2024), and an analysis of long-term trends from 2011 to 2024.

### 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**

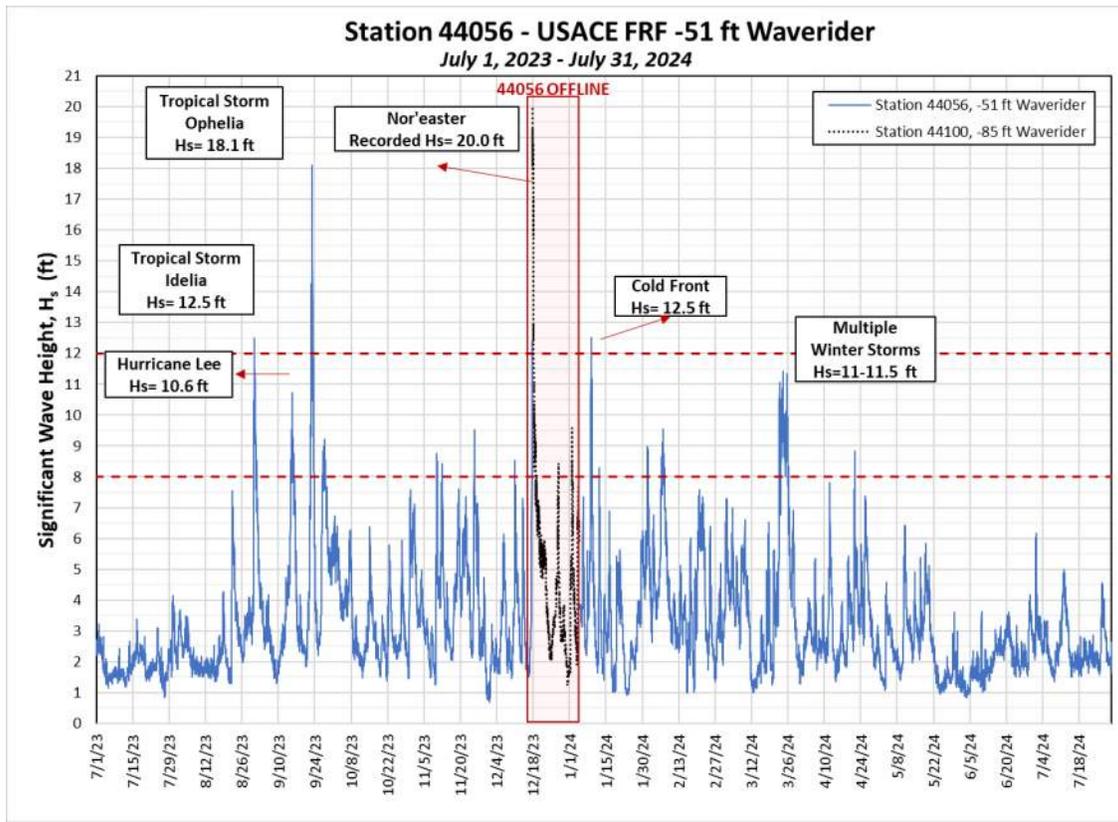
Reach	Length	Final Volume (cy)	Final Density (cy/ft)
Reach 2	13,000	179,355	13.8
Reach 3N	5,500	142,137	25.8
Reach 3S	3,500	198,441	56.7
Reach 4	2,000	94,173	47.1
<b>Total</b>	<b>24,000</b>	<b>614,106</b>	

### 5.1.2 Wave Climate and Storm Events

Wave data from the National Data Buoy Center (NDBC) Station 44056 (USACE Field Research Facility (FRF)), located approximately 15 miles north of the Town, was downloaded for July 2023 through July 2024. The wave data was then plotted to analyze wave activity which may have impacted the Town. **Figure 5-1** shows the location of the buoy while **Figure 5-2** presents a plot of the wave heights during the reporting period. During the observation period, the station 44056 buoy was unmoored from December 18, 2023, to January 5, 2024. To assess the wave climate during this time, data from station 44100 (offshore of station 44056) is also presented in **Figure 5-2**.



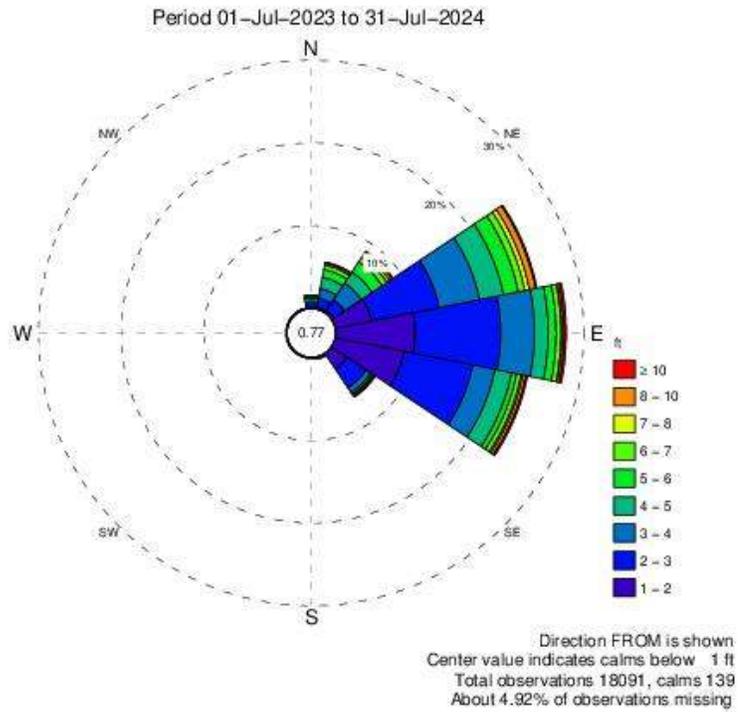
**Figure 5-1. USACE FRF Buoy Locations**



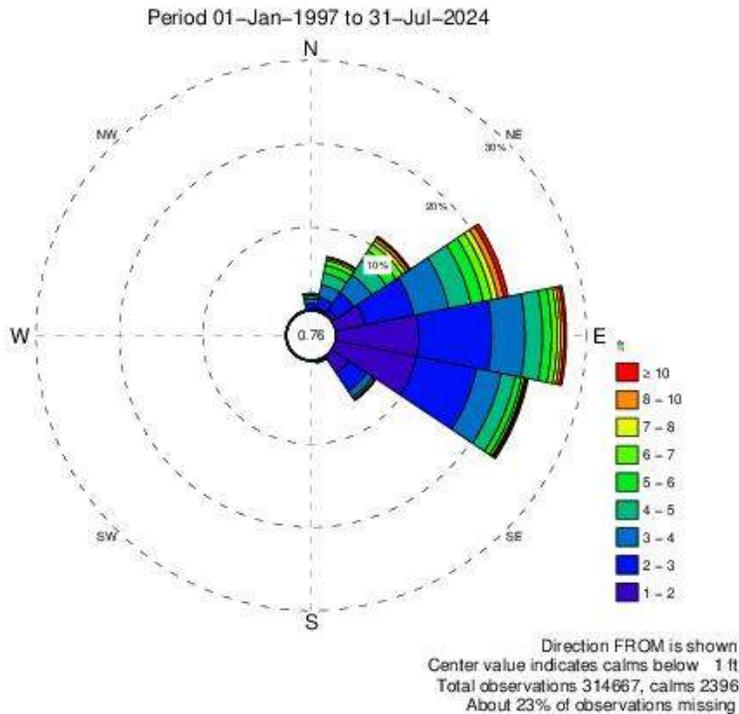
**Figure 5-2. USACE FRF Station 44056 Wave Height**

The data highlights an active wave climate throughout the monitoring period. In the fall/winter season of 2023 (September – December 2023), 10 wave events exceeded 8 ft, with the highest recorded during Tropical Storm Ophelia (18.1 ft) and a December Nor'easter (20.0 ft). In the winter storm season (January – May 2024), seven events occurred with wave heights between 8 ft and 12.5 ft. Notably, a winter storm starting on March 23, 2024, lasted about 70 hours, creating prolonged erosion conditions that prevented recovery of offshore material. The active storm season between the summer 2023 and summer 2024 surveys likely contributed to higher erosion rates than the average annual background rates.

**Figure 5-3** and **Figure 5-4** depict the directional wave roses for the annual monitoring period and the period from January 1997 to July 2024, respectively. Statistical analysis reveals that for both time spans, prevailing waves originate from east-northeast to east-southeast directions. The percentage of waves coming from east-northeast has slightly increased (~3%) in this monitoring period while the percentages for the other two dominant directions (east, east-southeast) remained the same.



**Figure 5-3. Station 44056 Significant Wave Height Rose from July 2023 – July 2024**



**Figure 5-4. Station 44056 Significant Wave Height Rose from January 1997 – July 2024**

## 5.2 Determination of Background Erosion Rates for Town of Nags Head (2011 – 2024)

To develop long-term trends in volume losses/gains, it is important to determine background erosion rates which do not include the volume gains from nourishment events. Since the establishment of the beach monitoring program immediately after the construction of the 2011 beach nourishment project, the Nags Head oceanfront has undergone one beach nourishment project in 2019 and another one 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 2024. Table 5-3 shows the computed volume change (including nourishments) above -19 ft NAVD88 from 2011-2024 for the defined monitoring reaches.

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

Reach	Volume Change (cy) 2011-2012	Volume Change (cy) 2012-2013	Volume Change (cy) 2013-2014	Volume Change (cy) 2014-2015	Volume Change (cy) 2015-2016	Volume Change (cy) 2016-2017	Volume Change (cy) 2017-2018	Volume Change (cy) 2018-2019	Volume Change (cy) 2019-2020	Volume Change (cy) 2020-2021	Volume Change (cy) 2021-2022	Volume Change (cy) 2022-2023	Volume Change (cy) 2023-2024
Nags Head - North (430+00 - 495+00)	12,512	459	-61,997	42,855	-21,464	-107,963	-76,609	-273	14,451	82,466	-9,240	156,991	57,395
Nags Head - Reach 1 (495+00 - 790+00)	199,722	-210,804	16,718	-110,558	294,941	-418,152	-644,783	1,441,871	253,604	205,765	-210,748	259,165	-41,313
Nags Head - Reach 2 (790+00 - 920+00)	117,215	-195,136	54,157	-81,138	33,499	-429,523	-328,626	696,896	156,913	143,886	-206,347	461,067	-85,912
Nags Head - Reach 3N (920+00 - 975+00)	85,381	-144,828	-13,818	-133,901	15,540	-252,798	-168,797	423,513	21,457	10,346	-159,340	327,560	-210,239
Nags Head - Reach 3S (975+00 - 1010+00)	-32,942	-48,873	-101,531	-89,412	-54,799	-104,590	-84,187	383,465	-106,581	-60,949	-12,855	179,797	-136,136
Nags Head - Reach 4 (1010+00 - 1025+00)	71,930	-105,463	-14,079	-33,271	-42,050	-57,636	-31,569	136,047	-42,197	-11,624	-8,292	54,562	-28,187
National Seashore - North (1025+00 - 1200+00)	107,833	-235,944	153,705	-442,192	3,220	-470,987	-520,298	-181,579	-93,041	610,231	284,283	500,960	-326,727
<b>Nourished Oceanfront (495+00 - 1025+00)</b>	<b>441,306</b>	<b>-705,102</b>	<b>-58,553</b>	<b>-448,280</b>	<b>247,132</b>	<b>-1,262,698</b>	<b>-1,257,961</b>	<b>3,081,792</b>	<b>283,196</b>	<b>287,425</b>	<b>-597,582</b>	<b>1,282,153</b>	<b>-501,787</b>
<b>Total Monitored Oceanfront (430+00 - 1200+00)</b>	<b>561,651</b>	<b>-940,588</b>	<b>33,154</b>	<b>-847,616</b>	<b>228,887</b>	<b>-1,841,647</b>	<b>-1,854,868</b>	<b>2,899,940</b>	<b>204,606</b>	<b>980,122</b>	<b>-322,539</b>	<b>1,940,103</b>	<b>-771,119</b>

To calculate the background erosion rate, the documented nourishment volumes were subtracted from total volume changes above -19 ft NAVD88 between 2012 and 2024 and annualized over the 11-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 -6.7 cy/ft/yr and -5.3 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 - 2024)**

Reach (Transects)	Length	Volume Change Above -19 ft NAVD88 (cy) 2012-2024	Nourishment Volume (cy)	Background Erosion (cy)	Average Annual Background Erosion Rates (cy/ft/yr)
Nags Head - North (430+00 - 495+00)	6,500	77,072	0	77,072	1.0
Nags Head - Reach 1 (495+00 - 790+00)	29,500	835,707	1,762,213	-926,506	-2.6
Nags Head - Reach 2 (790+00 - 920+00)	13,000	219,737	1,064,942	-845,205	-5.4
Nags Head - Reach 3N (920+00 - 975+00)	5,500	-285,304	718,840	-1,004,144	-15.2
Nags Head - Reach 3S (975+00 - 1010+00)	3,500	-236,650	739,274	-975,924	-23.2
Nags Head - Reach 4 (1010+00 - 1025+00)	1,500	-183,758	333,471	-517,229	-28.7
National Nearshore - North (1030+00 - 1200+00)	17,500	-718,369	0	-718,369	-3.4
<b>Nourished Oceanfront (495+00 - 1025+00)</b>	<b>53,000</b>	<b>349,732</b>	<b>4,618,740</b>	<b>-4,269,008</b>	<b>-6.7</b>
<b>Total Monitored Oceanfront (430+00 -</b>	<b>77,000</b>	<b>-291,564</b>	<b>4,618,740</b>	<b>-4,910,304</b>	<b>-5.3</b>

### **5.3 Nags Head Annual Shoreline and Volume Change Analysis (June 2023 – June 2024)**

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 2023, October 2023 and summer 2024 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 2023 and the summer 2024 surveys in tabular format.

5.3.1 Nags Head - North Reach (June 2023 – June 2024)

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**). As a reminder, six transects were added to this reach during the 2020 surveying effort, creating 500 ft spacing for the whole reach. A summary of average shoreline and volume changes between June 2023 and June 2024 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 2023 – June 2024)**

June 2023 vs. June 2024	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	6.1	3.4	4.5	0.8	11.8	9.6	26.6
Total Monitored Oceanfront	430+00 - 1200+00	77,000	6.9	1.7	3.3	0.6	-10.5	-9.8	-2.9

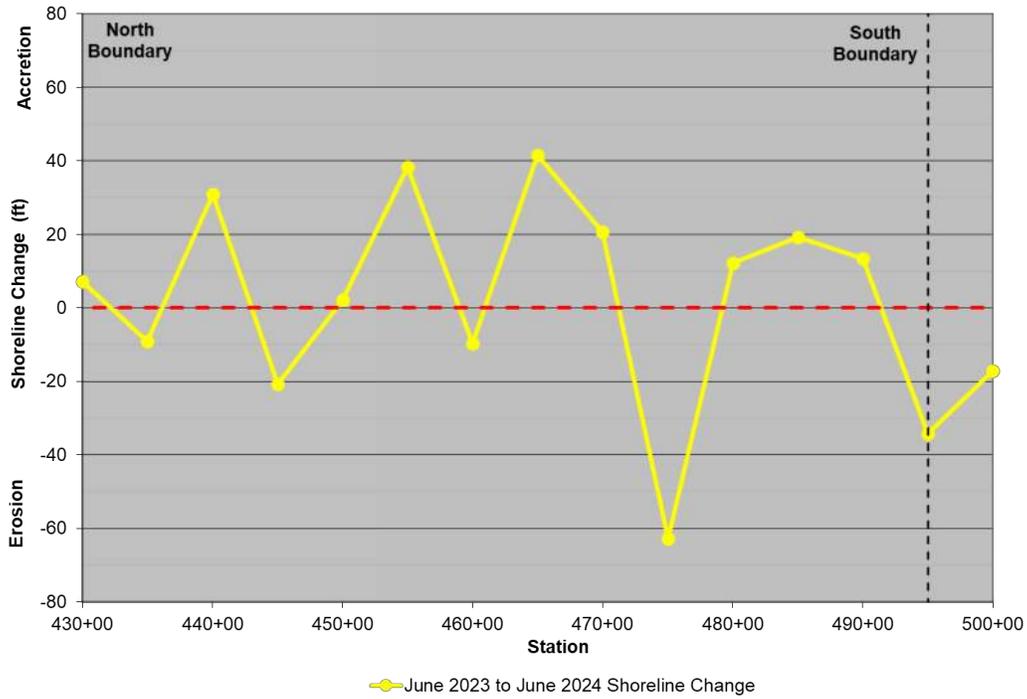
**Table 5-6. Cumulative Volume Change for Nags Head – North Reach (June 2023 – June 2024)**

June 2023 vs. June 2024	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	20,432	27,027	4,771	70,965	57,395	159,508
Total Monitored Oceanfront	430+00 - 1200+00	77,000	130,713	249,384	36,080	-833,226	-771,119	-248,056

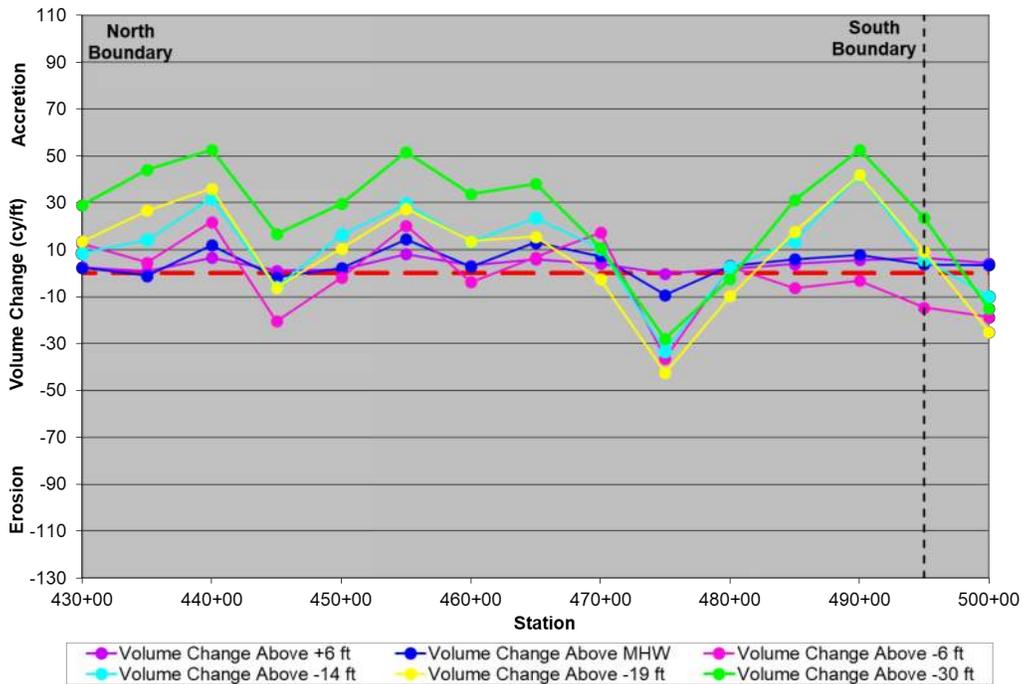
**Table 5-5** indicates that North Reach experienced a slight seaward advancement of the shoreline at MHW over the past year. **Figure 5-5** presents the shoreline changes at each transect, indicating widely varying shoreline movement patterns within the reach.

**Table 5-5** and **Table 5-6** show that the Nags Head – North reach experienced volume gains across all analyzed elevations. The largest gains were observed above -30 ft NAVD88 (+159,508 cy or +26.6 cy/ft) and above -14 ft NAVD88 (+70,965 cy or +9.6 cy/ft). Unlike other areas of the monitored oceanfront, which experienced erosion, this reach saw sand accumulation, likely due to alongshore sediment transport from adjacent areas.

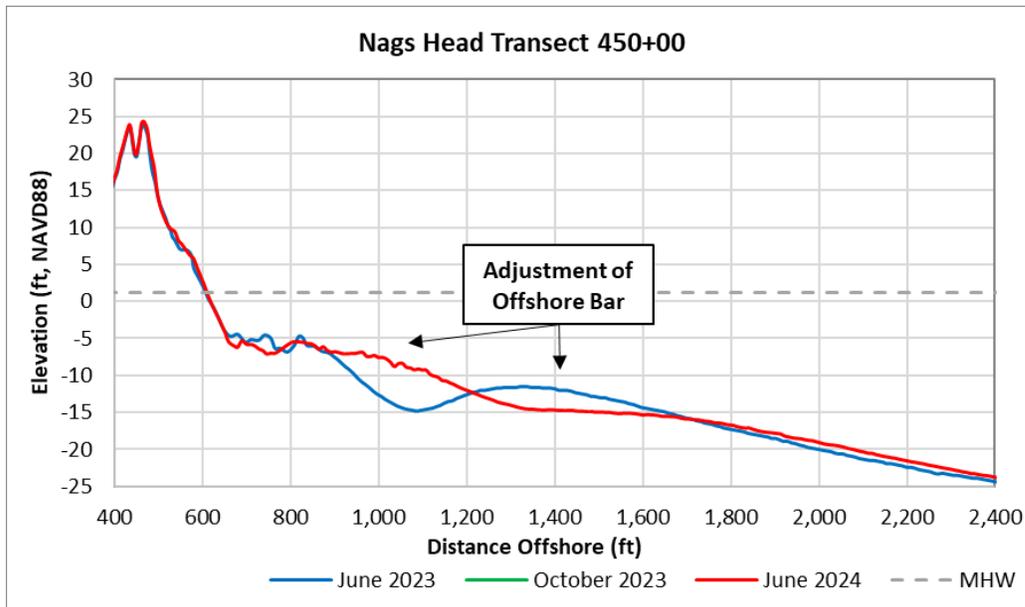
**Figure 5-6** illustrates the unit volume change at each transect, with most transects showing gains. Profile plots in **Appendix B** further display the onshore movement of the offshore sandbar, and **Figure 5-7** presents an example of this offshore bar adjustment.



**Figure 5-5. Nags Head – North Shoreline Change (June 2023 – June 2024)**



**Figure 5-6. Nags Head – North Unit Volume Change (June 2023 – June 2024)**



**Figure 5-7. Example Nags Head – North Profile, Station 450+00 (E. Albatross St.)**

5.3.2 Nags Head - Reach 1 (June 2023 – June 2024)

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 2023 and June 2024 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 2023 due to observed scarping. The volume and shoreline changes between the October 2023 survey and the June 2024 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 2023 – June 2024)**

June 2023 vs. June 2024	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	5.1	2.5	4.2	0.2	2.2	-1.4	14.7
Total Monitored Oceanfront	430+00 - 1200+00	77,000	6.9	1.7	3.3	0.6	-10.5	-9.8	-2.9

**Table 5-8. Cumulative Volume Change for Reach 1 (June 2023 – June 2024)**

June 2023 vs. June 2024	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	74,639	123,358	6,401	64,852	-41,313	433,683
Total Monitored Oceanfront	430+00 - 1200+00	77,000	130,713	249,384	36,080	-833,226	-771,119	-248,056

**Table 5-9. Average Shoreline and Average Unit Volume Change for Reach 1 (October 2023 – June 2024)**

October 2023 vs. June 2024 (Total Change)	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	9.6	2.9	6.8	-5.8	-5.8	-12.1	2.9
Nourished Oceanfront	495+00 - 1025+00	53,000	10.2	2.5	6.6	-8.1	-14.5	-17.5	-4.7

**Table 5-10. Cumulative Volume Change for Reach 1 (October 2023 – June 2024)**

October 2023 vs. June 2024 (Total Change)	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	84,643	201,615	-170,628	-170,367	-357,057	86,057
Nourished Oceanfront	430+00 - 1200+00	53,000	131,559	348,496	-427,836	-765,977	-927,406	-251,008

The annual shoreline change at MHW showed a minor overall seaward advancement of 5.1 ft. **Figure 5-8** presents the shoreline changes at each transect from June 2023 to June 2024. The shoreline shift from October 2023 to June 2024 was slightly greater, indicating partial recovery from the October storms, which had caused material in this reach to be transported offshore to the nearshore zone. The figure indicates widely varying shoreline movement patterns within the reach, spanning from -49.0 ft at station 695+00 to +62.9 ft at station 730+00.

**Table 5-7** and **Table 5-8** show that Reach 1 experienced volume gains above most analyzed elevations during the annual monitoring period, except for a loss at -19 ft NAVD88 (-41,313 cy or -1.4 cy/ft). This loss was even more pronounced between October 2023 and June 2024, with a volume loss of -357,057 cy (-12.1 cy/ft) above -19 ft NAVD88, likely due to continued high-energy wave climate pushing material from the nearshore, as observed in the October 2023 survey, to even lower elevations. Both periods showed material gains above -30 ft NAVD88, suggesting that sediment may be shifting to lower elevations and moving beyond the depth of closure.

During the previous annual monitoring period (June 2022 – June 2023), Reach 1 experienced significant volume losses at Mean High Water (MHW), indicating a steepening of the beachface as material shifted to the nearshore. However, subsequent surveys in October 2023 and June 2024 show a reversal of this trend, with both periods indicating volume gains at subaerial elevations (+6 ft NAVD88 and MHW). Profile plots in **Appendix B** reveal that material was deposited on the beachface from lower elevations. The plots also show that while transects at the northern and southern ends of the reach showed material losses as the offshore bar migrated further offshore to lower elevations, transects in the middle of the reach observed offshore bar adjustments, with the bar moving closer to higher elevations.

**Figure 5-9** displays the unit volume change at each transect above the six elevations analyzed and further illustrate the trends observed in comparison plots. **Figure 5-10** presents an example profile from the middle of the reach, showing the offshore bar moving onshore and expanding. Additionally, **Figure 5-11** presents an example profile from south of the reach where the sand bar moved offshore and lost material.

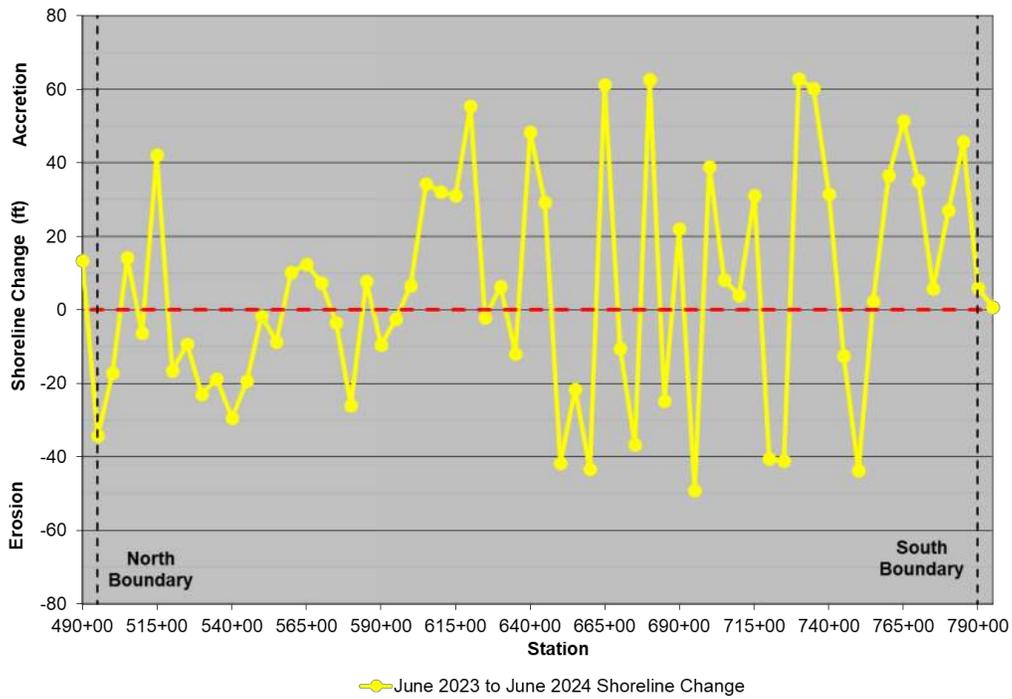


Figure 5-8. Nags Head – Reach 1 Shoreline Change (June 2023 – June 2024)

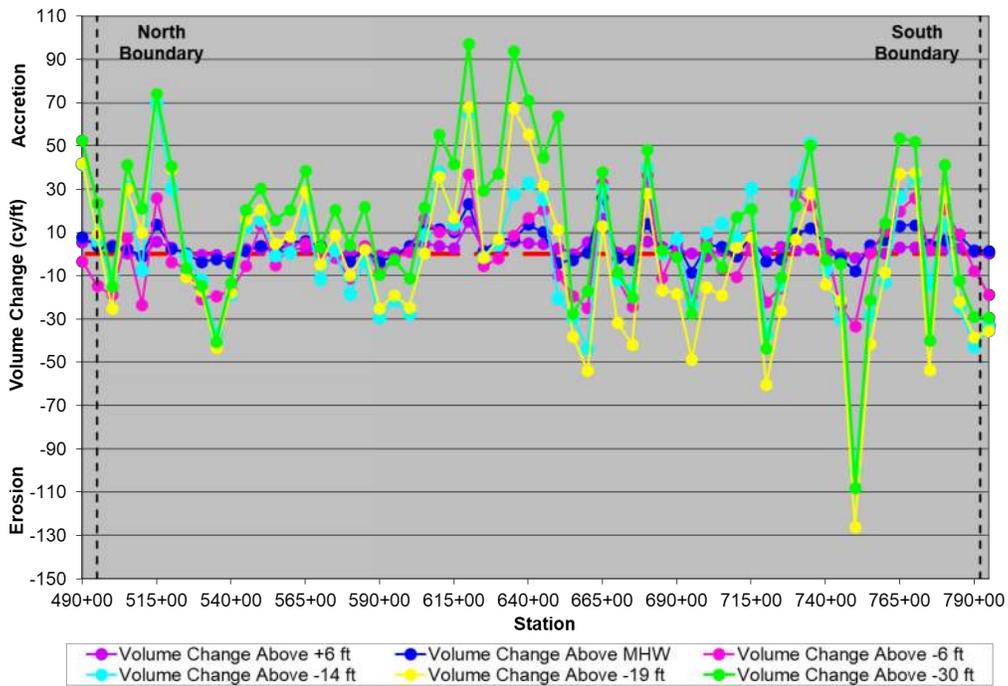
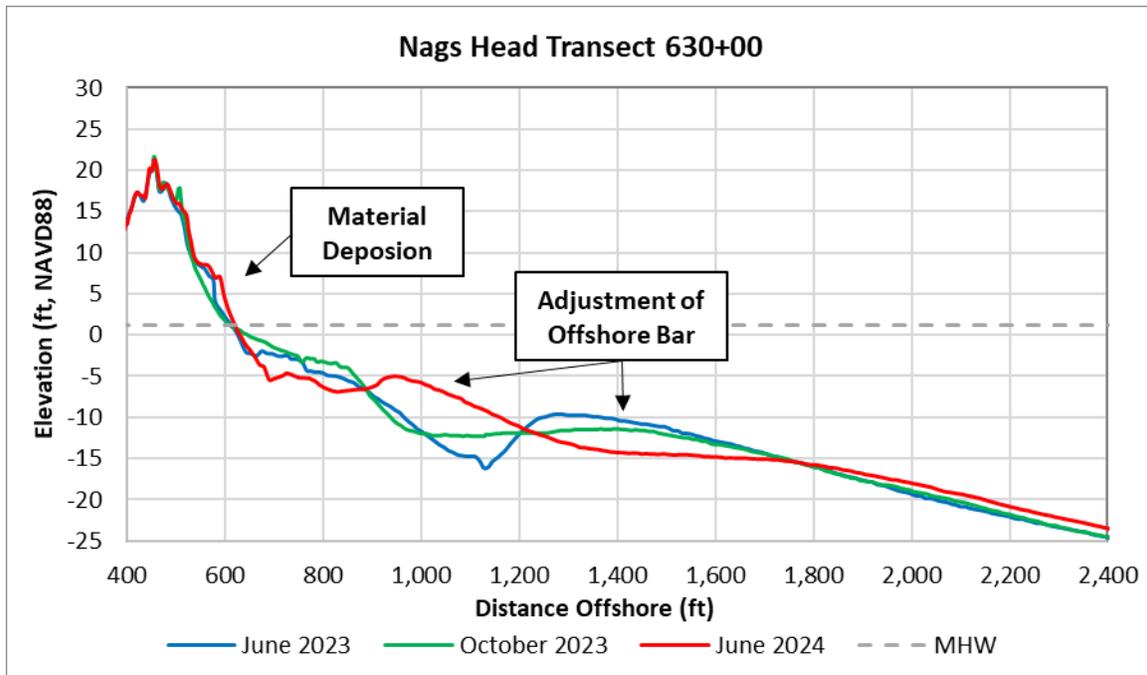
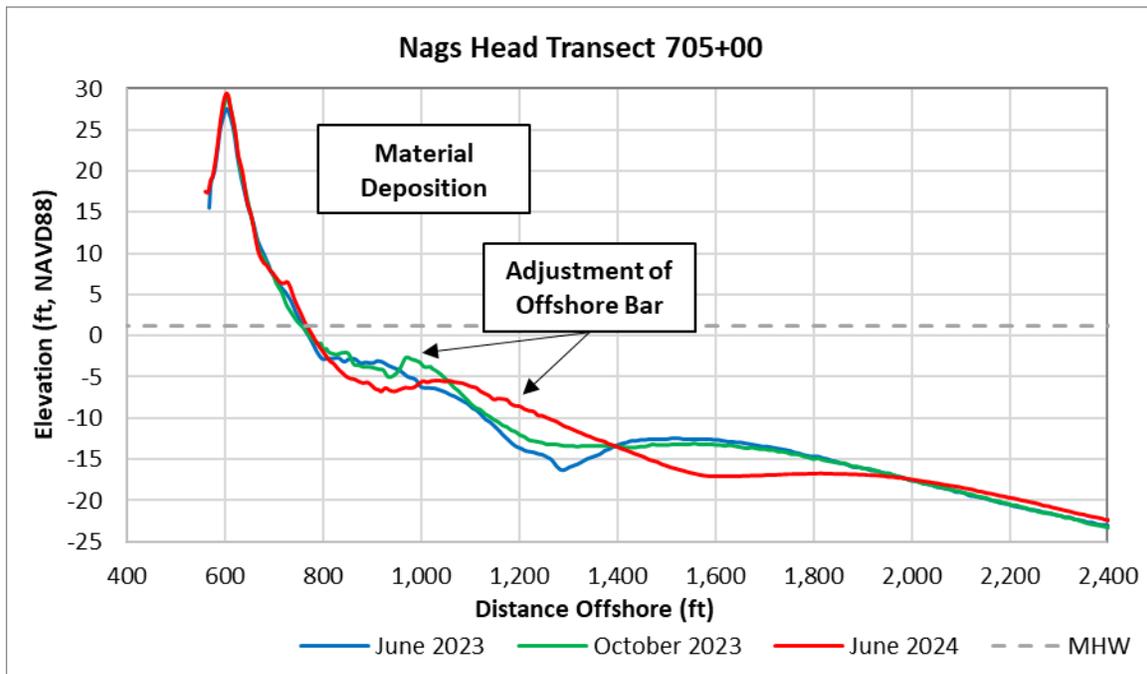


Figure 5-9. Nags Head – Reach 1 Unit Volume Change (June 2023 – June 2024)



**Figure 5-10. Example Reach 1 Profile, Station 630+00 (E Small St.)**



**Figure 5-11. Example Reach 1 Profile, Station 705+00 (E Sea Spray Ct.)**

5.3.3 Nags Head - Reach 2 (June 2023 – June 2024)

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 2023 and June 2024 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 2023 survey; the volume and shoreline changes observed between this fall survey and June 2024 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 2023 – June 2024)**

June 2023 vs. June 2024	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	6.4	4.7	8.0	-0.3	-7.6	-6.6	5.5
Total Monitored Oceanfront	430+00 - 1200+00	77,000	6.9	1.7	3.3	0.6	-10.5	-9.8	-2.9

**Table 5-12. Cumulative Volume Change for Reach 2 (June 2023 – June 2024)**

June 2023 vs. June 2024	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	61,511	103,820	-3,551	-98,804	-85,912	71,490
Total Monitored Oceanfront	430+00 - 1200+00	77,000	130,713	249,384	36,080	-833,226	-771,119	-248,056

**Table 5-13. Average Shoreline and Average Unit Volume Change for Reach 2 (October 2023 – June 2024)**

October 2023 vs. June 2024 (Total Change)	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	19.9	4.2	11.0	-7.5	-14.4	-12.7	-1.6
Nourished Oceanfront	495+00 - 1025+00	53,000	10.2	2.5	6.6	-8.1	-14.5	-17.5	-4.7

**Table 5-14. Cumulative Volume Change for Reach 2 (October 2023 – June 2024)**

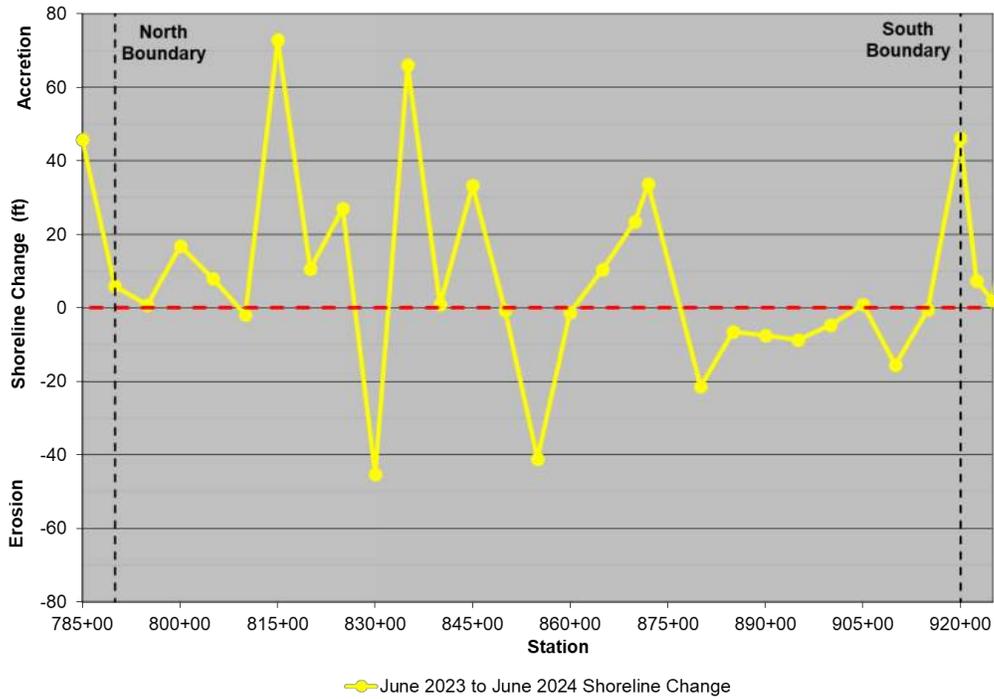
October 2023 vs. June 2024 (Total Change)	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative volume change above -30 ft NAVD88
Reach	#	ft	cy	cy	cy	cy	cy	cy
Nags Head - Reach 2	790+00 - 920+00	13,000	54,314	143,347	-98,142	-186,887	-164,709	-21,033
Nourished Oceanfront	430+00 - 1200+00	53,000	131,559	348,496	-427,836	-765,977	-927,406	-251,008

Shoreline change at MHW showed an overall minor accretion of +6.4 ft. This showed some recovery of the recession observed over June 2023 – October 2023 period. **Figure 5-12** illustrates the shoreline changes at each transect from June 2023 to June 2024, revealing that the majority of transects experienced accretion in the north part of the reach while recession was observed in between 880+00 to 915+00. The seaward advancement observed can be attributed to the material carried onshore to beachface from lower elevations.

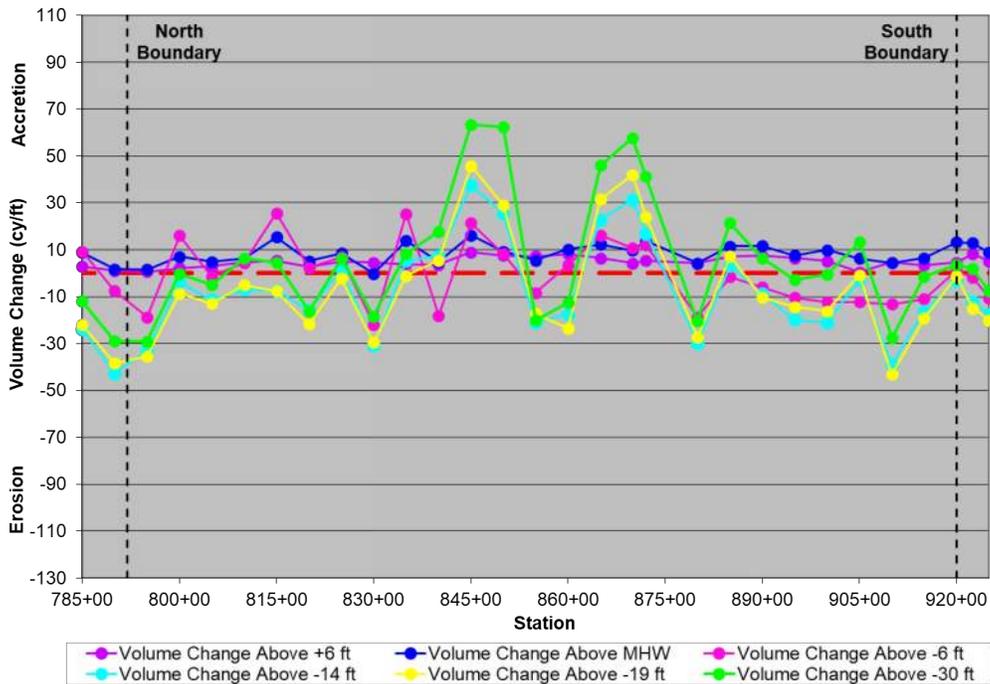
**Table 5-11** and **Table 5-12** show that during the annual monitoring period, Reach 2 experienced volume gains at the subaerial beach (+6 ft NAVD88 and MHW) and above -30 ft NAVD88, but lost material at lower elevations. The most significant volume losses were observed above -14 ft NAVD88 (-98,804 cubic yards or -7.6 cy/ft) and above -19 ft NAVD88 (-85,912 cubic yards or -6.6 cy/ft). The volume gain above -30 ft NAVD88 suggests that material lost from higher elevations has shifted offshore.

Similar to Reach 1, Reach 2 experienced increased volume losses between October 2023 and June 2024, particularly above -14 ft NAVD88 and -19 ft NAVD88. This is likely due to persistent high-energy wave events, which have hindered the typical recovery of material during the spring-summer months. **Figure 5-13** displays the unit volume change at each transect above the six elevations analyzed. As can be seen, almost all transects experienced volume losses below MHW.

Profile plots in **Appendix B** reveal multiple instances of material deposition on the beachface, contributing to berm growth. At the same time, troughs have formed between -10 ft NAVD88 and -20 ft NAVD88, indicating material shifting offshore to lower elevations. **Figure 5-14** presents an example profile showing these trends.



**Figure 5-12. Nags Head – Reach 2 Shoreline Change (June 2023 – June 2024)**



**Figure 5-13. Nags Head – Reach 2 Unit Volume Change (June 2023 – June 2024)**

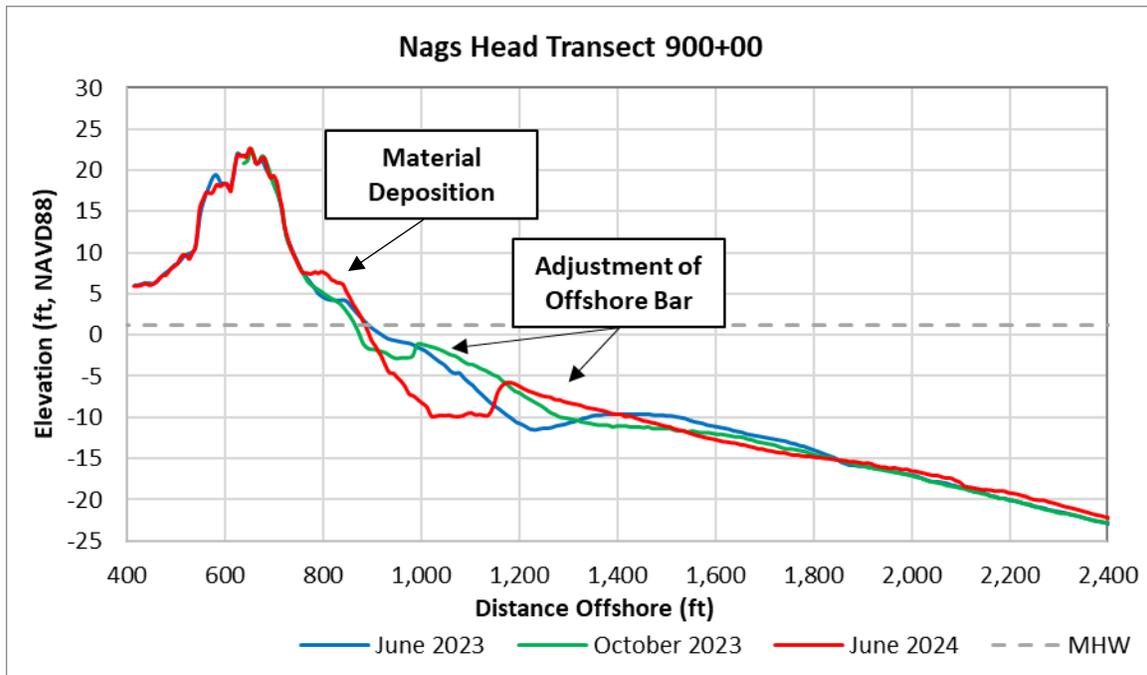


Figure 5-14. Example Reach 2 Profile, Station 900+00 (E Jay St.)

5.3.4 Nags Head - Reach 3 - North (June 2023 - June 2024)

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 2023 and June 2024 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 2023 and June 2024.

**Table 5-15. Average Shoreline and Average Unit Volume Change for Reach 3 - North (June 2023 – June 2024)**

June 2023 vs. June 2024	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	8.2	3.7	5.9	-10.0	-34.3	-36.6	-30.2
Total Monitored Oceanfront	430+00 - 1200+00	77,000	6.9	1.7	3.3	0.6	-10.5	-9.8	-2.9

**Table 5-16. Cumulative Volume Change for Reach 3 - North (June 2023 – June 2024)**

June 2023 vs. June 2024	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	21,031	33,981	-57,347	-197,490	-210,239	-173,746
Total Monitored Oceanfront	430+00 - 1200+00	77,000	130,713	249,384	36,080	-833,226	-771,119	-248,056

**Table 5-17. Average Shoreline and Average Unit Volume Change for Reach 3 - North (October 2023 – June 2024)**

October 2023 vs. June 2024 (Total Change)	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	23.0	1.7	7.3	-10.6	-35.2	-38.3	-23.9
Nourished Oceanfront	495+00 - 1025+00	53,000	10.2	2.5	6.6	-8.1	-14.5	-17.5	-4.7

**Table 5-18. Cumulative Volume Change for Reach 3 - North (October 2023 – June 2024)**

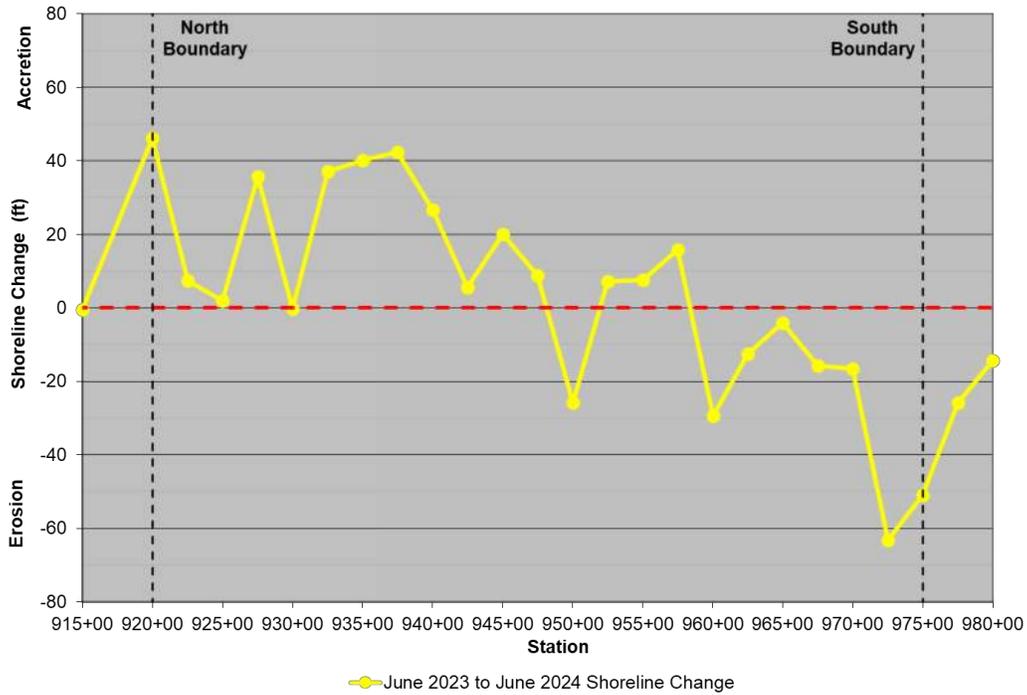
October 2023 vs. June 2024 (Total Change)	Transects	Reach Length	cumulative volume change above +6 ft NAVD88	cumulative volume change above +1.18 ft NAVD88	cumulative volume change above -6 ft NAVD88	cumulative volume change above -14 ft NAVD88	cumulative volume change above -19 ft NAVD88	cumulative 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	9,142	39,897	-58,243	-193,529	-210,619	-131,518
Nourished Oceanfront	430+00 - 1200+00	53,000	131,559	348,496	-427,836	-765,977	-927,406	-251,008

Reach 3 - North experienced recession between June 2023 and October 2023, but recovered between October 2023 and June 2024, with material being deposited above MHW. This led to an overall annual seaward advancement of +8.2 ft. **Figure 5-15** shows the shoreline changes at each transect from June 2023 to June 2024, with accretion primarily occurring at the northern transects of the reach.

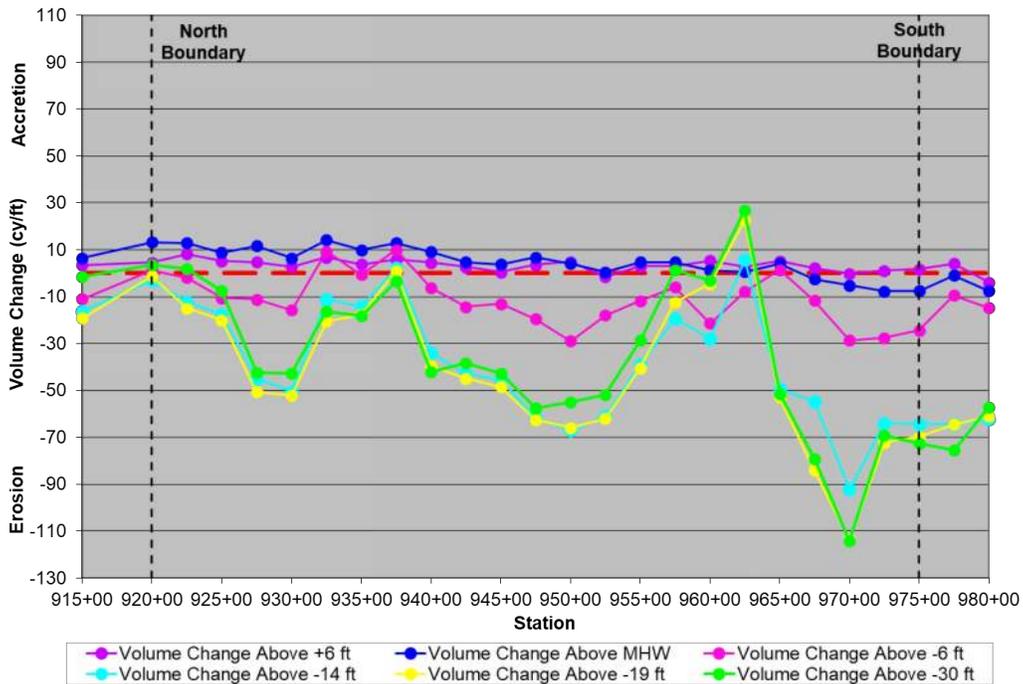
**Table 5-15** and **Table 5-16** indicate that during the annual monitoring period, Reach 3 - North experienced overall volume loss at elevations below MHW. The most significant volume losses occurred above -14 ft NAVD88 (-197,490 cy or -34.3 cy/ft) and above -19 ft NAVD88 (-210,239 cy or -36.6 cy/ft). These losses are consistent with the erosion observed between October 2023 and June 2024, suggesting that most of the erosion happened during this period. Volume losses above -30 ft NAVD88 suggest that some material may have been transported offshore or to adjacent reaches, as longshore transport rates in this area tend to accelerate compared to the more stable northern reaches.

The volume loss above -19 ft NAVD88 during the monitoring period significantly exceeded the average annual background erosion rate previously observed at Reach 3 - North (-15.2 cy/ft). This is likely due to a combination of high-energy wave conditions and slightly increased east-northeast wave directions, which can cause southerly sediment transport. Additionally, during the prior monitoring period (June 2022 – June 2023), material gains along the Town boundaries were attributed to sediment migrating south from nourishment projects in northern towns. The volume losses above -30 ft NAVD88 support the theory that alongshore transport continued towards Oregon Inlet, removing material from the Town's system.

**Figure 5-16** displays the unit volume change at each transect above the six elevations analyzed. As can be seen, a significant majority of transects experienced volume losses below MHW.

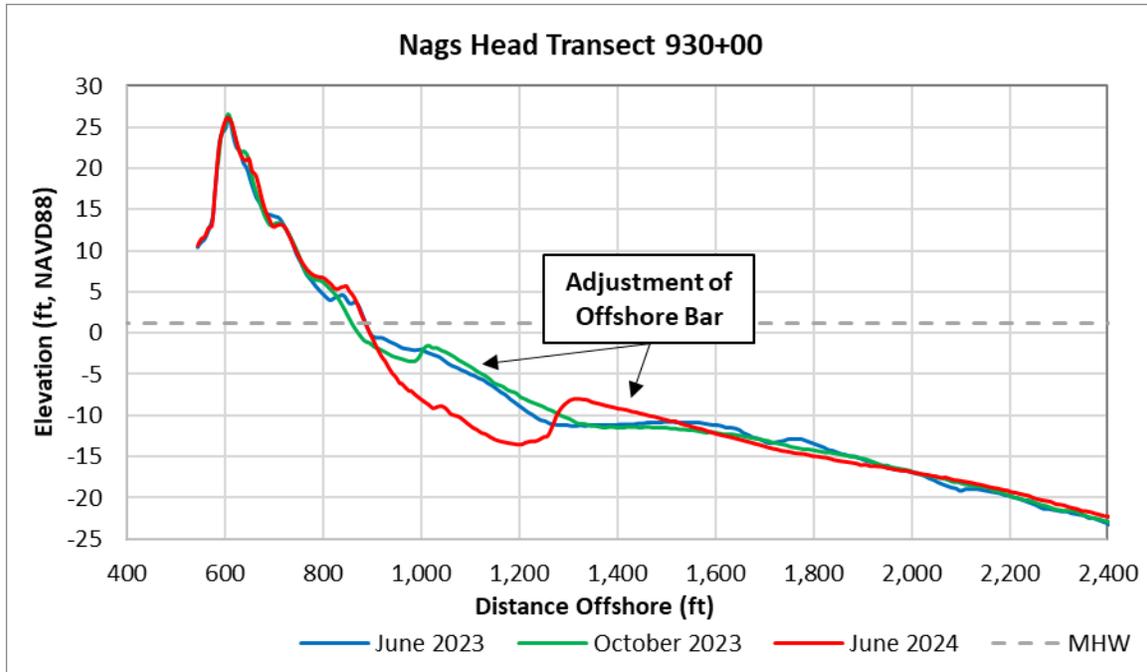


**Figure 5-15. Nags Head – Reach 3 - N Shoreline Change (June 2023 – June 2024)**



**Figure 5-16. Nags Head – Reach 3 - N Unit Volume Change (June 2023 – June 2024)**

The profile plots in **Appendix B** show several instances where the offshore sand bar shifted further offshore and diminished in size, while a large trough formed in front of it between MHW and -15 ft NAVD88. **Figure 5-17** presents an example profile which shows the adjustment of the offshore sand bar.



**Figure 5-17. Example Reach 3 - North Profile, Station 930+00 (E Jacobs St.)**

5.3.5 Nags Head - Reach 3 - South (June 2023 – June 2024)

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 2023 and June 2024 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 2023 and June 2024 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 2023 – June 2024)**

June 2023 vs. June 2024	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	-20.4	-0.1	-3.4	-12.7	-41.2	-38.9	-36.5
Total Monitored Oceanfront	430+00 - 1200+00	77,000	6.9	1.7	3.3	0.6	-10.5	-9.8	-2.9

**Table 5-20. Cumulative Volume Change for Reach 3 - South (June 2023 – June 2024)**

June 2023 vs. June 2024	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	-350	-11,880	-44,415	-144,269	-136,136	-127,669
Total Monitored Oceanfront	430+00 - 1200+00	77,000	130,713	249,384	36,080	-833,226	-771,119	-248,056

**Table 5-21. Average Shoreline and Average Unit Volume Change for Reach 3 - South (October 2023 – June 2024)**

October 2023 vs. June 2024 (Total Change)	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	-16.0	-3.0	-4.8	-17.9	-42.3	-41.5	-38.3
Nourished Oceanfront	495+00 - 1025+00	53,000	10.2	2.5	6.6	-8.1	-14.5	-17.5	-4.7

**Table 5-22. Cumulative Volume Change for Reach 3 - South (October 2023 – June 2024)**

October 2023 vs. June 2024 (Total Change)	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	-10,484	-16,939	-62,705	-148,128	-145,316	-134,130
Nourished Oceanfront	430+00 - 1200+00	53,000	131,559	348,496	-427,836	-765,977	-927,406	-251,008

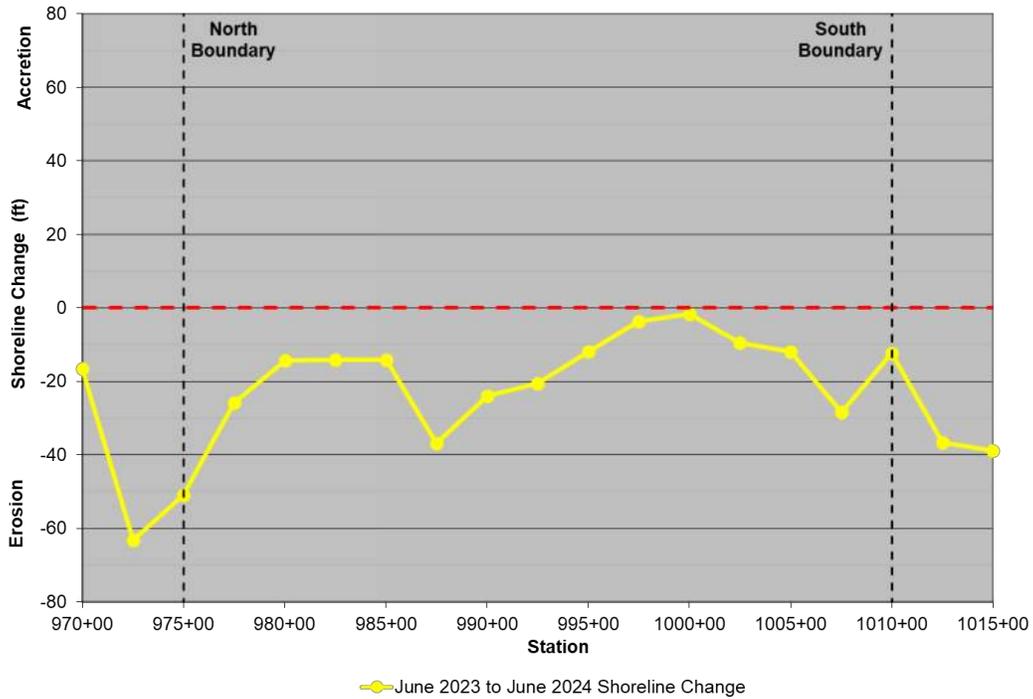
During the annual monitoring period, the shoreline at MHW experienced significant overall recession, with a retreat of -20.4 ft. The majority of this recession occurred between October 2023 and June 2024, accounting for -16.0 ft of the total. **Figure 5-18** illustrates the shoreline changes at each transect from June 2023 to June 2024, showing recession across all transects.

**Table 5-19** and **Table 5-20** show that Reach 3 - South experienced volume losses across all analyzed elevations. The most significant losses were above -14 ft NAVD88 (-144,269 cubic yards or -41.2 cy/ft) and above -19 ft NAVD88 (-136,131 cubic yards or -38.9 cy/ft), mainly occurring between October 2023 and June 2024. Volume losses above -30 ft NAVD88 suggest that material may have been transported alongshore out of the reach, rather than simply being deposited offshore.

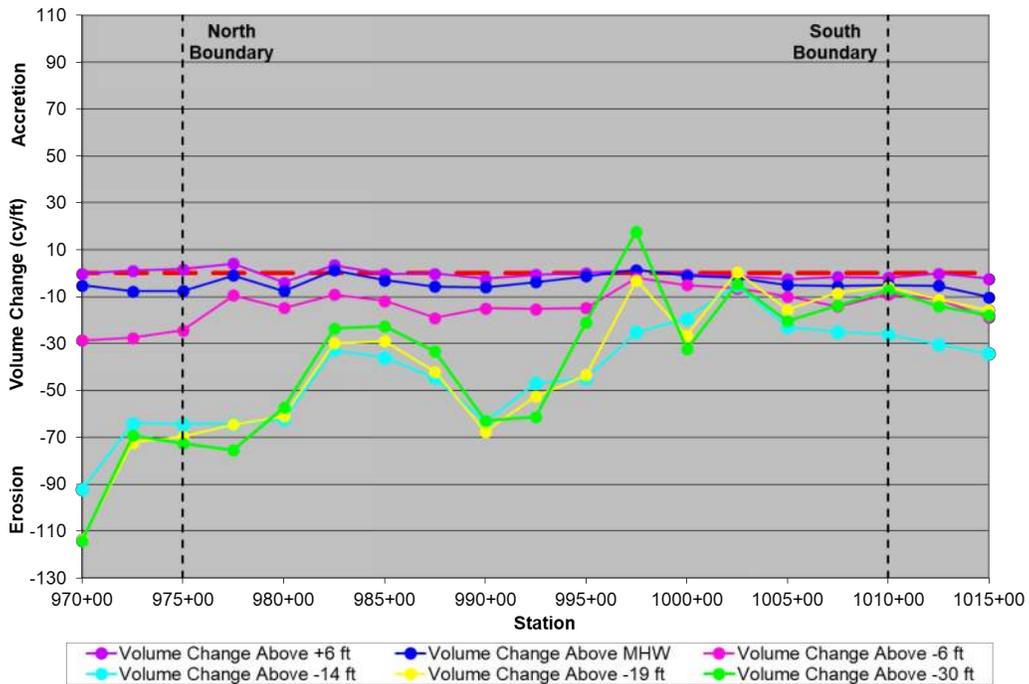
As with Reach 3-North, the volume loss above -19 ft NAVD88 far exceeded the previously observed average annual erosion rate at Reach 3 - South (-23.2 cy/ft), likely due to high-energy wave conditions and slightly increased east-northeast wave directions causing sediment to be transported offshore or southward. In addition, during the previous monitoring period (June 2022 – June 2023), material gains at the Town boundaries were thought to be caused by sediment drifting south from nourishment projects in northern areas. The continued volume losses above -30 ft NAVD88 suggest that sediment was likely transported further south toward Oregon Inlet, moving out of the Town's system altogether.

Reach 3 - South also experienced volume losses at subaerial elevations. As the material shifted offshore the shoreline receded and material from the beachface and dune shifted lower, causing slight dune scarping and narrowing of recreational beach.

**Figure 5-19** displays the unit volume change at each transect across the six analyzed elevations, indicating volume losses at most transects. Notably, significant losses are observed at the northern transects below -6 ft NAVD88. Similar to Reach 3 - North, the profile plots in **Appendix B** illustrate the offshore sand bar moving further offshore and shrinking in size, while a large trough formed between -6 ft NAVD88 and -15 ft NAVD88. Concurrently, material loss from the berm is also evident.



**Figure 5-18. Nags Head – Reach 3 – S Shoreline Change (June 2023 – June 2024)**



**Figure 5-19. Nags Head – Reach 3 – S Unit Volume Change (June 2023 – June 2024)**

Figure 5-20 presents an example profile from Reach 3 - South that provides an example profile illustrating the adjustment of the offshore sand bar and shoreline recession.

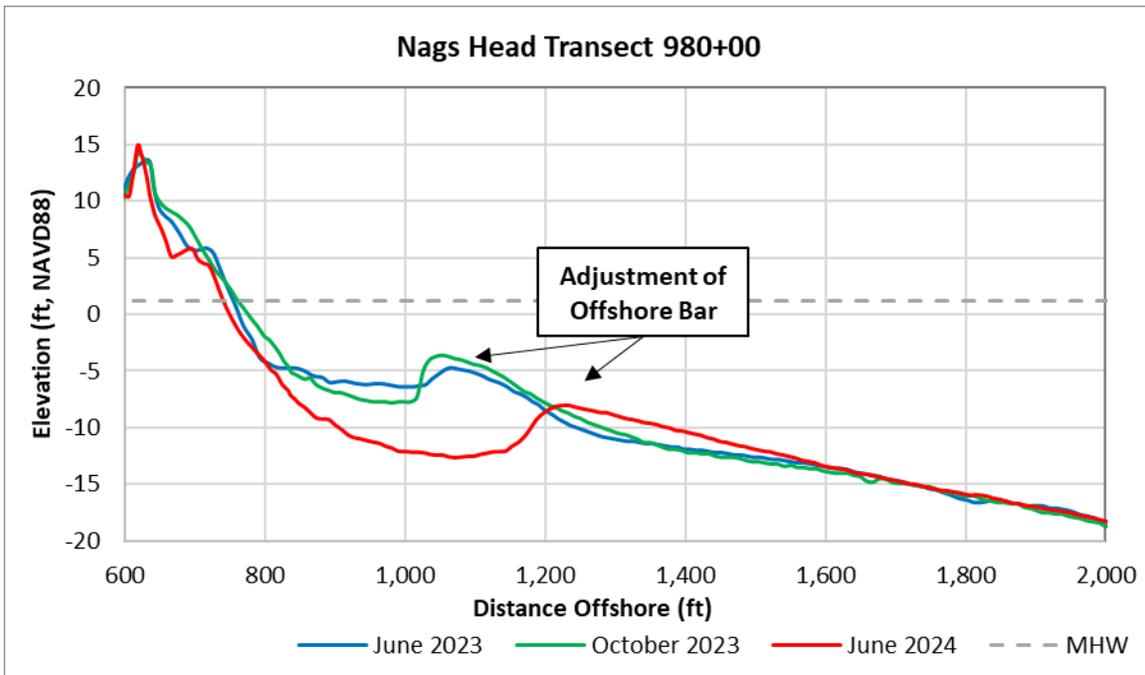


Figure 5-20. Example Reach 3 - South Profile, Station 980+00 (E Altoona St.)

5.3.6 Nags Head - Reach 4 (June 2023 – July 2024)

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 2023 and July 2024 for this reach in comparison with the Total Monitored Oceanfront. Note that this reach was resurveyed in July 2024 due to scarping observed after several storms post-June 2024 survey, so the results reflect changes over the June 2023 – July 2024 period. The volume changes between June and July 2024 surveys are presented in **Appendix E**. Additionally, **Table 5-25** and **Table 5-26** present shoreline and volume changes between the October 2023 and July 2024 surveys.

**Table 5-23. Average Shoreline and Average Unit Volume Change for Reach 4 (June 2023 – July 2024)**

June 2023 vs. July 2024	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	-44.9	-2.5	-10.4	-17.9	-36.1	-16.1	-16.5
Total Monitored Oceanfront	430+00 - 1200+00	77,000	6.9	1.7	3.3	0.6	-10.5	-9.8	-2.9

**Table 5-24. Cumulative Volume Change for Reach 4 (June 2023 – July 2024)**

June 2023 vs. July 2024	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	-4,288	-18,134	-31,341	-63,252	-28,187	-28,798
Total Monitored Oceanfront	430+00 - 1200+00	77,000	130,713	249,384	36,080	-833,226	-771,119	-248,056

**Table 5-25. Average Shoreline and Average Unit Volume Change for Reach 4 (October 2023 – July 2024)**

October 2023 vs. July 2024 (Total Change)	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	-47.3	-4.0	-12.9	-25.4	-44.7	-33.1	-33.6
Nourished Oceanfront	495+00 - 1025+00	53,000	10.2	2.5	6.6	-8.1	-14.5	-17.5	-4.7

**Table 5-26. Cumulative Volume Change for Reach 4 (October 2023 – July 2024)**

October 2023 vs. July 2024 (Total Change)	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	-6,056	-19,425	-38,118	-67,067	-49,705	-50,384
Nourished Oceanfront	430+00 - 1200+00	53,000	131,559	348,496	-427,836	-765,977	-927,406	-251,008

During the annual monitoring period, the shoreline at MHW experienced a significant overall recession of -44.9 ft, with the entire retreat occurring between October 2023 and July 2024. This led to the significant narrowing of the recreational beach and began causing dune scarping, as shown in the photo in **Figure 5-21**. **Figure 5-22** illustrates the shoreline changes at each transect from June 2023 to July 2024, showing recession across all transects.

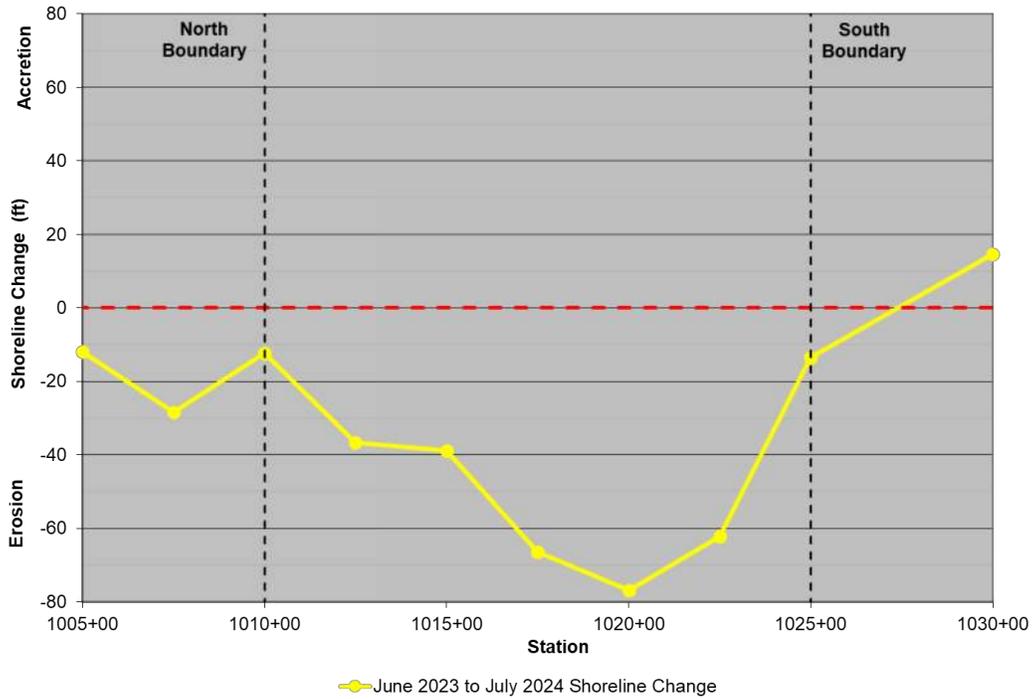


**Figure 5-21. Scarping adjacent to McCall Ct. on July 27, 2024. (D. Ryan Photo)**

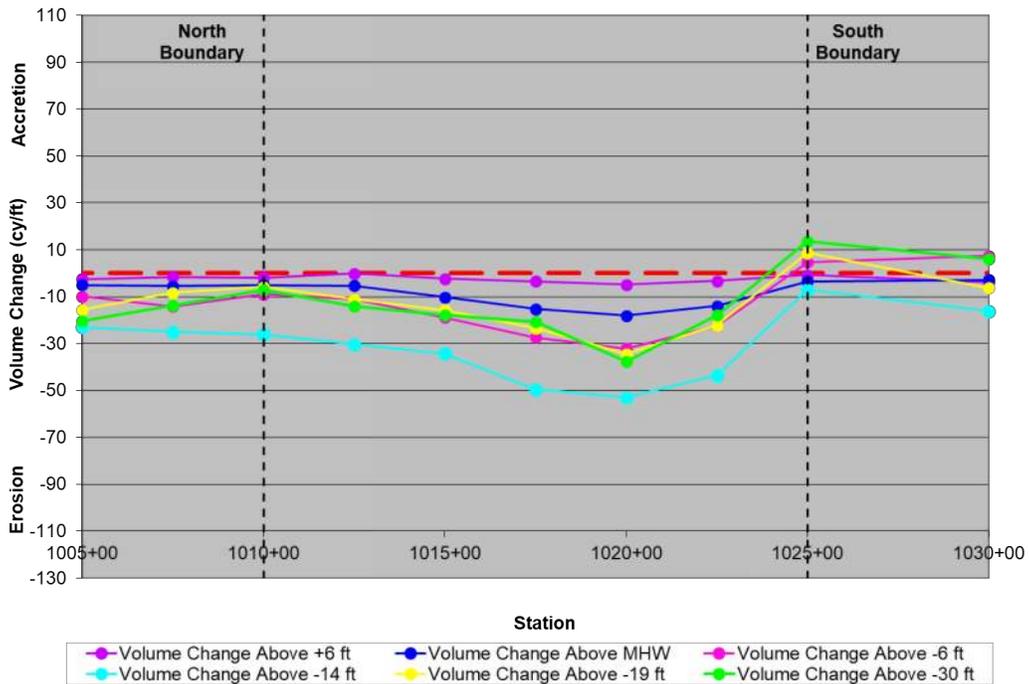
Similar to Reach 3 - South, Reach 4 experienced volume losses across all analyzed elevations during the annual monitoring period, particularly between October 2023 and July 2024. The most significant losses occurred above -14 ft NAVD88 (-67,067 cy or -44.7 cy/ft), primarily due to the removal of the offshore sand bar. Although some material was recovered above -19 ft NAVD88, the volume losses above -30 ft NAVD88 suggest that sediment may have been transported out of the reach.

As with previous reaches, the volume loss above -19 ft NAVD88 greatly exceeded the average annual erosion rate previously observed at Reach 4 (-28.7 cy/ft), likely due to high-energy wave conditions and slightly increased east-northeast wave directions causing southward and offshore sediment transport. Material gains at the Town boundaries in the prior monitoring period (June 2022 – June 2023) were attributed to sediment moving south from northern nourishment projects. The ongoing volume losses above -30 ft NAVD88 suggest that sediment was transported further south toward Oregon Inlet, moving out of the Town's system.

**Figure 5-23** shows unit volume changes at each transect above the six elevations analyzed, indicating volume losses across all transects and elevations. Correspondingly, profile plots in **Appendix B** illustrate erosion along the profiles with a significant removal of the offshore sand bar. **Figure 5-24** presents an example profile displaying the erosion along the profile with and offshore bar removal.



**Figure 5-22. Nags Head – Reach 4 Shoreline Change (June 2023 – July 2024)**



**Figure 5-23. Nags Head – Reach 4 Unit Volume Change (June 2023 – July 2024)**

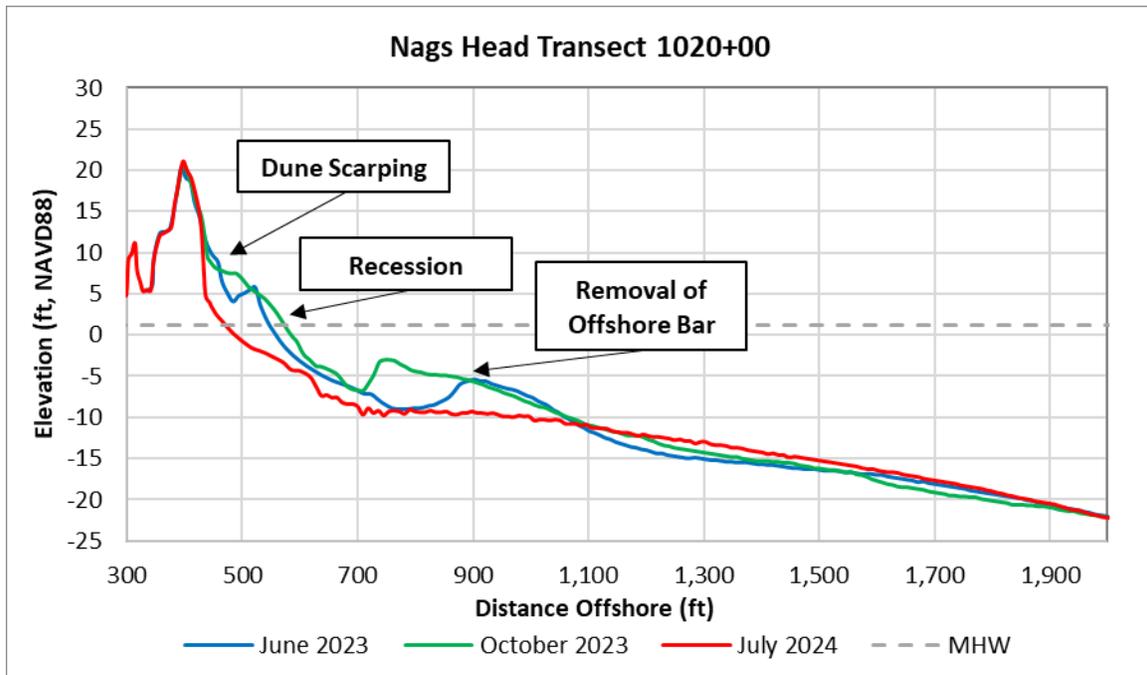


Figure 5-24. Example Reach 4 Profile, Station 1020+00 (McCall Court)

5.3.7 National Seashore - North (June 2023 – July 2024)

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 2023 and July 2024 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 2023 – July 2024)**

June 2023 vs. July 2024	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	20.0	-2.4	-0.5	9.2	-26.6	-18.7	-33.3
Total Monitored Oceanfront	430+00 - 1200+00	77,000	6.9	1.7	3.3	0.6	-10.5	-9.8	-2.9

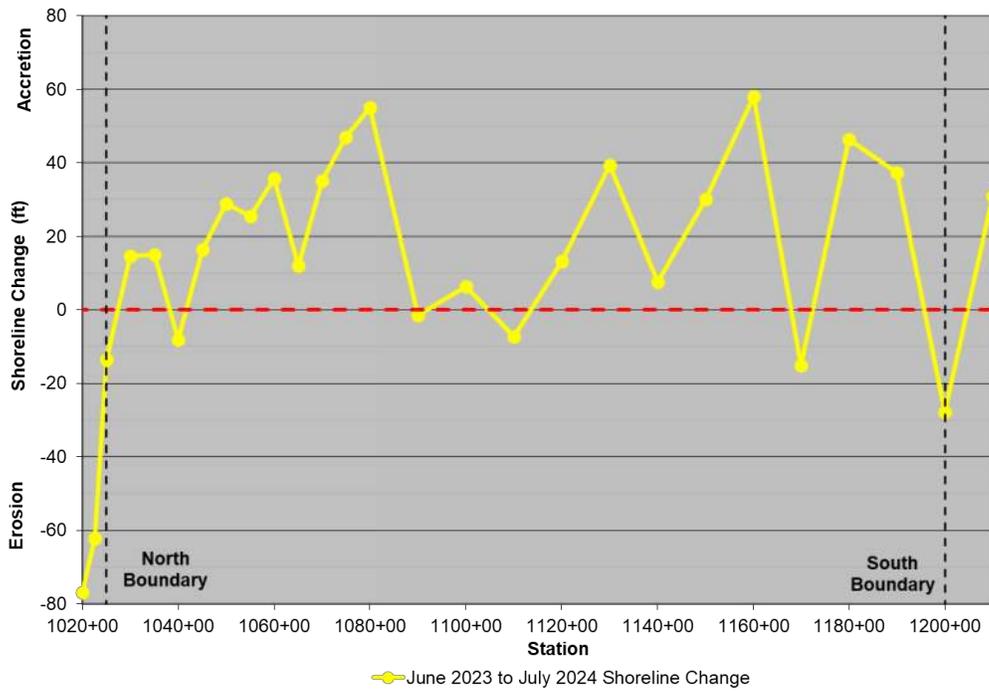
**Table 5-28. Cumulative Volume Change for National Seashore - North (June 2023 – July 2024)**

June 2023 vs. July 2024	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	-42,262	-8,788	161,561	-465,228	-326,727	-582,524
Total Monitored Oceanfront	430+00 - 1200+00	77,000	130,713	249,384	36,080	-833,226	-771,119	-248,056

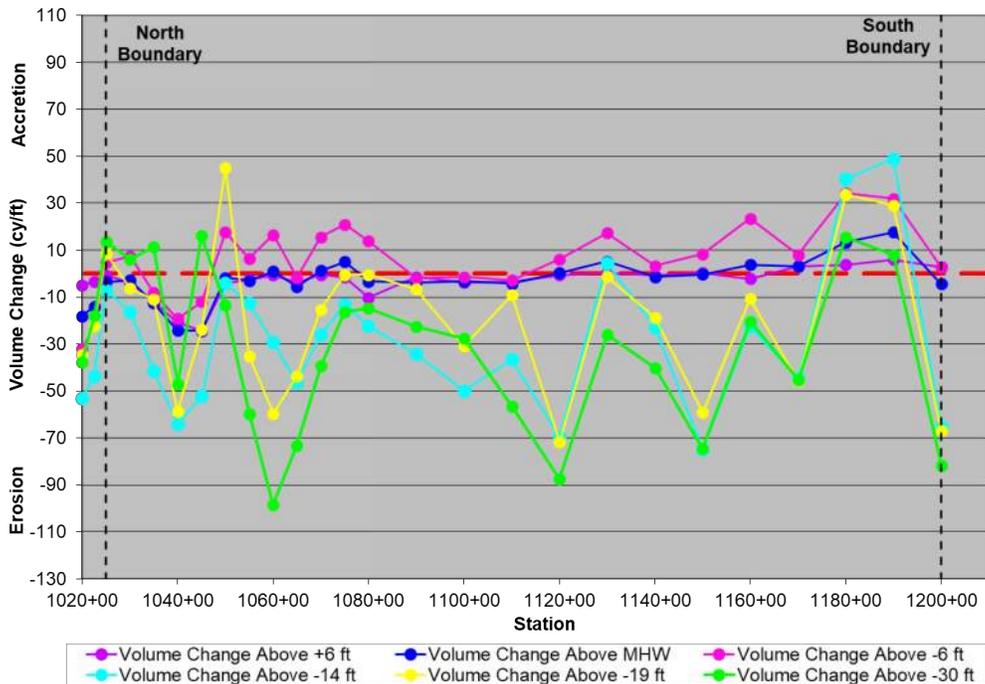
Shoreline change at MHW showed an overall average seaward advancement of +20.0 ft. **Figure 5-25** presents the shoreline changes at each transect, showing accretion along most of the transects.

Overall, the National Seashore - North reach experienced volume losses across all analyzed elevations except above -6 ft NAVD88. The most significant losses occurred above -14 ft NAVD88 (-465,228 cy or -26.6 cy/ft) and above -30 ft NAVD88 (-582,524 cy or -33.3 cy/ft). Losses above -19 ft NAVD88 (-326,727 cy or -18.7 cy/ft) were also substantial but slightly smaller than those above -14 ft NAVD88, indicating only partial recovery of the material lost beyond the depth of closure. Some transects also showed removal of the frontal dune.

**Figure 5-26** displays unit volume changes at each transect across the six analyzed elevations, with most transects showing volume losses below -6 ft NAVD88. Profile plots in **Appendix B** reveal that the slope between MHW and the offshore bar has become milder due to material deposition. The offshore bar is observed to be moving further offshore, lowering, shrinking, and in some cases being removed. **Figure 5-27** provides an example profile illustrating these trends.



**Figure 5-25. National Seashore - North Shoreline Change (June 2023 – July 2024)**



**Figure 5-26. National Seashore - North Unit Volume Change (June 2023 – July 2024)**

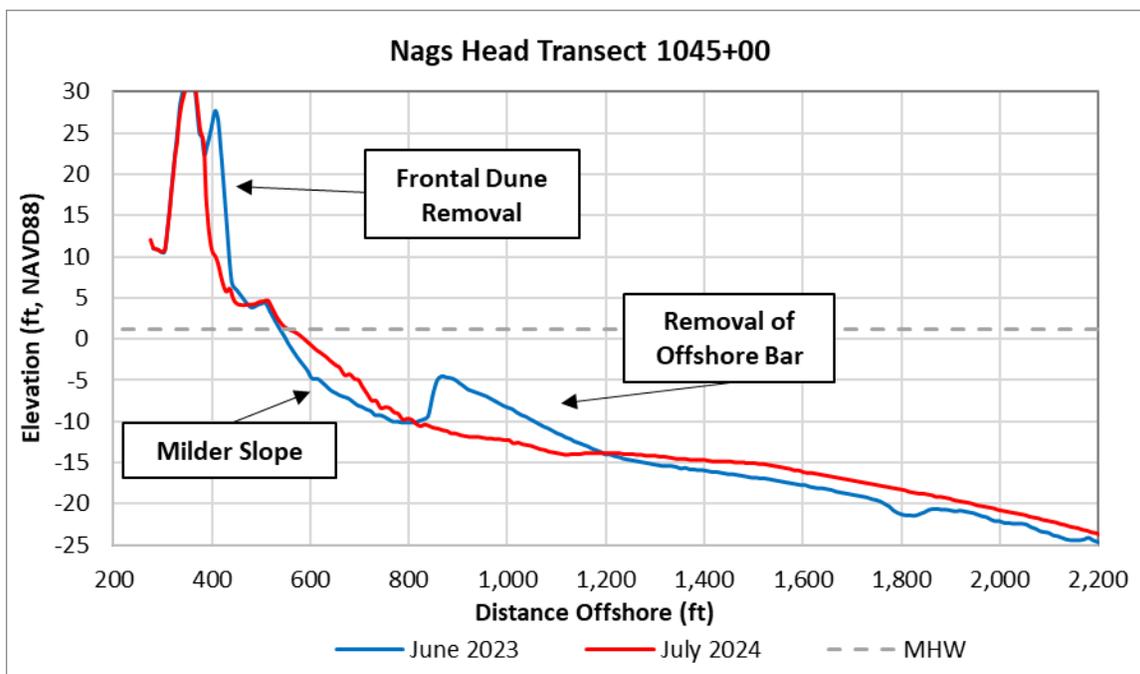
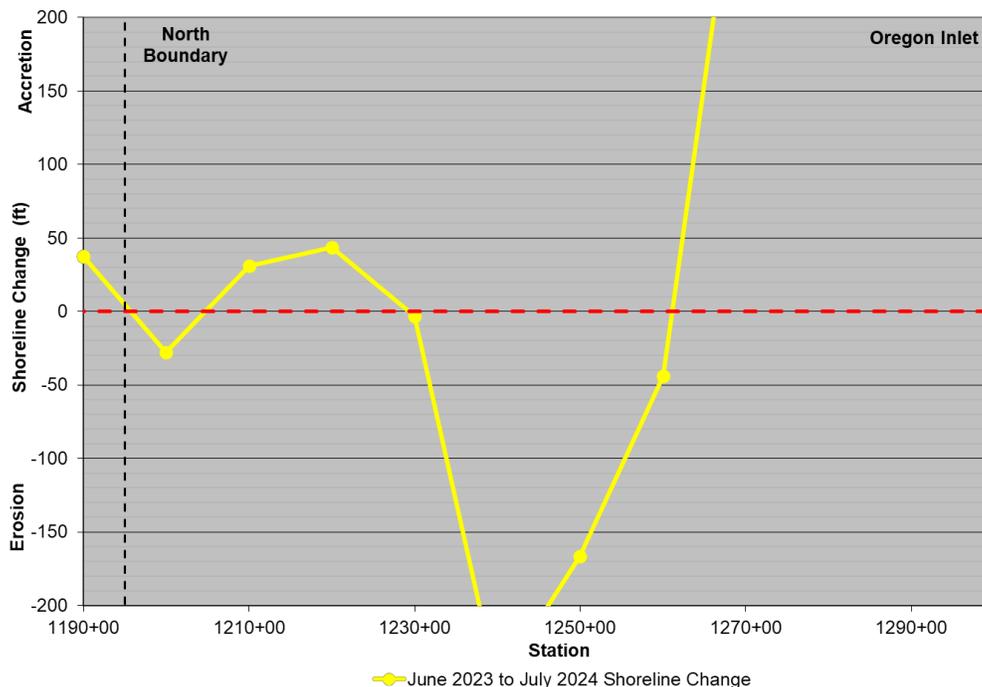


Figure 5-27. Example National Seashore - North Profile, Station 1045+00

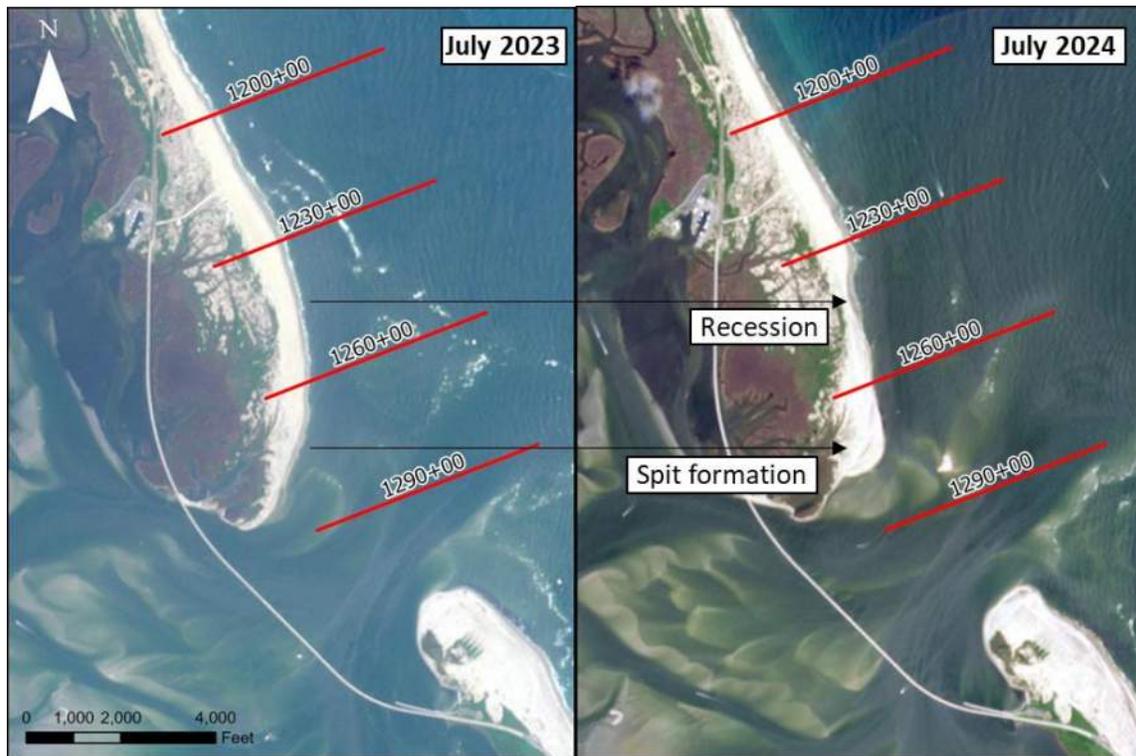
### 5.3.8 National Seashore - South (June 2023 – July 2024)

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 5-28** presents the shoreline changes at each transect, revealing a predominant seaward advancement in transects to the north and recession in transects to the south except Station 1270+00. **Figure 5-29** shows the aerial image of Oregon Inlet from the beginning and end of the monitoring period. During the monitoring period, material from Station 1230+00 to 1260+00 shifted southward into Bodie Island Spit (**Figure 5-29**), causing recession at the transects in between while leading to significant accretion at Station 1270+00.

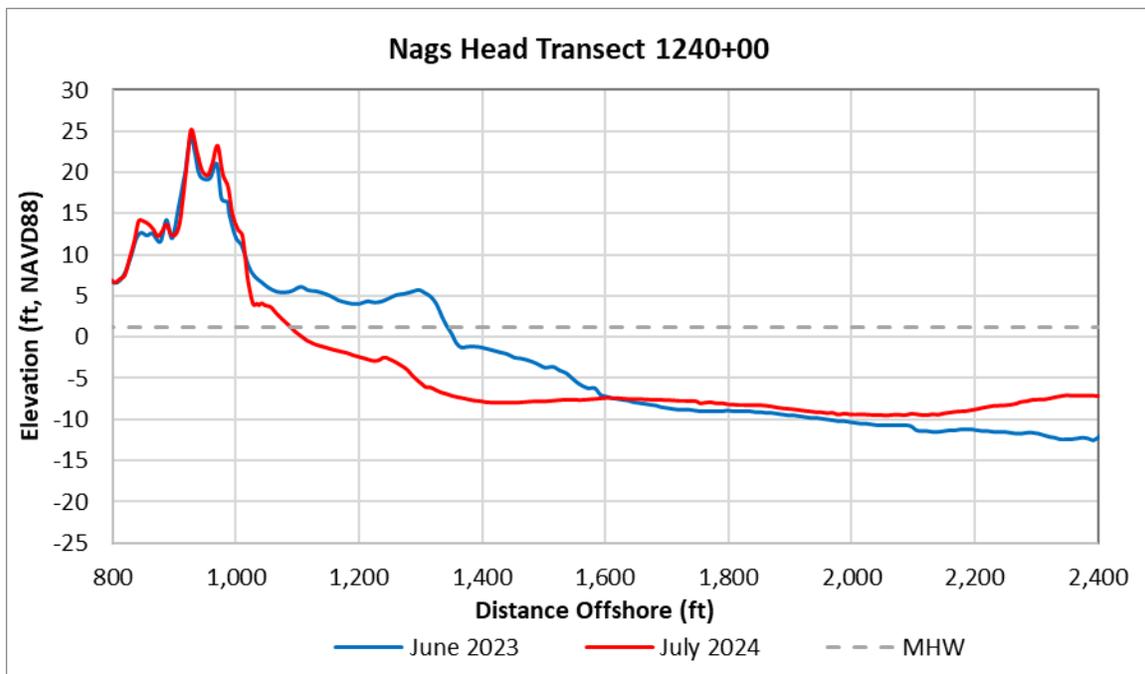
Due to the dynamic nature of Oregon Inlet, volume calculations were not meaningful. Instead, profile comparisons between June 2023 and July 2024 (**Appendix B**) were investigated to determine trends. At northern transects, material was deposited on the beachface, leading to the accretion of the shoreline, while transects from Station 1230+00 to 1260+00 experienced erosion. **Figure 5-30** provides an example profile illustrating the erosion.



**Figure 5-28. National Seashore - South Shoreline Change (June 2023 – July 2024)**



**Figure 5-29. Oregon Inlet Change (07/01/2023 USGS Sentinel Imagery; 07/20/2024 USGS-Sentinel Imagery)**



**Figure 5-30. Example National Seashore - North Profile, Station 1240 (Bodie Island Spit)**

5.3.9 Oceanfront Trends Summary for All Reaches (June 2023 – June 2024)

**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 2023 and the June 2024 surveys at each transect along Nags Head.

**Table 5-29. Nags Head Shoreline and Average Unit Volume Change Statistics (June 2023 – June 2024)**

June 2023 vs. June 2024	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	6.1	3.4	4.5	0.8	11.8	9.6	26.6
Nags Head - Reach 1	495+00 - 790+00	29,500	5.1	2.5	4.2	0.2	2.2	-1.4	14.7
Nags Head - Reach 2	790+00 - 920+00	13,000	6.4	4.7	8.0	-0.3	-7.6	-6.6	5.5
Nags Head - Reach 3N	920+00 - 975+00	5,500	8.2	3.7	5.9	-10.0	-34.3	-36.6	-30.2
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-20.4	-0.1	-3.4	-12.7	-41.2	-38.9	-36.5
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-44.9	-2.5	-10.4	-17.9	-36.1	-16.1	-16.5
National Seashore North	1025+00 - 1200+00	17,500	20.0	-2.4	-0.5	9.2	-26.6	-18.7	-33.3
	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>2.7</b>	<b>2.9</b>	<b>4.4</b>	<b>-2.3</b>	<b>-7.9</b>	<b>-9.2</b>	<b>3.5</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>6.9</b>	<b>1.7</b>	<b>3.3</b>	<b>0.6</b>	<b>-10.5</b>	<b>-9.8</b>	<b>-2.9</b>

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

**Table 5-30. Nags Head Cumulative Volume Change Statistics (June 2023 – June 2024)**

June 2023 vs. June 2024	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	20,432	27,027	4,771	70,965	57,395	159,508
Nags Head - Reach 1	495+00 - 790+00	29,500	74,639	123,358	6,401	64,852	-41,313	433,683
Nags Head - Reach 2	790+00 - 920+00	13,000	61,511	103,820	-3,551	-98,804	-85,912	71,490
Nags Head - Reach 3N	920+00 - 975+00	5,500	21,031	33,981	-57,347	-197,490	-210,239	-173,746
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-350	-11,880	-44,415	-144,269	-136,136	-127,669
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-4,288	-18,134	-31,341	-63,252	-28,187	-28,798
National Seashore - North	1025+00 - 1200+00	17,500	-42,262	-8,788	161,561	-465,228	-326,727	-582,524
	Transects	Reach Length	total	total	total	total	total	total
<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>53,000</b>	152,543	231,146	-130,252	-438,963	-501,787	174,960
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	130,713	249,384	36,080	-833,226	-771,119	-248,056

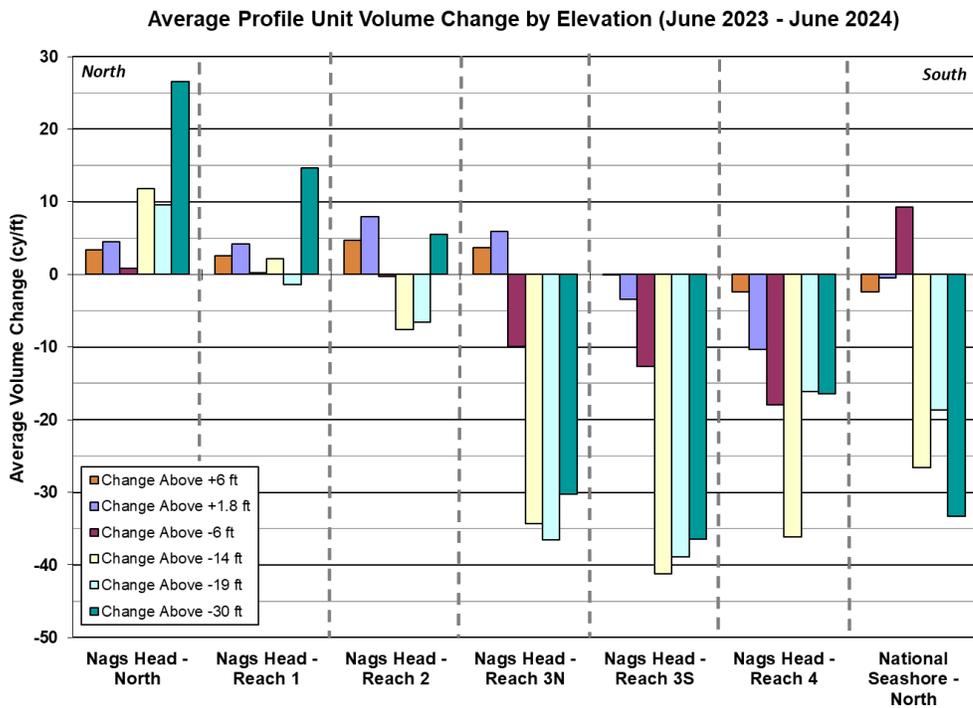
\*National Seashore South Reach not included in the Total Monitored Oceanfront

During the June 2023 - June 2024 monitoring period, Reach 3S and Reach 4 experienced significant shoreline recession, eroding much of the recreational beach. This erosion allowed waves to reach the dunes, resulting in dune scarping especially in Reach 4. The remaining reaches showed slight seaward advancement as material from nearshore was deposited to beachface.

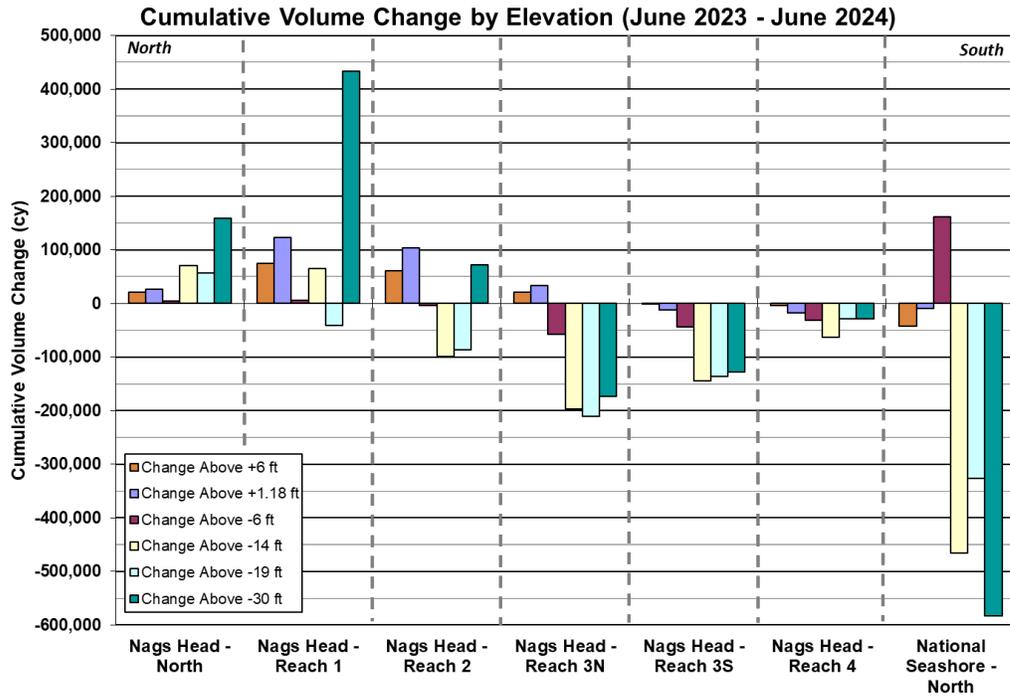
The Nags Head Oceanfront experienced material gains along the subaerial portions of the profiles (+6 ft NAVD88 and MHW), as shown in the profile plots in **Appendix B**. This was mainly due to nearshore material being deposited on the beachface. However, below MHW, volume losses occurred across all analyzed elevations, except above -30 ft NAVD88, where gains were only observed in Reaches 1 and 2. The most significant volume loss along the nourished oceanfront was recorded above -19 ft NAVD88 (-501,787 cy or -9.2 cy/ft), exceeding the historical background erosion rate (-6.7 cy/ft). This elevated loss can be attributed to the active 2023-2024 storm season, which brought 17 events with significant wave heights exceeding 8 ft. The frequent storm activity likely prevented the offshore-deposited material from returning to the beach, instead pushing it further offshore to lower elevations. Additionally, material gains at the Town boundaries in the prior monitoring period (June 2022 – June 2023) were attributed to sediment moving south from northern nourishment projects. The ongoing volume losses above -30 ft NAVD88 suggest that sediment was transported further south toward Oregon Inlet, moving out of the Town’s system.

The Total Monitored Oceanfront, which includes both the Nags Head North and National Seashore-North reaches flanking the Nourished Oceanfront, exhibited a similar trend of material gains at subaerial elevations and losses below MHW. While the Nags Head North reach showed material gains across all analyzed elevations, the National Seashore-North reach experienced material losses above all analyzed elevations.

**Figure 5-31** and **Figure 5-32** 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 help to visualize the overall changes within the Nags Head monitoring area and highlight how the magnitude of changes compares between reaches. Both figures show significant volume losses above -14 ft NAVD88 and -19 ft NAVD88 across all monitored shoreline reaches, with the exception of the Nags Head North reach. Reaches south of Reach 2 also experienced volume losses above -30 ft NAVD88, suggesting that sediment was either transported further offshore or alongshore, leaving the Town’s sediment system.



**Figure 5-31. Average Unit Volume Change Within Each Reach (June 2023 – June/July 2024)**

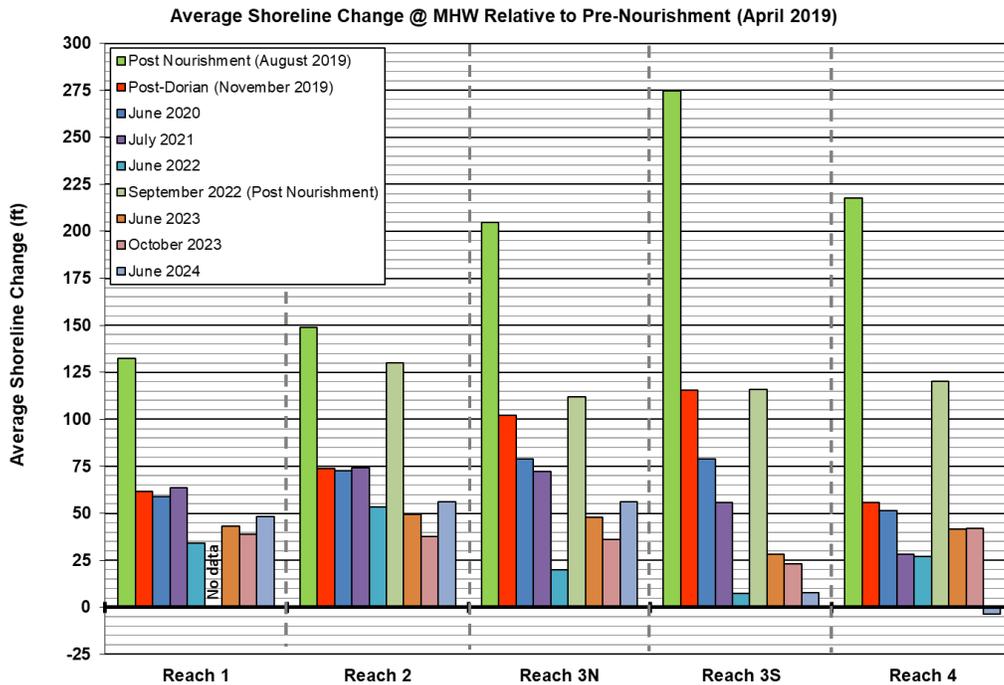


**Figure 5-32. Cumulative Volume Change Within Each Reach (June 2023 – June/July 2024)**

### 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 5-33** illustrates the shoreline changes relative to pre-nourishment condition (April 2019) along the Nourished Oceanfront. As can be seen from the figure, a significant landward recession occurred along the Nourished Oceanfront since the completion of the 2019 nourishment project. The majority of this recession, noted before the post-Dorian survey, can be attributed to Hurricane Dorian. However, a portion of it was also due to profile equilibration, a natural occurrence during the stabilization of the nourishment profile. Similarly, the August 2022 post-Dorian renourishment project helped mitigate some of the recession. However, by June 2023, the shoreline had receded again, likely due to ongoing profile equilibration. This year, high-energy wave events caused further significant recession, particularly in the southern reaches (3S and Reach 4). In Reach 4, the shoreline has receded beyond the April 2019 pre-nourishment condition.



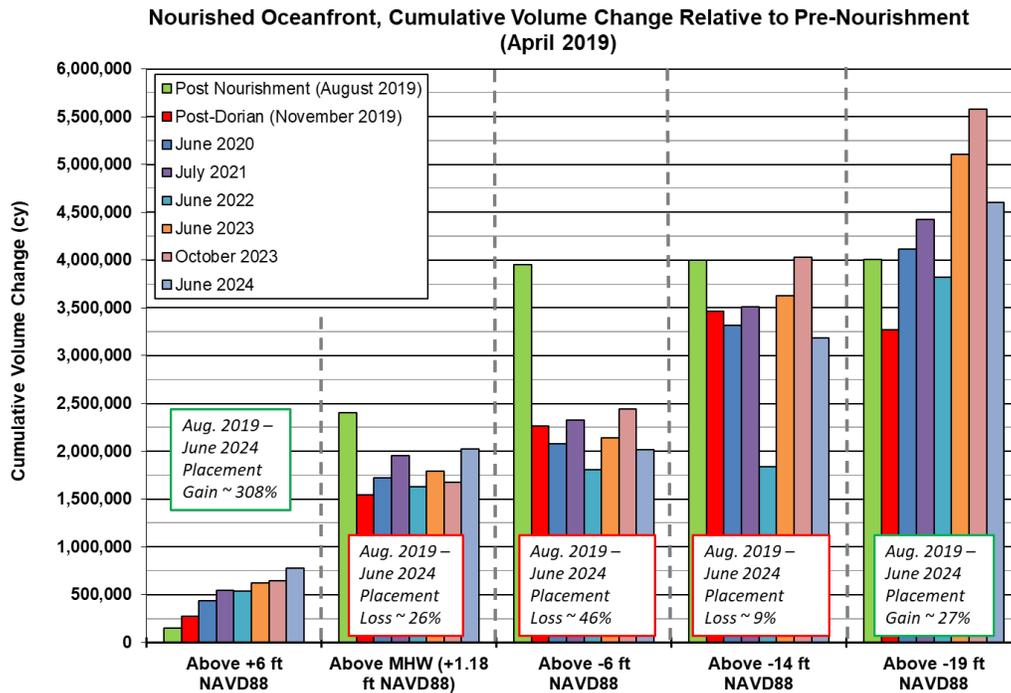
**Figure 5-33. Nourished Oceanfront Average Shoreline Change Relative to Pre-Nourishment Conditions**

**Figure 5-34** and **Table 5-31** presents the volume changes relative to pre-nourishment conditions (April 2019) above six elevations along the Nourished Oceanfront. Notably, the Nourished Oceanfront exhibited material gains along the subaerial elevations (+6 ft NAVD88 and MHW) while losing significant material below MHW.

**Table 5-31** confirms that since the completion of the 2019 nourishment project approximately 598,349 cy (11.3 cy/ft) of volume gain was observed above -19 ft NAVD88 along the Nourished Oceanfront. It's important to highlight that 614,106 cubic yards of material were placed during the 2022 Post-Dorian Renourishment project, indicating that without this renourishment, material loss would have likely occurred above -19 ft NAVD88. The results suggest significant cross-shore shifts of sand across various elevations. Notably, much of the sand has moved to lower NAV elevations near the depth of closure, where it becomes vulnerable to being removed 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>

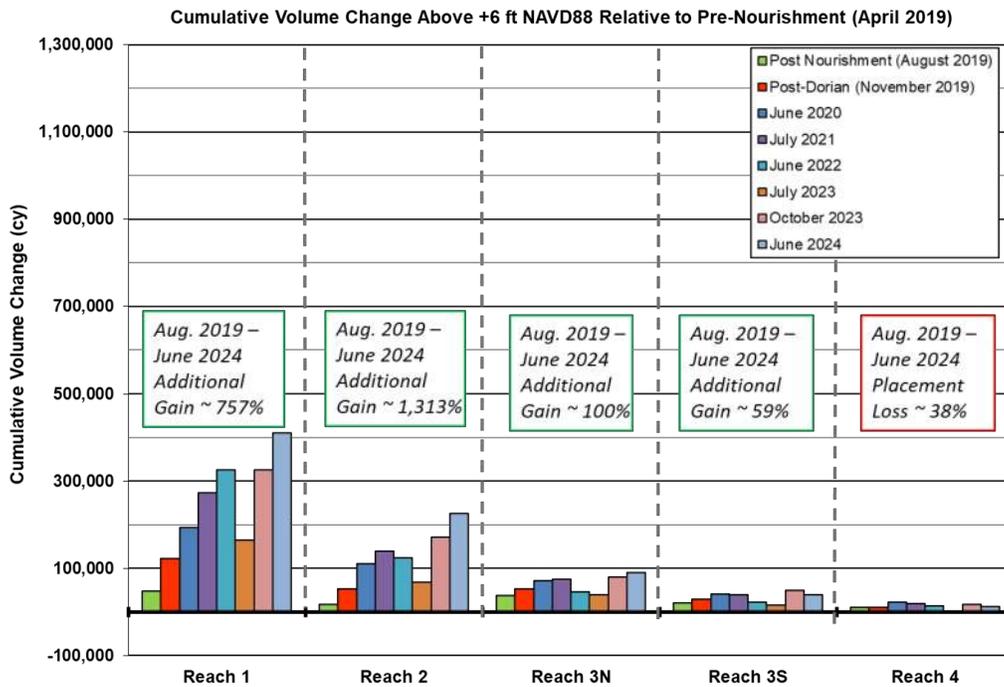


**Figure 5-34. Nourished Oceanfront Cumulative Volume Change Relative to Pre-Nourishment**

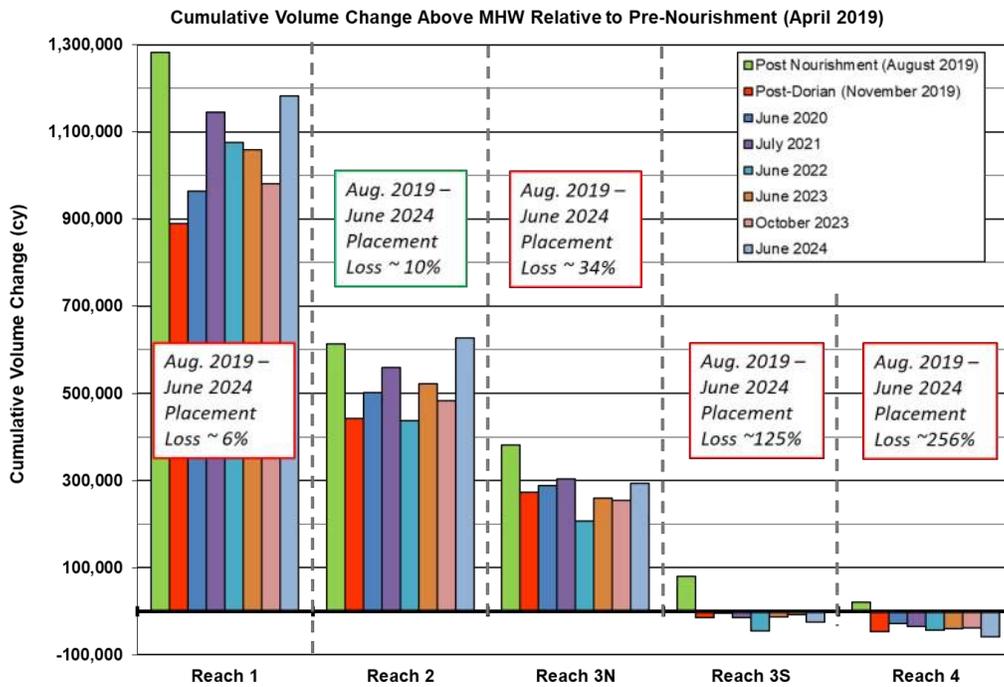
**Figure 5-35** illustrates the volume changes relative to pre-nourishment conditions (April 2019) above +6 ft NAVD88 along the Nourished Oceanfront. All the reaches, excluding Reach 4, experienced a gain in material above +6 ft NAVD88. However, Reach 4 incurred a loss of approximately 38% of the material that was originally placed above +6 ft NAVD88 during the 2019 Nourishment Project. Notably, 31% of this loss occurred this year, driven by substantial recession that led to dune scarping.

**Figure 5-36** shows the volume changes relative to pre-nourishment conditions (April 2019) above MHW (+1.18 ft NAVD88) along the Nourished Oceanfront. Notably, all reaches except Reach 2, experienced material losses above MHW following the completion of the 2019 nourishment project. Similar to shoreline changes (see **Figure 5-33**), the majority of these losses were observed during the Post-Dorian survey, encompassing both the erosion caused by Hurricane Dorian and the equilibrium of the nourishment profile.

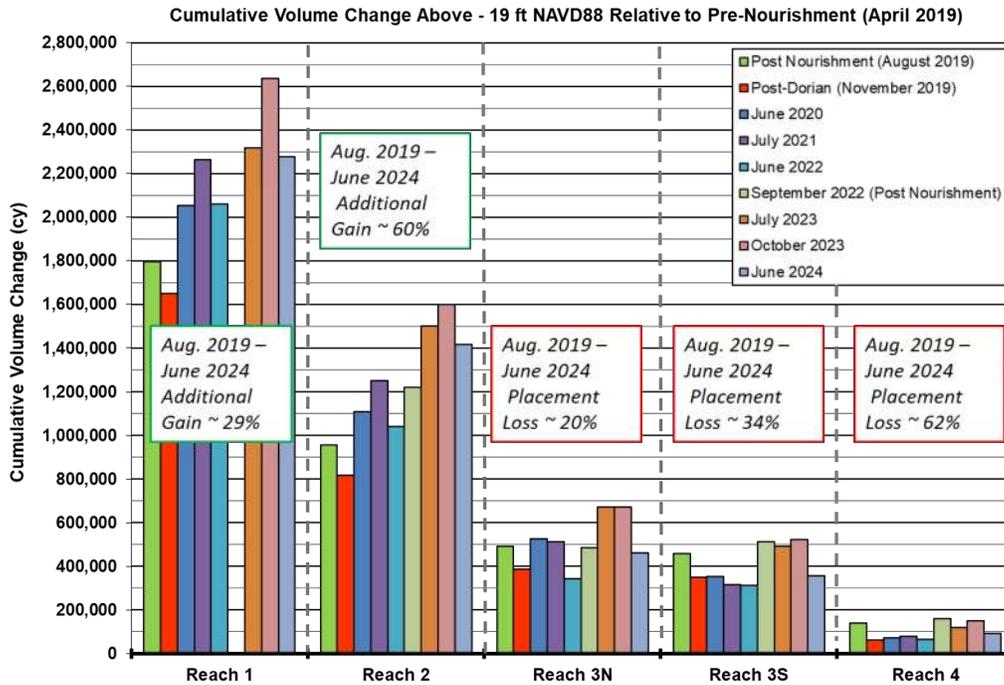
**Figure 5-37** presents the volume changes above -19 ft NAVD88 relative to pre-nourishment conditions (April 2019) along the Nourished Oceanfront. Reach 1 and Reach 2 show volume gains above -19 ft NAVD88 when compared to pre-nourishment levels. In contrast, the remaining reaches experienced material 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 62% of the nourished material by the end of this monitoring period.



**Figure 5-35. Cumulative Volume Change Above +6 ft NAVD88 Relative to Pre-Nourishment**



**Figure 5-36. Cumulative Volume Change Above MHW Relative to Pre-Nourishment**



**Figure 5-37. Cumulative Volume Change Above -19 ft NAVD88 Relative to Pre-Nourishment**

### 5.5 Multi-Decadal Beach Nourishment Master Plan

The Town of Nags Head has developed a Multi-Decadal Beach Nourishment Master Plan (Master Plan), adopted in July 2024, to provide a framework to plan and conduct beach maintenance and storm response projects over a 50-year timeframe. With this framework in place, the Town will be able to efficiently plan the permitting, financing, and construction of future beach nourishment projects.

The annual monitoring efforts will decide the timing and extents of these projects by tracking the average profile volume in each management reach as compared to the nourishment triggers that define the minimum profile volumes required to provide an equivalent level of protection along the Nags Head shoreline. While future beach nourishment projects will be sequenced and designed predominantly upon volumetric needs for infrastructure protection, other factors including funding sources and availability, feasibility of construction, and tourism and recreational use can also influence design considerations and may be considered on a project-by-project basis.

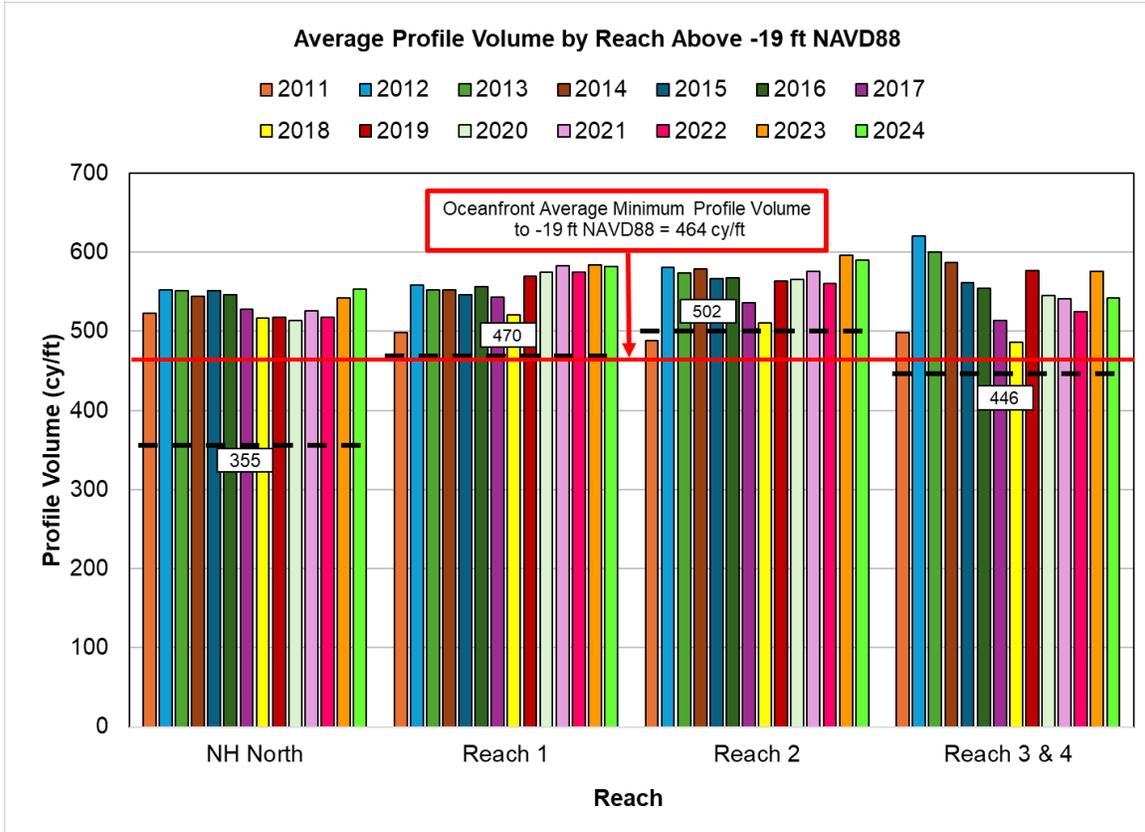
The volumetric triggers developed as part of the Master Plan are based on the profile volume from the foredune (landward most crest of primary dune) to the outer bar, above the -19 ft NAVD88 elevation. These triggers were developed to provide equivalent protection along the Nags Head oceanfront. Based on the engineering analysis and historical and expected future funding levels, it was determined that the Town would be able to maintain a Level of Protection (LoP) from a 25-year return period storm event. Detailed CSHORE modeling (a 1-D cross-shore numerical model) was used to determine the amount of sand above -19 ft NAVD88 that is needed to provide the 25-year event LoP in each management reach. This is different for each reach, depending on the existing dune height, berm width, and other profile characteristics. **Table 5-32** presents the management reaches and nourishment triggers determined in the Master Plan. As shown in the table, each reach has a slightly different volume trigger, 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

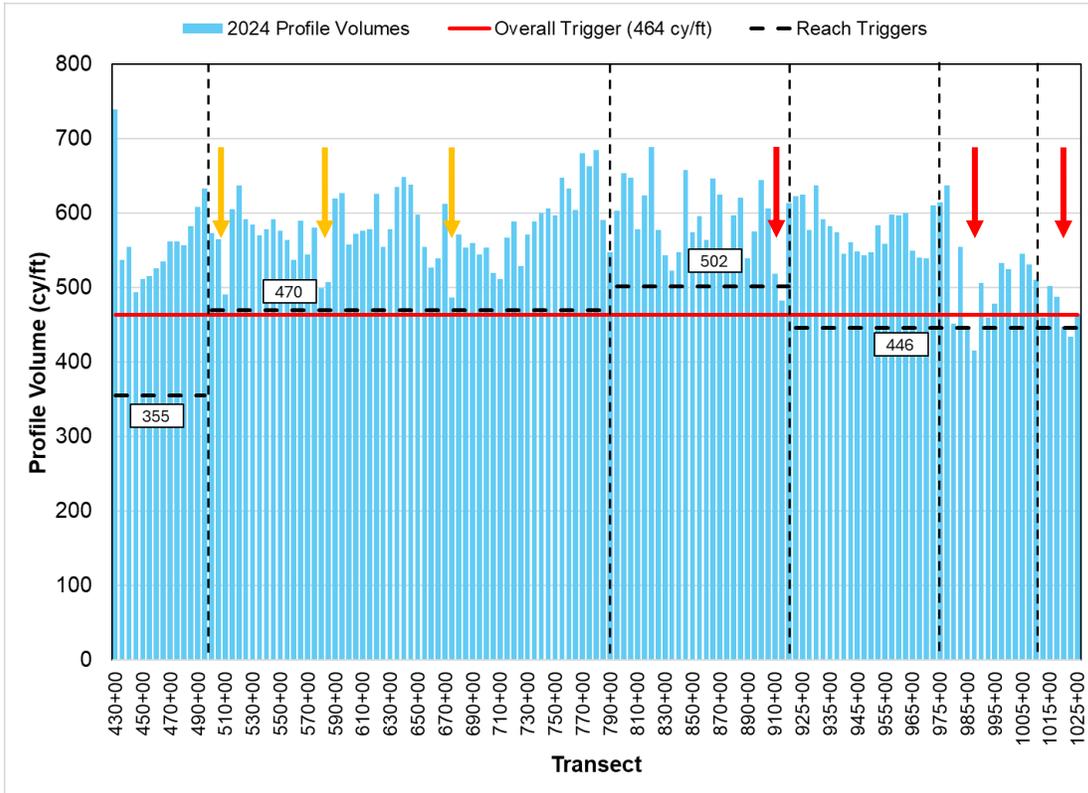
Because this is a new protocol for evaluating the state of the Town’s beach, all profile data from 2011 to present was re-evaluated considering these volumetric triggers, as shown in **Figure 5-38**. It is noted that the start position for the volumetric computation in the trigger

evaluation is different from the Xon (computation start) location for the historical volume change analysis presented in this and previous reports. The volumetric trigger is computed from the approximate dune crest location to the offshore location of the -19 ft NAVD88 contour.



**Figure 5-38. Master Plan Nourishment Trigger Volume Comparison**

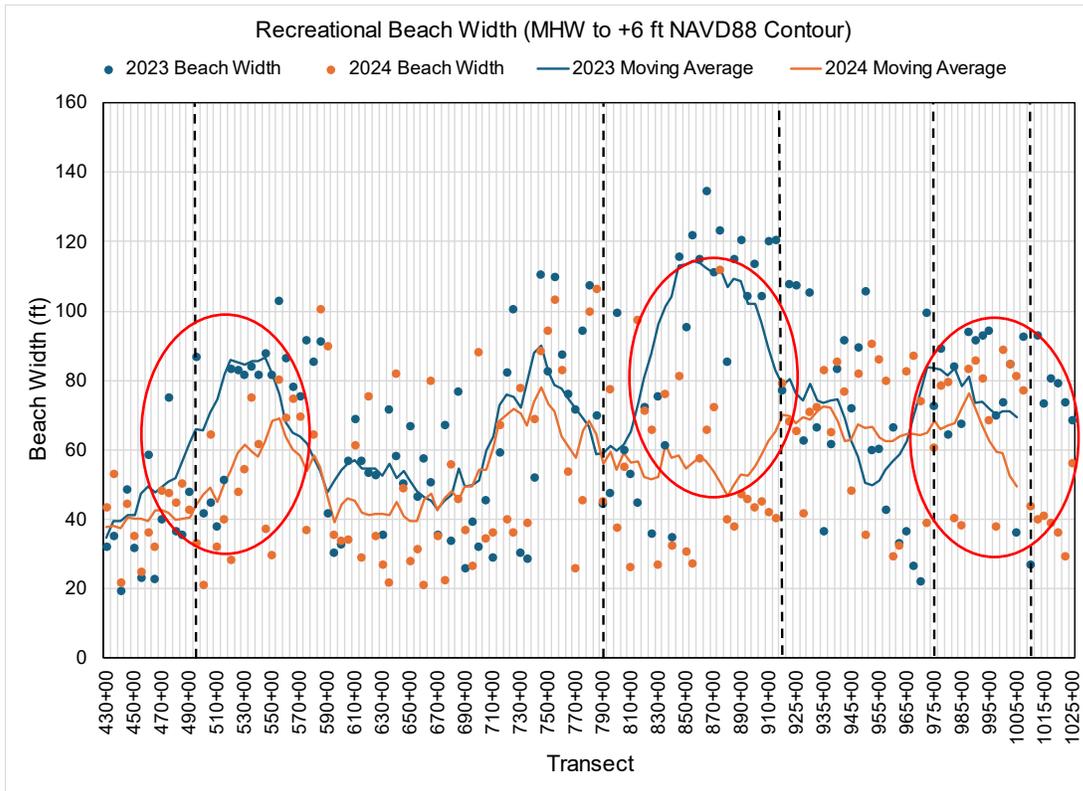
All management reaches currently contain average profile volumes above the nourishment triggers, however, there have been localized erosion hotspots observed along the Town’s shoreline in the summer of 2024. To more closely examine the current status of the beach, the profile volumes from all transects as of June – July 2024 are presented in **Figure 5-39**. Localized segments of Reaches 3 and 4 have profiles below the trigger volumes (red arrows), and additional localized segments of Reaches 1 and 2 are close to the triggers (yellow arrows).



**Figure 5-39. 2024 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 5-40**. Because of the scatter in the data points, a 9-point moving average was employed to more clearly illustrate overall trends along the shoreline. There has been substantial loss of the recreational beach width in several sections of the shoreline, including STA 470+00 to 570+00, 810+00 to 925+00, and 975+00 south to the Town boundary. The loss of the dry beach also makes it more likely that the dunes will be impacted by high water level and wave events.

Given these results, the Town may consider accelerating the timeline for the next beach nourishment project, currently planned for Summer 2027.



**Figure 5-40. Recreational Beach Width Comparison, 2023 to 2024**

**5.6 Long-Term Volume Change Trends (2011 – 2024)**

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 5-41** shows the mean volume change from 2011 to 2024 with nourishment, and **Figure 5-42** 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.

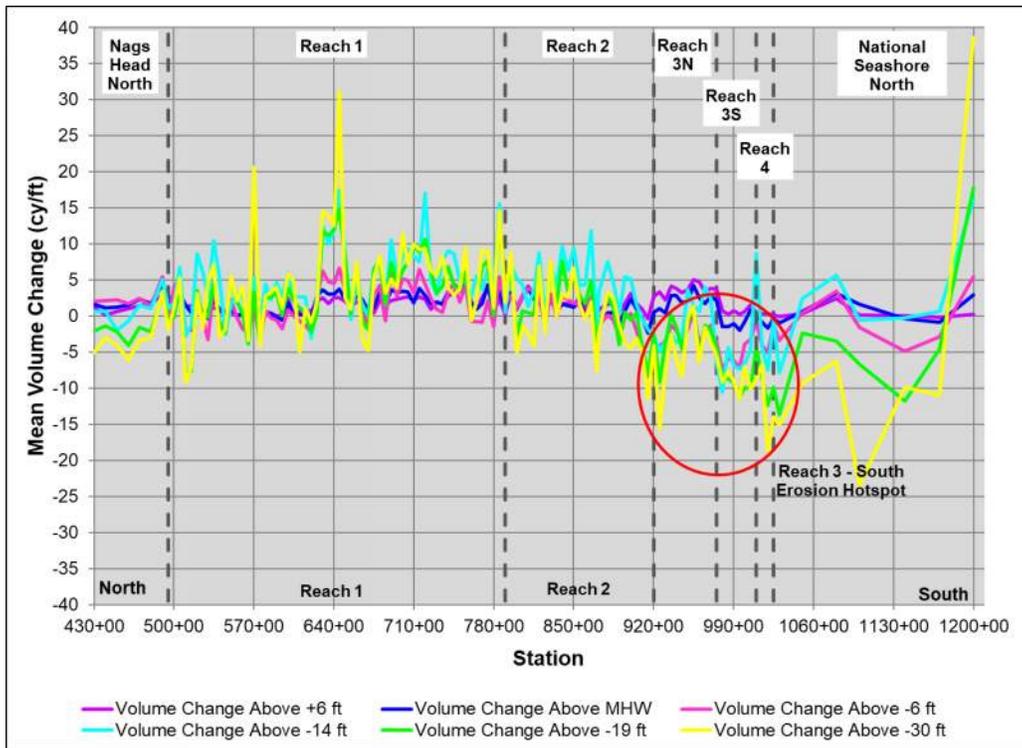


Figure 5-41. Mean Volume Change per year (2011 – 2024) (With Nourishment)

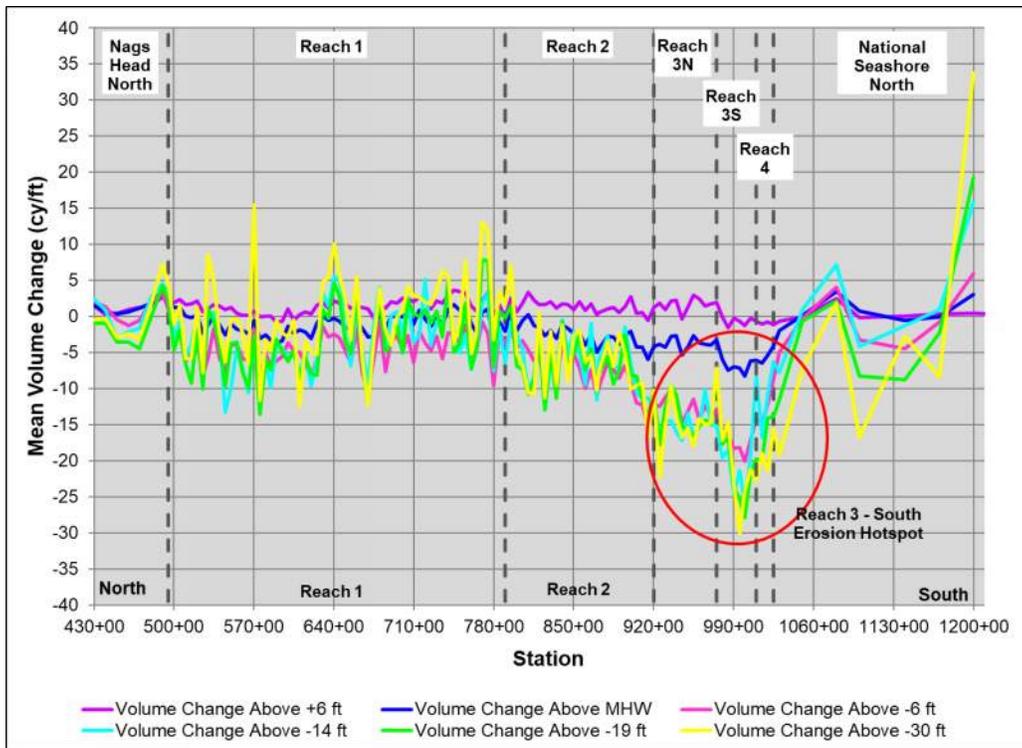


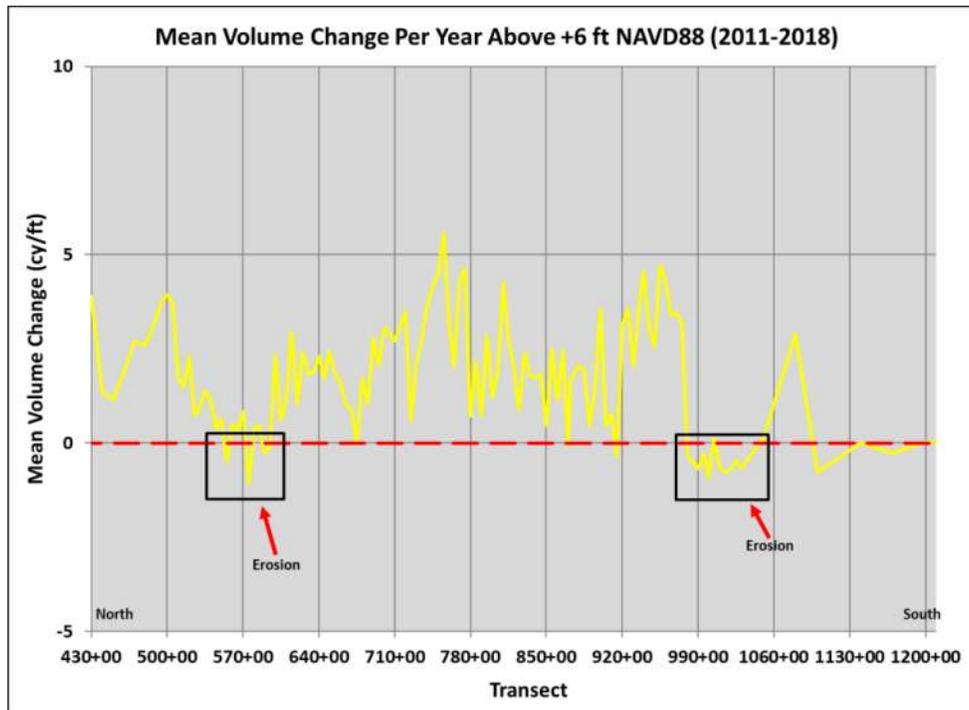
Figure 5-42. Mean Volume Change per year (2011 – 2024) (Without Nourishment)

## 5.7 Long-Term Dune Volume Trends

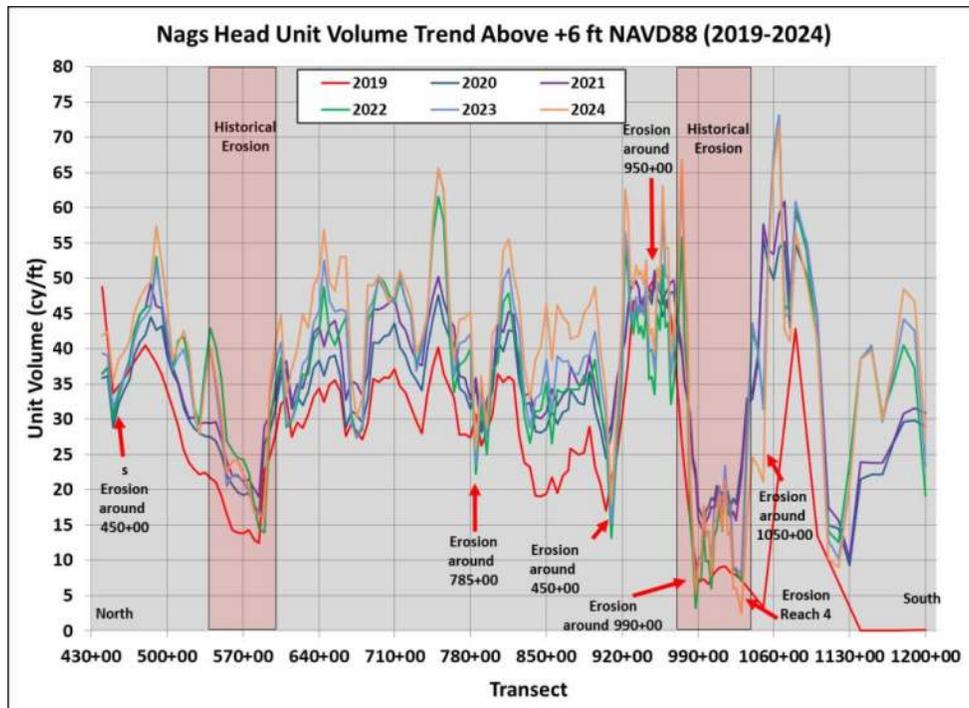
After the 2011 Beach Nourishment study it was noted (CSE 2018) that sand fencing has managed to capture the wind-blown sand and caused steady dune growth until 2014. The dune growth rates declined after 2014 as the available sand for aeolian transport decreased. Shoreline recession and reduction in dry beach width for aeolian transport caused dunes to lose sand from 2016 to 2018. The wider beaches created by the 2019 Beach Nourishment Project allowed for aeolian transport, and during the next four monitoring periods (2019 - 2023) dune growth was observed above +6 ft NAVD88. During the June 2023 to June 2024 monitoring period, dune growth continued across Reach 1, Reach 2, and Reach 3N, with the most significant growth occurring in Reach 2, which saw an increase of + 65,511 cy (+4.7 cy/ft) (**Table 5-29**). In contrast, Reach 3S and Reach 4 experienced dune scarping due to shoreline recession. This was particularly significant in Reach 4, where -4,288 cy (-2.5 cy/ft) of material was lost above +6 ft NAVD88.

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 5-43** 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 5-44** presents the moving average analysis of unit volumes above +6 NAVD88 ft along the monitoring shoreline from 2019 to 2024. The analysis reveals dune erosion at Reach 4, as well as other areas where dune erosion has been ongoing.



**Figure 5-43. Unit Dune Volume Change from 2011 to 2018 (Moving Average Trend Above +6 ft NAVD88)**



**Figure 5-44. Unit Dune Volume by Year (Moving Average Trend Above +6 ft NAVD88)**

## 6.0 SUMMARY

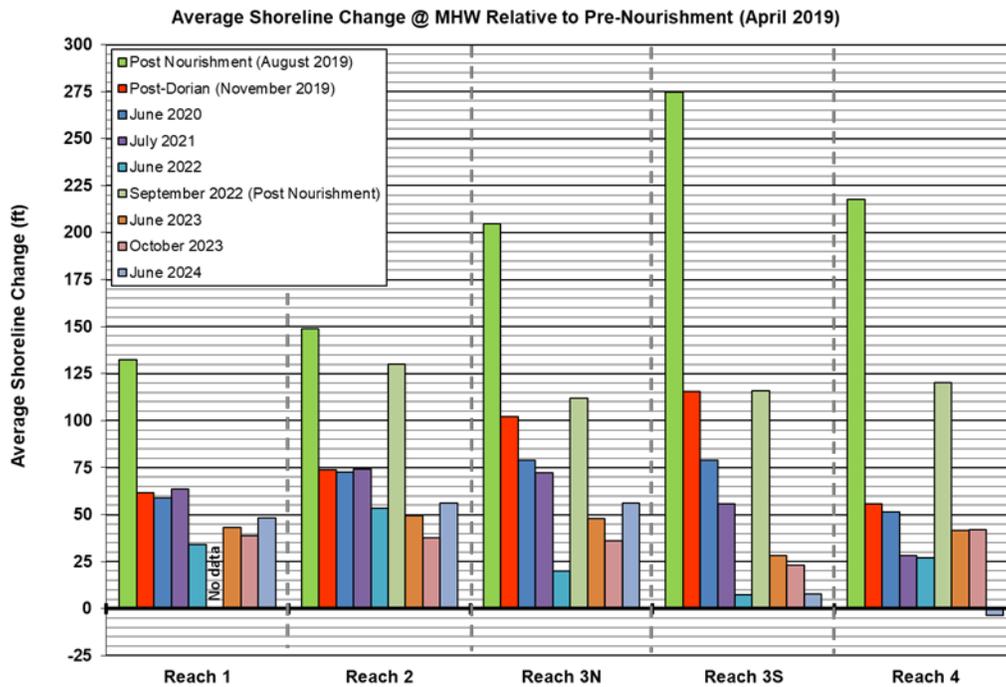
The Town of Nags Head Beach Monitoring and Maintenance Plan is sponsored by the Town of Nags Head (Town) as a continuation of the 2011 monitoring program initiated for assessing beach conditions. The primary purpose of the program is to assess current and historical shoreline conditions, determine shoreline 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 2024 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 2023, along with another annual survey in June 2023. This report outlines the data sources, methodologies, and findings of a survey evaluation conducted by Moffatt & Nichol. The evaluation compares the June 2024 survey to the data from October 2023 and June 2023 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.

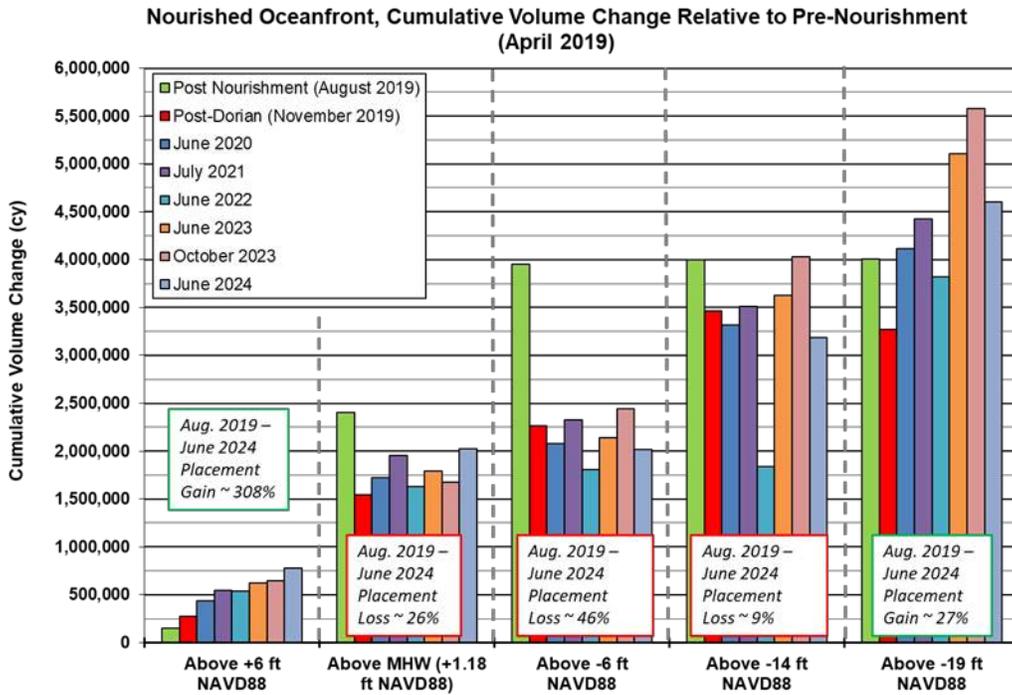
**Figure 6-1** illustrates the shoreline changes relative to pre-nourishment condition (April 2019) along the Nourished Oceanfront. As can be seen from the figure, a significant landward recession occurred along the Nourished Oceanfront since the completion of the 2019 nourishment project. The majority of this recession, noted before the post-Dorian survey, can be attributed to Hurricane Dorian. However, a portion of it was also due to profile equilibration, a natural occurrence during the stabilization of the nourishment profile. Similarly, the August 2022 post-Dorian renourishment project helped mitigate some of the recession. However, by June 2023, the shoreline had receded again, likely due to ongoing profile equilibration. This year, high-energy wave events caused further significant recession, particularly in the southern reaches (3S and Reach 4). In Reach 4, the shoreline has receded beyond the April 2019 pre-nourishment condition.



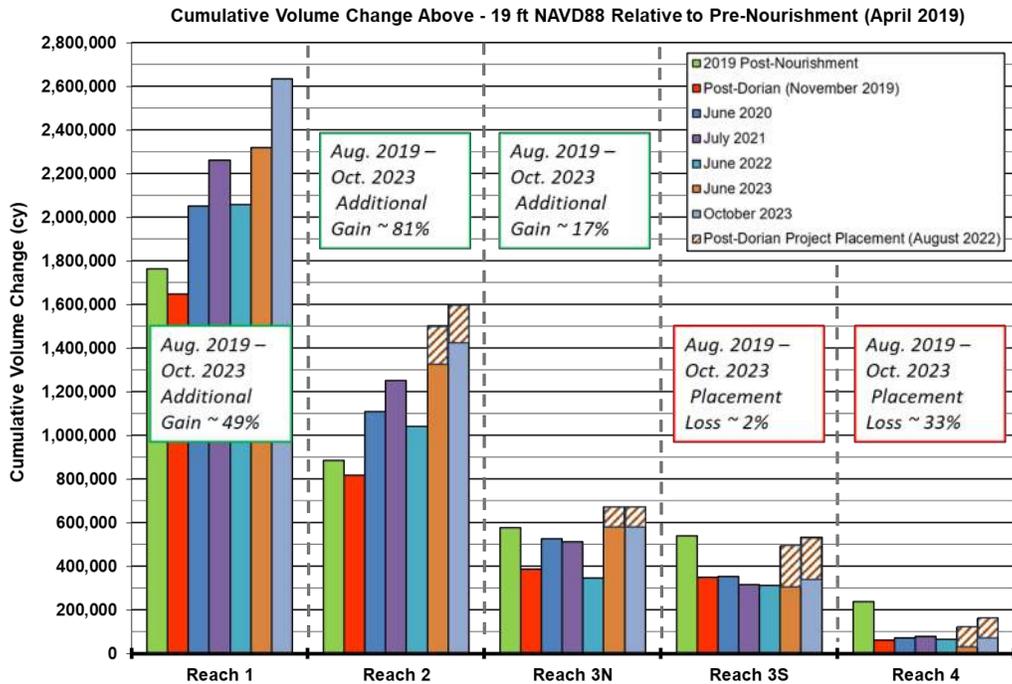
**Figure 6-1. Nourished Oceanfront Average Shoreline Change Relative to Pre-Nourishment Conditions**

**Figure 6-2** illustrates that the overall changes in sand volume vary with the depth above which volumes are assessed. Since the completion of the 2019 nourishment project approximately 598,349 cy (11.3 cy/ft) of volume gain was observed above -19 ft NAVD88 along the Nourished Oceanfront. This indicates that 127% of the volume present in August 2019 above -19 ft NAVD88 has remained within the system through the June 2024 survey. It's important to highlight that 614,106 cubic yards of material were placed during the 2022 Post-Dorian Renourishment project, indicating that without this renourishment, material loss would have likely occurred above -19 ft NAVD88. The results suggest significant cross-shore shifts of sand across various elevations. Notably, much of the sand has moved to lower elevations near the depth of closure, where it becomes vulnerable to being removed from the system during high-energy wave events.

**Figure 6-3** 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 62% of the nourished material by the end of this monitoring period.



**Figure 6-2. Nourished Oceanfront Cumulative Volume Change Relative to Pre-Nourishment**



**Figure 6-3. 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 losses in material above -19 ft NAVD88 indicating material being moved out of the Town’s sediment system. Key statistics for are shown in **Table 6-1** and **Table 6-2**.

**Table 6-1. Nags Head Shoreline and Average Unit Volume Change Statistics (June 2023 – June 2024)**

June 2023 vs. June 2024	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	6.1	3.4	4.5	0.8	11.8	9.6	26.6
Nags Head - Reach 1	495+00 - 790+00	29,500	5.1	2.5	4.2	0.2	2.2	-1.4	14.7
Nags Head - Reach 2	790+00 - 920+00	13,000	6.4	4.7	8.0	-0.3	-7.6	-6.6	5.5
Nags Head - Reach 3N	920+00 - 975+00	5,500	8.2	3.7	5.9	-10.0	-34.3	-36.6	-30.2
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-20.4	-0.1	-3.4	-12.7	-41.2	-38.9	-36.5
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-44.9	-2.5	-10.4	-17.9	-36.1	-16.1	-16.5
National Seashore North	1025+00 - 1200+00	17,500	20.0	-2.4	-0.5	9.2	-26.6	-18.7	-33.3
	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>2.7</b>	<b>2.9</b>	<b>4.4</b>	<b>-2.3</b>	<b>-7.9</b>	<b>-9.2</b>	<b>3.5</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>6.9</b>	<b>1.7</b>	<b>3.3</b>	<b>0.6</b>	<b>-10.5</b>	<b>-9.8</b>	<b>-2.9</b>

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

**Table 6-2. Nags Head Cumulative Volume Change Statistics (June 2023 – June 2024)**

June 2023 vs. June 2024	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	20,432	27,027	4,771	70,965	57,395	159,508
Nags Head - Reach 1	495+00 - 790+00	29,500	74,639	123,358	6,401	64,852	-41,313	433,683
Nags Head - Reach 2	790+00 - 920+00	13,000	61,511	103,820	-3,551	-98,804	-85,912	71,490
Nags Head - Reach 3N	920+00 - 975+00	5,500	21,031	33,981	-57,347	-197,490	-210,239	-173,746
Nags Head - Reach 3S	975+00 - 1010+00	3,500	-350	-11,880	-44,415	-144,269	-136,136	-127,669
Nags Head - Reach 4	1010+00 - 1025+00	1,500	-4,288	-18,134	-31,341	-63,252	-28,187	-28,798
National Seashore - North	1025+00 - 1200+00	17,500	-42,262	-8,788	161,561	-465,228	-326,727	-582,524
	Transects	Reach Length	total	total	total	total	total	total
<b>Nourished Oceanfront</b>	<b>495+00 - 1025+00</b>	<b>53,000</b>	<b>152,543</b>	<b>231,146</b>	<b>-130,252</b>	<b>-438,963</b>	<b>-501,787</b>	<b>174,960</b>
<b>Total Monitored Oceanfront*</b>	<b>430+00 - 1200+00</b>	<b>77,000</b>	<b>130,713</b>	<b>249,384</b>	<b>36,080</b>	<b>-833,226</b>	<b>-771,119</b>	<b>-248,056</b>

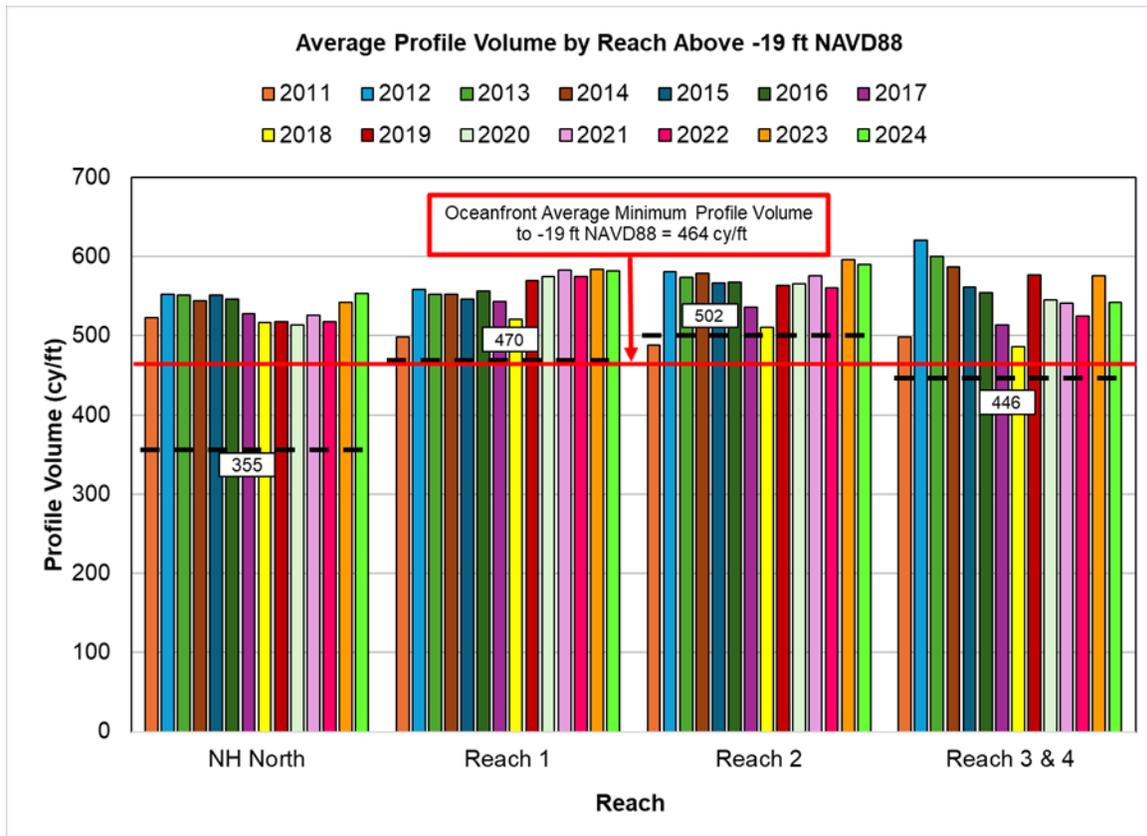
During the June 2023 - June 2024 monitoring period, Reach 3S and Reach 4 experienced significant shoreline recession, eroding much of the recreational beach. This erosion allowed waves to reach the dunes, resulting in dune scarping especially in Reach 4. The remaining reaches showed slight seaward advancement as material from nearshore was deposited to the beachface.

The Nags Head Oceanfront experienced material gains along the subaerial portions of the profiles (+6 ft NAVD88 and MHW). This was mainly due to nearshore material being deposited on the beachface. However, below MHW, volume losses occurred across all analyzed elevations, except above -30 ft NAVD88, where gains were only observed in Reaches 1 and 2. The most significant volume loss along the nourished oceanfront was recorded above -19 ft NAVD88 (-501,787 cy or -9.2 cy/ft), exceeding the historical background erosion rate (-6.7 cy/ft). This elevated loss can be attributed to the active 2023-2024 storm season, which brought 17 events with significant wave heights exceeding 8 ft. The frequent storm activity likely prevented the offshore-deposited material from returning to the beach, instead pushing it further offshore to lower elevations. Additionally, material gains at the Town boundaries in the prior monitoring period (June 2022 – June 2023) were attributed to sediment moving south from northern nourishment projects. The ongoing volume losses above -30 ft NAVD88 suggest that sediment may have been transported further south toward Oregon Inlet, moving out of the Town's system.

The Total Monitored Oceanfront, which includes both the Nags Head North and National Seashore-North reaches flanking the Nourished Oceanfront, exhibited a similar trend of material gains at subaerial elevations and losses below MHW. While the Nags Head North reach showed material gains across all analyzed elevations, the National Seashore-North reach experienced material losses above all analyzed elevations, similar to the adjacent areas in the Nourished Oceanfront.

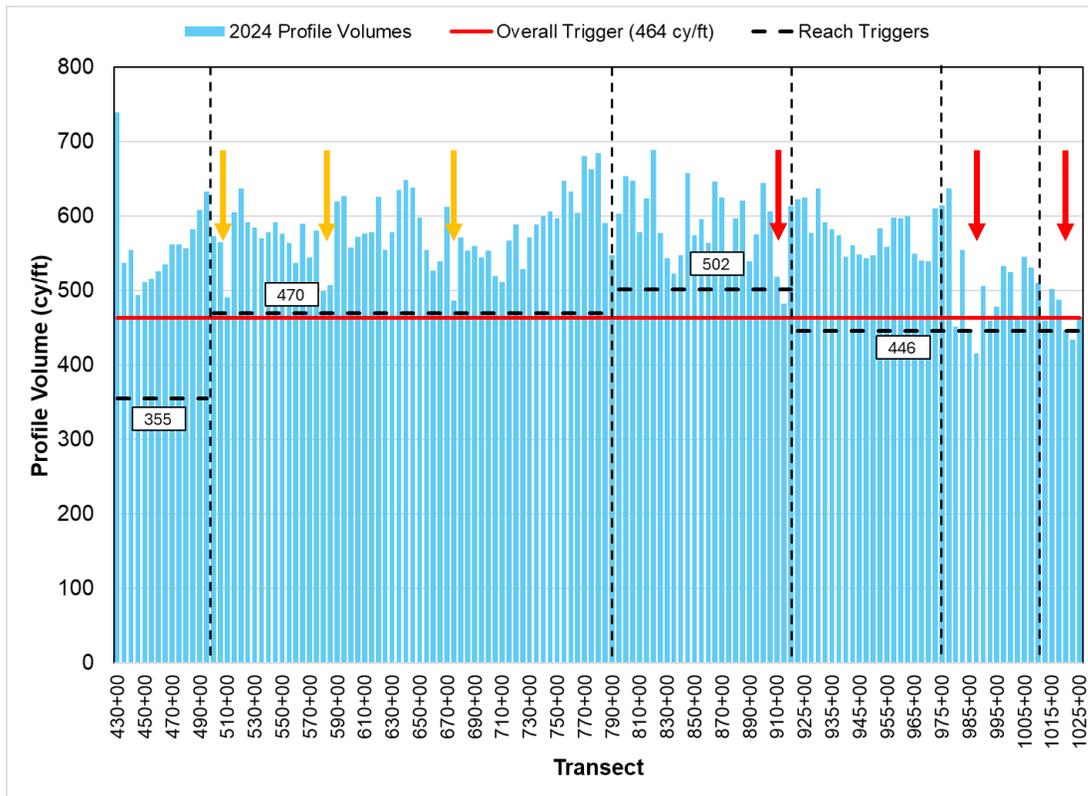
During the June 2023 to June 2024 monitoring period, dune growth continued across Reach 1, Reach 2, and Reach 3N, with the most significant growth occurring in Reach 2, which saw an increase of +65,511 cy (+4.7 cy/ft). In contrast, Reach 3S and Reach 4 experienced dune scarping and shoreline recession. This was particularly significant in Reach 4, where -4,288 cy (-2.5 cy/ft) of material was lost above +6 ft NAVD88.

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 6-5** 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 6-4. 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 2024. The profile volumes from all transects as of June – July 2024 are presented in **Figure 6-5**. Localized segments of Reaches 3 and 4 have profiles below the trigger volumes (red arrows), and additional localized segments of Reaches 1 and 2 are close to the triggers (yellow arrows).



**Figure 6-5. 2024 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. Loss of the dry beach increases the likelihood that the dunes will be further impacted by high water level and wave events.

Given these results, the Town may consider accelerating the timeline for the next beach nourishment project, currently planned for Summer 2027.

## **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), 2020. Town of Nags Head Beach Monitoring Analysis Program. 2020 Summer Annual Monitoring Survey Evaluation. Raleigh, NC. October 2020.



moffatt & nichol

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# APPENDIX A MCKIM & CREED SURVEY REPORT



**2024 Nag's Head  
Annual Beach Monitoring  
Data Acquisition Survey Report  
Town of Nags Head, Dare County, North Carolina**

Prepared for:

Town of Nags Head

Prepared by:

McKim & Creed, Inc.

243 North Front  
Street Wilmington,  
NC 28401



**2024 Nag's Head Annual Beach Monitoring Data Acquisition Survey Report**

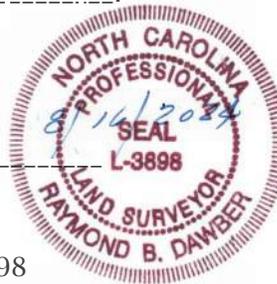
August 2024

**Survey Certification**

I, Raymond B Dawber NCPLS 3898, certify that this project was completed under my direct and responsible charge from an actual survey made under my supervision; meeting the requirements of the SOW, the hydrographic and topographic survey was performed at the 95% percent confidence level to meet Federal Geographic Data Committee Standards; meets the requirements for a topographic/planimetric survey to the horizontal and vertical accuracy of Class III surveys, and that the original data was obtained on 17 June 2024 through 31 July 2024; horizontal coordinates are presented in the North Carolina State Plane Coordinates (NAD83 2011) and all elevations are based on North American Vertical Datum of 1988 (NAVD88). All coordinates are ground unless specified otherwise.

THIS 16 DAY OF AUGUST, AD 2024.  
-----  
RAYMOND B DAWBER

PROFESSIONAL LAND SURVEYOR NCPLS 3898



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### **Digital Addendums:**

2024 Nags's Head Monitoring DWG  
 2024 Nags's Head Monitoring ASCII XYZ Data  
 2024 Nag's Head Monitoring Plan View Map  
 2024 Nag's Head Monitoring 5-column File  
 2024 Nag's Head Monitoring BMAP Files  
 2024 Nag's Head Monitoring MHWL Extracted Shape File  
 2024 Nag's Head Monitoring DEM  
 2024 Nag's Head Monitoring Beach Profile PDF Plots  
 2024 Nag's Head Monitoring Digital Ground Photography

## General scope of work

The work under the Task Order consisted of topographic and hydrographic beach profiles collected along the entire 10.1 miles of Nag's Head Atlantic Ocean Shoreline. 174 beach profiles were surveyed using a crew of employees of McKim & Creed Inc.

## Planning

On 14 June 2024 a project kickoff meeting was held between the field and office crew to review the scope of work in detail. All anticipated safety conditions were discussed along with the necessary safety equipment. The field team began monitoring the weather conditions at the beginning of June to determine the best time to mobilize to the survey area. Field work commenced on 17 June 2024, with a reconnaissance of control monuments and general mobilization activities. Survey data was collected from 18 June 2024 through 31 July 2024. The crew demobilized for the first time on June 26, 2024, due to not having permission to survey inside the Cape Hatteras National Seashore. The permit (Appendix A) was signed on July 9, 2024, and received by McKim & Creed on July 19, 2024. McKim & Creed mobilized for the second time on July 29, 2024, after weather conditions improved on site, and finished surveying the 32 lines inside the park and resurveyed an additional 7 lines (requested by the Town of Nags Head) on July 31, 2024.

The surveys were conducted to meet or exceed the Minimum Performance Standards for the U.S. Army Corps of Engineers (USACE), Engineering and Design Hydrographic Surveying Manual (EM 1110-2-1003) and in accordance with Chapter 56.1606 of the North Carolina Administrative Code (NCAC) specifications established by The North Carolina Engineering and Land Surveying Act (GS89C). The hydrographic survey was conducted under the direct supervision of an NSPS-THSOA Certified Hydrographer (CH).

Vertical data was collected in the North American Vertical Datum of 1988 (NAVD88) using Geoid 18. All Horizontal data is provided in the North Carolina State Plane Coordinate System, North American Datum (NAD) of 1983(2011).

All survey personnel adhered to the safety standards and used the necessary PPE as required for this type of project.

The field survey and data collection activities encompassed four (4) phases. Brief descriptions of each survey phase, including methodologies and quality control/quality assurance procedures, are described below.

## Phase 1-Control Reconnaissance/Establishment/Verification

Prior to surveying beach profiles, reconnaissance of the monuments was conducted to confirm that survey control was in place and undisturbed. Real Time Kinematic Global Positioning System (RTK GNSS) base stations were used in conjunction with the North Carolina virtual reference station (NCVRS) network to locate and confirm survey control

## 2024 Nag's Head Annual Beach Monitoring Data Acquisition Survey Report

for this project using a 3-minute observation at each monument. The horizontal and vertical accuracy of control data meets the accuracy requirements as set forth in the Engineering and Design Hydrographic Surveying Manual (EM 1110-2-1003). To achieve required accuracy, the surveys were controlled using 2nd order monuments, including T168 and CAHA 2 from the National Geodetic Survey (NGS). Three-minute GNSS observations were measured on all monuments utilized and temporary benchmarks (TBM) established. Horizontal and vertical positioning checks were conducted at the beginning and end of each day using at least two control benchmarks in the project area. The control check shots were acquired using a minimum of five (5) epochs.

### Phase 2-Beach Profiles

Upon completion of the control reconnaissance survey, beach/upland and nearshore operations were initiated. Profiles of the beach in the project area were surveyed using extended rod RTK GNSS rovers, and standard RTK GNSS rovers. Extended rod RTK GNSS rovers were used to augment RTK GNSS survey capability into the nearshore.

Profiles commenced from the baseline and extended seaward overlapping the nearshore/wade data. Nearshore portions of the profiles were surveyed by two (2) surveyors with an Extended Rod Trimble R8 or R10 RTK GNSS rovers. The nearshore survey extended seaward to a point overlapping the offshore portion of the profiles by at least fifty (50) feet.

Elevations were taken at a maximum of twenty-five (25) foot intervals along each profile line and at all grade breaks. The integrity of the profiles line directions used the RTK GNSS feature to remain on azimuth.

### Phase 3-Nearshore/Offshore Profiles

The Nearshore/Offshore profiles were conducted along each required profile station. The profiles were obtained 3,500 feet beyond the shoreline or to the -30' NAVD88 contour, whichever is more landward. The landward limits of the nearshore profiles were based on a minimum overlap of fifty (50) feet beyond the seaward extent of beach profiles.

Soundings were collected at 200kHz with an Odom Echotrac E20 single beam echosounder, hull-mounted transducer on McKim & Creed's twenty-five (25) foot survey vessel, the *S/V Cawood*. To maintain the vessel navigation along the profile lines, HYPACK navigation software was used.

These soundings were reduced to 9' spacing, sufficient to provide a smooth and accurate depiction of the seafloor.

Data was digitally stored using HYPACK 2023 Software. An Applanix POSMV Inertia Navigation System onboard the survey vessel provided pitch, roll, heave, and tide corrections. Bar checks were performed daily and as needed to check and calibrate the system. Tide verifications, echosounder checks, and sound velocity results are presented in the tables presented below.

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The AML sound velocity profiler was used to measure the sound velocity along the water column, with casts performed inside the project area. Bar-checks were performed from a depth of five (5) feet to a depth of at least twenty-five (25) feet. Offshore data was collected within 2 (two) days of onshore data collection for each line.

### Phase 4-Data Processing/Submittals

Upon completion of the field work, data was edited using Trimble Business Center, and HYPACK 2023. The upland and nearshore portions of the beach profile were viewed and edited in Trimble Business Center to provide the required comma delimited XYZ file. The raw bathymetry digital data was viewed and edited in HYPACK Single Beam Editor. The collected tide data was compared to NOAA measured water levels using NOAA Tide Stations 8651370 (Duck, NC) and 8652587 (Oregon Inlet, NC). Tide corrected offshore data was exported and included into a comma delimited XYZ file. All overlapping profile data was reviewed in the cross sections to ensure system accuracy. The edited beach profile data and offshore profile data were merged to create a representative profile for each station. The final plots were edited and reviewed with comparisons to previous years; discrepancies were noted and resolved. The profiles were developed using HYPACK *Cross-section and Volumes* software. Profiles are presented in PDF format with the digital files accompanying this report.

### Map Preparation

Upon completion of the surveys and data reduction, the plan view map was prepared in Autodesk Civil 3D. Elevations are displayed in NAVD88 and are spaced at 75' for better visualization. Dare County GIS parcel lines were used for background reference.

### Ground Digital Photography

A total of two (2) digital photos were taken at a mid-beach location at each profile line, facing Northerly and Westerly directions. Additional photographs were taken as needed. Digital files are included with the deliverables in .jpeg format. Ground Photography is presented in digital format with files accompanying this report.

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### Control and GNSS Quality Checks

All Control Monuments provided by the client are shown in Table 1. Monuments utilized for survey control were found to be in good condition.

<b>NAG'S HEAD, NC - Control Status</b>					
<b>UNITS: US Survey Feet</b>					
<b>Station</b>	<b>Easting</b>	<b>Northing</b>	<b>Elevation</b>	<b>Status</b>	<b>Comment</b>
T 168	2993941.37	827213.86	10.57	Found	Recovered as Described
W 168 (BM 72)	3005850.14	806503.64	7.53	Found	Recovered as Described
CAHA 2	3007349.70	801455.42	4.20	Found	Recovered as Described
F 255	3018120.00	778913.91	2.78	Found	Recovery Drawing in Notes
EDEN	3009247.87	799346.34	32.66	Not Found	Under House
BREW	2997818.79	823218.51	16.93	Not Found	Missing
LOGGERHEAD	3001986.83	814705.66	15.49	Not Found	Missing
BROOKE	3020429.10	774768.51	19.38	Not Found	Missing

TABLE 1 - CONTROL PROVIDED BY CLIENT

Using RTK GNSS, a 3-minute observation was performed on all monuments. Results of control measurements are presented in Table 2.

<b>RTK GNSS 3-Minute Observations</b>			
<b>Measured Values - June 2024</b>			
<b>UNITS: US Survey Feet</b>			
<b>Station</b>	<b>Easting</b>	<b>Northing</b>	<b>Elevation</b>
T 168	2993941.37	827213.86	10.39
T 168	2993941.37	827213.89	10.34
T 168	2993941.34	827213.87	10.33
T 168	2993941.31	827213.89	10.28
T 168	2993941.30	827213.88	10.28
W 168	3005850.15	806503.71	7.42
CAHA 2	3007349.67	801455.52	4.05
CAHA 2	3007349.62	801455.51	4.12
F255	3018119.99	778913.88	2.71
F255	3018120.00	778913.90	2.78
F255	3018119.95	778913.99	2.75
F255	3018119.93	778914.00	2.79

TABLE 2 - 3-MINUTE GNSS OBSERVATIONS

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The provided control data was compared to the measurements from the surveyed 3-minute observations, the variations (delta values) are presented in Table 3.

Variations Provided values vs. Measured Values			
Station	Easting Var.	Northing Var.	Elevation Var.
T 168	0.00	-0.01	-0.18
T 168	0.00	0.03	-0.23
T 168	-0.04	0.01	-0.24
T 168	-0.06	0.03	-0.29
T 168	-0.07	0.02	-0.29
W 168	0.01	0.07	-0.11
CAHA 2	-0.03	0.10	-0.15
CAHA 2	-0.08	0.09	-0.08
F255	-0.01	-0.03	-0.07
F255	0.00	-0.01	0.00
F255	-0.05	0.08	-0.03
F255	-0.07	0.09	0.01

TABLE 3 - VARIATIONS FROM PROVIDED CONTROLS TO RTK GNNS MEASUREMENTS

Control checks were performed at the beginning and end of each survey day. Measurements are compared to the client provided control or results from an average of the 3-minute observations performed on TBMS. Inverses are presented in table 4 and table 5.

Beginning of Survey Day TRIMBLE R8/TSC5 - UNIT: HYDRO 1			
Date	Station	$\Delta$ Horizontal	$\Delta$ Vertical
6/18/2024	T 168	0.10	-0.05
6/19/2024	T 168	0.13	0.04
6/20/2024	CAHA 2	0.13	-0.08
6/20/2024	F 255	0.14	-0.14
6/21/2024	T 168	0.10	0.03
6/23/2024	CAHA 2	0.13	-0.08
6/25/2024	F 255	0.10	-0.05
7/30/2024	F 255	0.08	0.02
7/31/2024	F 255	0.09	-0.01

End of Survey Day TRIMBLE R8/TSC5 - UNIT: HYDRO 1			
Date	Station	$\Delta$ Horizontal	$\Delta$ Vertical
6/18/2024	T 168	0.11	0.05
6/19/2024	T 168	0.10	-0.06
6/20/2024	CAHA 2	0.15	-0.08
6/20/2024	F 255	0.15	0.04
6/21/2024	T 168	0.08	-0.01
6/23/2024	CAHA 2	0.09	0.03
6/25/2024	F 255	0.12	-0.06
7/30/2024	F 255	0.07	-0.09
7/31/2024	F 255	0.09	-0.03

TABLE 4 - RESULTS OF DAILY CONTROL CHECKS

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Beginning of Survey Day TRIMBLE R8/TSC5 - UNIT: HYDRO 2				End of Survey Day TRIMBLE R8/TSC5 - UNIT: HYDRO 2			
Date	Station	$\Delta$ Horizontal	$\Delta$ Vertical	Date	Station	$\Delta$ Horizontal	$\Delta$ Vertical
6/18/2024	T 168	0.11	-0.04	6/18/2024	T 168	0.10	0.02
6/19/2024	T 168	0.15	-0.06	6/19/2024	T 168	0.11	0.08
6/20/2024	CAHA 2	0.13	0.10	6/20/2024	CAHA 2	0.15	0.11
6/20/2024	F255	0.17	-0.01	6/20/2024	F255	0.16	-0.04
6/21/2024	T 168	0.07	0.04	6/21/2024	T 168	0.10	-0.01
6/22/2024	CAHA 2	0.15	-0.04	6/22/2024	CAHA 2	0.10	-0.01
6/23/2024	CAHA 2	0.14	0.10	6/23/2024	CAHA 2	0.10	0.06
6/24/2024	F 255	0.17	-0.04	6/24/2024	F 255	0.04	0.16
6/25/2024	F 255	0.18	0.02	6/25/2024	F 255	0.17	-0.11

TABLE 5 - RESULTS OF DAILY CONTROL CHECKS

### VESSEL CALIBRATIONS

The Survey Vessel *Cawood* (a 25' Safe Boat) was used for this survey. Offsets were measured and calculated on May 28, 2024.

Daily vessel calibration verifications were performed in the survey area with values presented in table 6, table 7, and table 8.

Daily Tide Checks		
Date	R8s Elevation (Ft)	Hypack Corr.(Ft)
6/18/2024	-0.18	0.17
6/22/2024	0.32	-0.36
6/23/2024	0.61	0.71
6/24/2024	0.76	-0.73
6/25/2024	-0.37	0.30
6/26/2024	0.84	-0.84
7/30/2024	0.23	-0.22

TABLE 6-DAILY TIDE CHECKS

Daily Bar Checks	
Date	Confirmed Depths (ft)
6/18/2024	5, 10, 15, 20 *
6/22/2024	5, 10, 15, 20, 25, 30
6/23/2024	5, 10, 15, 20, 25
6/24/2024	5, 10, 15, 20, 25
6/25/2024	5, 10, 15, 20, 25, 30
6/26/2024	5, 10, 15 *
7/30/2024	5, 10, 15 *

\*DEEPER CHECKS IMPOSSIBLE DUE TO ROUGH SEA

TABLE 7-DAILY BAR CHECKS

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<b>Daily Sound Velocity Checks</b>	
<b>Date</b>	<b>Average (ft/sec)</b>
6/18/2024	4963.5
6/22/2024	4950
6/23/2024	4958
6/24/2024	5012.5
6/25/2024	4979.5
6/26/2024	4996
7/30/2024	4974

*TABLE 8-DAILY SOUND VELOCITY*

### List of Equipment Used

Below is a summary list of equipment utilized for the survey for data collection, processing, and deliverables.

- 25' Safe Boat *S/V Cawood*
- Teledyne ECHOTRAC E20 transducer 200 kHz
- Applanix Pos-MV Inertia Navigation System I2NS
- Sound Velocity Profiler AML CTD Base X Profiler
- Hypack 2023 for hydrographic data collection and processing (23.2.2.0)
- Trimble R8 GNSS Receivers/ TSC3 data collectors Trimble Access (23.002.12)
- Trimble R10 GNSS Receivers/ TSC5 data collectors Trimble Access (23.00.212)
- Trimble Business Center (2023.11)
- AutoCAD Civil 3D 2020.5.1 Update (13.2.3093.0)



## 2024 Nag's Head Annual Beach Monitoring Data Acquisition Survey Report

- Program Manager (252-475-0463) contacted immediately. As required by law, the coroner will be notified first. All provisions outlined in the Native American Graves Protection and Repatriation Act (1990) will be followed.
- (4) Archeological excavation will require an ARPA permit and related documents prior to beginning of activities.
- (5) Researchers who perform research during periods of darkness (bat surveys, etc.) must follow project-specific mitigation. Guidance will be applied on a case-by-case basis to enhance researcher safety, resource protection, and reduce impacts to visitor experience.
- (6) No species collected from outside the park is permitted to be introduced or reintroduced into the park.
- (7) Any commercial or for-profit activity is prohibited without the express permission of the Superintendent of the Outer Banks Group.
- (8) All research staff must adhere to all conditions of research and collection permit. Field staff must possess a copy of the permit at all times while in the field.
- (9) All general park regulations must be followed, unless a specific exemption was granted by the Chief of Resource Management. All conditions listed in the National Park Service, General Conditions for Scientific Research and Collecting Permit, and any project-specific Research Permit Conditions must be followed unless an exemption was granted.
- (10) As mandated by Cape Hatteras National Seashore's Off-Road Vehicle (ORV) Management Plan, everyone driving on the beach at the Seashore is required to have a beach driving permit, including those operating under a NPS research permit. In the event a researcher needs to drive an ORV on the beach for research, the park will provide this permit to them free of charge. To obtain an ORV permit, they must stop by NPS Headquarters in Manteo, NC when they arrive and present a valid driver's license, vehicle registration, and your current research permit. After watching an orientation video, staff will provide them with a temporary voucher. If they will be making multiple visits to the Seashore throughout the year, they will need to stop by an office each time to pick up a new temporary voucher, though they will not be required to go through the orientation again.
- (11) Permission to enter closed or restricted areas may be granted to select researchers that meet certain criteria. Examples of restricted areas include most service roads, shorebird nesting areas and sea turtle nesting areas. If exemptions are granted, mitigation for entering closed areas may include restriction to party size, period of entry, or date/s of entry (36 CFR 1.5 (a)(2)).
- (12) Any research activities proposed to impact state species of concern requires consultation with NC Wildlife Resources Commission and NC National Heritage Program.
- (13) Equipment installed and left in the field (e.g. plot markers, seismic equipment, dataloggers) must be placed in a way that will reduce or eliminate public view of the equipment. Unless explicitly permitted to remain, all equipment deployed in the field must be retrieved by the researcher.
- (14) Any collecting or research that will result in permanent changes or degradation of habitat is prohibited. Researchers must follow Leave No Trace ethics when conducting research in the park. Access trails shall be brushed in; natural contours shall be reestablished; soil scarified and mulched with native leaf litter.
- (15) If researchers propose the collection of vegetation, sampling amounts are approved and evaluated on a case-by-case basis. Mitigation may be required. If the collection of plant material is proposed, the Research Coordinator will consult with the RM staff to confirm there is no potential impact on listed species or species of concern. Plant surveys may need to be completed before any collection or ground disturbance can occur.
- (16) If authorized to collect sediment or vegetation samples, researchers must take samples from areas out of public view. They may not sample adjacent to roads, trails, ramps, pullouts or other visible areas. Where possible, researchers are asked to rehab collection site(s) to make them look natural. To avoid visitor reports of illegal collecting, specimens must be carried inside packs after sampling.
- (17) Unless otherwise authorized, all research activities must be conducted out of the public view. Exemptions may be granted if the researcher demonstrates that the work cannot occur at another location and if impacts to visitor experience are negligible. Project-specific mitigation (such as wearing orange vests, displaying placards, working with NPS staff, working while park is closed, etc.) will be recommended.
- (18) Approval to conduct social science surveys is contingent on the approval of the investigators' university Human Subjects Committee. Social science surveys may not unduly impact visitor experience. Conditions of approval include submission of specific staging locations, specific study dates, number of visitors to be contacted, and submission of the approach script and survey for pre-approval. Social science surveys may be sent to the NPS Social Science Program staff for peer review. Park or government-sponsored surveys may be subject to OMB approval. Research coordinator should consult with Chief of Interpretation for appropriate locations to conduct social science surveys.

## 2024 Nag's Head Annual Beach Monitoring Data Acquisition Survey Report

(19) Any project or activity must avoid altering stream flow characteristics, affecting a watershed, wetland or floodplain.

(20) Most animal handling is subject to the Animal Welfare Act and requires the review of an institution's Animal Care and Use Committee (IACUC), researchers must submit proof of IACUC approval for consideration. Researchers are required to submit an animal capture and handling plan for any wildlife handling proposal. This plan should include at minimum emergency contacts, employee medical response procedures, animal physiological norms and drug use protocol, processing procedure, and euthanasia procedure. The Resource Management staff will determine an acceptable level of mortality and consultation with wildlife specialists; if this level is exceeded the researcher must stop capture work and notify the park. A capture evaluation will occur, after which the park may allow continued capture work or require the researcher to cease operations.

### CONDITIONS SUBJECT TO ALL NATIONAL PARK SERVICE RESEARCH PERMITS

(1) Authority - The permittee is granted privileges covered under this permit subject to the supervision of the superintendent or a designee, and shall comply with all applicable laws and regulations of the National Park System area and other federal and state laws. A National Park Service (NPS) representative may accompany the permittee in the field to ensure compliance with regulations.

(2) Responsibility - The permittee is responsible for ensuring that all persons working on the project adhere to permit conditions and applicable NPS regulations.

(3) False information - The permittee is prohibited from giving false information that is used to issue this permit. To do so will be considered a breach of conditions and be grounds for revocation of this permit and other applicable penalties.

(4) Assignment - This permit may not be transferred or assigned. Additional investigators and field assistants are to be coordinated by the person(s) named in the permit and should carry a copy of the permit while they are working in the park. The principal investigator shall notify the park's Research and Collecting Permit Office when there are desired changes in the approved study protocols or methods, changes in the affiliation or status of the principal investigator, or modification of the name of any project member.

(5) Revocation - This permit may be terminated for breach of any condition. The permittee may consult with the appropriate NPS Regional Science Advisor to clarify issues resulting in a revoked permit and the potential for reinstatement by the park superintendent or a designee.

(6) Collection of specimens (including materials) - No specimens (including materials) may be collected unless authorized on the Scientific Research and Collecting permit.

The general conditions for specimen collections are:

- Collection of archeological materials without a valid Federal Archeology Permit is prohibited.
- Collection of federally listed threatened or endangered species without a valid U.S. Fish and Wildlife Service endangered species permit is prohibited.
- Collection methods shall not attract undue attention or cause unapproved damage, depletion, or disturbance to the environment and other park resources, such as historic sites.
- New specimens must be reported to the NPS annually or more frequently if required by the park issuing the permit. Minimum information for annual reporting includes specimen classification, number of specimens collected, location collected, specimen status (e.g., herbarium sheet, preserved in alcohol/formalin, tanned and mounted, dried and boxed, etc.), and current location.
- Collected specimens that are not consumed in analysis or discarded after scientific analysis remain federal property. The NPS reserves the right to designate the repositories of all specimens removed from the park and to approve or restrict reassignment of specimens from one repository to another. Because specimens are Federal property, they shall not be destroyed or discarded without prior NPS authorization.
- Each specimen (or groups of specimens labeled as a group) that is retained permanently must bear NPS labels and must be accessioned and cataloged in the NPS National Catalog. Unless exempted by additional park-specific stipulations, the permittee will complete the labels and catalog records and will provide accession information. It is the permittee's responsibility to contact the park for cataloging instructions and specimen labels as well as instructions on repository designation for the specimens.
- Collected specimens may be used for scientific or educational purposes only, and shall be dedicated to public benefit and be accessible to the public in accordance with NPS policies and procedures.
- Any specimens collected under this permit, any components of any specimens (including but not limited to natural organisms, enzymes or other bioactive molecules, genetic materials, or seeds), and research results derived from collected specimens are to be used for scientific or educational purposes only, and may not be used for commercial or other revenue-generating purposes unless the permittee has entered into a Cooperative Research And Development Agreement (CRADA) or other approved benefit-sharing agreement with the NPS. The sale of collected research specimens or other unauthorized transfers to third parties is prohibited. Furthermore, if the permittee sells or otherwise transfers collected specimens, any components thereof, or any products or research results developed from such specimens or their components without a CRADA or other approved benefit-sharing agreement with NPS, permittee will pay the NPS a royalty rate of twenty percent (20%) of gross revenue from such sales or other revenues. In addition to such royalty, the NPS may seek other damages to which the NPS may be entitled including but not limited to injunctive relief against

## 2024 Nag's Head Annual Beach Monitoring Data Acquisition Survey Report

the permittee.

(7) Reports - The permittee is required to submit an Investigator's Annual Report and copies of final reports, publications, and other materials resulting from the study. Instructions for how and when to submit an annual report will be provided by NPS staff. Park research coordinators will analyze study proposals to determine whether copies of field notes, databases, maps, photos, and/or other materials may also be requested. The permittee is responsible for the content of reports and data provided to the National Park Service.

(8) Confidentiality - The permittee agrees to keep the specific location of sensitive park resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

(9) Methods of travel - Travel within the park is restricted to only those methods that are available to the general public unless otherwise specified in additional stipulations associated with this permit.

(10) Other permits - The permittee must obtain all other required permit(s) to conduct the specified project.

(11) Insurance - If liability insurance is required by the NPS for this project, then documentation must be provided that it has been obtained and is current in all respects before this permit is considered valid.

(12) Mechanized equipment - No use of mechanized equipment in designated, proposed, or potential wilderness areas is allowed unless authorized by the superintendent or a designee in additional specific conditions associated with this permit.

(13) NPS participation - The permittee should not anticipate assistance from the NPS unless specific arrangements are made and documented in either an additional stipulation attached to this permit or in other separate written agreements.

(14) Permanent markers and field equipment - The permittee is required to remove all markers or equipment from the field after the completion of the study or prior to the expiration date of this permit. The superintendent or a designee may modify this requirement through additional park specific conditions that may be attached to this permit. Additional conditions regarding the positioning and identification of markers and field equipment may be issued by staff at individual parks.

(15) Access to park and restricted areas - Approval for any activity is contingent on the park being open and staffed for required operations. No entry into restricted areas is allowed unless authorized in additional park specific stipulations attached to this permit.

(16) Notification - The permittee is required to contact the park's Research and Collecting Permit Office (or other offices if indicated in the stipulations associated with this permit) prior to initiating any fieldwork authorized by this permit. Ideally this contact should occur at least one week prior to the initial visit to the park.

(17) Expiration date - Permits expire on the date listed. Nothing in this permit shall be construed as granting any exclusive research privileges or automatic right to continue, extend, or renew this or any other line of research under new permit(s).

(18) Other stipulations - This permit includes by reference all stipulations listed in the application materials or in additional attachments to this permit provided by the superintendent or a designee. Breach of any of the terms of this permit will be grounds for revocation of this permit and denial of future permits.

**Summary of permitted field methods and activities:**  
 provide land based surveys using Trimble R8/R10 dual frequency GNSS receivers beginning at the landward toe of the Primary Dune and extend out to the surf zone at wading depth (wading will occur at low tide). Land survey crews will have survey-grade GNSS receivers mounted on fixed height rover poles that are equipped with topo shoes (flat rod tips that do not sink into the sand). The data collectors are clamped onto the pole; the systems is lightweight and ideal for one person. To move up and down the beach efficiently, side by side utility vehicles (Kawasaki Mule) will be used. Crew trucks are painted with the McKim and Creed company logo, field crews wear highly visible orange/yellow shirts and vests. Hydrographic surveys will collect data from -30 ft NAVD88 to the surf zone (during high tide cycle) to achieve overlapping data as weather/sea conditions allow. Our survey vessels range from 22' to 28' in length and are equipped with inertial navigations systems that include survey grade dual frequency sonar, IMU, VRS RTK GNSS and sound velocity probes, all of which compensate for heave, pitch, roll, heading and the speed of sound, to calculate position and depth.

**Recommended by park staff(name and title):** **MEAGHAN JOHNSON**  
Digitally signed by MEAGHAN JOHNSON  
 Date: 2024.07.09  
 07:54:03 -0400

**Reviewed by Collections Manager:**

Yes  No

**Approved by park official:**

**Date Approved:**

# 2024 Nag's Head Annual Beach Monitoring Data Acquisition Survey Report

**ROBIN SNYDER** Digitally signed by ROBIN SNYDER  
Date: 2024.07.09 08:21:39 -0400

**Title:**

Deputy Superintendent

**I Agree To All Conditions And Restrictions Of this Permit As Specified**  
(Not valid unless signed and dated by the principal investigator)

(Principal investigator's signature)

(Date)

**THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)**

## 2024 Nag's Head Annual Beach Monitoring Data Acquisition Survey Report

**GENERAL CONDITIONS  
For  
SCIENTIFIC RESEARCH AND COLLECTING  
PERMIT**

United States Department of the Interior  
National Park Service

1. **Authority** - The permittee is granted privileges covered under this permit subject to the supervision of the superintendent or a designee, and shall comply with all applicable laws and regulations of the National Park System area and other federal and state laws. A National Park Service (NPS) representative may accompany the permittee in the field to ensure compliance with regulations.
2. **Responsibility** - The permittee is responsible for ensuring that all persons working on the project adhere to permit conditions and applicable NPS regulations.
3. **False information** - The permittee is prohibited from giving false information that is used to issue this permit. To do so will be considered a breach of conditions and be grounds for revocation of this permit and other applicable penalties.
4. **Assignment** - This permit may not be transferred or assigned. Additional investigators and field assistants are to be coordinated by the person(s) named in the permit and should carry a copy of the permit while they are working in the park. The principal investigator shall notify the park's Research and Collecting Permit Office when there are desired changes in the approved study protocols or methods, changes in the affiliation or status of the principal investigator, or modification of the name of any project member.
5. **Revocation** - This permit may be terminated for breach of any condition. The permittee may consult with the appropriate NPS Regional Science Advisor to clarify issues resulting in a revoked permit and the potential for reinstatement by the park superintendent or a designee.
6. **Collection of specimens (including materials)** - No specimens (including materials) may be collected unless authorized on the Scientific Research and Collecting permit.

The general conditions for specimen collections are:

- Collection of archeological materials without a valid Federal Archeology Permit is prohibited.
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- New specimens must be reported to the NPS annually or more frequently if required by the park issuing the permit. Minimum information for annual reporting includes specimen classification, number of specimens collected, location collected, specimen status (e.g., herbarium sheet, preserved in alcohol / formalin, tanned and mounted, dried and boxed, etc.), and current location.
- Collected specimens that are not consumed in analysis or discarded after scientific analysis remain federal property. The NPS reserves the right to designate the repositories of all specimens removed from the park and to approve or restrict reassignment of specimens from one repository to another. Because specimens are Federal property, they shall not be destroyed or discarded without prior NPS authorization.
- Each specimen (or groups of specimens labeled as a group) that is retained permanently must bear NPS labels and must be accessioned and cataloged in the NPS National Catalog. Unless exempted by additional park - specific stipulations, the permittee will complete the labels and catalog records and will provide accession information. It is the permittee's responsibility to contact the park for cataloging instructions and specimen labels as well as instructions on repository designation for the specimens.
- Collected specimens may be used for scientific or educational purposes only, and shall be dedicated to public benefit and be accessible to the public in accordance with NPS policies and procedures.
- Any specimens collected under this permit, any components of any specimens (including but not limited to natural organisms, enzymes or other bioactive molecules, genetic materials, or seeds), and research results derived from collected specimens are to be used for

## 2024 Nag's Head Annual Beach Monitoring Data Acquisition Survey Report

scientific or educational purposes only, and may not be used for commercial or other revenue - generating purposes unless the permittee has entered into a Cooperative Research And Development Agreement (CRADA) or other approved benefit - sharing agreement with the NPS. The sale of collected research specimens or other unauthorized transfers to third parties is prohibited. Furthermore, if the permittee sells or otherwise transfers collected specimens, any components thereof, or any products or research results developed from such specimens or their components without a CRADA or other approved benefit-sharing agreement with NPS, permittee will pay the NPS a royalty rate of twenty percent (20 %) of gross revenue from such sales or other revenues. In addition to such royalty, the NPS may seek other damages to which the NPS may be entitled including but not limited to injunctive relief against the permittee.

**7. Reports** - - The permittee is required to submit an Investigator's Annual Report and copies of final reports, publications, and other materials resulting from the study. Instructions for how and when to submit an annual report will be provided by NPS staff. Park research coordinators will analyze study proposals to determine whether copies of field notes, databases, maps, photos, and / or other materials may also be requested. The permittee is responsible for the content of reports and data provided to the National Park Service

**8. Confidentiality** - - The permittee agrees to keep the specific location of sensitive park resources confidential. Sensitive resources include threatened species, endangered species, and rare species, archeological sites, caves, fossil sites, minerals, commercially valuable resources, and sacred ceremonial sites.

**9. Methods of travel** - Travel within the park is restricted to only those methods that are available to the general public unless otherwise specified in additional stipulations associated with this permit.

**10. Other permits** - The permittee must obtain all other required permit(s) to conduct the specified project.

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**17. Expiration date** - Permits expire on the date listed. Nothing in this permit shall be construed as granting any exclusive research privileges or automatic right to continue, extend, or renew this or any other line of research under new permit(s).

**18. Other stipulations** - This permit includes by reference all stipulations listed in the application materials or in additional attachments to this permit provided by the superintendent or a designee. Breach of any of the terms of this permit will be grounds for revocation of this permit and denial of future permits.



2023 Nags Head Beach Monitoring Data Acquisition Survey Report

# **2023 Town of Nags Head Data Acquisition Survey Report**

**Dare County, North Carolina**

Prepared for:

Town of Nags Head  
PO Box 99  
Nags Head, NC 27959

Prepared by:

McKim & Creed, Inc.  
243 North Front Street  
Wilmington, NC 28401



2023 Nags Head Beach Monitoring Data Acquisition Survey Report

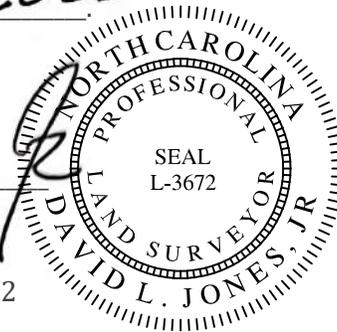
I, David L. Jones Jr., NC-PLS L-3672, certify that this project was completed under my direct and responsible charge from an actual survey made under my supervision; that this hydrographic and topographic survey was performed at the 95% percent confidence level to meet Federal Geographic Data Committee Standards; that this survey was performed to meet the requirements for a topographic/planimetric survey to the accuracy of Class III and vertical accuracy to the Class III standard, and that the original data was obtained on 11 June 2023; 01 July 2023; and all coordinates are based on North Carolina State Plane Coordinates (NAD83 2011) and all elevations are based on North American Vertical Datum of 1988 (NAVD88).

THIS 31<sup>st</sup> DAY OF July, AD 2023.

*David L. Jones*

DAVID L. JONES, JR.

PROFESSIONAL LAND SURVEYOR L-3672





## INTRODUCTION

### General scope of work

The work under the Task Order shall consist of performing topographic and hydrographic surveys along 174 beach profile lines in the City of Nags Head.

### Survey area

The study area starts on the North between the Town of Nags Head and Kill Devil Hills and ends South at Oregon Inlet. This area has total linear distance of approximately 18 statute miles.

### Planning

On June 5<sup>th</sup>, 2023, McKim & Creed Field Manager held a meeting with field and office crews to discuss the scope of work entailing the 173 beach monitoring profiles survey to be conducted in Dare County, North Carolina. In the two weeks prior to the meeting, preparations started to get the boat ready, arrange accommodations, create HYPACK project, gather control point information, line files, etc.

## FIELD METHODOLOGY

The surveys were conducted in accordance with the Minimum Performance Standards for the U.S. Army Corps of Engineers (USACE), Engineering and Design Hydrographic Surveying Manual (EM 1110-2-1003).

This survey is in accordance with Chapter 56.1606 of the North Carolina Administrative Code (NCAC) specifications established by The North Carolina Engineering and Land Surveying Act (GS89C). In addition, all hydrographic surveying was conducted under the direct supervision of an NSPS-THSOA Certified Hydrographer (CH). Included in the deliverables are 61 cross-section profiles; one (1) plan view map; ground photos in .jpeg; one processed easting, northing, and elevation (xyz) in ASCII file format; and field notes. The plan view maps show reduced true position elevation data collected during the survey, and the location of published control monuments.

Vertical data was collected in the North American Vertical Datum of 1988 (NAVD88) using geoid 18. All Horizontal data is provided in the North Carolina State Plane Coordinate System, North American Datum (NAD) of 1983(2011).



The field survey and data collection activities encompassed four (4) phases. Brief descriptions of each survey phase, including methodologies and quality control/quality assurance procedures, are described below.

## Control Reconnaissance/Establishment/Verification

Prior to surveying beach profiles, reconnaissance of the monuments was conducted to confirm that survey control was in place and undisturbed. Real Time Kinematic Global Positioning System (RTK GNSS) was used within the North Carolina virtual reference station (NCVRS) network to locate and confirm survey control for this project using a 3-minute observation at each monument (Table 1,2, and 3). The horizontal and vertical accuracy of control data meets the accuracy requirements as set forth in the Engineering and Design Hydrographic Surveying Manual (EM 1110-2-1003). To achieve required accuracy, the surveys were controlled using 2nd order monuments, specifically W 168 and CAHA 2, both from the National Geodetic Survey (NGS) (Datasheets can be found in appendix A). Horizontal and vertical positioning checks were conducted at the beginning and end of each day using at least two 2nd order monuments in the project area. The control check shots were acquired using a minimum of five (5) epochs which results in a high accuracy location (Tables 7 and 8).

## Beach Profiles

Upon completion of the control reconnaissance survey, beach/upland and nearshore operations were initiated. Cross-sections of the beach in the project area were surveyed using extended rod RTK GNSS rovers, and standard RTK GNSS rovers. Extended rod RTK GNSS rovers were used to augment RTK GNSS survey capability into the nearshore.

Profiles commenced from the baseline and extended seaward overlapping the nearshore/wade data. Nearshore portions of the profiles were surveyed by two (2) surveyors with an Extended Rod Trimble R8 or R10 RTK GNSS rovers who entered the water wearing Personal Floatation Devices (PFD). The nearshore survey extended seaward to a point overlapping the offshore portion of the profiles.

Elevations were taken at a maximum of twenty-five (25) foot intervals along each profile line and at all grade breaks. To maintain online accuracy, surveyors utilized the RTK GNSS feature stakeout point. Stakeout point allows surveyors to maintain the profile azimuth without relying on a survey lathe or conventional compass bearings.



## Nearshore/Offshore Profiles

The Nearshore/Offshore profiles were conducted at each required profile station. The profiles were obtained 2,500 feet beyond the shoreline or to the -30 NAVD88 contour, whichever is more landward. The landward limits of the nearshore profiles were based on a minimum overlap of fifty (50) feet beyond the seaward extent of beach profiles. Soundings were collected at 200kHz with an Odom Echotrac E20 single beam echosounder, hull-mounted transducer on McKim & Creed's twenty-five (25) foot survey vessel, the S/V Cawood. These soundings were then reduced to 9' spacing, sufficient to provide a smooth and accurate depiction of the seafloor.

Data was digitally stored using HYPACK 2022/2023 Software. An Applanix POSMV Inertia Navigation System was used onboard the survey vessel to provide pitch, roll, heave, and tide corrections. Tide (Table 4), echosounder (Table 5), sound velocity (Table 6), and bar checks were performed daily and as needed to check and calibrate the system. To maintain the vessel navigation along the profile lines, HYPACK navigation software was used.

## Data Processing/Submittals

Upon completion of the field work, data was edited using Trimble Business Center, and HYPACK 2022/2023. The upland and nearshore portions of the beach profile were viewed and edited in Trimble Business Center and a comma delimited XYZ file was created. The raw bathymetry digital data was viewed and edited in HYPACK Single Beam Editor. The collected tide data was compared to NOAA measured tide for Duck, NC (NOAA Station ID: 8651370) and corrected as needed. Tide corrected offshore data was exported and a comma delimited XYZ file was created. All overlapping profile data was compared in cross section to ensure system accuracy. The edited beach profile data and offshore profile data were merged to create a representative cross-section for each profile line. The cross-sections were developed using HYPACK Cross-section software.

The final plots were edited and reviewed with comparisons to previous years; discrepancies were noted and resolved. Digital data is provided in the vertical datum NAVD88.

## Map Preparation



2023 Nags Head Beach Monitoring Data Acquisition Survey Report

Upon completion of the surveys and data reduction, the plan view map was prepared in Autodesk Civil 3D. Elevations are displayed in NAVD88 and were sorted for display for better visualization. GIS parcel lines were used for background reference.

## FIELD WORK

Control monuments were recovered on June 11<sup>th</sup>, 2023, and all profile lines were surveyed from June 11<sup>th</sup> to July 1<sup>st</sup>, 2023. The hydrographic survey crew used Oregon Inlet in Nags Head to access the beach profiles. Below is the timeline for the field work:

DATE	ACTIVITIES
06/05/2023	Scope Meeting at the office.
06/10/2023	First mobilization to job site.
06/11/2023	Control points were checked into to ensure horizontal and vertical tolerances were within standard. Land – 430+00 to 525+00
06/12/2023	Survey was performed on lines: Land – 530+00 to 775+00 No hydro or wade was surveyed.
06/13/2023	Survey was performed on lines: Land – 780+00 to 995+00 No hydro or wade was surveyed.
06/14/2023	Survey was performed on lines: Hydro Nearshore – 977+50 to 1025+00 Hydro Offshore – 977+50 to 982+50 Land – 997+50 to 1025+00 Wade – 997+50 to 977+50
06/15/2023	Survey was performed on lines: Hydro Offshore – 927+50 to 1025+00 Wade – 927+50 to 975+00 No land was surveyed.
06/16/2023	First Demobilization from job site
06/26/2023	Second mobilization to job site



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<b>06/27/2023</b>	Survey was performed on lines: Hydro Nearshore – 1030+00 to 1290+00 Hydro Offshore – 1280+00 to 1090+00 Land – 1030+00 to 1200+00 No wade was surveyed.
<b>06/28/2023</b>	Survey was performed on lines: Hydro Offshore – 435+00 to 515+00, and 1030+00 to 1240+00 Hydro Nearshore – 430+00 to 515+00 Land – 430+00 to 460+00, 1030+00 to 1070+00, 1140+00 to 1270+00 Wade – 1030+00 to 1180+00
<b>06/29/2023</b>	Survey was performed on lines: Hydro Offshore – 525+00 to 750+00 Hydro Nearshore – 495+00 to 625+00 Wade – 450+00 to 560+00 No land was surveyed.
<b>06/30/2023</b>	Survey was performed on lines: Hydro Offshore – 925+00 to 755+00 Hydro Nearshore – 630+00 to 925+00 Wade – 565+00 to 760+00 Land Gap Fills – 435+00 to 495+00
<b>07/01/2023</b>	Survey was performed on lines: Wade – 770+00 to 922+50 No land or hydro was surveyed Second demobilization from job site

Special comments:

- Line 872+00 was surveyed instead of line 875+00 due to Jennette’s pier proximity.
- Object in line for land survey on lines: 440+00, 470+00, 500+00, 520+00, 525+00, 545+00, 555+00, 610+00, 670+00, 700+00, 770+00, 620+00, 625+00, 660+00, 780+00, 880+00, 915+00, 987+50, 245+00, 885+00, 890+00, 945+00, 972+50, 1015+00, 1025+00, 490+00.
- Obstructions for hydro: 1025+00 has wooden jetty on line, 525+00 pier in way of line.



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- Could not locate monuments Loggerhead, Brooke and Eden.

**CONTROL**

NAGS HEAD, NC – NGS CONTROL MONUMENTS					
Station	Northing	Easting	Elevation	Comment	Station Description
BREW	823218.51	2997818.79	16.93	NOT FOUND	NOT USED
BROOKE	774768.51	3020429.10	19.38	NOT FOUND	NOT USED
EDEN	799346.34	3009247.87	32.66	NOT ACCESSIBLE	NOT USED
LOGGERHEAD	814705.66	3009247.87	15.49	NOT FOUND	NOT USED
W168	806503.64	3005850.14	7.54	FOUND	GOOD CONDITION AS DESCRIBED
CAHA2	801455.42	3007349.70	4.12	FOUND	GOOD CONDITION AS DESCRIBED
U168	816655.22	3000721.01	6.81	FOUND	OUTSIDE OF VERTICAL TOLERANCE/NOT USED FOR CHECKS

Table 1. List of Control Monuments

Using RTK GNSS, a 3-minute observation was performed for all monuments accessible.

Table 2. 3-minute observation values on NGS control monuments.

Measured			
July 2023 - RTK GPS (NCVRS) - 3 min. Obs.			
Station	Northing	Easting	Elevation
W168	806503.65	3005850.17	7.40
CAHA2	801455.44	3007349.71	4.02
U168	816655.23	3000720.98	6.50

Upon comparing the published NGS control monuments values and the data measured in the field, the variations (deltas) were determined in Table 3.

Table 3. Difference between published and control verification.

Variations from Client Provided Control to McKim & Creed			
Station	Northing	Easting	Elevation
W168	-0.01	-0.03	0.14
CAHA2	-0.02	-0.01	0.10
U168	-0.01	0.03	0.31

## VESSEL CALIBRATIONS

The Survey Vessel Cawood (a 25' safe boat) was used for this survey. Offsets were measured and calculated on May 15<sup>th</sup>, 2023.

Daily vessel calibrations were performed in the survey area:

Table 4. Tide Checks

<b>Tide Checks (in feet)</b>	<b>Trimble Receiver (in elevation)</b>	<b>Vessel System/Hypack</b>
06/14/2023	0.94	-0.95
06/15/2023	0.84	-0.85
06/27/2023	1.25'	-1.23
06/28/2023	0.87	-0.88
06/29/2023	0.62	-0.62
06/30/2023	0.72	-0.72

Table 5. Echosounder Checks using rod reading.

<b>Bar Checks (in feet)</b>	<b>Bar Check</b>	<b>Vessel Echosounder</b>
06/14/2023	25, 20, 15, 10, 5	25, 20, 15, 10, 5
06/15/2023	6.40	6.41
06/27/2023	6.75	6.70
06/28/2023	5.92	5.95
06/29/2023	7.70	7.60
06/30/2023	7.00	7.10

Table 6. Sound Velocity Values

	<b>Average Sound Velocity (in feet/second)</b>
06/14/2023	4962
06/15/2023	4966
06/27/2023	5003
06/28/2023	4990
06/29/2023	4987
06/30/2023	5000

## GPS CALIBRATION CHECKS

Table 7. GNSS calibration checks for Trimble R8 unit.

TRIMBLE R8 UNIT	CONTROL POINT	$\Delta$ Horizontal (in US Survey feet)	$\Delta$ Vertical (in US Survey feet)
06/11/2023 BEGIN	U168	0.041	0.293
06/11/2023 END	U168	0.026	0.264
06/11/2023 END	W168	0.040	0.188
06/11/2023 END	CAHA2	0.024	0.096
06/12/2023 BEGIN	CAHA2	0.043	0.096
06/12/2023 END	W168	0.019	0.089
06/13/2023 BEGIN	W168	0.013	0.096
06/13/2023 END	W168	0.056	0.103
06/14/2023 BEGIN	W168	0.010	0.154
06/14/2023 END	W168	0.048	0.159
06/15/2023 BEGIN	W168	0.025	0.324
06/15/2023 END	W168	0.038	-0.037
06/27/2023 BEGIN	CAHA2	0.039	-0.080
06/27/2023 END	CAHA2	0.021	-0.088
06/28/2023 BEGIN	CAHA2	0.054	-0.027
06/28/2023 END	CAHA2	0.093	-0.178
06/29/2023 BEGIN	W168	0.006	-0.035
06/29/2023 END	W168	0.019	-0.021
06/30/2023 BEGIN	W168	0.306	-0.036
06/30/2023 END	W168	0.089	-0.034

Table 8. GNSS calibration checks for Trimble R10 unit.

TRIMBLE R10 UNIT	CONTROL POINT	$\Delta$ Horizontal (in US Survey feet)	$\Delta$ Vertical (in US Survey feet)
06/11/2023 BEGIN	W168	0.071	0.284
06/11/2023 END	W168	0.048	0.190
06/11/2023 END	CAHA2	0.029	0.115
06/12/2023 BEGIN	CAHA2	0.027	0.105
06/12/2023 END	W168	0.047	0.081
06/13/2023 BEGIN	W168	0.034	0.041
06/13/2023 END	W168	0.022	0.058
06/14/2023 BEGIN	W168	0.036	0.141
06/14/2023 END	W168	0.059	0.190
06/15/2023 BEGIN	W168	0.072	0.183
06/15/2023 END	W168	0.034	-0.010
06/27/2023 BEGIN	CAHA2	0.105	-0.017
06/27/2023 END	NA	NA	NA
06/28/2023 BEGIN	CAHA2	0.020	0.042
06/28/2023 END	NA	NA	NA
06/29/2023 BEGIN	W168	0.074	0.109
06/29/2023 END	W168	0.045	0.005
06/30/2023 BEGIN	W168	0.021	0.062
06/30/2023 END	W168	0.064	0.077
07/01/2023 BEGIN	CAHA2	0.059	-0.065
07/01/2023 END	W168	0.114	-0.112

## LIST OF EQUIPMENT USED DURING THE SURVEY

Below is a list of equipment used during the survey:

- 25' Survey Vessel "Cawood"
- Teledyne ECHOTRAC E20 transducer 200 kHz
- Applanix Pos-MV Inertia Navigation System I2NS
- Sound Velocity Profiler AML CTD Base X Profiler
- Hypack 2022/2023 for hydrographic data collection and processing
- Trimble R8 GNSS Receivers/ TSC3 data collectors
- Trimble R10 GNSS Receivers/ TSC5 data collectors
- Trimble Business Center
- AutoDesk Civil 3D



# APPENDIX A. CONTROL DATASHEETS

## The NGS Data Sheet

See file [dsdata.pdf](#) for more information about the datasheet.

```

PROGRAM = datasheet95, VERSION = 8.12.5.15
Starting Datasheet Retrieval...
1 National Geodetic Survey, Retrieval Date = JULY 25, 2023
EX0112 *****
EX0112 DESIGNATION - W 168
EX0112 PID - EX0112
EX0112 STATE/COUNTY- NC/DARE
EX0112 COUNTRY - US
EX0112 USGS QUAD - ROANOKE ISLAND NE (2019)
EX0112
EX0112 *CURRENT SURVEY CONTROL
EX0112
EX0112* NAD 83(2011) POSITION- 35 55 07.16930(N) 075 36 08.34047(W) ADJUSTED
EX0112* NAD 83(2011) ELLIP HT- -36.679 (meters) (06/27/12) ADJUSTED
EX0112* NAD 83(2011) EPOCH - 2010.00
EX0112* NAVD 88 ORTHO HEIGHT - 2.296 (meters) 7.53 (feet) ADJUSTED
EX0112
EX0112 GEOID HEIGHT - -38.978 (meters) GEOID18
EX0112 NAD 83(2011) X - 1,285,839.762 (meters) COMP
EX0112 NAD 83(2011) Y - -5,008,856.047 (meters) COMP
EX0112 NAD 83(2011) Z - 3,720,864.572 (meters) COMP
EX0112 LAPLACE CORR - 1.37 (seconds) DEFLEC18
EX0112 DYNAMIC HEIGHT - 2.294 (meters) 7.53 (feet) COMP
EX0112 MODELED GRAVITY - 979,770.6 (mgal) NAVD 88
EX0112
EX0112 VERT ORDER - FIRST CLASS II
EX0112
EX0112 Network accuracy estimates per FGDC Geospatial Positioning Accuracy
EX0112 Standards:
EX0112 FGDC (95% conf, cm) Standard deviation (cm) CorrNE
EX0112 Horiz Ellip SD_N SD_E SD_h (unitless)
EX0112 -----
EX0112 NETWORK 0.89 1.10 0.40 0.32 0.56 -0.13113158
EX0112 -----
EX0112 Click here for local accuracies and other accuracy information.
EX0112
EX0112.The horizontal coordinates were established by GPS observations
EX0112.and adjusted by the National Geodetic Survey in June 2012.
EX0112
EX0112.NAD 83(2011) refers to NAD 83 coordinates where the reference frame has
EX0112.been affixed to the stable North American tectonic plate. See
EX0112.NA2011 for more information.
EX0112
EX0112.The horizontal coordinates are valid at the epoch date displayed above
EX0112.which is a decimal equivalence of Year/Month/Day.
EX0112
EX0112.The orthometric height was determined by differential leveling and
EX0112.adjusted by the NATIONAL GEODETIC SURVEY
EX0112.in June 1991.
EX0112
EX0112.Significant digits in the geoid height do not necessarily reflect accuracy.
EX0112.GEOID18 height accuracy estimate available here.
EX0112
EX0112.Click photographs - Photos may exist for this station.
EX0112
EX0112.The X, Y, and Z were computed from the position and the ellipsoidal ht.
EX0112
EX0112.The Laplace correction was computed from DEFLEC18 derived deflections.

```



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EX0112.The dynamic height is computed by dividing the NAVD 88  
EX0112.geopotential number by the normal gravity value computed on the  
EX0112.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45  
EX0112.degrees latitude (g = 980.6199 gals.).  
EX0112  
EX0112.The modeled gravity was interpolated from observed gravity values.  
EX0112  
EX0112. The following values were computed from the NAD 83(2011) position.  
EX0112  
EX0112;  

	North	East	Units	Scale Factor	Converg.
EX0112;SPC NC	- 245,822.802	916,184.955	MT	0.99994021	+1 57 39.8
EX0112;SPC NC	- 806,503.64	3,005,850.14	sFT	0.99994021	+1 57 39.8
EX0112;UTM 18	- 3,975,094.077	445,658.612	MT	0.99963639	-0 21 12.1

EX0112  
EX0112!  

EX0112!SPC NC	-	1.00000576	x	0.99994021	=	0.99994597
EX0112!UTM 18	-	1.00000576	x	0.99963639	=	0.99964214

EX0112  
EX0112:  

	Primary Azimuth Mark	Grid Az
EX0112:SPC NC	- E 255	333 26 37.1
EX0112:UTM 18	- E 255	335 45 29.0

EX0112  
EX0112\_U.S. NATIONAL GRID SPATIAL ADDRESS: 18SVE4565875094(NAD 83)  
EX0112  
EX0112  

PID	Reference Object	Distance	Geod. Az
			ddmmss.s
EX0112	EX0289 E 255	434.500 METERS	3352416.9

EX0112  
EX0112  

SUPERSEDED SURVEY CONTROL

EX0112  

EX0112	NAD 83(2007)-	35 55 07.16915(N)	075 36 08.34140(W)	AD(2002.00)	1
EX0112	ELLIP H (03/05/08)	-36.651 (m)		GP(2002.00)	4 2
EX0112	NAD 83(2001)-	35 55 07.16963(N)	075 36 08.33999(W)	AD( )	2
EX0112	NAD 83(1986)-	35 55 07.18952(N)	075 36 08.34906(W)	AD( )	2
EX0112	NAD 27	- 35 55 06.57010(N)	075 36 09.73001(W)	AD( )	2
EX0112	NAVD 88	2.30 (m)	7.5 (f)	LEVELING	3
EX0112	NGVD 29	2.59 (m)	8.5 (f)	LEVELING	3
EX0112	NGVD 29 (11/26/84)	2.593 (m)	8.51 (f)	ADJUSTED	1 2

EX0112  
EX0112.Superseded values are not recommended for survey control.  
EX0112  
EX0112.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.  
EX0112.See file [dsdata.pdf](#) to determine how the superseded data were derived.  
EX0112  
EX0112\_MARKER: DB = BENCH MARK DISK  
EX0112\_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT  
EX0112\_STAMPING: W 168 1963  
EX0112\_MARK LOGO: CGS  
EX0112\_PROJECTION: PROJECTING 25 CENTIMETERS  
EX0112\_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO  
EX0112+STABILITY: SURFACE MOTION  
EX0112\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR  
EX0112+SATELLITE: SATELLITE OBSERVATIONS - October 07, 2020  
EX0112  

HISTORY	- Date	Condition	Report By
EX0112	- 1963	MONUMENTED	CGS
EX0112	- 1974	GOOD	NGS
EX0112	- 1974	GOOD	NGS
EX0112	- 1981	GOOD	NGS
EX0112	- 1990	GOOD	USPSQD
EX0112	- 20051001	GOOD	GEOCAC
EX0112	- 20051027	GOOD	NCGS
EX0112	- 20061126	GOOD	GEOCAC
EX0112	- 20100801	GOOD	NGS



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EX0112'STATION MARK IS A STANDARD USC AND GS BENCH MARK DISK STAMPED  
EX0112'W-168 1963, SET IN THE TOP OF A CONCRETE CYLINDER, THE TOP OF  
EX0112'WHICH IS PROJECTING 2 INCHES ABOVE THE GROUND.  
EX0112'  
EX0112'MARK IS 29.0 FT ENE OF C/L OF U.S. 158 BUSINESS  
EX0112'  
EX0112'14.4 FT SSE OF C/L OF CONCRETE DRIVEWAY  
EX0112'  
EX0112'2.9 FT SSW OF NORTHERNMOST FENCE CORNER  
EX0112'  
EX0112'66.5 FT ESE OF FIRE HYDRANT TOP  
EX0112'  
EX0112'2.5 FT NNW OF WOODEN WITNESS POST  
EX0112  
EX0112 STATION RECOVERY (1974)  
EX0112  
EX0112'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1974  
EX0112'RECOVERED IN GOOD CONDITION.  
EX0112  
EX0112 STATION RECOVERY (1981)  
EX0112  
EX0112'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1981  
EX0112'1.4 KILOMETERS (0.9 MILE) NORTH ALONG U.S. HIGHWAY 158 BUSINESS FROM  
EX0112'ITS JUNCTION WITH U.S. HIGHWAYS 64, 264 AND STATE HIGHWAY 12 IN NAGS  
EX0112'HEAD, TO THE MARK ON THE RIGHT, ON THE SOUTH SIDE OF THE CONCRETE  
EX0112'ENTRANCE DRIVEWAY OF CARE FREE COTTAGES, 8.83 METERS (29.0 FEET) EAST  
EX0112'OF THE CENTER LINE OF THE HIGHWAY, 1.40 METERS (4.6 FEET) SOUTH OF THE  
EX0112'SOUTH EDGE OF THE CONCRETE ENTRANCE DRIVEWAY OF CARE FREE COTTAGES,  
EX0112'0.30 METER (1.0 FOOT) WEST OF A WOODEN FENCE.  
EX0112'THE MARK IS 1.52 METERS NW FROM A WITNESS POST.  
EX0112'THE MARK IS 0.18 M ABOVE HIGHWAY.  
EX0112  
EX0112 STATION RECOVERY (1990)  
EX0112  
EX0112'RECOVERY NOTE BY US POWER SQUADRON 1990 (PEM)  
EX0112'RECOVERED IN GOOD CONDITION.  
EX0112  
EX0112 STATION RECOVERY (2005)  
EX0112  
EX0112'RECOVERY NOTE BY GEOCACHING 2005 (LWB)  
EX0112'FOUND IN GOOD CONDITION NEAR A FENCE CORNER. CARE FREE COTTAGES HAS  
EX0112'NO SIGN, AND IS LOOKING PRETTY SAD. MARK IS SSE OF THE FIRST COLONY  
EX0112'INN ACROSS THE STREET.  
EX0112  
EX0112 STATION RECOVERY (2005)  
EX0112  
EX0112'RECOVERY NOTE BY NORTH CAROLINA GEODETIC SURVEY 2005 (EJH)  
EX0112'RECOVERED IN GOOD CONDITION WITH THE FOLLOWING CORRECTION, MARK IS  
EX0112'PROJECTING 10 INCHES (25 CM) ABOVE THE GROUND.  
EX0112  
EX0112 STATION RECOVERY (2006)  
EX0112  
EX0112'RECOVERY NOTE BY GEOCACHING 2006 (DEB)  
EX0112'RECOVERED IN GOOD CONDITION.  
EX0112  
EX0112 STATION RECOVERY (2010)  
EX0112  
EX0112'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2010 (DRD)  
EX0112'RECOVERED IN GOOD CONDITION.  
EX0112  
EX0112 STATION RECOVERY (2020)  
EX0112  
EX0112'RECOVERY NOTE BY US POWER SQUADRON 2020 (CAC)  
EX0112'RECOVERED IN GOOD CONDITION.



# The NGS Data Sheet

See file [dsdata.pdf](#) for more information about the datasheet.

PROGRAM = datasheet95, VERSION = 8.12.5.15

Starting Datasheet Retrieval...

1 National Geodetic Survey, Retrieval Date = JULY 25, 2023

DN6292 \*\*\*\*\*

DN6292 HT\_MOD - This is a Height Modernization Survey Station.

DN6292 DESIGNATION - CAHA 2

DN6292 PID - DN6292

DN6292 STATE/COUNTY- NC/DARE

DN6292 COUNTRY - US

DN6292 USGS QUAD - ROANOKE ISLAND NE (2019)

DN6292

\*CURRENT SURVEY CONTROL

DN6292

DN6292\* NAD 83(2011) POSITION- 35 54 16.76469(N) 075 35 52.22233(W) ADJUSTED

DN6292\* NAD 83(2011) ELLIP HT- -37.723 (meters) (06/27/12) ADJUSTED

DN6292\* NAD 83(2011) EPOCH - 2010.00

DN6292\* NAVD 88 ORTHO HEIGHT - 1.28 (meters) 4.2 (feet) GPS OBS

DN6292

DN6292 NAVD 88 orthometric height was determined with geoid model GEOID09

DN6292 GEOID HEIGHT - -38.953 (meters) GEOID09

DN6292 GEOID HEIGHT - -38.979 (meters) GEOID18

DN6292 NAD 83(2011) X - 1,286,457.595 (meters) COMP

DN6292 NAD 83(2011) Y - -5,009,637.305 (meters) COMP

DN6292 NAD 83(2011) Z - 3,719,605.716 (meters) COMP

DN6292 LAPLACE CORR - 1.33 (seconds) DEFLEC18

DN6292

DN6292 Network accuracy estimates per FGDC Geospatial Positioning Accuracy

DN6292 Standards:

DN6292 FGDC (95% conf, cm) Standard deviation (cm) CorrNE

DN6292 Horiz Ellip SD\_N SD\_E SD\_h (unitless)

DN6292 -----

DN6292 NETWORK 0.89 1.04 0.40 0.31 0.53 -0.22594700

DN6292 -----

DN6292 Click [here](#) for local accuracies and other accuracy information.

DN6292

DN6292.The horizontal coordinates were established by GPS observations

DN6292.and adjusted by the National Geodetic Survey in June 2012.

DN6292

DN6292.NAD 83(2011) refers to NAD 83 coordinates where the reference frame has

DN6292.been affixed to the stable North American tectonic plate. See

DN6292.[NA2011](#) for more information.

DN6292

DN6292.The horizontal coordinates are valid at the epoch date displayed above

DN6292.which is a decimal equivalence of Year/Month/Day.

DN6292

DN6292.The orthometric height was determined by GPS observations and a

DN6292.high-resolution geoid model using precise GPS observation and

DN6292.processing techniques.

DN6292

DN6292.Significant digits in the geoid height do not necessarily reflect accuracy.

DN6292.GEOID18 height accuracy estimate available [here](#).

DN6292

DN6292.Click [photographs](#) - Photos may exist for this station.

DN6292

DN6292.The X, Y, and Z were computed from the position and the ellipsoidal ht.

DN6292

DN6292.The Laplace correction was computed from DEFLEC18 derived deflections.

DN6292

DN6292.The ellipsoidal height was determined by GPS observations



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DN6292.The ellipsoidal height was determined by GPS observations  
DN6292.and is referenced to NAD 83.

DN6292

DN6292. The following values were computed from the NAD 83(2011) position.

DN6292

DN6292;		North	East	Units	Scale Factor	Converg.
DN6292;SPC NC	-	244,284.101	916,642.023	MT	0.99993740	+1 57 49.1
DN6292;SPC NC	-	801,455.42	3,007,349.70	sFT	0.99993740	+1 57 49.1
DN6292;UTM 18	-	3,973,538.645	446,053.053	MT	0.99963586	-0 21 02.2

DN6292

DN6292! - Elev Factor x Scale Factor = Combined Factor

DN6292!SPC NC - 1.00000592 x 0.99993740 = 0.99994332

DN6292!UTM 18 - 1.00000592 x 0.99963586 = 0.99964178

DN6292

DN6292\_U.S. NATIONAL GRID SPATIAL ADDRESS: 18SVE4605373538(NAD 83)

DN6292

SUPERSEDED SURVEY CONTROL

DN6292

DN6292 NAD 83(2007)- 35 54 16.76468(N) 075 35 52.22336(W) AD(2002.00) 1

DN6292 ELLIP H (02/27/12) -37.703 (m) GP(2002.00) 3 1

DN6292

DN6292.Superseded values are not recommended for survey control.

DN6292

DN6292.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

DN6292.See file [dsdata.pdf](#) to determine how the superseded data were derived.

DN6292

DN6292\_MARKER: F = FLANGE-ENCASED ROD

DN6292\_SETTING: 59 = STAINLESS STEEL ROD IN SLEEVE (10 FT.+)

DN6292\_STAMPING: CAHA 2 2010

DN6292\_MARK LOGO: NPS

DN6292\_PROJECTION: RECESSED 3 CENTIMETERS

DN6292\_MAGNETIC: T = STEEL SPIKE ADJACENT TO MONUMENT

DN6292\_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL

DN6292\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

DN6292+SATELLITE: SATELLITE OBSERVATIONS - October 07, 2020

DN6292\_ROD/PIPE-DEPTH: 30.5 meters

DN6292\_SLEEVE-DEPTH : 0.6 meters

DN6292

DN6292 HISTORY - Date Condition Report By

DN6292 HISTORY - 20100302 MONUMENTED NCGS

DN6292 HISTORY - 20201007 GOOD USPSQD

DN6292

STATION DESCRIPTION

DN6292

DN6292'DESCRIBED BY NORTH CAROLINA GEODETIC SURVEY 2010 (EJH)

DN6292'THE MARK IS LOCATED ABOUT 8.1 MI (13.0 KM) SOUTH-SOUTHEAST OF KILL

DN6292'DEVIL HILLS, 4.0 MI (6.4 KM) EAST OF MANTEO AND 3.9 MI (6.3 KM)

DN6292'SOUTH-SOUTHEAST OF NAGS HEAD.

DN6292'

DN6292'IN WHALEBONE, AT THE NATIONAL PARK SERVICE INFORMATION CENTER. ALONG

DN6292'NC 12 FOR 0.2 MI (0.3 KM) SOUTH FROM THE INTERSECTION WITH US 158, IN

DN6292'WHALEBONE JUNCTION, TO THE NATIONAL PARK SERVICE INFORMATION CENTER

DN6292'AND STATION NEAR FLAG POLE.

DN6292'

DN6292'MARK IS ABOUT LEVEL WITH THE ASPHALT PARKING LOT AND IS RECESSED 1

DN6292'INCH (3 CM) WITH THE GROUND. LOCATED 86.3 FT (26.3 M) WEST OF THE

DN6292'CENTERLINE OF NC 12, 49 FT (14.9 M) EAST OF THE CENTER OF ENTRANCE

DN6292'ROAD, 30.5 FT (9.3 M) NORTH-NORTHEAST OF THE METAL FLAG POLE---AND

DN6292'96.0 FT (29.3 M) NORTH-NORTHWEST OF THE NORTHWEST CORNER OF PORCH OF

DN6292'INFORMATION CENTER.

DN6292

STATION RECOVERY (2020)

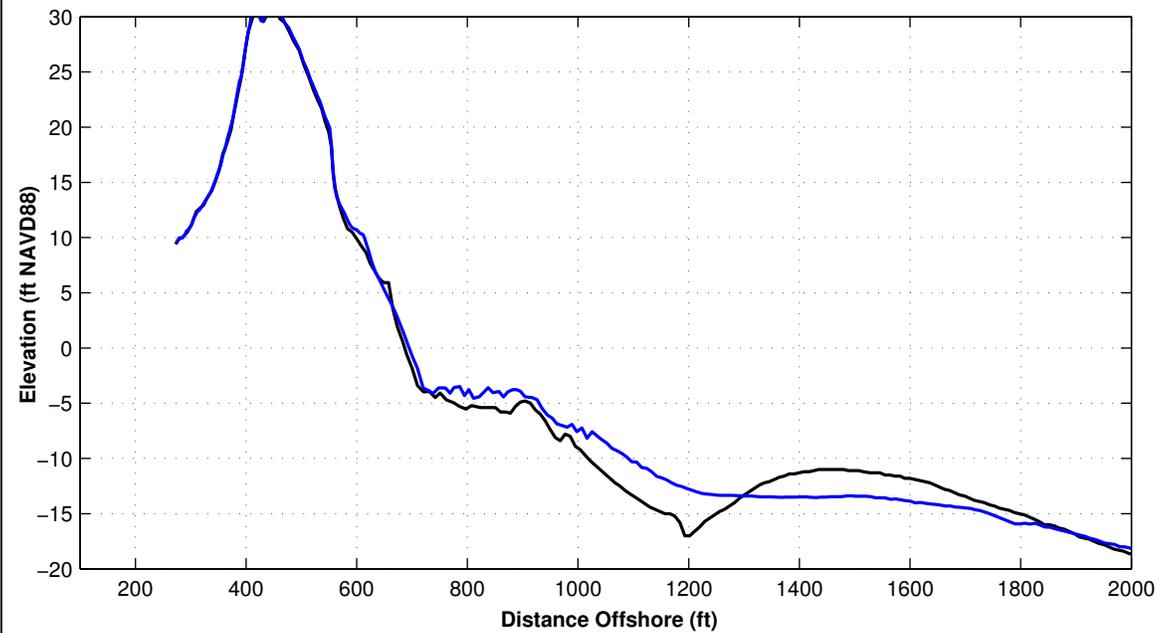
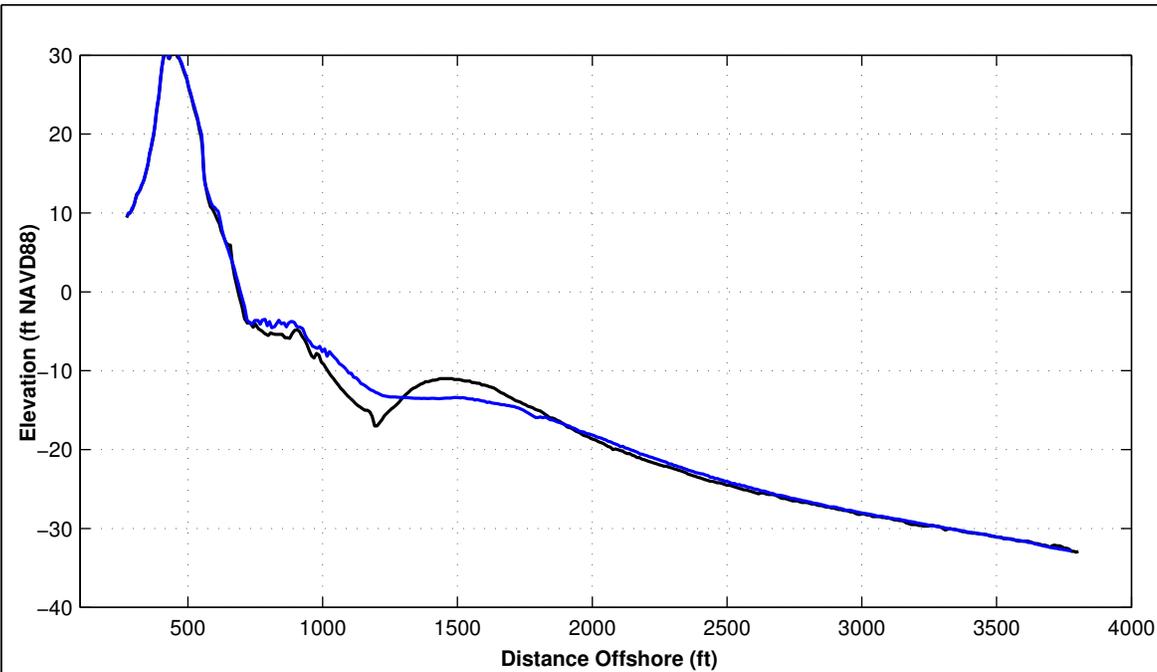
DN6292

DN6292'RECOVERY NOTE BY US POWER SQUADRON 2020 (CAC)

DN6292'RECOVERED IN GOOD CONDITION.

# APPENDIX B SURVEY PROFILE COMPARISON PLOTS





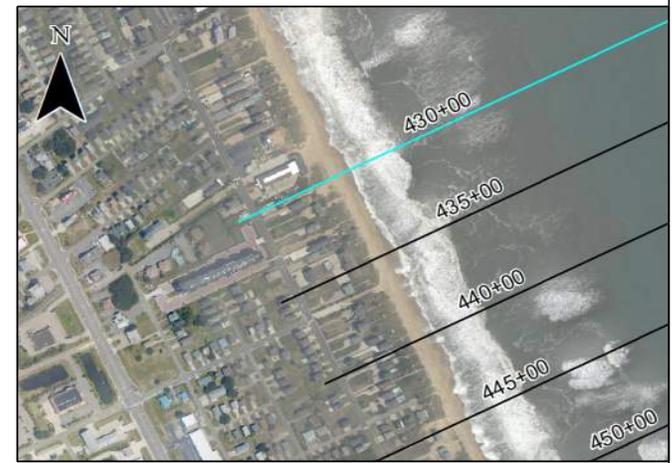
Survey Transect 430+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	62.71 ft	-45.68 ft
Volume Change Above +6 ft NAVD88	5.87 cy/ft	1.85 cy/ft
Volume Change Above 1.18 ft NAVD88	13.96 cy/ft	-5.08 cy/ft
Volume Change Above -6 ft NAVD88	36.59 cy/ft	-24.31 cy/ft
Volume Change Above -14 ft NAVD88	40.06 cy/ft	-27.28 cy/ft
Volume Change Above -19 ft NAVD88	28.16 cy/ft	-18.95 cy/ft
Volume Change Above -30 ft NAVD88	48.16 cy/ft	-31.74 cy/ft

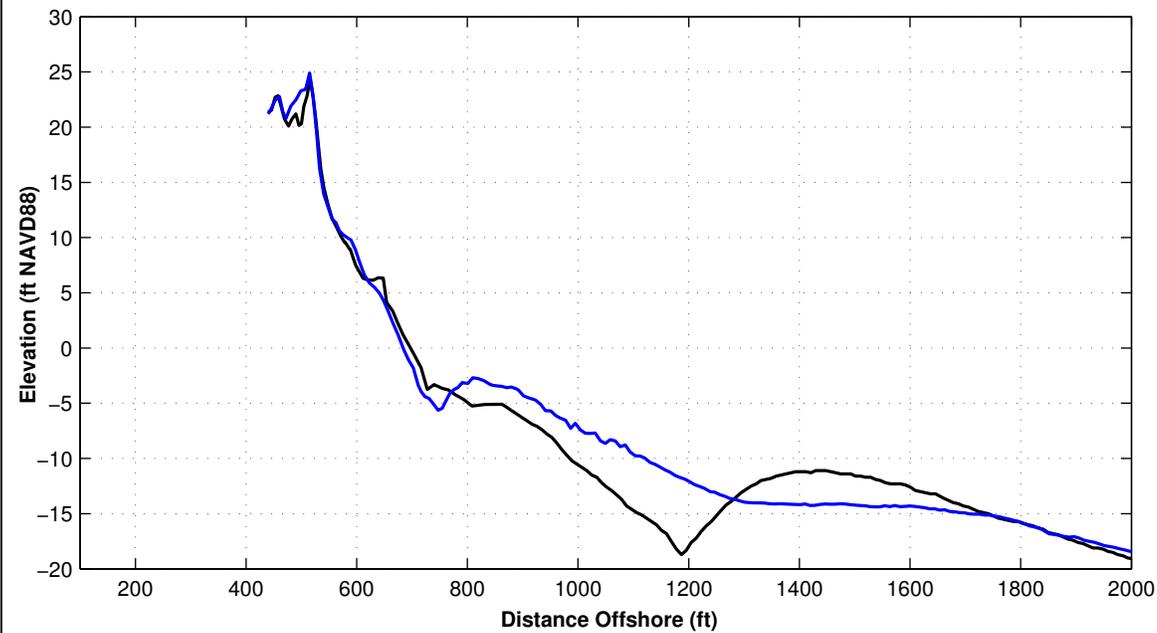
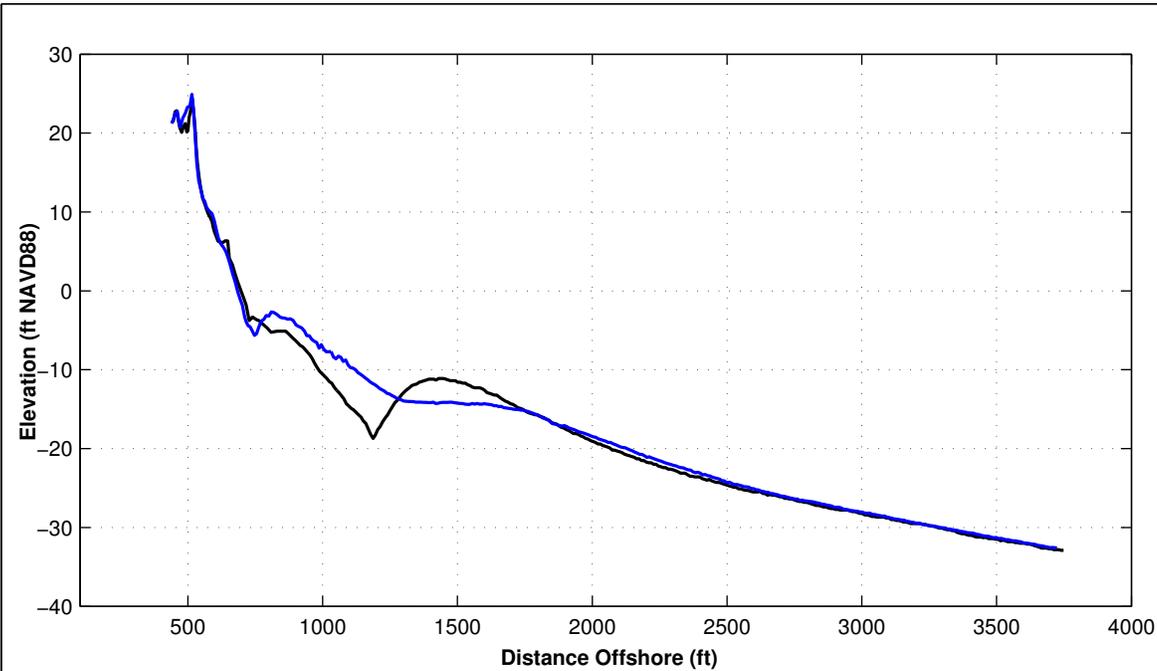
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023

JUNE 2024 ———— OCTOBER 2023

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



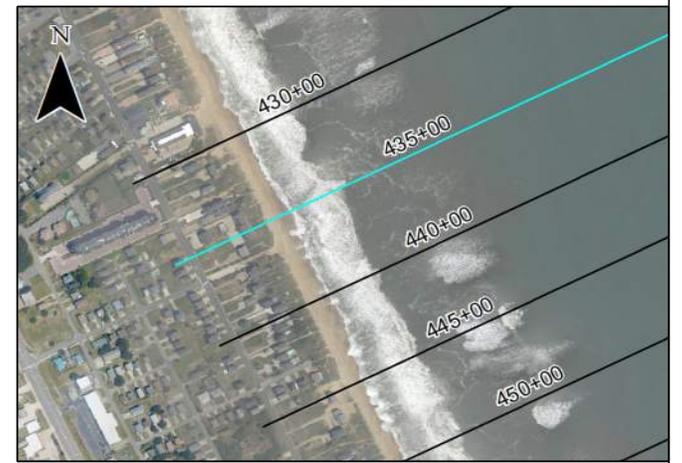


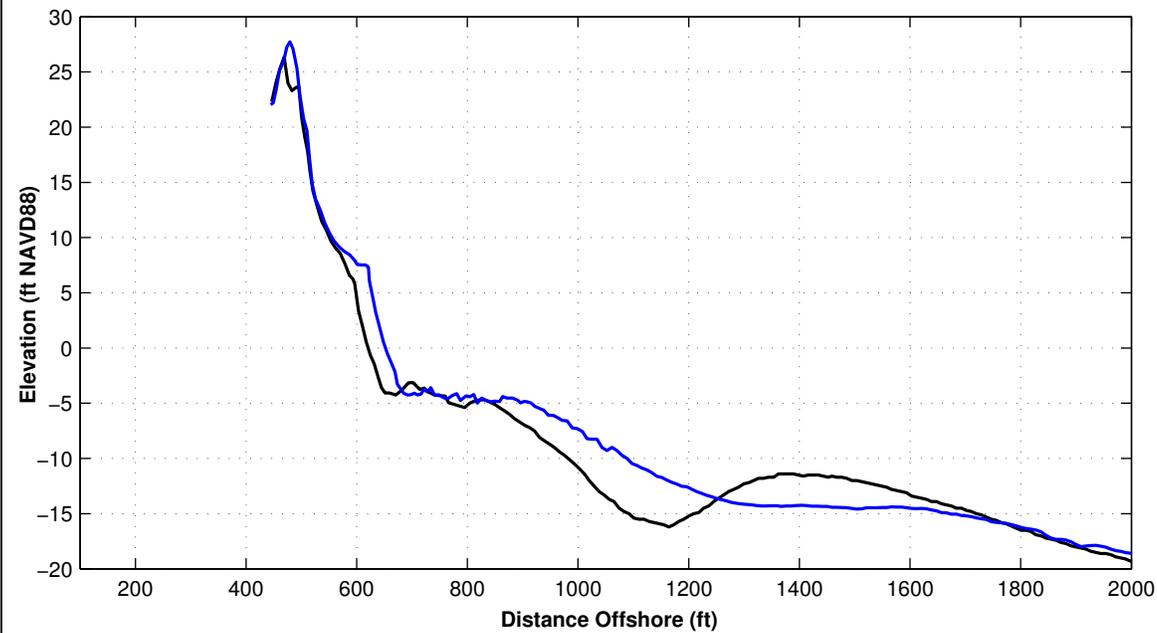
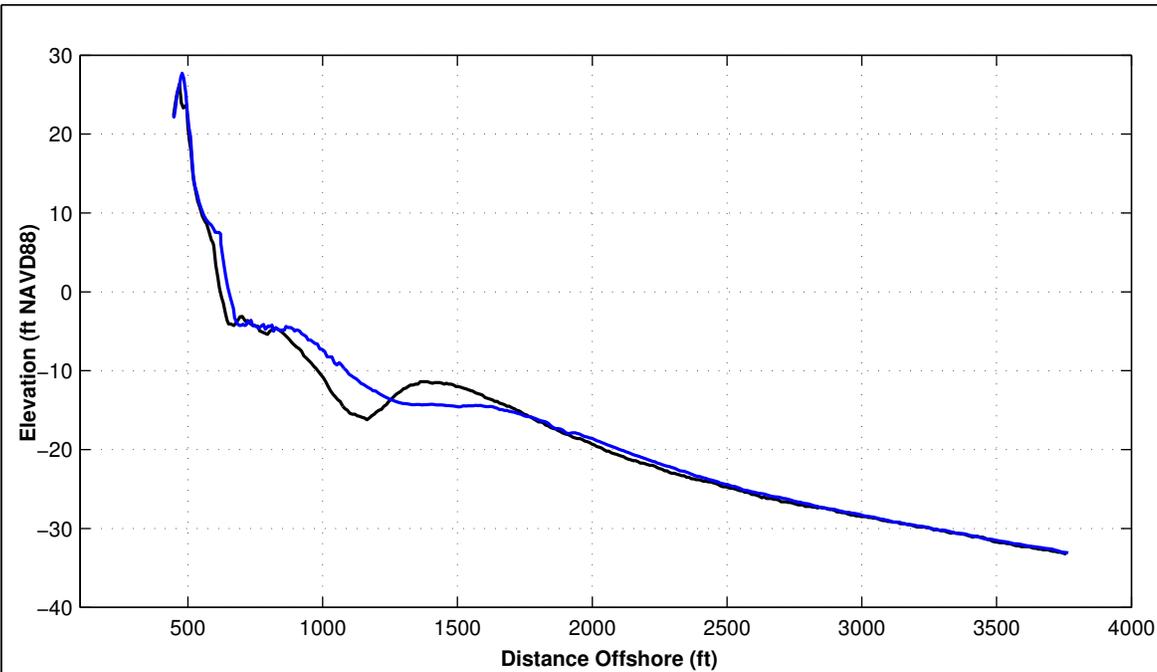
Survey Transect 435+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-24.87 ft	18.28 ft
Volume Change Above +6 ft NAVD88	3.47 cy/ft	0.62 cy/ft
Volume Change Above 1.18 ft NAVD88	1.29 cy/ft	0.63 cy/ft
Volume Change Above -6 ft NAVD88	-10.86 cy/ft	-0.49 cy/ft
Volume Change Above -14 ft NAVD88	0.56 cy/ft	-3.76 cy/ft
Volume Change Above -19 ft NAVD88	-16.74 cy/ft	4.88 cy/ft
Volume Change Above -30 ft NAVD88	1.80 cy/ft	-12.29 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



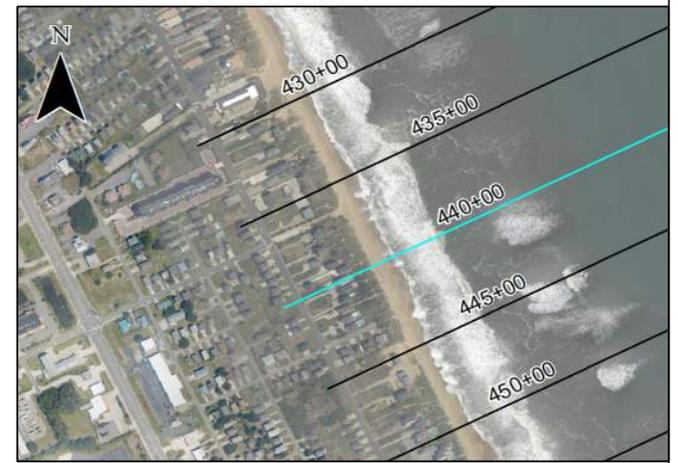


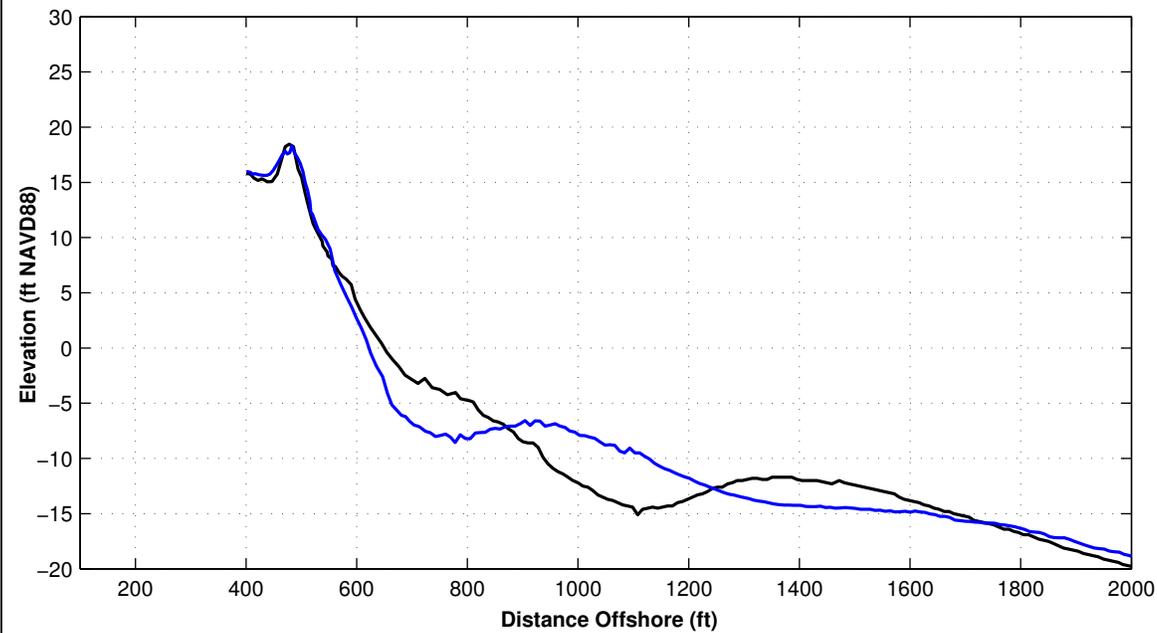
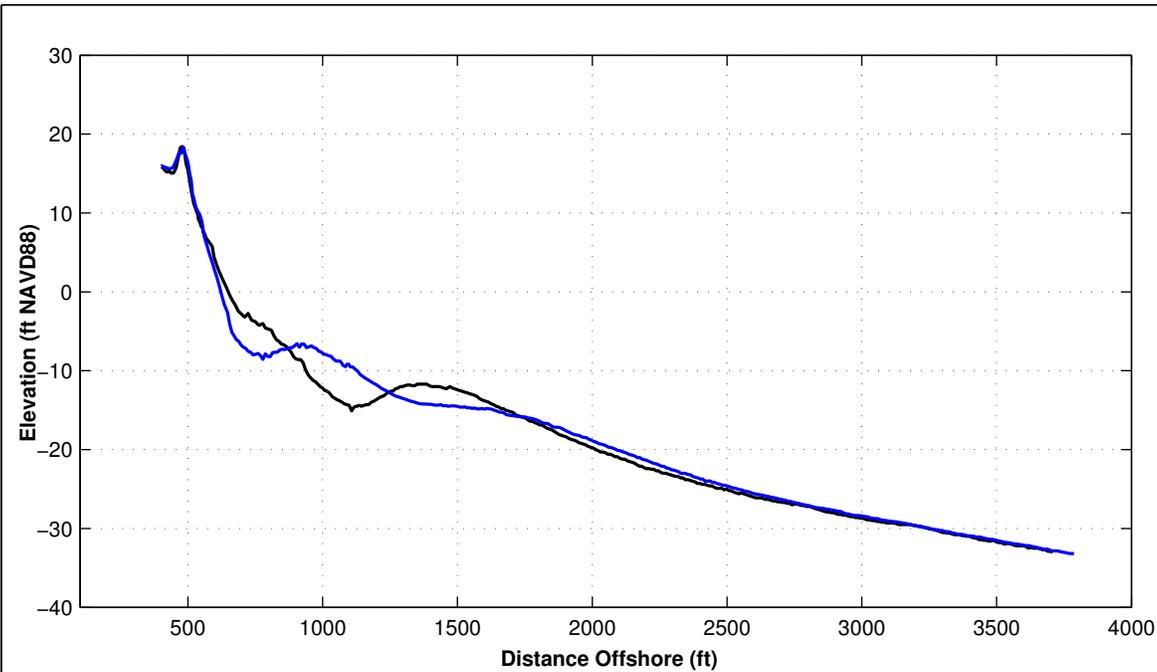
Survey Transect 440+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	22.14 ft	-36.03 ft
Volume Change Above +6 ft NAVD88	2.35 cy/ft	1.57 cy/ft
Volume Change Above 1.18 ft NAVD88	5.20 cy/ft	-3.33 cy/ft
Volume Change Above -6 ft NAVD88	5.54 cy/ft	-3.96 cy/ft
Volume Change Above -14 ft NAVD88	7.30 cy/ft	14.47 cy/ft
Volume Change Above -19 ft NAVD88	-18.20 cy/ft	37.83 cy/ft
Volume Change Above -30 ft NAVD88	-1.22 cy/ft	23.37 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



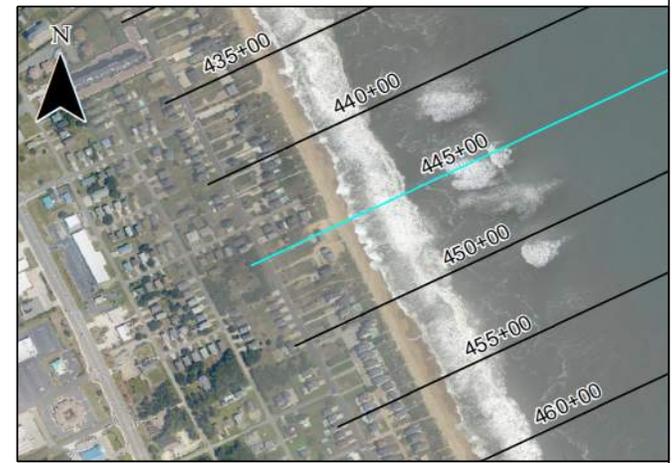


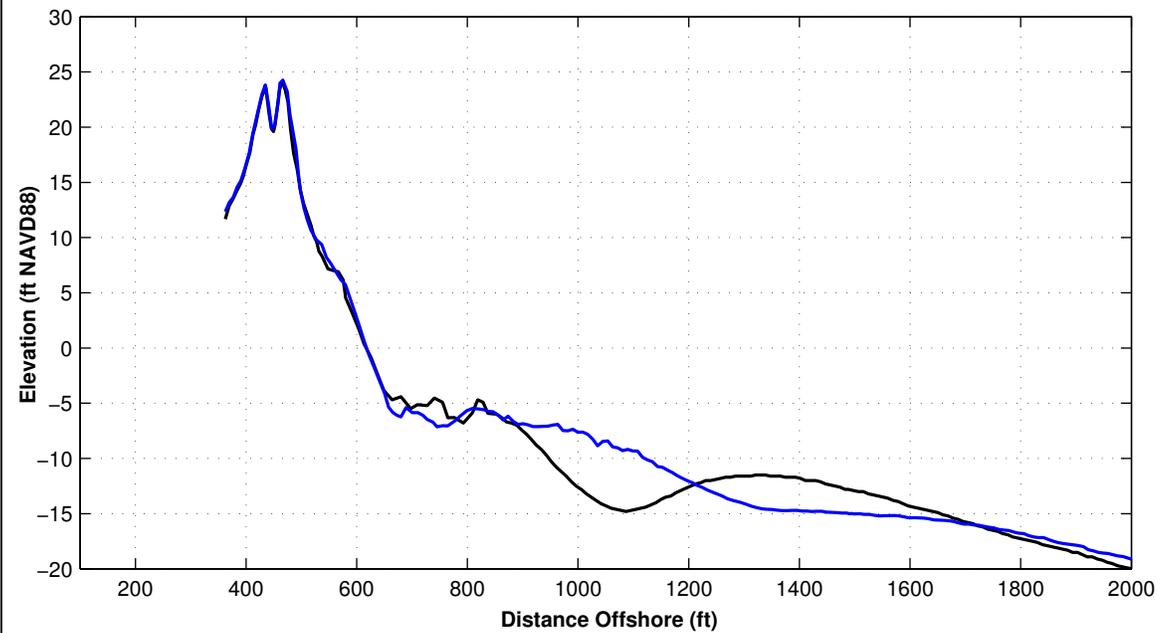
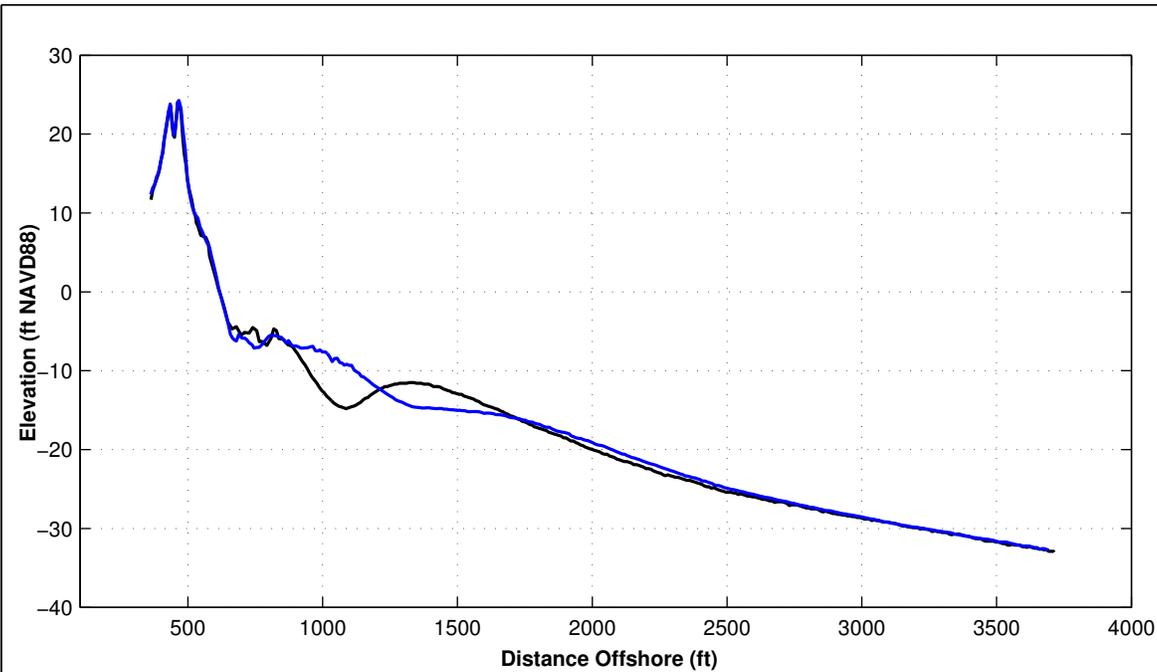
Survey Transect 445+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-49.04 ft	-10.66 ft
Volume Change Above +6 ft NAVD88	0.42 cy/ft	1.39 cy/ft
Volume Change Above 1.18 ft NAVD88	-8.28 cy/ft	-0.56 cy/ft
Volume Change Above -6 ft NAVD88	-19.45 cy/ft	-10.54 cy/ft
Volume Change Above -14 ft NAVD88	-22.99 cy/ft	6.80 cy/ft
Volume Change Above -19 ft NAVD88	-48.51 cy/ft	27.77 cy/ft
Volume Change Above -30 ft NAVD88	-27.44 cy/ft	14.16 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
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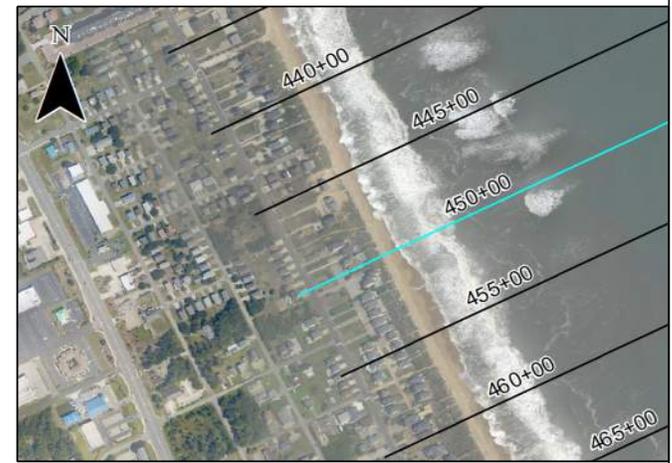


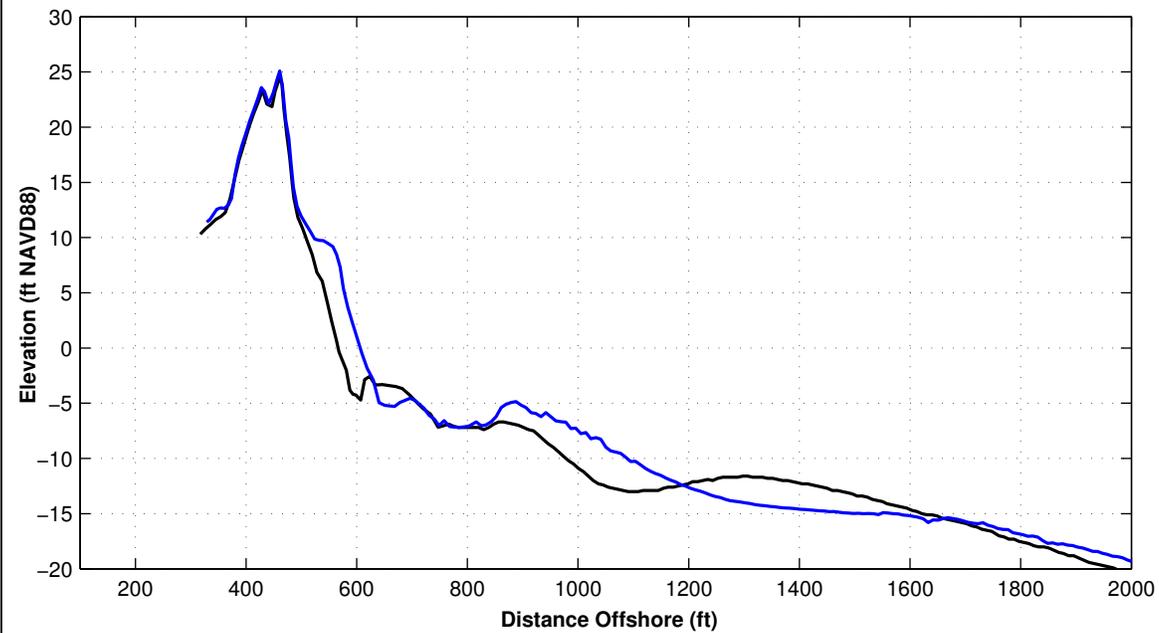
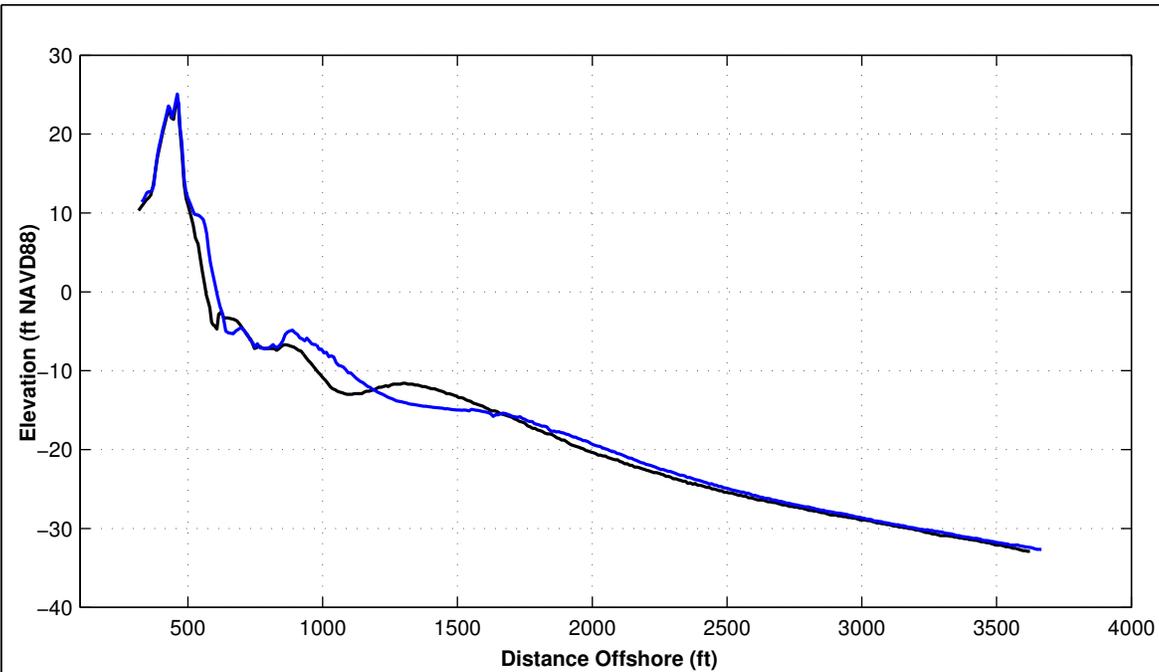
Survey Transect 450+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	38.88 ft	-12.45 ft
Volume Change Above +6 ft NAVD88	-0.86 cy/ft	-4.48 cy/ft
Volume Change Above 1.18 ft NAVD88	4.13 cy/ft	-5.80 cy/ft
Volume Change Above -6 ft NAVD88	7.42 cy/ft	-7.64 cy/ft
Volume Change Above -14 ft NAVD88	9.94 cy/ft	-15.63 cy/ft
Volume Change Above -19 ft NAVD88	-15.15 cy/ft	-2.03 cy/ft
Volume Change Above -30 ft NAVD88	3.64 cy/ft	-12.14 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 — OCTOBER 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





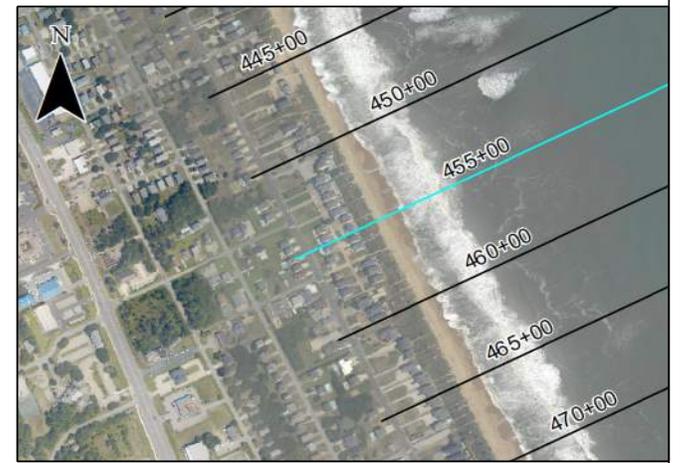
Survey Transect 455+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	8.09 ft	-17.61 ft
Volume Change Above +6 ft NAVD88	1.87 cy/ft	-0.25 cy/ft
Volume Change Above 1.18 ft NAVD88	3.66 cy/ft	-4.35 cy/ft
Volume Change Above -6 ft NAVD88	-6.74 cy/ft	0.71 cy/ft
Volume Change Above -14 ft NAVD88	14.36 cy/ft	-18.98 cy/ft
Volume Change Above -19 ft NAVD88	-19.11 cy/ft	-27.07 cy/ft
Volume Change Above -30 ft NAVD88	-5.99 cy/ft	-41.09 cy/ft

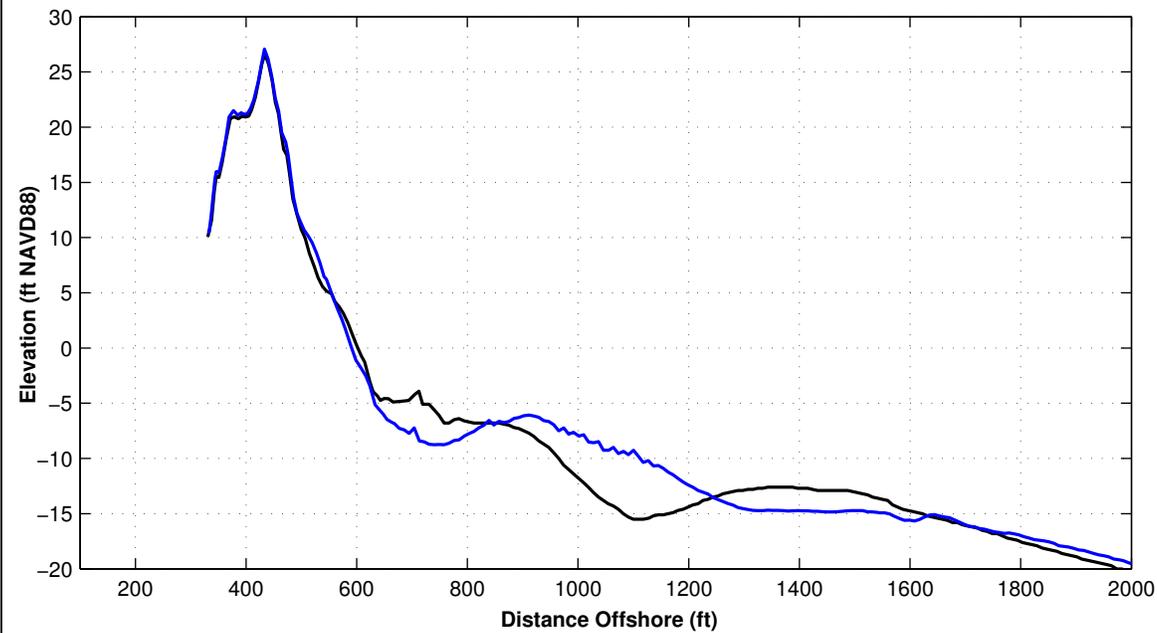
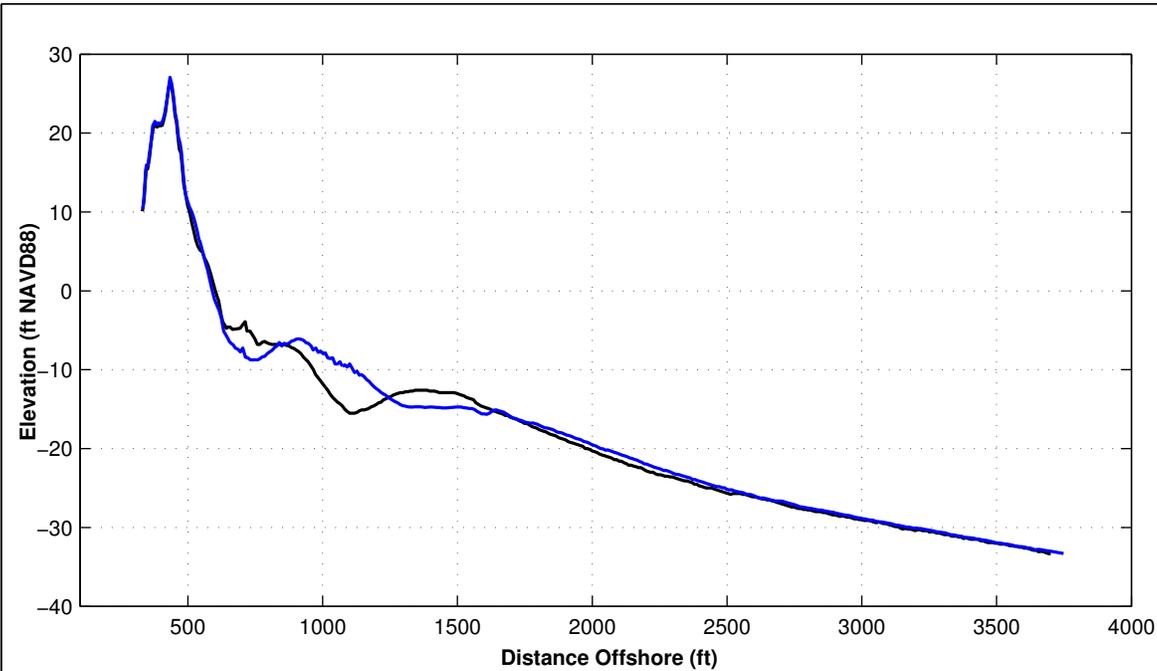
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023

JUNE 2024 ———— OCTOBER 2023

- Notes:
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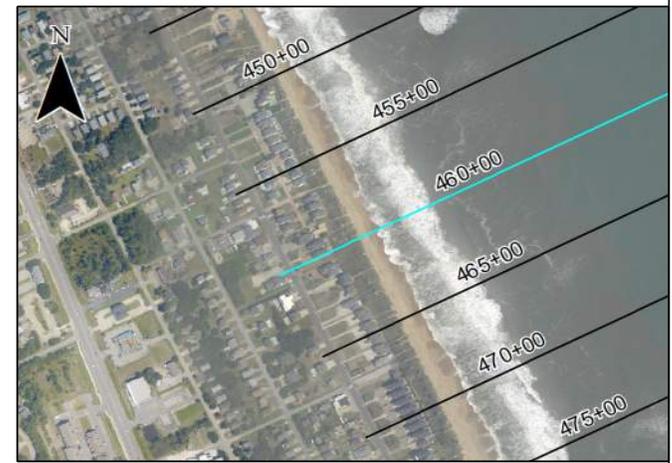


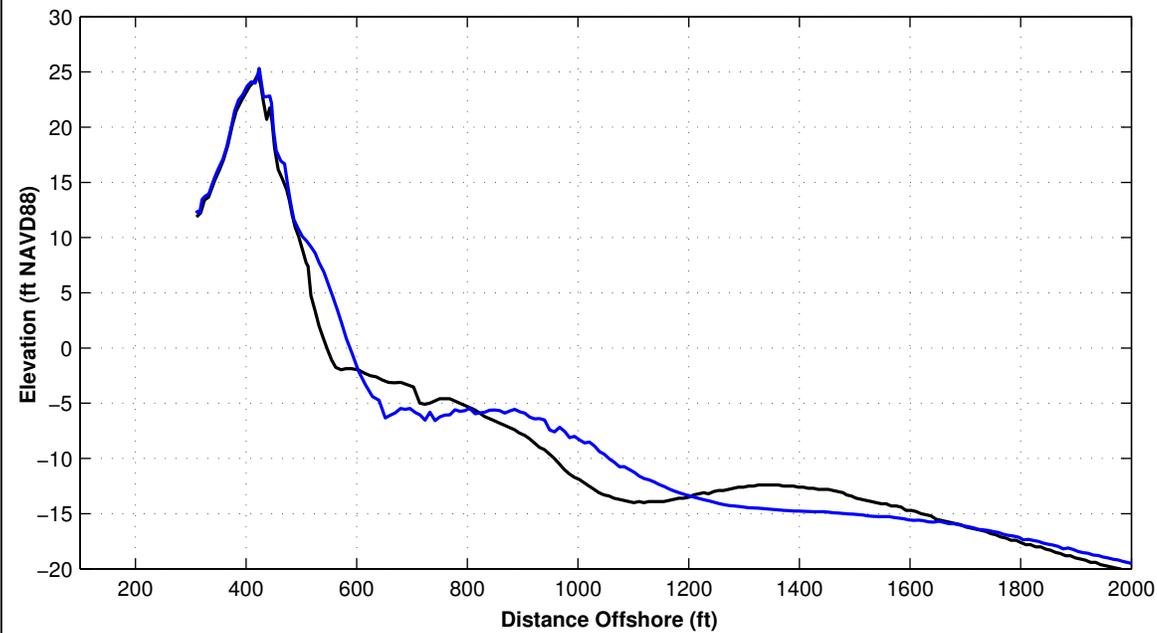
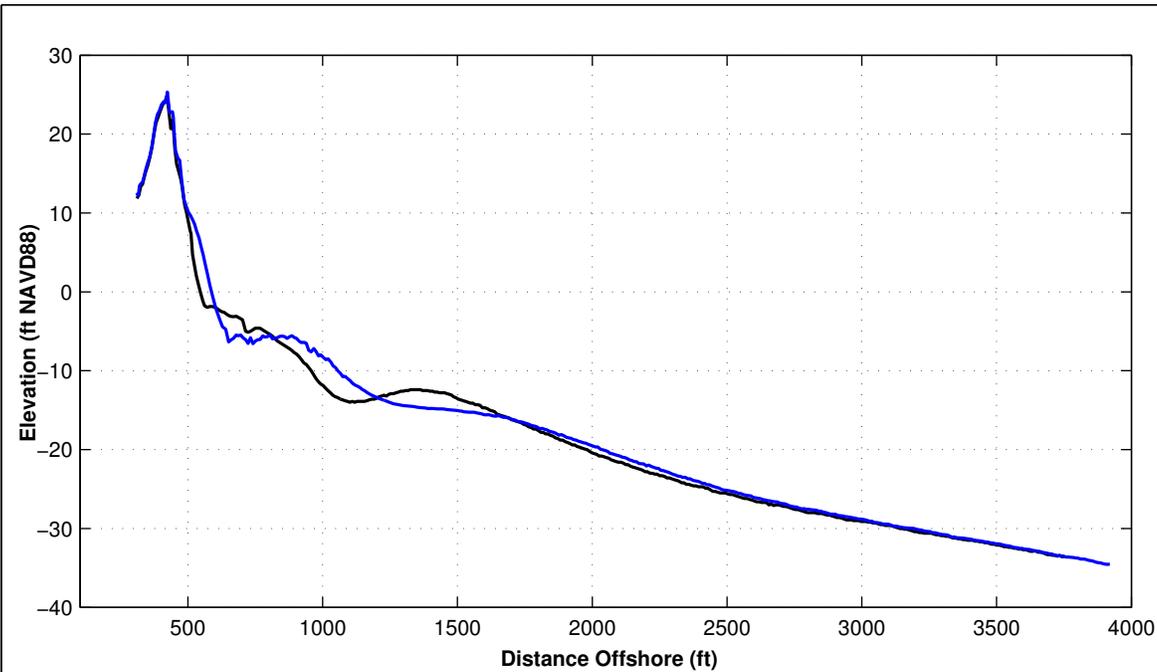
Survey Transect 460+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	3.96 ft	12.46 ft
Volume Change Above +6 ft NAVD88	-1.04 cy/ft	1.44 cy/ft
Volume Change Above 1.18 ft NAVD88	-1.00 cy/ft	4.58 cy/ft
Volume Change Above -6 ft NAVD88	-10.59 cy/ft	20.08 cy/ft
Volume Change Above -14 ft NAVD88	7.62 cy/ft	5.25 cy/ft
Volume Change Above -19 ft NAVD88	3.04 cy/ft	-20.00 cy/ft
Volume Change Above -30 ft NAVD88	17.03 cy/ft	-33.63 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

Notes:  
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Survey Transect 465+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	31.14 ft	-27.25 ft
Volume Change Above +6 ft NAVD88	1.67 cy/ft	-0.34 cy/ft
Volume Change Above 1.18 ft NAVD88	8.27 cy/ft	-7.29 cy/ft
Volume Change Above -6 ft NAVD88	3.08 cy/ft	-9.31 cy/ft
Volume Change Above -14 ft NAVD88	30.64 cy/ft	-29.17 cy/ft
Volume Change Above -19 ft NAVD88	8.01 cy/ft	-22.72 cy/ft
Volume Change Above -30 ft NAVD88	21.05 cy/ft	-35.79 cy/ft

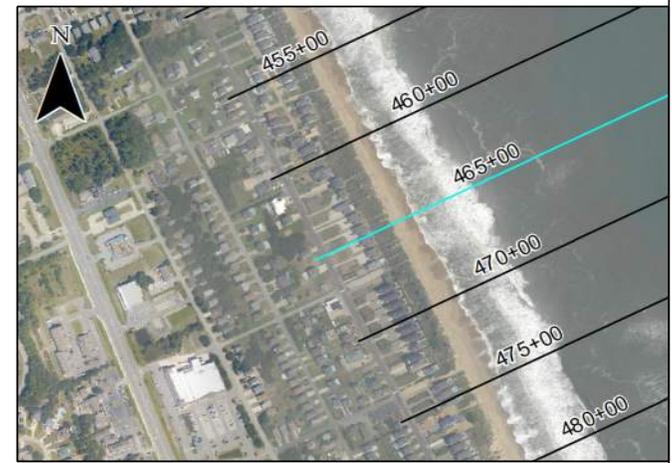
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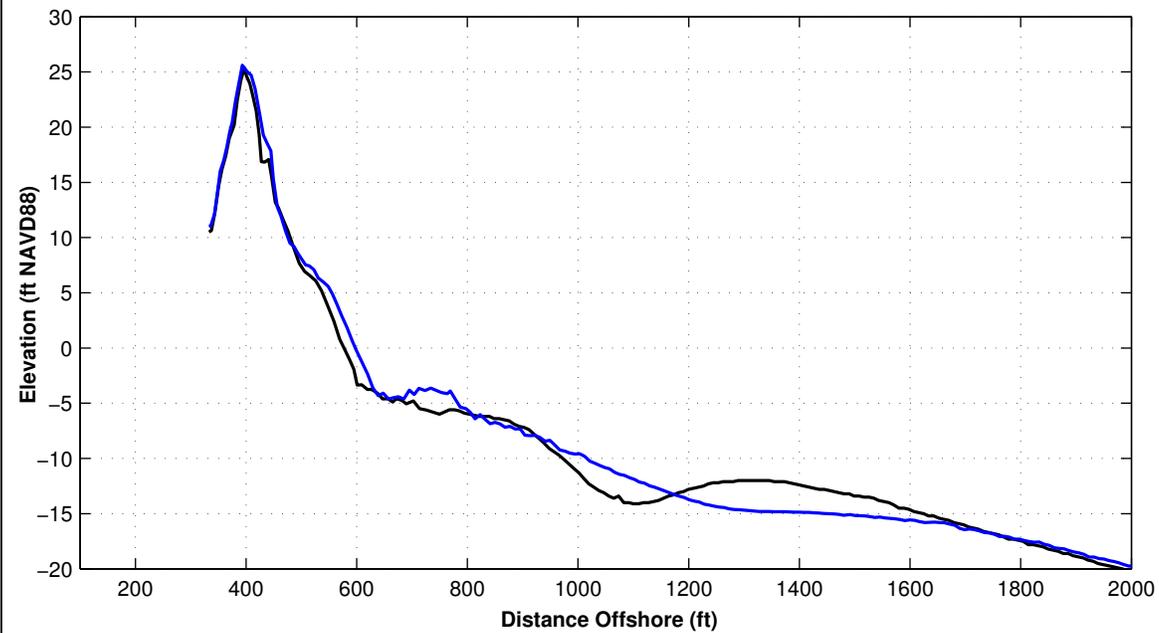
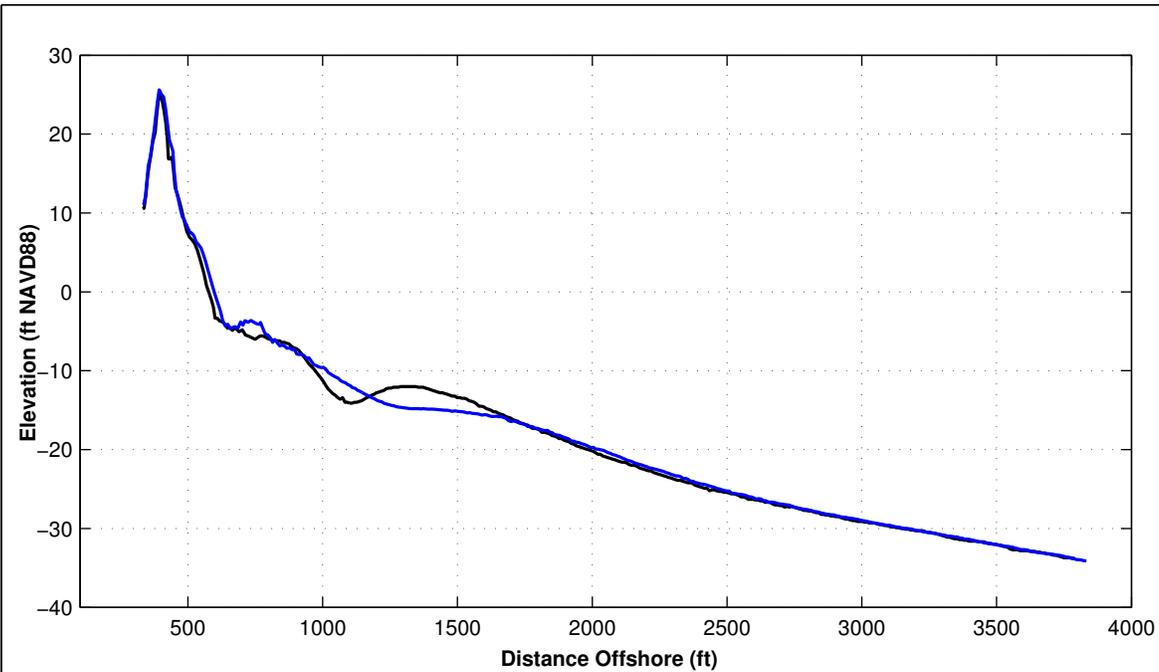
JUNE 2024 ————

OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
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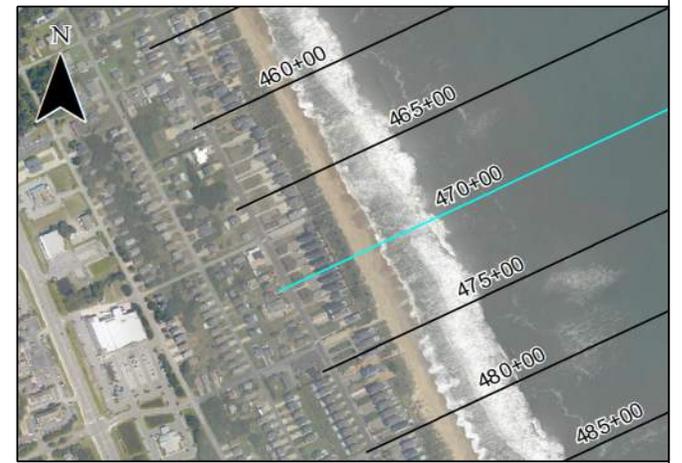


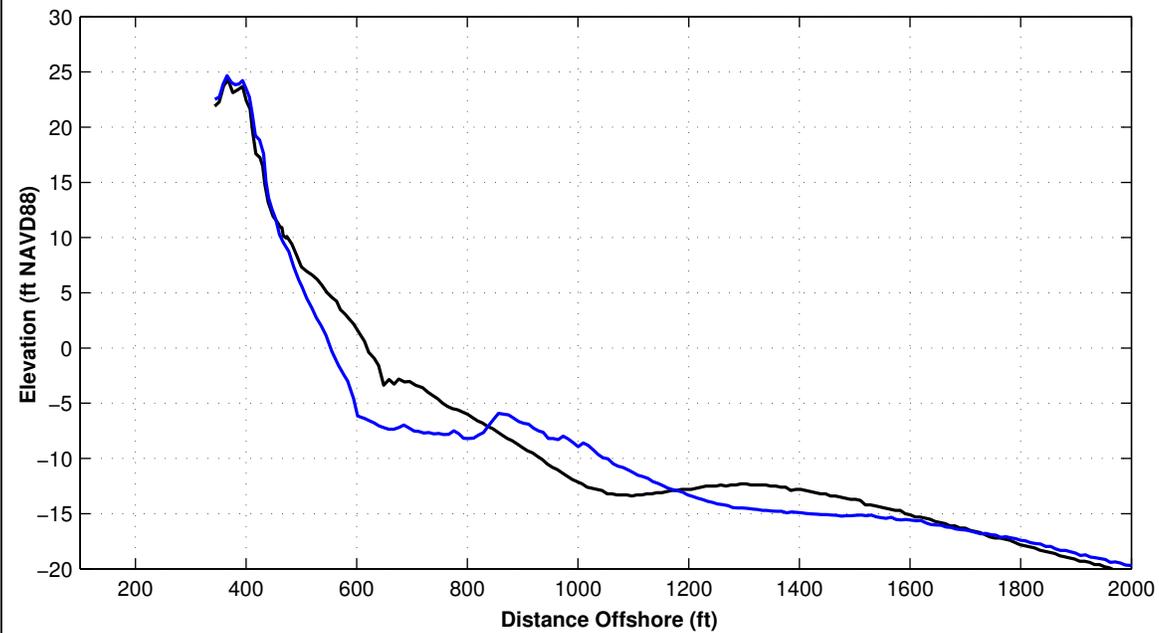
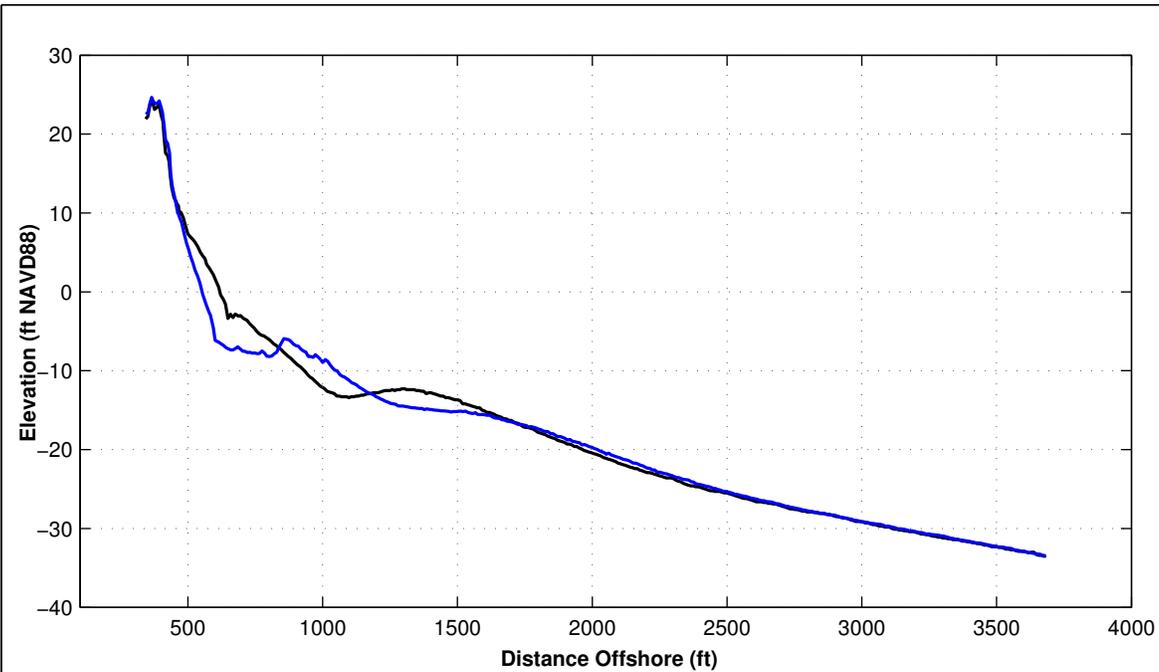
Survey Transect 470+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-40.56 ft	49.23 ft
Volume Change Above +6 ft NAVD88	1.22 cy/ft	1.01 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.17 cy/ft	6.48 cy/ft
Volume Change Above -6 ft NAVD88	-21.99 cy/ft	22.03 cy/ft
Volume Change Above -14 ft NAVD88	-36.92 cy/ft	46.22 cy/ft
Volume Change Above -19 ft NAVD88	-60.27 cy/ft	53.66 cy/ft
Volume Change Above -30 ft NAVD88	-43.53 cy/ft	38.69 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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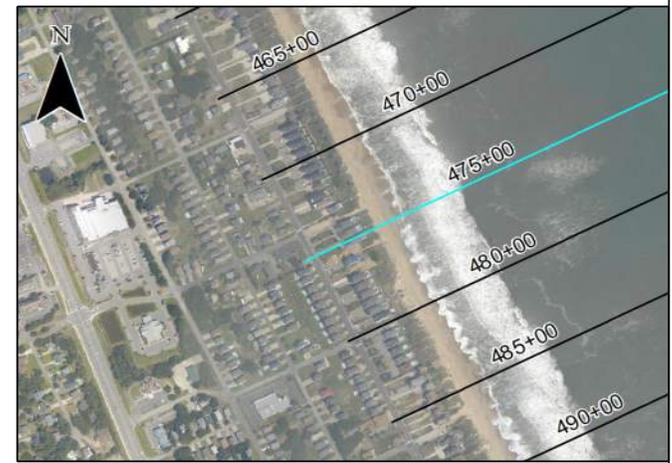


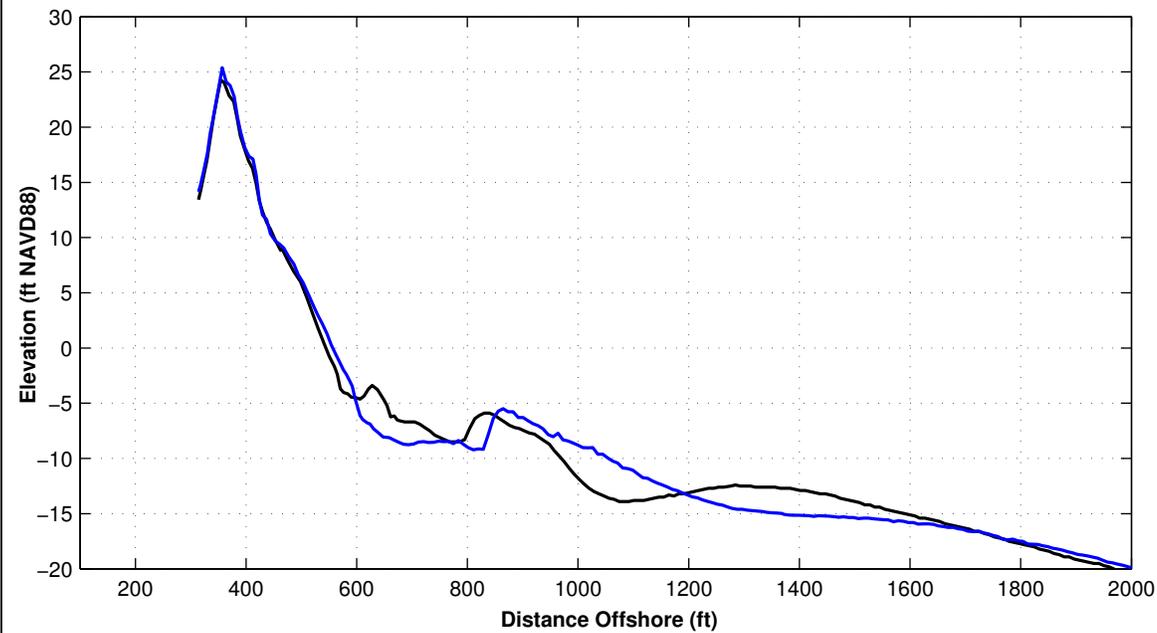
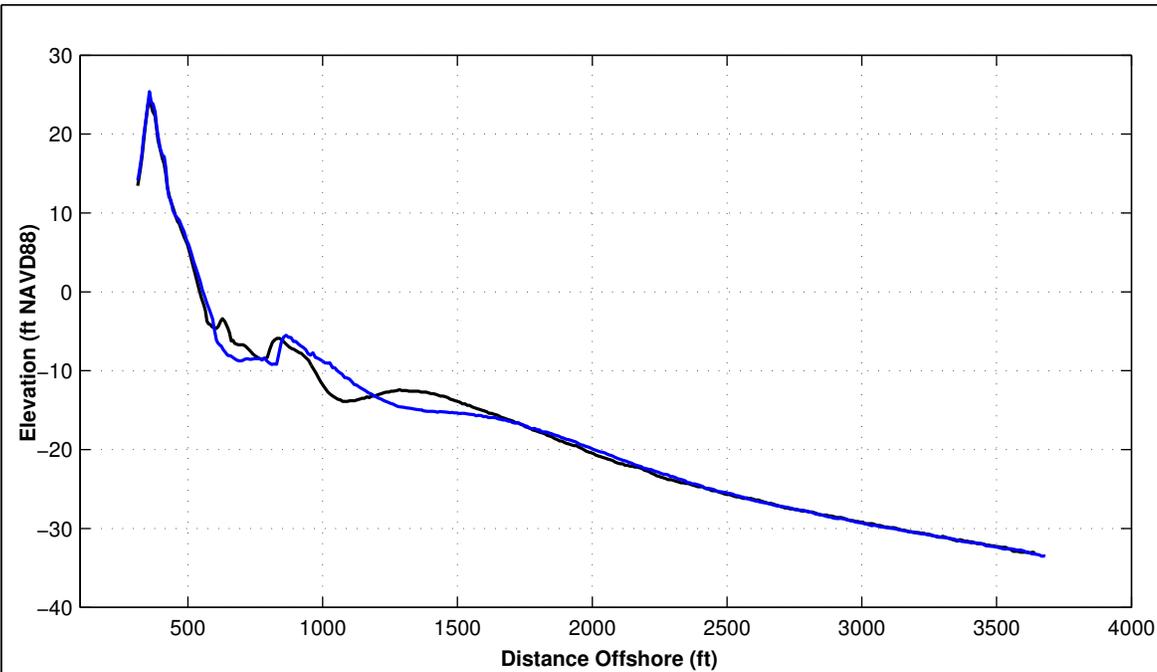
Survey Transect 475+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-41.03 ft	19.44 ft
Volume Change Above +6 ft NAVD88	3.69 cy/ft	-1.30 cy/ft
Volume Change Above 1.18 ft NAVD88	-2.31 cy/ft	0.50 cy/ft
Volume Change Above -6 ft NAVD88	-15.61 cy/ft	-2.53 cy/ft
Volume Change Above -14 ft NAVD88	-14.36 cy/ft	0.62 cy/ft
Volume Change Above -19 ft NAVD88	-26.02 cy/ft	0.21 cy/ft
Volume Change Above -30 ft NAVD88	-10.93 cy/ft	-18.45 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
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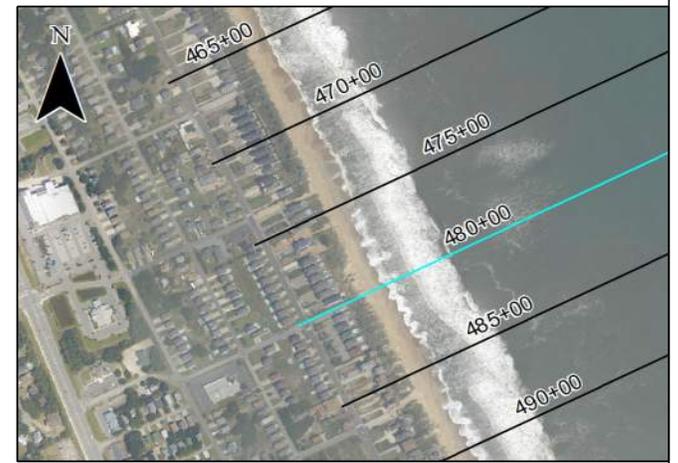


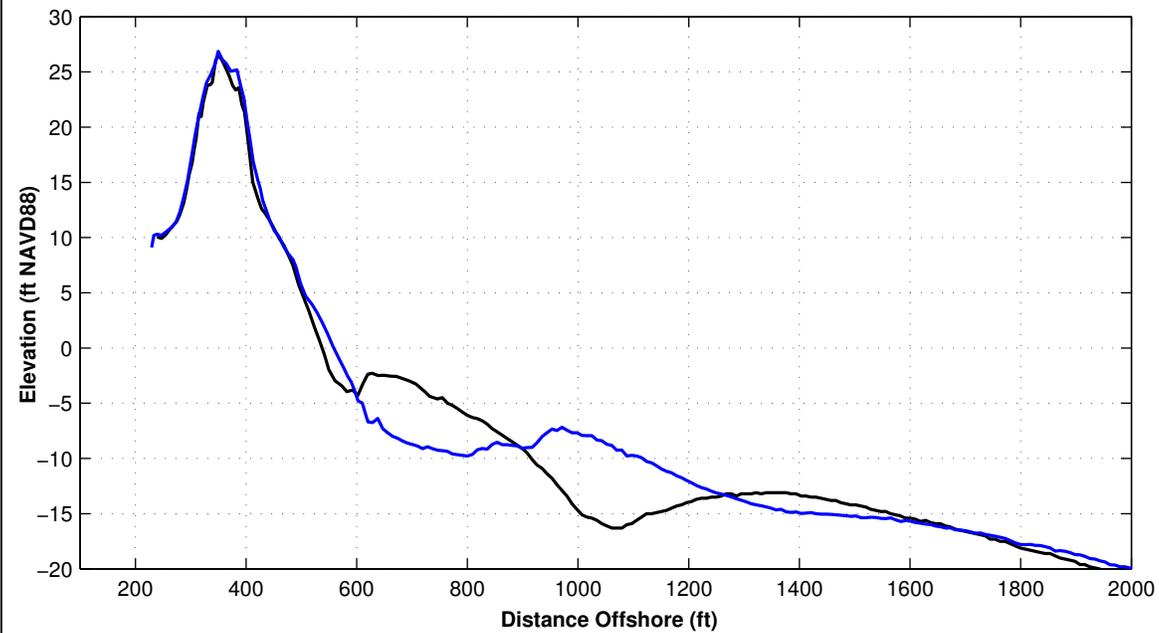
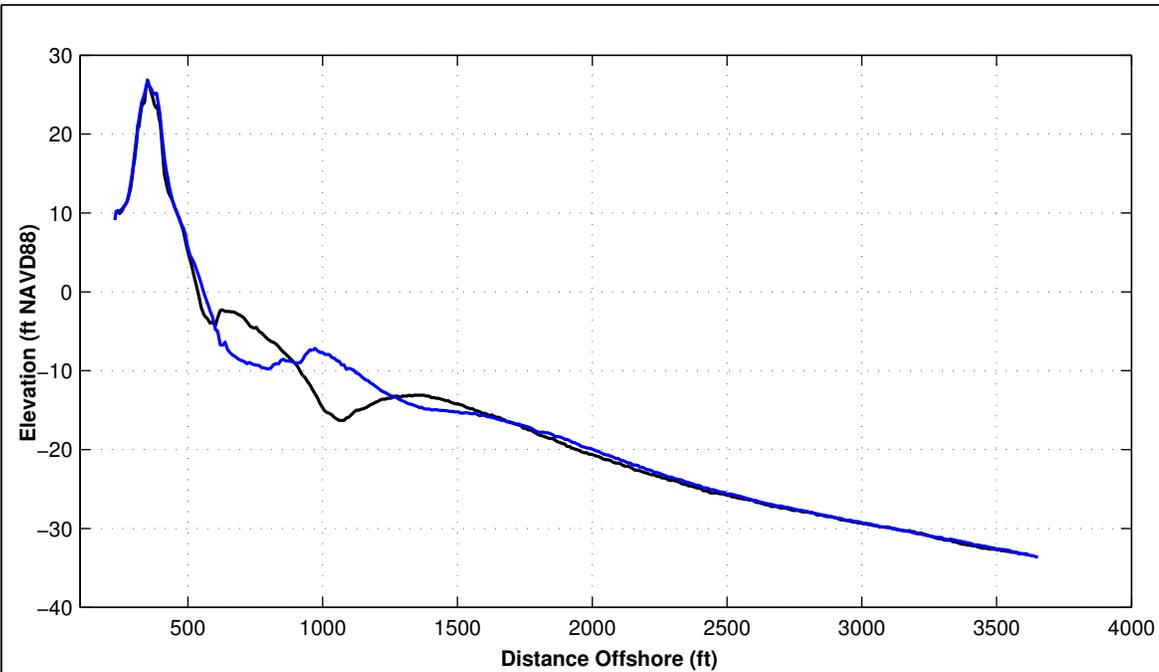
Survey Transect 480+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	62.85 ft	-42.05 ft
Volume Change Above +6 ft NAVD88	1.91 cy/ft	-0.24 cy/ft
Volume Change Above 1.18 ft NAVD88	9.56 cy/ft	-7.39 cy/ft
Volume Change Above -6 ft NAVD88	28.44 cy/ft	-27.70 cy/ft
Volume Change Above -14 ft NAVD88	33.05 cy/ft	-23.99 cy/ft
Volume Change Above -19 ft NAVD88	7.07 cy/ft	-14.50 cy/ft
Volume Change Above -30 ft NAVD88	22.32 cy/ft	-27.59 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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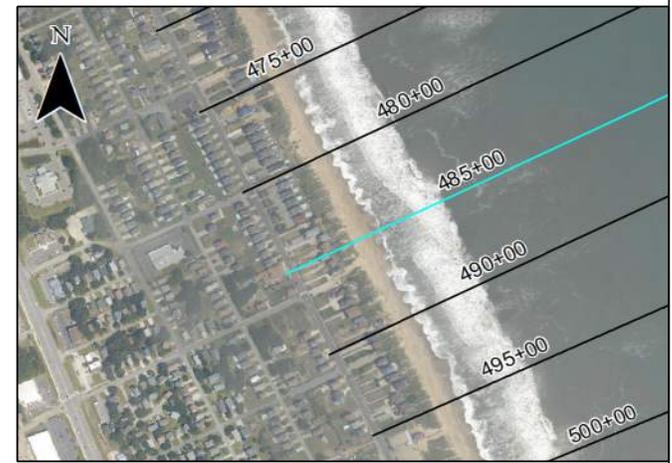


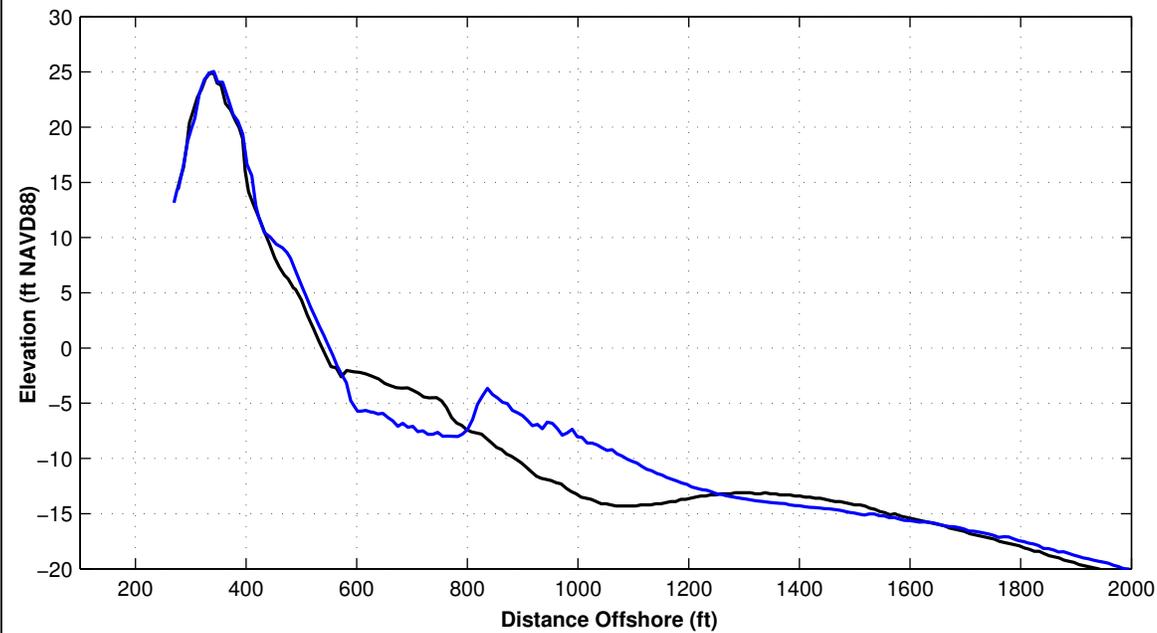
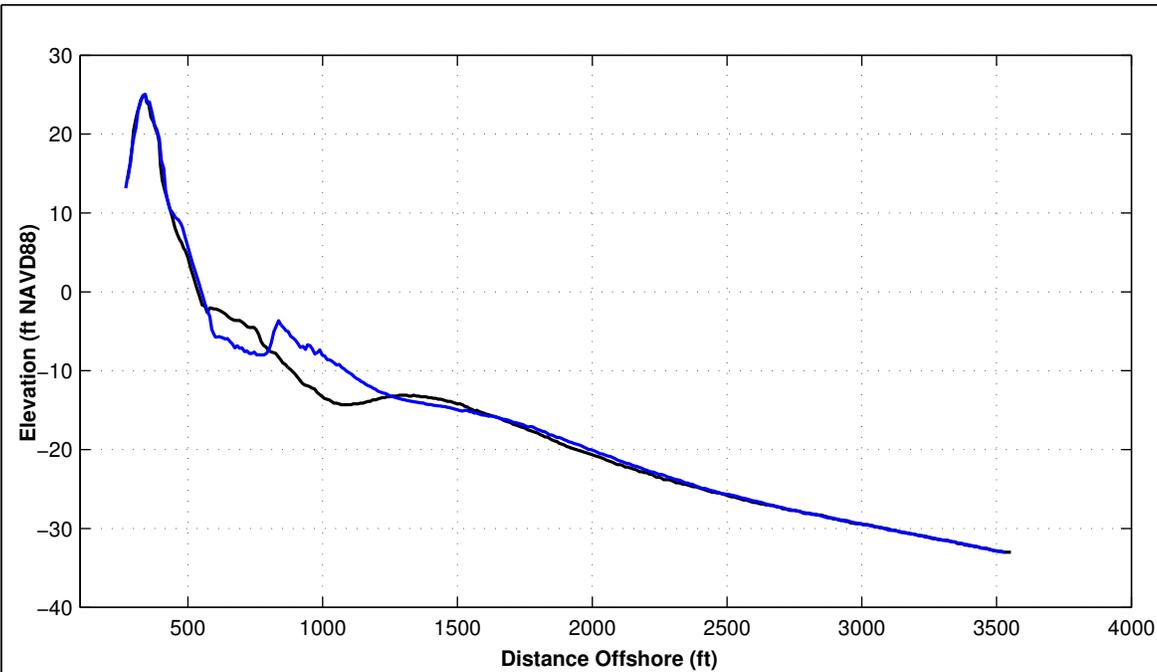
Survey Transect 485+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	60.32 ft	-38.15 ft
Volume Change Above +6 ft NAVD88	2.42 cy/ft	-1.31 cy/ft
Volume Change Above 1.18 ft NAVD88	12.00 cy/ft	-6.06 cy/ft
Volume Change Above -6 ft NAVD88	22.78 cy/ft	-6.99 cy/ft
Volume Change Above -14 ft NAVD88	51.40 cy/ft	-16.58 cy/ft
Volume Change Above -19 ft NAVD88	28.57 cy/ft	-12.36 cy/ft
Volume Change Above -30 ft NAVD88	50.41 cy/ft	-87.48 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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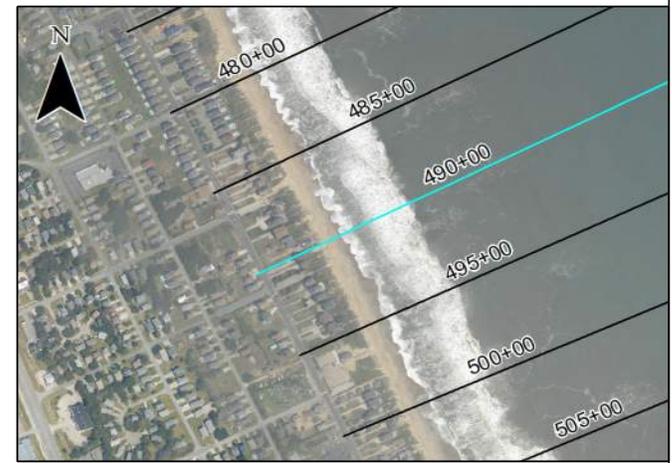
Survey Transect 490+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	31.51 ft	-43.79 ft
Volume Change Above +6 ft NAVD88	0.23 cy/ft	-0.64 cy/ft
Volume Change Above 1.18 ft NAVD88	4.90 cy/ft	-8.00 cy/ft
Volume Change Above -6 ft NAVD88	4.73 cy/ft	-15.49 cy/ft
Volume Change Above -14 ft NAVD88	-7.01 cy/ft	-26.00 cy/ft
Volume Change Above -19 ft NAVD88	-13.98 cy/ft	-48.41 cy/ft
Volume Change Above -30 ft NAVD88	-2.52 cy/ft	-57.10 cy/ft

**LEGEND:**

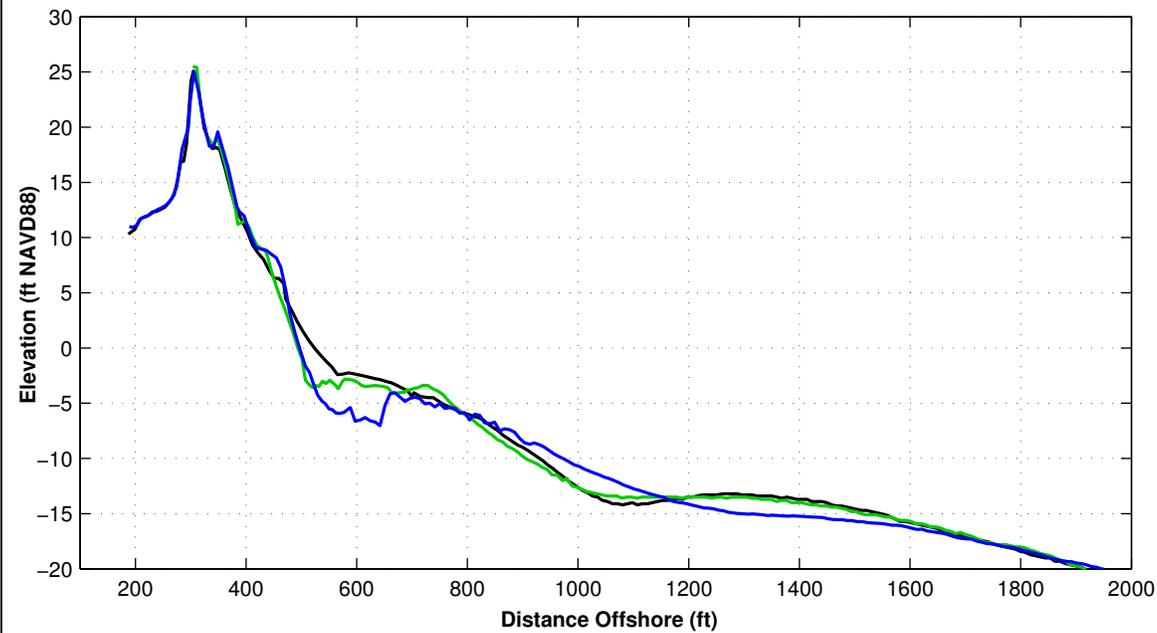
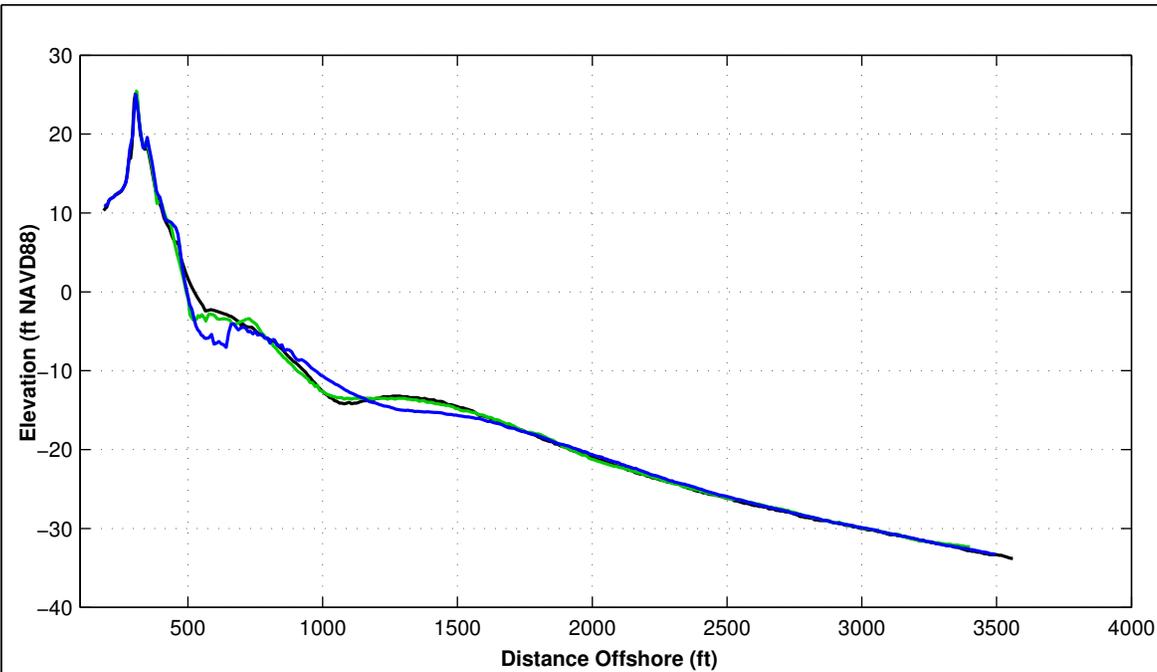
JUNE 2024 ———— OCTOBER 2023

JUNE 2024 ———— OCTOBER 2023

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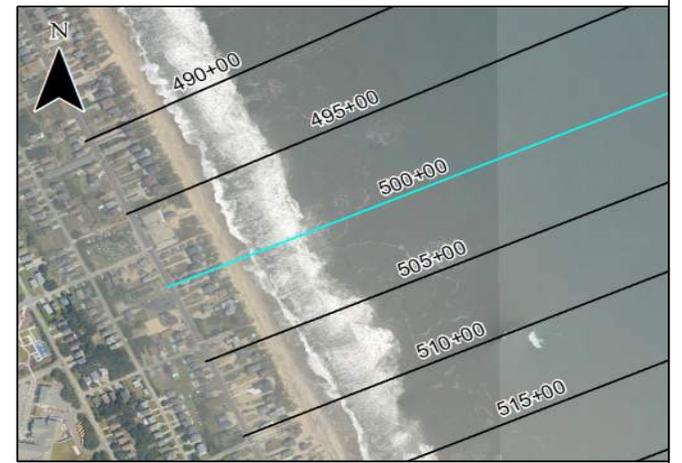


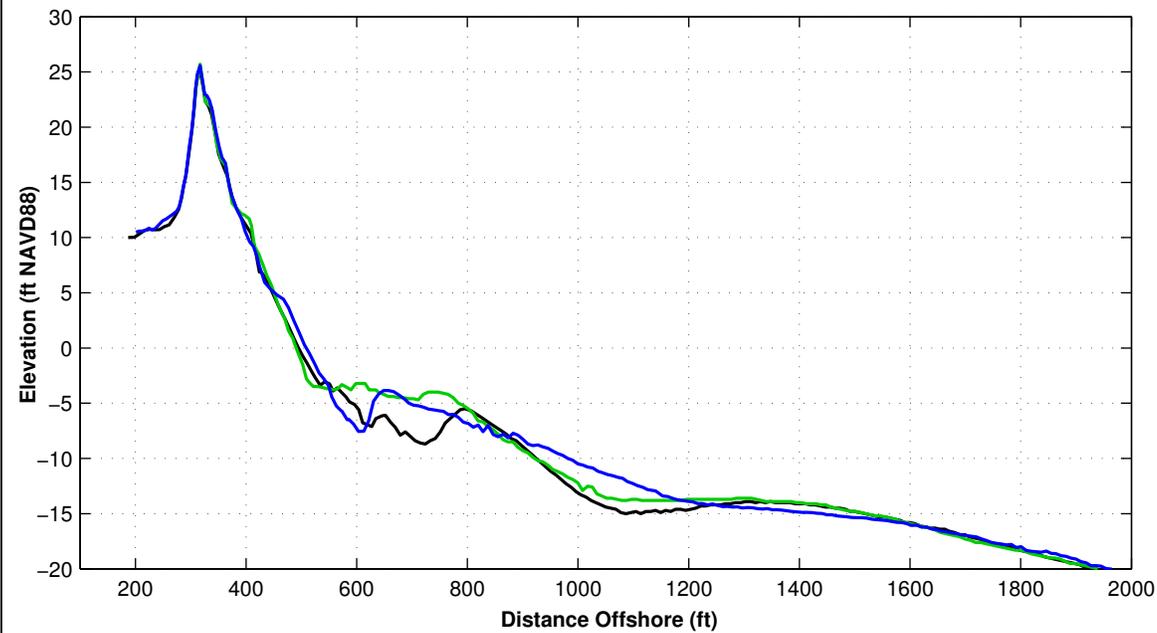
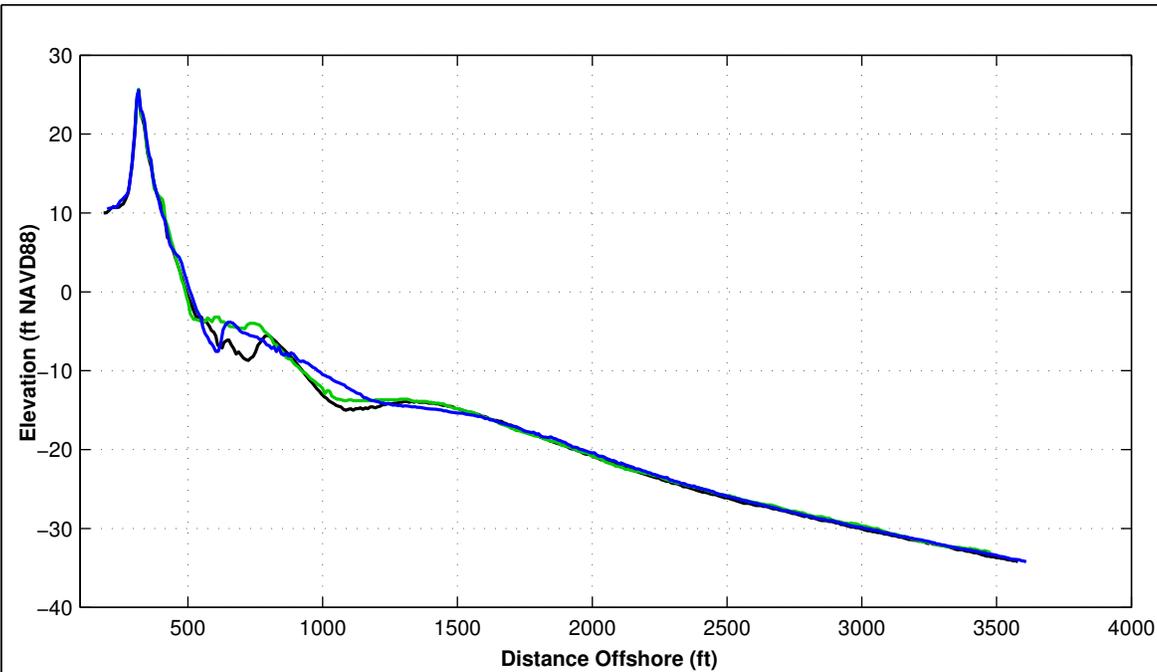
Survey Transect 500+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-43.77 ft	38.99 ft
Volume Change Above +6 ft NAVD88	-1.69 cy/ft	7.53 cy/ft
Volume Change Above 1.18 ft NAVD88	-7.67 cy/ft	11.58 cy/ft
Volume Change Above -6 ft NAVD88	-33.36 cy/ft	31.06 cy/ft
Volume Change Above -14 ft NAVD88	-99.84 cy/ft	88.18 cy/ft
Volume Change Above -19 ft NAVD88	-125.98 cy/ft	77.74 cy/ft
Volume Change Above -30 ft NAVD88	-108.10 cy/ft	61.32 cy/ft

**LEGEND:**

JUNE 2024 —      OCTOBER 2023 —  
 JUNE 2023 —      JUNE 2024 —

Notes:  
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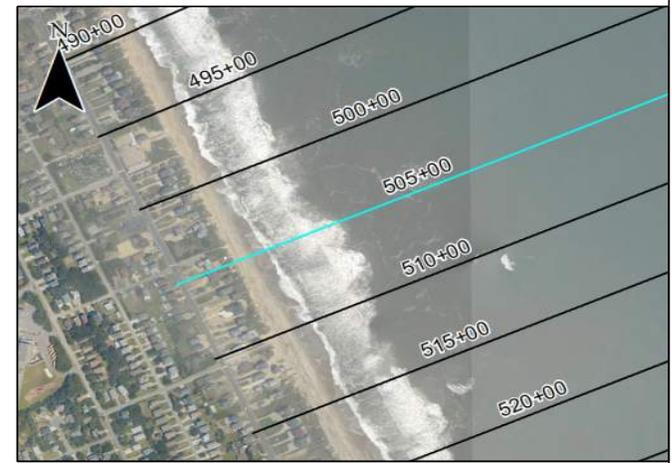


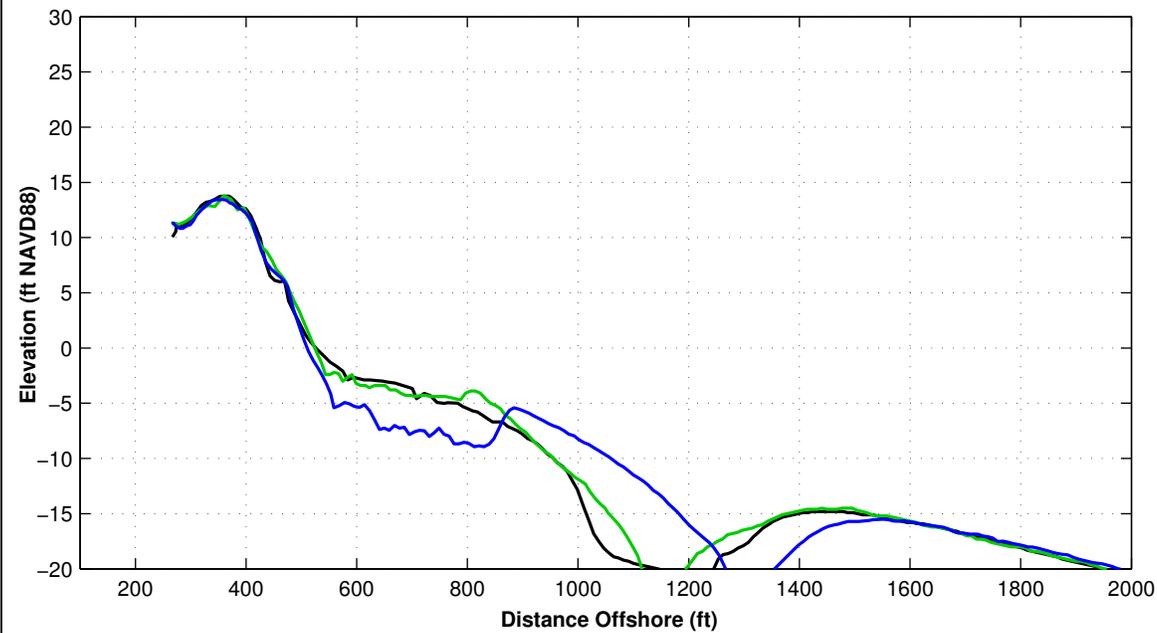
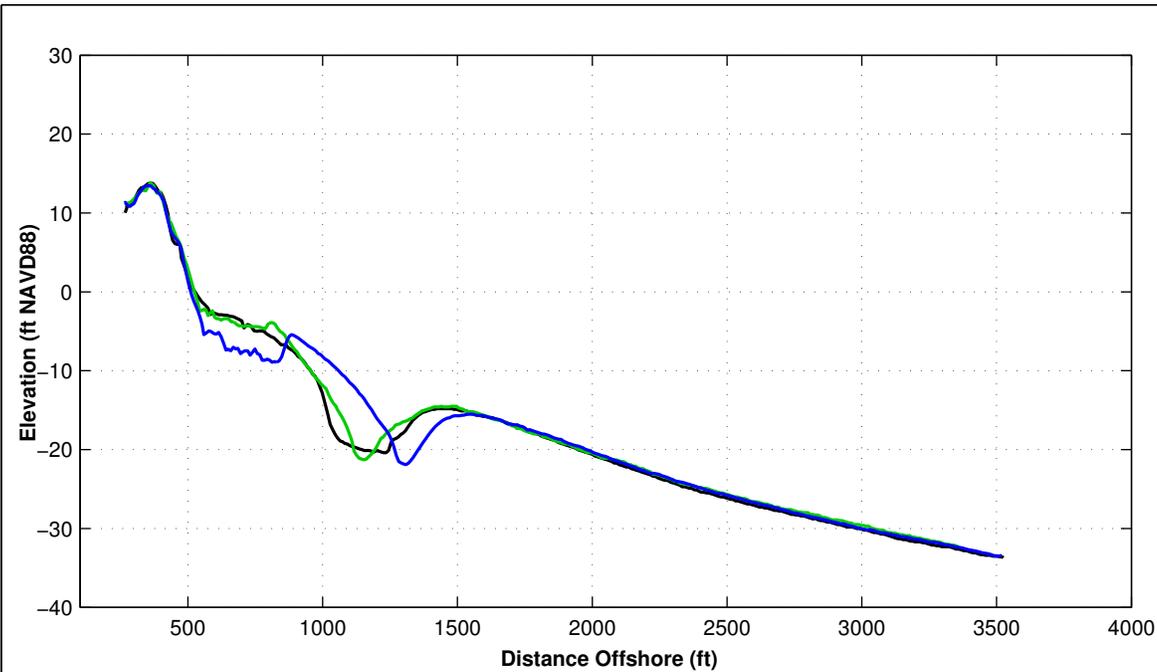
Survey Transect 505+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	2.31 ft	29.91 ft
Volume Change Above +6 ft NAVD88	2.17 cy/ft	4.34 cy/ft
Volume Change Above 1.18 ft NAVD88	4.15 cy/ft	7.71 cy/ft
Volume Change Above -6 ft NAVD88	0.47 cy/ft	21.61 cy/ft
Volume Change Above -14 ft NAVD88	-28.04 cy/ft	51.19 cy/ft
Volume Change Above -19 ft NAVD88	-41.38 cy/ft	25.24 cy/ft
Volume Change Above -30 ft NAVD88	-21.14 cy/ft	5.28 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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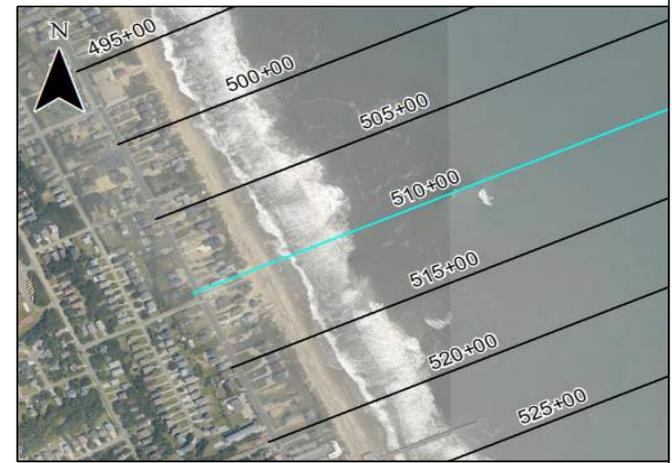
Survey Transect 510+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	36.54 ft	1.86 ft
Volume Change Above +6 ft NAVD88	0.36 cy/ft	0.70 cy/ft
Volume Change Above 1.18 ft NAVD88	6.45 cy/ft	5.28 cy/ft
Volume Change Above -6 ft NAVD88	10.79 cy/ft	11.36 cy/ft
Volume Change Above -14 ft NAVD88	-12.86 cy/ft	68.69 cy/ft
Volume Change Above -19 ft NAVD88	-8.27 cy/ft	41.85 cy/ft
Volume Change Above -30 ft NAVD88	14.42 cy/ft	21.22 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

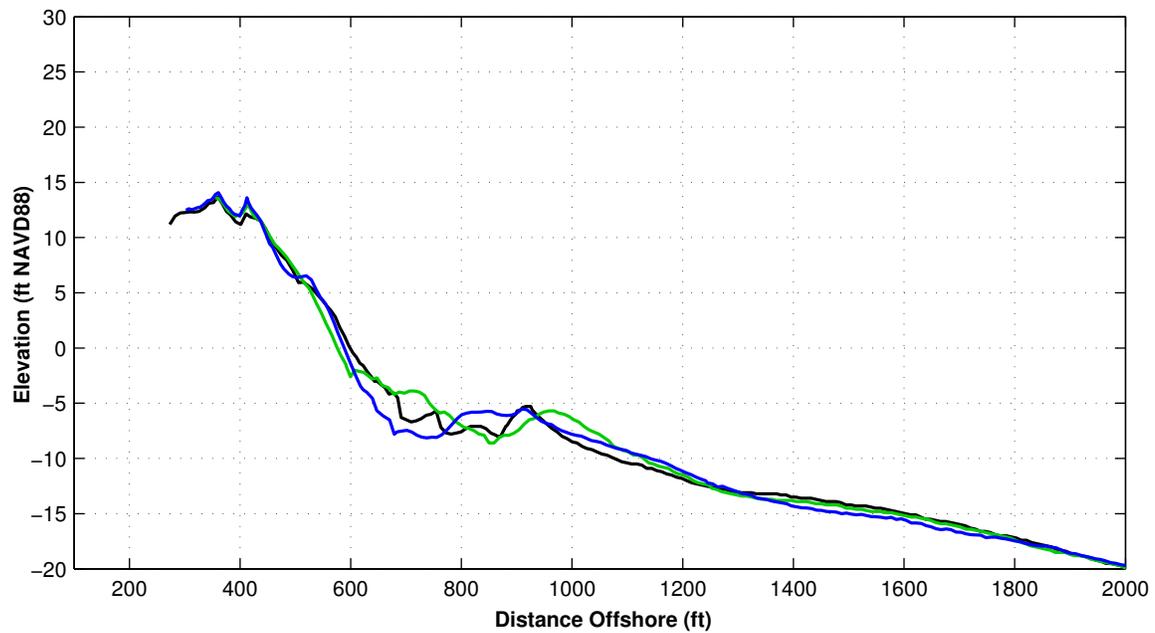
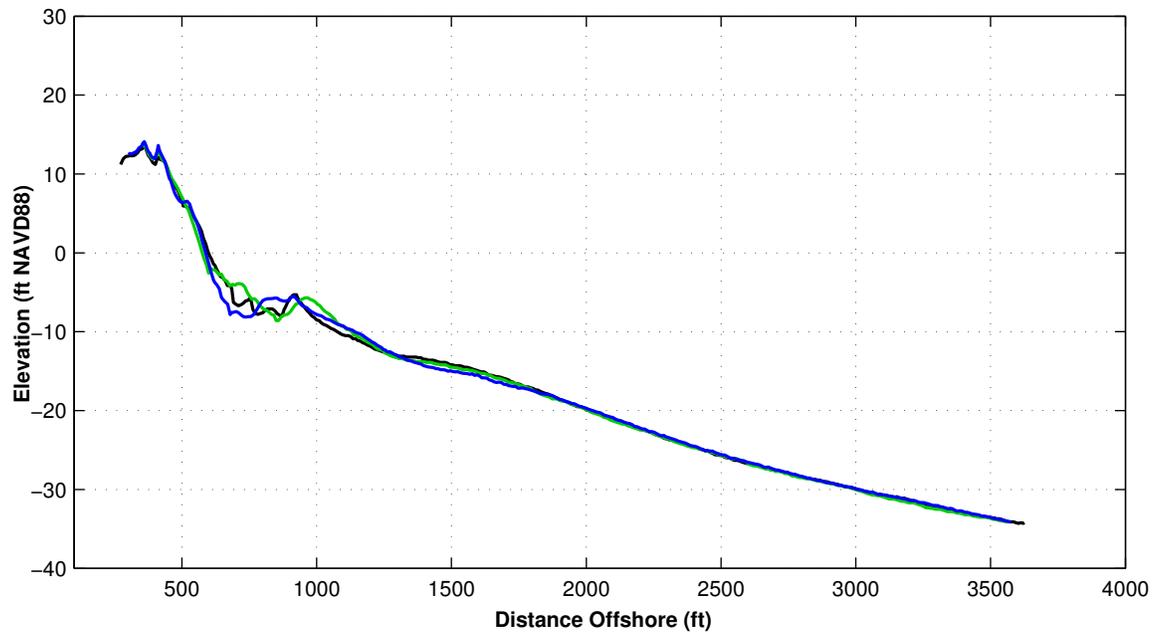
JUNE 2023 ————

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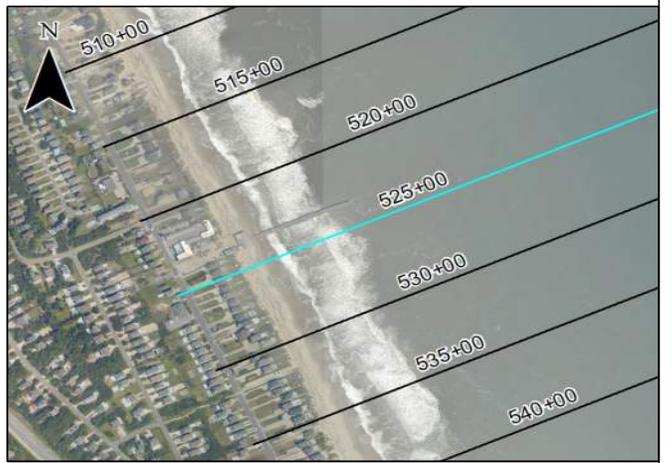
Survey Transect 525+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	5.86 ft	27.12 ft
Volume Change Above +6 ft NAVD88	3.47 cy/ft	3.41 cy/ft
Volume Change Above 1.18 ft NAVD88	4.66 cy/ft	7.97 cy/ft
Volume Change Above -6 ft NAVD88	1.89 cy/ft	27.28 cy/ft
Volume Change Above -14 ft NAVD88	-13.72 cy/ft	69.58 cy/ft
Volume Change Above -19 ft NAVD88	-53.28 cy/ft	44.63 cy/ft
Volume Change Above -30 ft NAVD88	-39.91 cy/ft	30.48 cy/ft

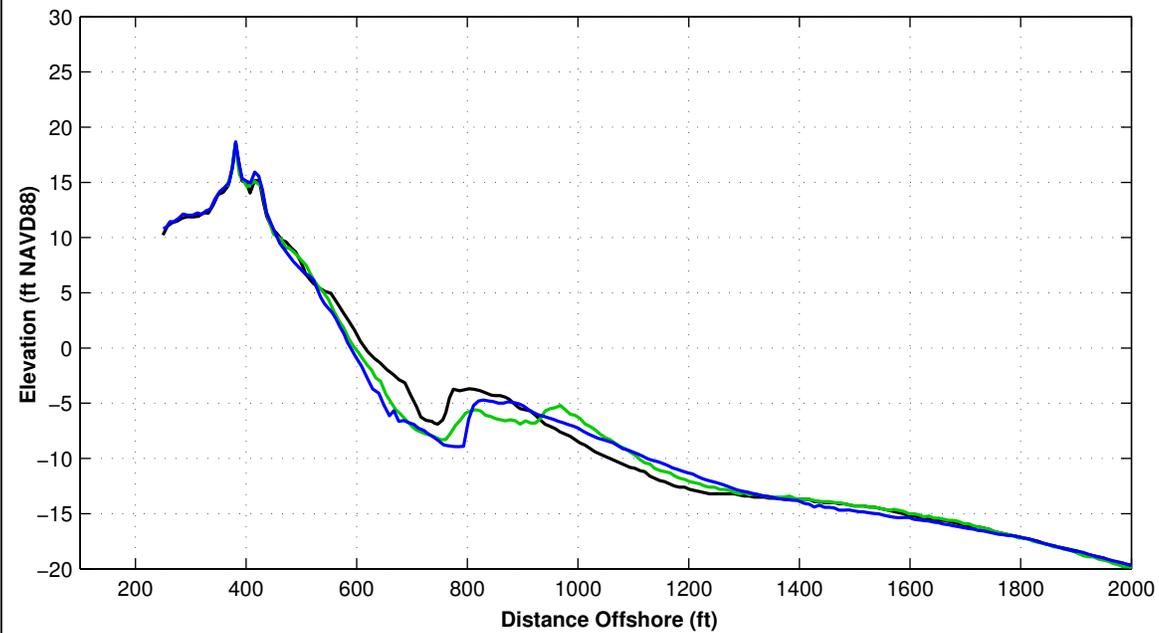
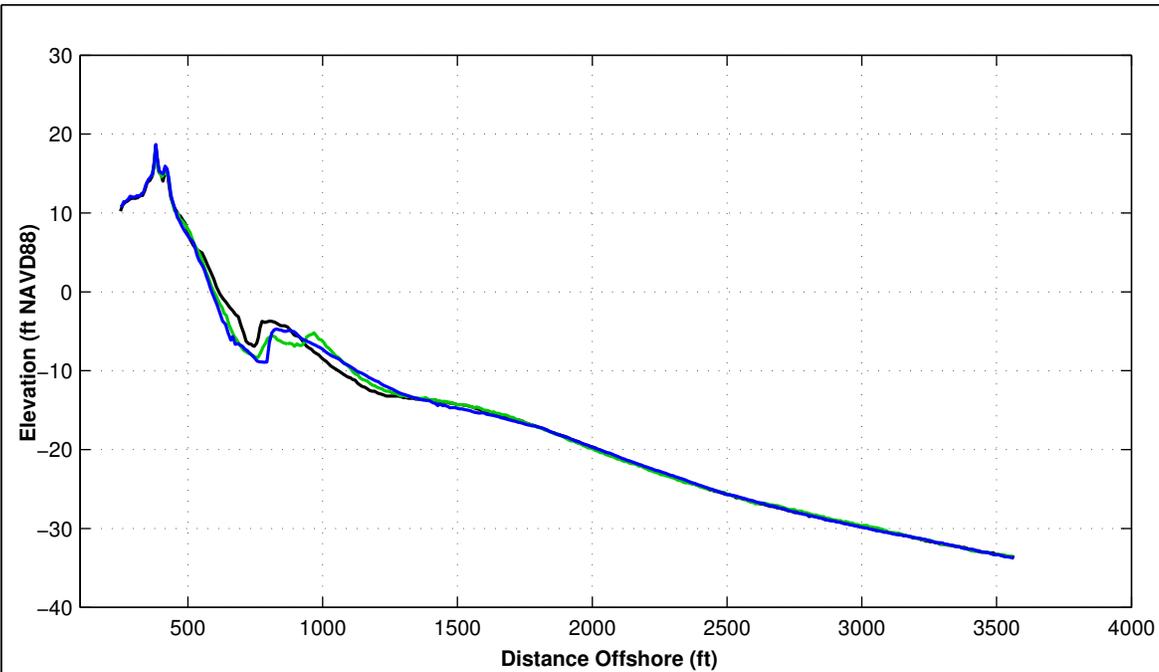
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





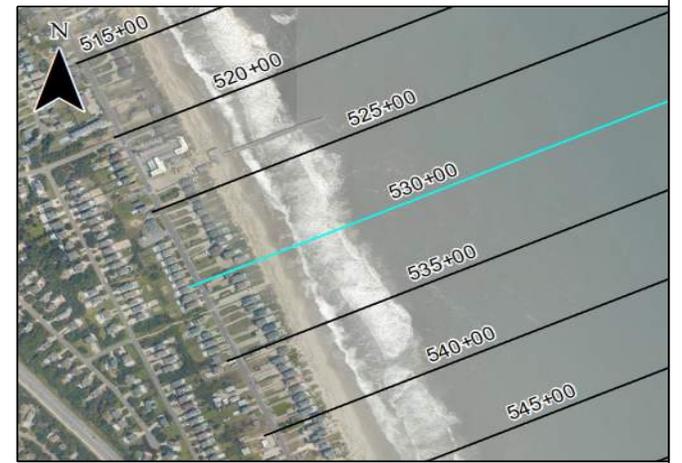
Survey Transect 530+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	27.15 ft	-3.79 ft
Volume Change Above +6 ft NAVD88	2.94 cy/ft	1.54 cy/ft
Volume Change Above 1.18 ft NAVD88	6.52 cy/ft	4.11 cy/ft
Volume Change Above -6 ft NAVD88	21.09 cy/ft	7.51 cy/ft
Volume Change Above -14 ft NAVD88	14.22 cy/ft	60.39 cy/ft
Volume Change Above -19 ft NAVD88	29.15 cy/ft	36.30 cy/ft
Volume Change Above -30 ft NAVD88	41.41 cy/ft	21.62 cy/ft

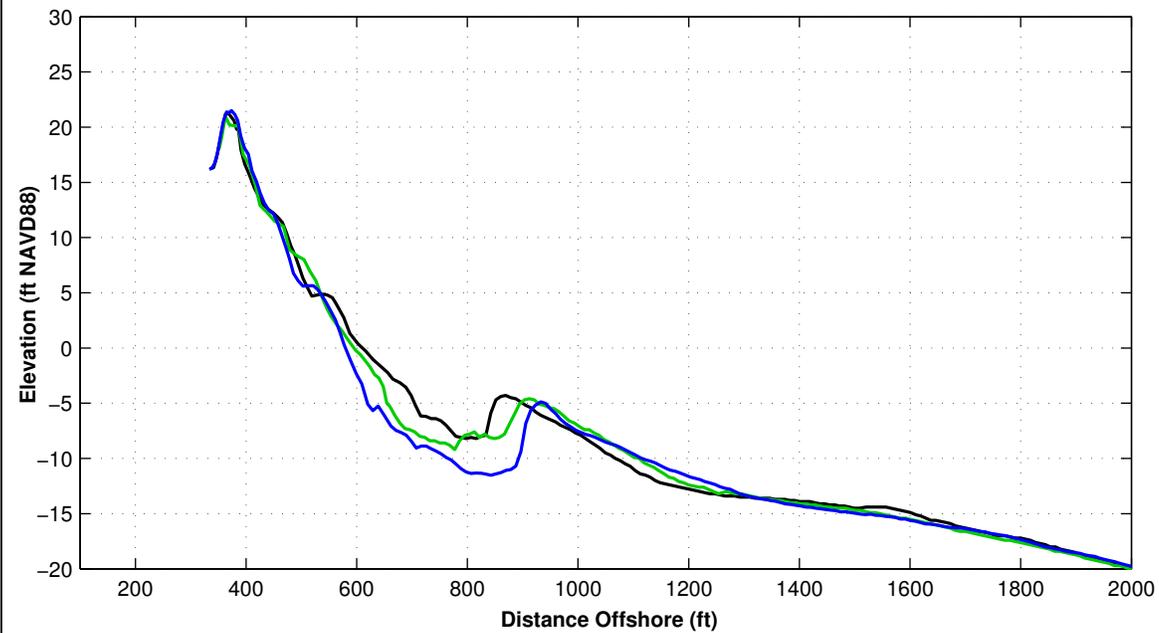
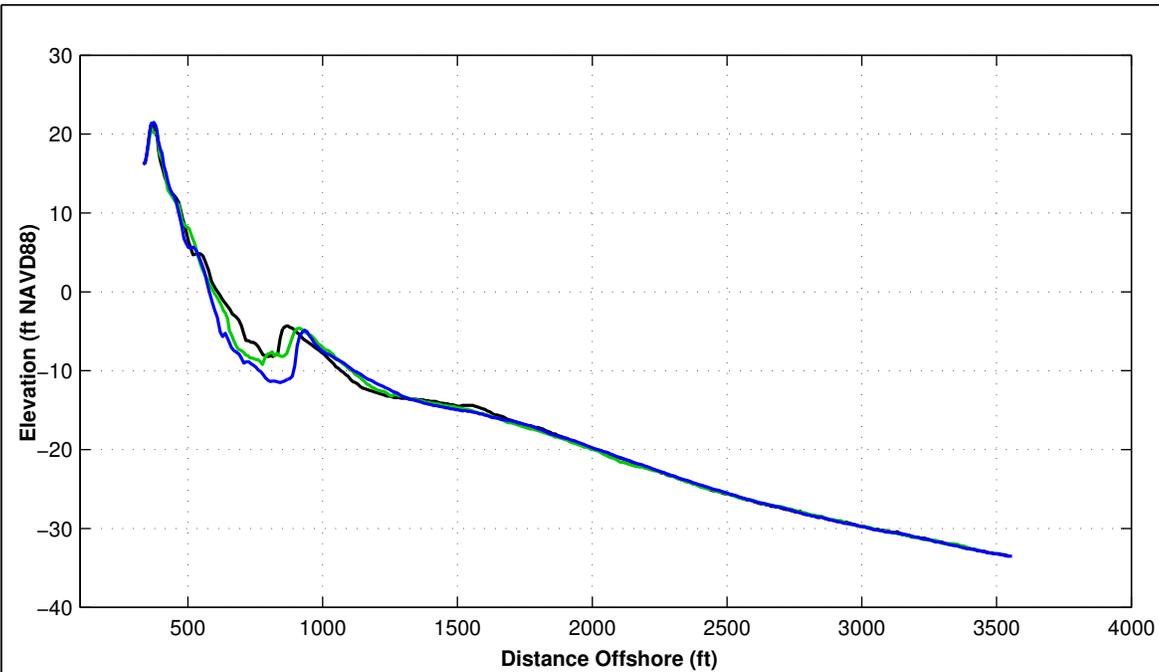
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
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  2. All Survey Elevations In Feet Referenced to NAVD88.





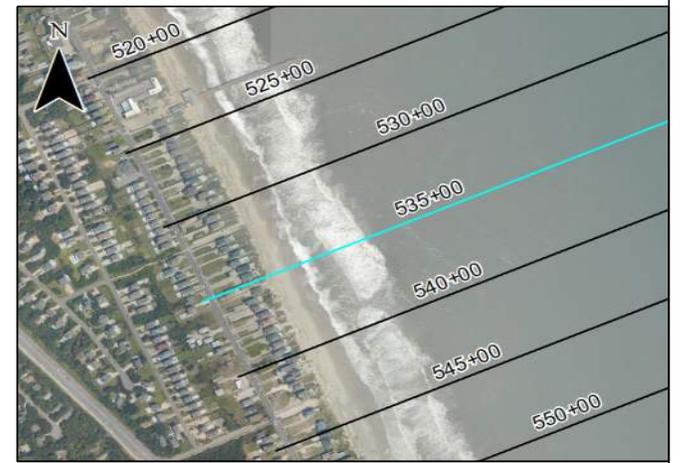
Survey Transect 535+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	45.78 ft	-44.38 ft
Volume Change Above +6 ft NAVD88	2.85 cy/ft	1.53 cy/ft
Volume Change Above 1.18 ft NAVD88	8.83 cy/ft	-4.15 cy/ft
Volume Change Above -6 ft NAVD88	9.31 cy/ft	-17.26 cy/ft
Volume Change Above -14 ft NAVD88	-23.95 cy/ft	48.05 cy/ft
Volume Change Above -19 ft NAVD88	-22.07 cy/ft	24.70 cy/ft
Volume Change Above -30 ft NAVD88	-11.98 cy/ft	11.46 cy/ft

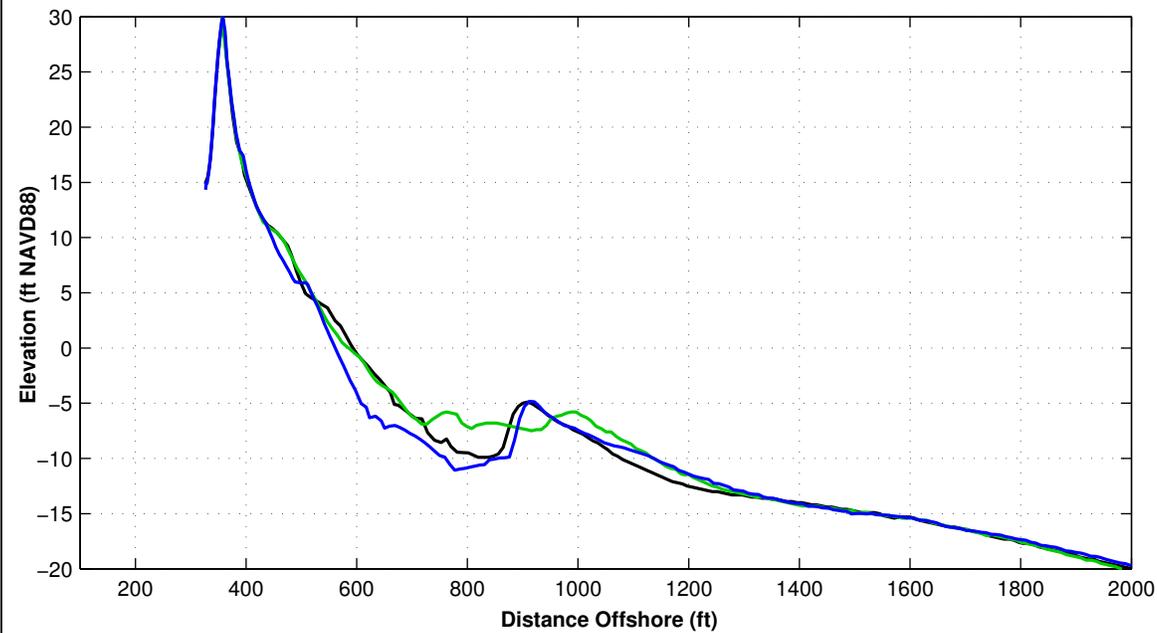
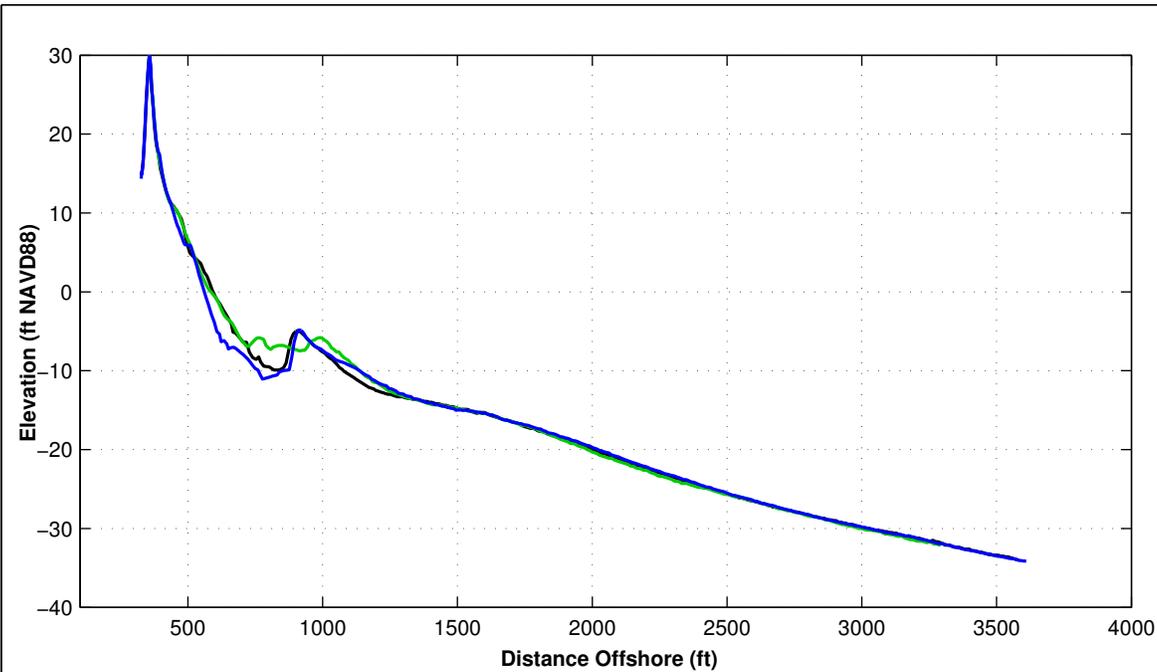
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 540+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	5.93 ft	-3.31 ft
Volume Change Above +6 ft NAVD88	1.04 cy/ft	0.53 cy/ft
Volume Change Above 1.18 ft NAVD88	1.74 cy/ft	1.37 cy/ft
Volume Change Above -6 ft NAVD88	-7.60 cy/ft	-2.23 cy/ft
Volume Change Above -14 ft NAVD88	-42.66 cy/ft	24.64 cy/ft
Volume Change Above -19 ft NAVD88	-38.41 cy/ft	-6.86 cy/ft
Volume Change Above -30 ft NAVD88	-28.98 cy/ft	-23.78 cy/ft

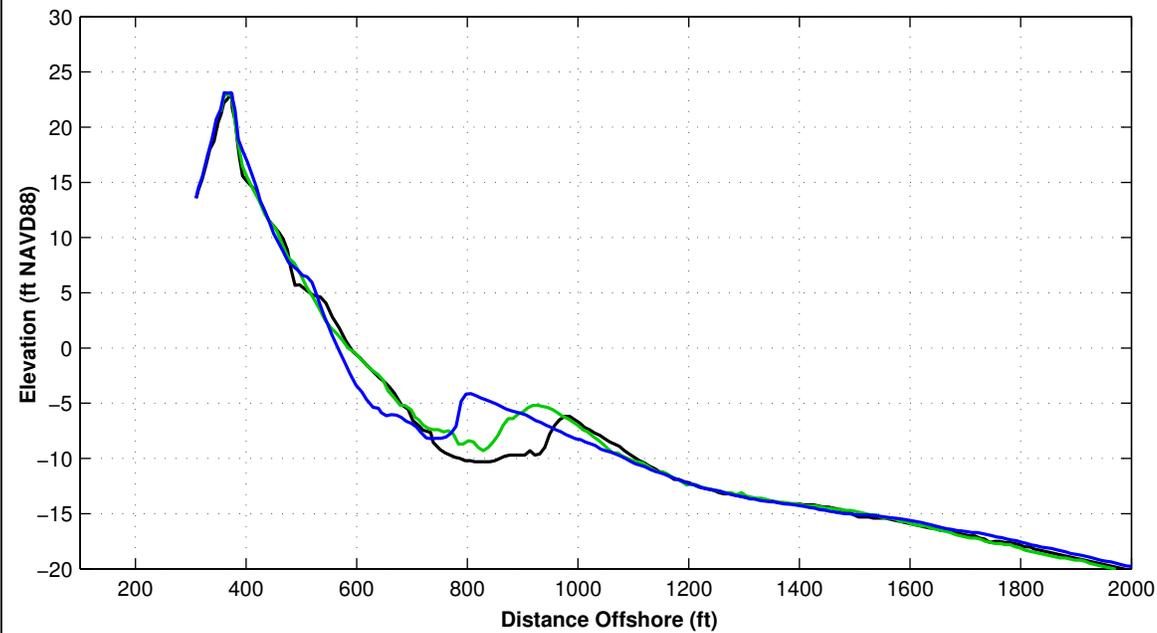
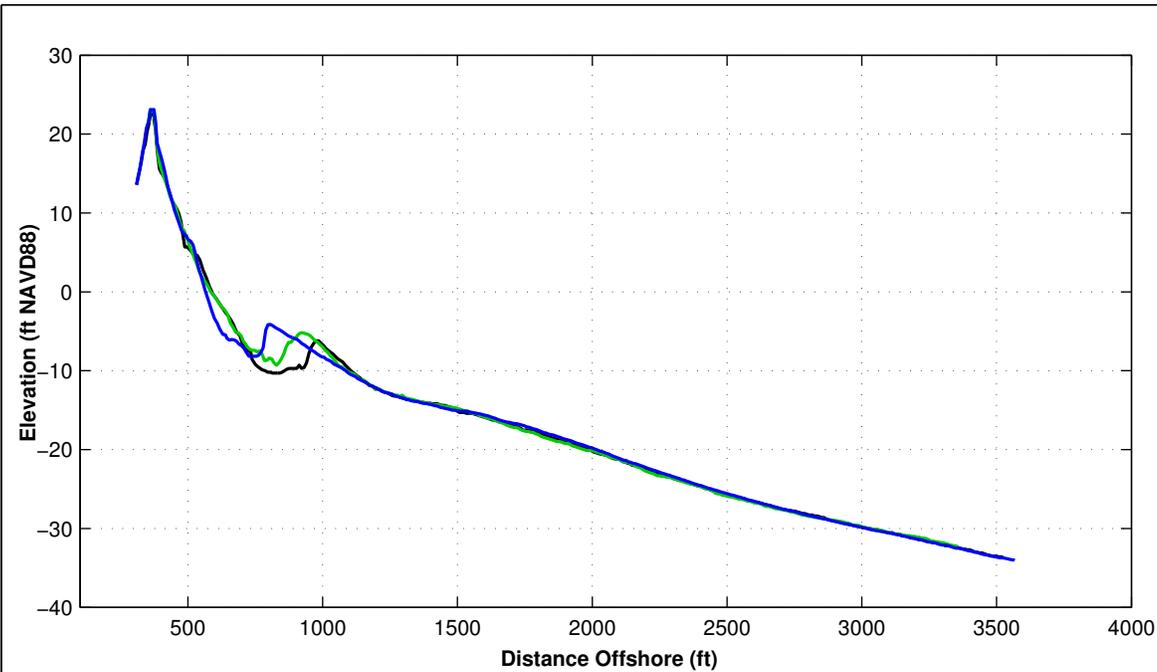
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023

————— JUNE 2023 ————

- Notes:
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Survey Transect 545+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	0.71 ft	-23.57 ft
Volume Change Above +6 ft NAVD88	0.61 cy/ft	5.07 cy/ft
Volume Change Above 1.18 ft NAVD88	1.53 cy/ft	3.86 cy/ft
Volume Change Above -6 ft NAVD88	-18.68 cy/ft	3.82 cy/ft
Volume Change Above -14 ft NAVD88	-33.05 cy/ft	55.46 cy/ft
Volume Change Above -19 ft NAVD88	-35.45 cy/ft	39.44 cy/ft
Volume Change Above -30 ft NAVD88	-29.26 cy/ft	25.50 cy/ft

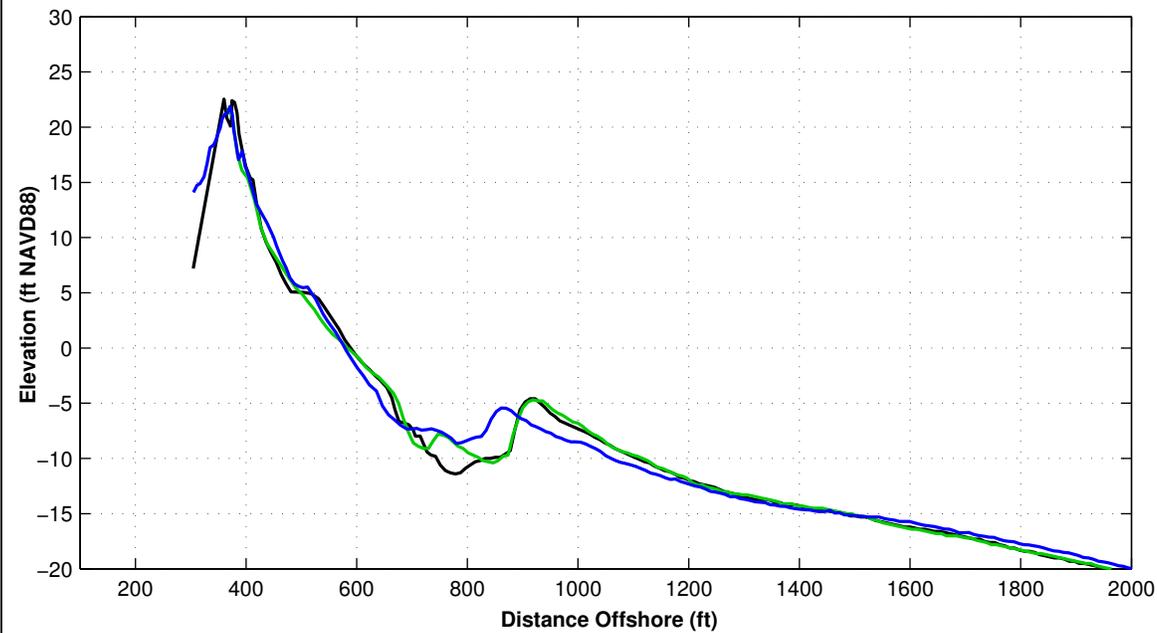
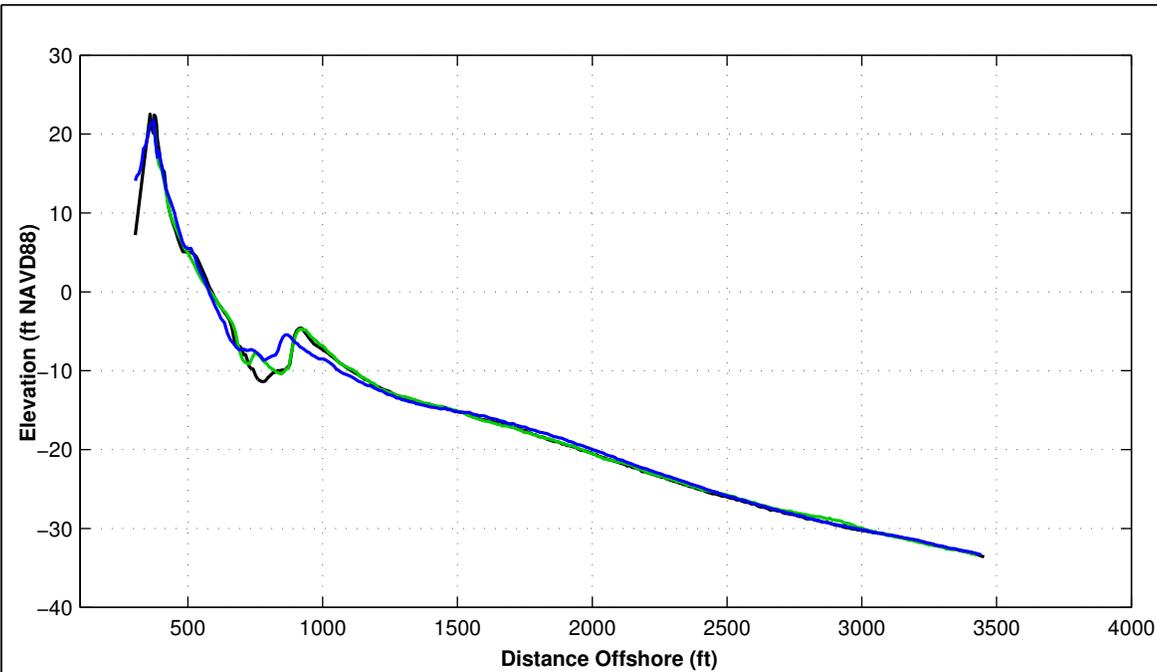
**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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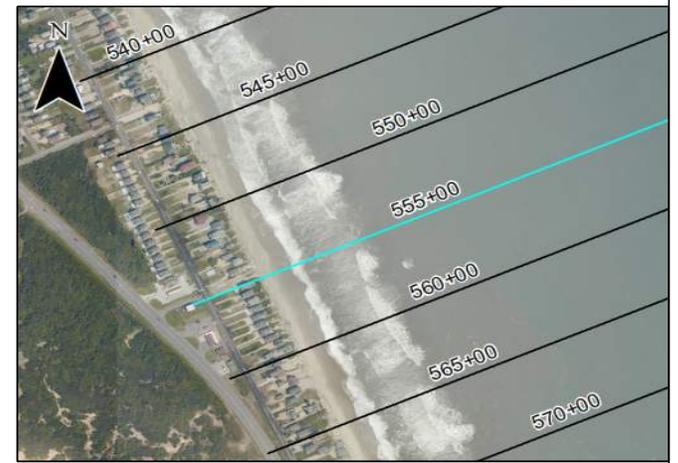


Survey Transect 555+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	8.05 ft	9.65 ft
Volume Change Above +6 ft NAVD88	3.04 cy/ft	3.14 cy/ft
Volume Change Above 1.18 ft NAVD88	4.87 cy/ft	6.22 cy/ft
Volume Change Above -6 ft NAVD88	-1.37 cy/ft	2.51 cy/ft
Volume Change Above -14 ft NAVD88	-11.33 cy/ft	65.28 cy/ft
Volume Change Above -19 ft NAVD88	-12.93 cy/ft	71.24 cy/ft
Volume Change Above -30 ft NAVD88	-4.83 cy/ft	58.56 cy/ft

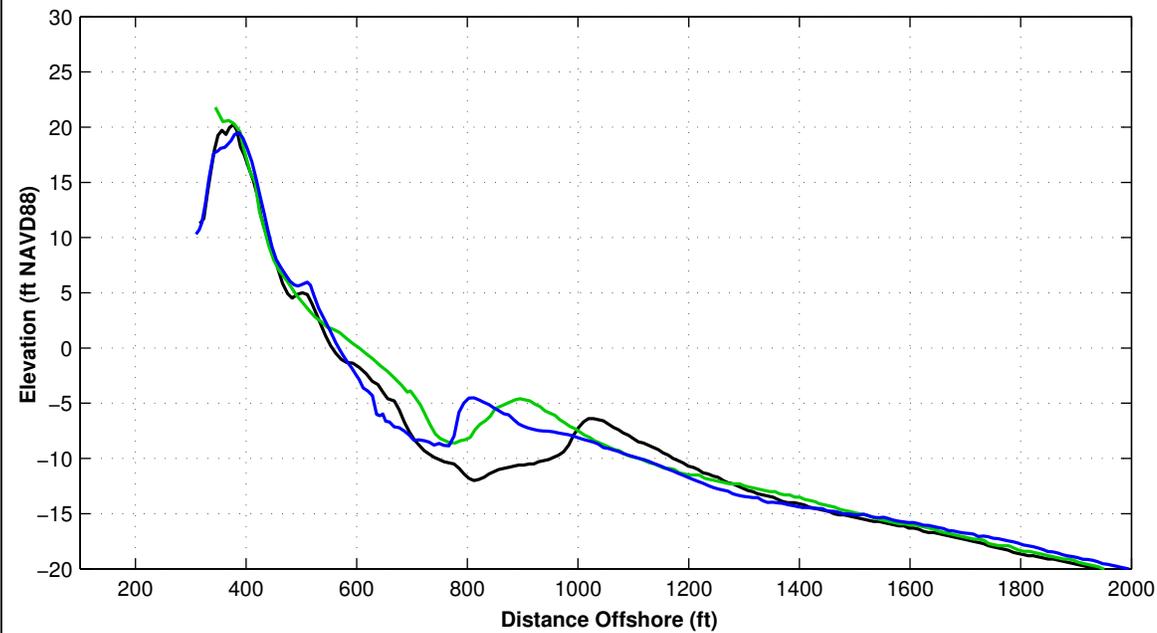
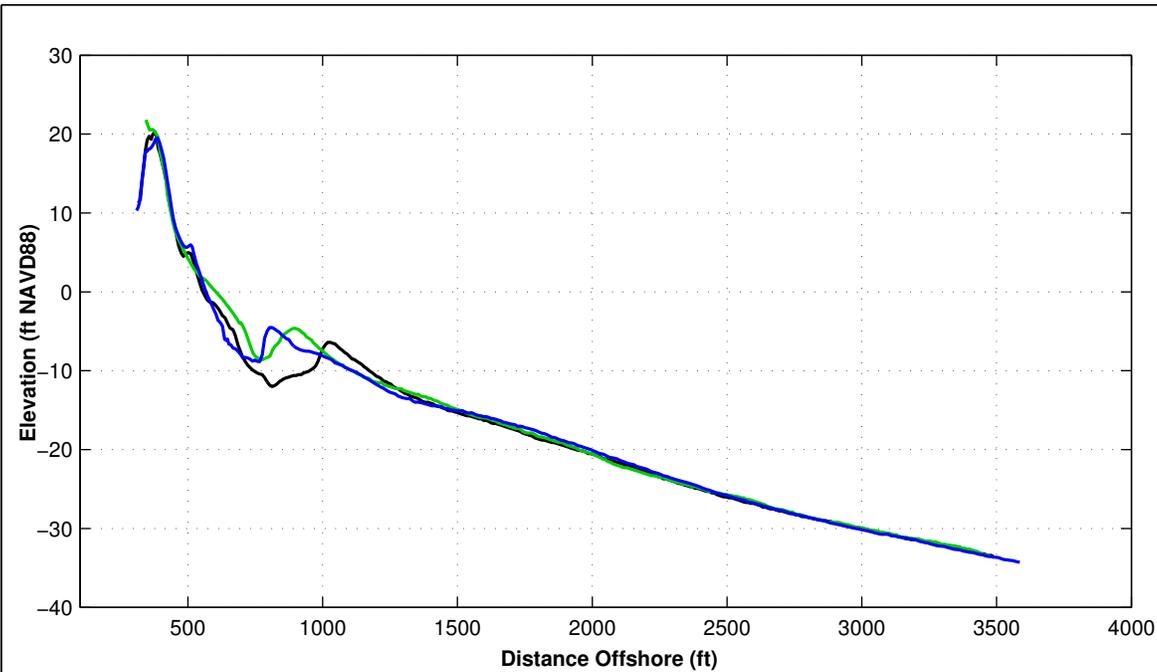
**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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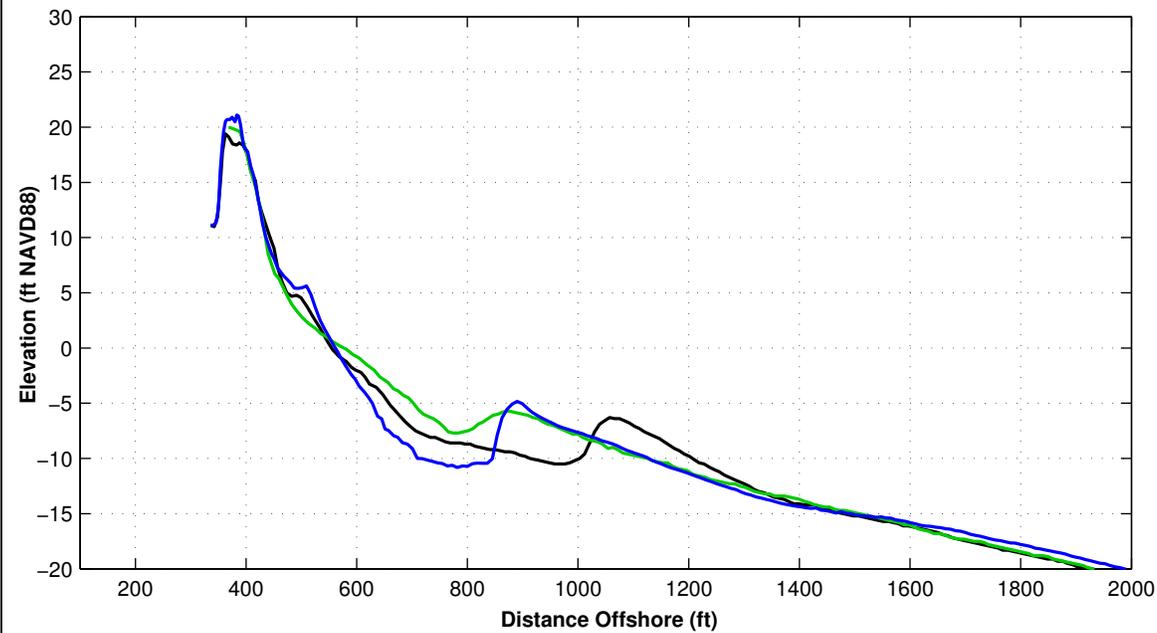
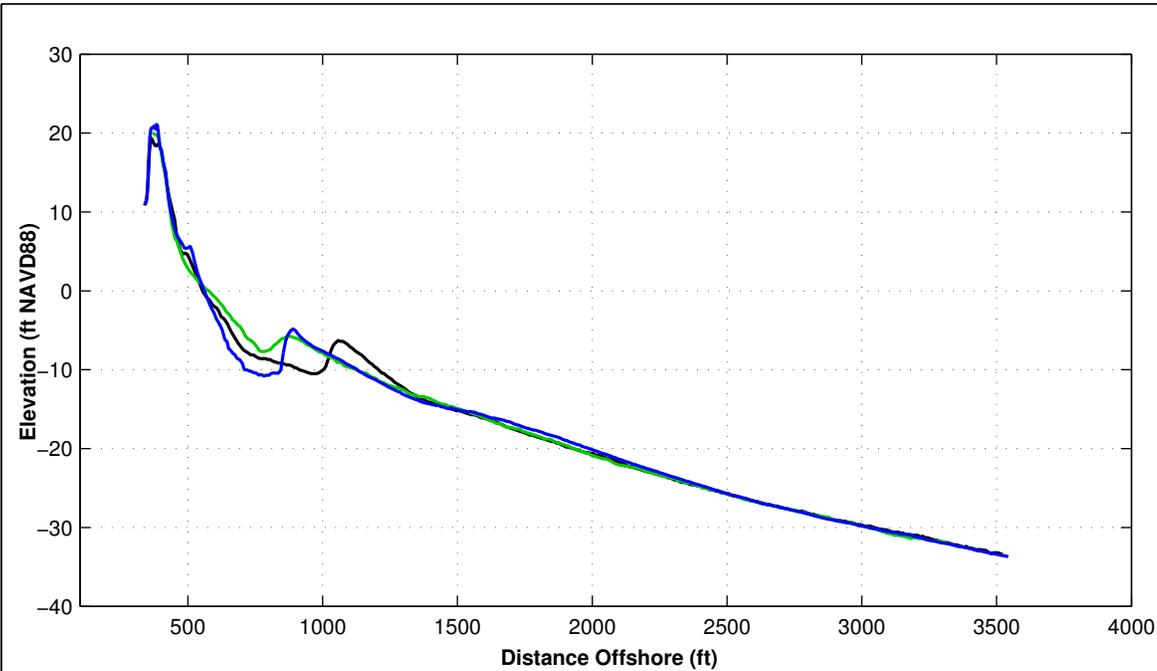
Survey Transect 565+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	72.97 ft	-14.60 ft
Volume Change Above +6 ft NAVD88	5.36 cy/ft	3.50 cy/ft
Volume Change Above 1.18 ft NAVD88	15.42 cy/ft	1.62 cy/ft
Volume Change Above -6 ft NAVD88	25.59 cy/ft	4.27 cy/ft
Volume Change Above -14 ft NAVD88	-7.44 cy/ft	52.61 cy/ft
Volume Change Above -19 ft NAVD88	-7.57 cy/ft	37.85 cy/ft
Volume Change Above -30 ft NAVD88	4.49 cy/ft	24.36 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

Notes:  
 1. Station From North To South At Varying Intervals.  
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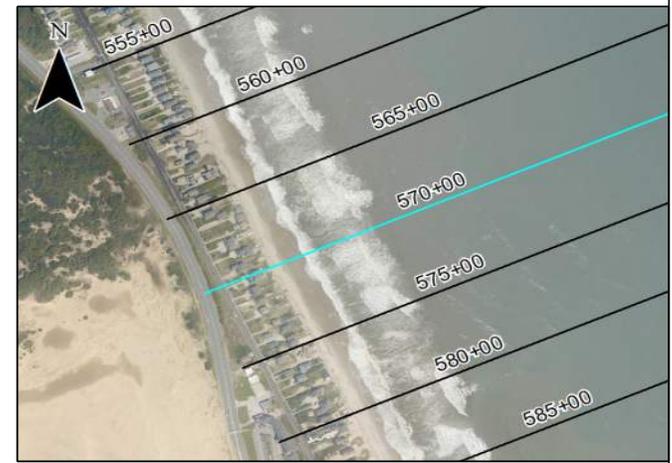
Survey Transect 570+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	10.62 ft	28.24 ft
Volume Change Above +6 ft NAVD88	2.81 cy/ft	4.62 cy/ft
Volume Change Above 1.18 ft NAVD88	5.16 cy/ft	8.18 cy/ft
Volume Change Above -6 ft NAVD88	2.30 cy/ft	14.16 cy/ft
Volume Change Above -14 ft NAVD88	-15.78 cy/ft	57.19 cy/ft
Volume Change Above -19 ft NAVD88	-21.66 cy/ft	62.54 cy/ft
Volume Change Above -30 ft NAVD88	-16.20 cy/ft	40.95 cy/ft

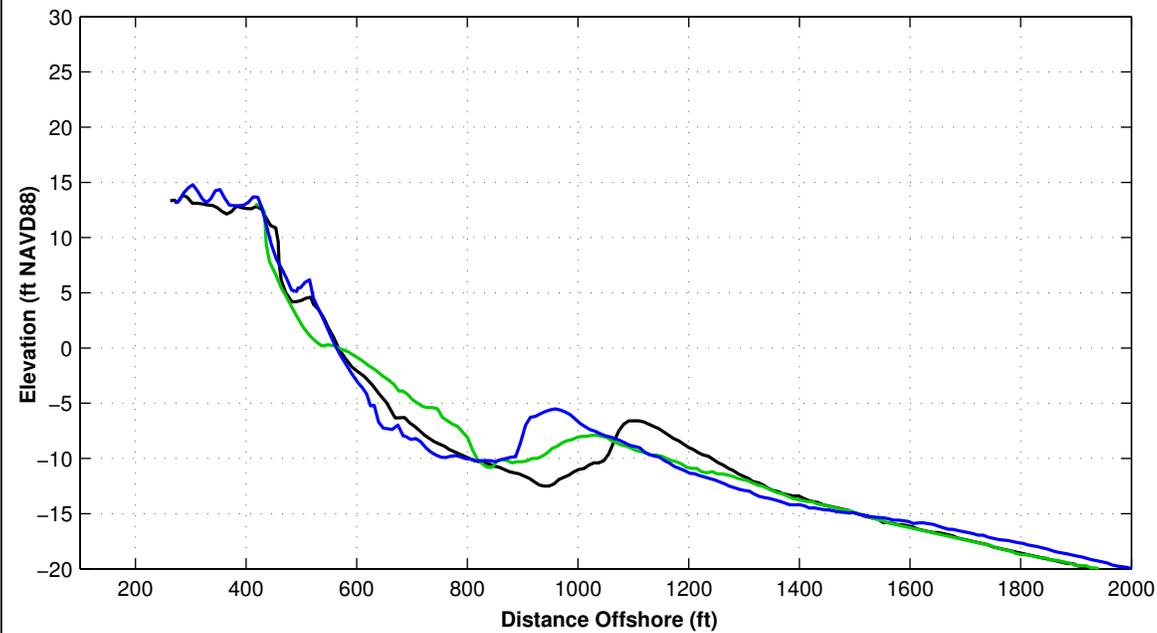
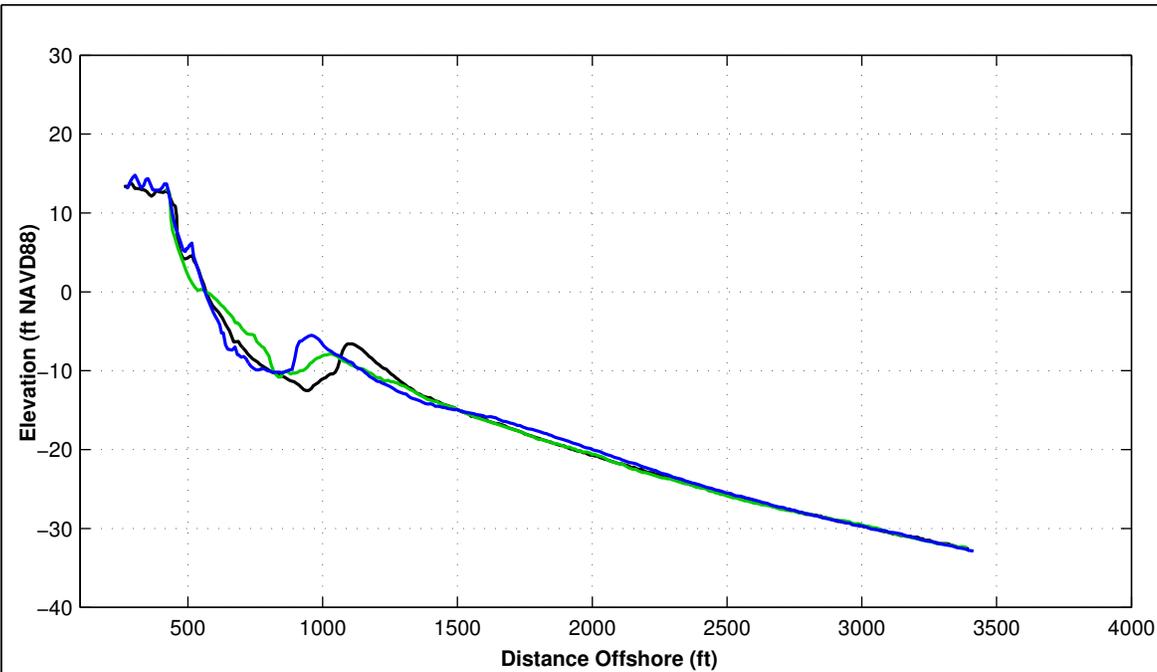
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

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Survey Transect 575+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	27.16 ft	-23.85 ft
Volume Change Above +6 ft NAVD88	4.85 cy/ft	3.97 cy/ft
Volume Change Above 1.18 ft NAVD88	8.53 cy/ft	0.56 cy/ft
Volume Change Above -6 ft NAVD88	6.90 cy/ft	-2.05 cy/ft
Volume Change Above -14 ft NAVD88	1.58 cy/ft	33.61 cy/ft
Volume Change Above -19 ft NAVD88	-2.23 cy/ft	29.33 cy/ft
Volume Change Above -30 ft NAVD88	6.44 cy/ft	20.10 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

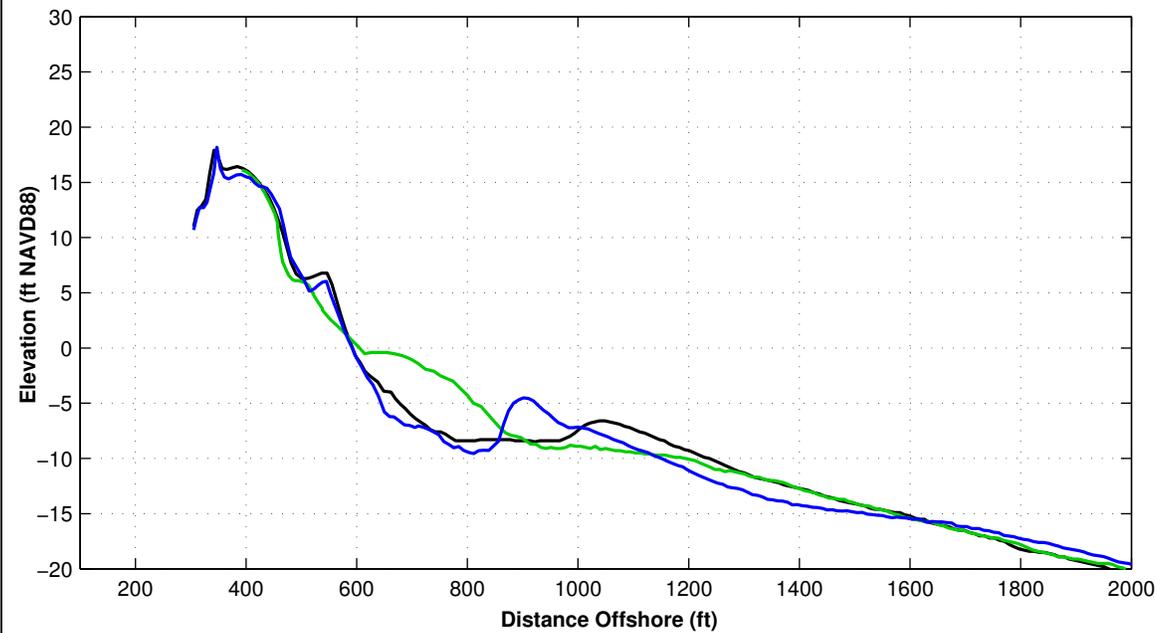
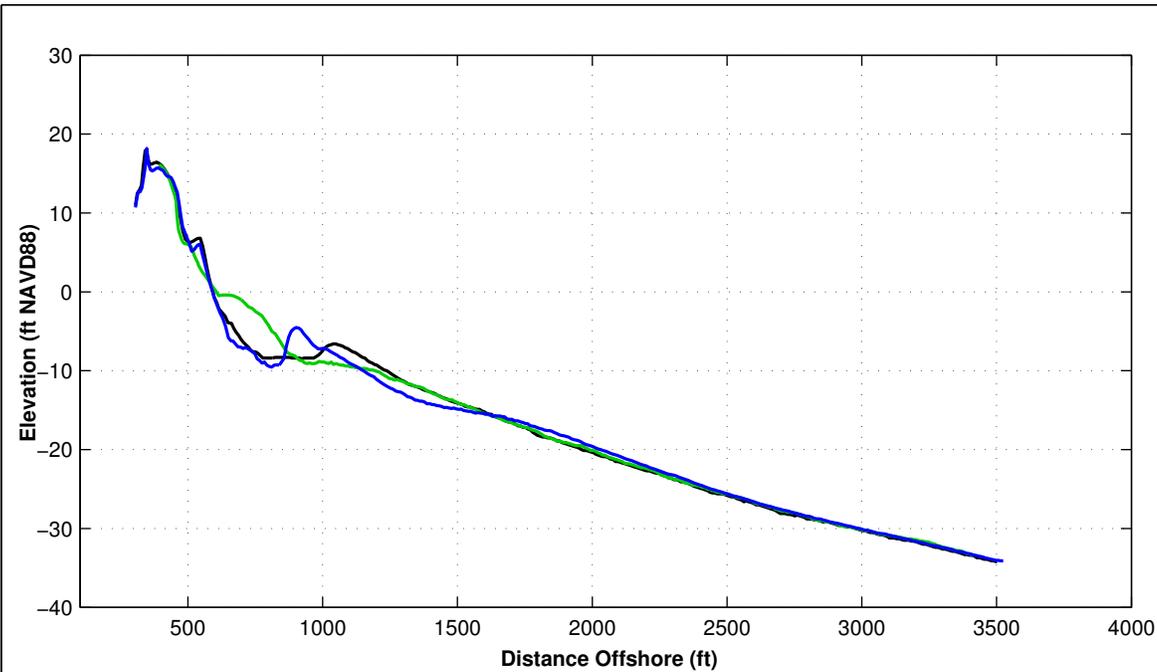
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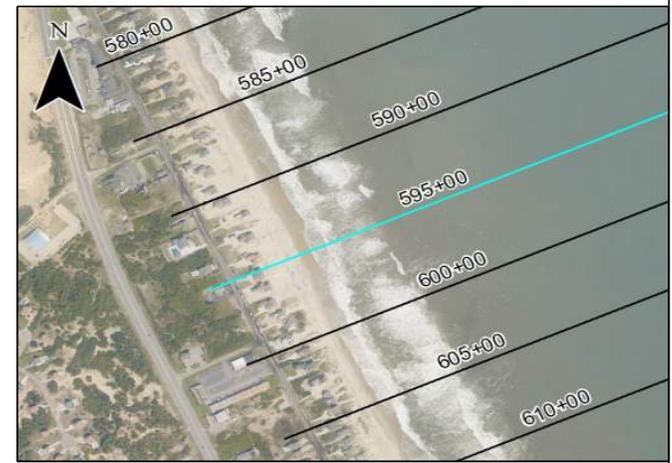
Survey Transect 595+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	33.35 ft	23.78 ft
Volume Change Above +6 ft NAVD88	8.92 cy/ft	1.78 cy/ft
Volume Change Above 1.18 ft NAVD88	16.28 cy/ft	3.78 cy/ft
Volume Change Above -6 ft NAVD88	21.44 cy/ft	5.54 cy/ft
Volume Change Above -14 ft NAVD88	37.39 cy/ft	29.66 cy/ft
Volume Change Above -19 ft NAVD88	45.75 cy/ft	32.24 cy/ft
Volume Change Above -30 ft NAVD88	63.29 cy/ft	31.27 cy/ft

**LEGEND:**

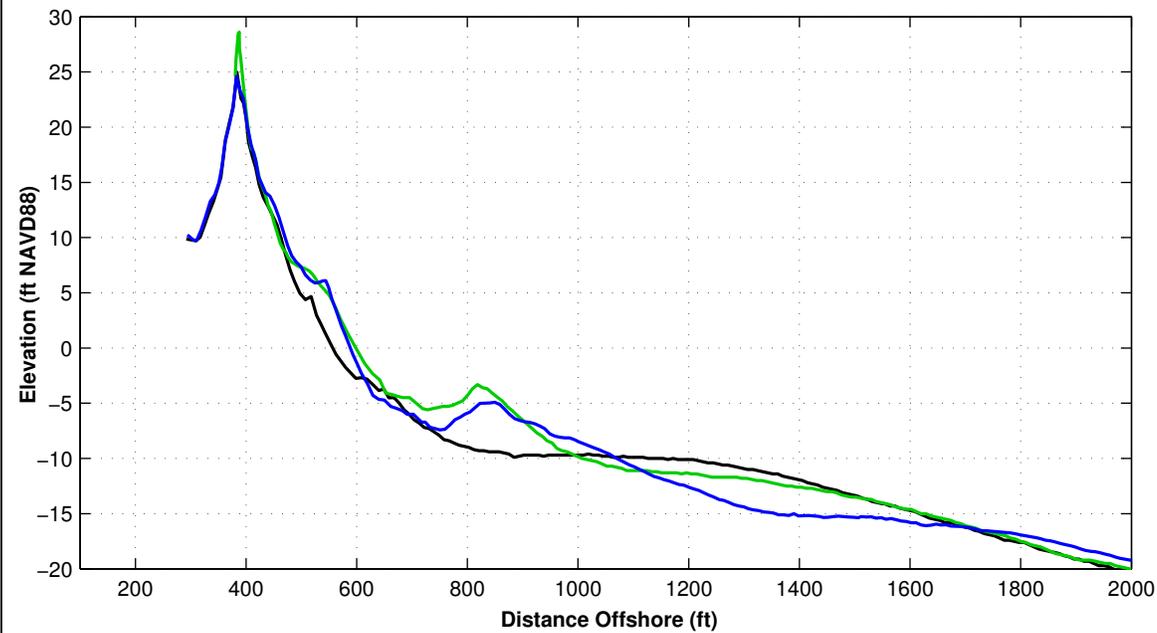
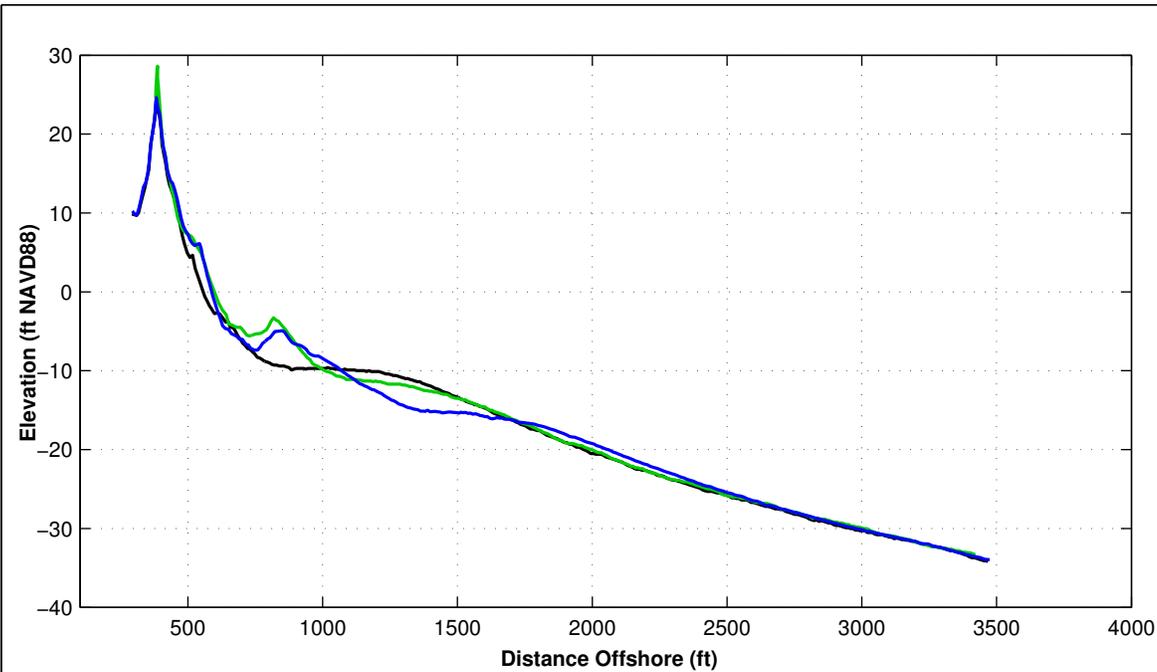
JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

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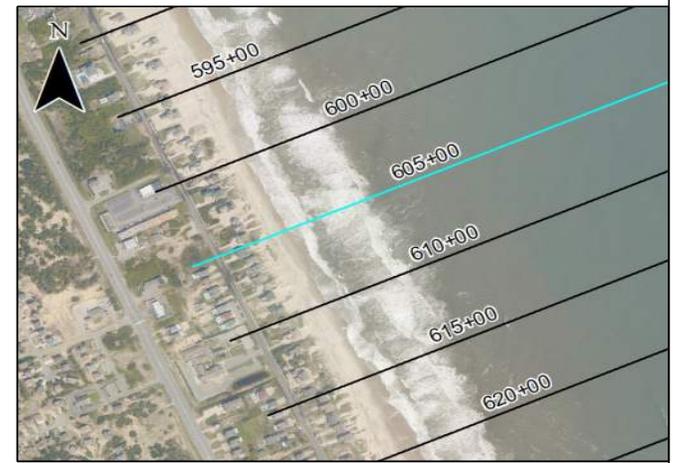


Survey Transect 605+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-41.02 ft	46.11 ft
Volume Change Above +6 ft NAVD88	7.25 cy/ft	4.79 cy/ft
Volume Change Above 1.18 ft NAVD88	5.45 cy/ft	9.23 cy/ft
Volume Change Above -6 ft NAVD88	-8.31 cy/ft	18.01 cy/ft
Volume Change Above -14 ft NAVD88	-20.95 cy/ft	31.84 cy/ft
Volume Change Above -19 ft NAVD88	-17.32 cy/ft	6.46 cy/ft
Volume Change Above -30 ft NAVD88	-20.06 cy/ft	14.15 cy/ft

**LEGEND:**

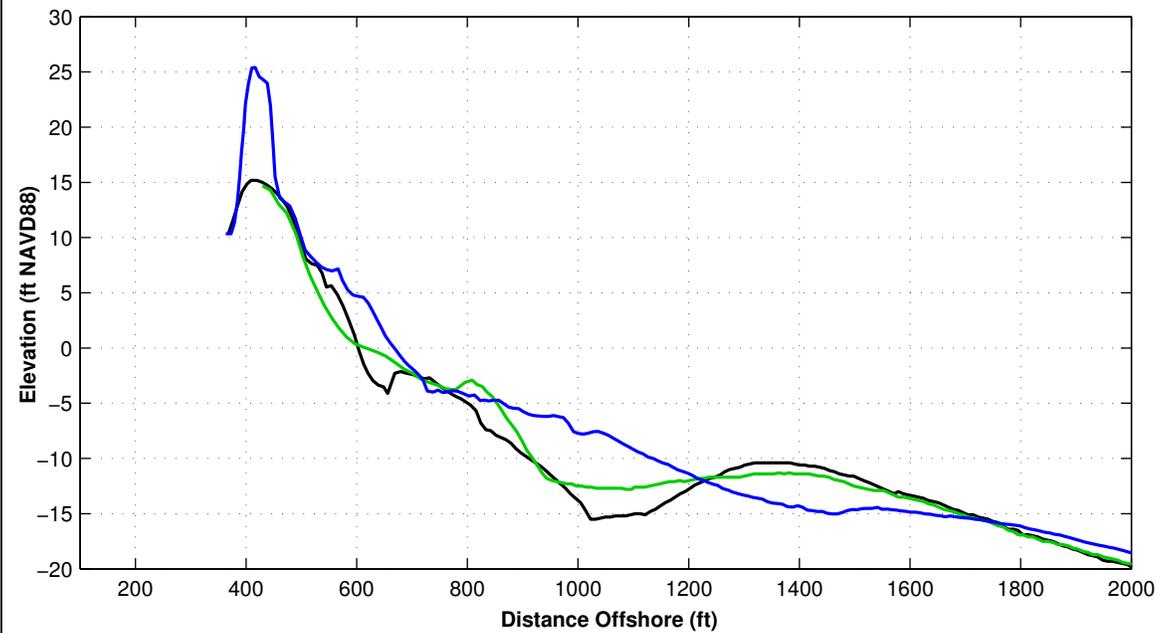
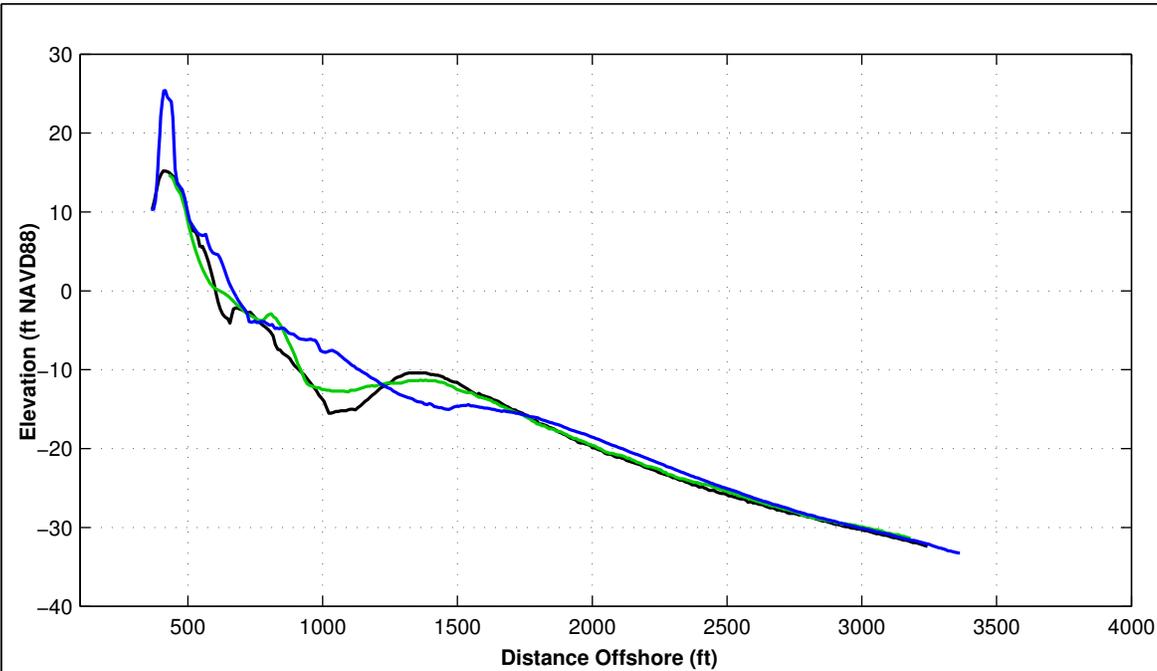
JUNE 2024		OCTOBER 2023	
		JUNE 2023	

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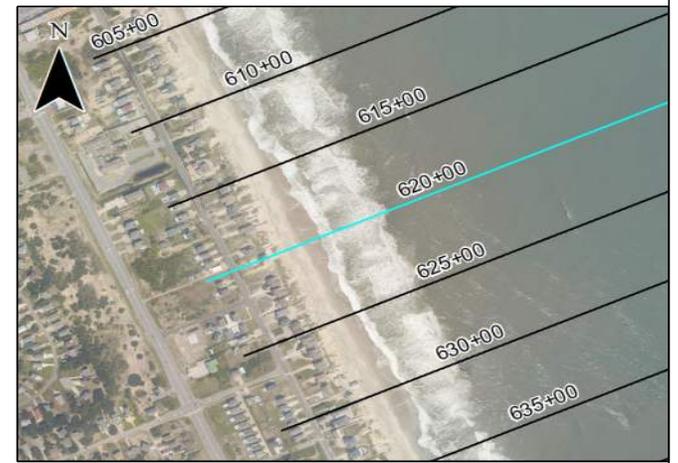
Survey Transect 620+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	23.53 ft	52.68 ft
Volume Change Above +6 ft NAVD88	4.33 cy/ft	3.73 cy/ft
Volume Change Above 1.18 ft NAVD88	9.76 cy/ft	9.03 cy/ft
Volume Change Above -6 ft NAVD88	10.77 cy/ft	15.87 cy/ft
Volume Change Above -14 ft NAVD88	31.37 cy/ft	12.75 cy/ft
Volume Change Above -19 ft NAVD88	42.03 cy/ft	-12.33 cy/ft
Volume Change Above -30 ft NAVD88	57.63 cy/ft	-36.29 cy/ft

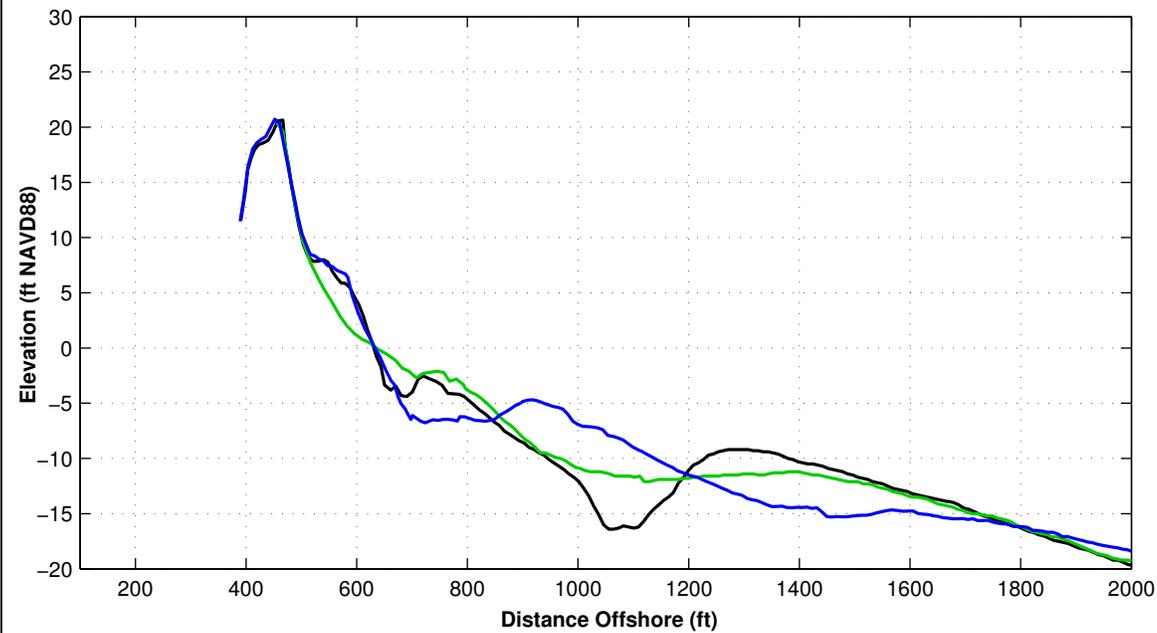
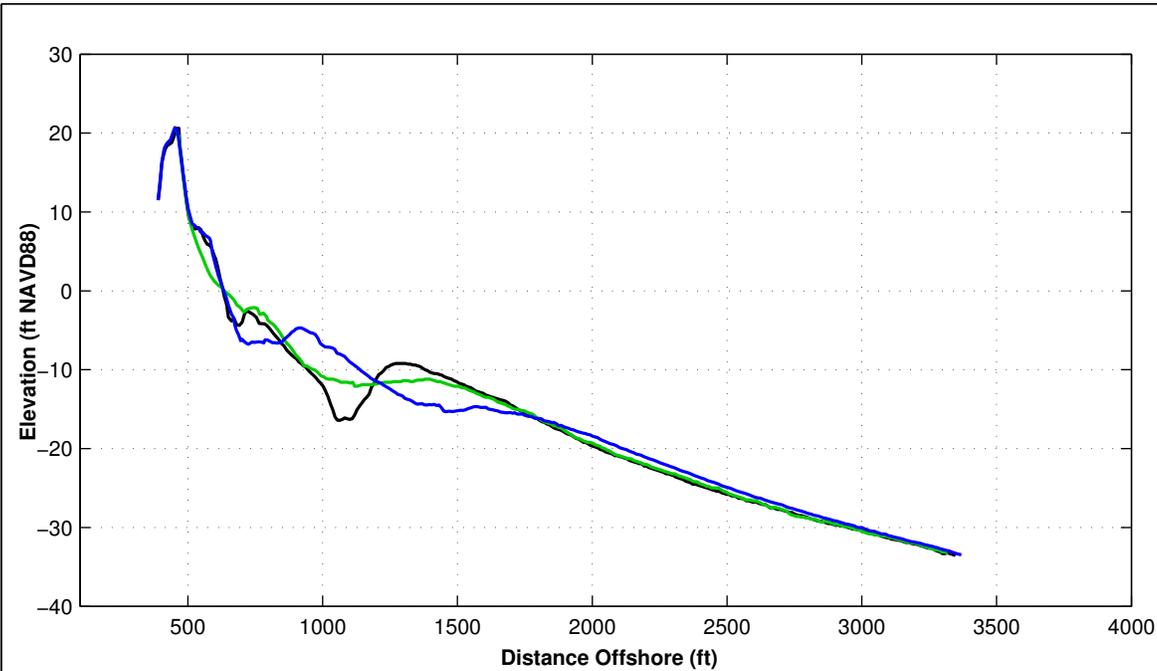
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JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

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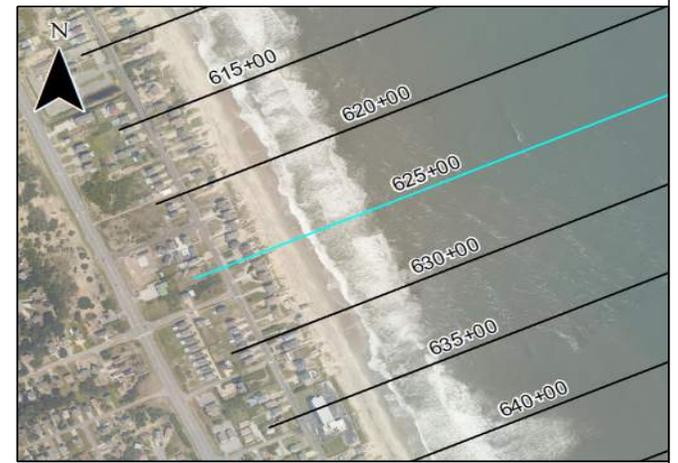


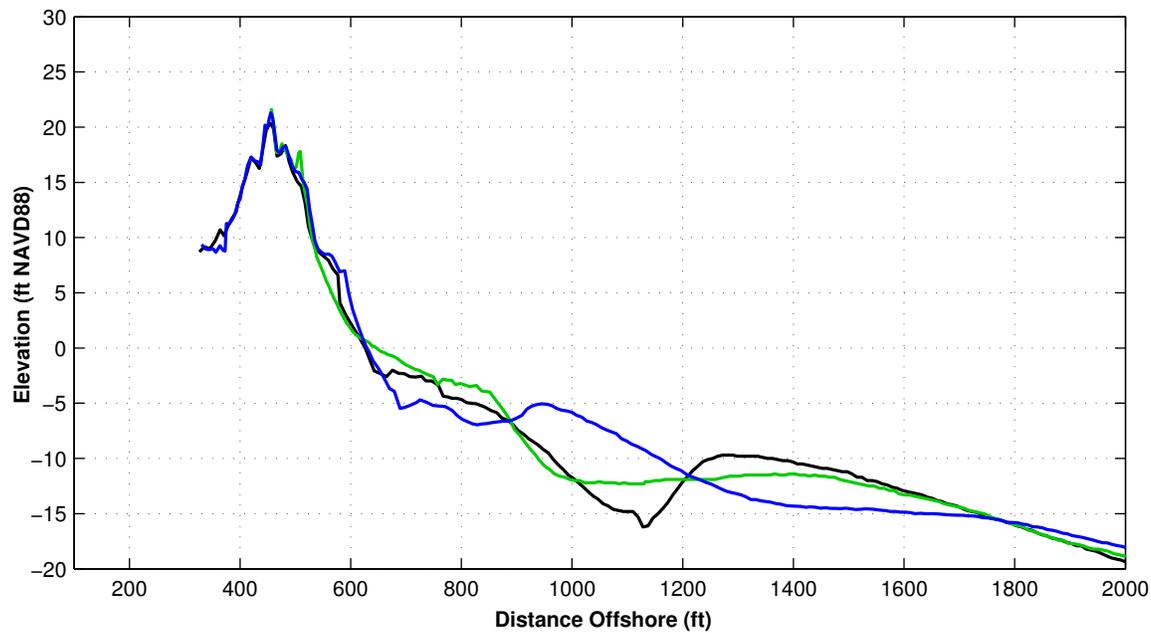
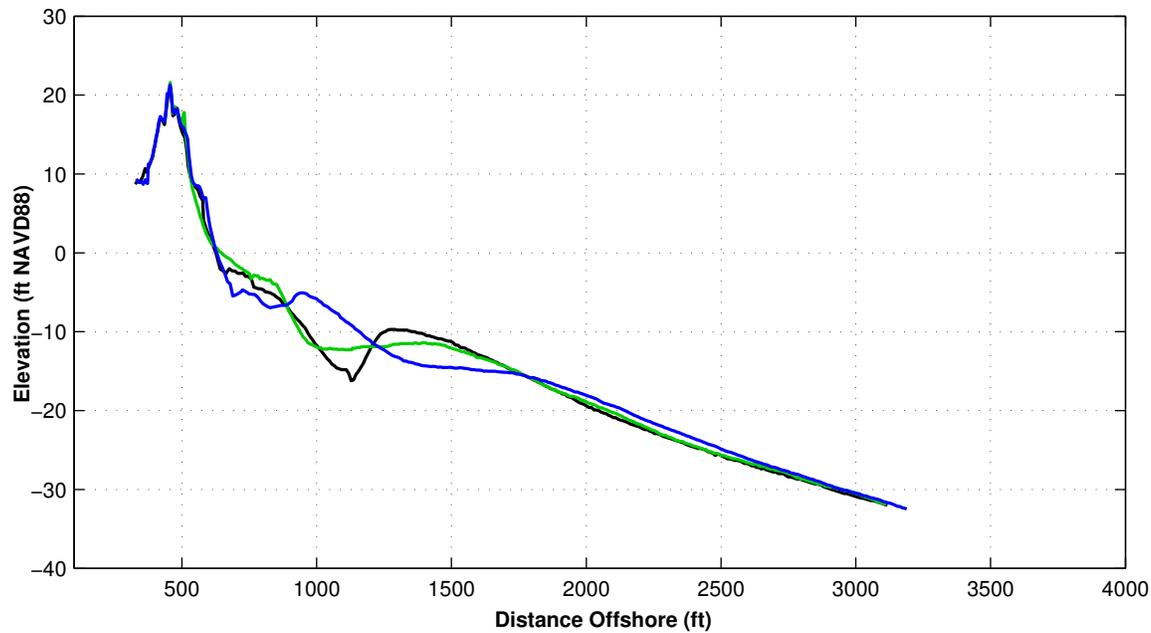
Survey Transect 625+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	33.74 ft	52.93 ft
Volume Change Above +6 ft NAVD88	5.32 cy/ft	2.78 cy/ft
Volume Change Above 1.18 ft NAVD88	13.76 cy/ft	8.41 cy/ft
Volume Change Above -6 ft NAVD88	11.94 cy/ft	14.40 cy/ft
Volume Change Above -14 ft NAVD88	16.92 cy/ft	29.50 cy/ft
Volume Change Above -19 ft NAVD88	23.98 cy/ft	12.35 cy/ft
Volume Change Above -30 ft NAVD88	41.27 cy/ft	-12.26 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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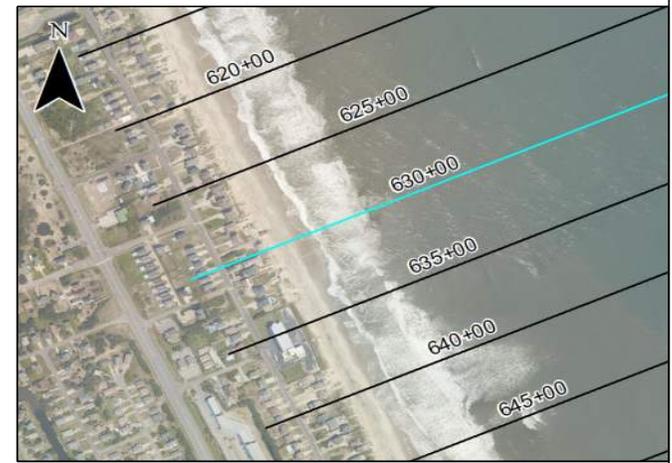
Survey Transect 630+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-21.34 ft	52.83 ft
Volume Change Above +6 ft NAVD88	4.20 cy/ft	1.01 cy/ft
Volume Change Above 1.18 ft NAVD88	4.27 cy/ft	6.24 cy/ft
Volume Change Above -6 ft NAVD88	-18.69 cy/ft	13.27 cy/ft
Volume Change Above -14 ft NAVD88	-29.72 cy/ft	51.73 cy/ft
Volume Change Above -19 ft NAVD88	-27.32 cy/ft	53.51 cy/ft
Volume Change Above -30 ft NAVD88	-20.41 cy/ft	17.87 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————  
 JUNE 2023 ————

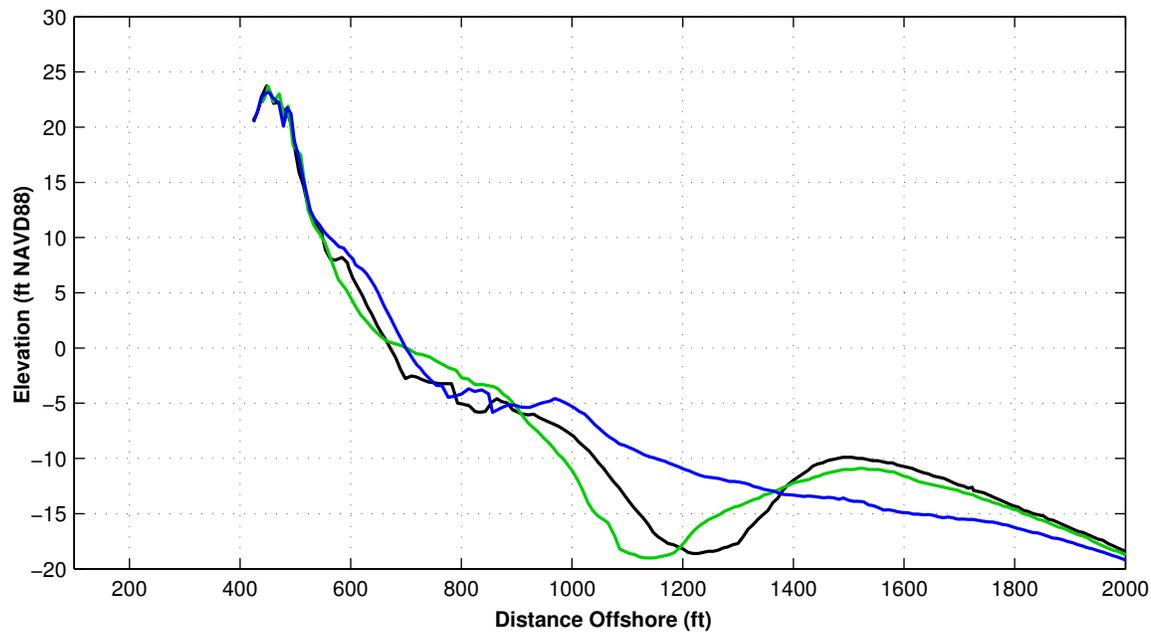
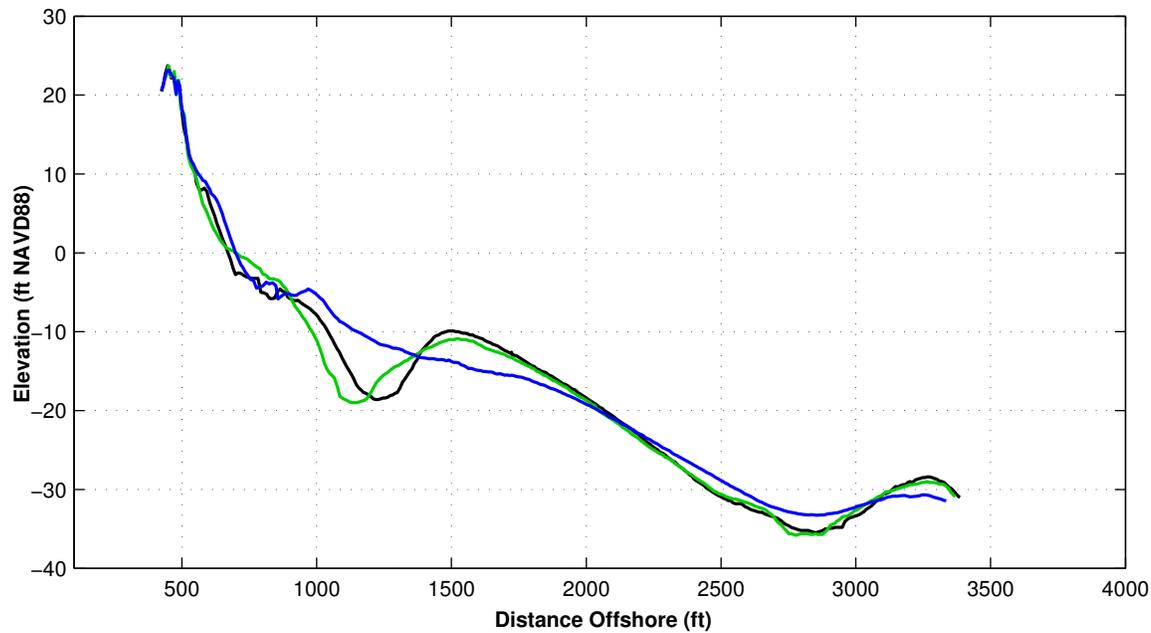
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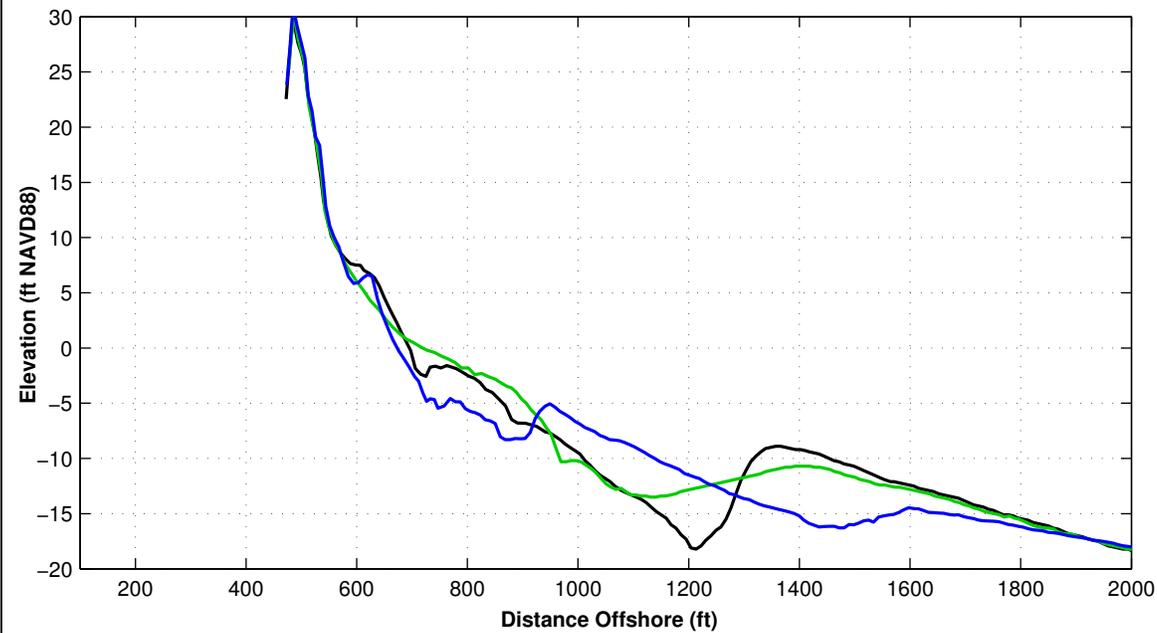
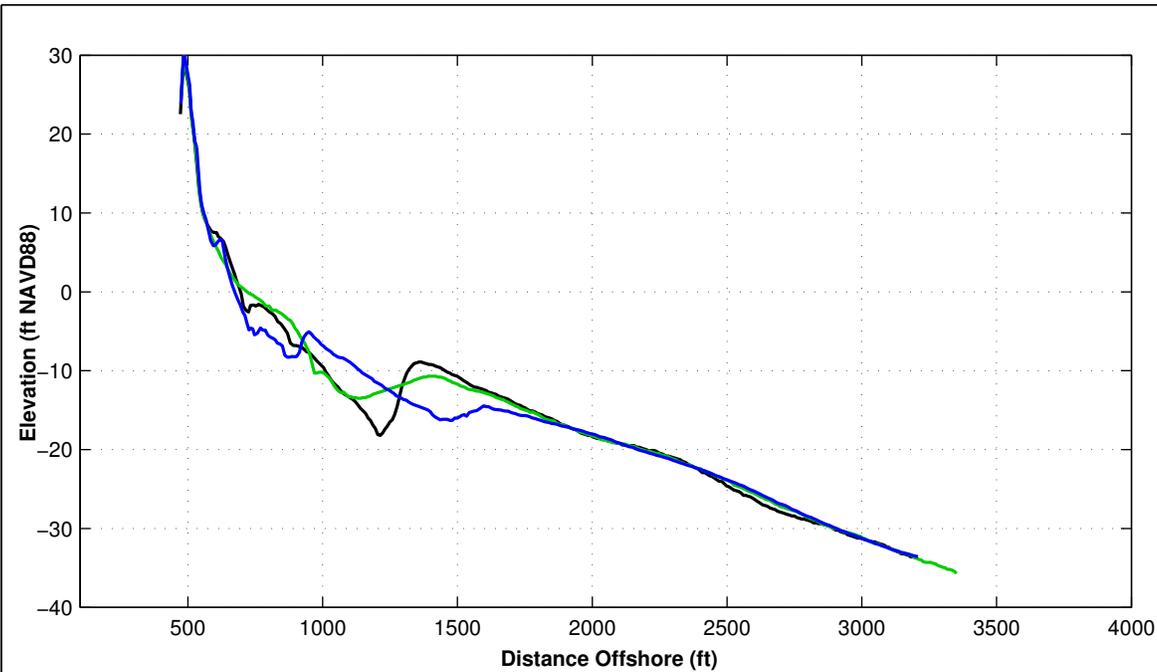
Survey Transect 645+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-8.73 ft	70.01 ft
Volume Change Above +6 ft NAVD88	6.48 cy/ft	6.05 cy/ft
Volume Change Above 1.18 ft NAVD88	7.61 cy/ft	17.15 cy/ft
Volume Change Above -6 ft NAVD88	-10.45 cy/ft	33.28 cy/ft
Volume Change Above -14 ft NAVD88	-19.77 cy/ft	70.84 cy/ft
Volume Change Above -19 ft NAVD88	-14.39 cy/ft	44.24 cy/ft
Volume Change Above -30 ft NAVD88	-2.80 cy/ft	21.36 cy/ft

**LEGEND:**  
 JUNE 2024 ———— OCTOBER 2023 ————  
 JUNE 2023 ————

- Notes:  
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Survey Transect 655+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	0.88 ft	64.68 ft
Volume Change Above +6 ft NAVD88	0.40 cy/ft	4.32 cy/ft
Volume Change Above 1.18 ft NAVD88	6.37 cy/ft	9.50 cy/ft
Volume Change Above -6 ft NAVD88	-12.21 cy/ft	28.48 cy/ft
Volume Change Above -14 ft NAVD88	-2.81 cy/ft	51.32 cy/ft
Volume Change Above -19 ft NAVD88	-0.75 cy/ft	25.26 cy/ft
Volume Change Above -30 ft NAVD88	13.30 cy/ft	1.63 cy/ft

**LEGEND:**

JUNE 2024 ————

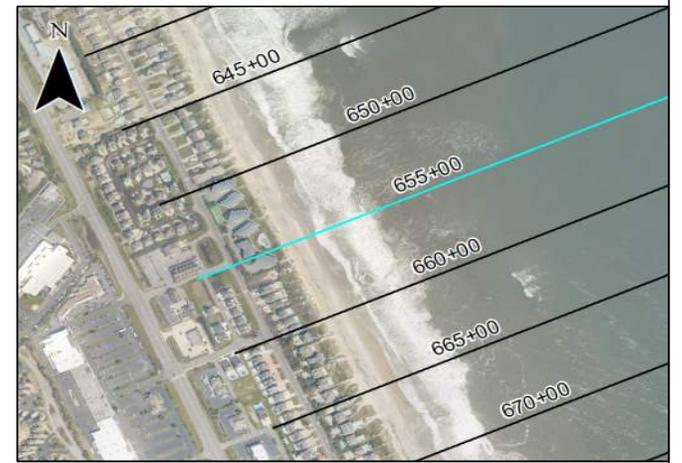
OCTOBER 2023 ————

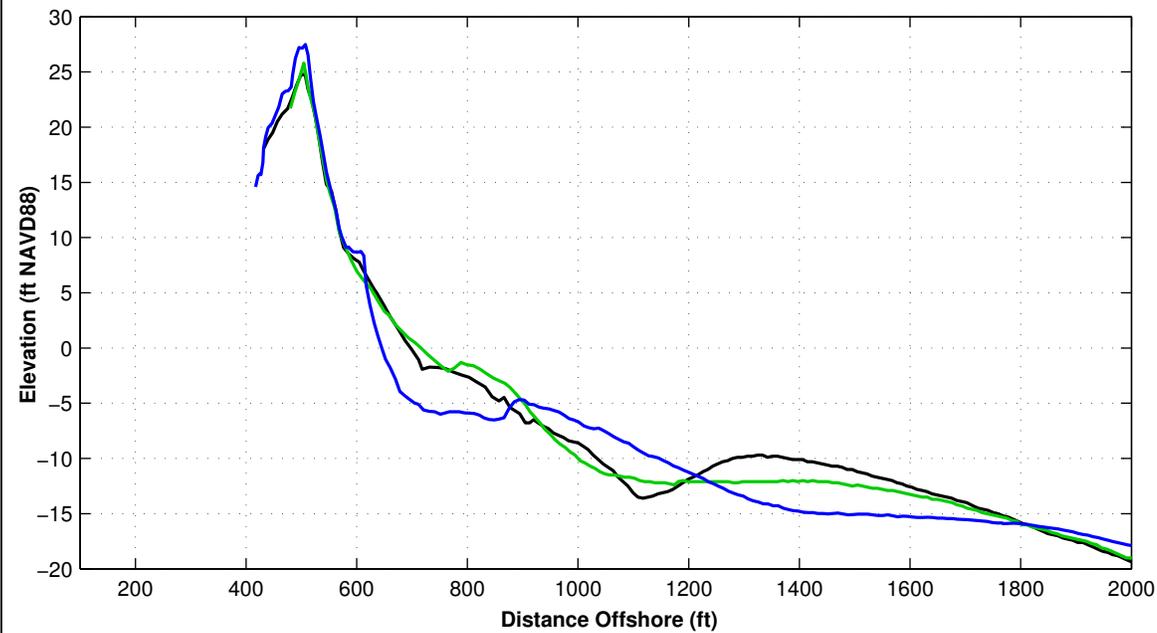
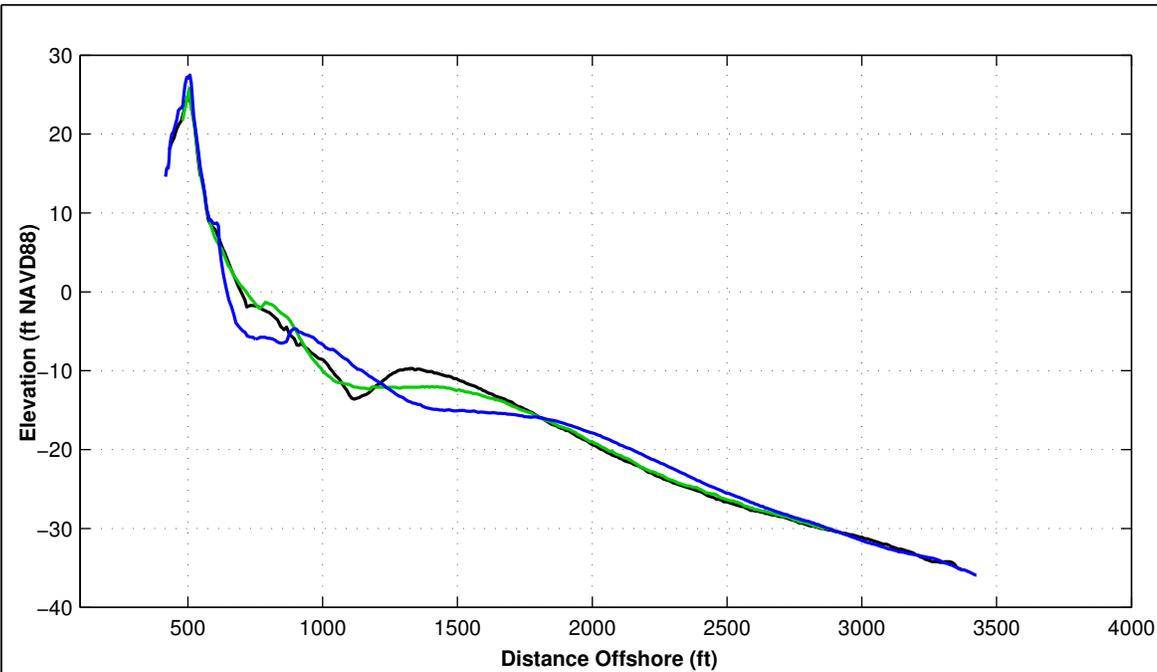
JUNE 2023 ————

OCTOBER 2023 ————

Notes:

1. Station From North To South At Varying Intervals.
2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 660+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-15.48 ft	51.91 ft
Volume Change Above +6 ft NAVD88	4.57 cy/ft	2.46 cy/ft
Volume Change Above 1.18 ft NAVD88	4.37 cy/ft	10.38 cy/ft
Volume Change Above -6 ft NAVD88	-13.16 cy/ft	22.85 cy/ft
Volume Change Above -14 ft NAVD88	-38.87 cy/ft	66.40 cy/ft
Volume Change Above -19 ft NAVD88	-43.10 cy/ft	38.83 cy/ft
Volume Change Above -30 ft NAVD88	-27.72 cy/ft	15.60 cy/ft

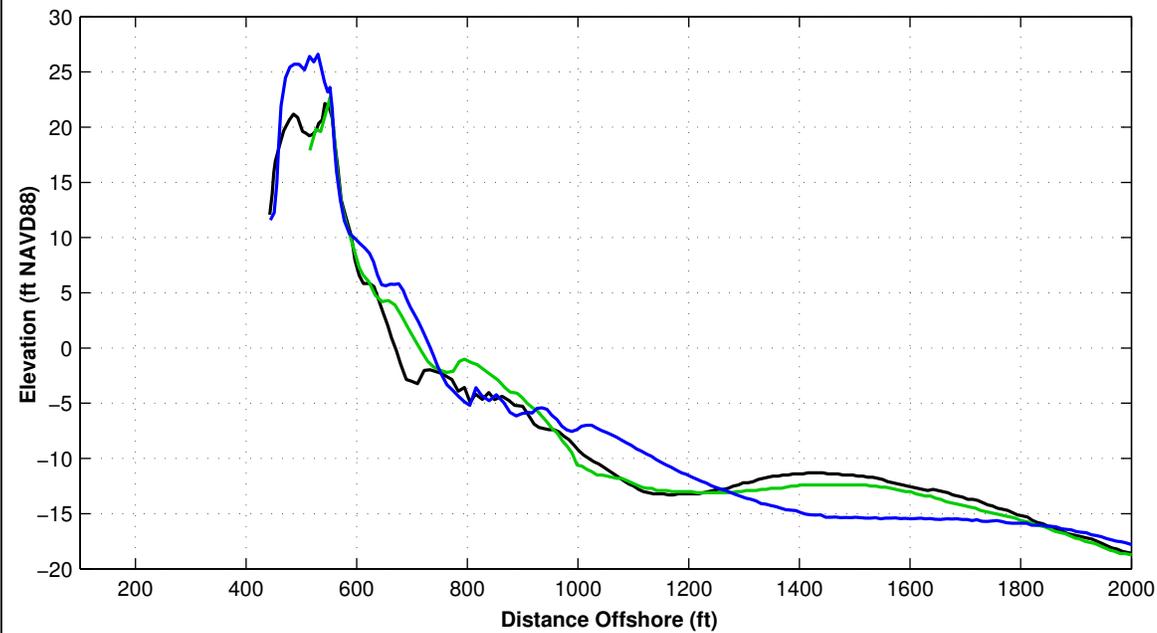
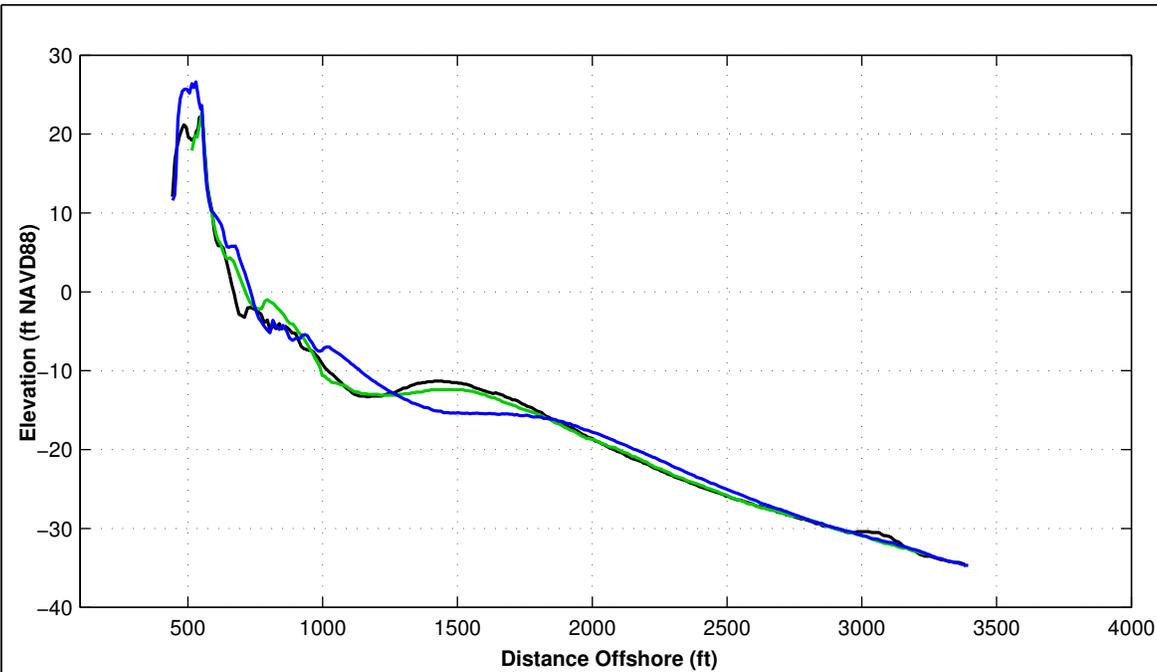
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 665+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-0.50 ft	42.02 ft
Volume Change Above +6 ft NAVD88	3.43 cy/ft	-0.35 cy/ft
Volume Change Above 1.18 ft NAVD88	6.50 cy/ft	6.53 cy/ft
Volume Change Above -6 ft NAVD88	-11.07 cy/ft	16.89 cy/ft
Volume Change Above -14 ft NAVD88	-16.14 cy/ft	66.70 cy/ft
Volume Change Above -19 ft NAVD88	-19.16 cy/ft	42.37 cy/ft
Volume Change Above -30 ft NAVD88	-1.64 cy/ft	17.48 cy/ft

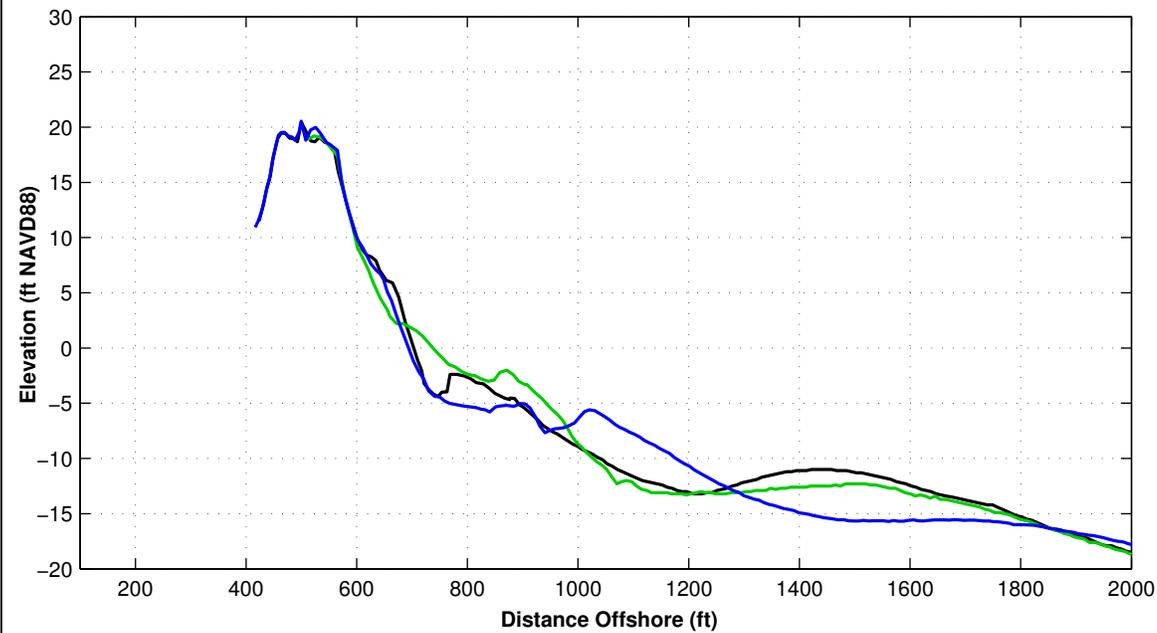
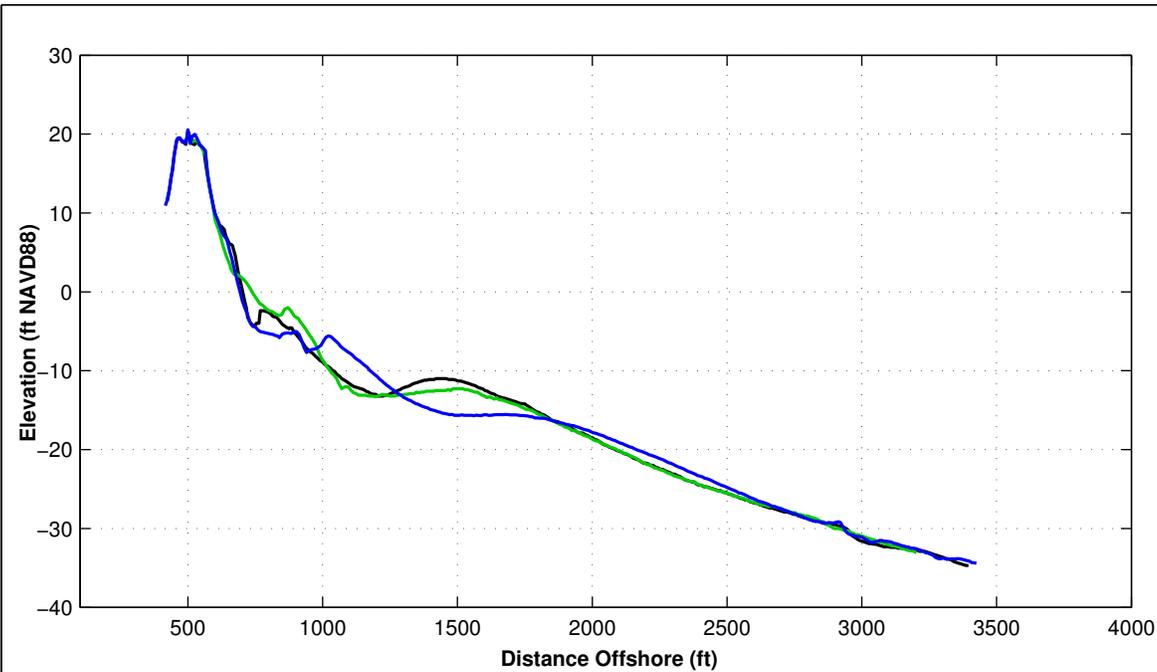
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





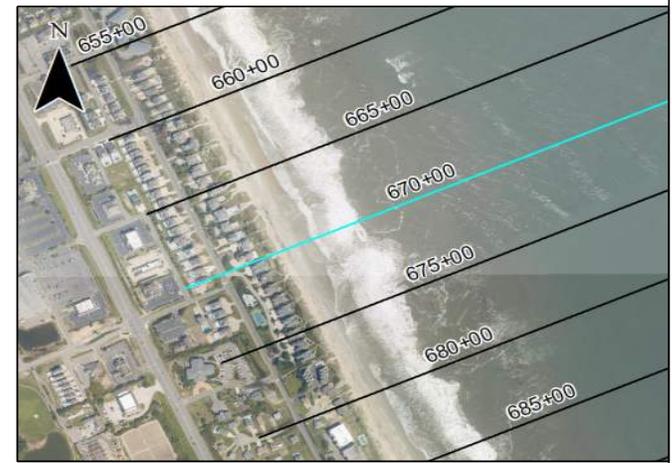
Survey Transect 670+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	46.20 ft	3.42 ft
Volume Change Above +6 ft NAVD88	4.61 cy/ft	3.56 cy/ft
Volume Change Above 1.18 ft NAVD88	13.15 cy/ft	6.07 cy/ft
Volume Change Above -6 ft NAVD88	1.29 cy/ft	11.94 cy/ft
Volume Change Above -14 ft NAVD88	-3.16 cy/ft	59.33 cy/ft
Volume Change Above -19 ft NAVD88	-1.21 cy/ft	37.15 cy/ft
Volume Change Above -30 ft NAVD88	3.41 cy/ft	24.79 cy/ft

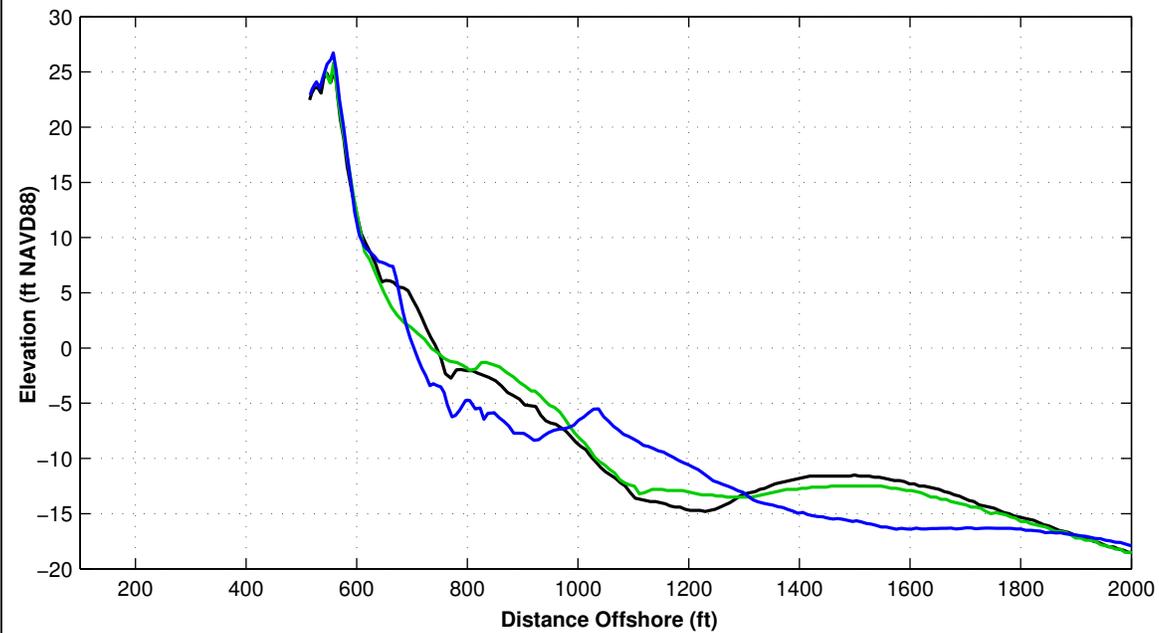
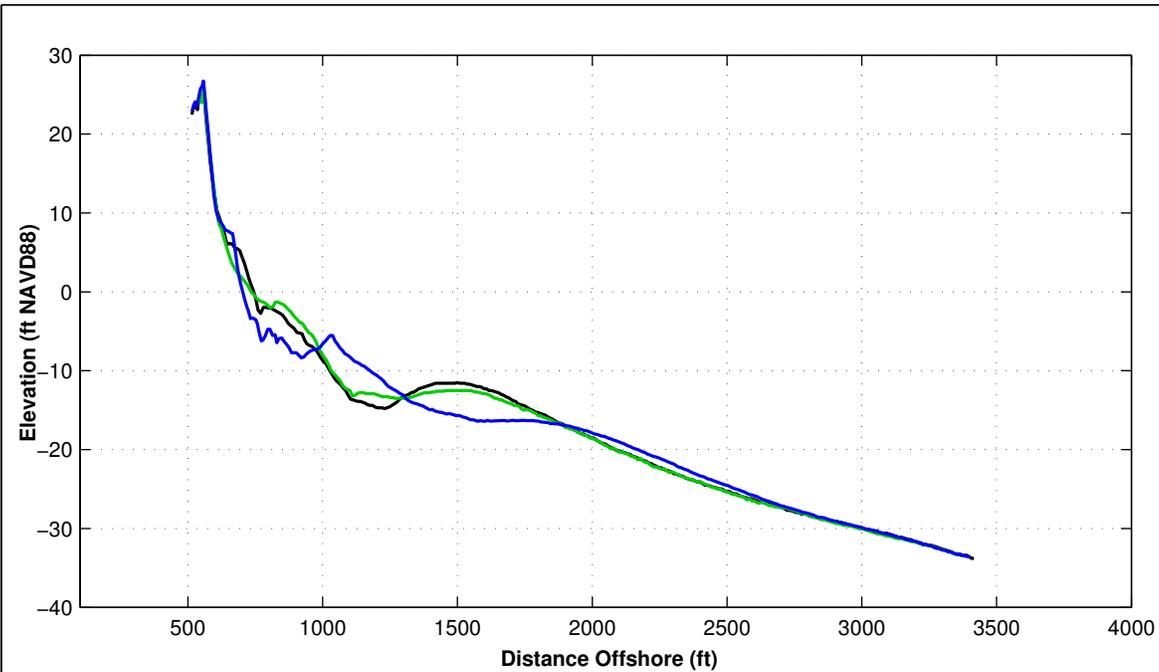
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ———— OCTOBER 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 675+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	1.87 ft	34.49 ft
Volume Change Above +6 ft NAVD88	5.12 cy/ft	1.36 cy/ft
Volume Change Above 1.18 ft NAVD88	8.88 cy/ft	6.94 cy/ft
Volume Change Above -6 ft NAVD88	-10.47 cy/ft	18.25 cy/ft
Volume Change Above -14 ft NAVD88	-17.62 cy/ft	69.62 cy/ft
Volume Change Above -19 ft NAVD88	-19.92 cy/ft	46.82 cy/ft
Volume Change Above -30 ft NAVD88	-7.43 cy/ft	28.00 cy/ft

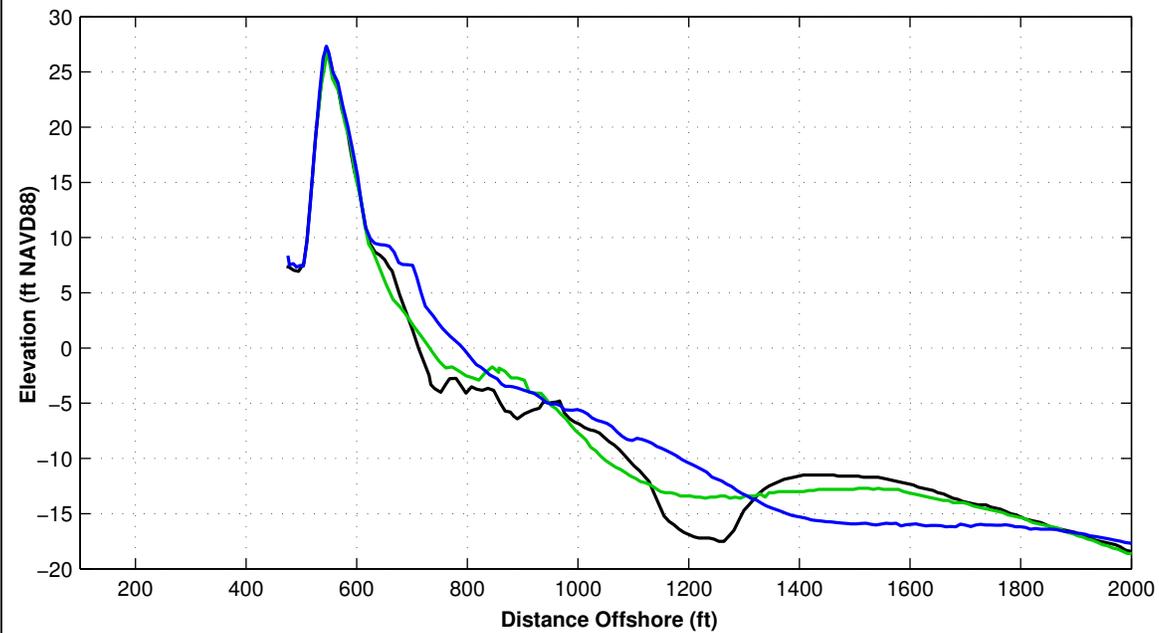
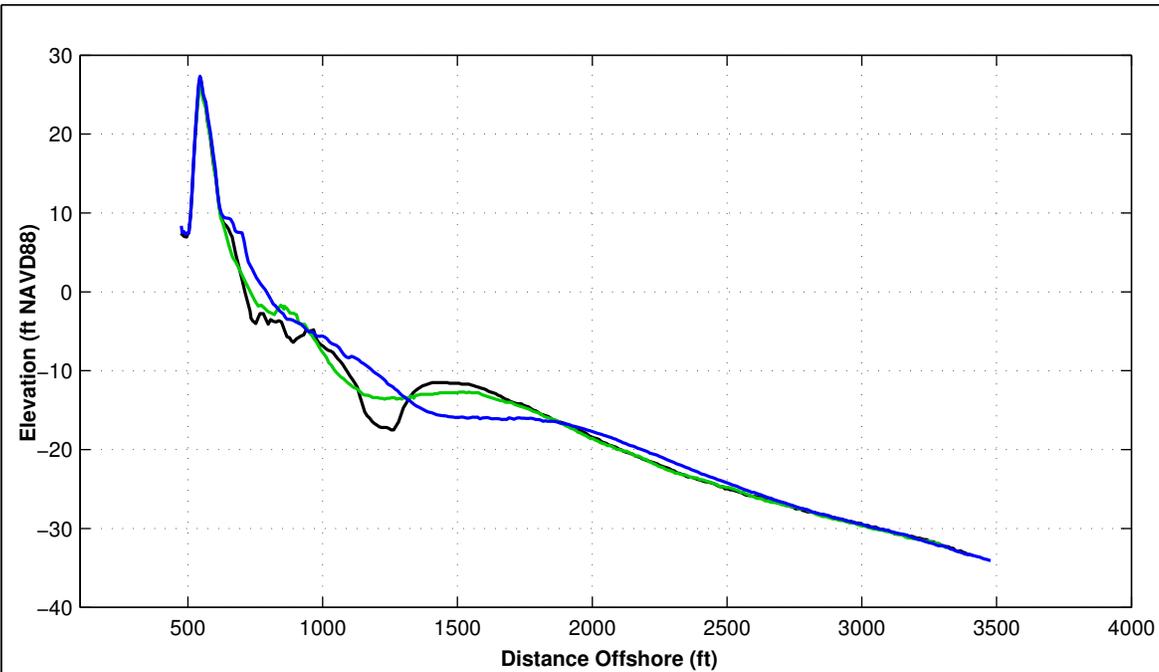
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



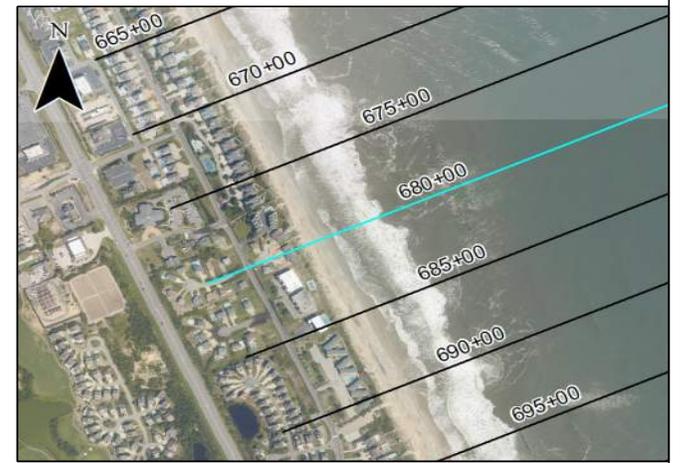


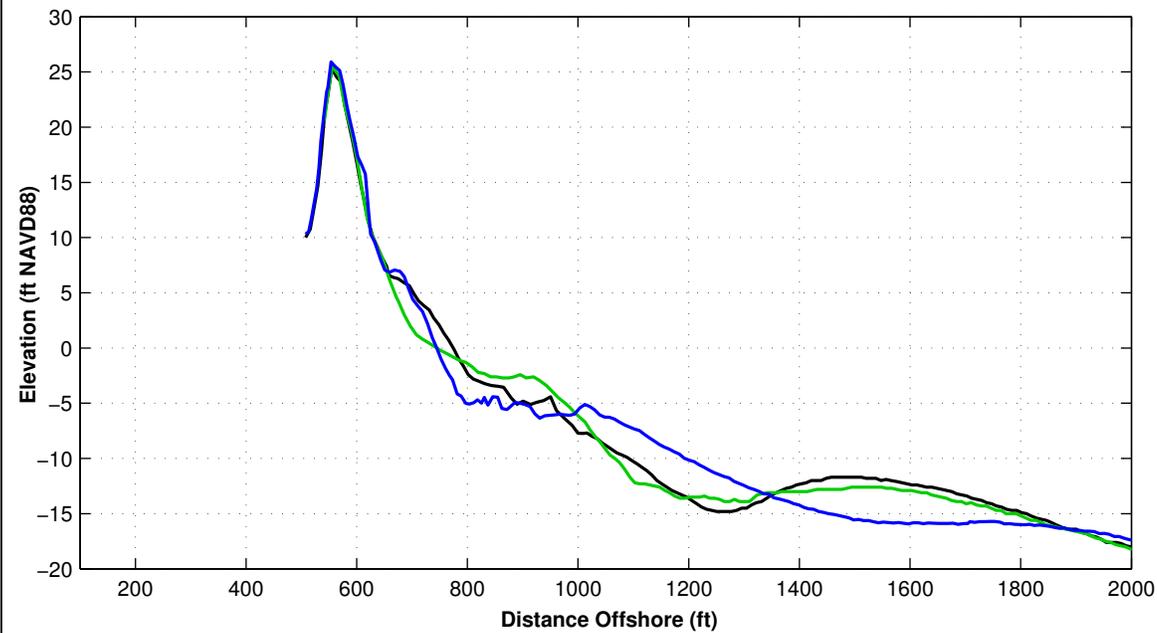
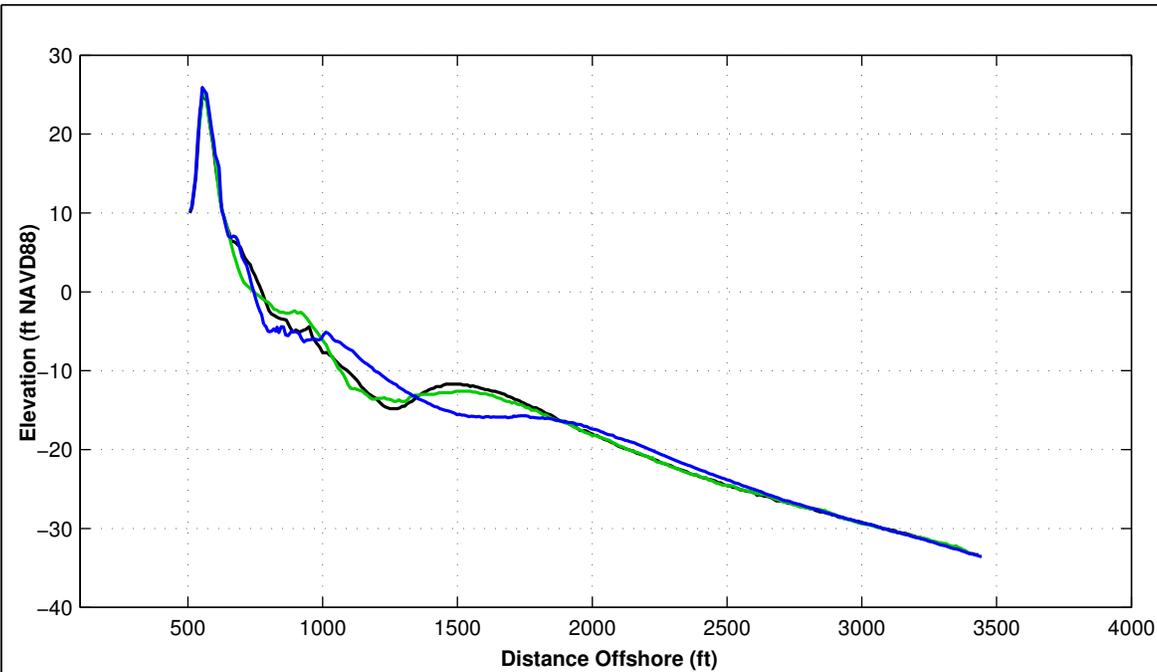
Survey Transect 680+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-0.27 ft	33.35 ft
Volume Change Above +6 ft NAVD88	2.87 cy/ft	-1.46 cy/ft
Volume Change Above 1.18 ft NAVD88	6.43 cy/ft	1.65 cy/ft
Volume Change Above -6 ft NAVD88	-15.73 cy/ft	17.24 cy/ft
Volume Change Above -14 ft NAVD88	-50.53 cy/ft	83.74 cy/ft
Volume Change Above -19 ft NAVD88	-52.14 cy/ft	61.43 cy/ft
Volume Change Above -30 ft NAVD88	-42.75 cy/ft	40.17 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





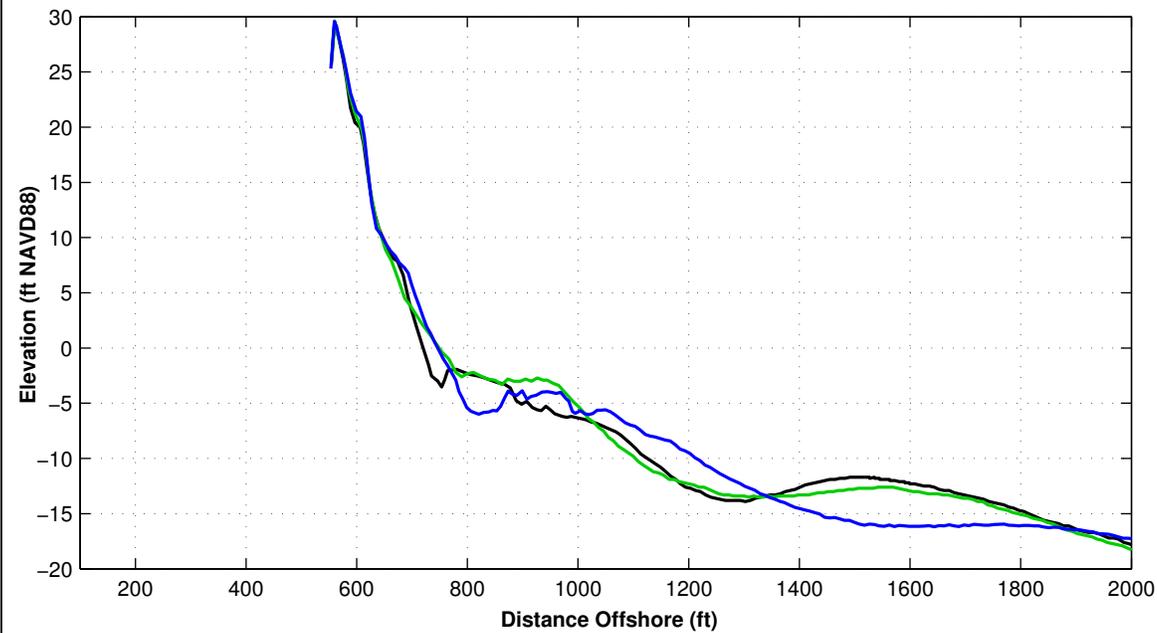
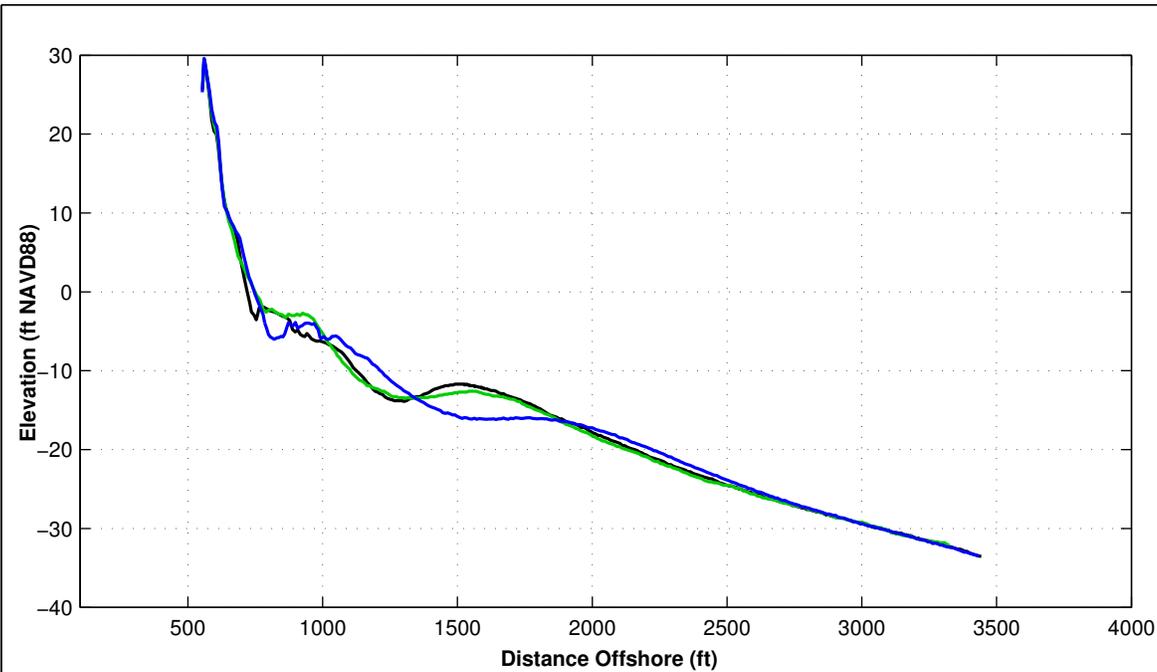
Survey Transect 685+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	40.13 ft	-16.61 ft
Volume Change Above +6 ft NAVD88	3.85 cy/ft	3.28 cy/ft
Volume Change Above 1.18 ft NAVD88	9.88 cy/ft	5.11 cy/ft
Volume Change Above -6 ft NAVD88	-0.55 cy/ft	10.14 cy/ft
Volume Change Above -14 ft NAVD88	-14.18 cy/ft	68.75 cy/ft
Volume Change Above -19 ft NAVD88	-17.70 cy/ft	47.16 cy/ft
Volume Change Above -30 ft NAVD88	-18.12 cy/ft	24.73 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————  
 JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



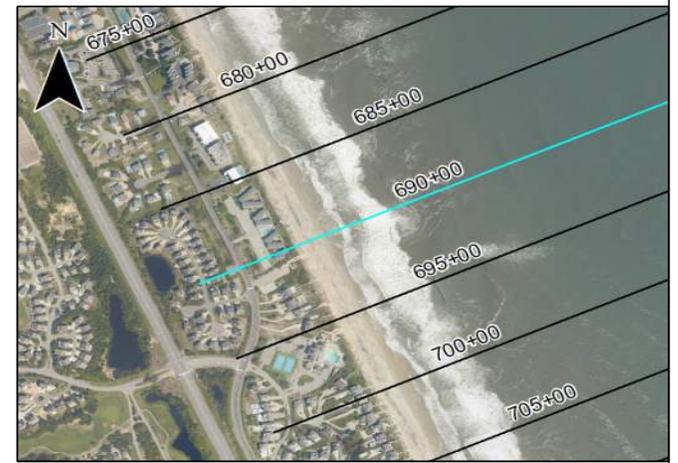


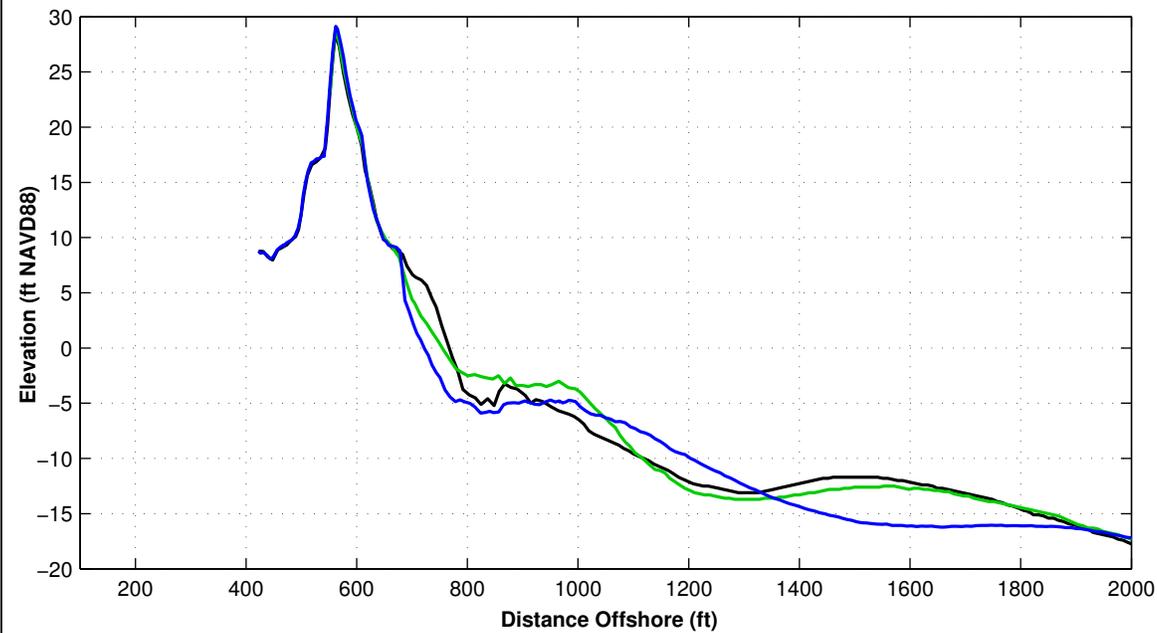
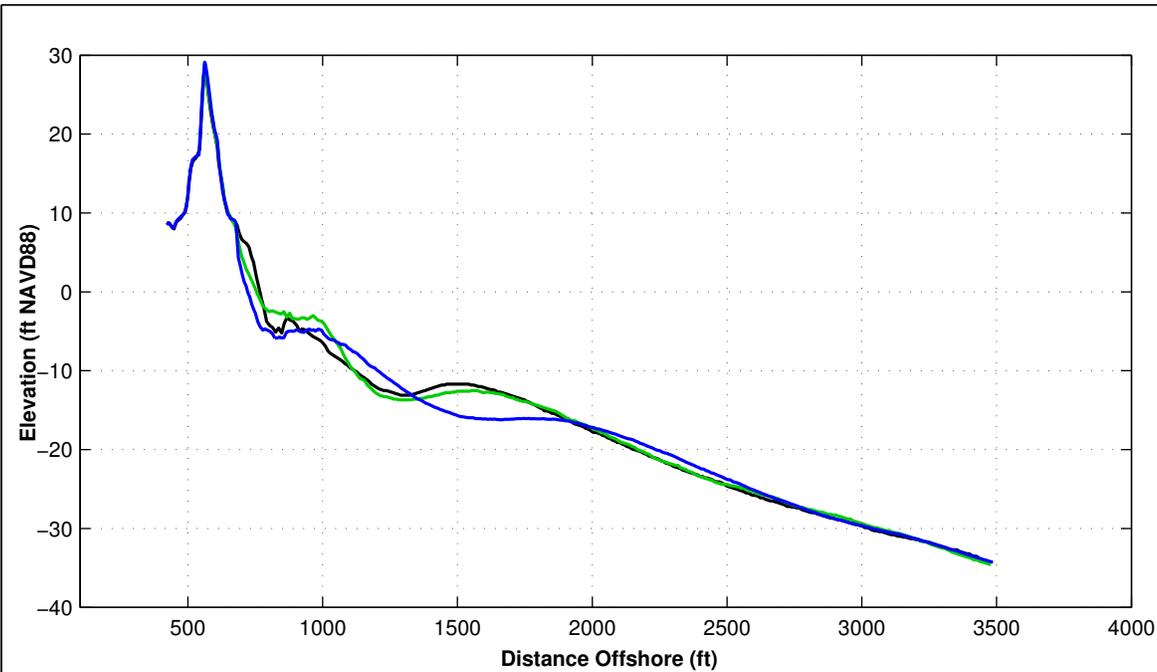
Survey Transect 690+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	26.63 ft	9.07 ft
Volume Change Above +6 ft NAVD88	4.55 cy/ft	3.66 cy/ft
Volume Change Above 1.18 ft NAVD88	9.13 cy/ft	6.51 cy/ft
Volume Change Above -6 ft NAVD88	-6.23 cy/ft	17.87 cy/ft
Volume Change Above -14 ft NAVD88	-34.06 cy/ft	66.03 cy/ft
Volume Change Above -19 ft NAVD88	-39.61 cy/ft	39.71 cy/ft
Volume Change Above -30 ft NAVD88	-41.97 cy/ft	18.29 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



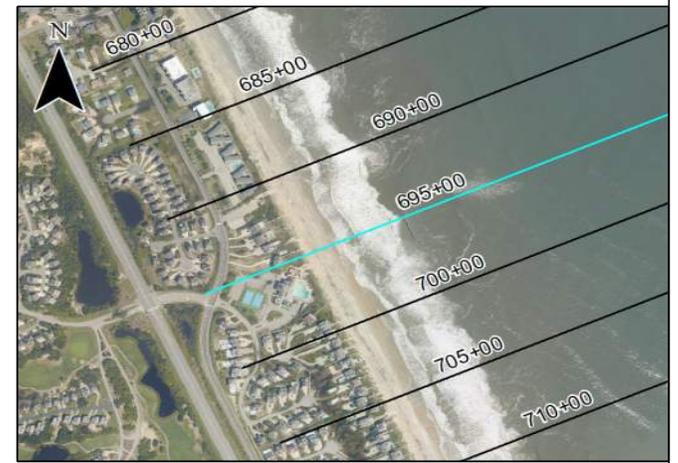


Survey Transect 695+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	20.05 ft	8.81 ft
Volume Change Above +6 ft NAVD88	0.48 cy/ft	5.41 cy/ft
Volume Change Above 1.18 ft NAVD88	3.81 cy/ft	8.30 cy/ft
Volume Change Above -6 ft NAVD88	-13.08 cy/ft	18.13 cy/ft
Volume Change Above -14 ft NAVD88	-45.25 cy/ft	76.47 cy/ft
Volume Change Above -19 ft NAVD88	-48.49 cy/ft	54.92 cy/ft
Volume Change Above -30 ft NAVD88	-42.77 cy/ft	26.12 cy/ft

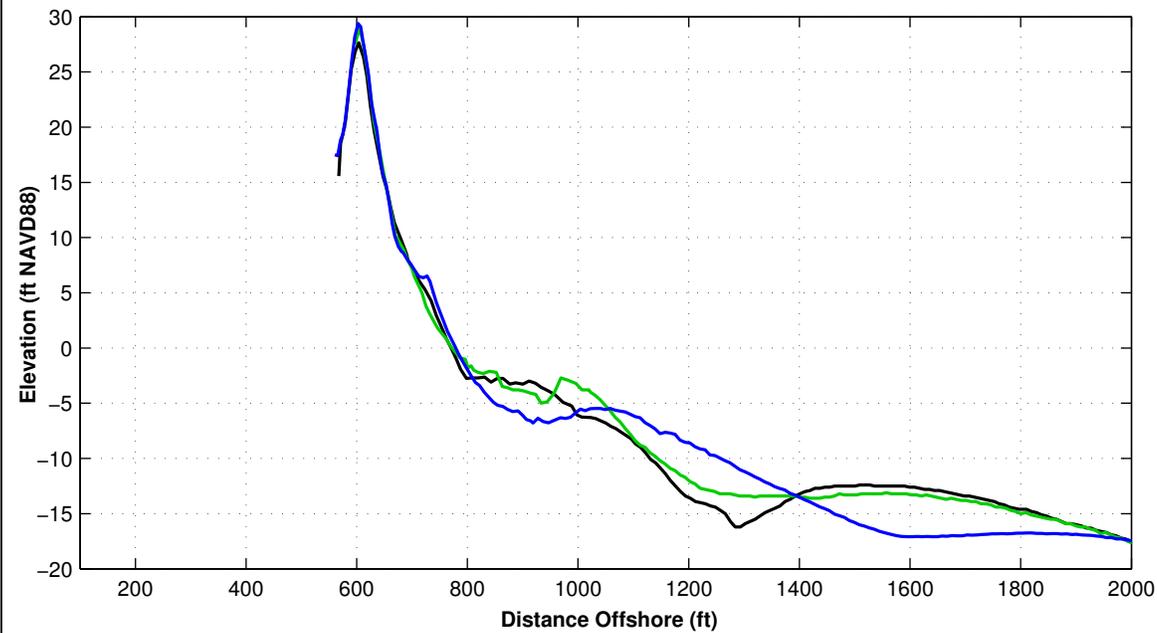
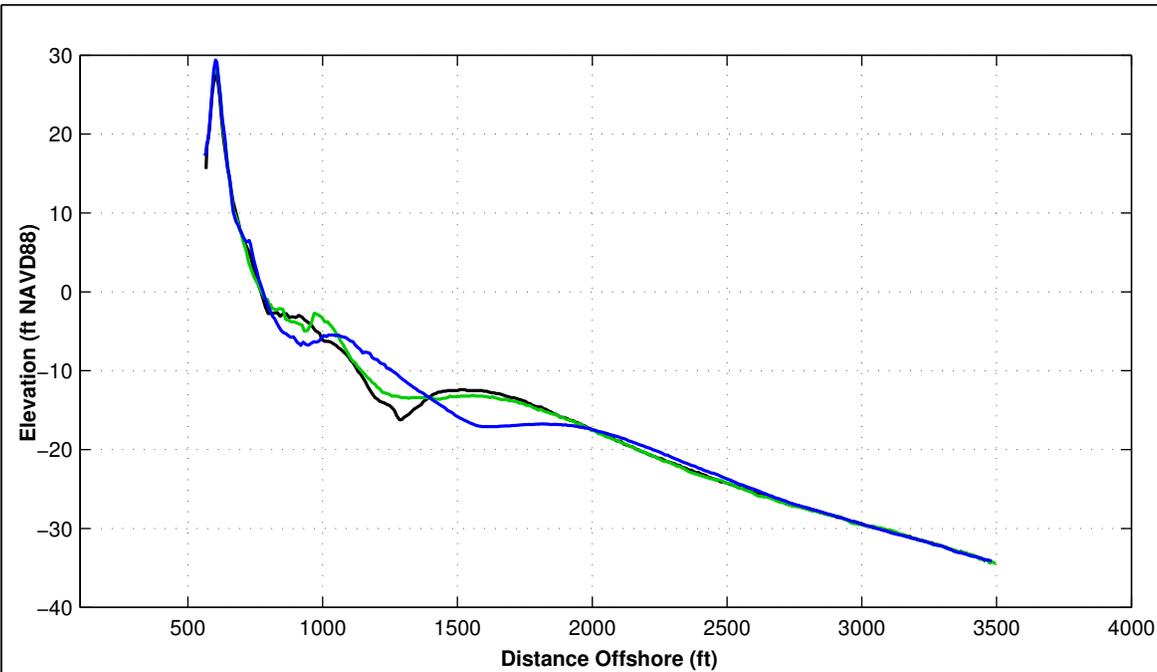
**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.







Survey Transect 705+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	7.48 ft	36.11 ft
Volume Change Above +6 ft NAVD88	2.92 cy/ft	5.74 cy/ft
Volume Change Above 1.18 ft NAVD88	4.75 cy/ft	13.98 cy/ft
Volume Change Above -6 ft NAVD88	-11.80 cy/ft	25.82 cy/ft
Volume Change Above -14 ft NAVD88	-39.06 cy/ft	89.84 cy/ft
Volume Change Above -19 ft NAVD88	-40.51 cy/ft	100.96 cy/ft
Volume Change Above -30 ft NAVD88	-28.65 cy/ft	82.58 cy/ft

**LEGEND:**

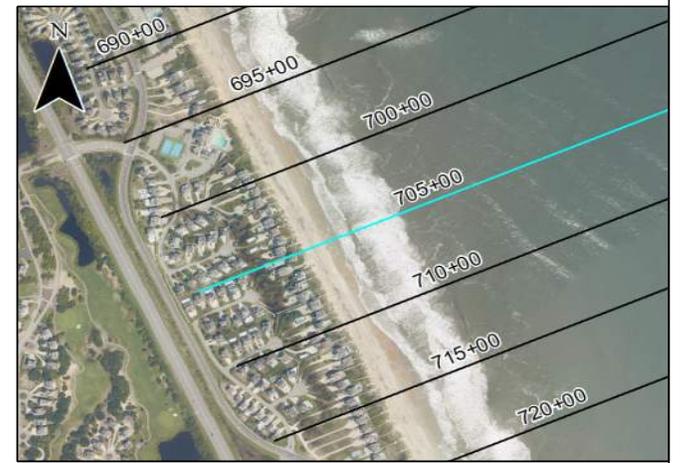
JUNE 2024 ————

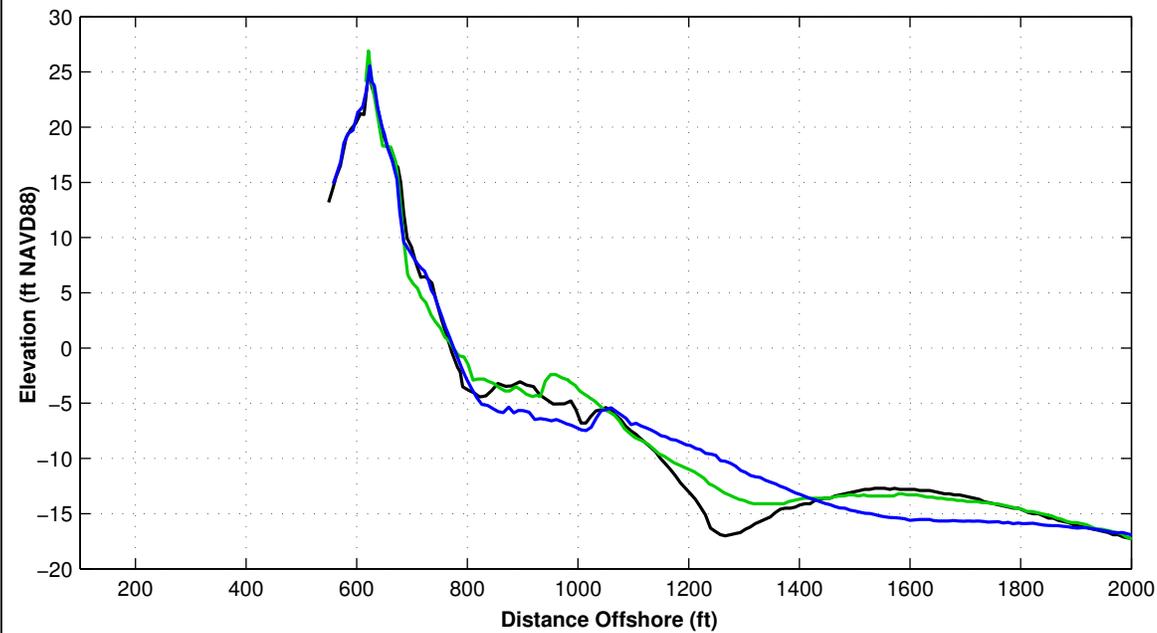
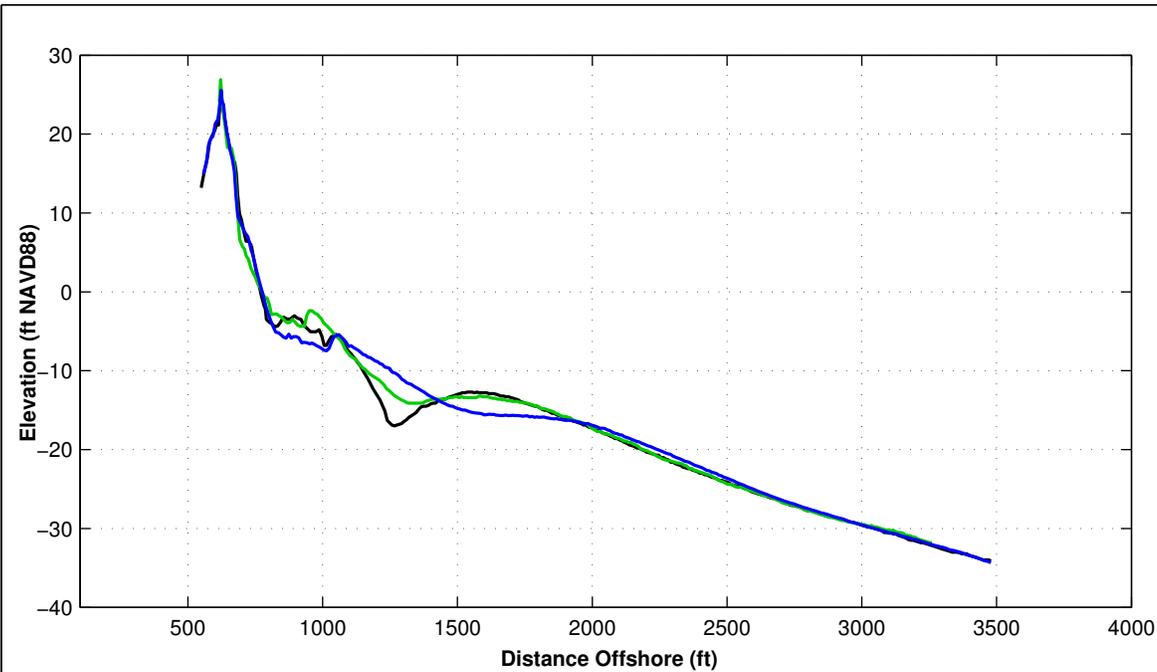
OCTOBER 2023 ————

JUNE 2023 ————

OCTOBER 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





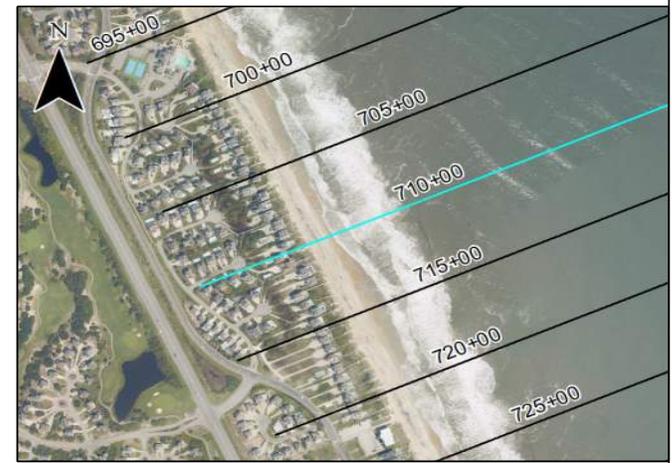
Survey Transect 710+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-29.42 ft	43.26 ft
Volume Change Above +6 ft NAVD88	5.38 cy/ft	9.87 cy/ft
Volume Change Above 1.18 ft NAVD88	1.23 cy/ft	21.82 cy/ft
Volume Change Above -6 ft NAVD88	-21.43 cy/ft	37.04 cy/ft
Volume Change Above -14 ft NAVD88	-27.79 cy/ft	93.40 cy/ft
Volume Change Above -19 ft NAVD88	-4.57 cy/ft	43.34 cy/ft
Volume Change Above -30 ft NAVD88	-2.97 cy/ft	14.81 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.

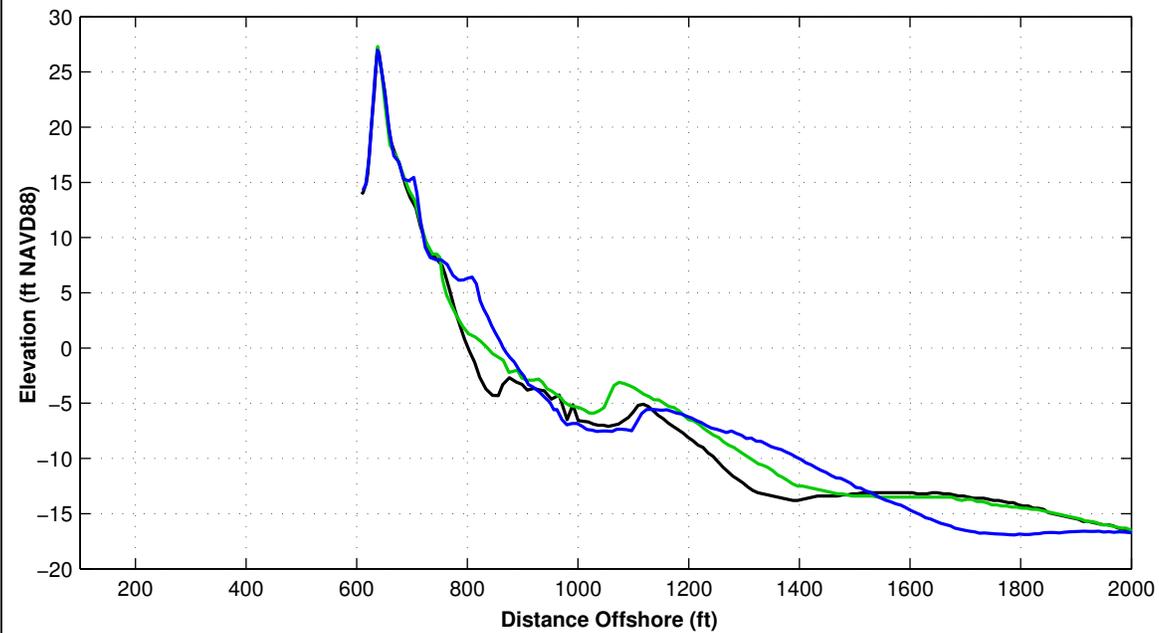
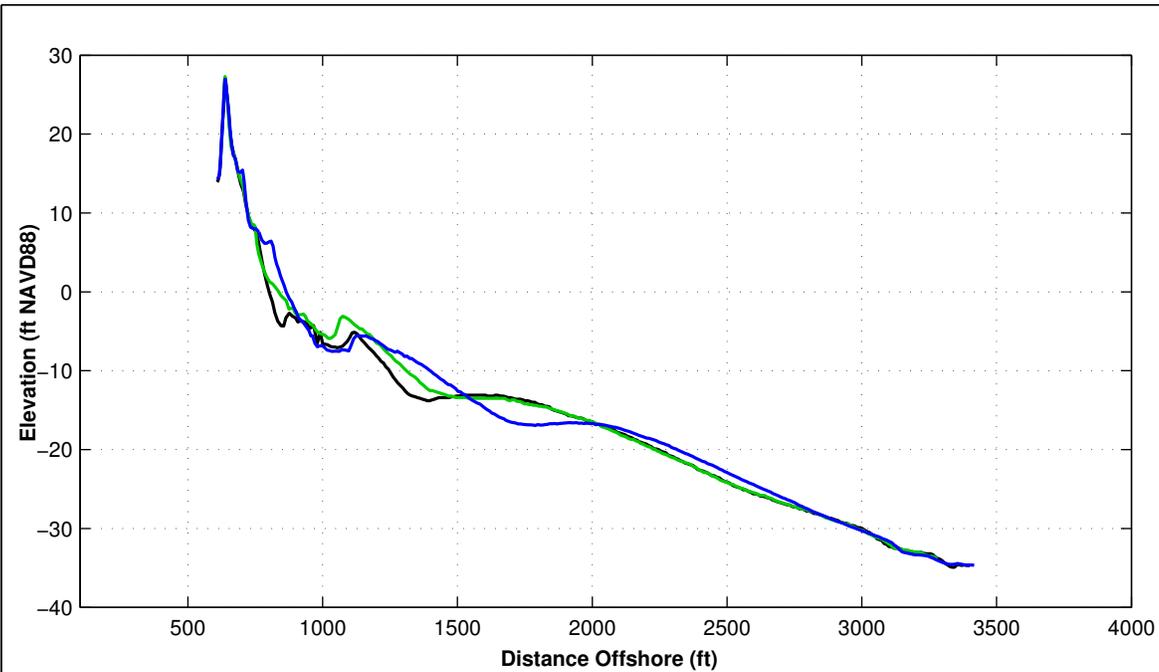












Survey Transect 735+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-14.11 ft	-11.46 ft
Volume Change Above +6 ft NAVD88	-0.25 cy/ft	4.19 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.06 cy/ft	5.56 cy/ft
Volume Change Above -6 ft NAVD88	-11.80 cy/ft	5.18 cy/ft
Volume Change Above -14 ft NAVD88	-36.12 cy/ft	35.36 cy/ft
Volume Change Above -19 ft NAVD88	-28.99 cy/ft	19.97 cy/ft
Volume Change Above -30 ft NAVD88	-22.67 cy/ft	-3.85 cy/ft

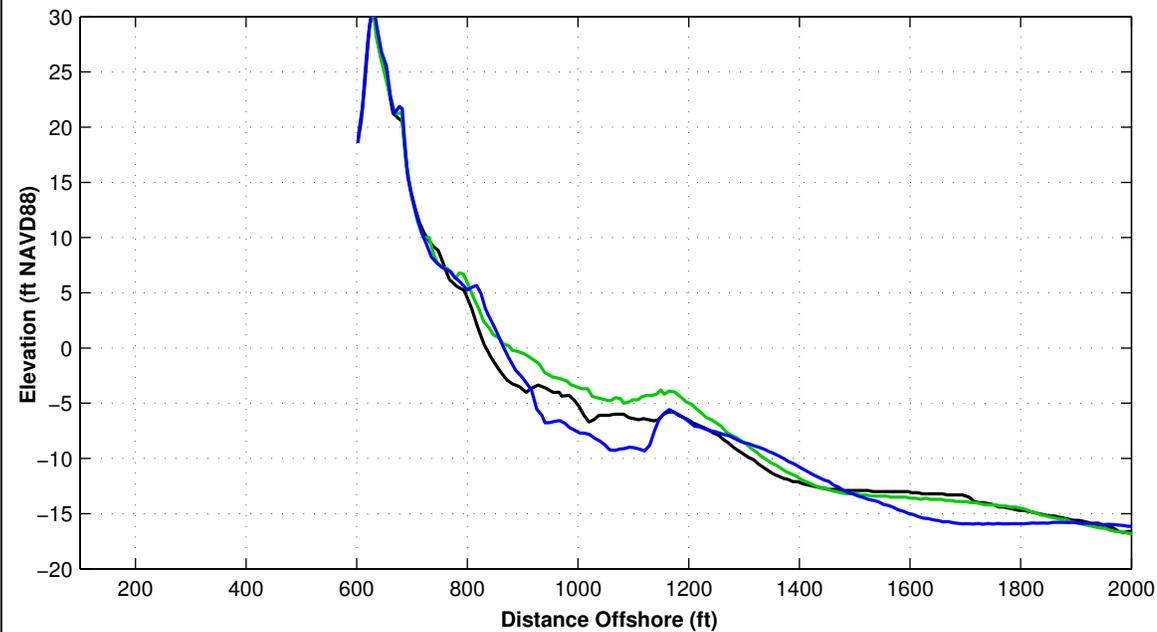
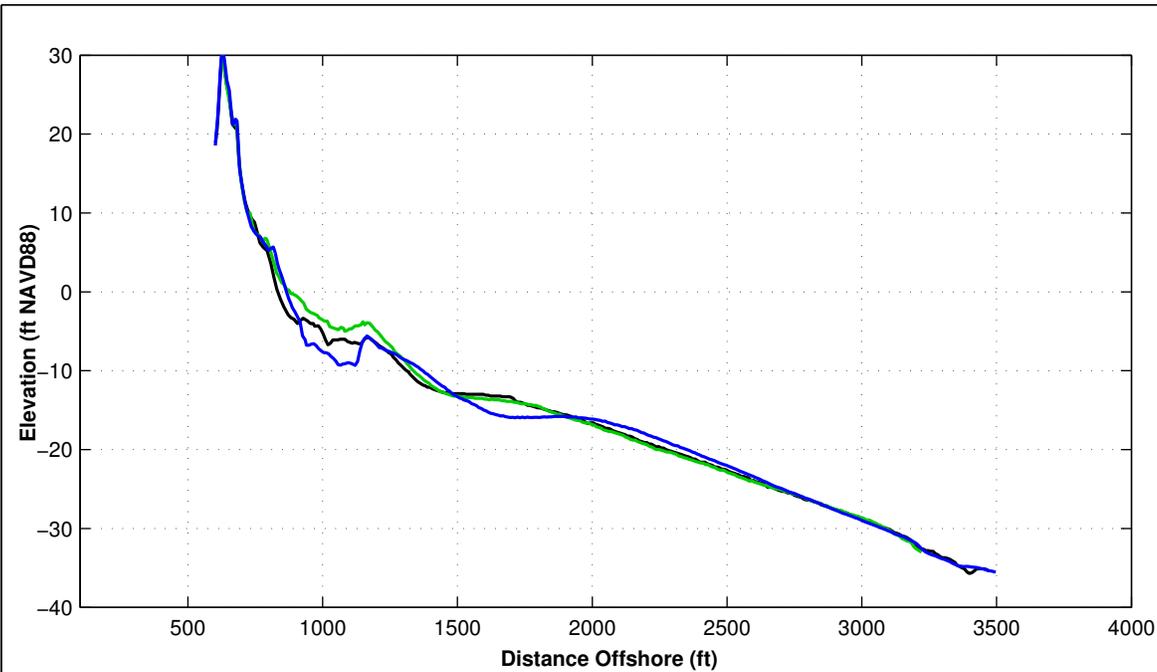
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





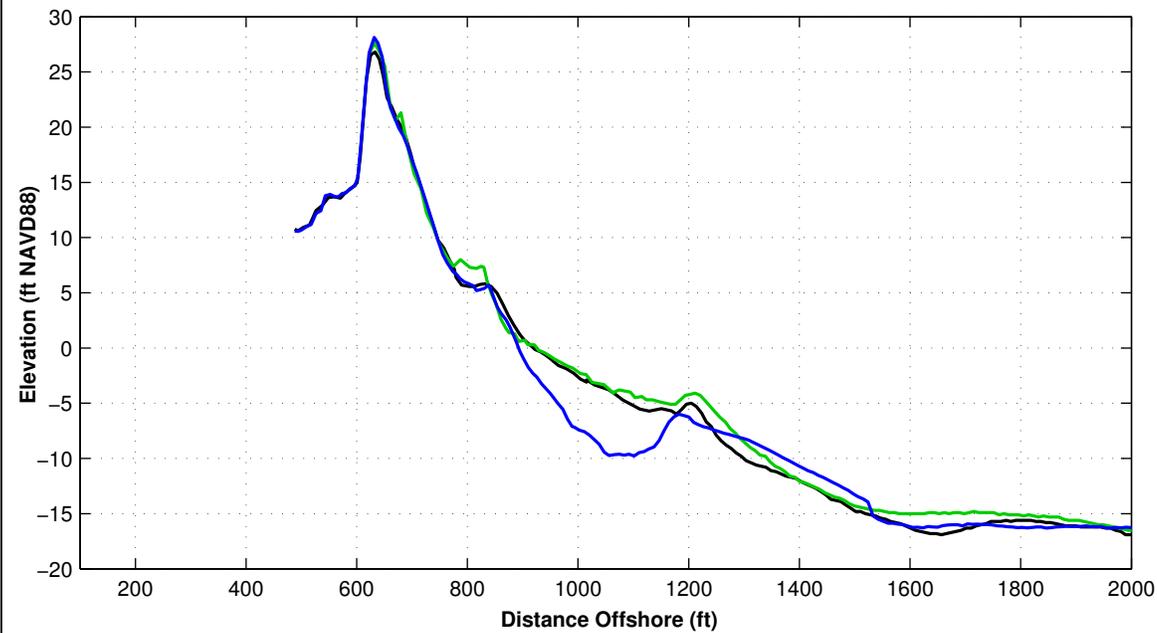
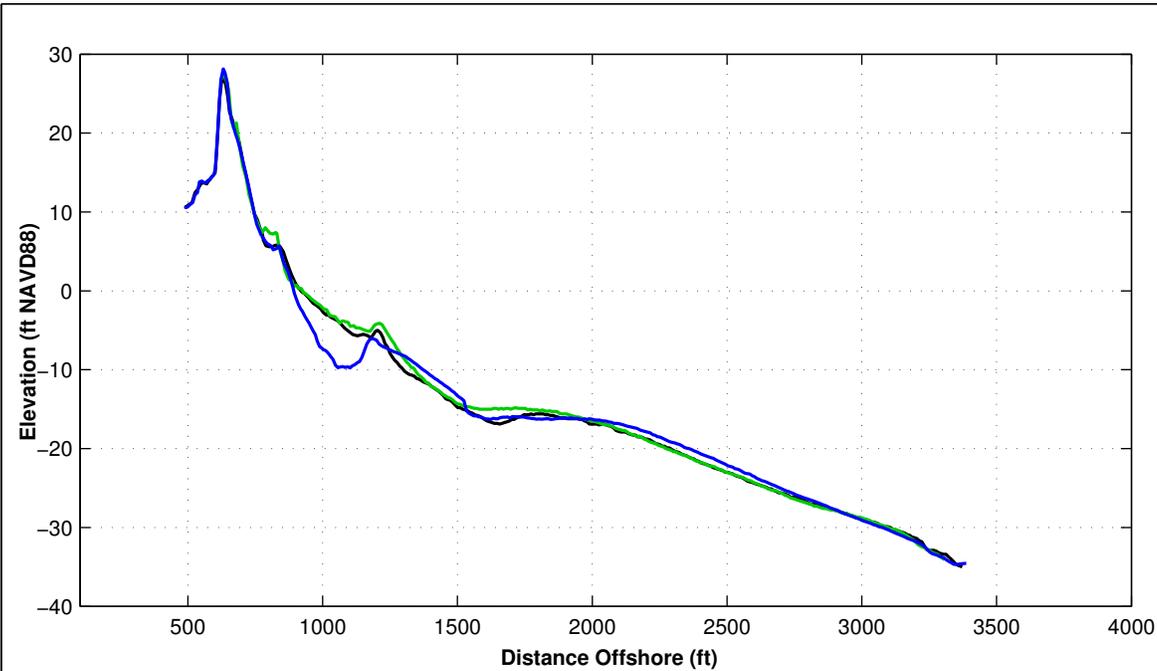
Survey Transect 740+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-24.04 ft	17.24 ft
Volume Change Above +6 ft NAVD88	-2.28 cy/ft	4.54 cy/ft
Volume Change Above 1.18 ft NAVD88	-5.99 cy/ft	9.48 cy/ft
Volume Change Above -6 ft NAVD88	-14.90 cy/ft	12.48 cy/ft
Volume Change Above -14 ft NAVD88	-63.50 cy/ft	58.51 cy/ft
Volume Change Above -19 ft NAVD88	-67.47 cy/ft	61.68 cy/ft
Volume Change Above -30 ft NAVD88	-62.74 cy/ft	41.15 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 745+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-11.96 ft	2.60 ft
Volume Change Above +6 ft NAVD88	0.17 cy/ft	1.29 cy/ft
Volume Change Above 1.18 ft NAVD88	-1.18 cy/ft	4.36 cy/ft
Volume Change Above -6 ft NAVD88	-14.72 cy/ft	12.96 cy/ft
Volume Change Above -14 ft NAVD88	-44.86 cy/ft	50.81 cy/ft
Volume Change Above -19 ft NAVD88	-43.45 cy/ft	83.85 cy/ft
Volume Change Above -30 ft NAVD88	-20.91 cy/ft	61.03 cy/ft

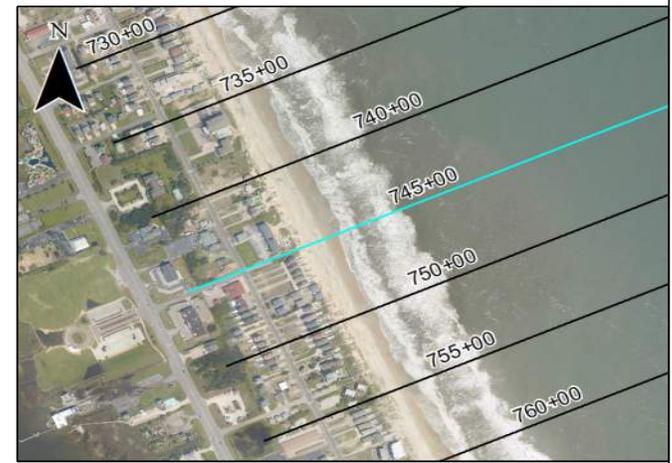
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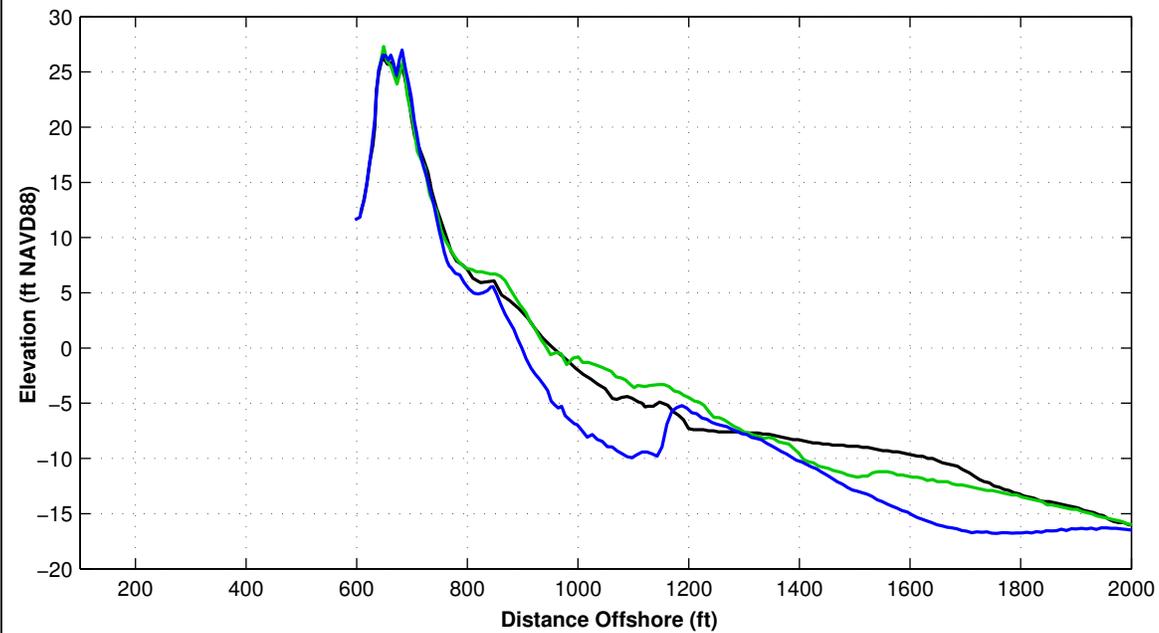
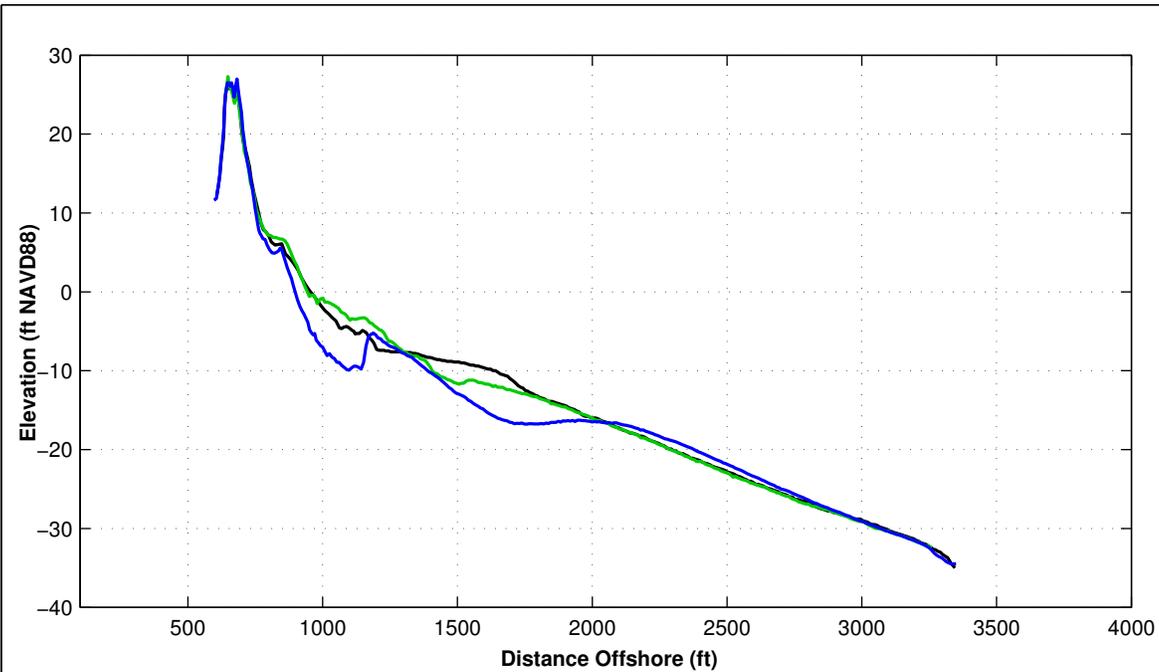
JUNE 2024 ————

OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





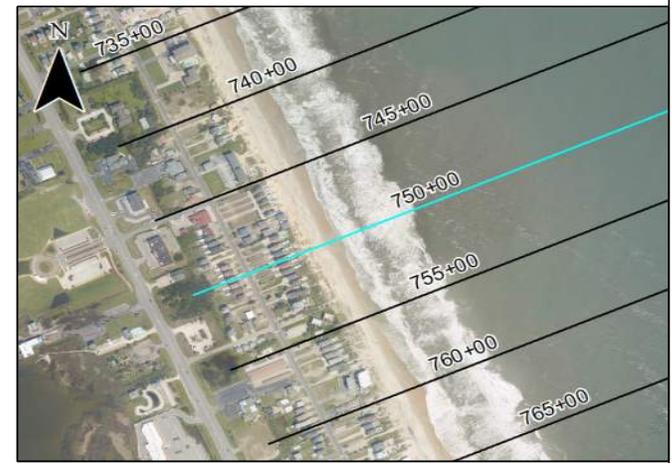
Survey Transect 750+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	ft	ft
Volume Change Above +6 ft NAVD88	cy/ft	cy/ft
Volume Change Above 1.18 ft NAVD88	cy/ft	cy/ft
Volume Change Above -6 ft NAVD88	cy/ft	cy/ft
Volume Change Above -14 ft NAVD88	cy/ft	cy/ft
Volume Change Above -19 ft NAVD88	cy/ft	cy/ft
Volume Change Above -30 ft NAVD88	cy/ft	cy/ft

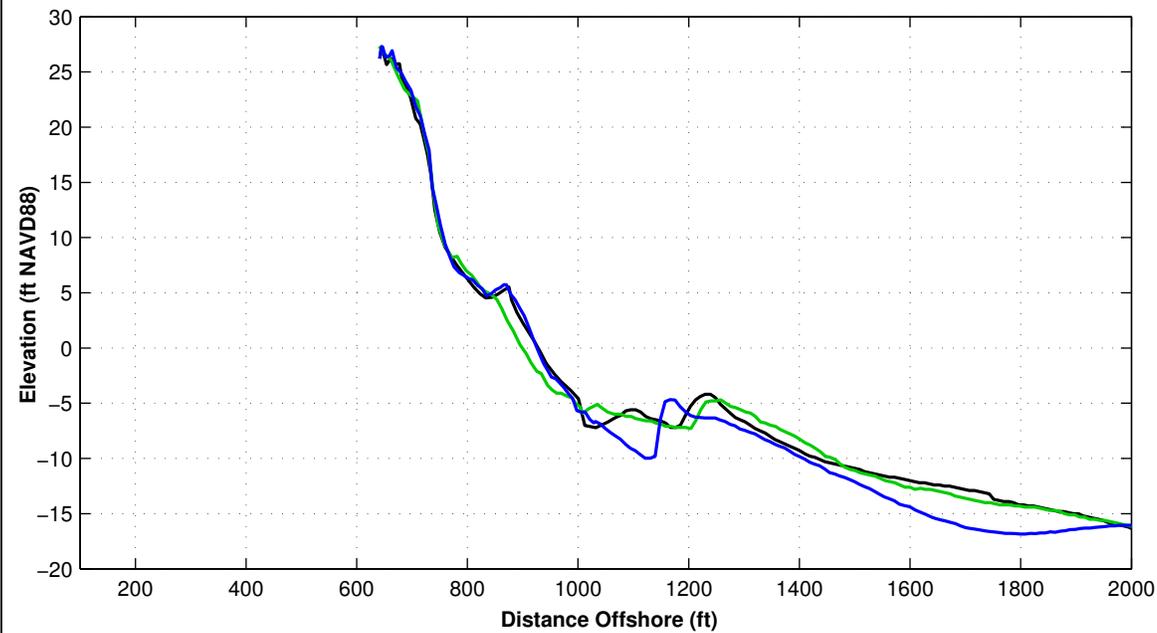
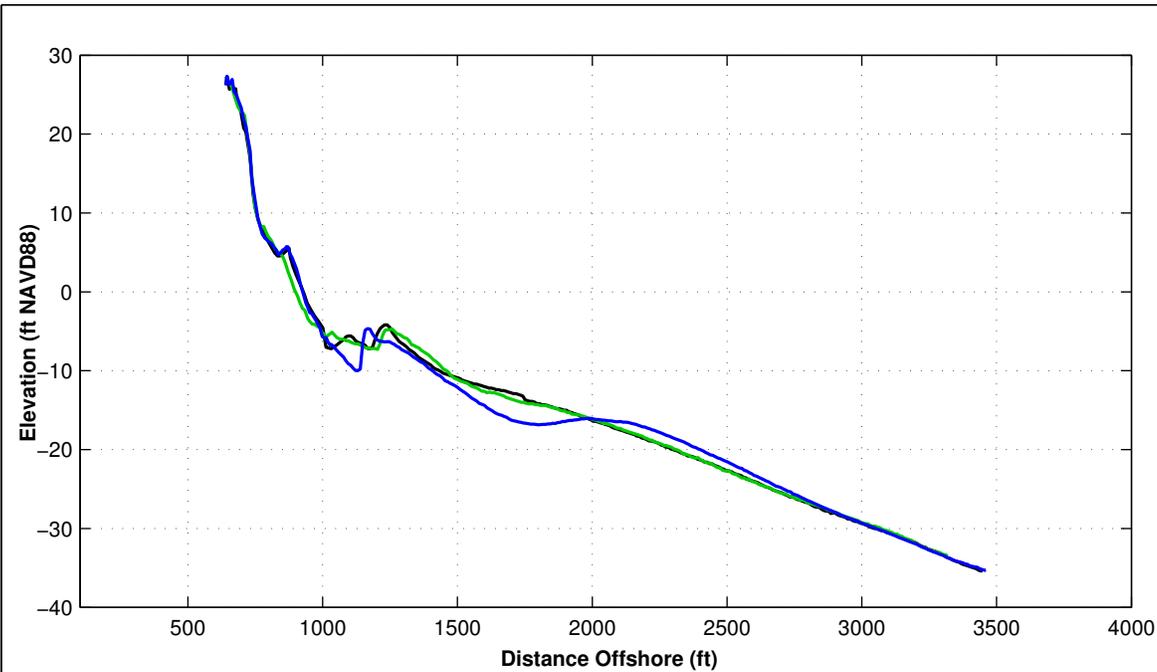
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023

JUNE 2024 ———— OCTOBER 2023

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



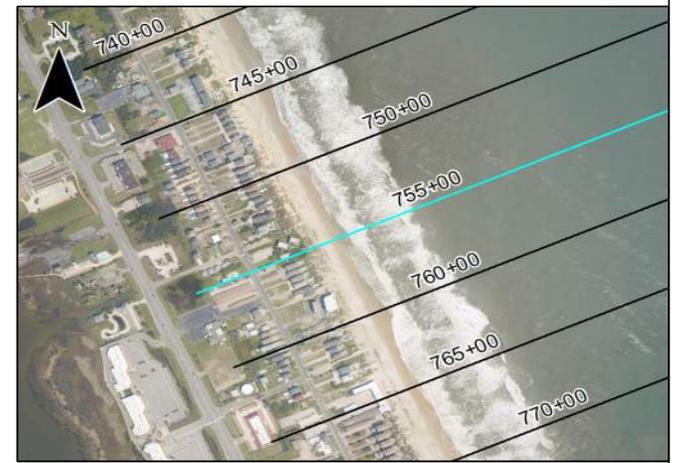


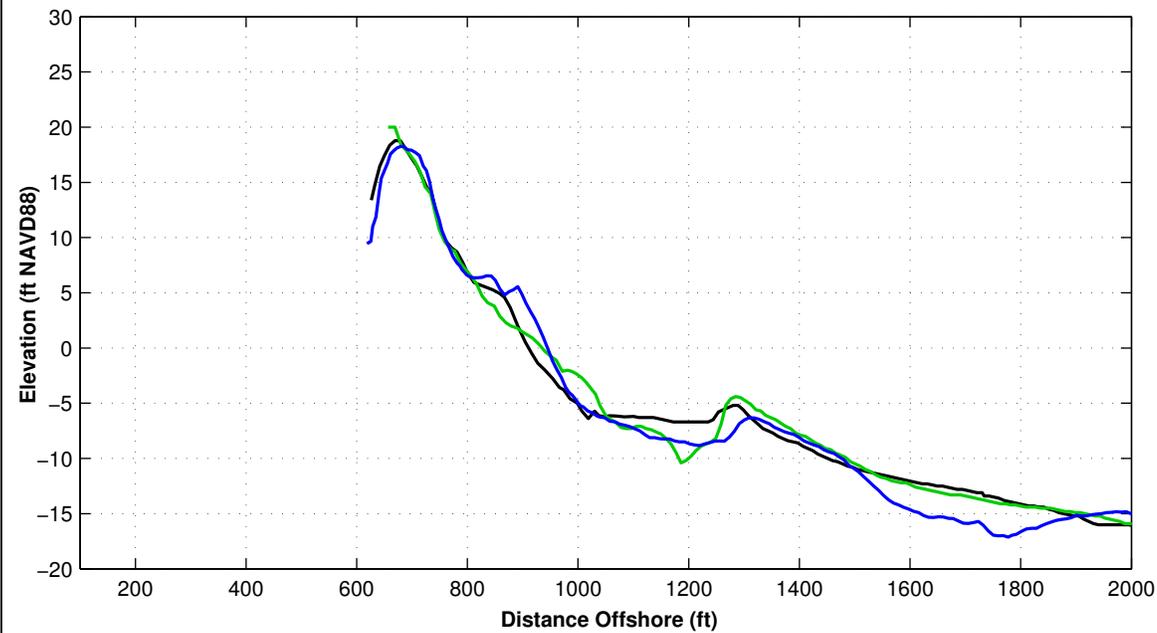
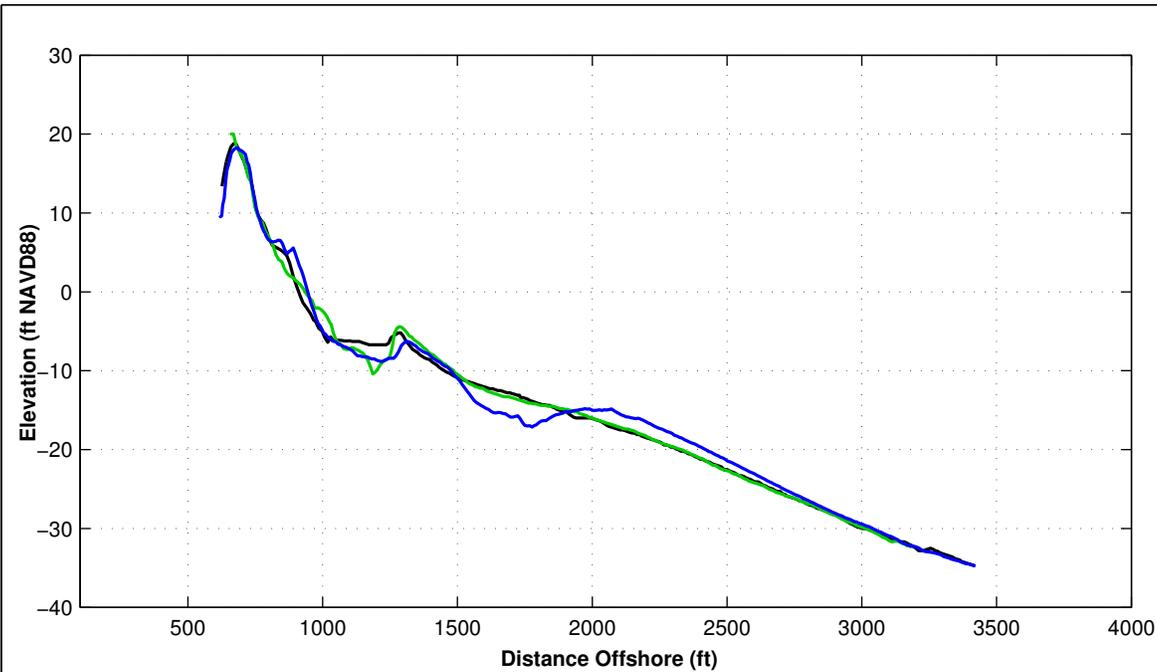
Survey Transect 755+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	2.31 ft	29.91 ft
Volume Change Above +6 ft NAVD88	2.17 cy/ft	4.34 cy/ft
Volume Change Above 1.18 ft NAVD88	4.15 cy/ft	7.71 cy/ft
Volume Change Above -6 ft NAVD88	0.47 cy/ft	21.61 cy/ft
Volume Change Above -14 ft NAVD88	-28.04 cy/ft	51.19 cy/ft
Volume Change Above -19 ft NAVD88	-41.38 cy/ft	25.24 cy/ft
Volume Change Above -30 ft NAVD88	-21.14 cy/ft	5.28 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 760+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	36.54 ft	1.86 ft
Volume Change Above +6 ft NAVD88	0.36 cy/ft	0.70 cy/ft
Volume Change Above 1.18 ft NAVD88	6.45 cy/ft	5.28 cy/ft
Volume Change Above -6 ft NAVD88	10.79 cy/ft	11.36 cy/ft
Volume Change Above -14 ft NAVD88	-12.86 cy/ft	68.69 cy/ft
Volume Change Above -19 ft NAVD88	-8.27 cy/ft	41.85 cy/ft
Volume Change Above -30 ft NAVD88	14.42 cy/ft	21.22 cy/ft

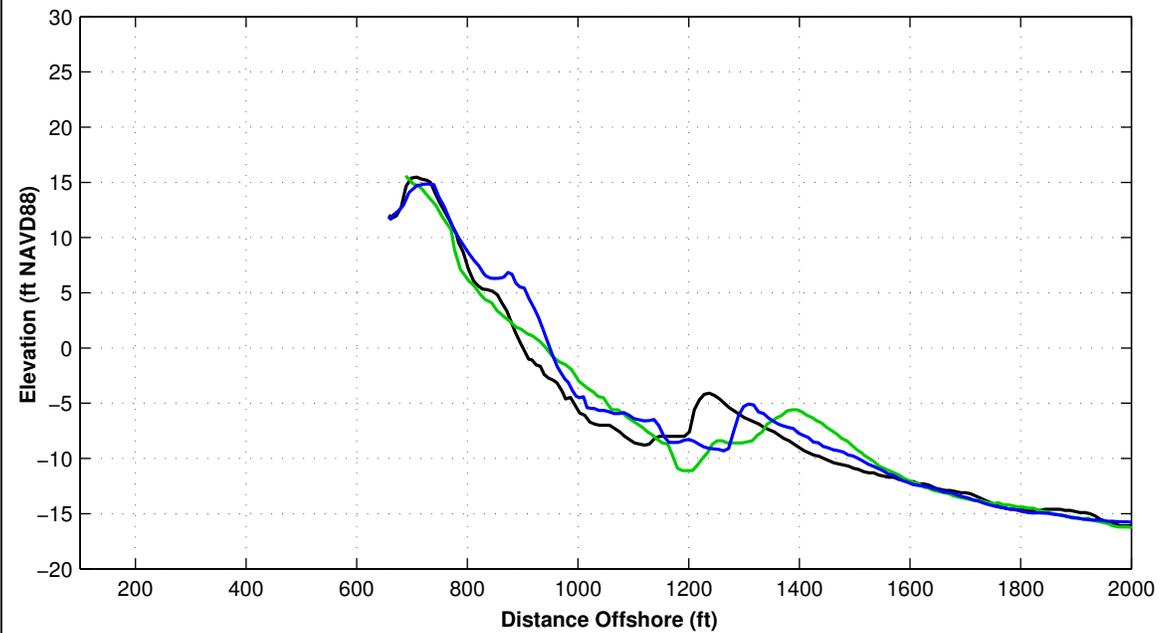
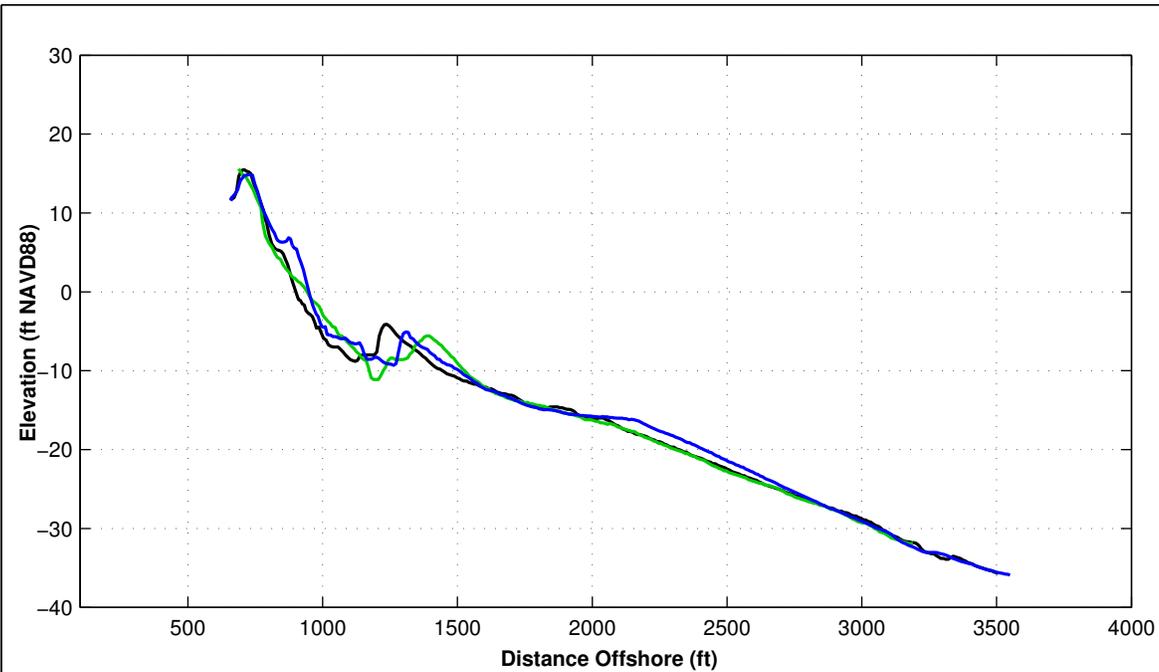
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





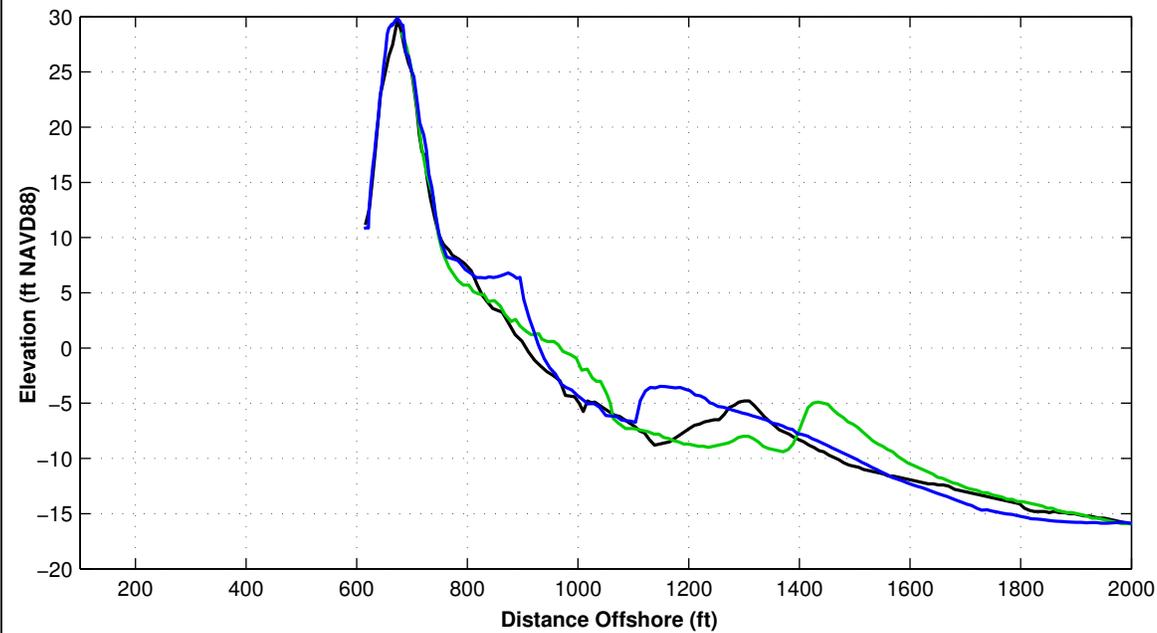
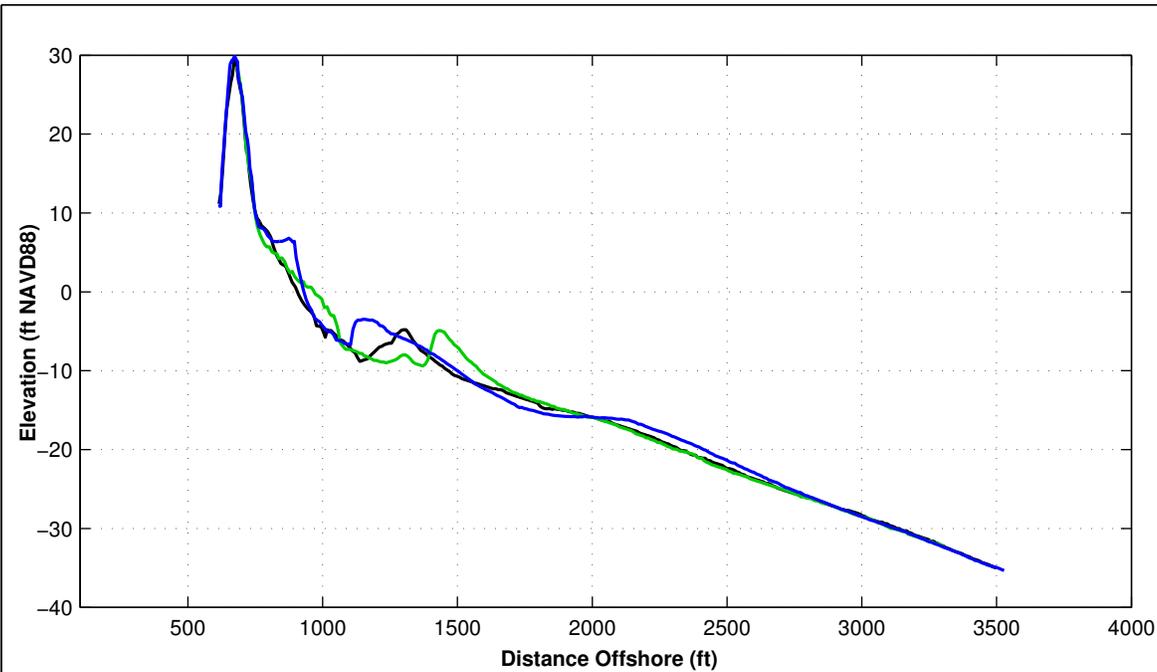
Survey Transect 765+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	51.50 ft	-10.61 ft
Volume Change Above +6 ft NAVD88	3.10 cy/ft	2.58 cy/ft
Volume Change Above 1.18 ft NAVD88	13.15 cy/ft	7.00 cy/ft
Volume Change Above -6 ft NAVD88	19.95 cy/ft	6.62 cy/ft
Volume Change Above -14 ft NAVD88	26.67 cy/ft	55.45 cy/ft
Volume Change Above -19 ft NAVD88	37.32 cy/ft	28.67 cy/ft
Volume Change Above -30 ft NAVD88	53.72 cy/ft	8.61 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 770+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	35.08 ft	-18.63 ft
Volume Change Above +6 ft NAVD88	3.27 cy/ft	3.26 cy/ft
Volume Change Above 1.18 ft NAVD88	13.48 cy/ft	1.74 cy/ft
Volume Change Above -6 ft NAVD88	26.12 cy/ft	-0.99 cy/ft
Volume Change Above -14 ft NAVD88	34.80 cy/ft	45.00 cy/ft
Volume Change Above -19 ft NAVD88	37.51 cy/ft	17.07 cy/ft
Volume Change Above -30 ft NAVD88	51.90 cy/ft	-0.65 cy/ft

**LEGEND:**

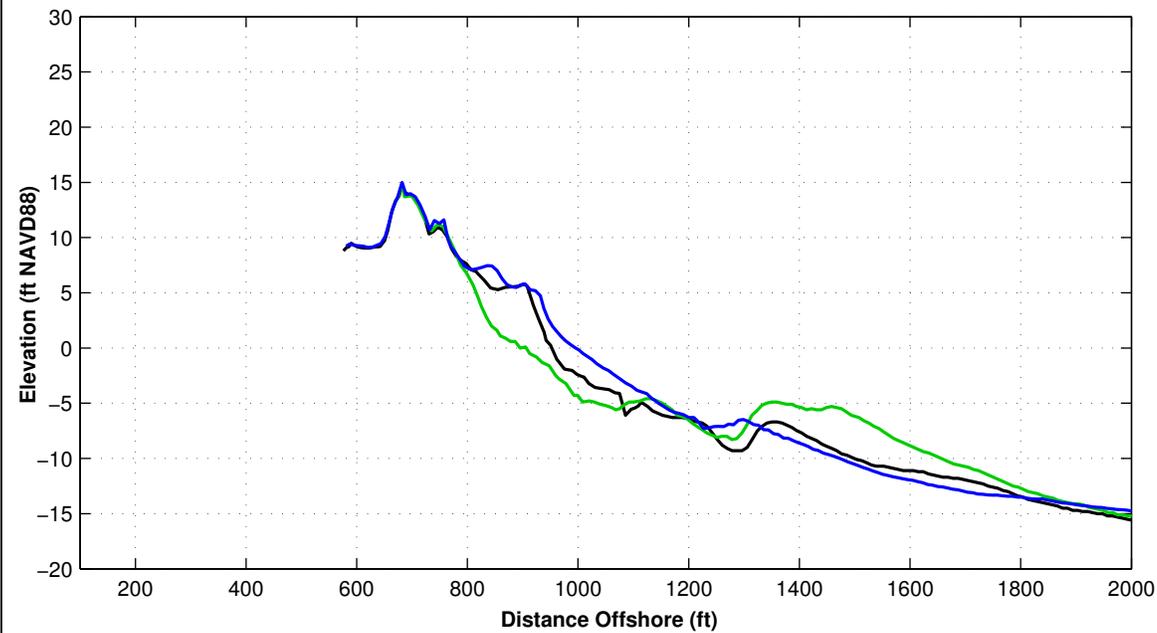
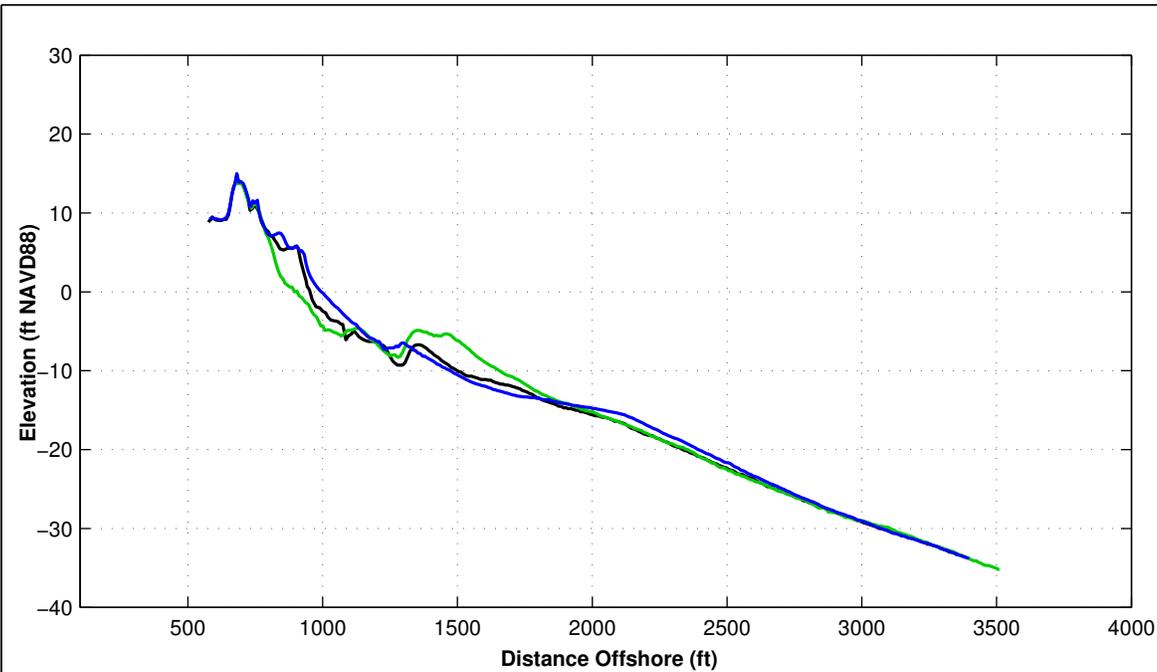
JUNE 2024 ———— OCTOBER 2023

OCTOBER 2023 ———— JUNE 2023

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





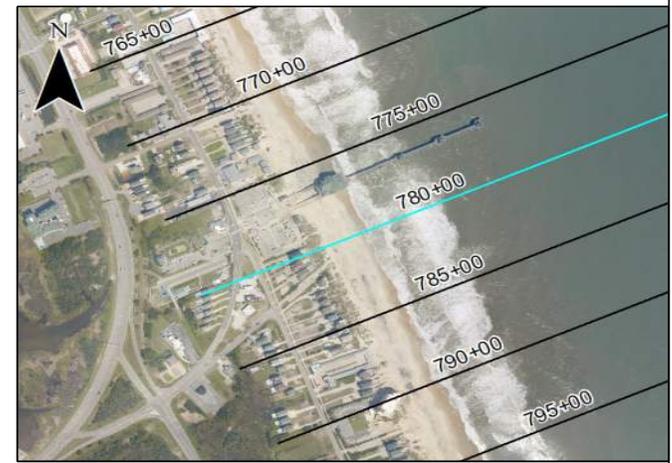


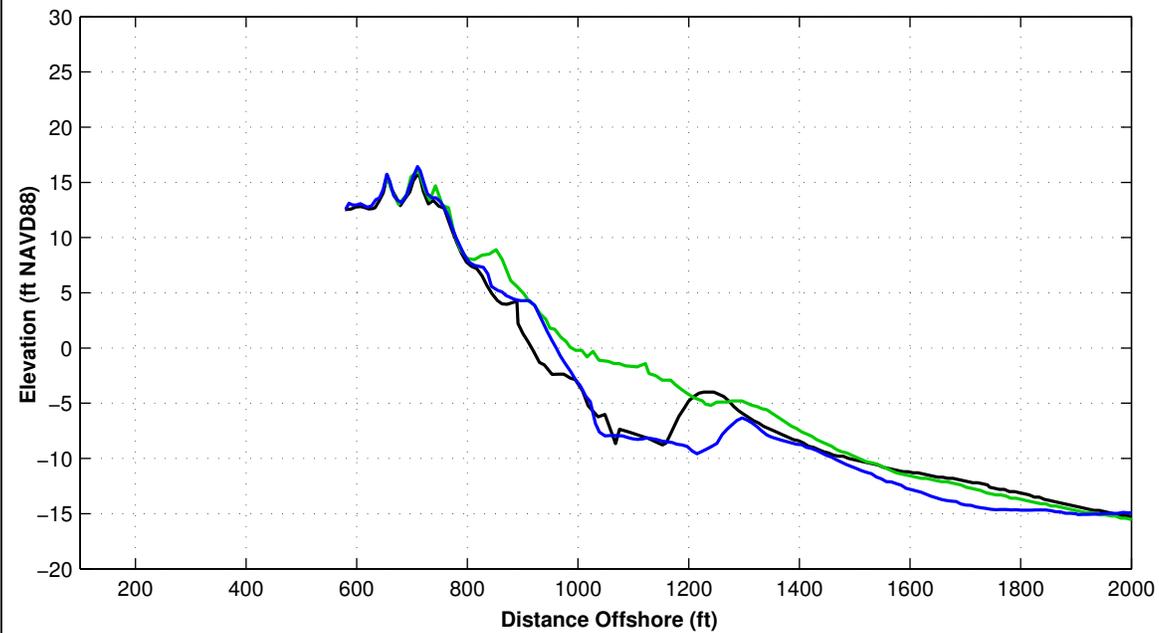
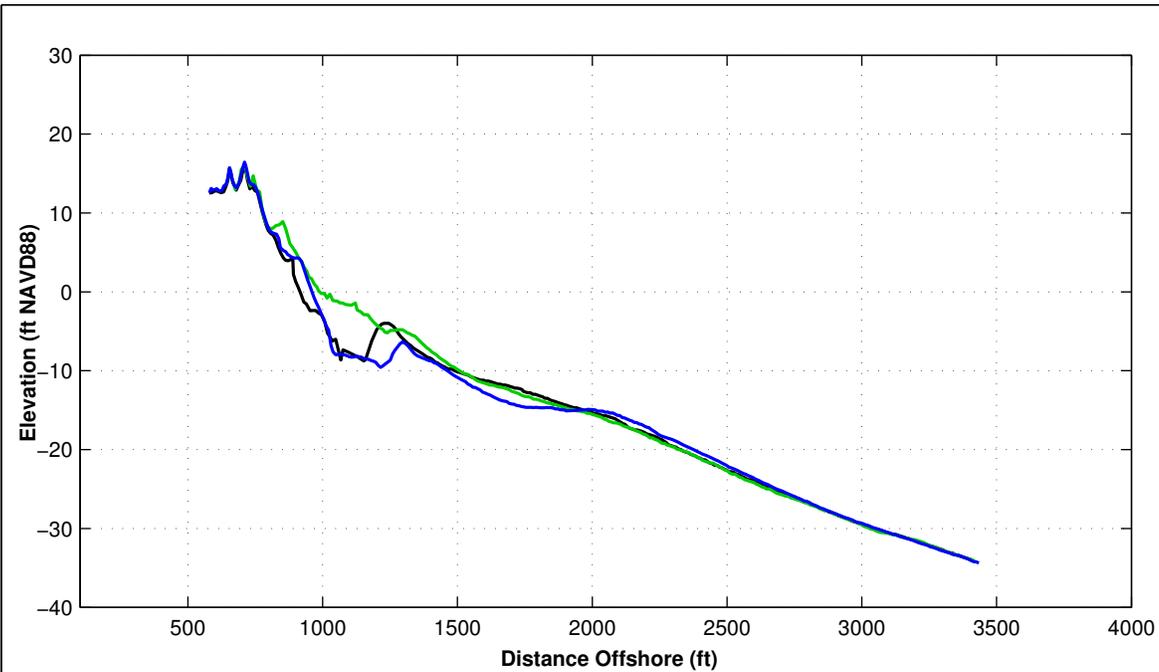
Survey Transect 780+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	27.15 ft	-3.79 ft
Volume Change Above +6 ft NAVD88	2.94 cy/ft	1.54 cy/ft
Volume Change Above 1.18 ft NAVD88	6.52 cy/ft	4.11 cy/ft
Volume Change Above -6 ft NAVD88	21.09 cy/ft	7.51 cy/ft
Volume Change Above -14 ft NAVD88	14.22 cy/ft	60.39 cy/ft
Volume Change Above -19 ft NAVD88	29.15 cy/ft	36.30 cy/ft
Volume Change Above -30 ft NAVD88	41.41 cy/ft	21.62 cy/ft

**LEGEND:**

JUNE 2024      OCTOBER 2023      JUNE 2023

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





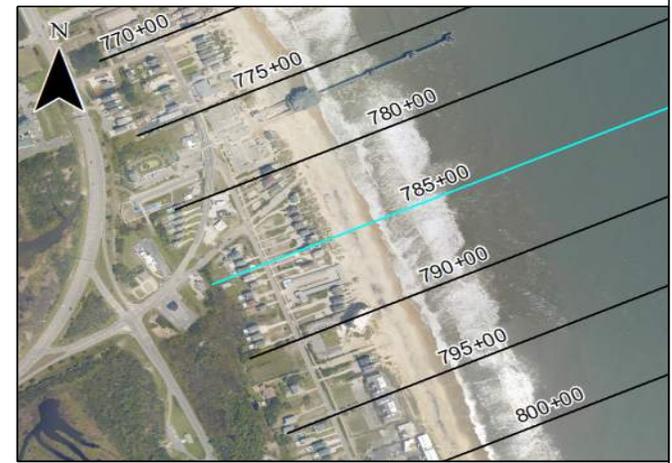
Survey Transect 785+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	45.78 ft	-44.38 ft
Volume Change Above +6 ft NAVD88	2.85 cy/ft	1.53 cy/ft
Volume Change Above 1.18 ft NAVD88	8.83 cy/ft	-4.15 cy/ft
Volume Change Above -6 ft NAVD88	9.31 cy/ft	-17.26 cy/ft
Volume Change Above -14 ft NAVD88	-23.95 cy/ft	48.05 cy/ft
Volume Change Above -19 ft NAVD88	-22.07 cy/ft	24.70 cy/ft
Volume Change Above -30 ft NAVD88	-11.98 cy/ft	11.46 cy/ft

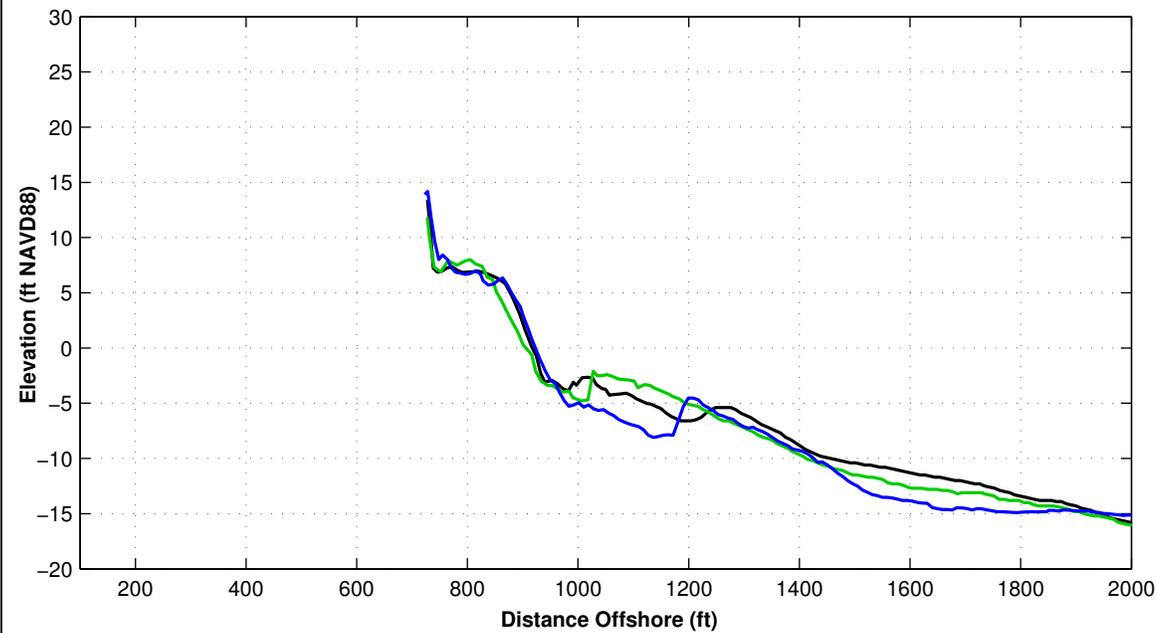
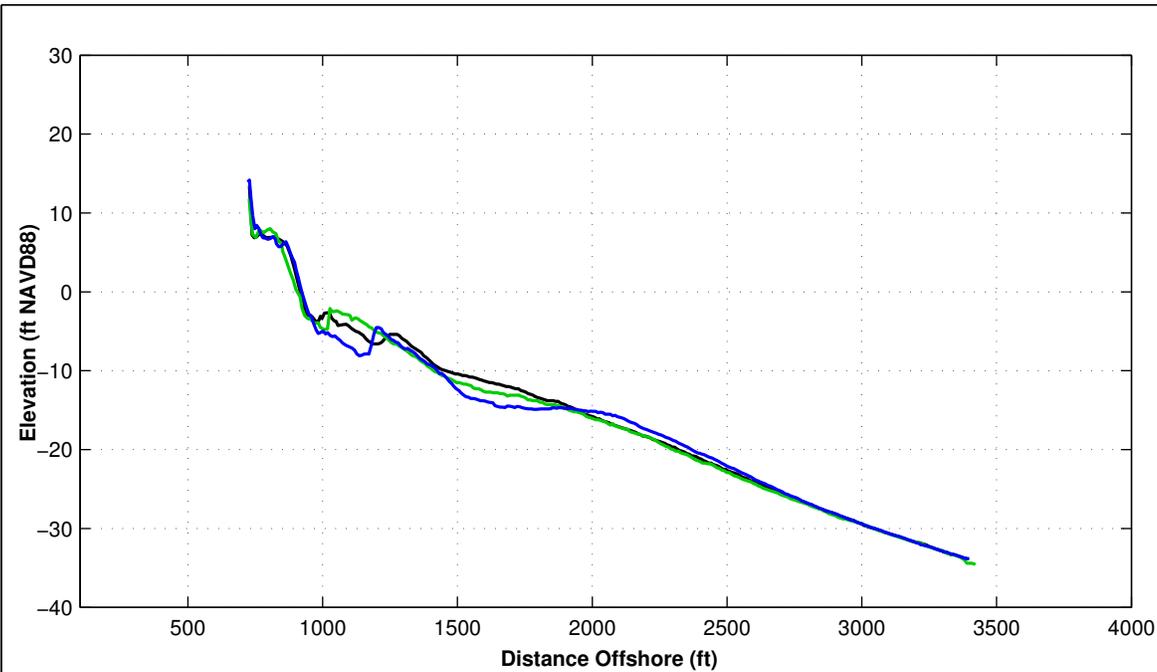
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



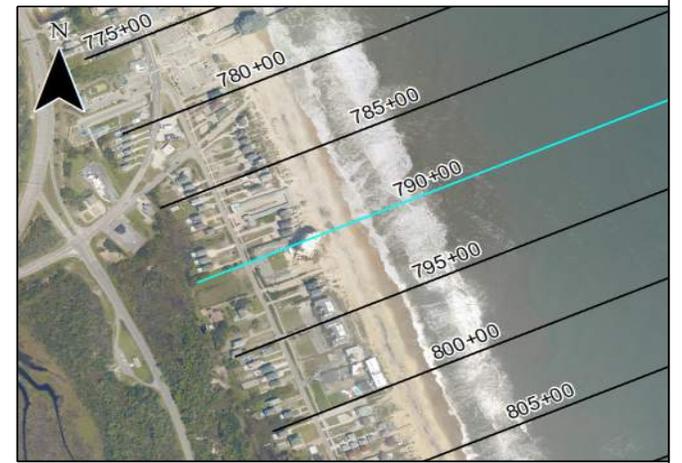


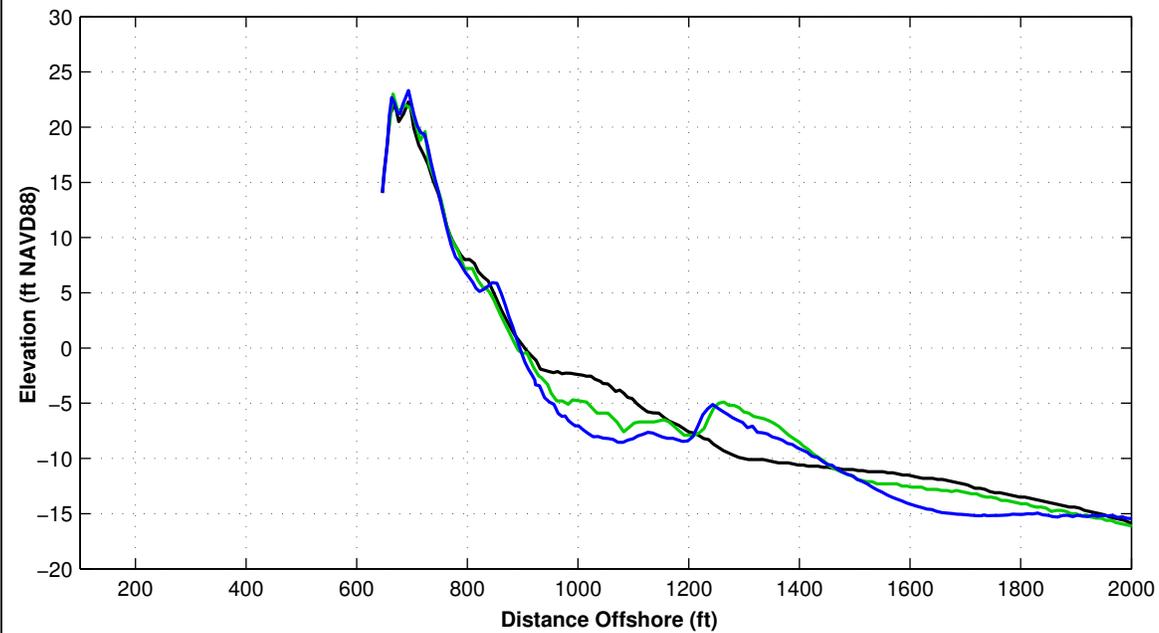
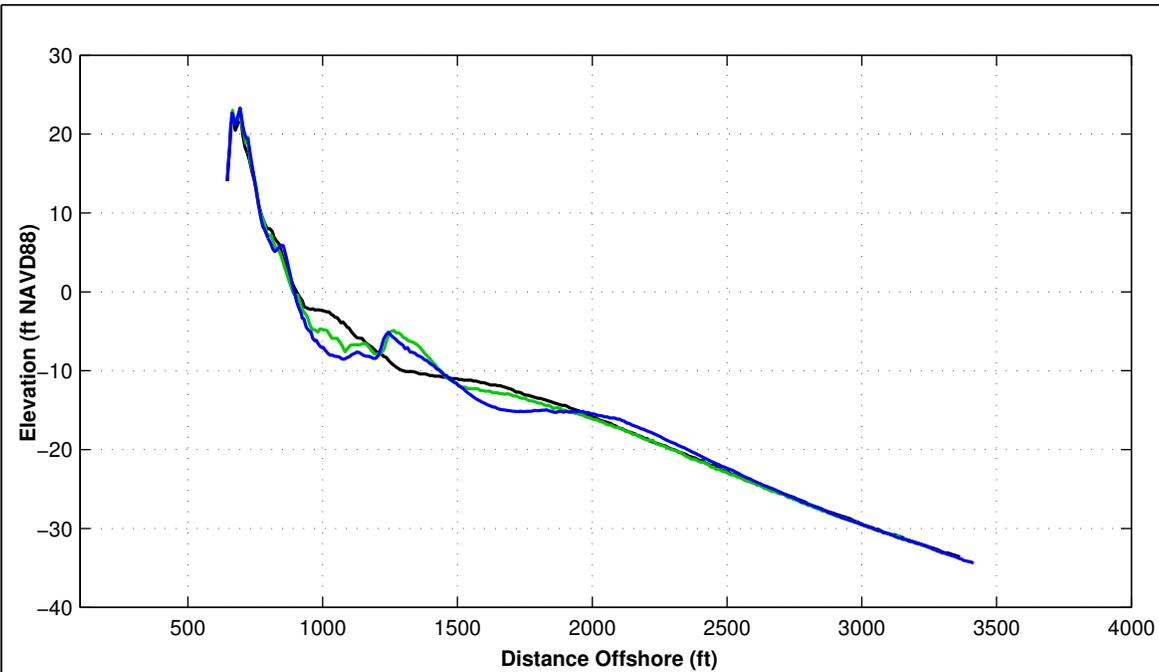
Survey Transect 790+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	5.93 ft	-3.31 ft
Volume Change Above +6 ft NAVD88	1.04 cy/ft	0.53 cy/ft
Volume Change Above 1.18 ft NAVD88	1.74 cy/ft	1.37 cy/ft
Volume Change Above -6 ft NAVD88	-7.60 cy/ft	-2.23 cy/ft
Volume Change Above -14 ft NAVD88	-42.66 cy/ft	24.64 cy/ft
Volume Change Above -19 ft NAVD88	-38.41 cy/ft	-6.86 cy/ft
Volume Change Above -30 ft NAVD88	-28.98 cy/ft	-23.78 cy/ft

**LEGEND:**

JUNE 2024      ————      OCTOBER 2023      ————  
 JUNE 2023      ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 795+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	0.71 ft	-23.57 ft
Volume Change Above +6 ft NAVD88	0.61 cy/ft	5.07 cy/ft
Volume Change Above 1.18 ft NAVD88	1.53 cy/ft	3.86 cy/ft
Volume Change Above -6 ft NAVD88	-18.68 cy/ft	3.82 cy/ft
Volume Change Above -14 ft NAVD88	-33.05 cy/ft	55.46 cy/ft
Volume Change Above -19 ft NAVD88	-35.45 cy/ft	39.44 cy/ft
Volume Change Above -30 ft NAVD88	-29.26 cy/ft	25.50 cy/ft

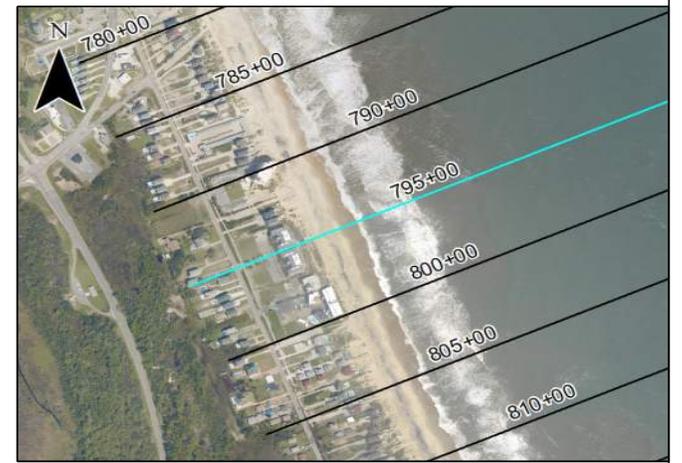
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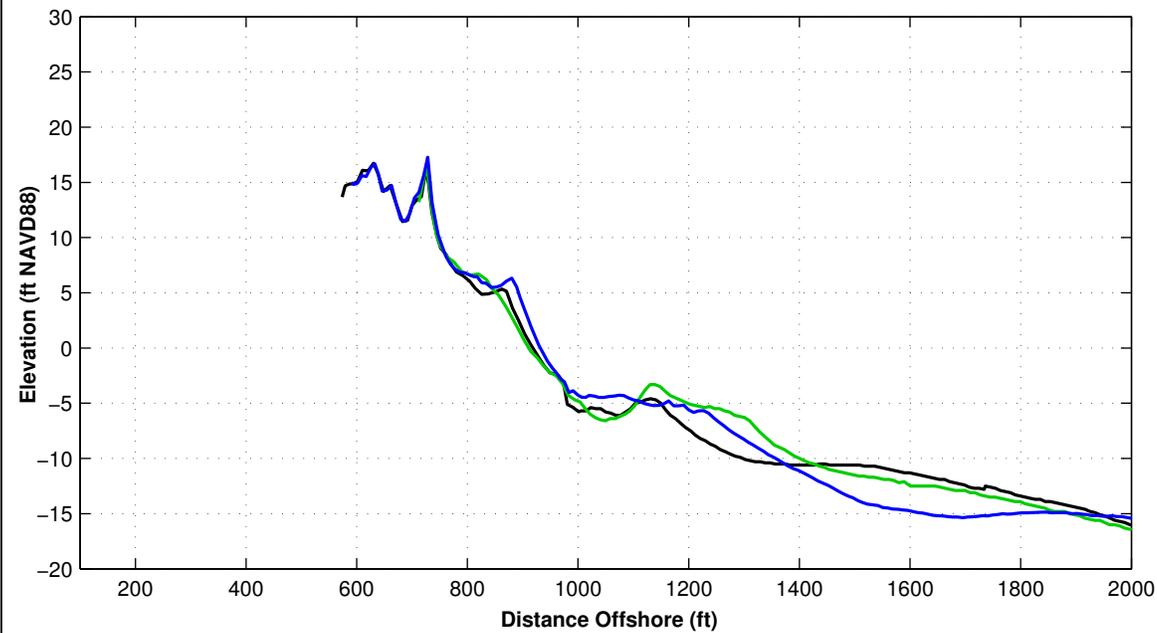
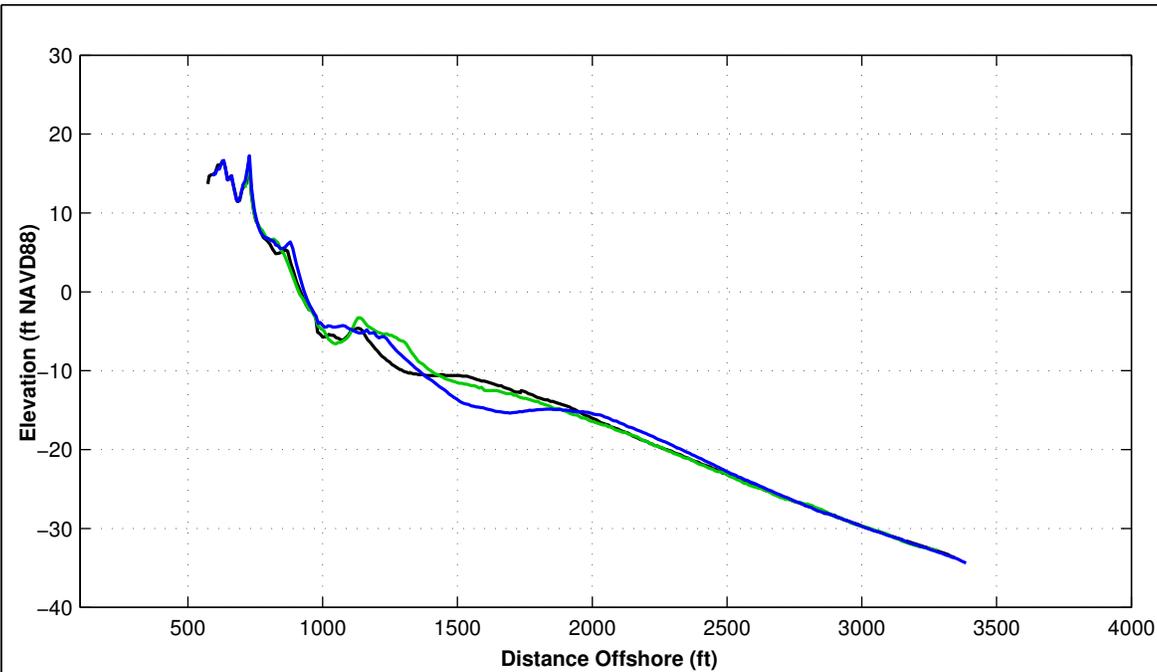
JUNE 2024 ————

OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



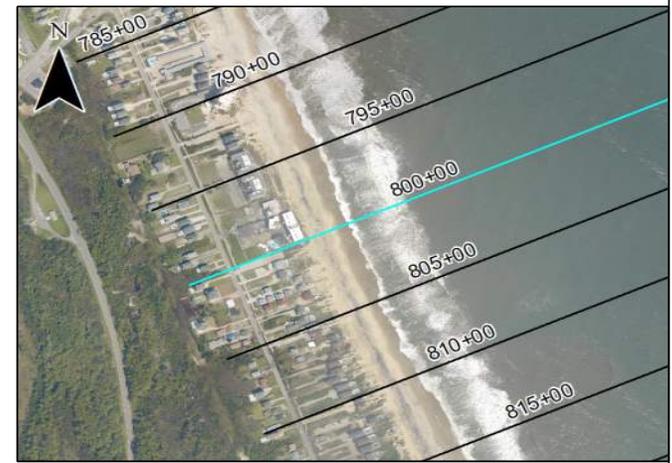


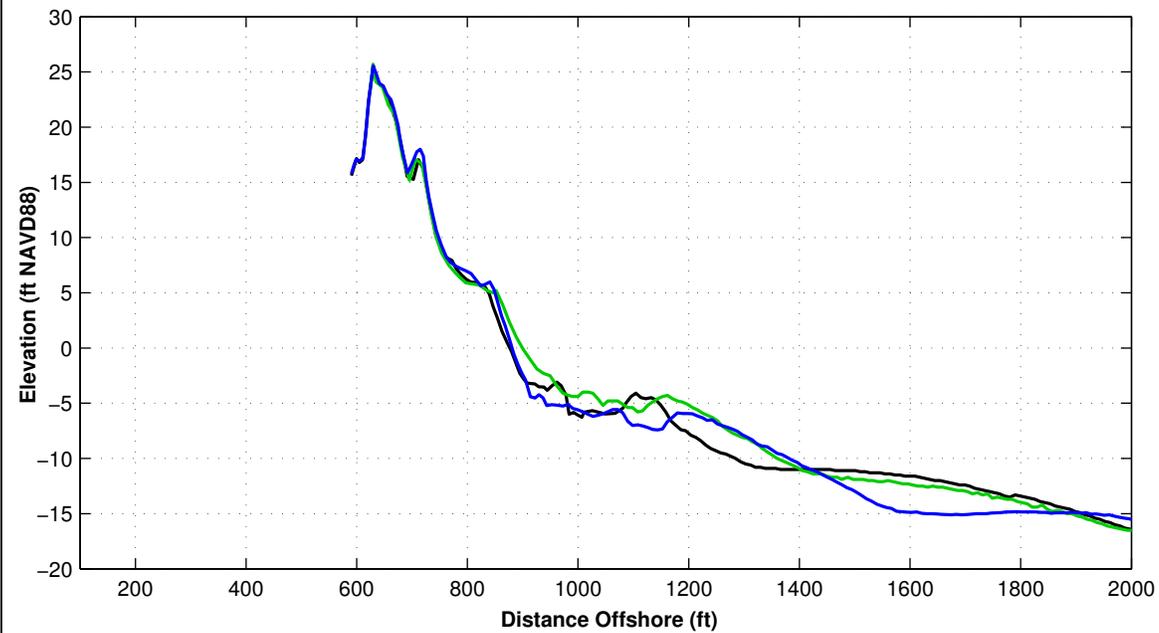
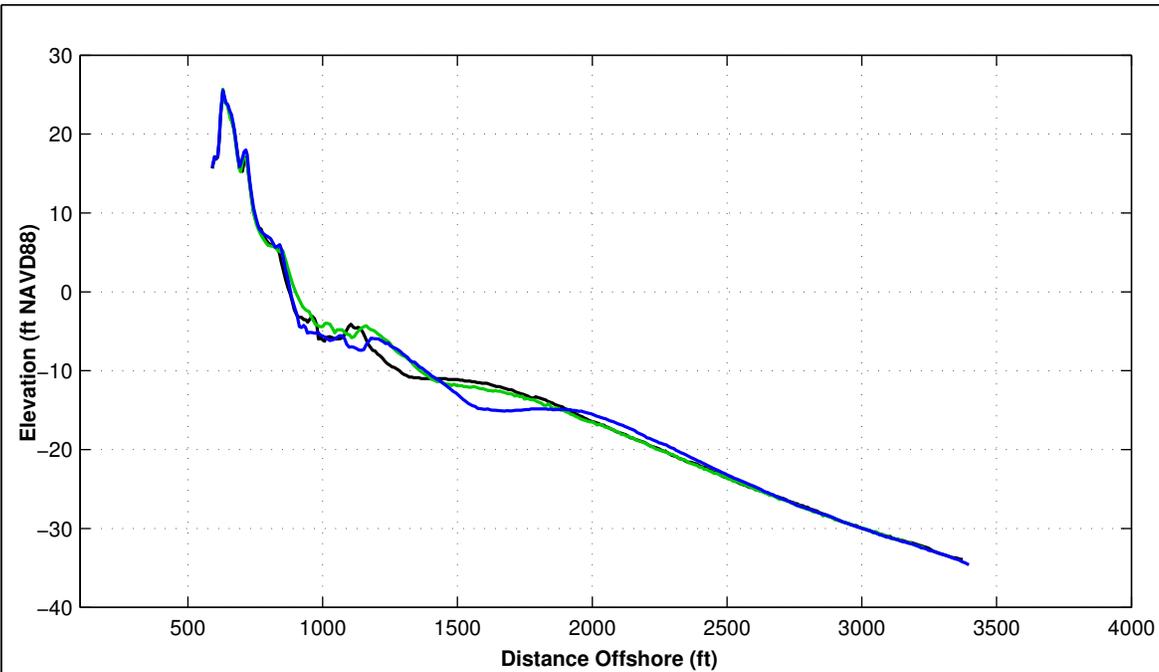
Survey Transect 800+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	16.82 ft	25.96 ft
Volume Change Above +6 ft NAVD88	2.21 cy/ft	1.68 cy/ft
Volume Change Above 1.18 ft NAVD88	7.12 cy/ft	7.30 cy/ft
Volume Change Above -6 ft NAVD88	16.09 cy/ft	6.88 cy/ft
Volume Change Above -14 ft NAVD88	-3.70 cy/ft	67.77 cy/ft
Volume Change Above -19 ft NAVD88	-8.60 cy/ft	47.88 cy/ft
Volume Change Above -30 ft NAVD88	-0.13 cy/ft	33.94 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 805+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	8.05 ft	9.65 ft
Volume Change Above +6 ft NAVD88	3.04 cy/ft	3.14 cy/ft
Volume Change Above 1.18 ft NAVD88	4.87 cy/ft	6.22 cy/ft
Volume Change Above -6 ft NAVD88	-1.37 cy/ft	2.51 cy/ft
Volume Change Above -14 ft NAVD88	-11.33 cy/ft	65.28 cy/ft
Volume Change Above -19 ft NAVD88	-12.93 cy/ft	71.24 cy/ft
Volume Change Above -30 ft NAVD88	-4.83 cy/ft	58.56 cy/ft

**LEGEND:**

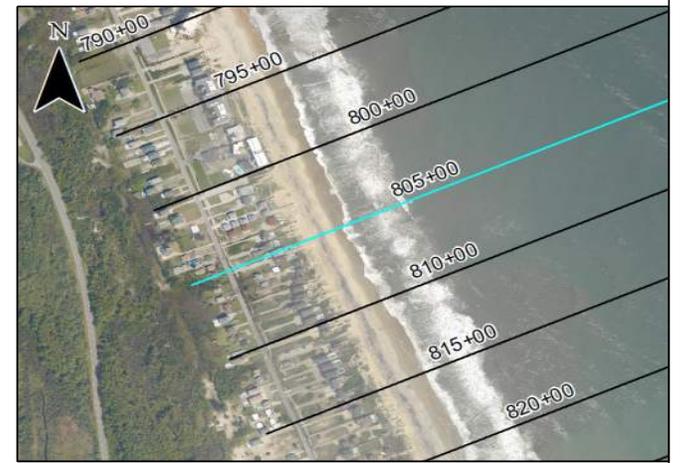
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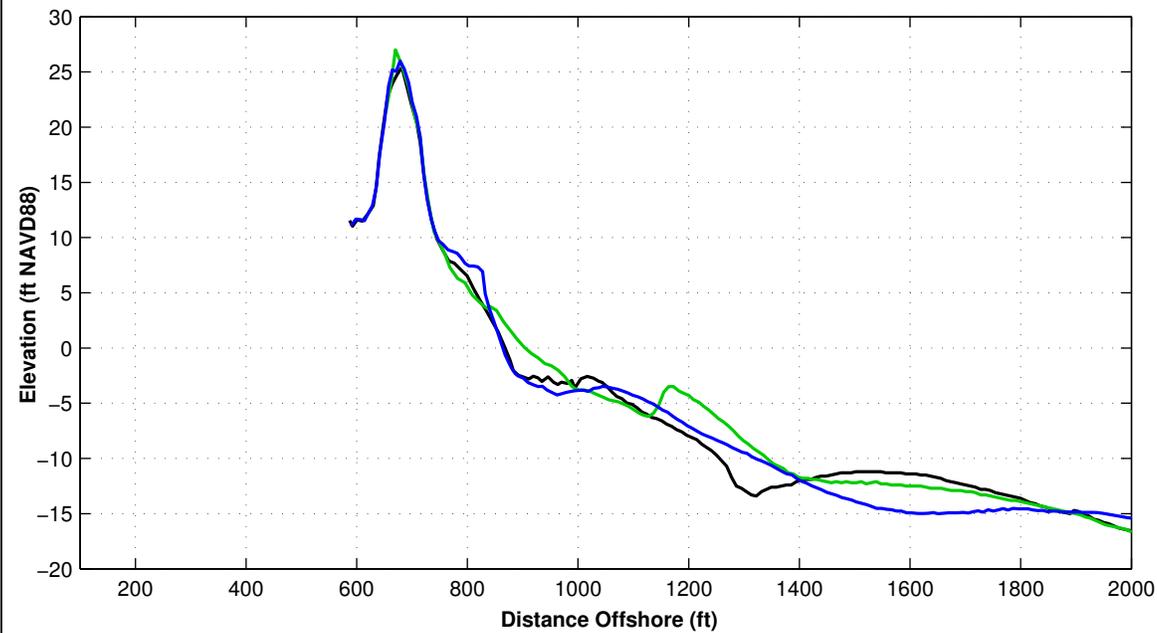
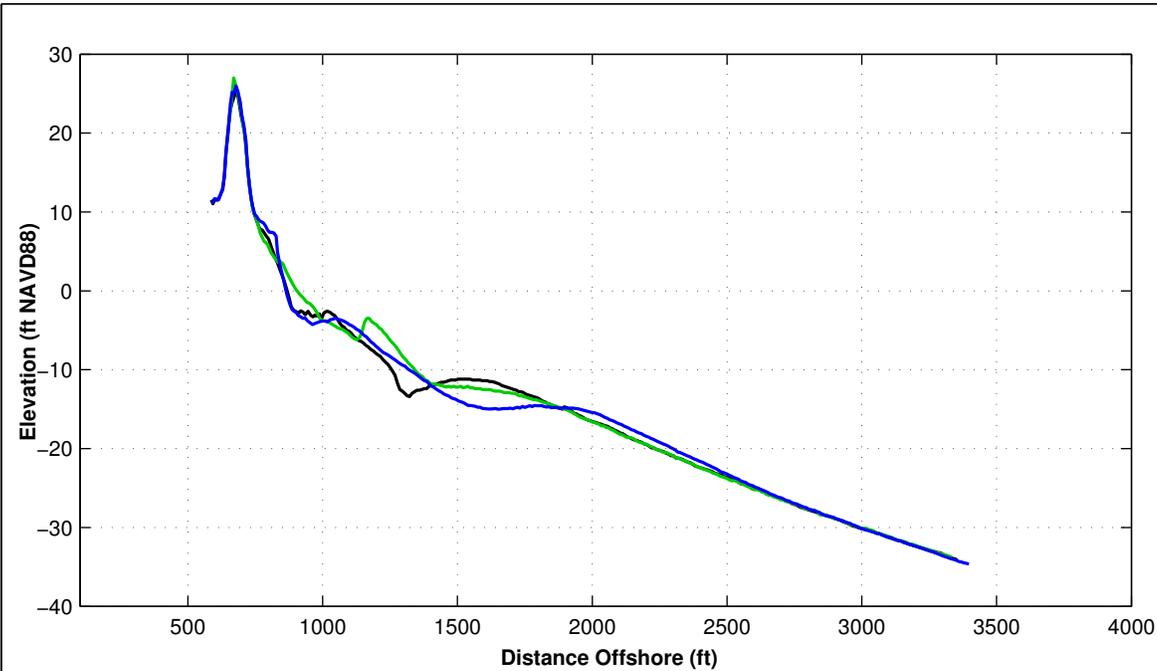
OCTOBER 2023 ————

JUNE 2023 ————

OCTOBER 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





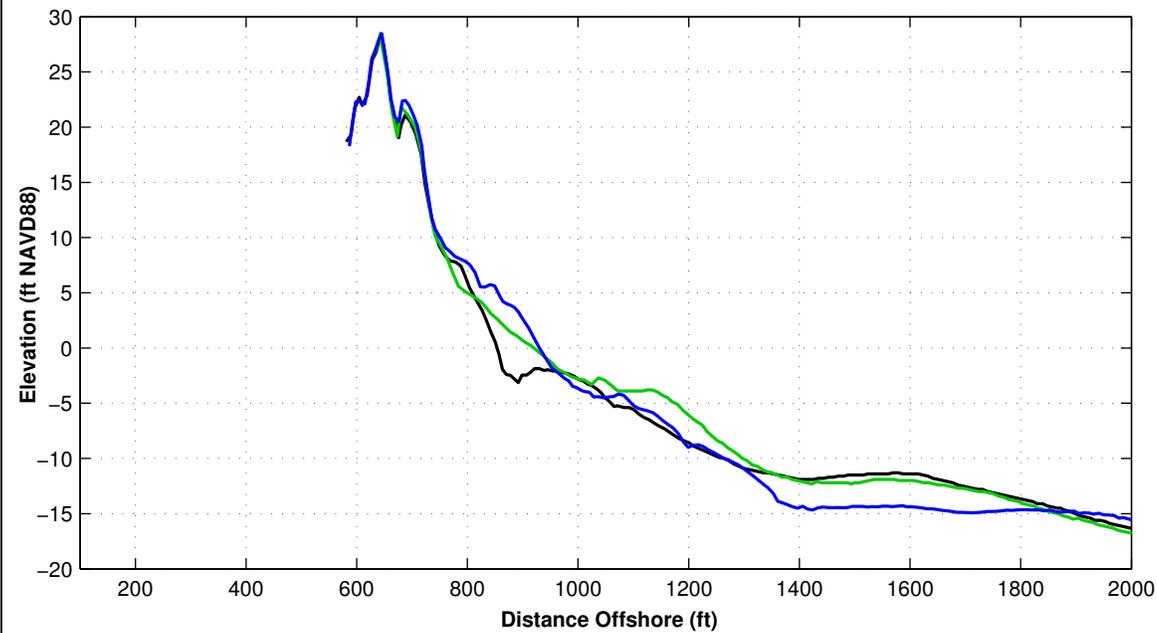
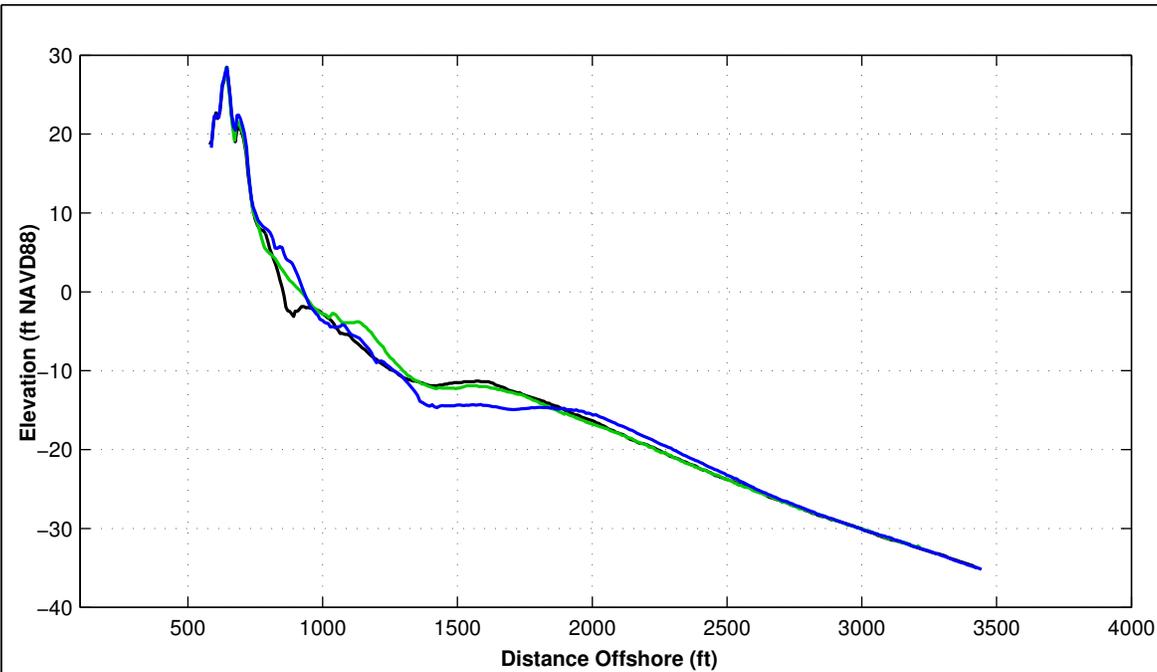
Survey Transect 810+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-1.86 ft	-12.43 ft
Volume Change Above +6 ft NAVD88	4.51 cy/ft	2.35 cy/ft
Volume Change Above 1.18 ft NAVD88	6.19 cy/ft	-0.23 cy/ft
Volume Change Above -6 ft NAVD88	4.40 cy/ft	1.75 cy/ft
Volume Change Above -14 ft NAVD88	-6.91 cy/ft	43.71 cy/ft
Volume Change Above -19 ft NAVD88	-5.08 cy/ft	49.97 cy/ft
Volume Change Above -30 ft NAVD88	6.29 cy/ft	35.89 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
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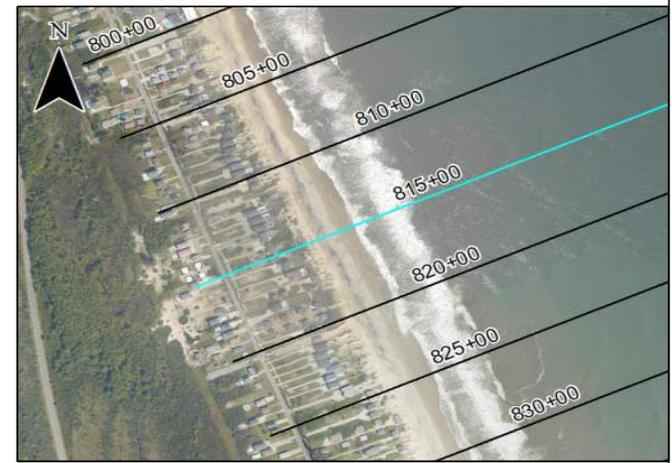


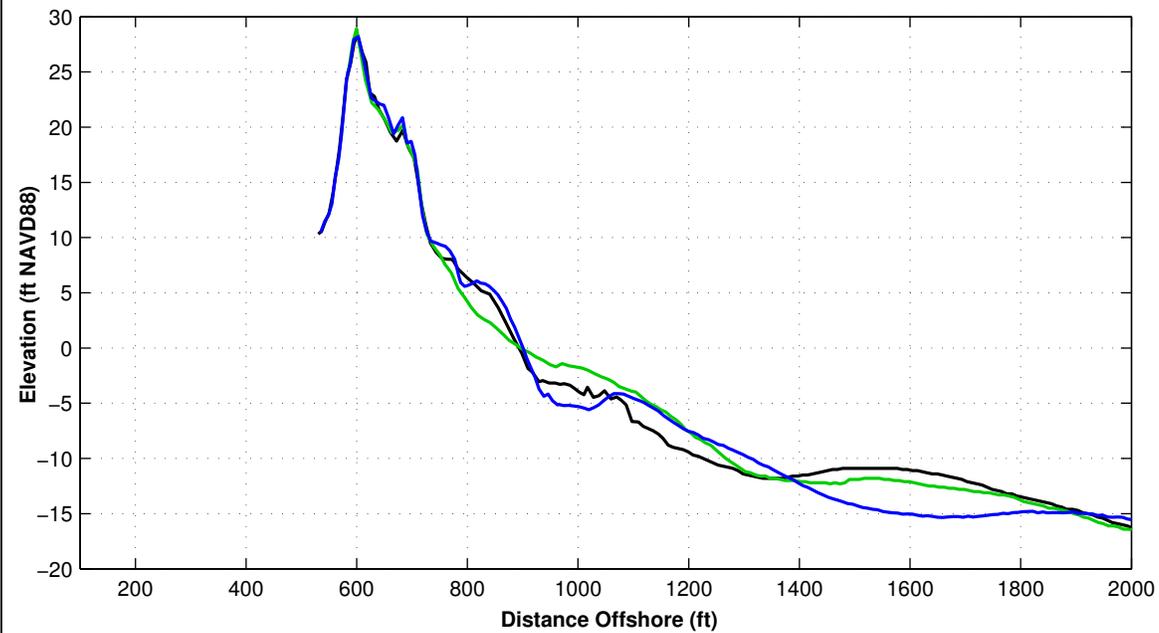
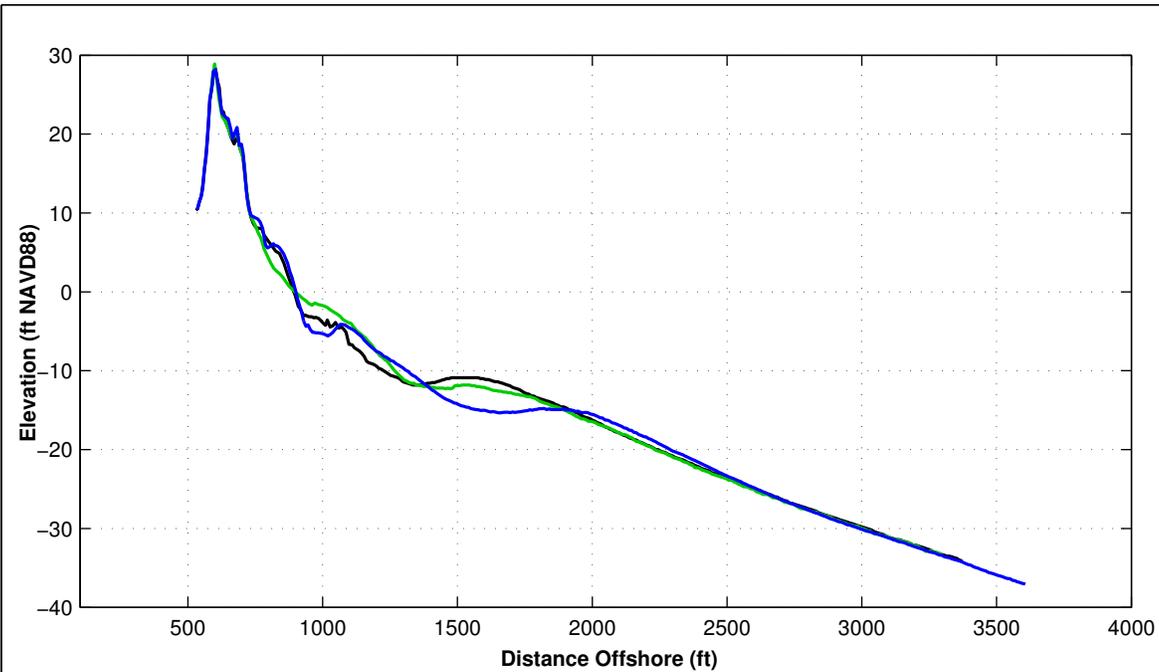
Survey Transect 815+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	72.97 ft	-14.60 ft
Volume Change Above +6 ft NAVD88	5.36 cy/ft	3.50 cy/ft
Volume Change Above 1.18 ft NAVD88	15.42 cy/ft	1.62 cy/ft
Volume Change Above -6 ft NAVD88	25.59 cy/ft	4.27 cy/ft
Volume Change Above -14 ft NAVD88	-7.44 cy/ft	52.61 cy/ft
Volume Change Above -19 ft NAVD88	-7.57 cy/ft	37.85 cy/ft
Volume Change Above -30 ft NAVD88	4.49 cy/ft	24.36 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
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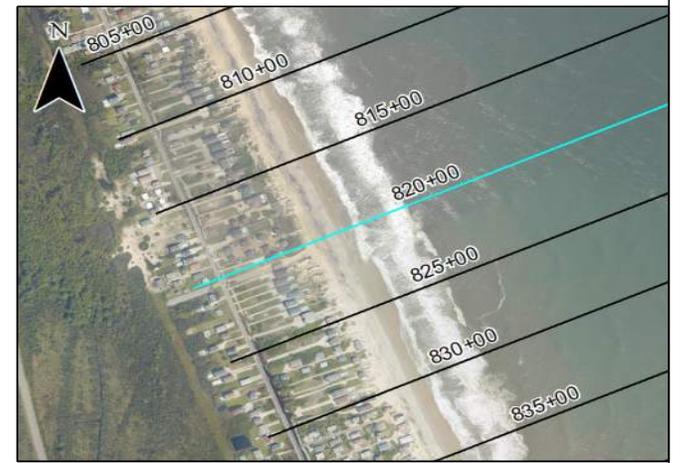


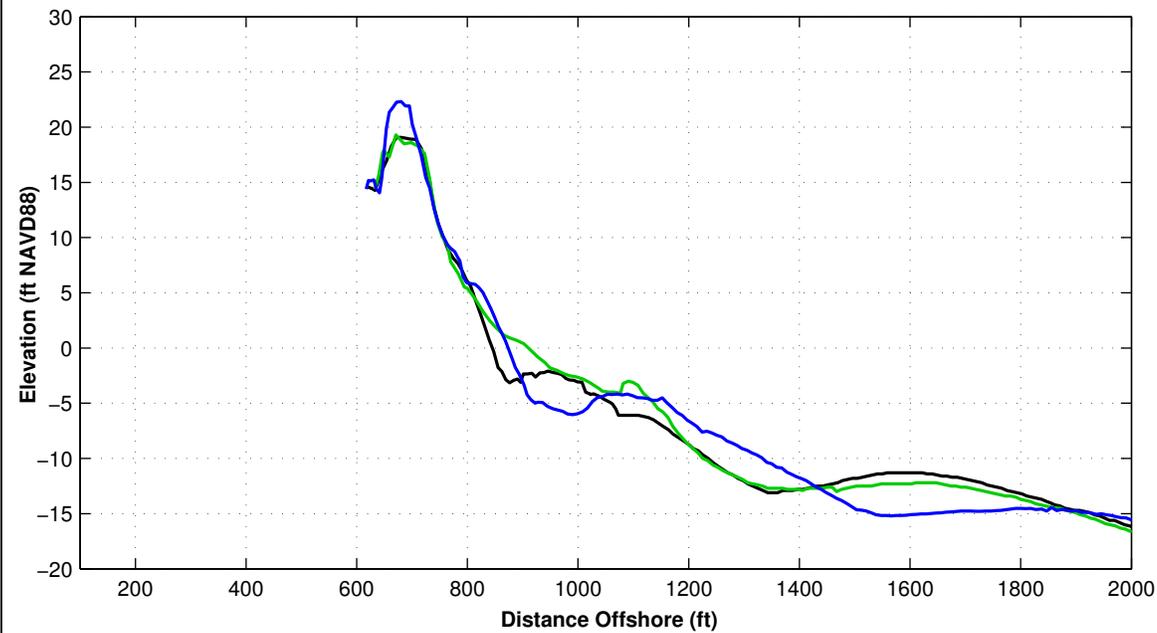
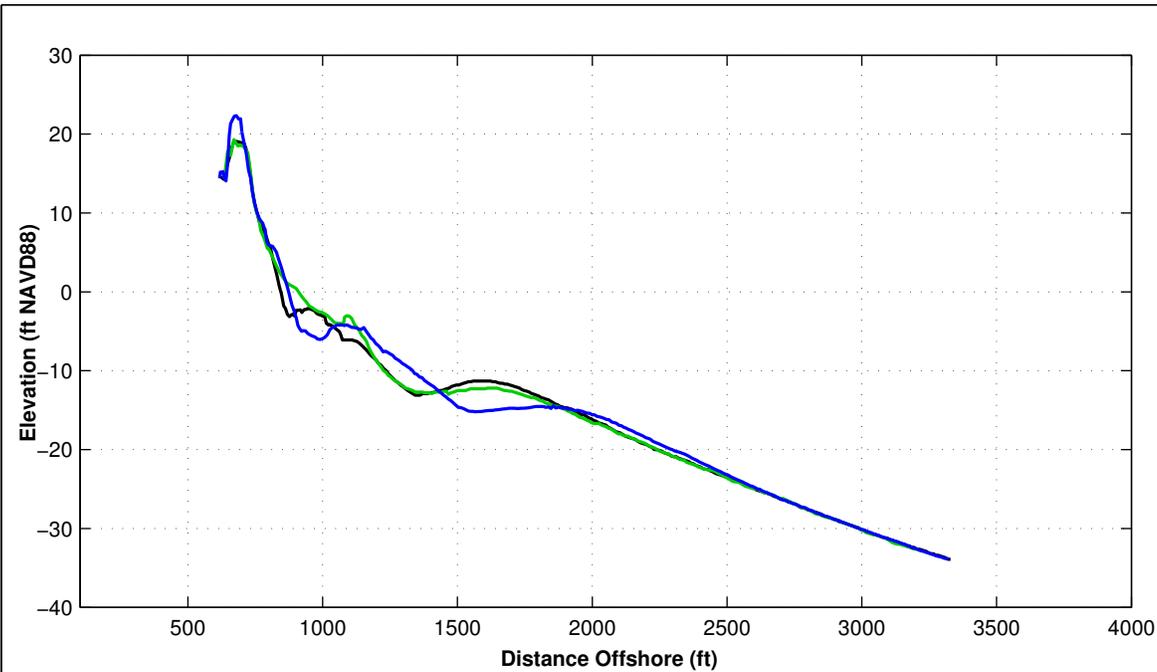
Survey Transect 820+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	10.62 ft	28.24 ft
Volume Change Above +6 ft NAVD88	2.81 cy/ft	4.62 cy/ft
Volume Change Above 1.18 ft NAVD88	5.16 cy/ft	8.18 cy/ft
Volume Change Above -6 ft NAVD88	2.30 cy/ft	14.16 cy/ft
Volume Change Above -14 ft NAVD88	-15.78 cy/ft	57.19 cy/ft
Volume Change Above -19 ft NAVD88	-21.66 cy/ft	62.54 cy/ft
Volume Change Above -30 ft NAVD88	-16.20 cy/ft	40.95 cy/ft

**LEGEND:**

JUNE 2024      ————      OCTOBER 2023      ————  
 JUNE 2023      ————      JUNE 2023      ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 825+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	27.16 ft	-23.85 ft
Volume Change Above +6 ft NAVD88	4.85 cy/ft	3.97 cy/ft
Volume Change Above 1.18 ft NAVD88	8.53 cy/ft	0.56 cy/ft
Volume Change Above -6 ft NAVD88	6.90 cy/ft	-2.05 cy/ft
Volume Change Above -14 ft NAVD88	1.58 cy/ft	33.61 cy/ft
Volume Change Above -19 ft NAVD88	-2.23 cy/ft	29.33 cy/ft
Volume Change Above -30 ft NAVD88	6.44 cy/ft	20.10 cy/ft

**LEGEND:**

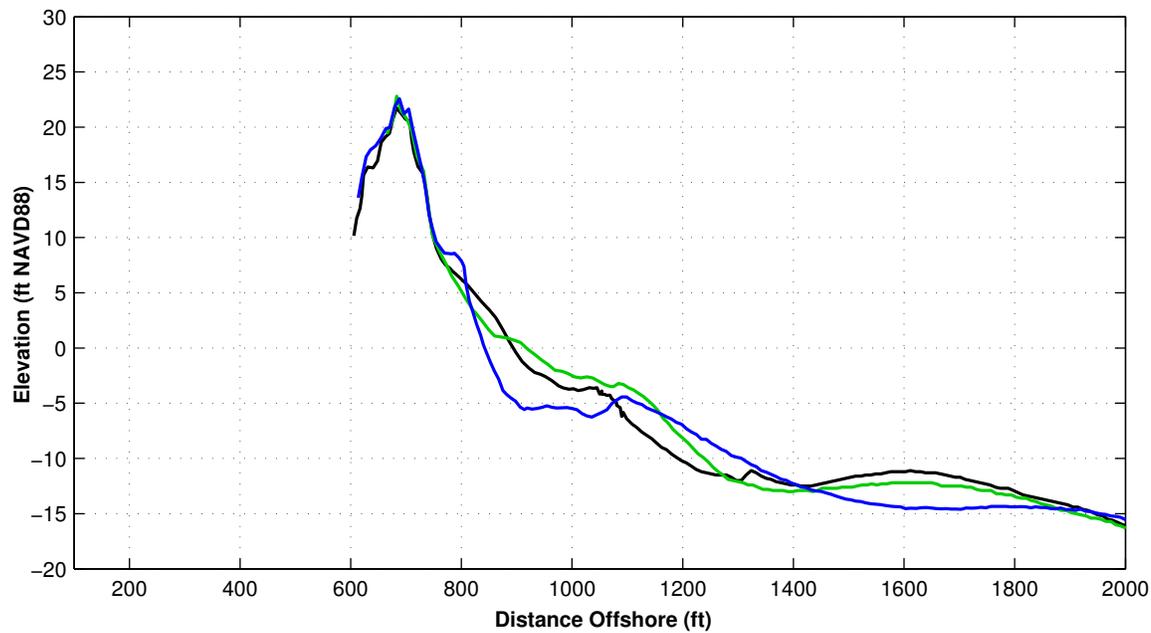
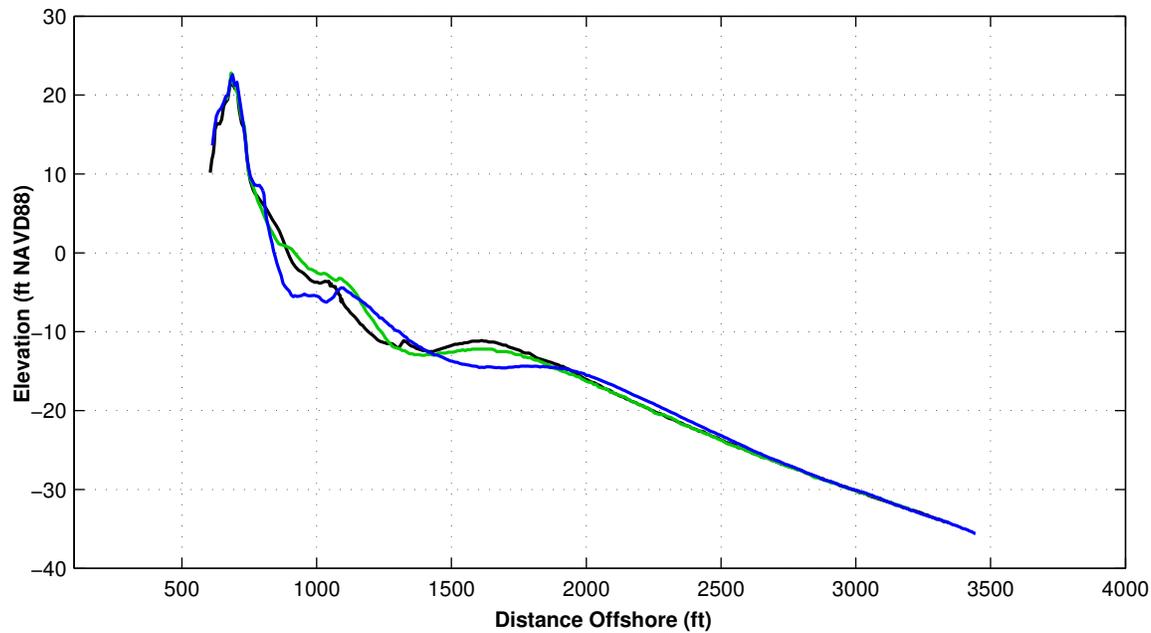
JUNE 2024 ————

OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 830+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-45.40 ft	12.49 ft
Volume Change Above +6 ft NAVD88	4.50 cy/ft	2.43 cy/ft
Volume Change Above 1.18 ft NAVD88	-0.23 cy/ft	6.30 cy/ft
Volume Change Above -6 ft NAVD88	-21.88 cy/ft	6.53 cy/ft
Volume Change Above -14 ft NAVD88	-30.72 cy/ft	34.15 cy/ft
Volume Change Above -19 ft NAVD88	-29.52 cy/ft	23.89 cy/ft
Volume Change Above -30 ft NAVD88	-18.35 cy/ft	10.16 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————  
 JUNE 2023 ———— OCTOBER 2023 ————

**Notes:**

1. Station From North To South At Varying Intervals.
2. All Survey Elevations In Feet Referenced to NAVD88.

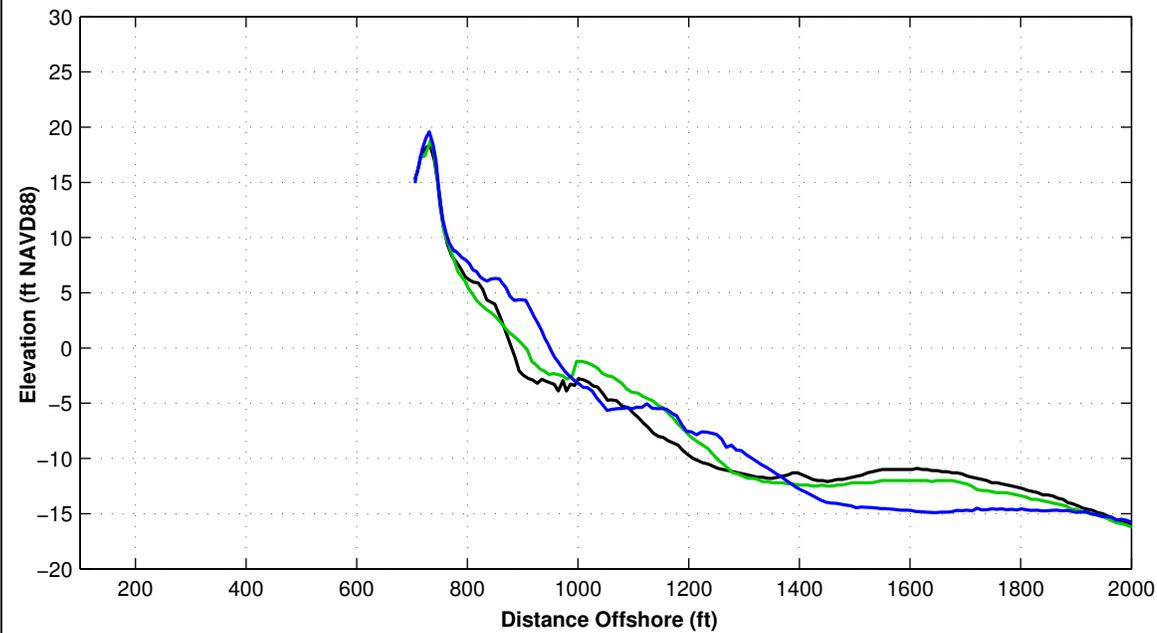
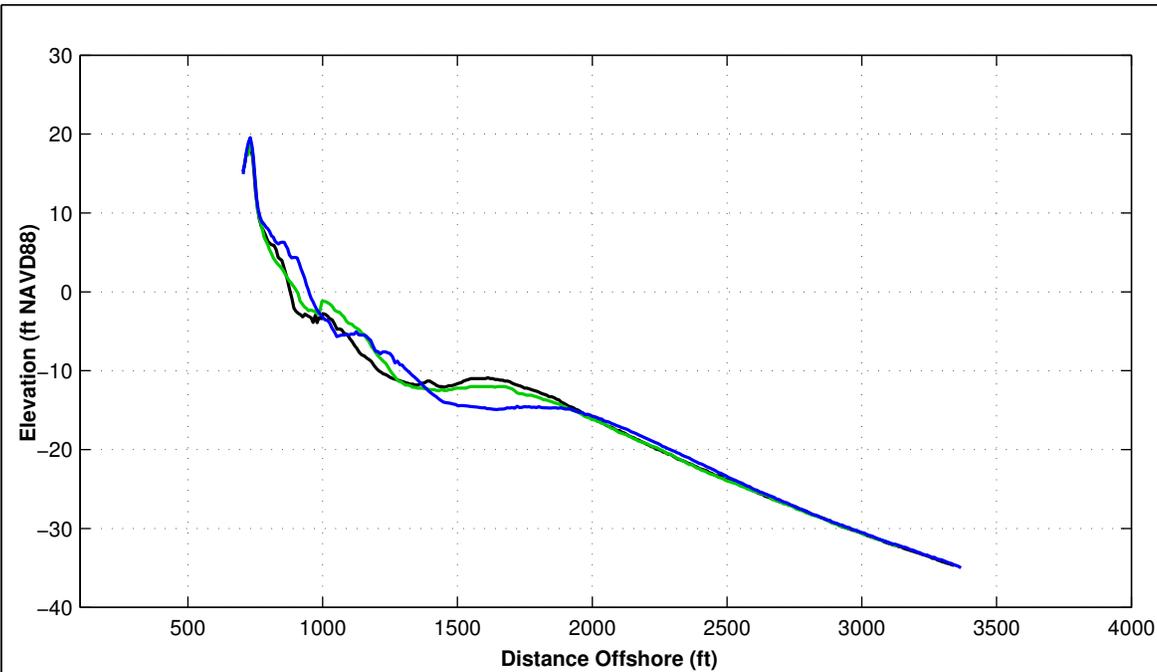


**Town of Nags Head Periodic Surveying Data Analysis**

ST 830+00

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2024



Survey Transect 835+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	66.19 ft	-0.08 ft
Volume Change Above +6 ft NAVD88	3.79 cy/ft	1.77 cy/ft
Volume Change Above 1.18 ft NAVD88	13.92 cy/ft	1.80 cy/ft
Volume Change Above -6 ft NAVD88	25.31 cy/ft	-3.26 cy/ft
Volume Change Above -14 ft NAVD88	5.36 cy/ft	39.39 cy/ft
Volume Change Above -19 ft NAVD88	-1.16 cy/ft	57.76 cy/ft
Volume Change Above -30 ft NAVD88	8.26 cy/ft	44.20 cy/ft

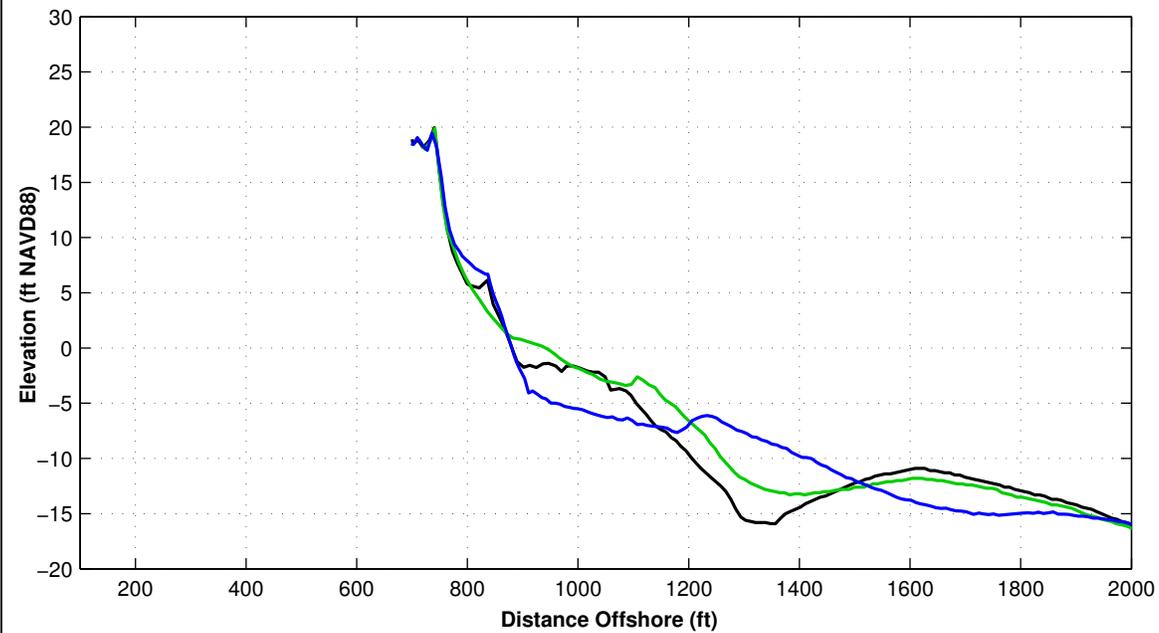
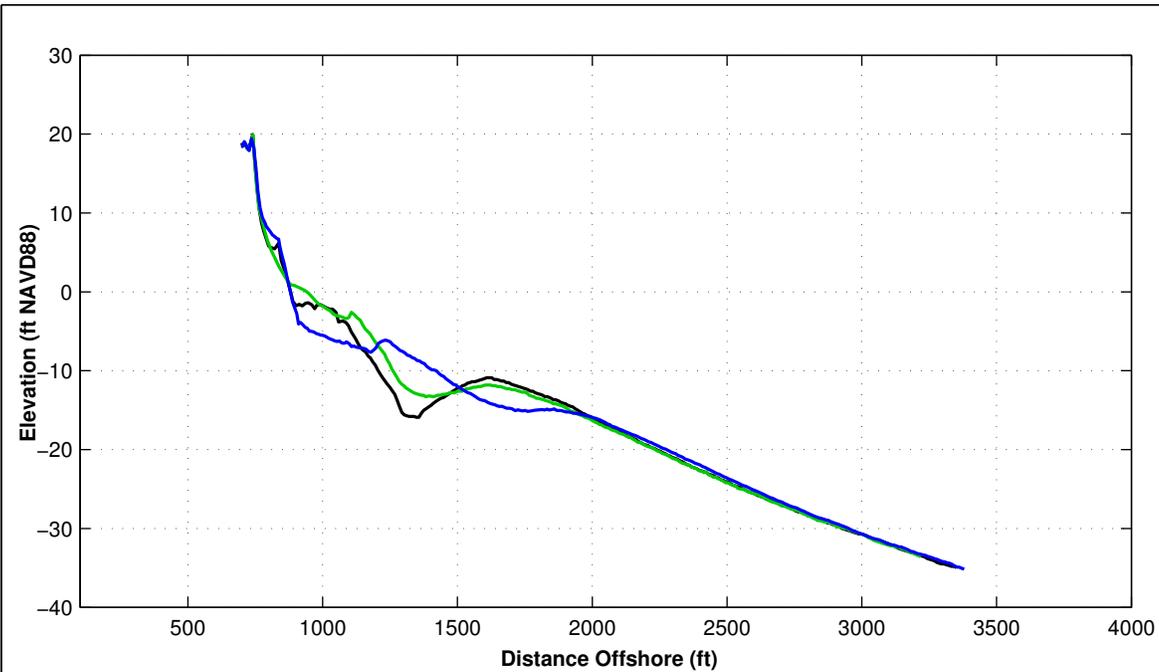
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 840+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	0.89 ft	0.98 ft
Volume Change Above +6 ft NAVD88	3.65 cy/ft	2.25 cy/ft
Volume Change Above 1.18 ft NAVD88	4.83 cy/ft	3.15 cy/ft
Volume Change Above -6 ft NAVD88	-18.03 cy/ft	8.65 cy/ft
Volume Change Above -14 ft NAVD88	7.35 cy/ft	22.50 cy/ft
Volume Change Above -19 ft NAVD88	5.55 cy/ft	12.16 cy/ft
Volume Change Above -30 ft NAVD88	17.83 cy/ft	0.06 cy/ft

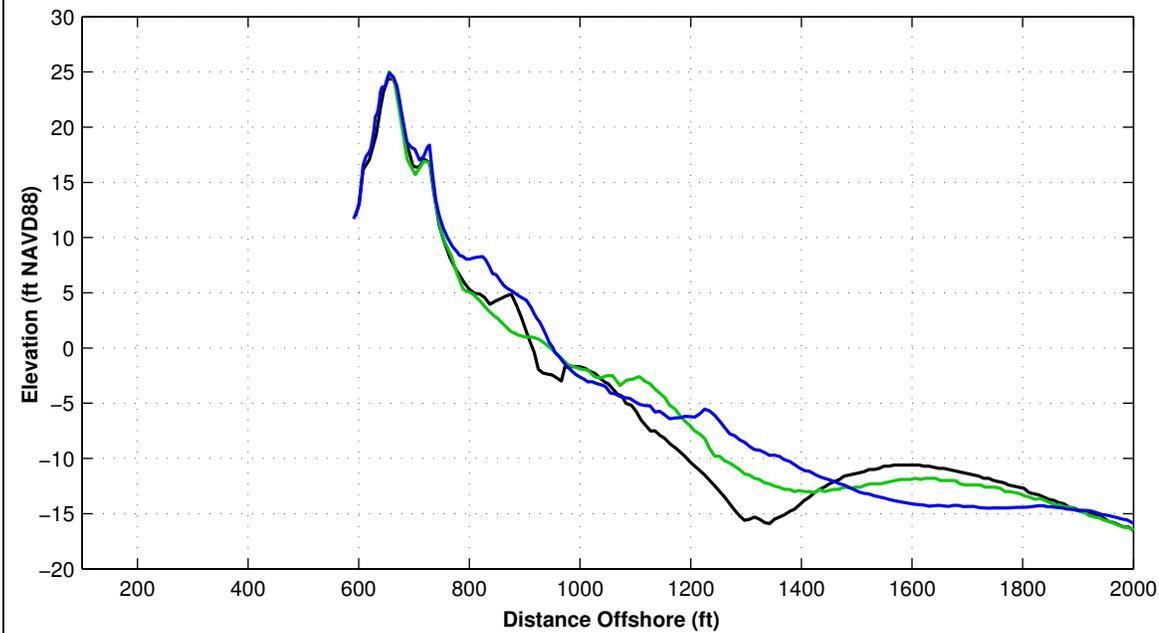
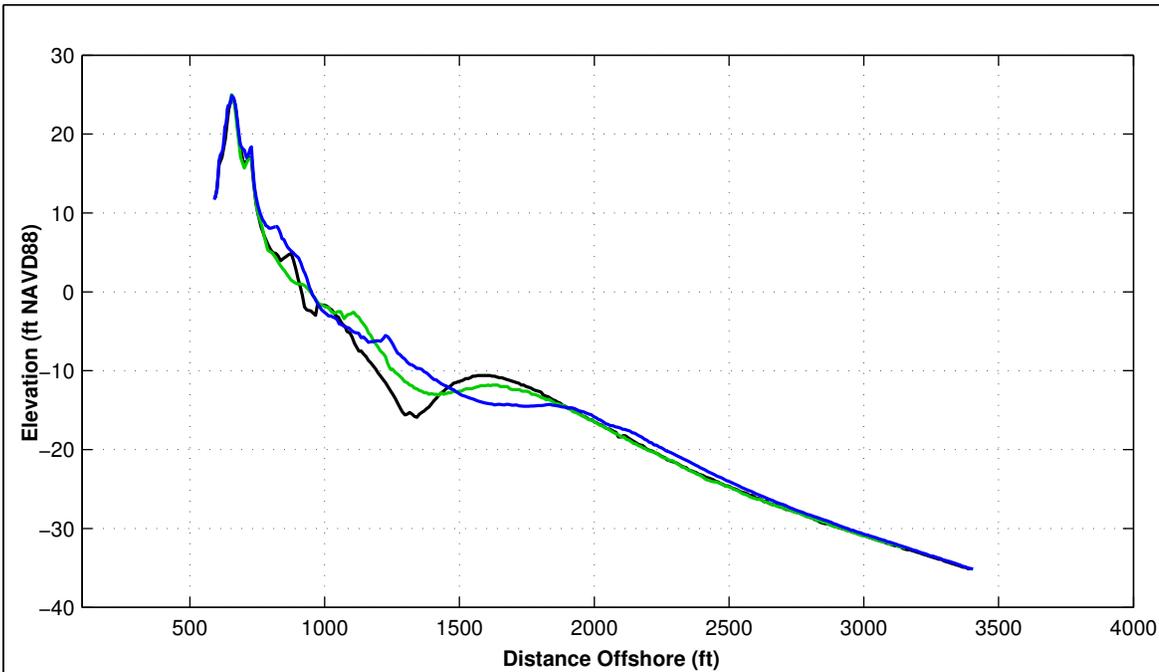
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 845+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	33.35 ft	23.78 ft
Volume Change Above +6 ft NAVD88	8.92 cy/ft	1.78 cy/ft
Volume Change Above 1.18 ft NAVD88	16.28 cy/ft	3.78 cy/ft
Volume Change Above -6 ft NAVD88	21.44 cy/ft	5.54 cy/ft
Volume Change Above -14 ft NAVD88	37.39 cy/ft	29.66 cy/ft
Volume Change Above -19 ft NAVD88	45.75 cy/ft	32.24 cy/ft
Volume Change Above -30 ft NAVD88	63.29 cy/ft	31.27 cy/ft

**LEGEND:**

JUNE 2024 ————

OCTOBER 2023 ————

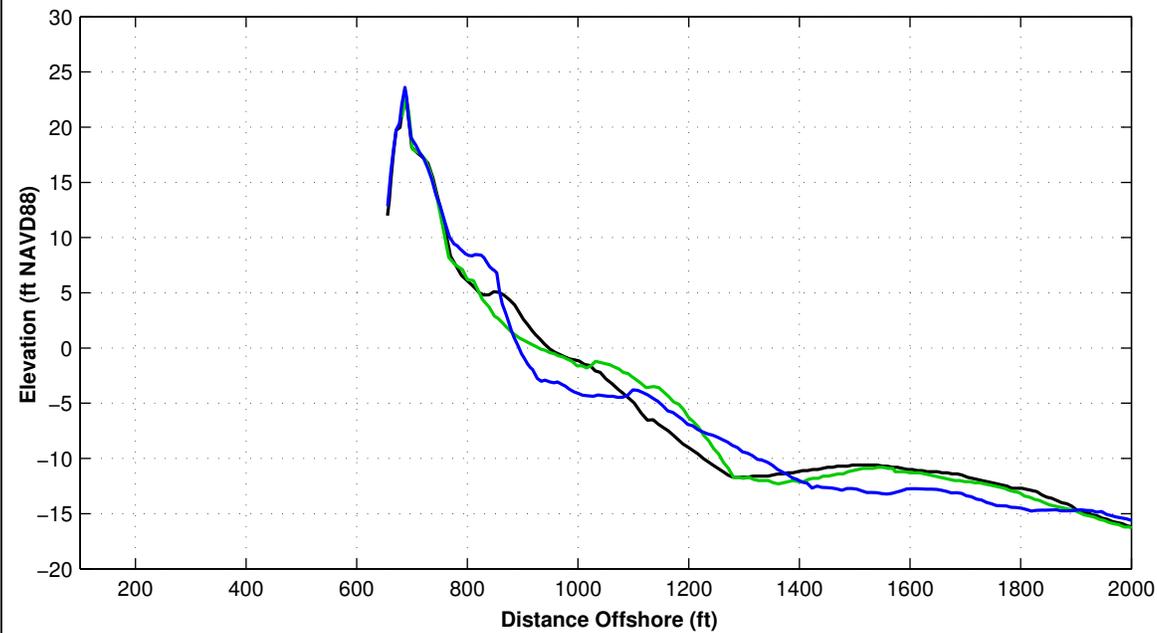
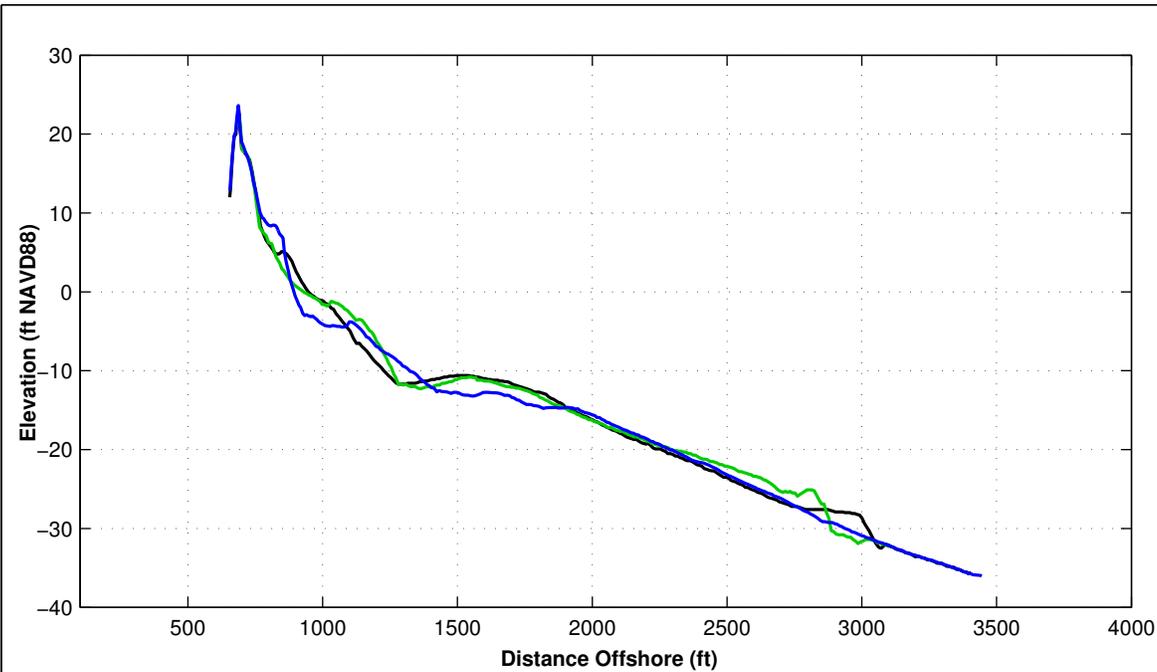
JUNE 2023 ————

OCTOBER 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





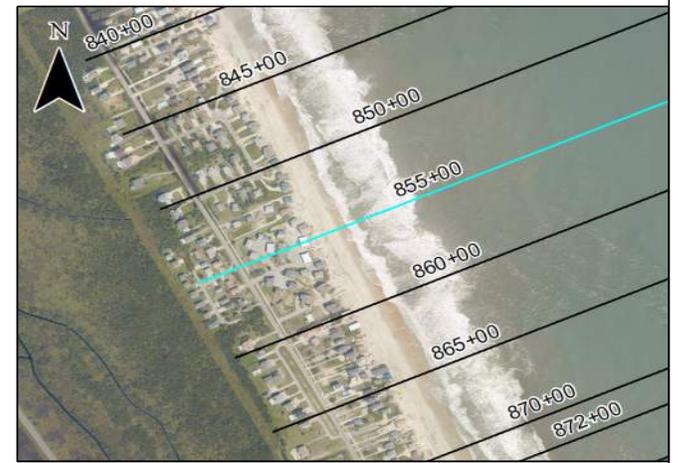


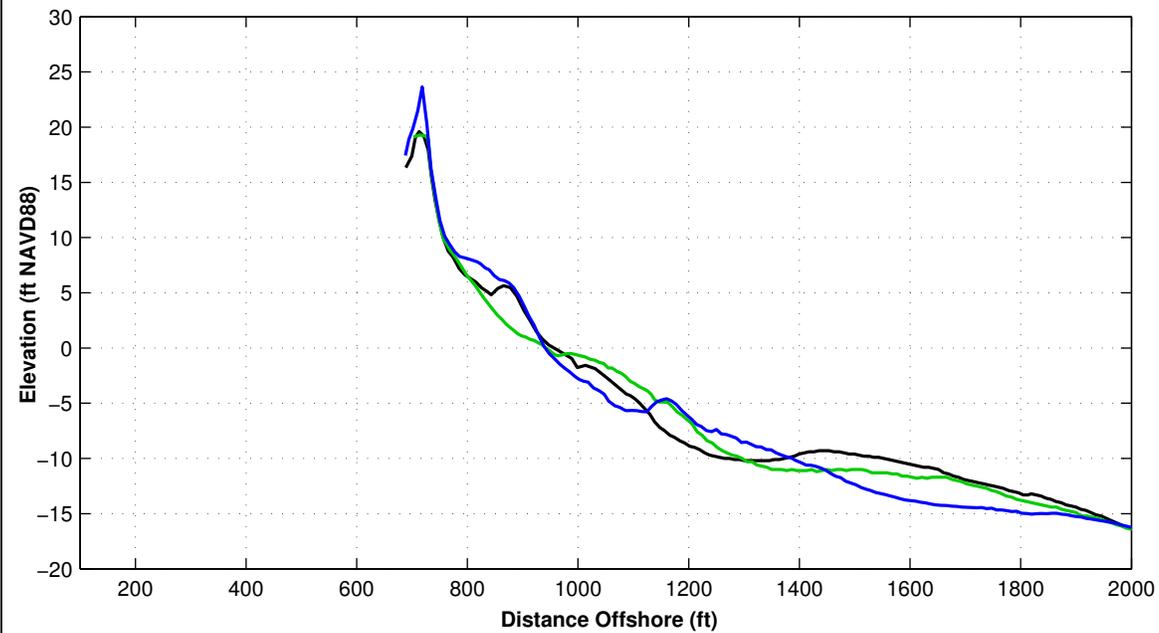
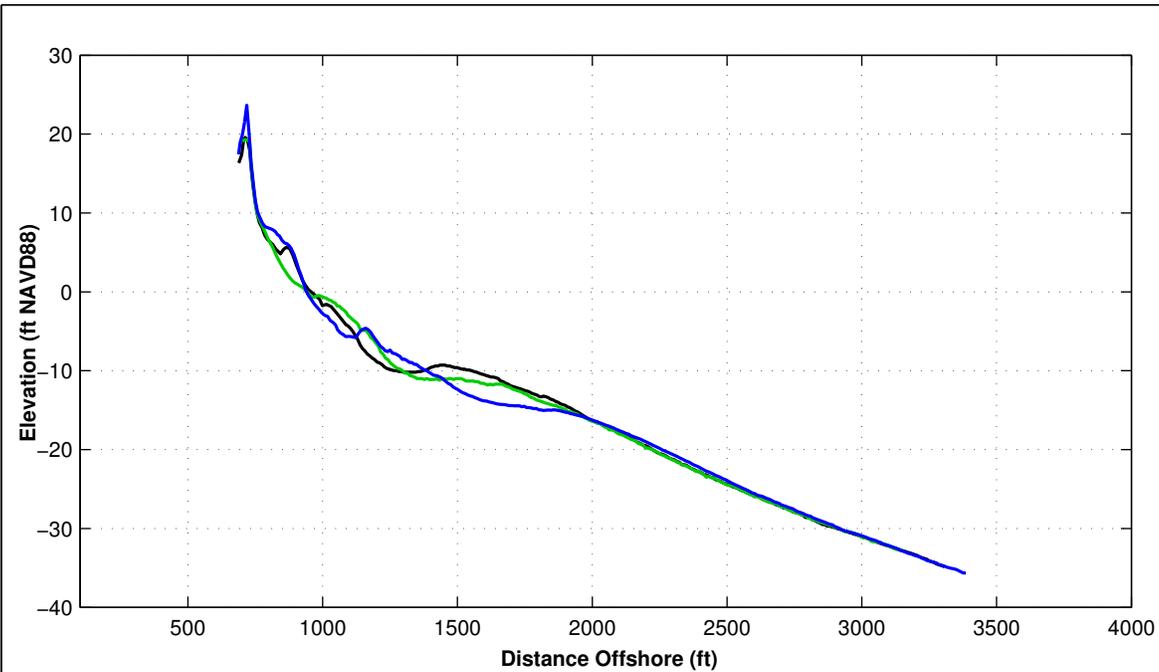
Survey Transect 855+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-41.02 ft	46.11 ft
Volume Change Above +6 ft NAVD88	7.25 cy/ft	4.79 cy/ft
Volume Change Above 1.18 ft NAVD88	5.45 cy/ft	9.23 cy/ft
Volume Change Above -6 ft NAVD88	-8.31 cy/ft	18.01 cy/ft
Volume Change Above -14 ft NAVD88	-20.95 cy/ft	31.84 cy/ft
Volume Change Above -19 ft NAVD88	-17.32 cy/ft	6.46 cy/ft
Volume Change Above -30 ft NAVD88	-20.06 cy/ft	14.15 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023		JUNE 2023	
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- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





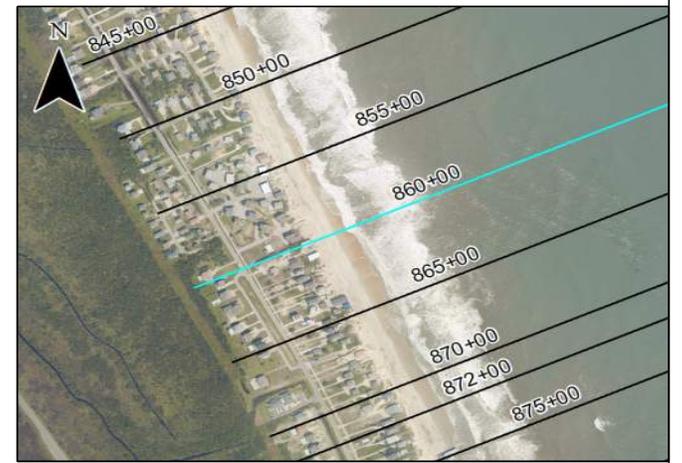
Survey Transect 860+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-1.25 ft	71.84 ft
Volume Change Above +6 ft NAVD88	8.22 cy/ft	4.66 cy/ft
Volume Change Above 1.18 ft NAVD88	10.21 cy/ft	14.25 cy/ft
Volume Change Above -6 ft NAVD88	3.41 cy/ft	32.97 cy/ft
Volume Change Above -14 ft NAVD88	-17.40 cy/ft	77.63 cy/ft
Volume Change Above -19 ft NAVD88	-23.46 cy/ft	54.49 cy/ft
Volume Change Above -30 ft NAVD88	-12.40 cy/ft	27.31 cy/ft

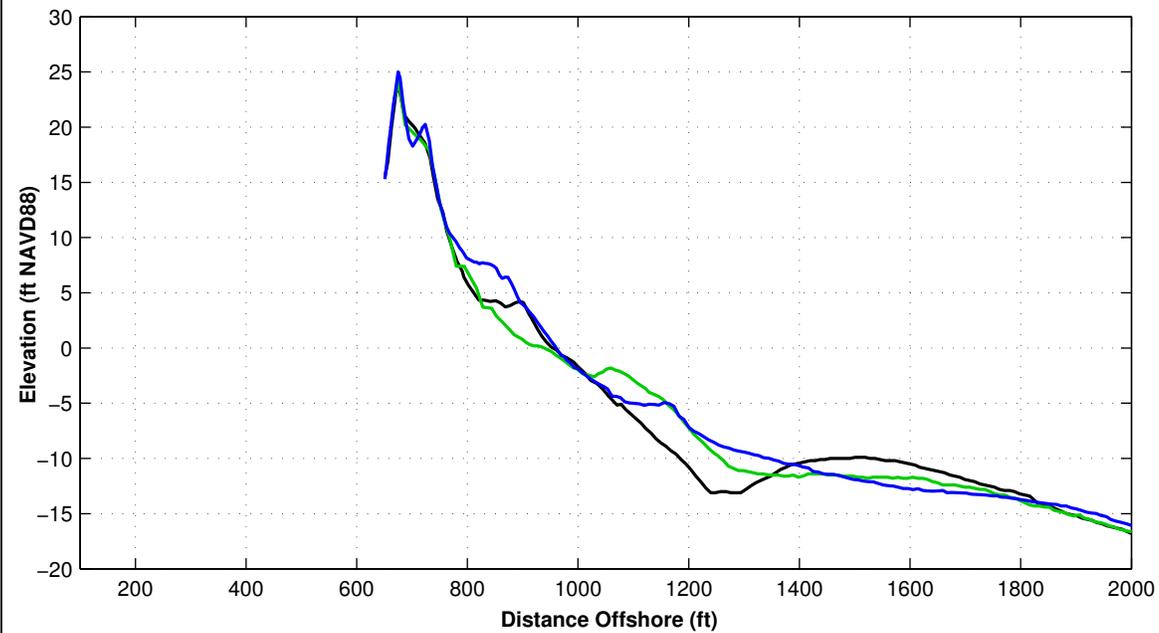
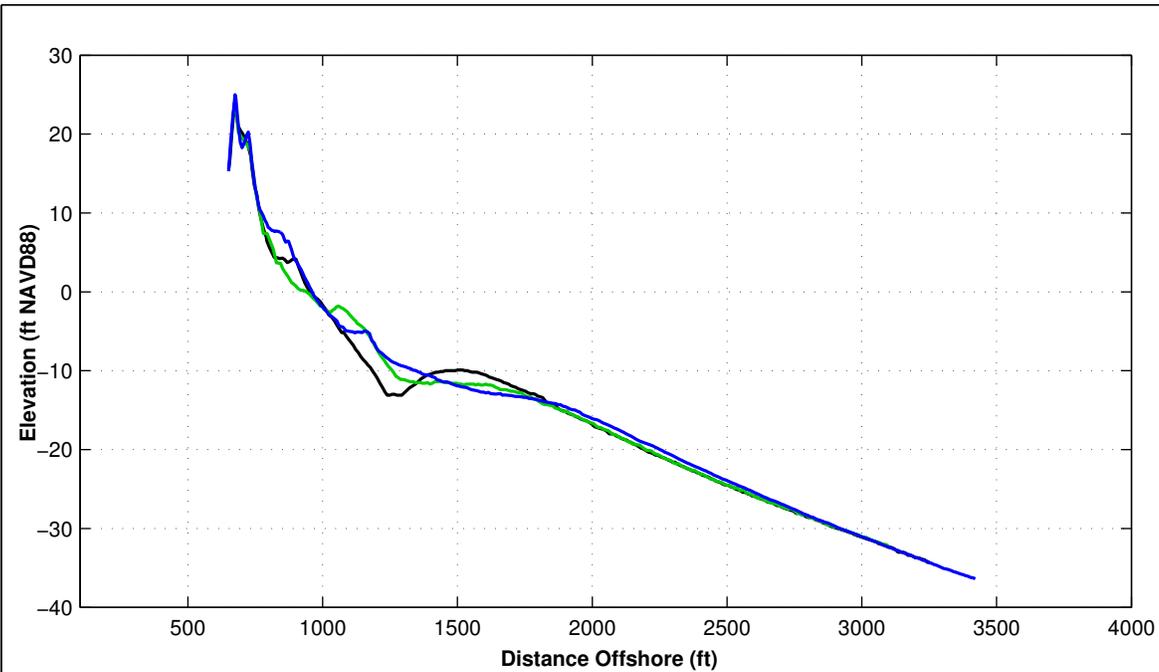
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
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  2. All Survey Elevations In Feet Referenced to NAVD88.





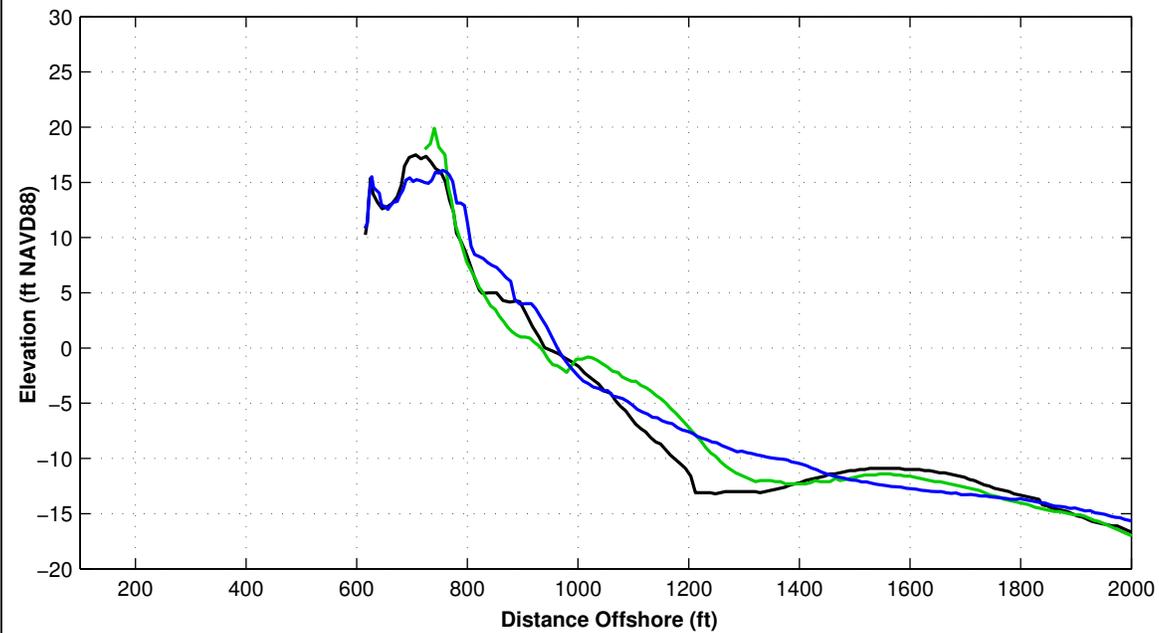
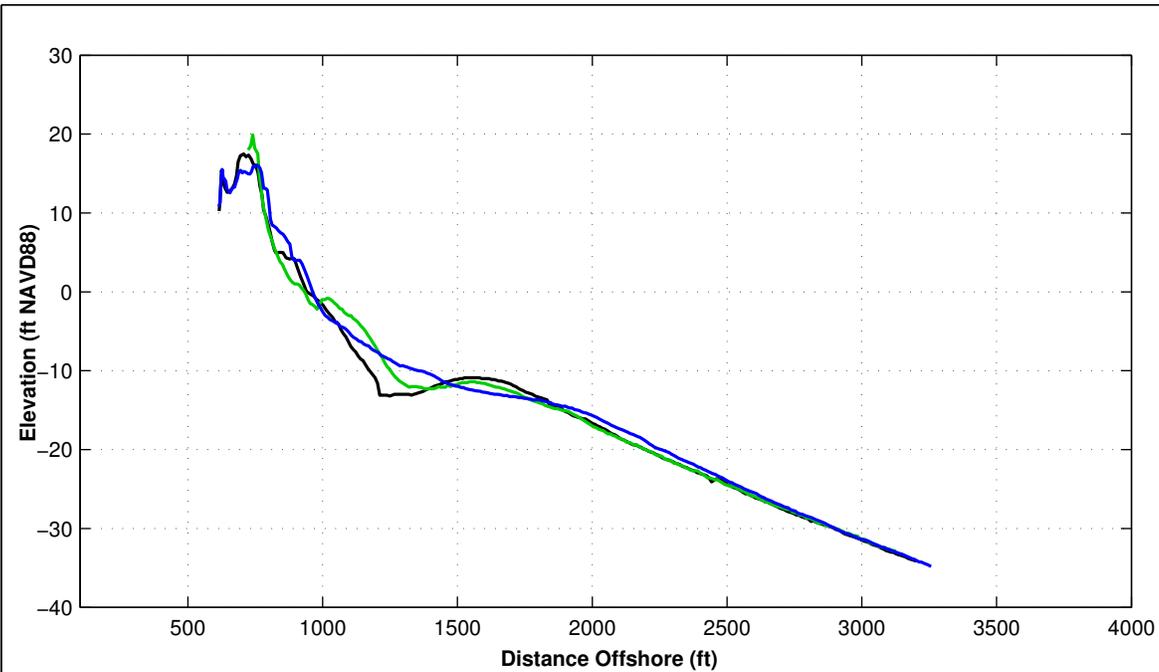
Survey Transect 865+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	10.39 ft	61.45 ft
Volume Change Above +6 ft NAVD88	6.40 cy/ft	4.85 cy/ft
Volume Change Above 1.18 ft NAVD88	12.24 cy/ft	9.80 cy/ft
Volume Change Above -6 ft NAVD88	16.29 cy/ft	23.19 cy/ft
Volume Change Above -14 ft NAVD88	22.77 cy/ft	61.81 cy/ft
Volume Change Above -19 ft NAVD88	31.42 cy/ft	48.30 cy/ft
Volume Change Above -30 ft NAVD88	46.15 cy/ft	28.73 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 870+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	23.53 ft	52.68 ft
Volume Change Above +6 ft NAVD88	4.33 cy/ft	3.73 cy/ft
Volume Change Above 1.18 ft NAVD88	9.76 cy/ft	9.03 cy/ft
Volume Change Above -6 ft NAVD88	10.77 cy/ft	15.87 cy/ft
Volume Change Above -14 ft NAVD88	31.37 cy/ft	12.75 cy/ft
Volume Change Above -19 ft NAVD88	42.03 cy/ft	-12.33 cy/ft
Volume Change Above -30 ft NAVD88	57.63 cy/ft	-36.29 cy/ft

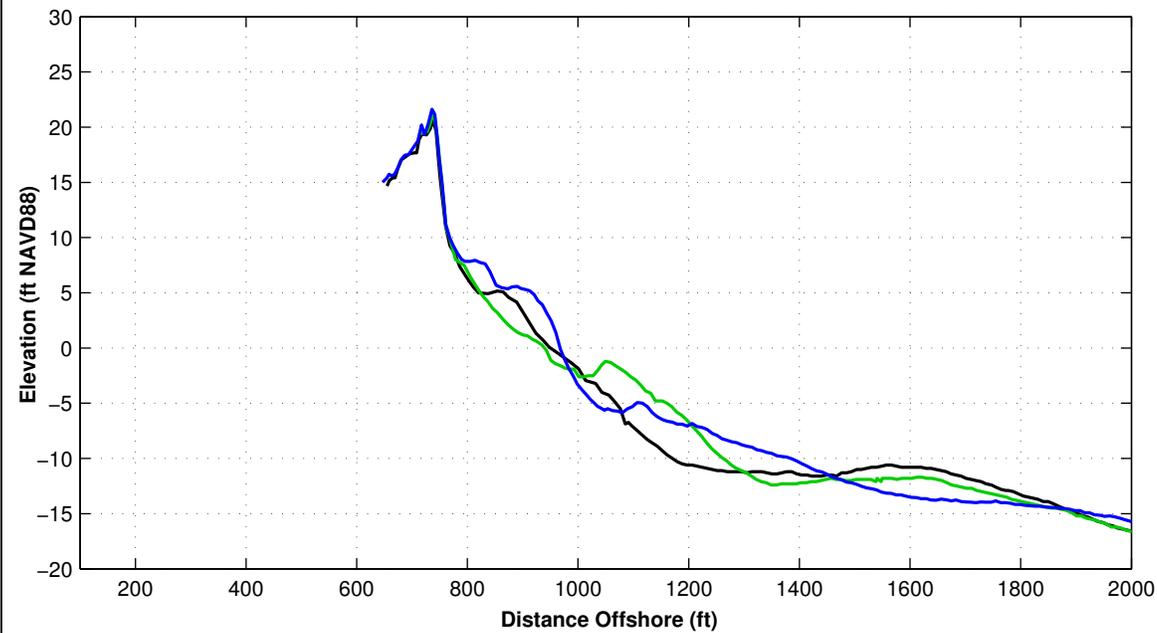
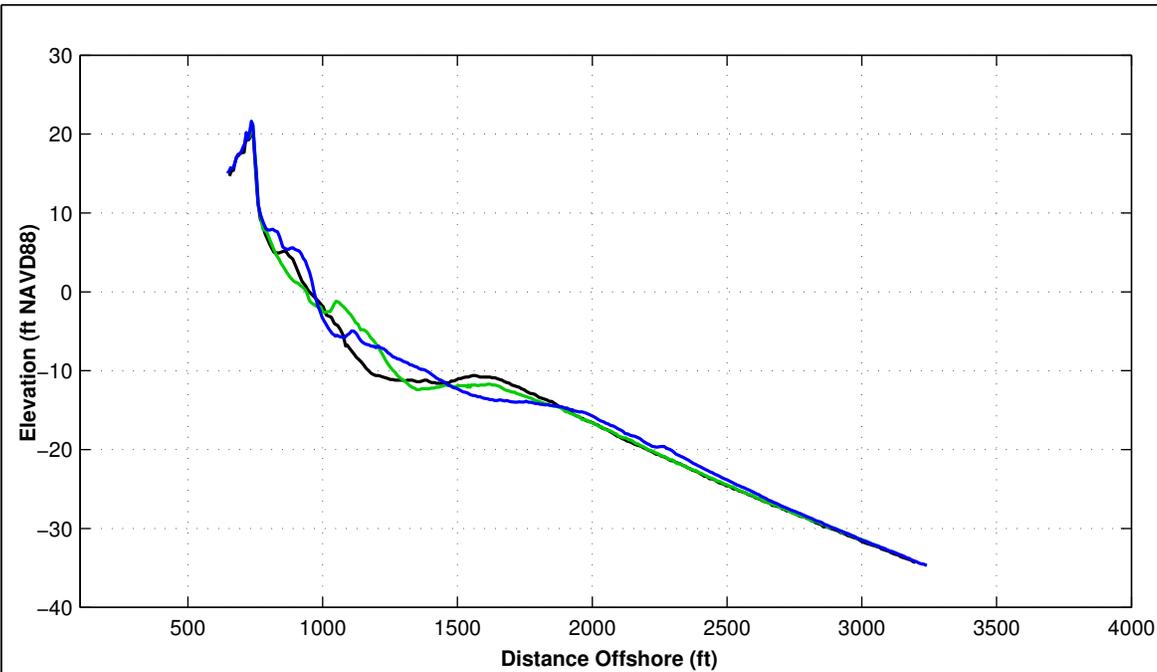
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
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  2. All Survey Elevations In Feet Referenced to NAVD88.





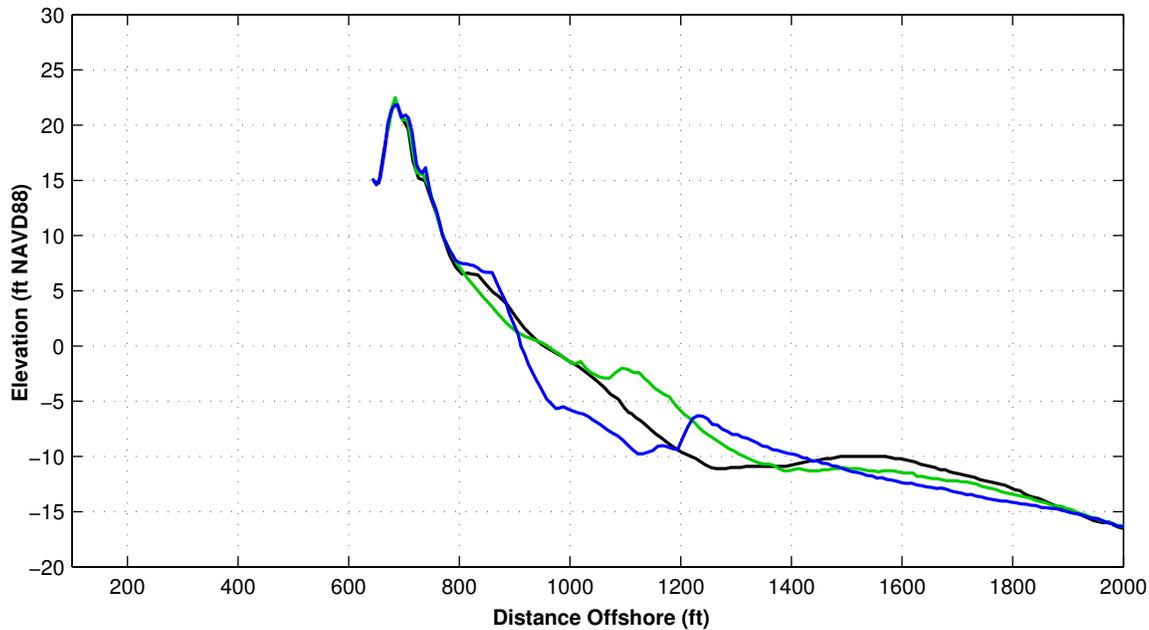
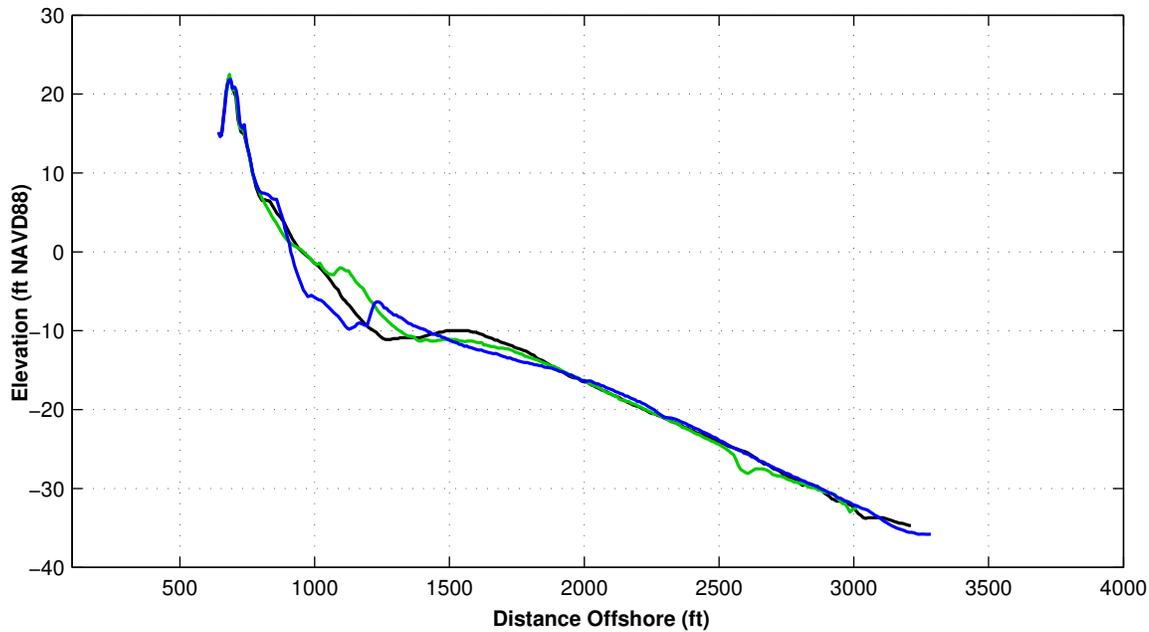
Survey Transect 872+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	33.74 ft	52.93 ft
Volume Change Above +6 ft NAVD88	5.32 cy/ft	2.78 cy/ft
Volume Change Above 1.18 ft NAVD88	13.76 cy/ft	8.41 cy/ft
Volume Change Above -6 ft NAVD88	11.94 cy/ft	14.40 cy/ft
Volume Change Above -14 ft NAVD88	16.92 cy/ft	29.50 cy/ft
Volume Change Above -19 ft NAVD88	23.98 cy/ft	12.35 cy/ft
Volume Change Above -30 ft NAVD88	41.27 cy/ft	-12.26 cy/ft

**LEGEND:**

JUNE 2024      OCTOBER 2023      JUNE 2023

- Notes:
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  2. All Survey Elevations In Feet Referenced to NAVD88.





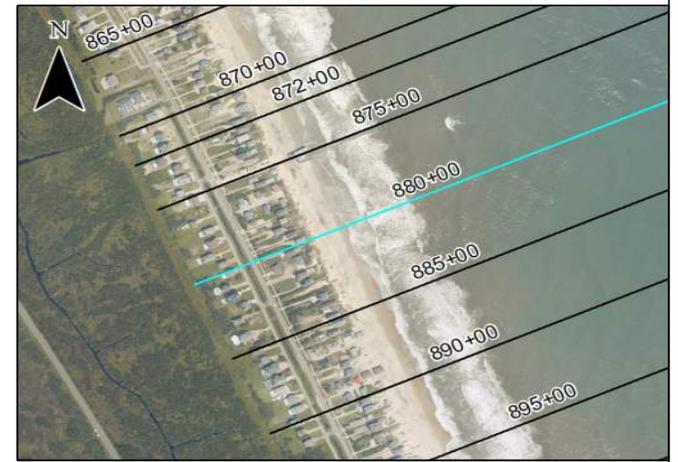
Survey Transect 880+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-21.34 ft	52.83 ft
Volume Change Above +6 ft NAVD88	4.20 cy/ft	1.01 cy/ft
Volume Change Above 1.18 ft NAVD88	4.27 cy/ft	6.24 cy/ft
Volume Change Above -6 ft NAVD88	-18.69 cy/ft	13.27 cy/ft
Volume Change Above -14 ft NAVD88	-29.72 cy/ft	51.73 cy/ft
Volume Change Above -19 ft NAVD88	-27.32 cy/ft	53.51 cy/ft
Volume Change Above -30 ft NAVD88	-20.41 cy/ft	17.87 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————  
 JUNE 2023 ————

**Notes:**

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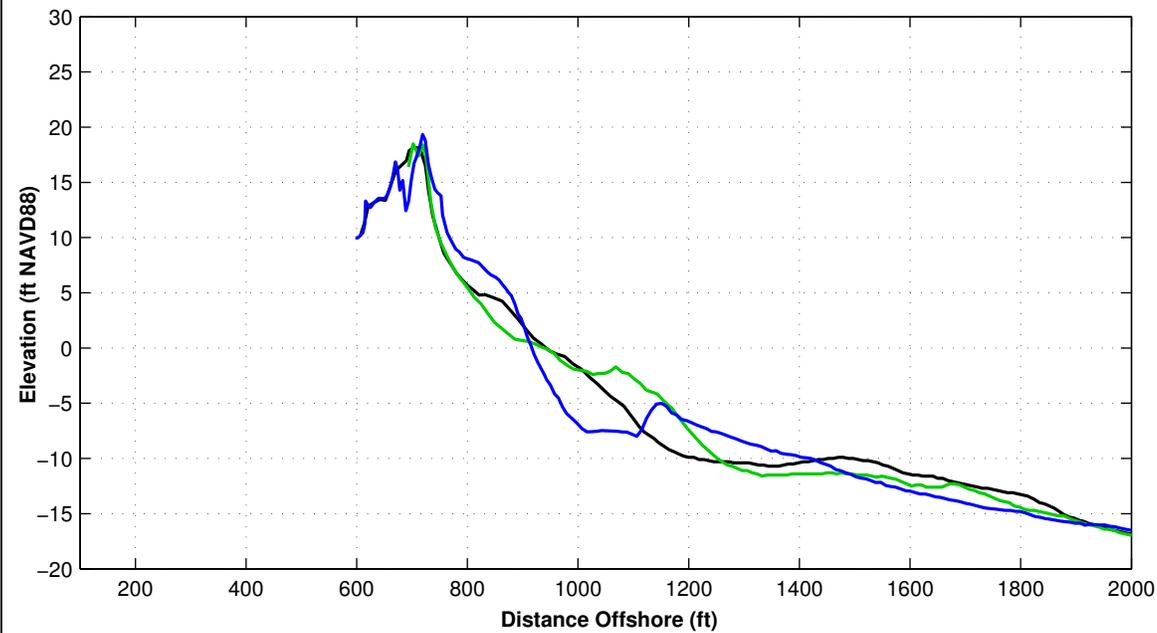
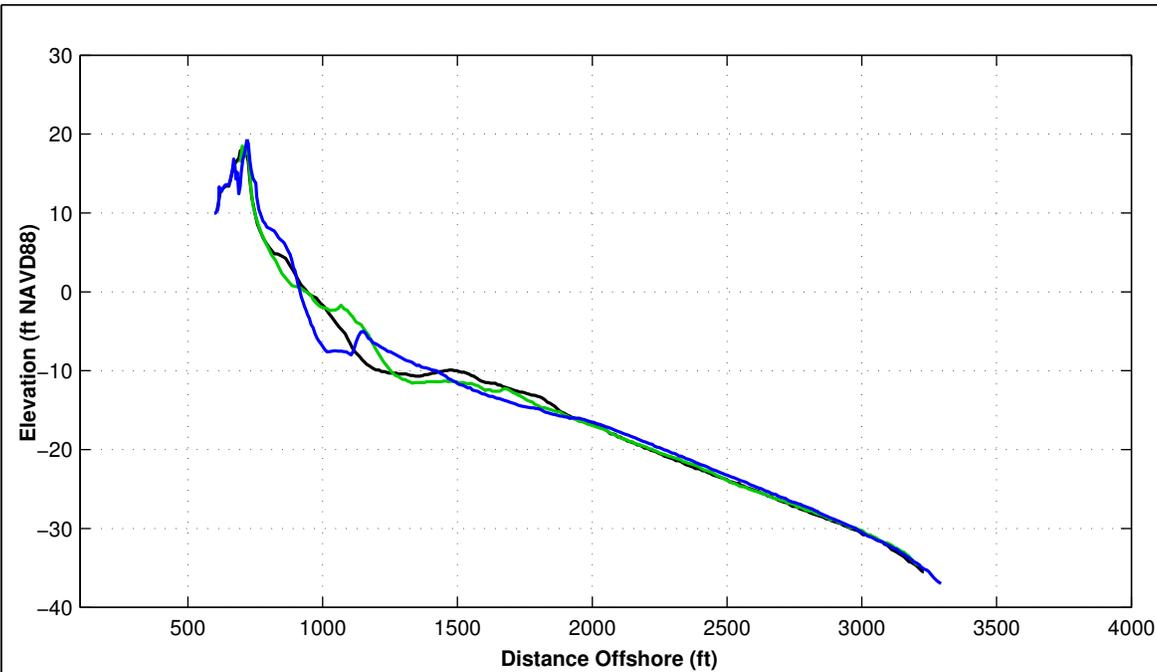
**Town of Nags Head Periodic Surveying Data Analysis**

ST 880+00

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2024





Survey Transect 890+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-7.56 ft	70.66 ft
Volume Change Above +6 ft NAVD88	7.46 cy/ft	4.18 cy/ft
Volume Change Above 1.18 ft NAVD88	11.61 cy/ft	11.47 cy/ft
Volume Change Above -6 ft NAVD88	-6.01 cy/ft	25.69 cy/ft
Volume Change Above -14 ft NAVD88	-8.81 cy/ft	60.93 cy/ft
Volume Change Above -19 ft NAVD88	-10.42 cy/ft	33.96 cy/ft
Volume Change Above -30 ft NAVD88	6.22 cy/ft	9.44 cy/ft

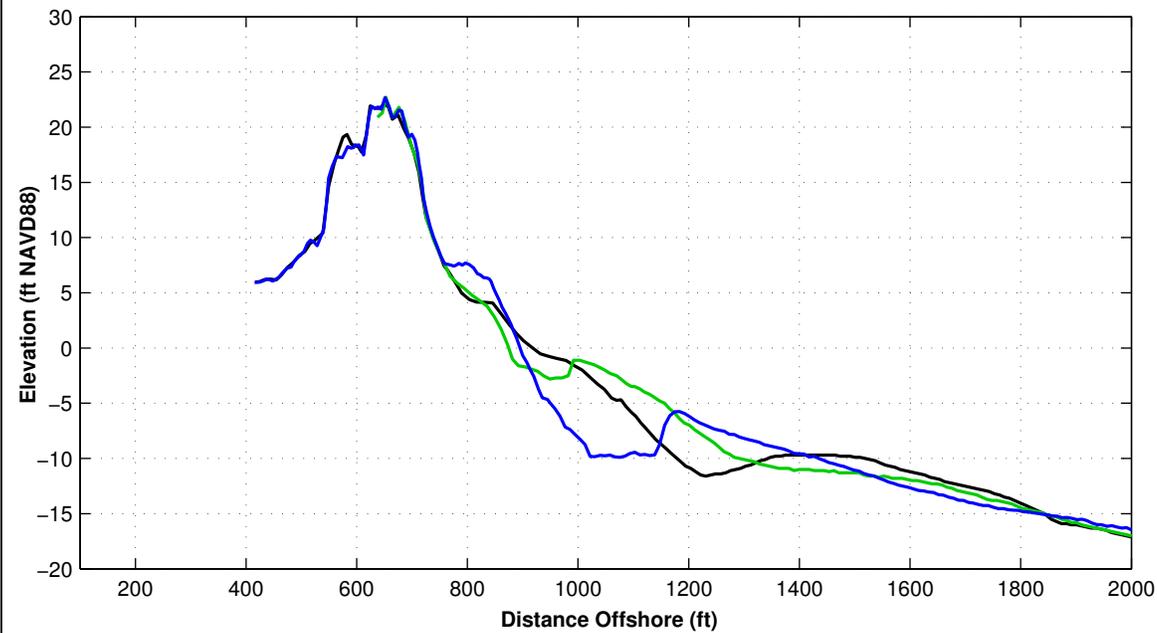
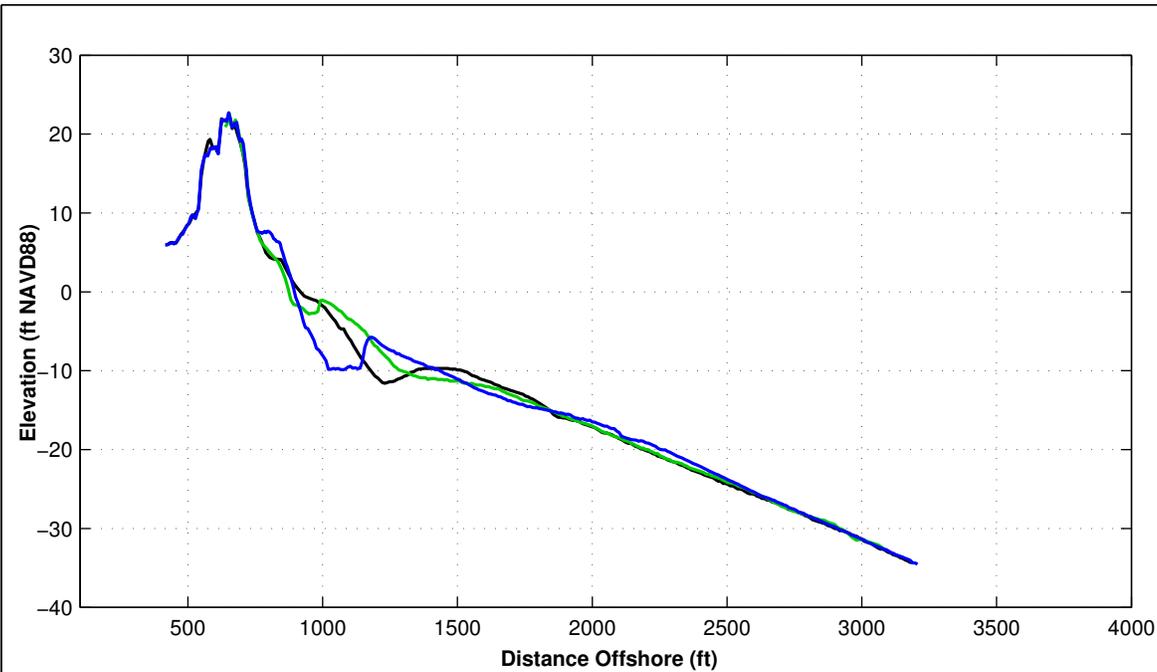
**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
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Survey Transect 900+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-4.64 ft	70.90 ft
Volume Change Above +6 ft NAVD88	5.18 cy/ft	1.70 cy/ft
Volume Change Above 1.18 ft NAVD88	9.93 cy/ft	8.06 cy/ft
Volume Change Above -6 ft NAVD88	-12.30 cy/ft	28.68 cy/ft
Volume Change Above -14 ft NAVD88	-21.01 cy/ft	62.22 cy/ft
Volume Change Above -19 ft NAVD88	-16.18 cy/ft	32.11 cy/ft
Volume Change Above -30 ft NAVD88	-0.69 cy/ft	8.79 cy/ft

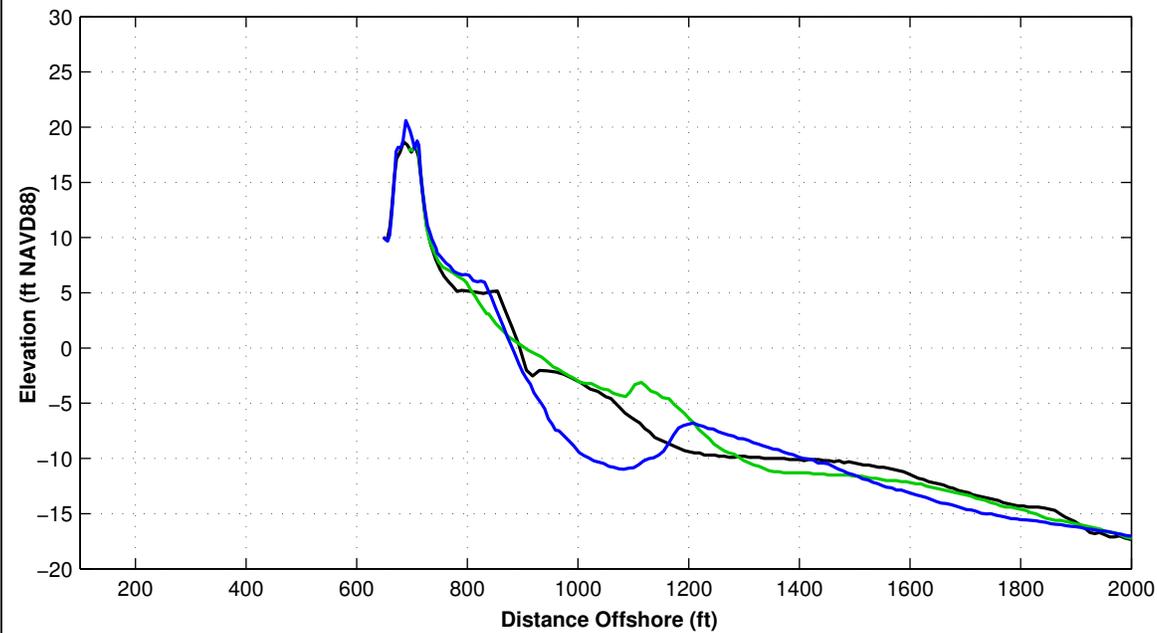
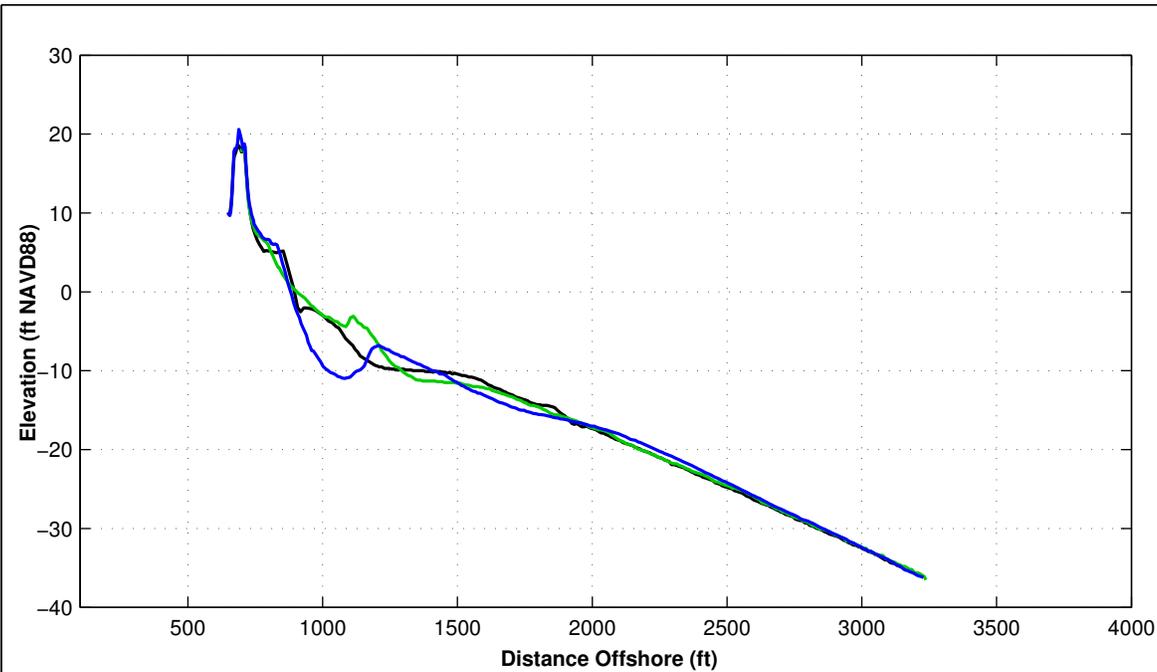
**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.







Survey Transect 910+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-15.48 ft	51.91 ft
Volume Change Above +6 ft NAVD88	4.57 cy/ft	2.46 cy/ft
Volume Change Above 1.18 ft NAVD88	4.37 cy/ft	10.38 cy/ft
Volume Change Above -6 ft NAVD88	-13.16 cy/ft	22.85 cy/ft
Volume Change Above -14 ft NAVD88	-38.87 cy/ft	66.40 cy/ft
Volume Change Above -19 ft NAVD88	-43.10 cy/ft	38.83 cy/ft
Volume Change Above -30 ft NAVD88	-27.72 cy/ft	15.60 cy/ft

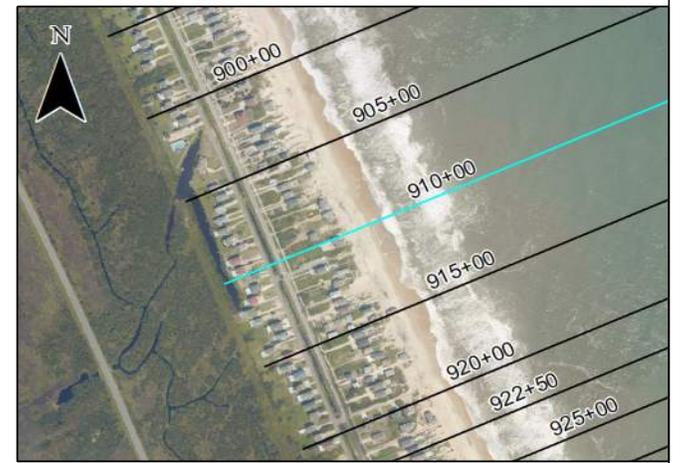
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JUNE 2024 ————

OCTOBER 2023 ————

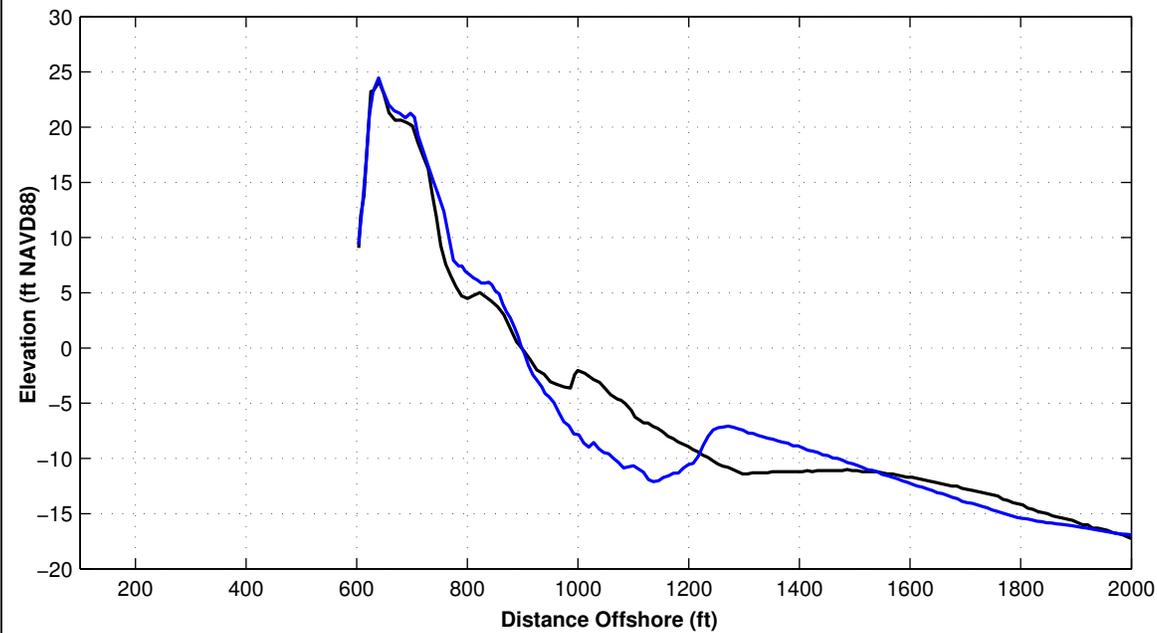
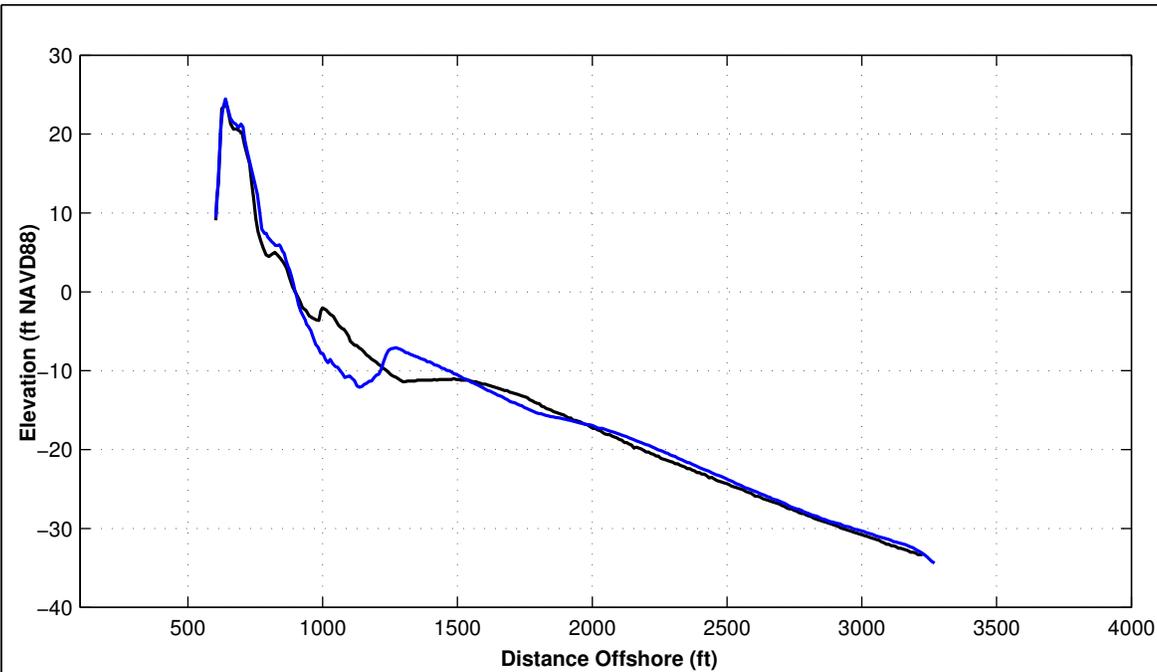
JUNE 2023 ————

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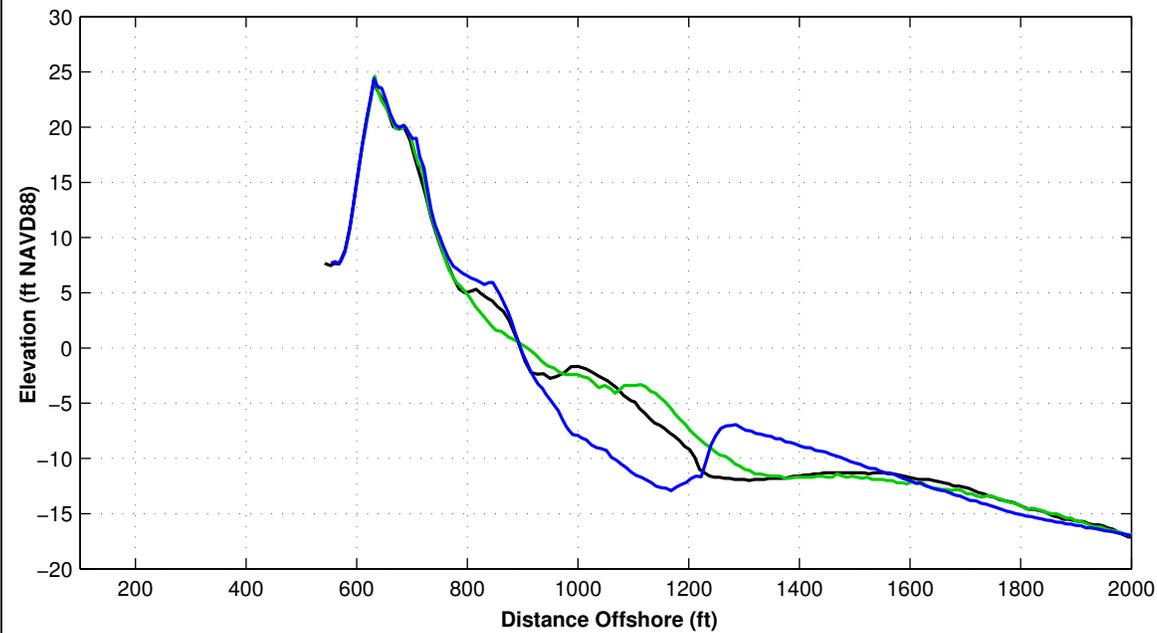
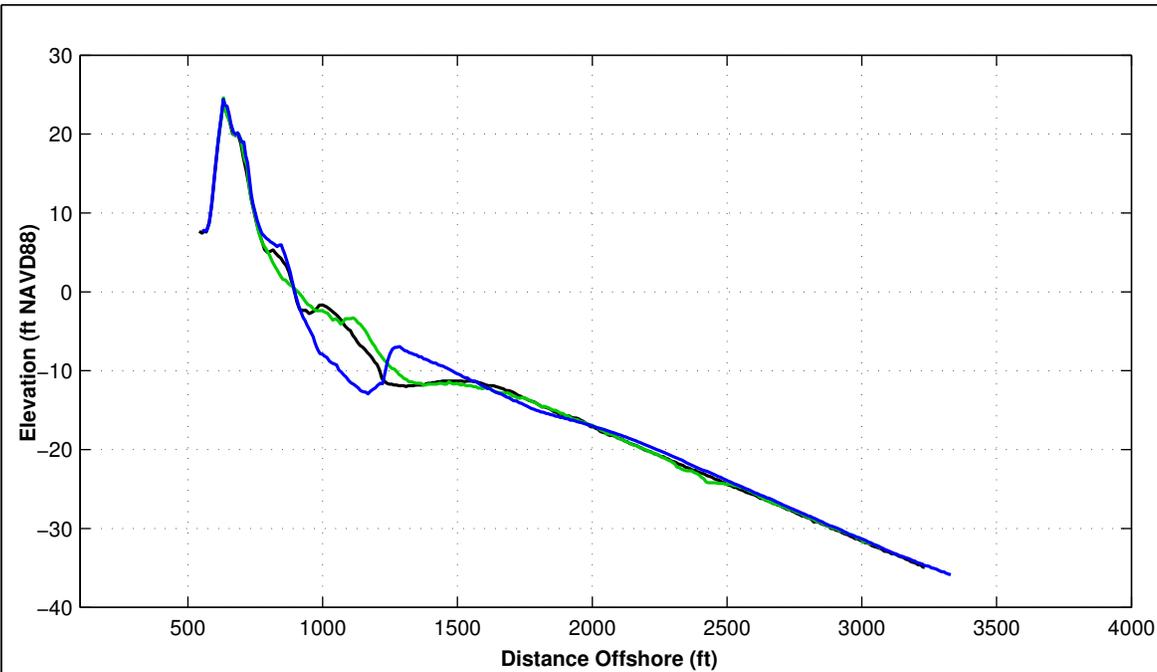
Survey Transect 922+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	7.30 ft	40.65 ft
Volume Change Above +6 ft NAVD88	8.24 cy/ft	2.84 cy/ft
Volume Change Above 1.18 ft NAVD88	12.84 cy/ft	7.70 cy/ft
Volume Change Above -6 ft NAVD88	-1.91 cy/ft	16.80 cy/ft
Volume Change Above -14 ft NAVD88	-12.09 cy/ft	65.59 cy/ft
Volume Change Above -19 ft NAVD88	-14.89 cy/ft	43.89 cy/ft
Volume Change Above -30 ft NAVD88	2.01 cy/ft	21.73 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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  2. All Survey Elevations In Feet Referenced to NAVD88.





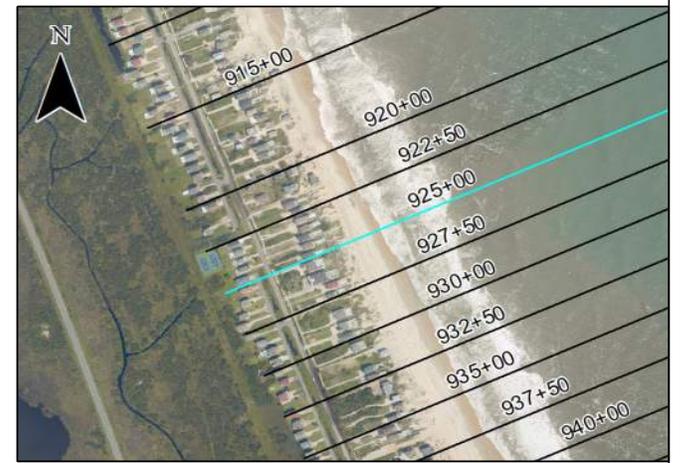
Survey Transect 925+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	1.87 ft	34.49 ft
Volume Change Above +6 ft NAVD88	5.12 cy/ft	1.36 cy/ft
Volume Change Above 1.18 ft NAVD88	8.88 cy/ft	6.94 cy/ft
Volume Change Above -6 ft NAVD88	-10.47 cy/ft	18.25 cy/ft
Volume Change Above -14 ft NAVD88	-17.62 cy/ft	69.62 cy/ft
Volume Change Above -19 ft NAVD88	-19.92 cy/ft	46.82 cy/ft
Volume Change Above -30 ft NAVD88	-7.43 cy/ft	28.00 cy/ft

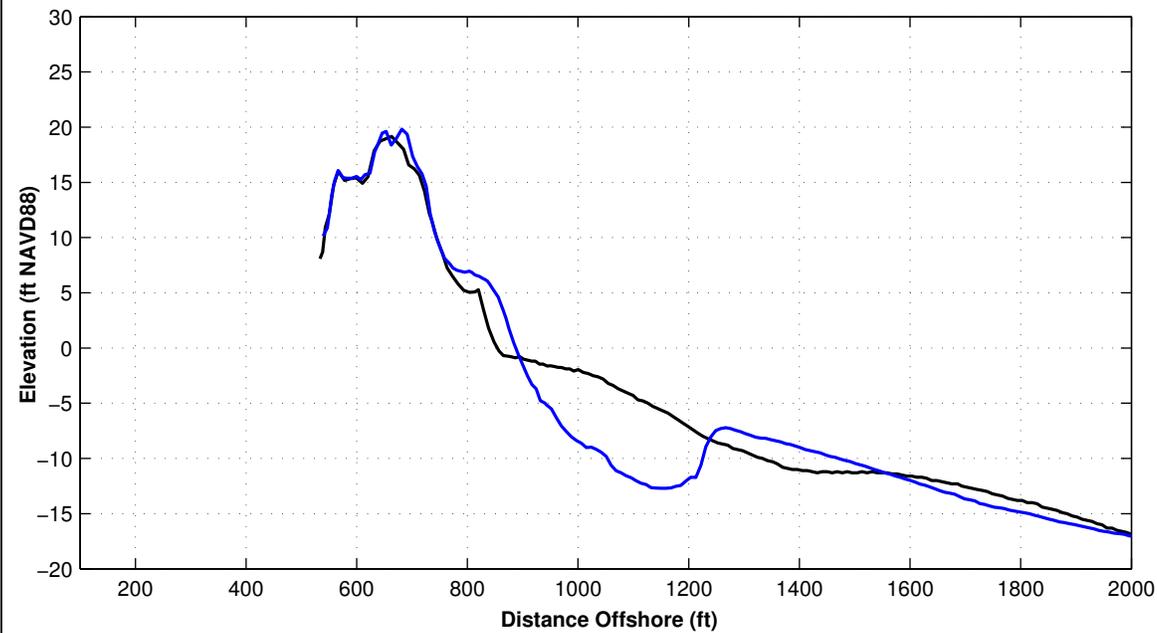
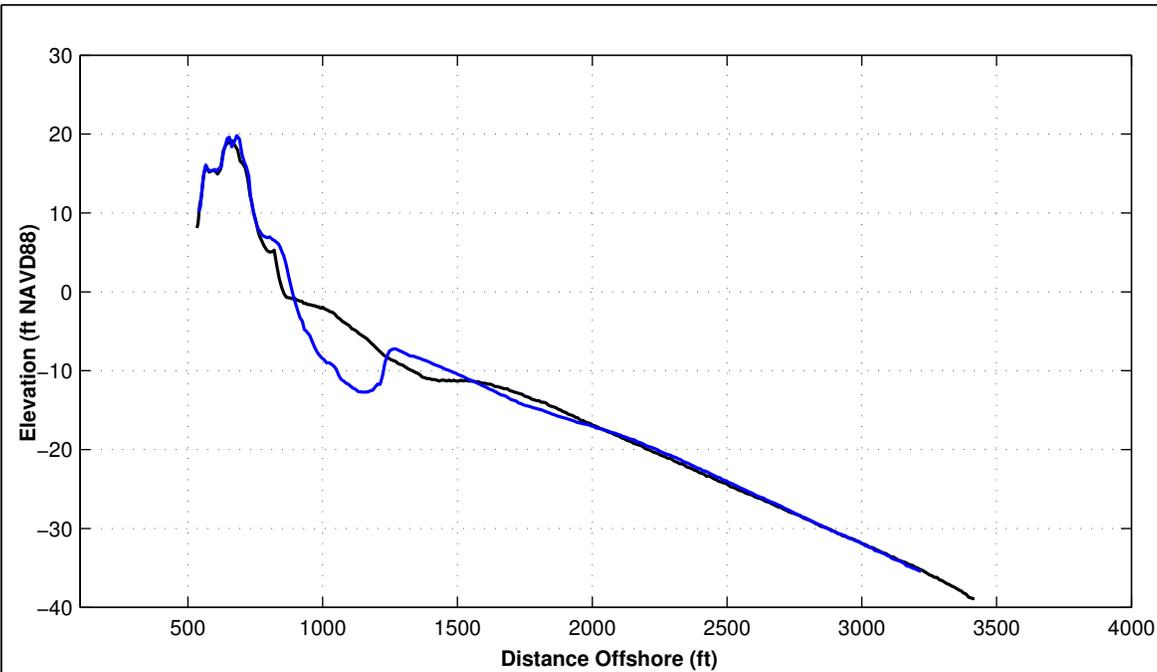
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

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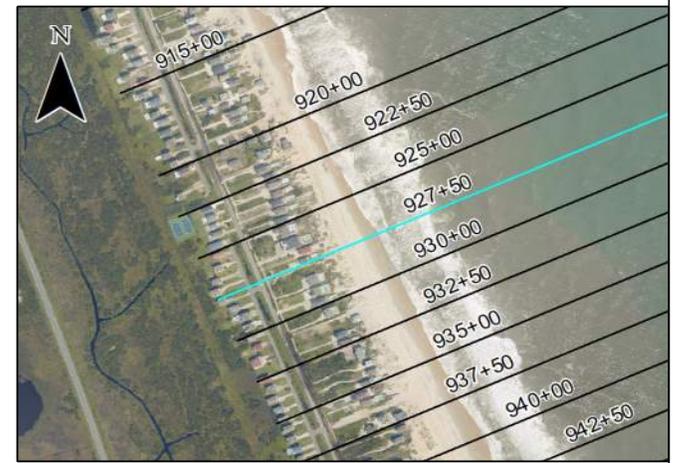


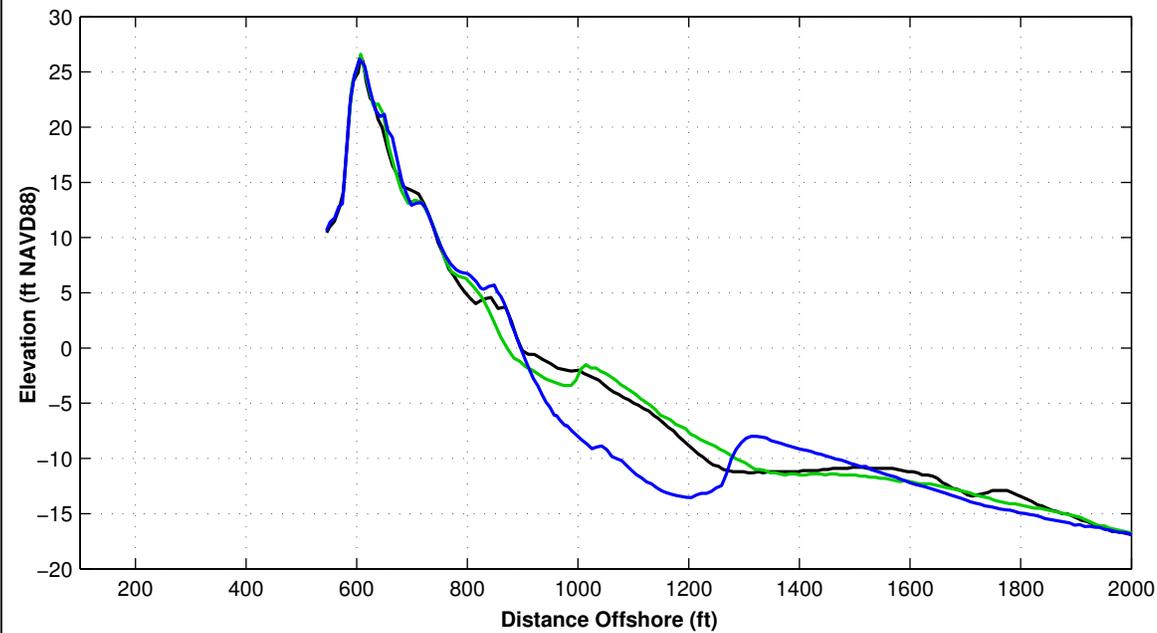
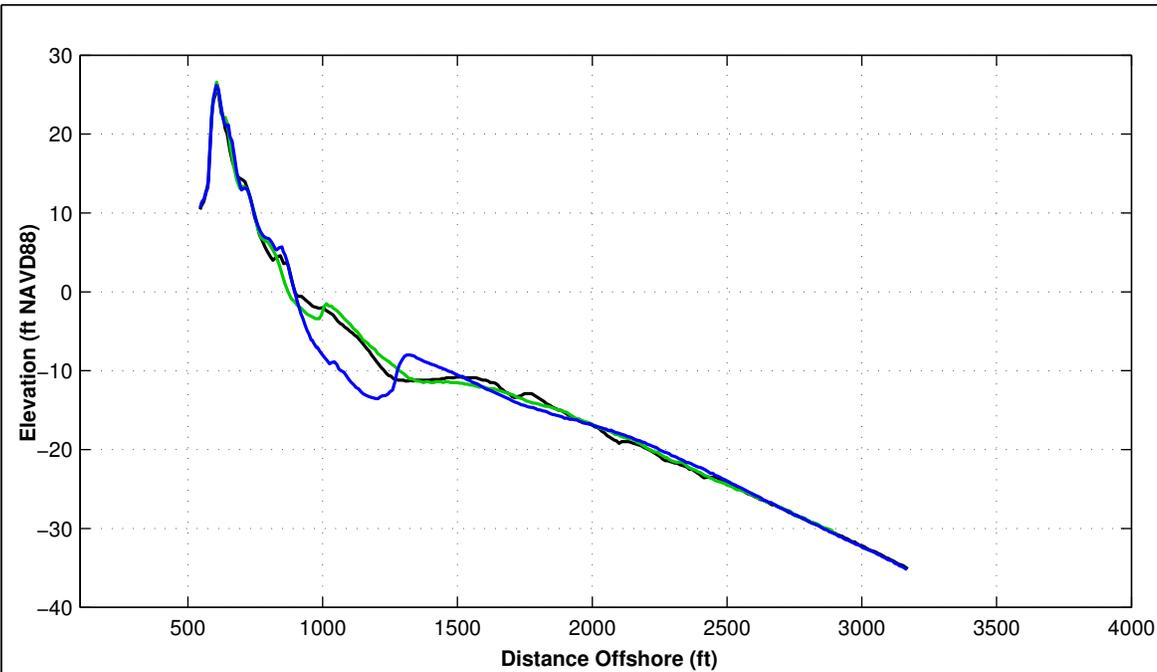
Survey Transect 927+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	35.78 ft	-13.77 ft
Volume Change Above +6 ft NAVD88	4.75 cy/ft	3.76 cy/ft
Volume Change Above 1.18 ft NAVD88	11.61 cy/ft	3.81 cy/ft
Volume Change Above -6 ft NAVD88	-11.10 cy/ft	16.42 cy/ft
Volume Change Above -14 ft NAVD88	-44.81 cy/ft	95.19 cy/ft
Volume Change Above -19 ft NAVD88	-50.65 cy/ft	76.01 cy/ft
Volume Change Above -30 ft NAVD88	-42.45 cy/ft	58.28 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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Survey Transect 930+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-0.27 ft	33.35 ft
Volume Change Above +6 ft NAVD88	2.87 cy/ft	-1.46 cy/ft
Volume Change Above 1.18 ft NAVD88	6.43 cy/ft	1.65 cy/ft
Volume Change Above -6 ft NAVD88	-15.73 cy/ft	17.24 cy/ft
Volume Change Above -14 ft NAVD88	-50.53 cy/ft	83.74 cy/ft
Volume Change Above -19 ft NAVD88	-52.14 cy/ft	61.43 cy/ft
Volume Change Above -30 ft NAVD88	-42.75 cy/ft	40.17 cy/ft

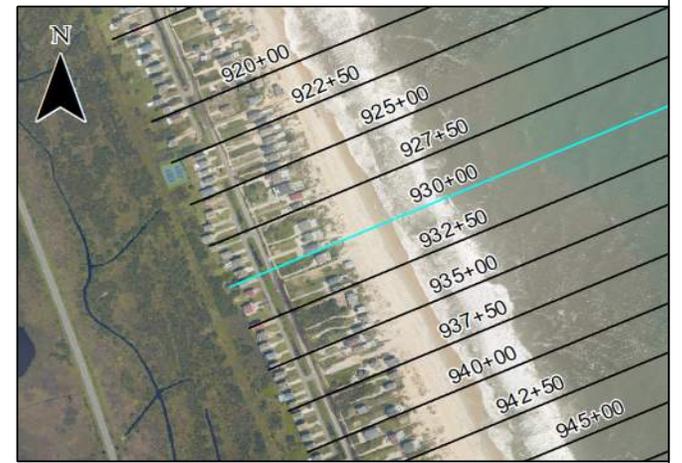
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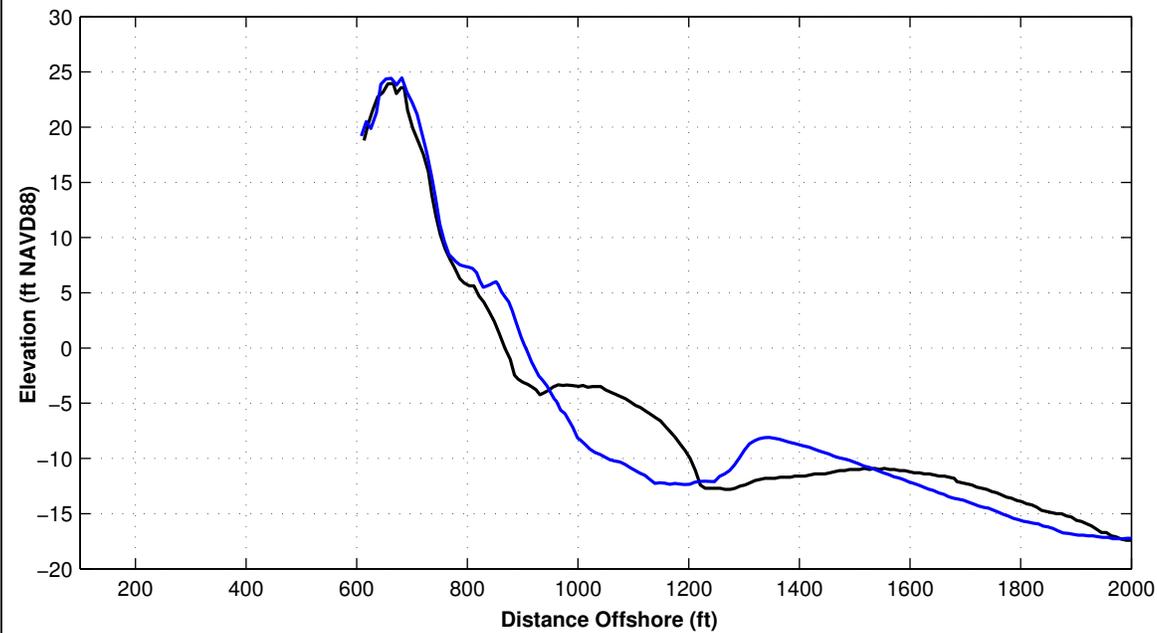
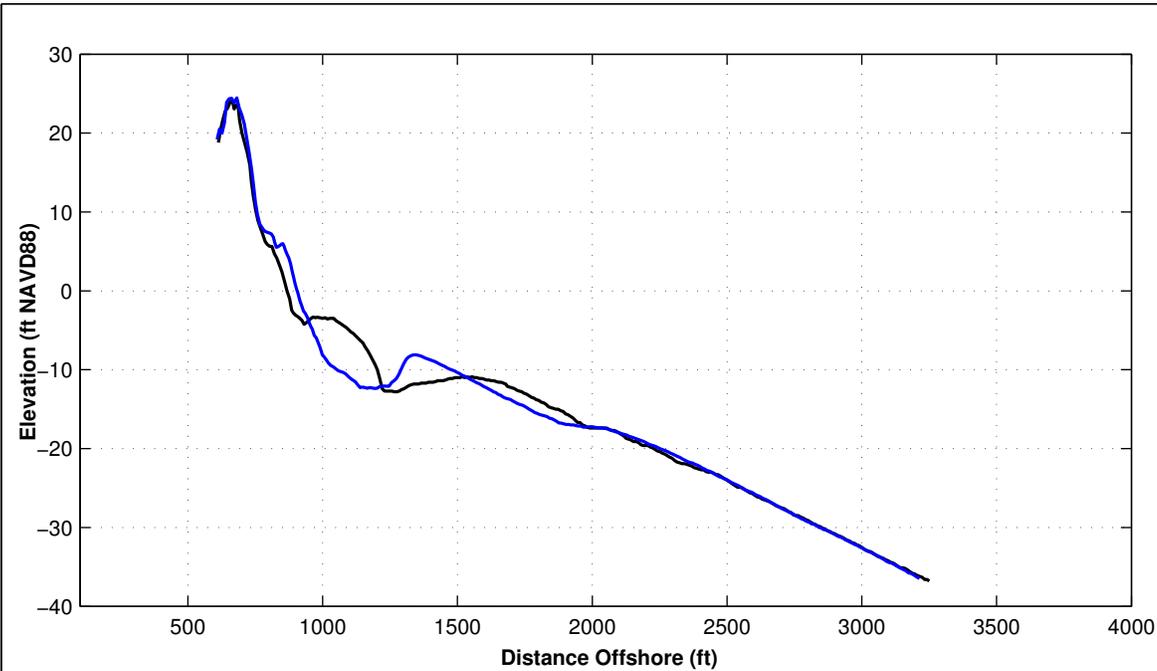
JUNE 2024 ————

OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
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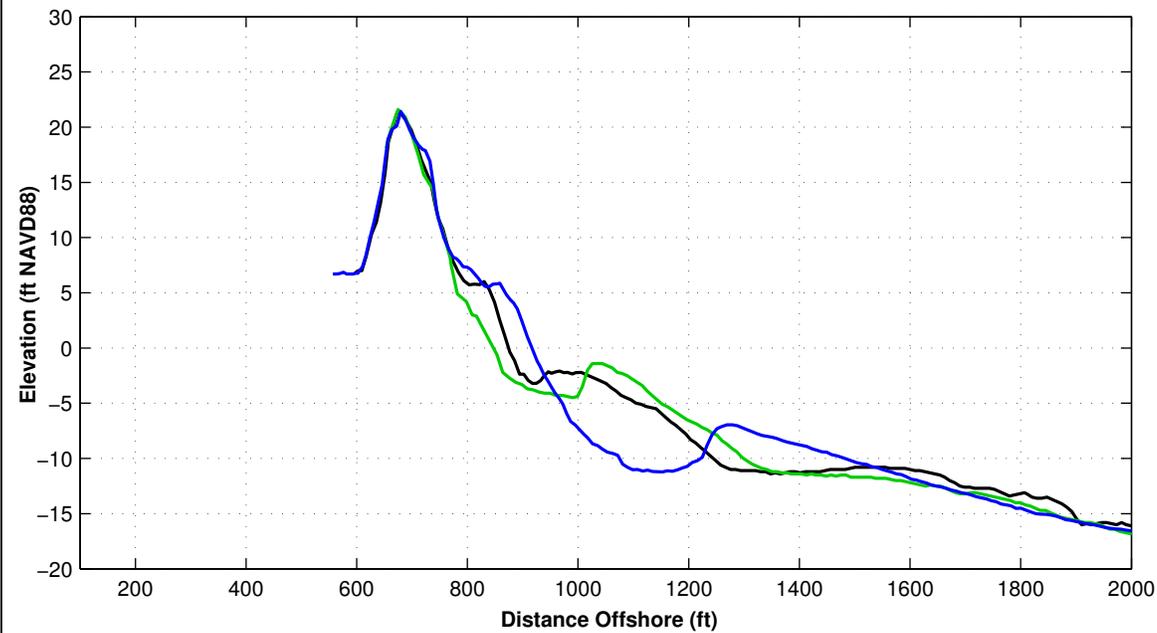
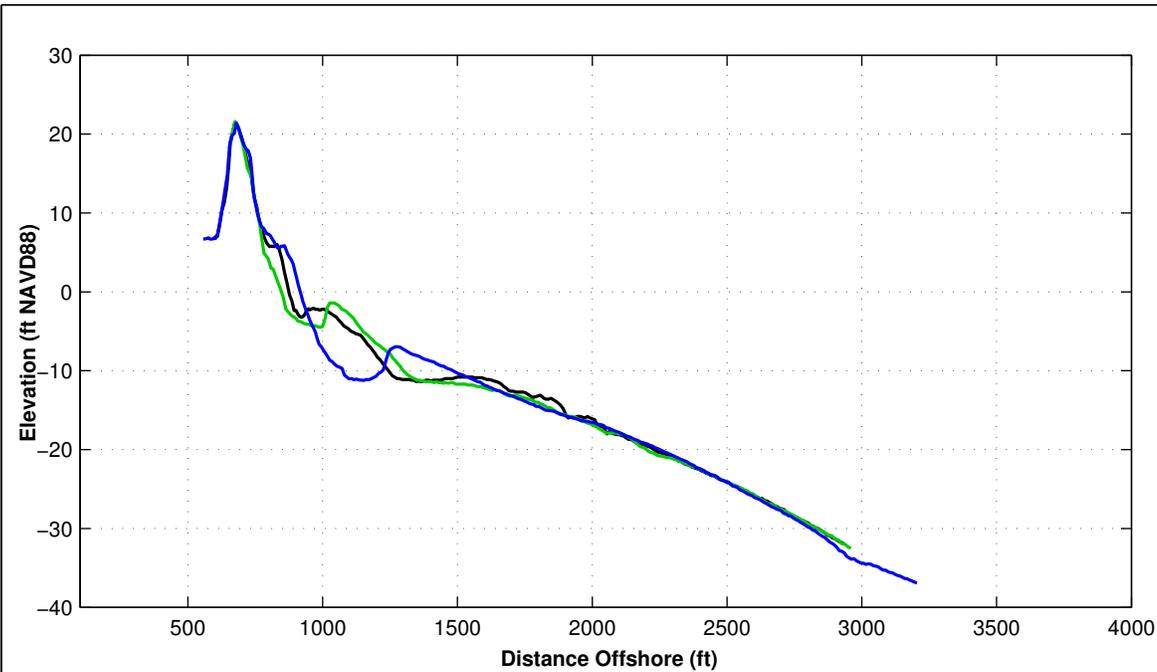
Survey Transect 932+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	37.21 ft	-5.48 ft
Volume Change Above +6 ft NAVD88	6.76 cy/ft	2.61 cy/ft
Volume Change Above 1.18 ft NAVD88	14.21 cy/ft	2.15 cy/ft
Volume Change Above -6 ft NAVD88	9.27 cy/ft	1.20 cy/ft
Volume Change Above -14 ft NAVD88	-11.13 cy/ft	44.78 cy/ft
Volume Change Above -19 ft NAVD88	-20.52 cy/ft	20.80 cy/ft
Volume Change Above -30 ft NAVD88	-16.18 cy/ft	-1.06 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



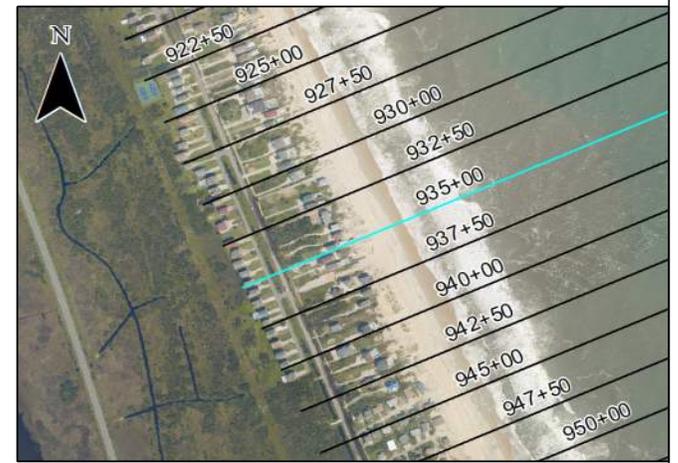


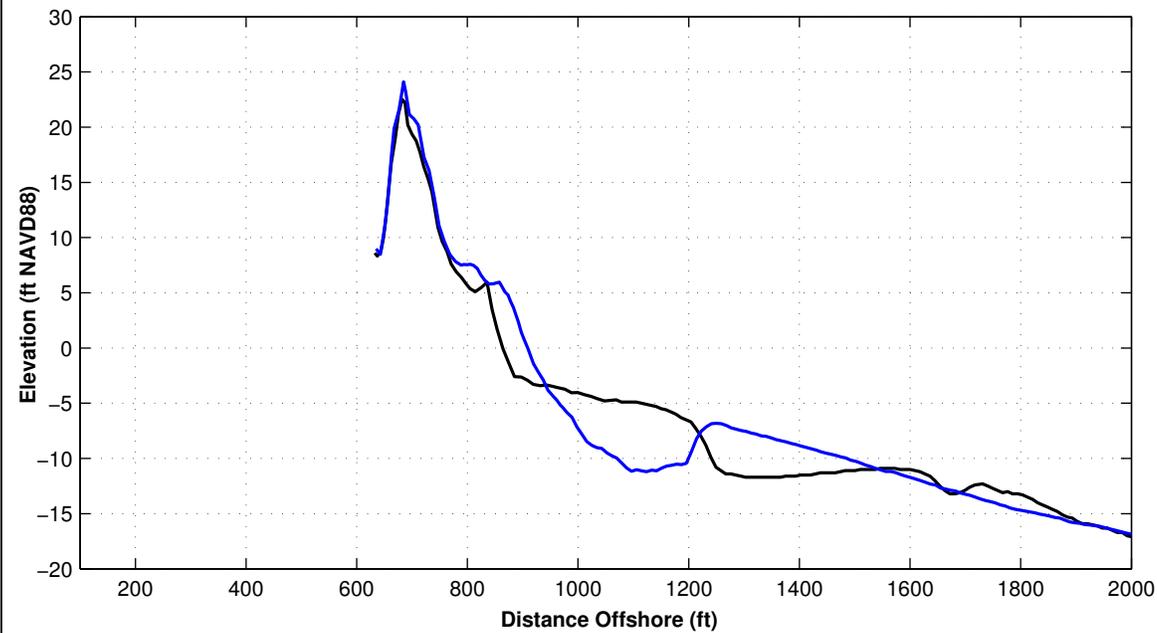
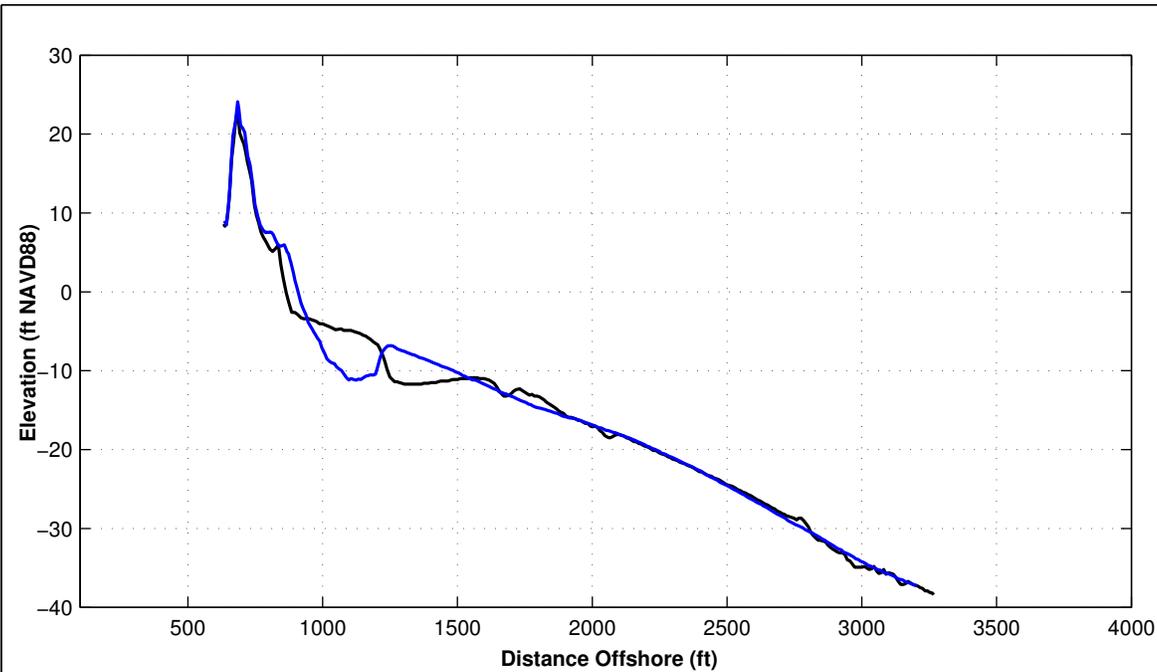
Survey Transect 935+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	40.13 ft	-16.61 ft
Volume Change Above +6 ft NAVD88	3.85 cy/ft	3.28 cy/ft
Volume Change Above 1.18 ft NAVD88	9.88 cy/ft	5.11 cy/ft
Volume Change Above -6 ft NAVD88	-0.55 cy/ft	10.14 cy/ft
Volume Change Above -14 ft NAVD88	-14.18 cy/ft	68.75 cy/ft
Volume Change Above -19 ft NAVD88	-17.70 cy/ft	47.16 cy/ft
Volume Change Above -30 ft NAVD88	-18.12 cy/ft	24.73 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



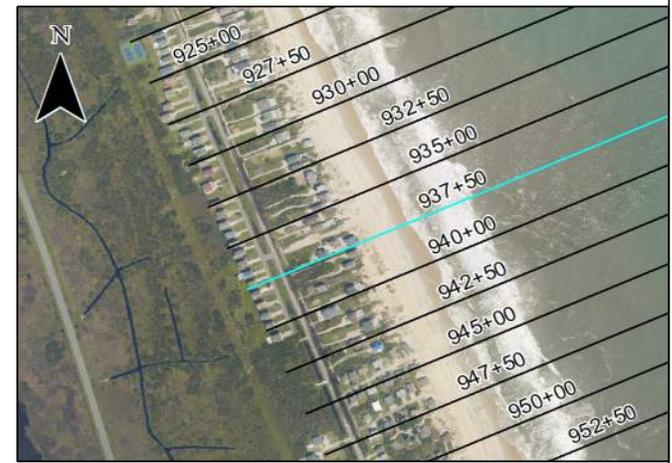


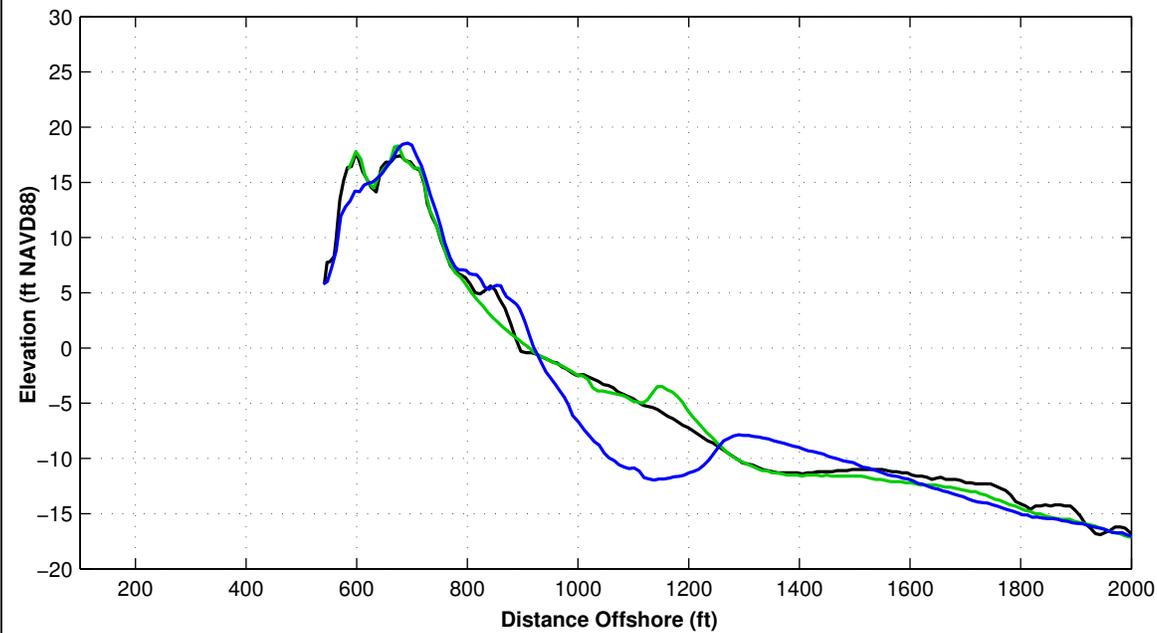
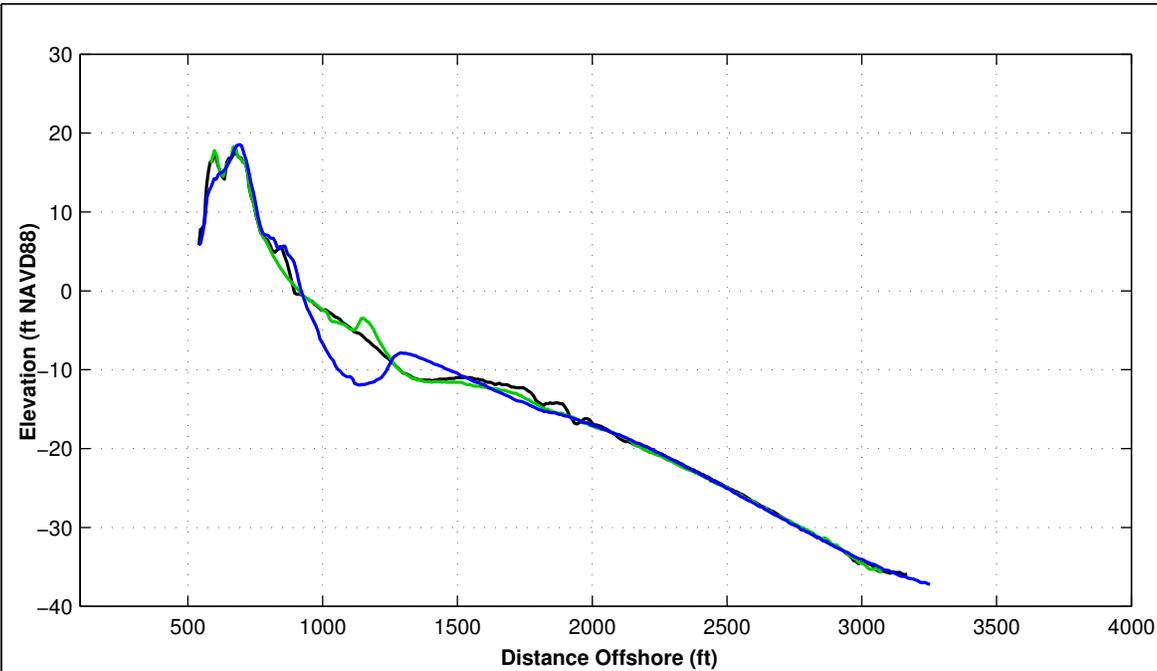
Survey Transect 937+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	42.43 ft	-16.61 ft
Volume Change Above +6 ft NAVD88	5.80 cy/ft	2.36 cy/ft
Volume Change Above 1.18 ft NAVD88	12.95 cy/ft	2.55 cy/ft
Volume Change Above -6 ft NAVD88	9.99 cy/ft	-2.43 cy/ft
Volume Change Above -14 ft NAVD88	2.26 cy/ft	41.64 cy/ft
Volume Change Above -19 ft NAVD88	0.99 cy/ft	10.32 cy/ft
Volume Change Above -30 ft NAVD88	-3.46 cy/ft	-13.65 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





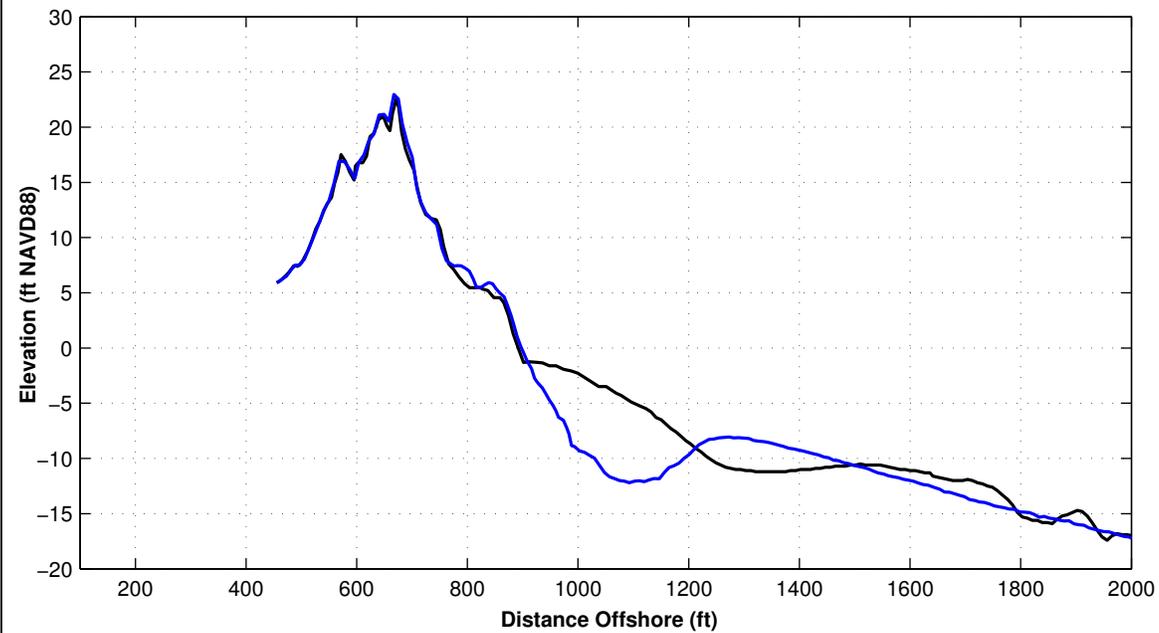
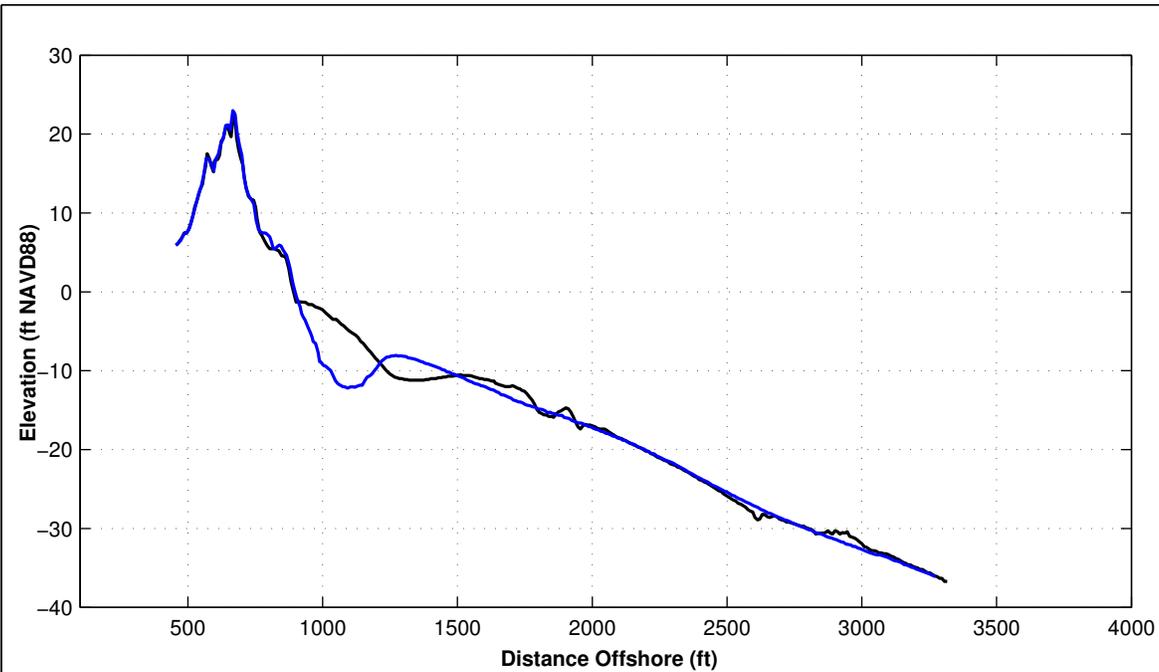
Survey Transect 940+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	26.63 ft	9.07 ft
Volume Change Above +6 ft NAVD88	4.55 cy/ft	3.66 cy/ft
Volume Change Above 1.18 ft NAVD88	9.13 cy/ft	6.51 cy/ft
Volume Change Above -6 ft NAVD88	-6.23 cy/ft	17.87 cy/ft
Volume Change Above -14 ft NAVD88	-34.06 cy/ft	66.03 cy/ft
Volume Change Above -19 ft NAVD88	-39.61 cy/ft	39.71 cy/ft
Volume Change Above -30 ft NAVD88	-41.97 cy/ft	18.29 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





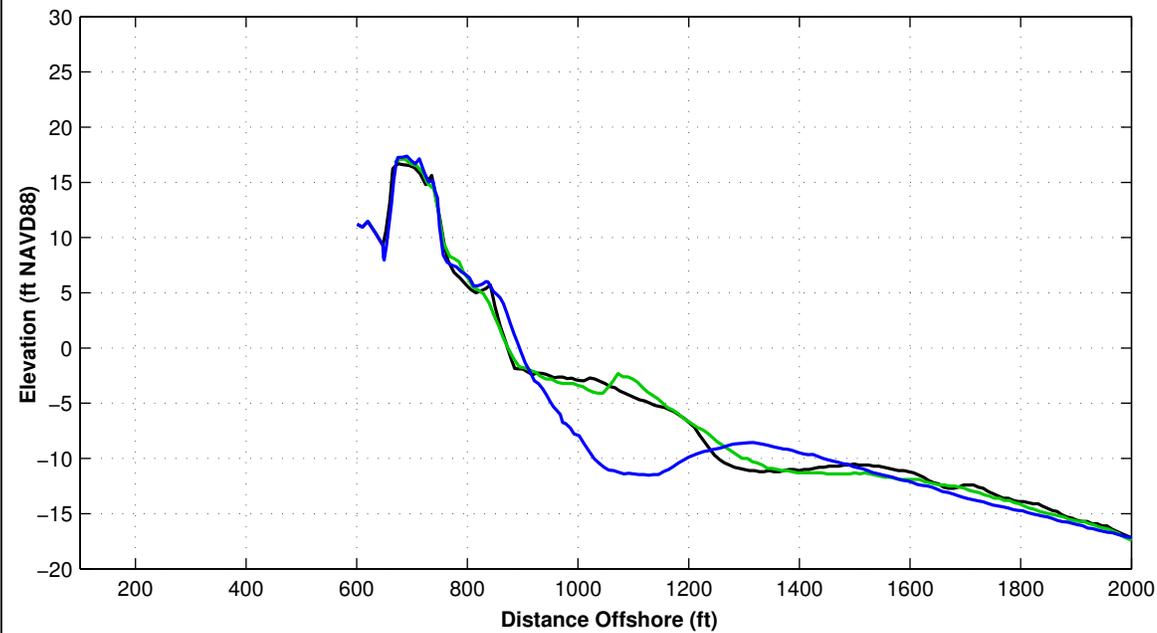
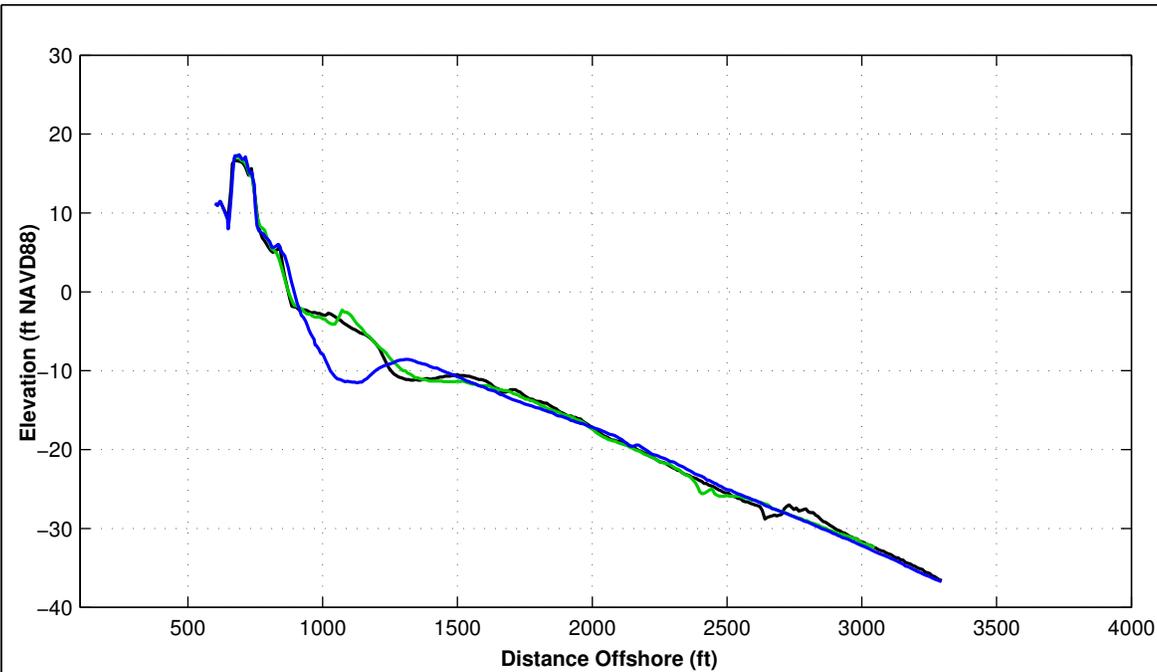
Survey Transect 942+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	5.57 ft	15.15 ft
Volume Change Above +6 ft NAVD88	2.71 cy/ft	3.92 cy/ft
Volume Change Above 1.18 ft NAVD88	4.66 cy/ft	8.05 cy/ft
Volume Change Above -6 ft NAVD88	-14.33 cy/ft	17.62 cy/ft
Volume Change Above -14 ft NAVD88	-42.82 cy/ft	72.10 cy/ft
Volume Change Above -19 ft NAVD88	-44.91 cy/ft	44.59 cy/ft
Volume Change Above -30 ft NAVD88	-38.18 cy/ft	12.52 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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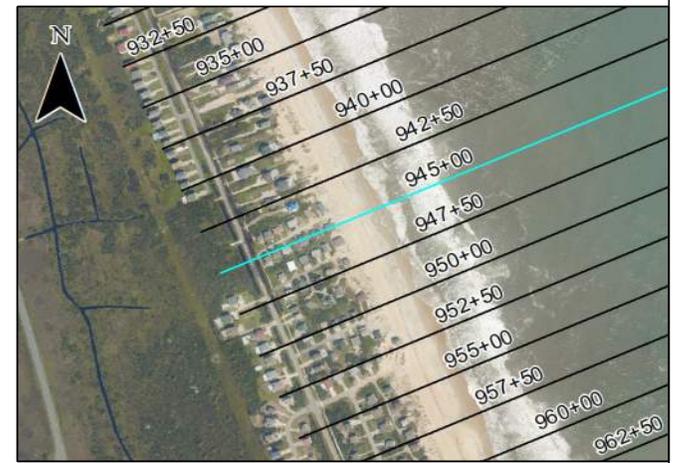


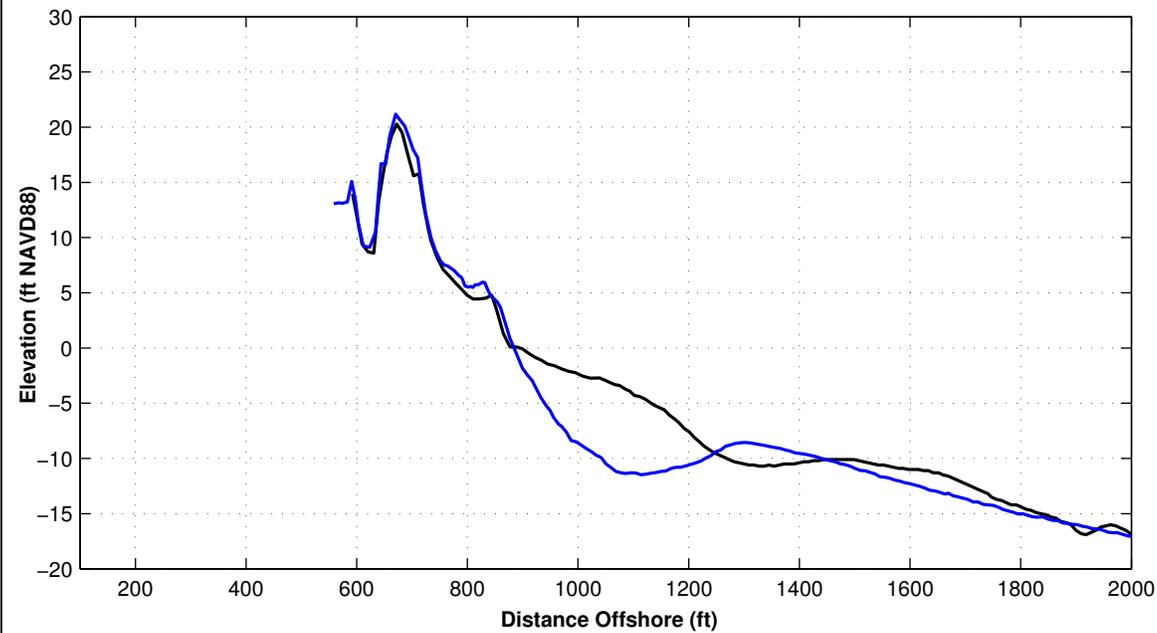
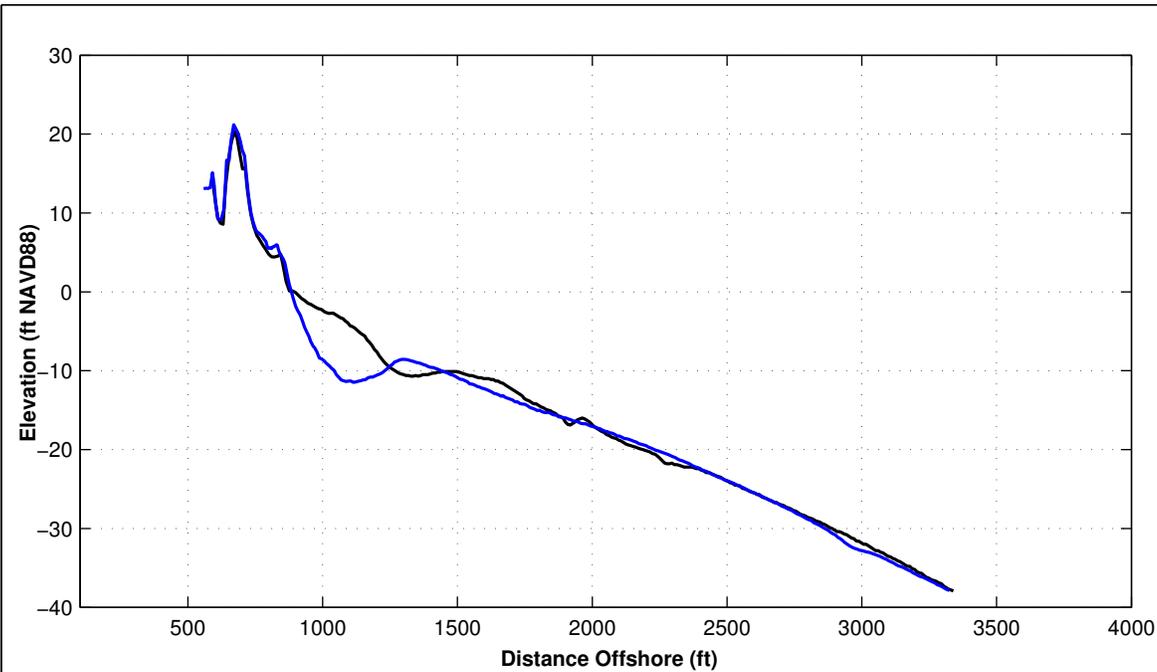
Survey Transect 945+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	20.05 ft	8.81 ft
Volume Change Above +6 ft NAVD88	0.48 cy/ft	5.41 cy/ft
Volume Change Above 1.18 ft NAVD88	3.81 cy/ft	8.30 cy/ft
Volume Change Above -6 ft NAVD88	-13.08 cy/ft	18.13 cy/ft
Volume Change Above -14 ft NAVD88	-45.25 cy/ft	76.47 cy/ft
Volume Change Above -19 ft NAVD88	-48.49 cy/ft	54.92 cy/ft
Volume Change Above -30 ft NAVD88	-42.77 cy/ft	26.12 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





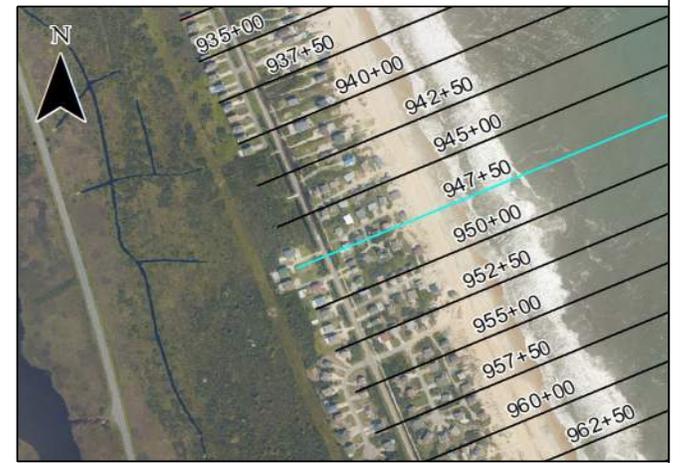
Survey Transect 947+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	8.79 ft	27.06 ft
Volume Change Above +6 ft NAVD88	3.62 cy/ft	2.35 cy/ft
Volume Change Above 1.18 ft NAVD88	6.77 cy/ft	6.48 cy/ft
Volume Change Above -6 ft NAVD88	-19.53 cy/ft	27.14 cy/ft
Volume Change Above -14 ft NAVD88	-61.75 cy/ft	96.16 cy/ft
Volume Change Above -19 ft NAVD88	-62.52 cy/ft	77.47 cy/ft
Volume Change Above -30 ft NAVD88	-57.46 cy/ft	60.16 cy/ft

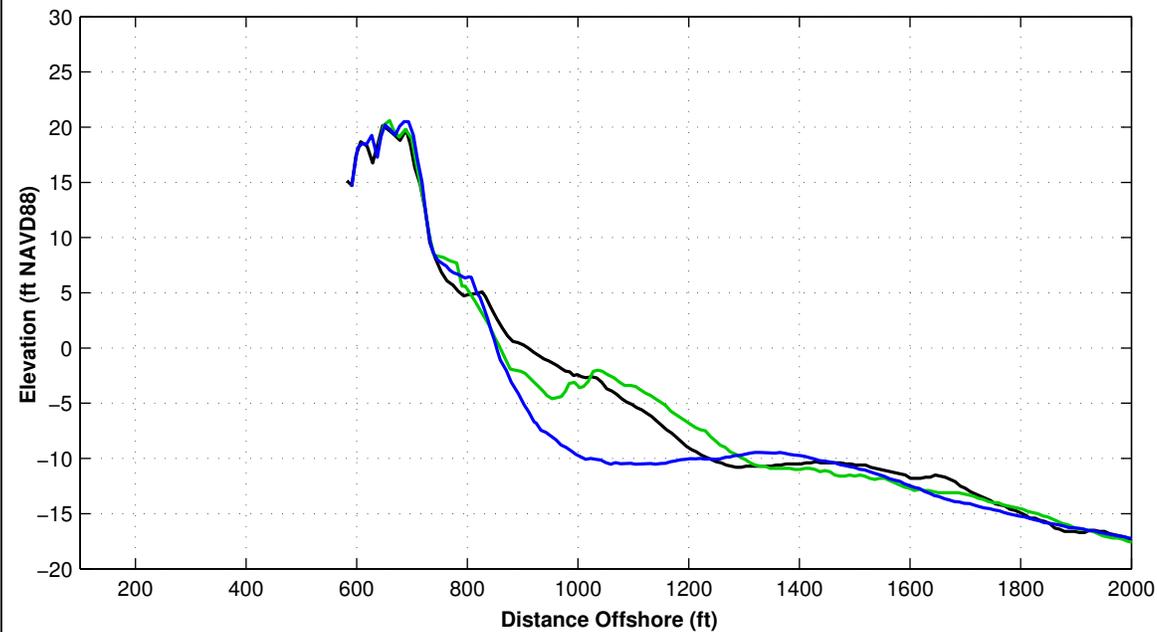
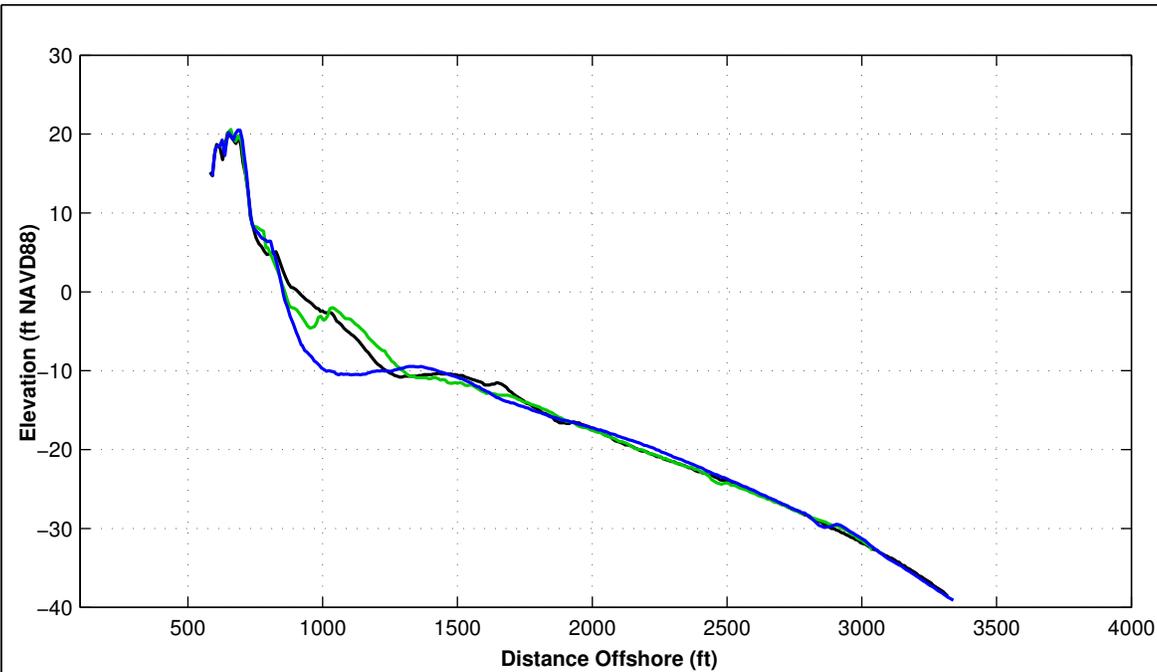
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023

JUNE 2024 ———— OCTOBER 2023

- Notes:
1. Station From North To South At Varying Intervals.
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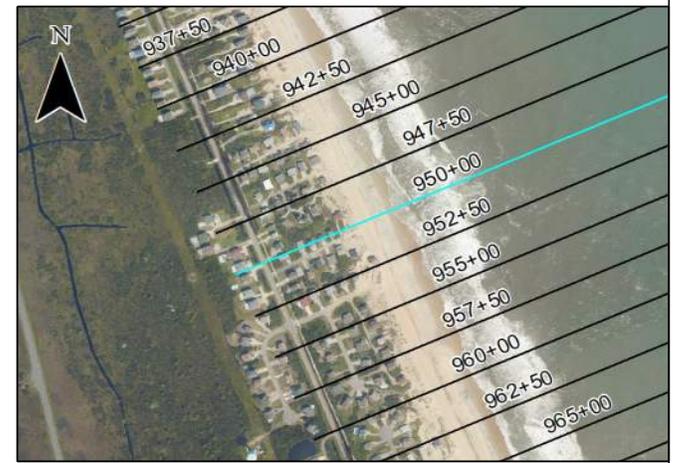


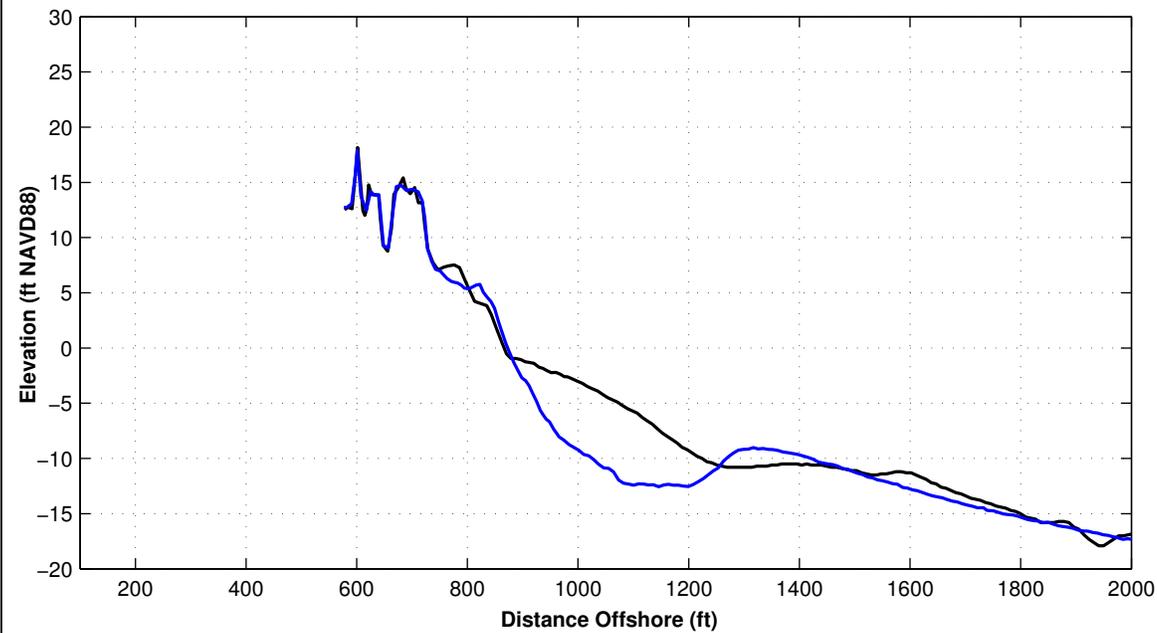
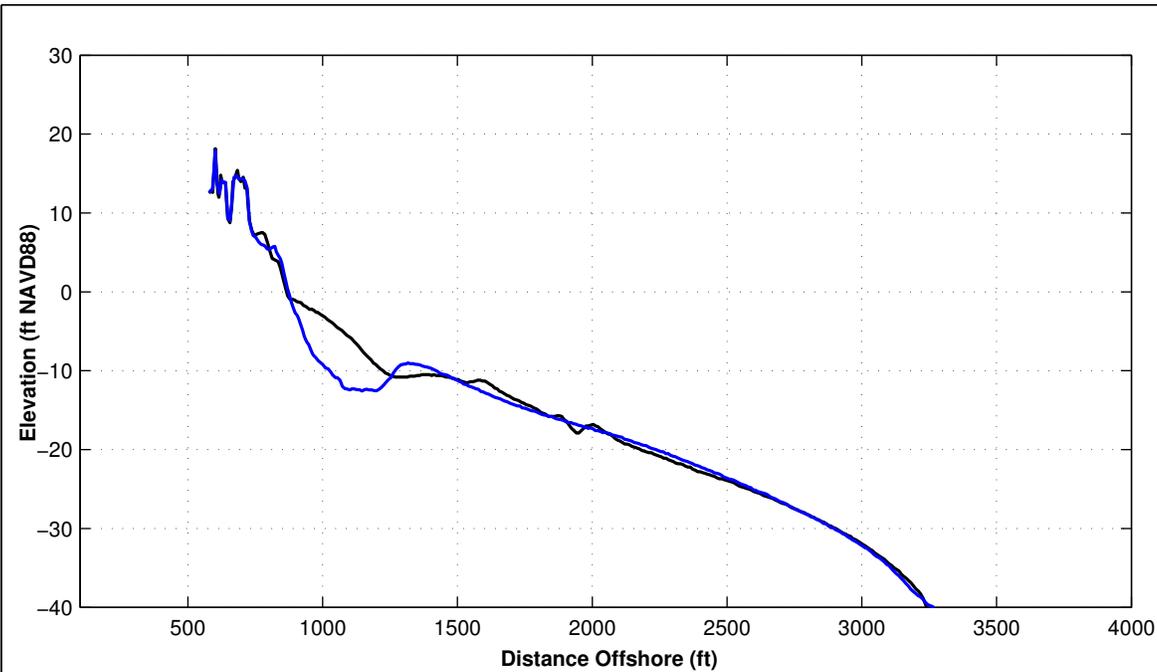
Survey Transect 950+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-25.81 ft	35.24 ft
Volume Change Above +6 ft NAVD88	4.83 cy/ft	3.84 cy/ft
Volume Change Above 1.18 ft NAVD88	4.07 cy/ft	9.85 cy/ft
Volume Change Above -6 ft NAVD88	-28.92 cy/ft	27.91 cy/ft
Volume Change Above -14 ft NAVD88	-67.08 cy/ft	101.52 cy/ft
Volume Change Above -19 ft NAVD88	-65.94 cy/ft	81.93 cy/ft
Volume Change Above -30 ft NAVD88	-55.09 cy/ft	48.33 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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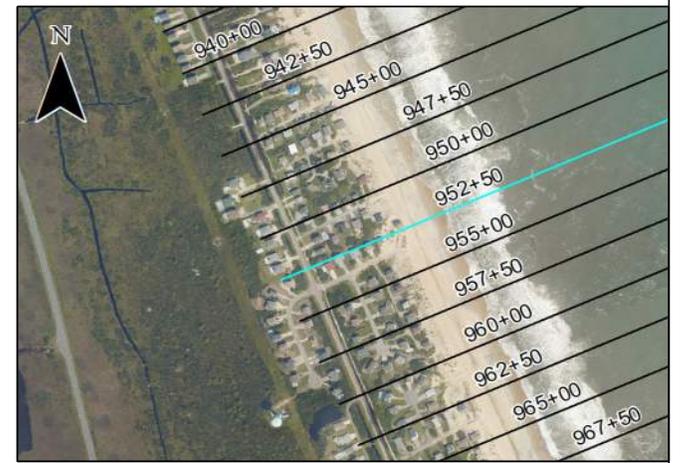


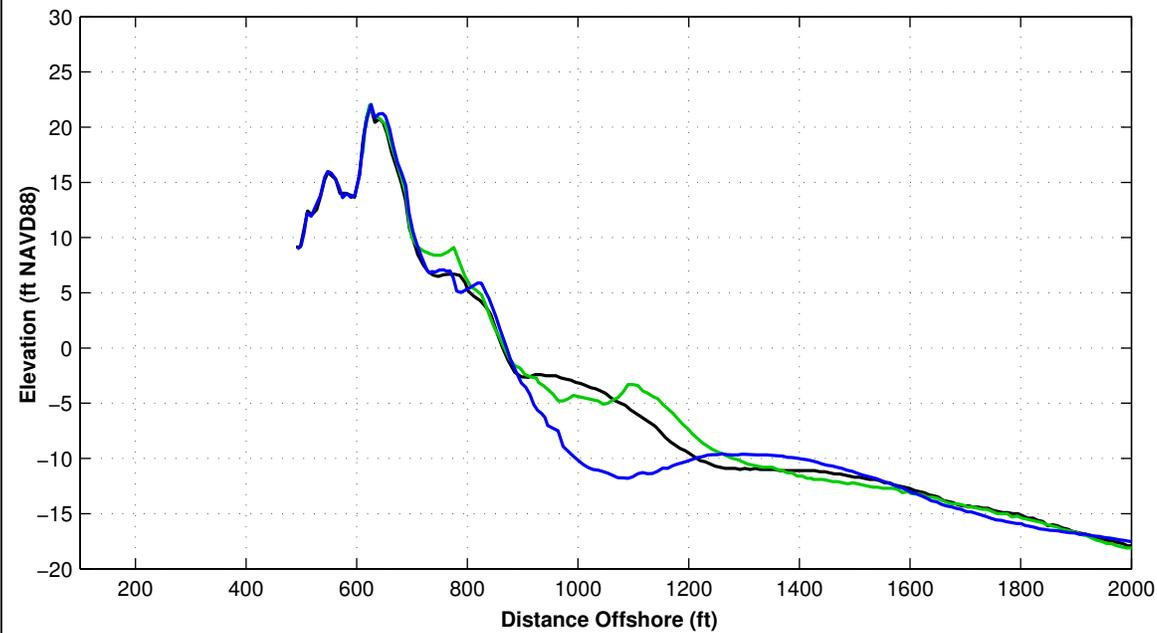
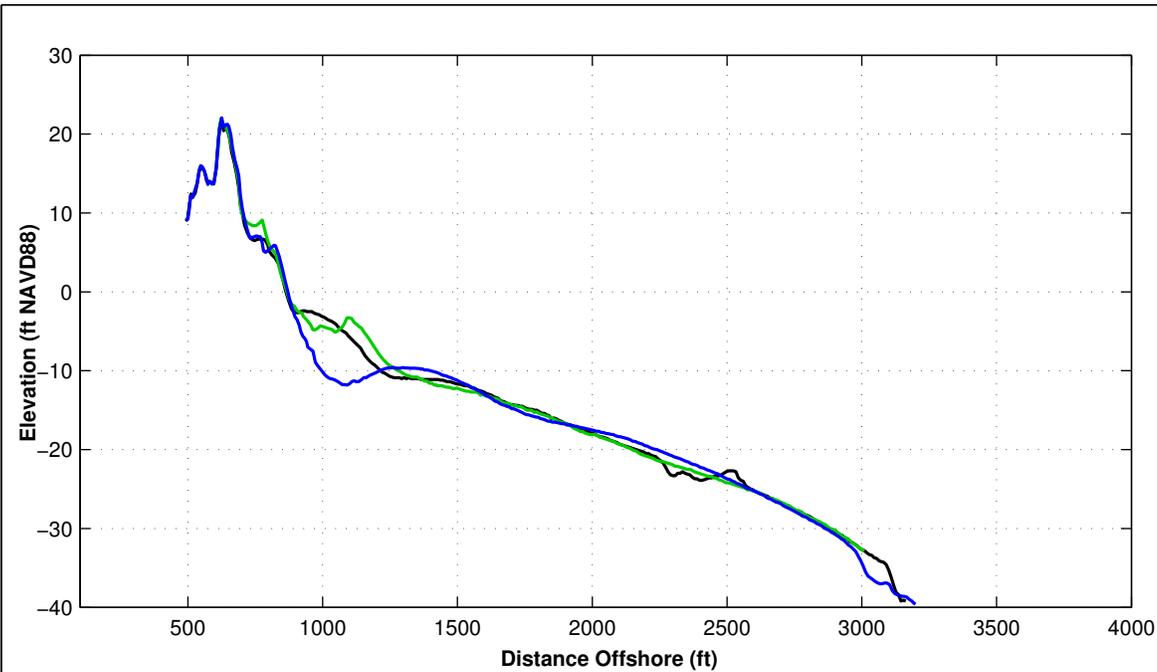
Survey Transect 952+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	7.23 ft	27.36 ft
Volume Change Above +6 ft NAVD88	-1.62 cy/ft	4.41 cy/ft
Volume Change Above 1.18 ft NAVD88	0.53 cy/ft	10.10 cy/ft
Volume Change Above -6 ft NAVD88	-17.91 cy/ft	21.76 cy/ft
Volume Change Above -14 ft NAVD88	-61.12 cy/ft	88.84 cy/ft
Volume Change Above -19 ft NAVD88	-62.08 cy/ft	80.48 cy/ft
Volume Change Above -30 ft NAVD88	-51.92 cy/ft	56.13 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
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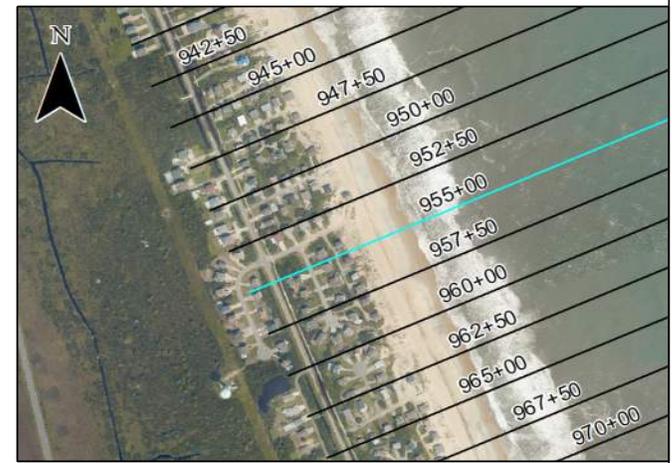
Survey Transect 955+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	7.48 ft	36.11 ft
Volume Change Above +6 ft NAVD88	2.92 cy/ft	5.74 cy/ft
Volume Change Above 1.18 ft NAVD88	4.75 cy/ft	13.98 cy/ft
Volume Change Above -6 ft NAVD88	-11.80 cy/ft	25.82 cy/ft
Volume Change Above -14 ft NAVD88	-39.06 cy/ft	89.84 cy/ft
Volume Change Above -19 ft NAVD88	-40.51 cy/ft	100.96 cy/ft
Volume Change Above -30 ft NAVD88	-28.65 cy/ft	82.58 cy/ft

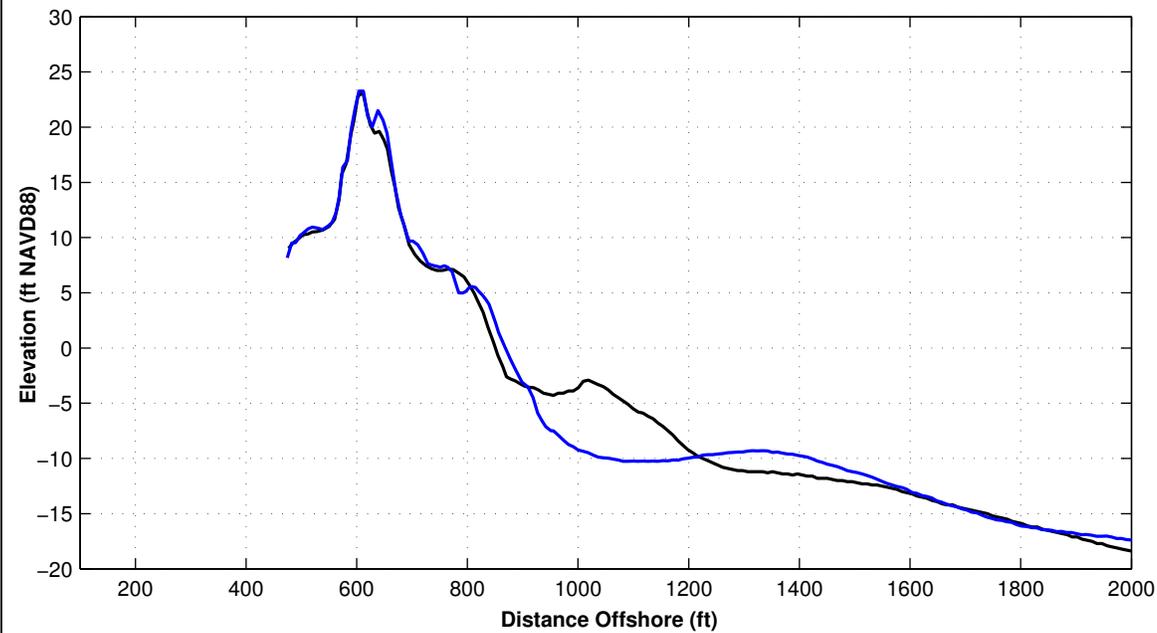
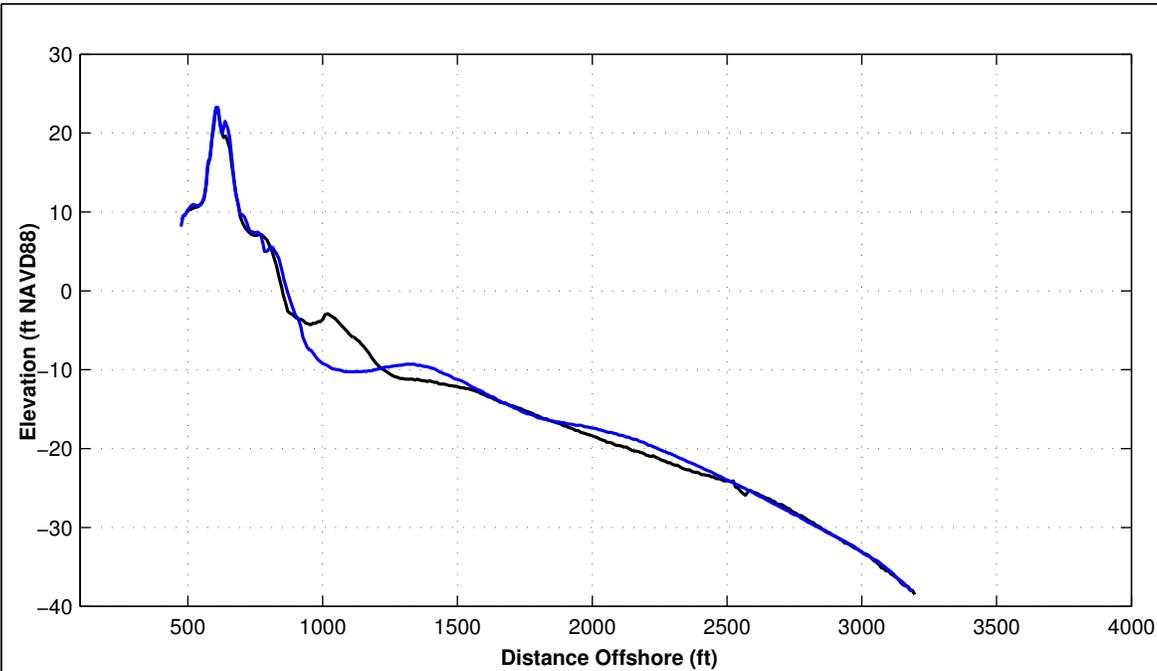
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

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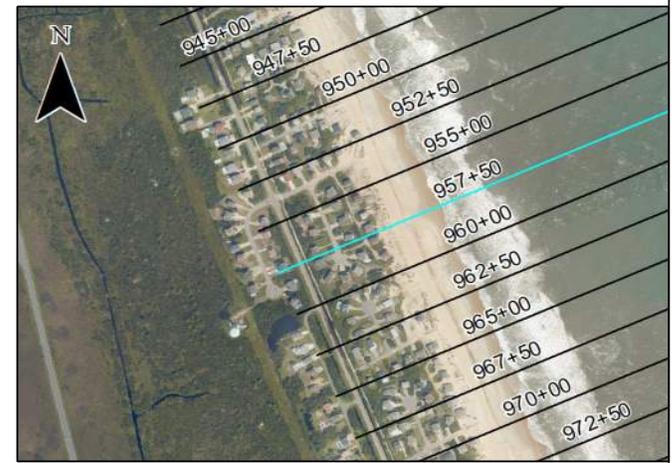


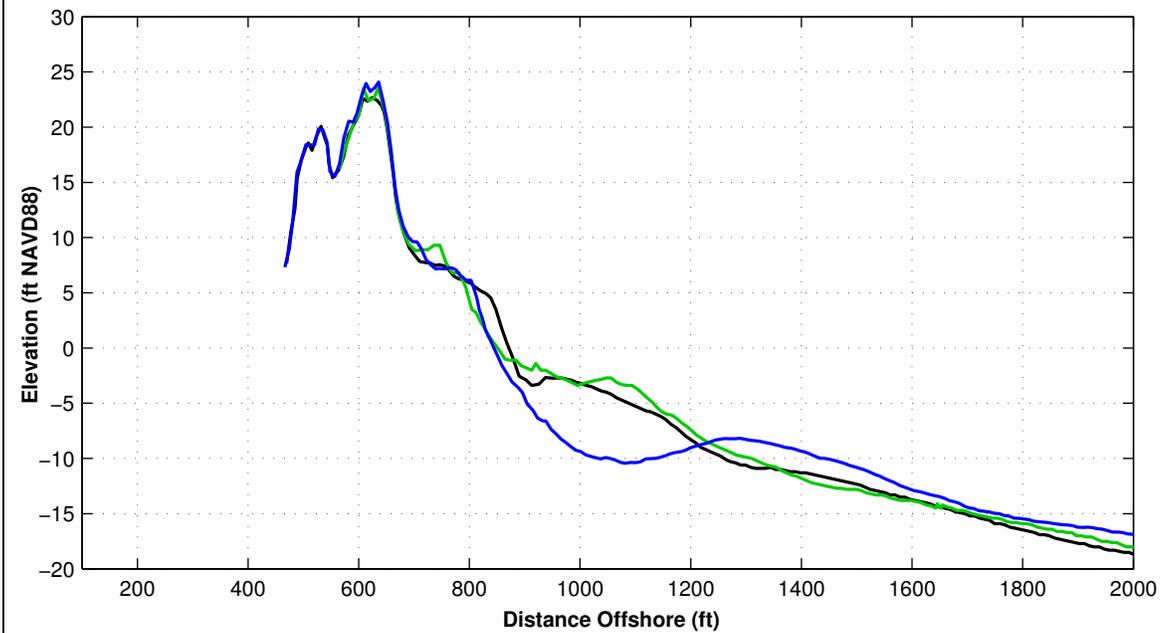
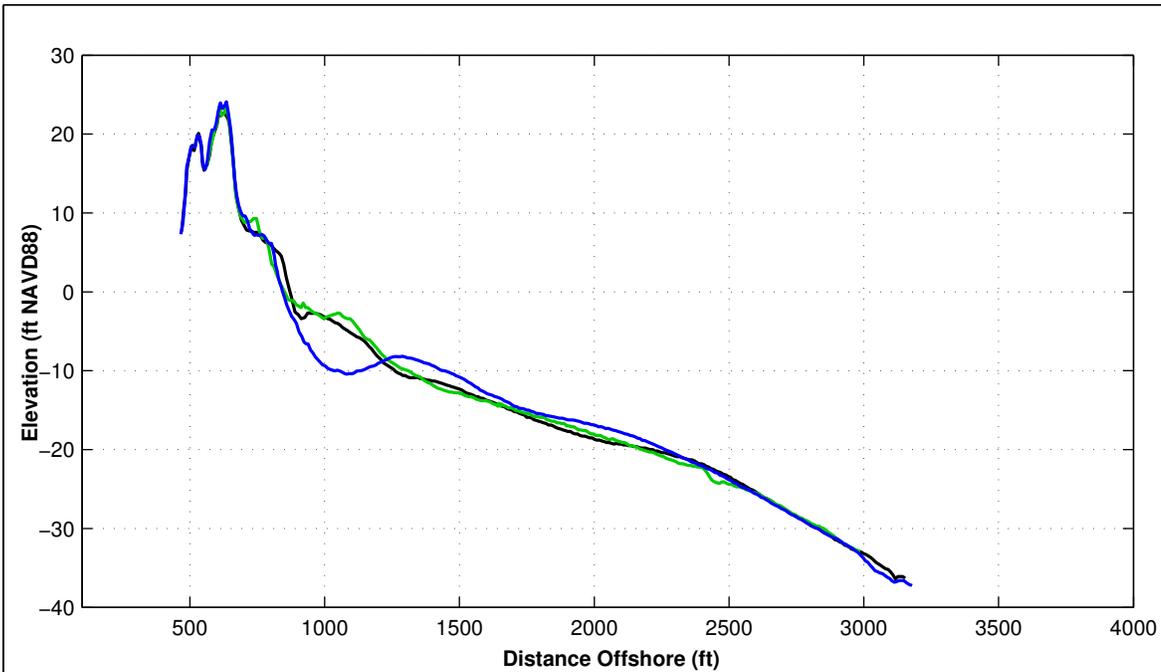
Survey Transect 957+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	15.84 ft	20.37 ft
Volume Change Above +6 ft NAVD88	3.09 cy/ft	6.86 cy/ft
Volume Change Above 1.18 ft NAVD88	4.78 cy/ft	13.98 cy/ft
Volume Change Above -6 ft NAVD88	-6.05 cy/ft	22.02 cy/ft
Volume Change Above -14 ft NAVD88	-19.42 cy/ft	88.03 cy/ft
Volume Change Above -19 ft NAVD88	-12.50 cy/ft	97.32 cy/ft
Volume Change Above -30 ft NAVD88	1.47 cy/ft	57.97 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

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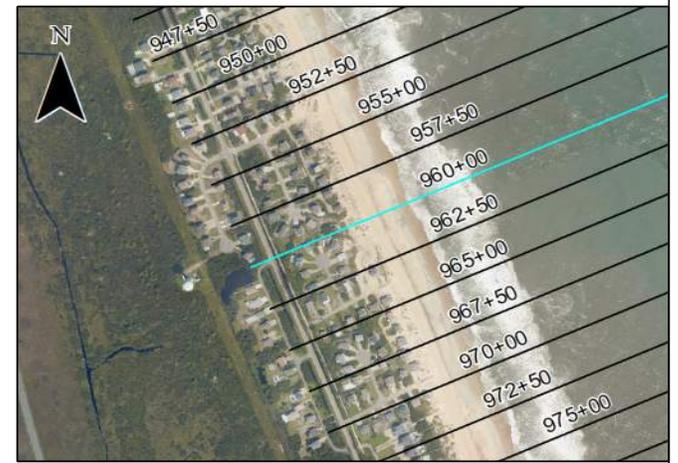


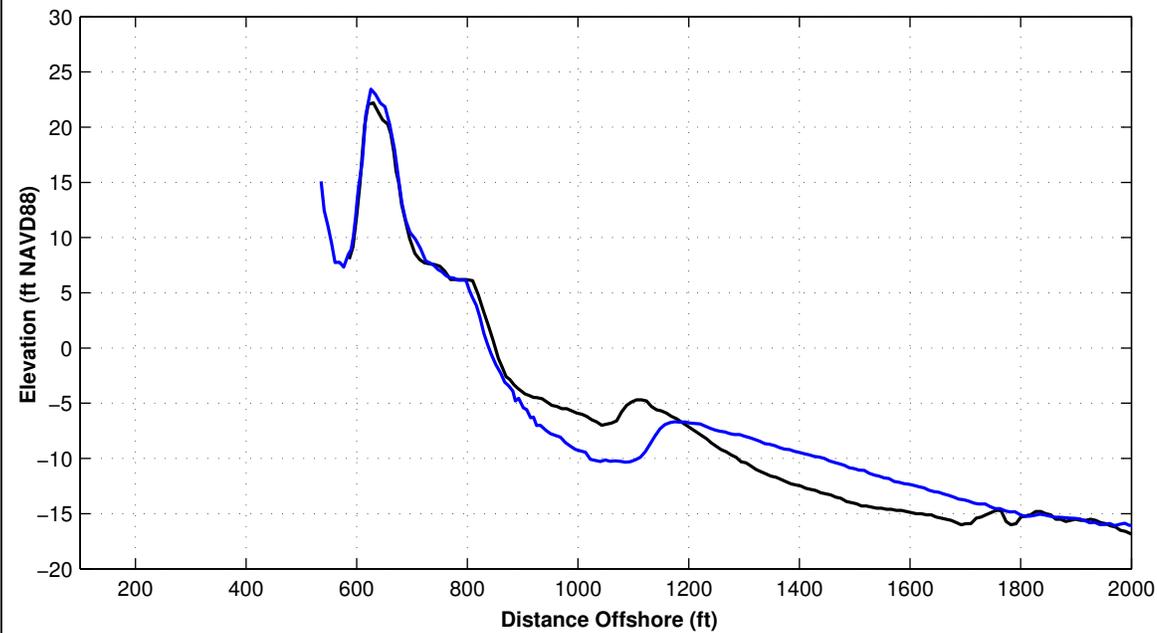
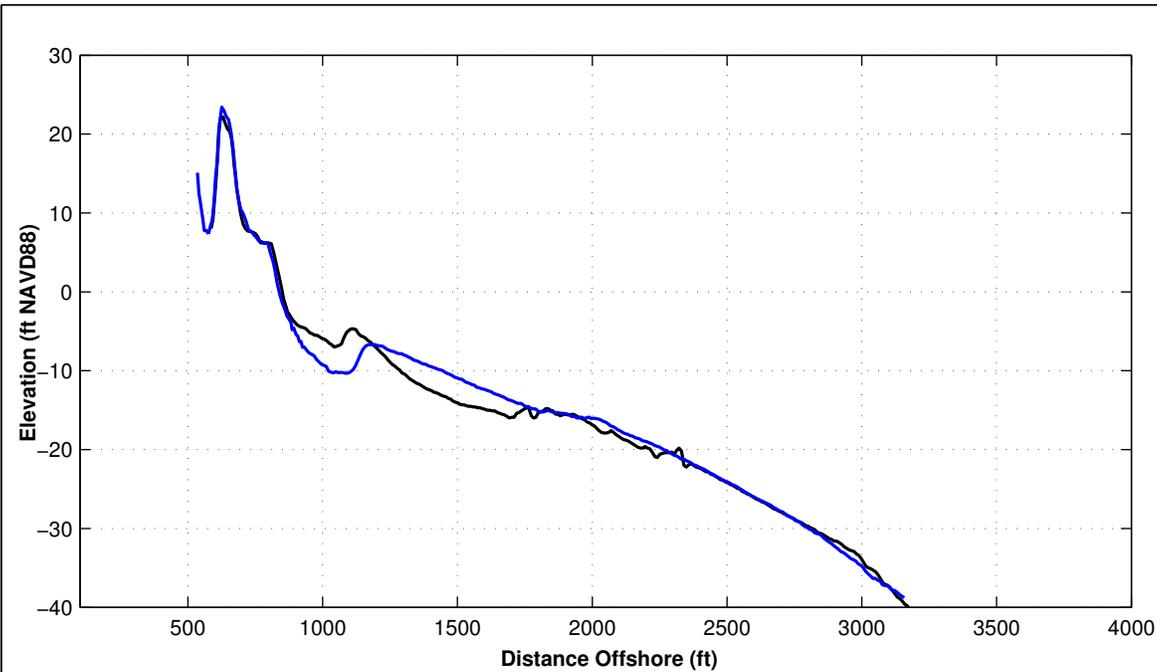
Survey Transect 960+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-29.42 ft	43.26 ft
Volume Change Above +6 ft NAVD88	5.38 cy/ft	9.87 cy/ft
Volume Change Above 1.18 ft NAVD88	1.23 cy/ft	21.82 cy/ft
Volume Change Above -6 ft NAVD88	-21.43 cy/ft	37.04 cy/ft
Volume Change Above -14 ft NAVD88	-27.79 cy/ft	93.40 cy/ft
Volume Change Above -19 ft NAVD88	-4.57 cy/ft	43.34 cy/ft
Volume Change Above -30 ft NAVD88	-2.97 cy/ft	14.81 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

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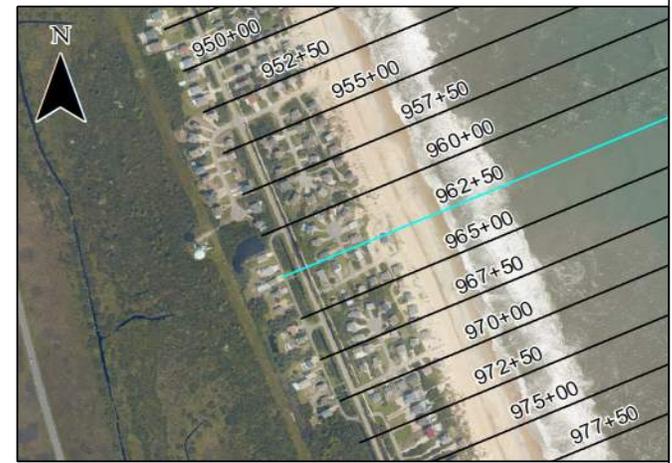
Survey Transect 962+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-12.48 ft	30.71 ft
Volume Change Above +6 ft NAVD88	2.61 cy/ft	5.28 cy/ft
Volume Change Above 1.18 ft NAVD88	0.60 cy/ft	14.16 cy/ft
Volume Change Above -6 ft NAVD88	-7.84 cy/ft	14.48 cy/ft
Volume Change Above -14 ft NAVD88	5.75 cy/ft	58.30 cy/ft
Volume Change Above -19 ft NAVD88	22.68 cy/ft	23.15 cy/ft
Volume Change Above -30 ft NAVD88	26.91 cy/ft	-1.30 cy/ft

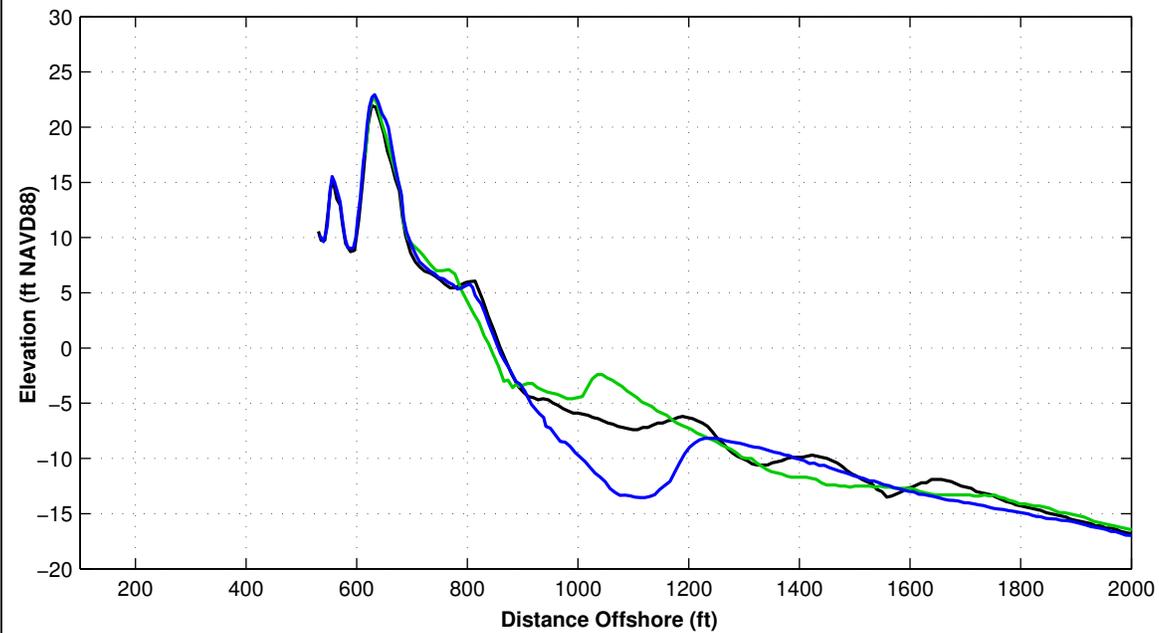
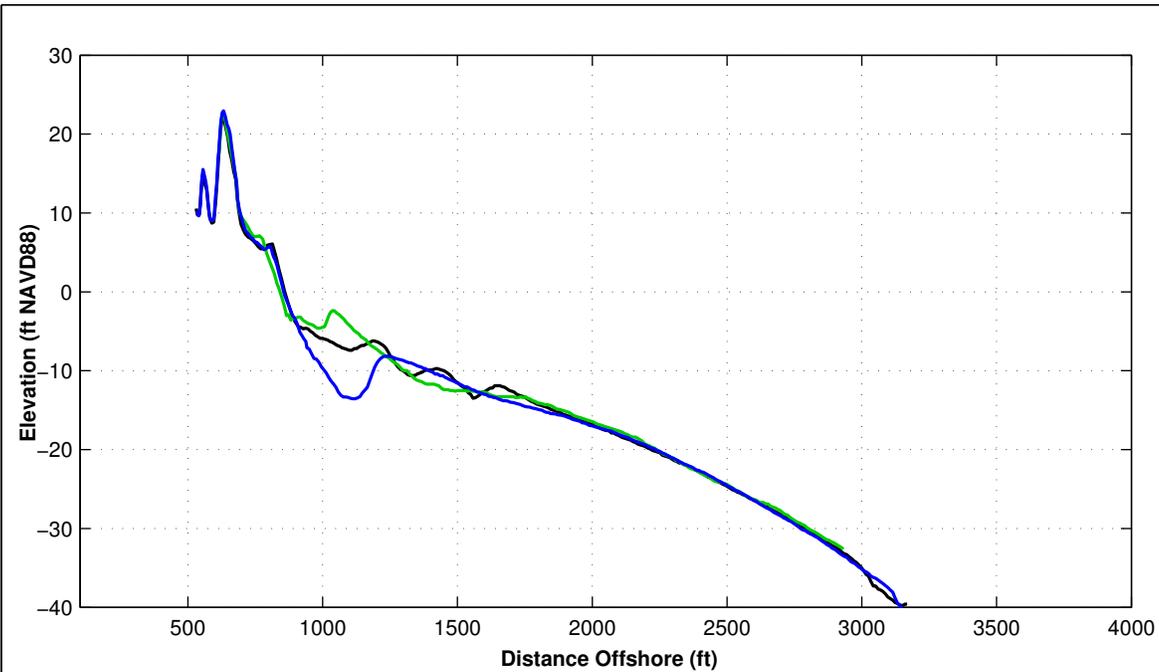
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023

————— JUNE 2023 ————

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Survey Transect 965+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-4.09 ft	31.77 ft
Volume Change Above +6 ft NAVD88	5.27 cy/ft	3.41 cy/ft
Volume Change Above 1.18 ft NAVD88	4.12 cy/ft	11.53 cy/ft
Volume Change Above -6 ft NAVD88	1.43 cy/ft	13.46 cy/ft
Volume Change Above -14 ft NAVD88	-49.41 cy/ft	77.89 cy/ft
Volume Change Above -19 ft NAVD88	-52.94 cy/ft	72.31 cy/ft
Volume Change Above -30 ft NAVD88	-51.56 cy/ft	52.33 cy/ft

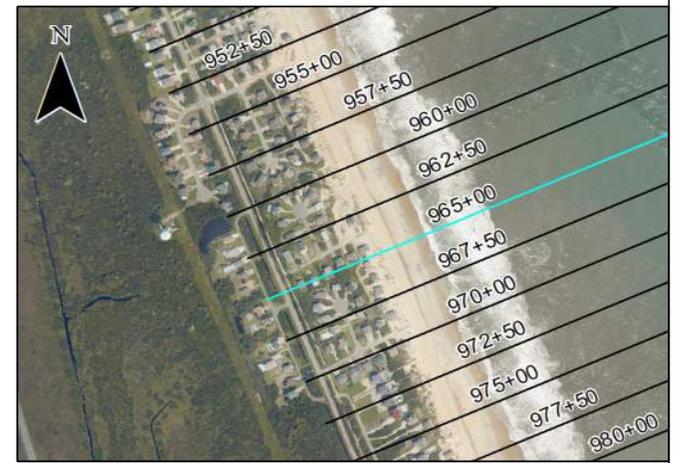
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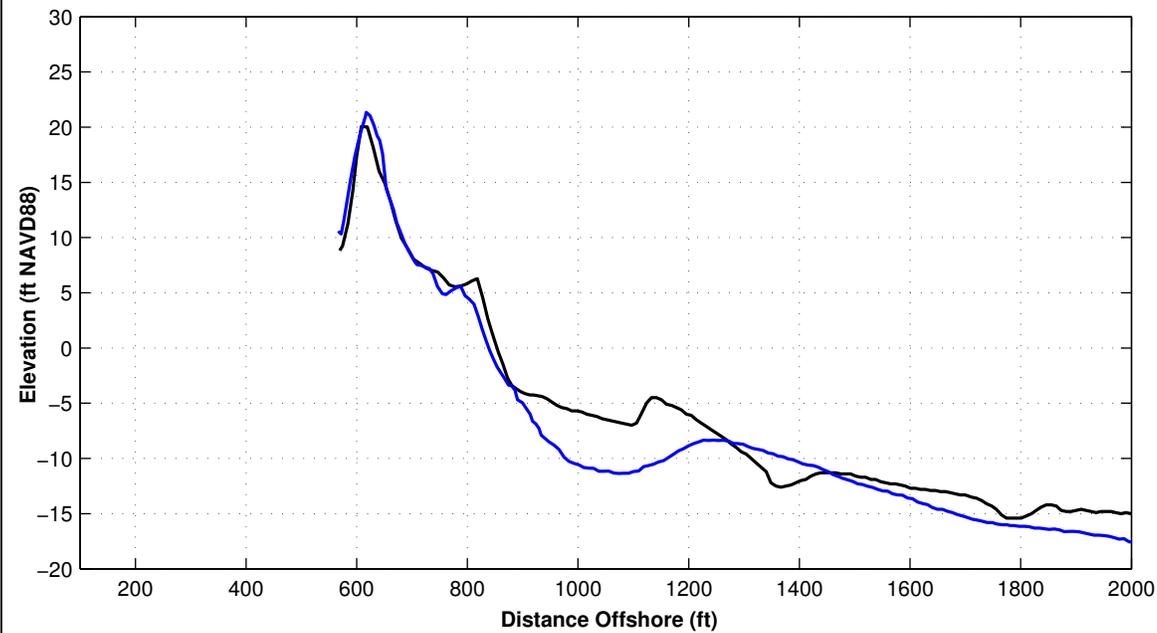
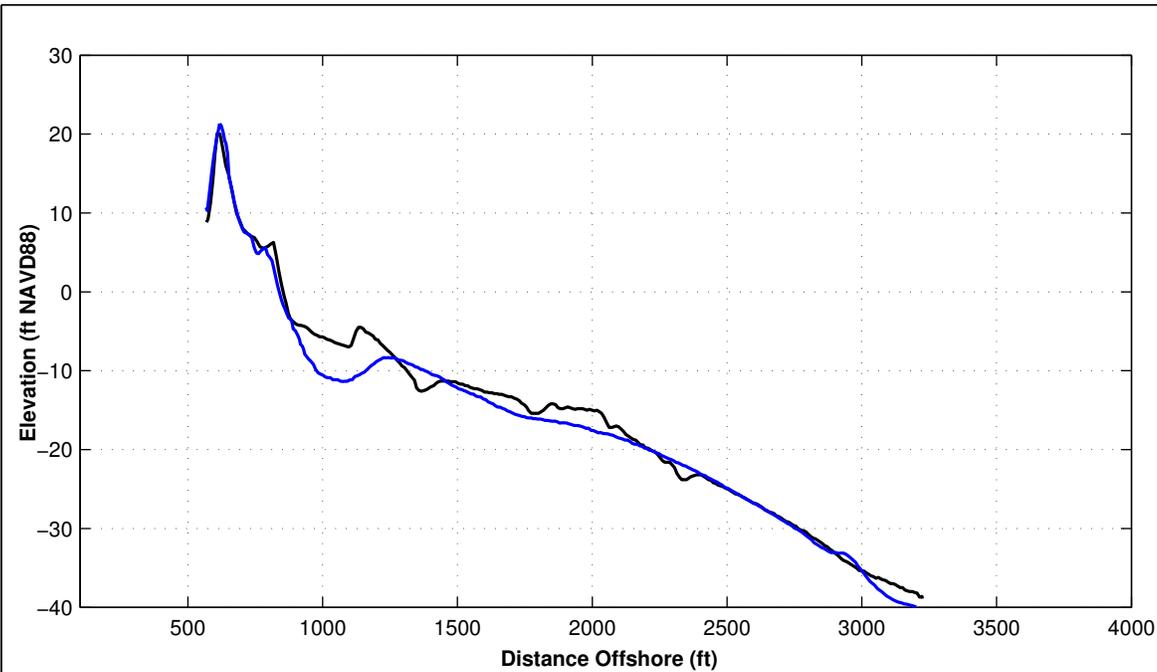
JUNE 2024 ————

OCTOBER 2023 ————

JUNE 2023 ————

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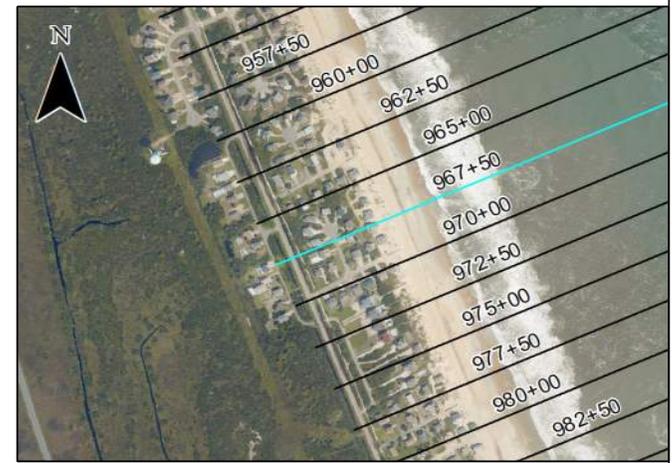
Survey Transect 967+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-15.73 ft	36.42 ft
Volume Change Above +6 ft NAVD88	2.19 cy/ft	3.43 cy/ft
Volume Change Above 1.18 ft NAVD88	-2.54 cy/ft	13.80 cy/ft
Volume Change Above -6 ft NAVD88	-11.70 cy/ft	17.01 cy/ft
Volume Change Above -14 ft NAVD88	-54.64 cy/ft	66.83 cy/ft
Volume Change Above -19 ft NAVD88	-84.06 cy/ft	76.19 cy/ft
Volume Change Above -30 ft NAVD88	-79.13 cy/ft	51.73 cy/ft

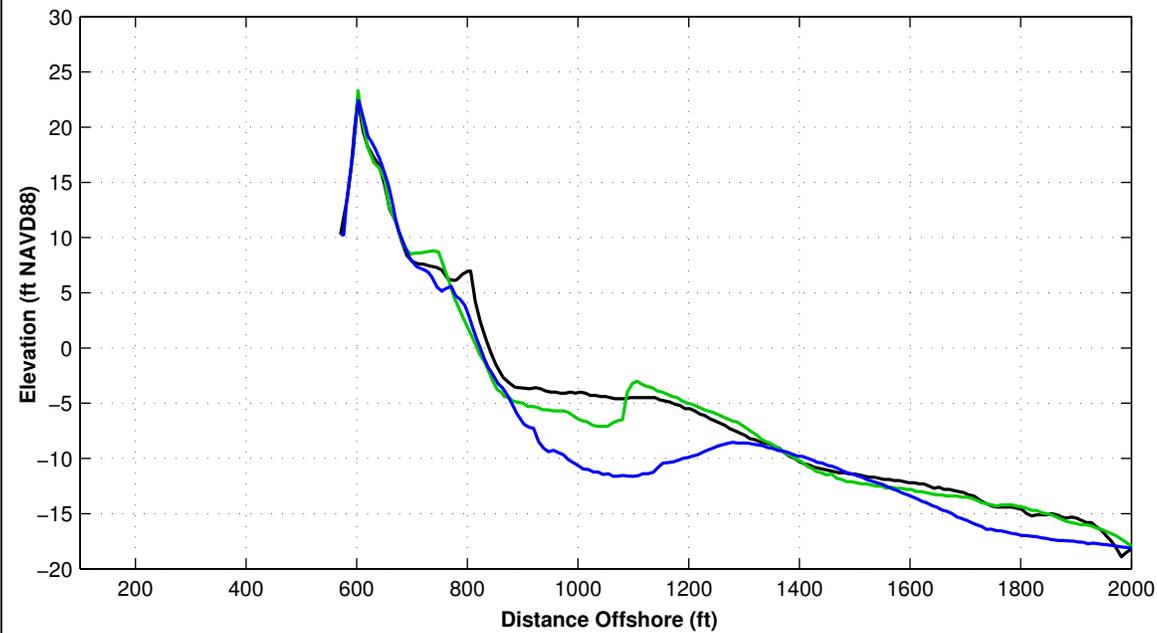
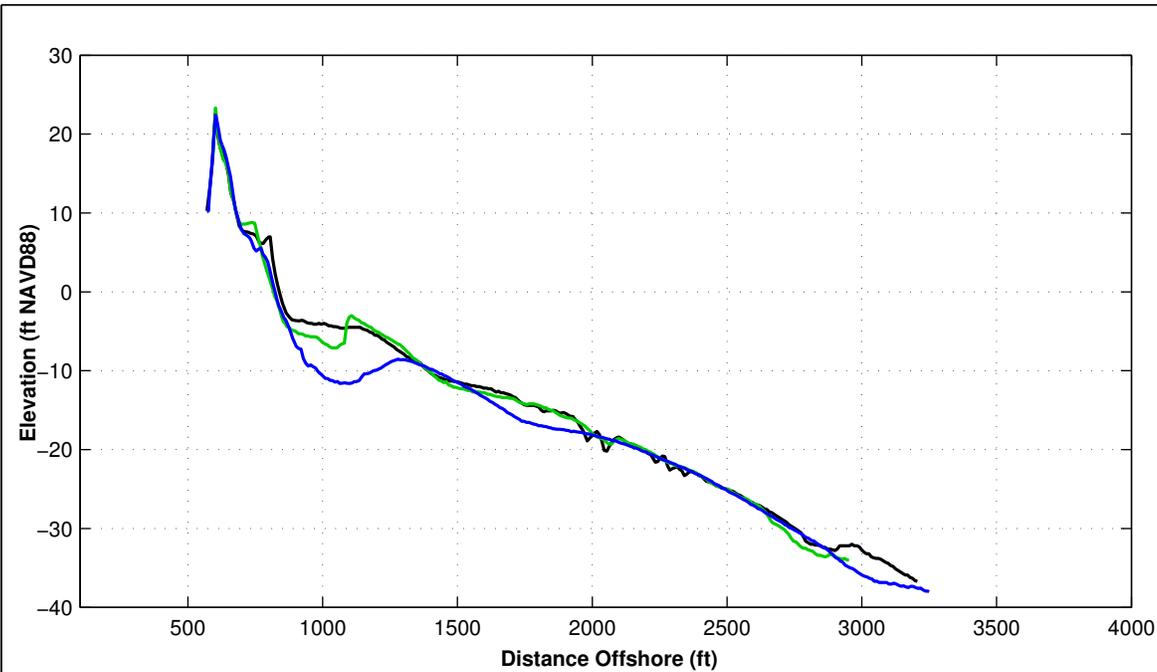
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023

JUNE 2024 ———— JUNE 2023

- Notes:
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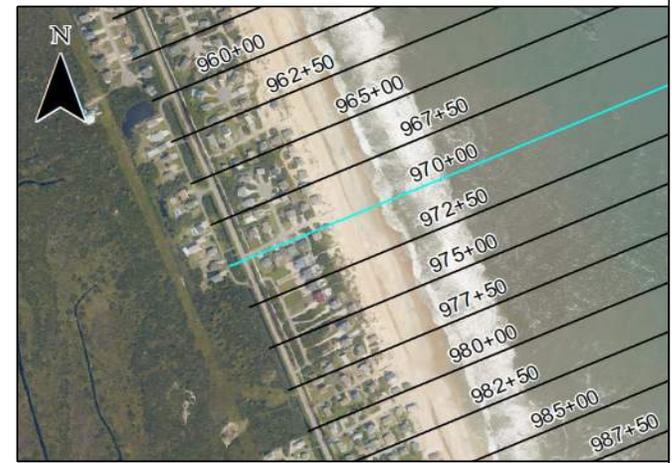


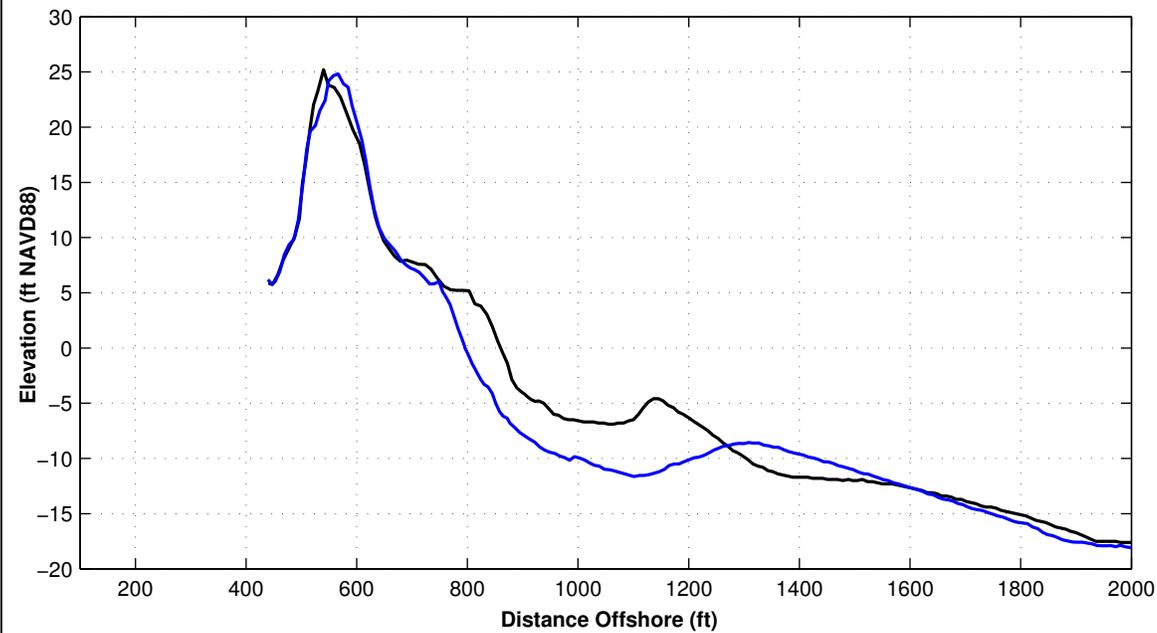
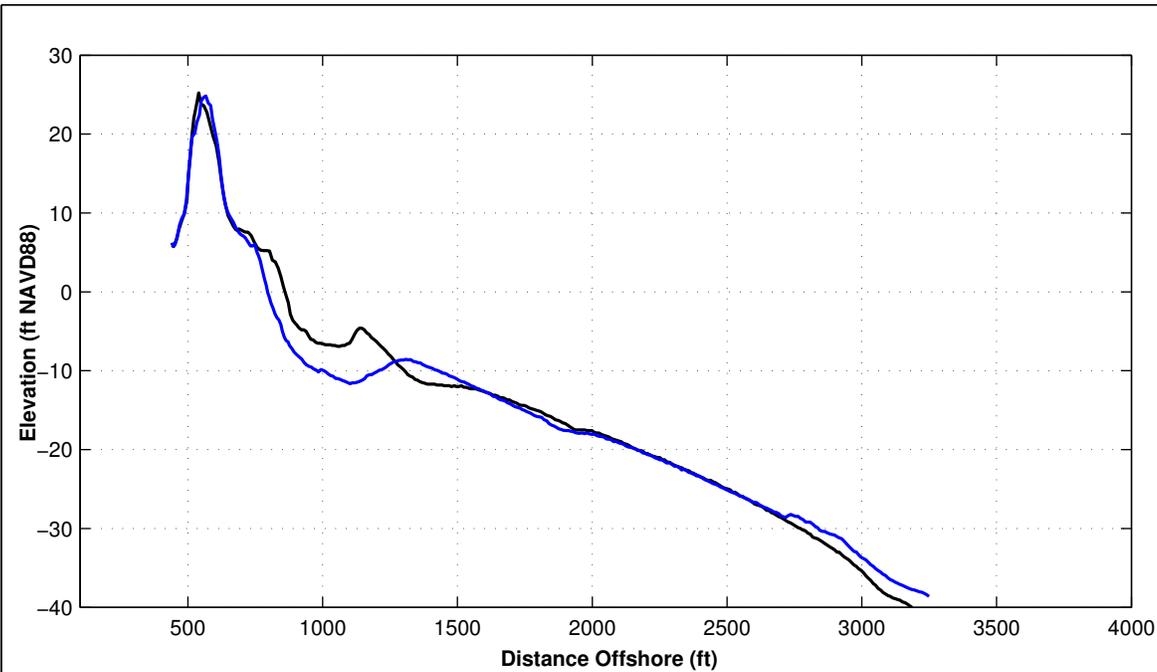
Survey Transect 970+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-16.64 ft	27.33 ft
Volume Change Above +6 ft NAVD88	-0.17 cy/ft	7.68 cy/ft
Volume Change Above 1.18 ft NAVD88	-5.17 cy/ft	16.77 cy/ft
Volume Change Above -6 ft NAVD88	-28.58 cy/ft	30.27 cy/ft
Volume Change Above -14 ft NAVD88	-92.24 cy/ft	100.43 cy/ft
Volume Change Above -19 ft NAVD88	-113.63 cy/ft	86.85 cy/ft
Volume Change Above -30 ft NAVD88	-114.19 cy/ft	52.18 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023		JUNE 2023	
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- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



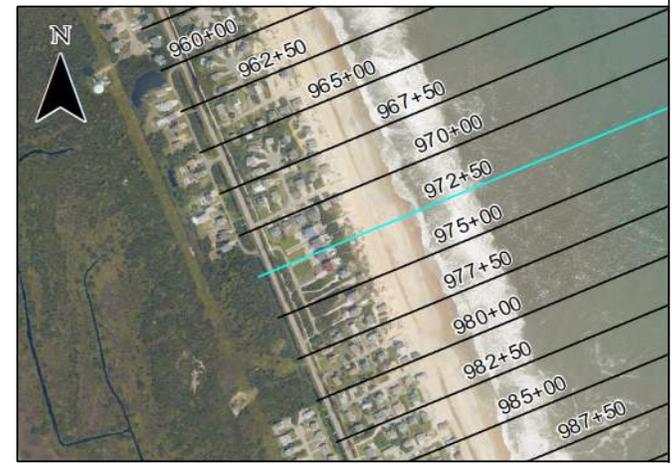


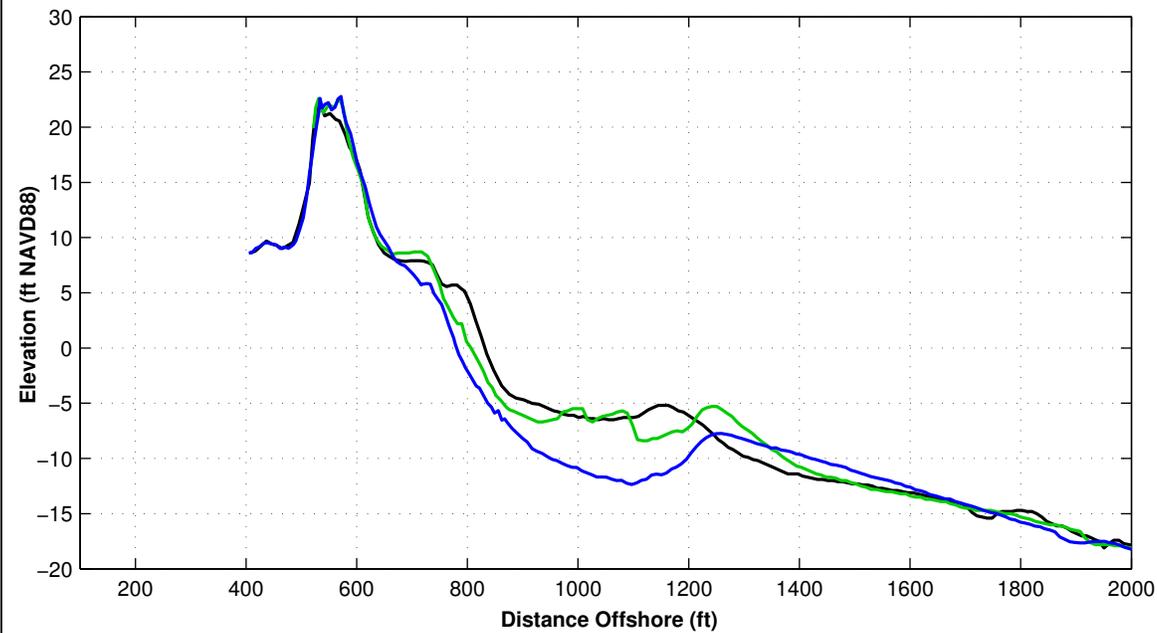
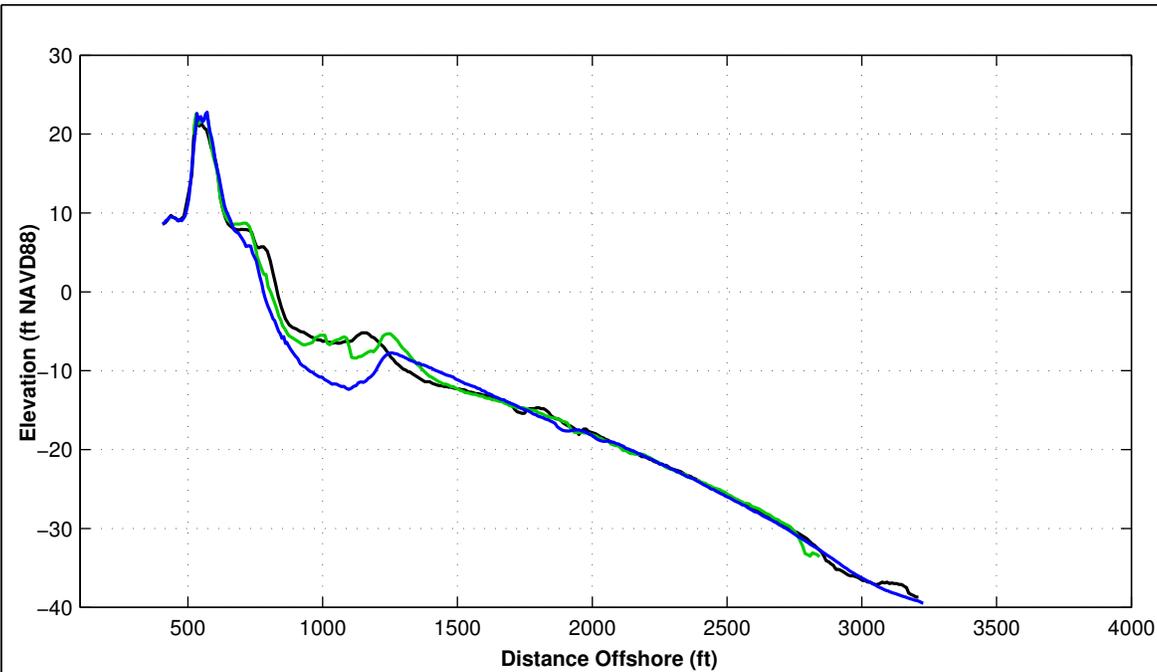
Survey Transect 972+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-63.16 ft	54.91 ft
Volume Change Above +6 ft NAVD88	1.03 cy/ft	10.14 cy/ft
Volume Change Above 1.18 ft NAVD88	-7.70 cy/ft	21.41 cy/ft
Volume Change Above -6 ft NAVD88	-27.55 cy/ft	27.15 cy/ft
Volume Change Above -14 ft NAVD88	-64.13 cy/ft	73.03 cy/ft
Volume Change Above -19 ft NAVD88	-72.21 cy/ft	53.02 cy/ft
Volume Change Above -30 ft NAVD88	-69.08 cy/ft	28.66 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



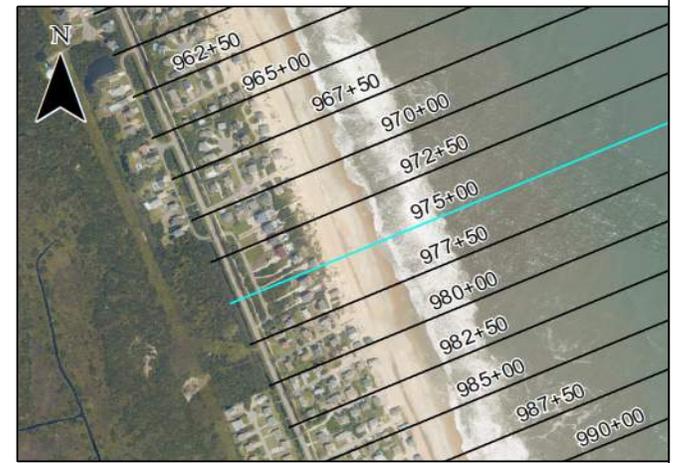


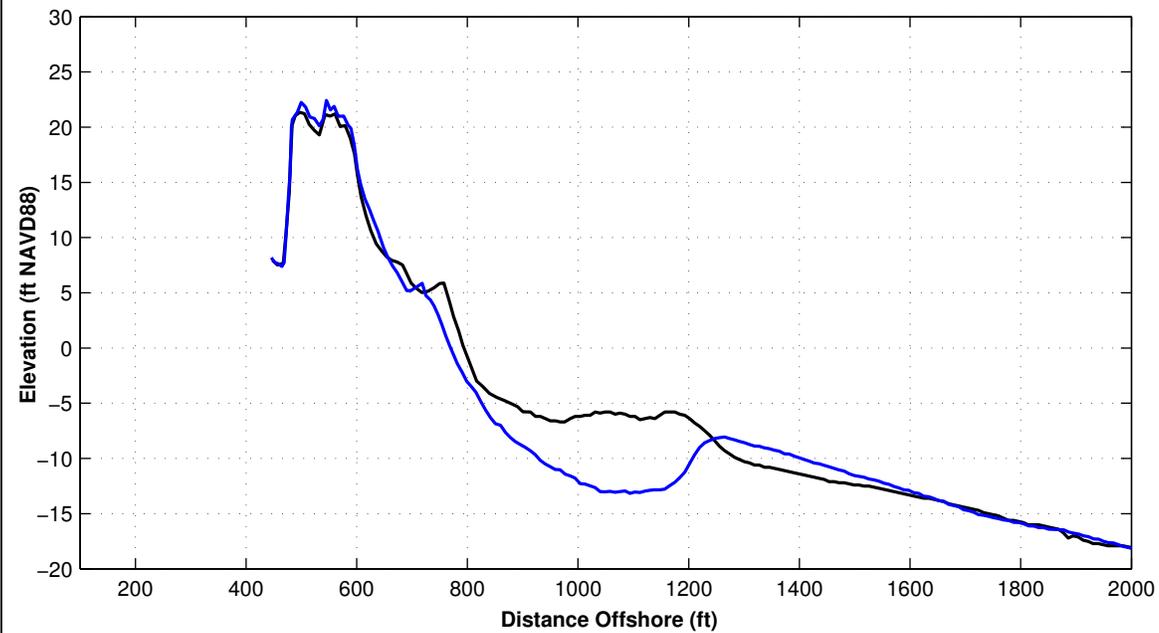
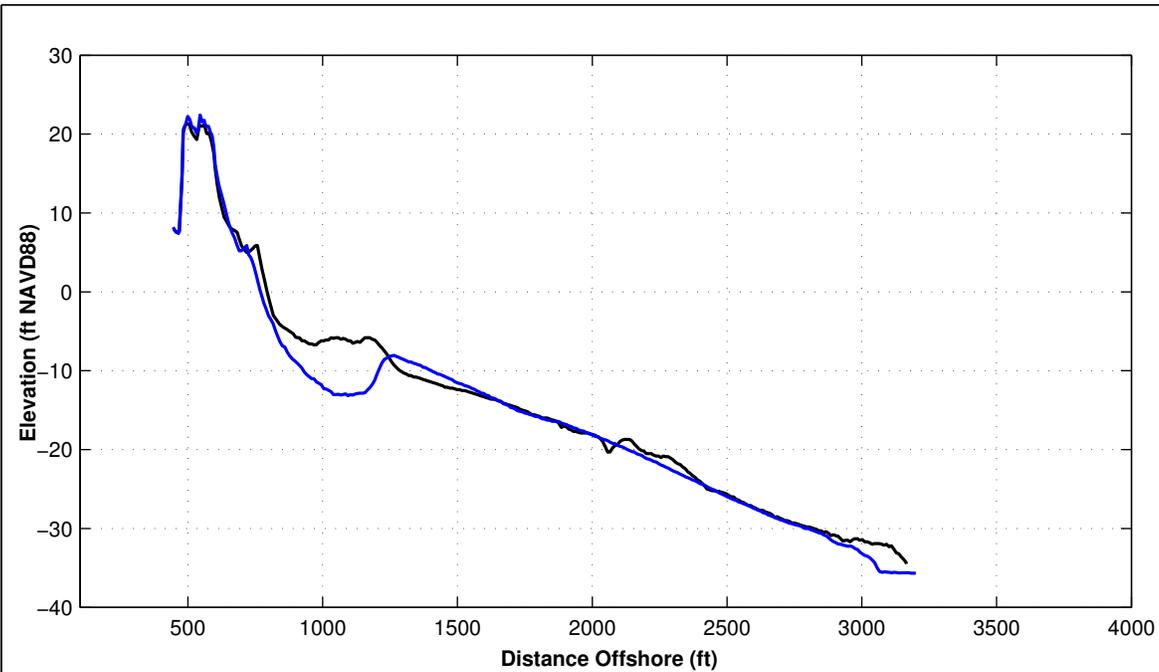
Survey Transect 975+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-50.98 ft	37.48 ft
Volume Change Above +6 ft NAVD88	1.68 cy/ft	8.15 cy/ft
Volume Change Above 1.18 ft NAVD88	-7.48 cy/ft	19.13 cy/ft
Volume Change Above -6 ft NAVD88	-24.34 cy/ft	22.00 cy/ft
Volume Change Above -14 ft NAVD88	-64.35 cy/ft	66.76 cy/ft
Volume Change Above -19 ft NAVD88	-69.71 cy/ft	33.74 cy/ft
Volume Change Above -30 ft NAVD88	-72.48 cy/ft	-4.02 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





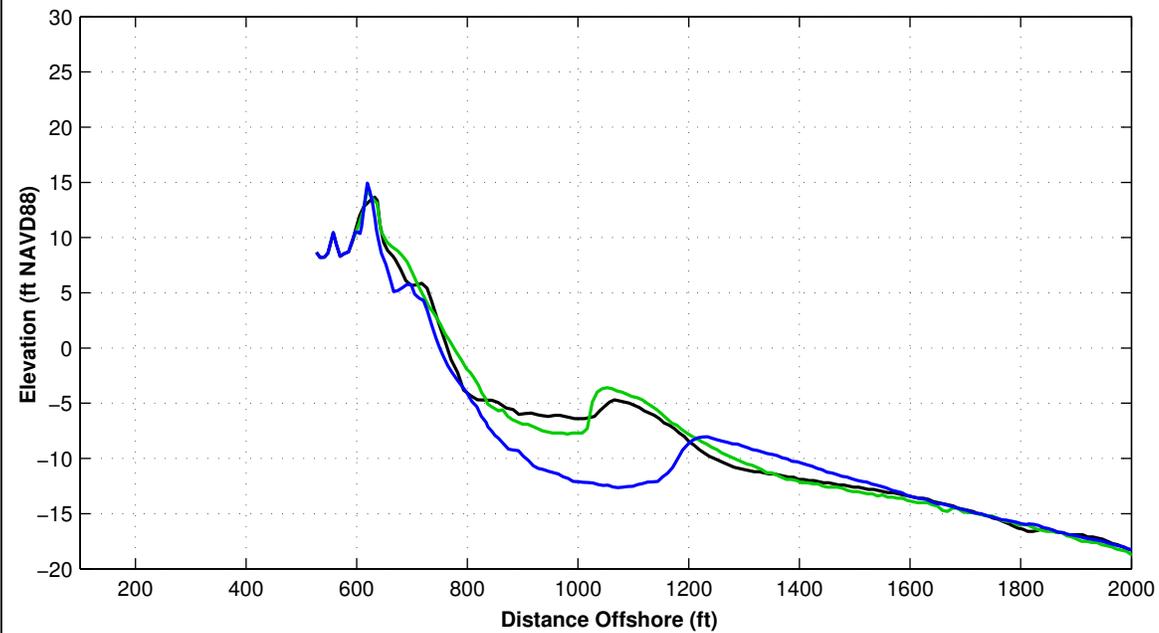
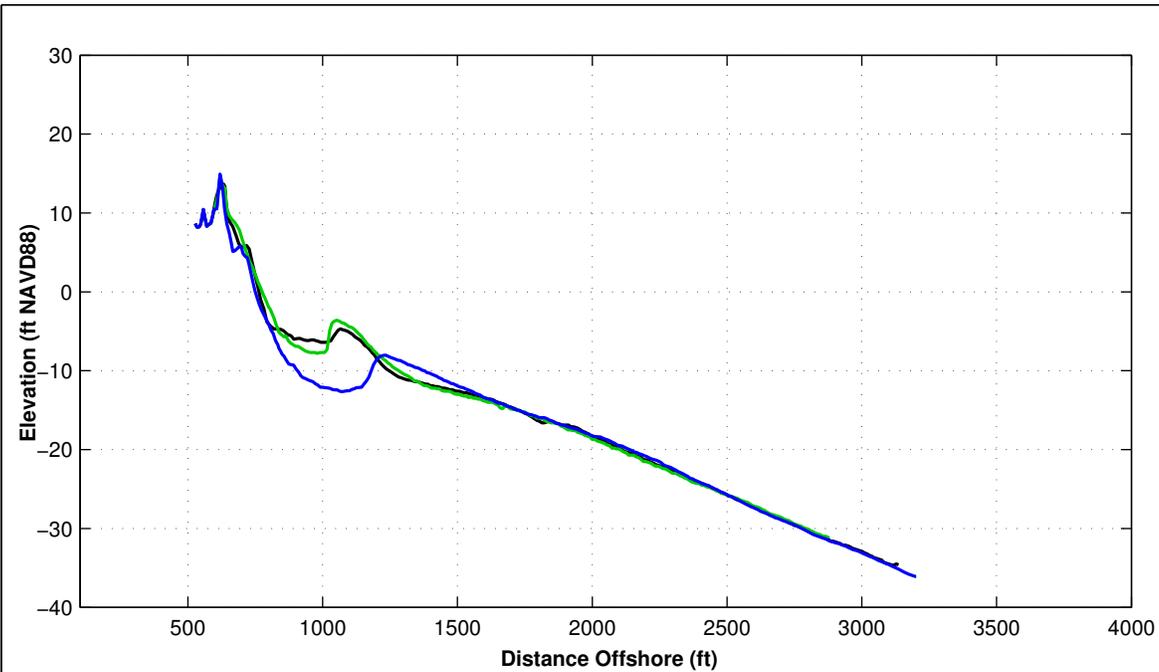
Survey Transect 977+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-25.84 ft	16.55 ft
Volume Change Above +6 ft NAVD88	4.08 cy/ft	8.28 cy/ft
Volume Change Above 1.18 ft NAVD88	-1.00 cy/ft	14.35 cy/ft
Volume Change Above -6 ft NAVD88	-9.37 cy/ft	11.14 cy/ft
Volume Change Above -14 ft NAVD88	-64.41 cy/ft	60.65 cy/ft
Volume Change Above -19 ft NAVD88	-64.61 cy/ft	48.21 cy/ft
Volume Change Above -30 ft NAVD88	-75.48 cy/ft	32.73 cy/ft

**LEGEND:**

JUNE 2024 —      OCTOBER 2023 —  
 JUNE 2023 —      JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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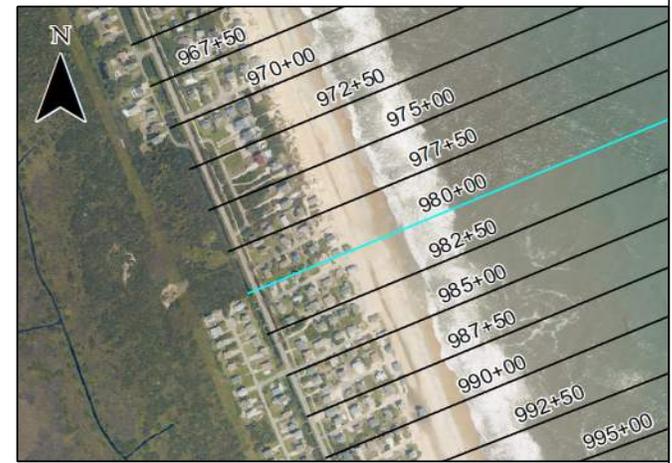


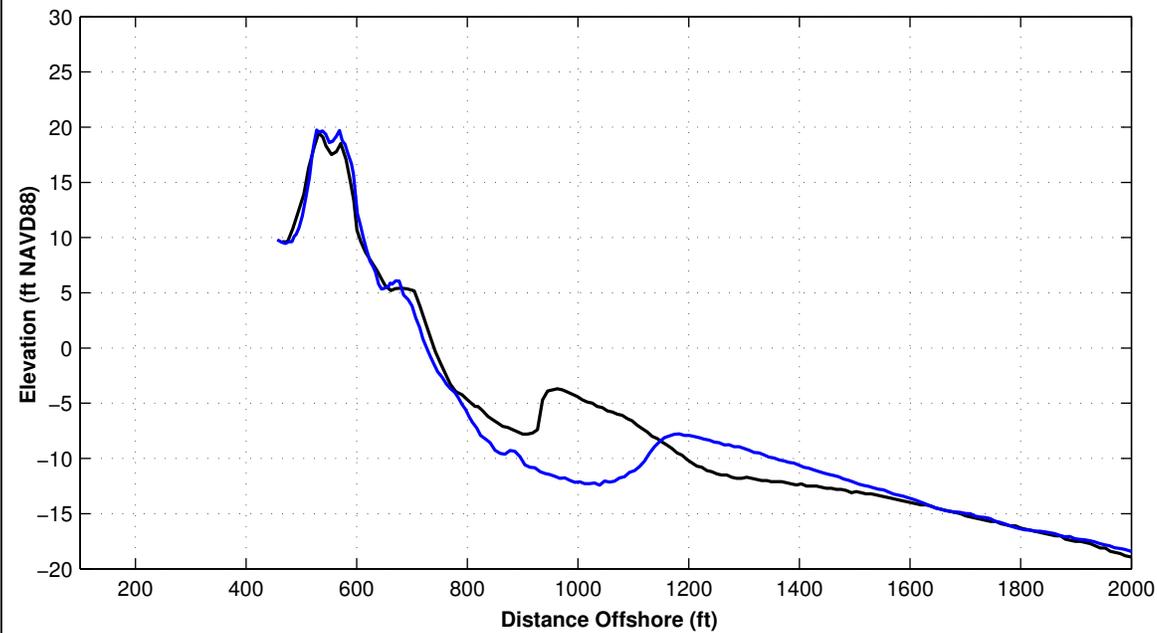
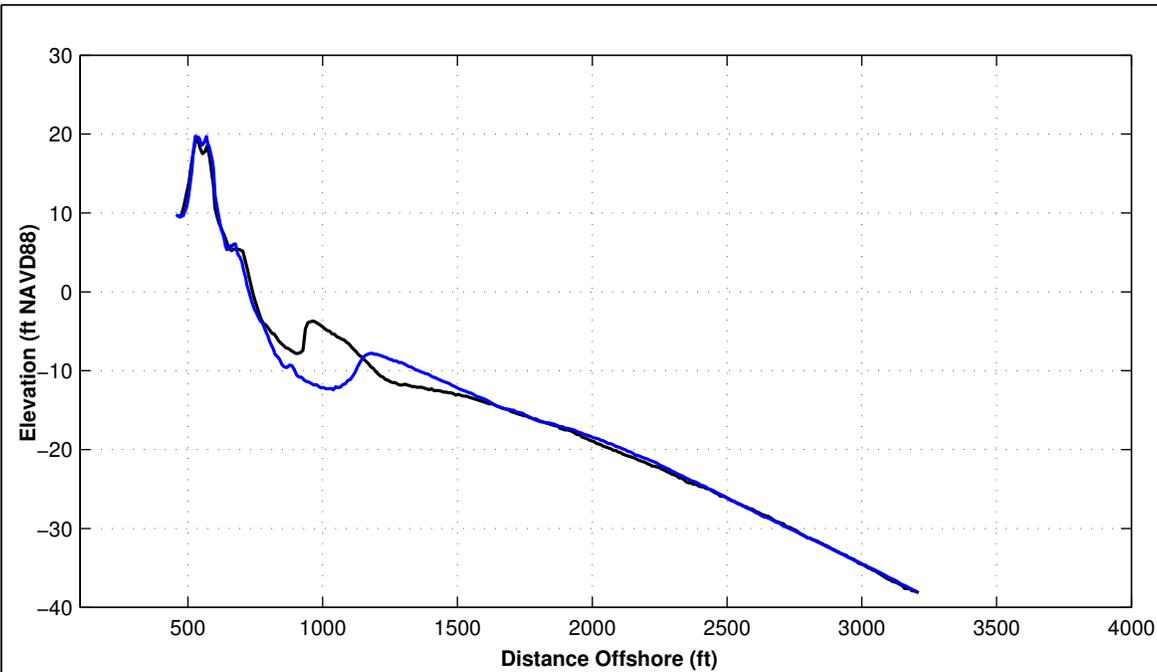
Survey Transect 980+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-14.38 ft	11.69 ft
Volume Change Above +6 ft NAVD88	-3.96 cy/ft	8.10 cy/ft
Volume Change Above 1.18 ft NAVD88	-7.48 cy/ft	12.68 cy/ft
Volume Change Above -6 ft NAVD88	-14.86 cy/ft	11.30 cy/ft
Volume Change Above -14 ft NAVD88	-62.34 cy/ft	59.51 cy/ft
Volume Change Above -19 ft NAVD88	-61.09 cy/ft	83.58 cy/ft
Volume Change Above -30 ft NAVD88	-57.06 cy/ft	64.57 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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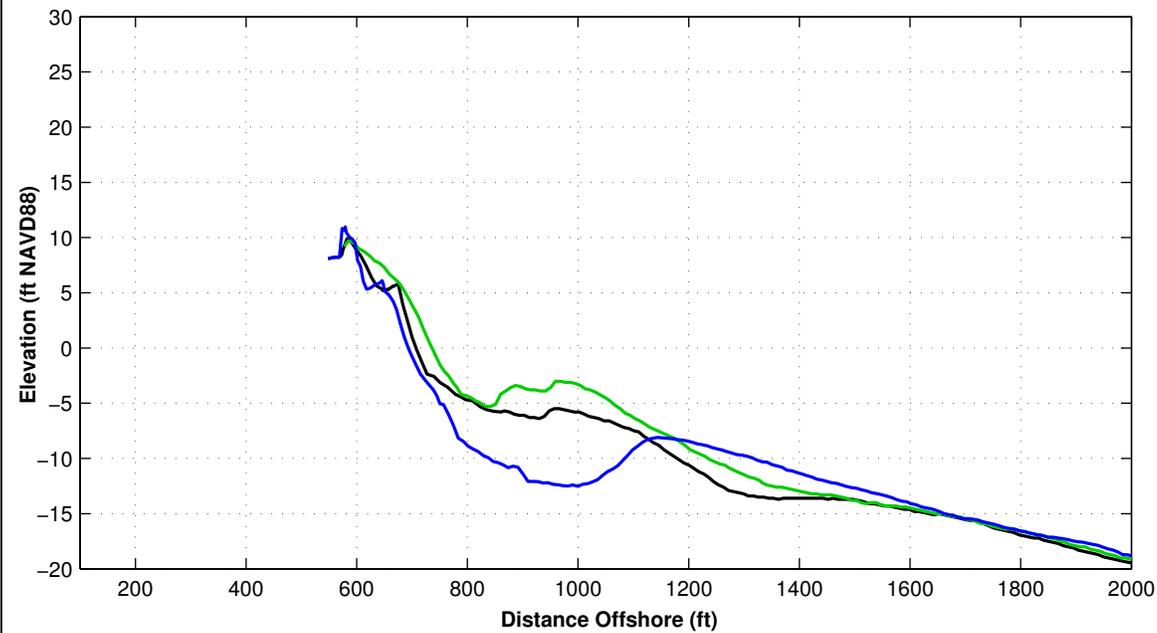
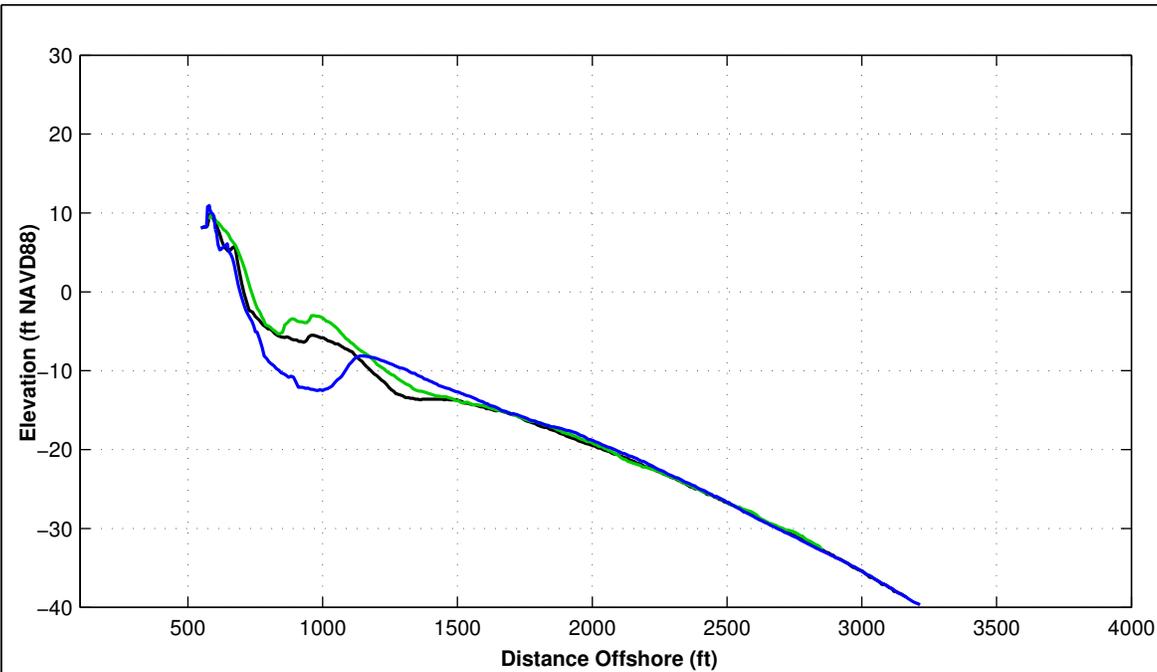
Survey Transect 982+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-14.08 ft	1.44 ft
Volume Change Above +6 ft NAVD88	3.49 cy/ft	3.58 cy/ft
Volume Change Above 1.18 ft NAVD88	1.30 cy/ft	5.92 cy/ft
Volume Change Above -6 ft NAVD88	-9.07 cy/ft	7.80 cy/ft
Volume Change Above -14 ft NAVD88	-32.74 cy/ft	45.64 cy/ft
Volume Change Above -19 ft NAVD88	-29.92 cy/ft	34.62 cy/ft
Volume Change Above -30 ft NAVD88	-23.53 cy/ft	11.18 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





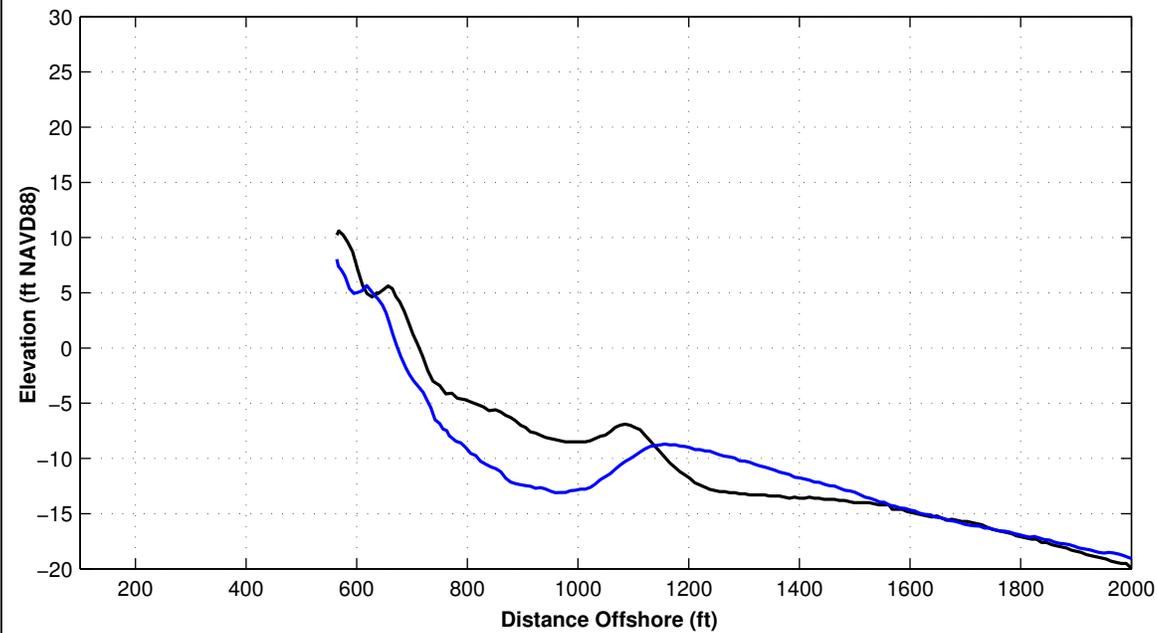
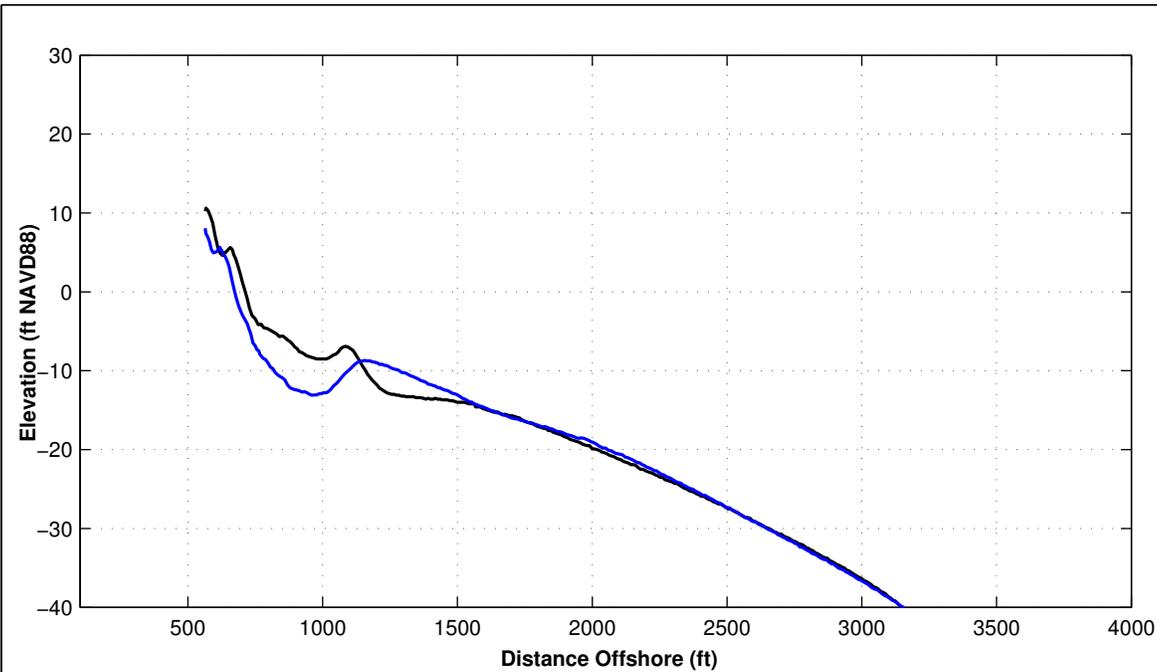
Survey Transect 985+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-14.11 ft	-11.46 ft
Volume Change Above +6 ft NAVD88	-0.25 cy/ft	4.19 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.06 cy/ft	5.56 cy/ft
Volume Change Above -6 ft NAVD88	-11.80 cy/ft	5.18 cy/ft
Volume Change Above -14 ft NAVD88	-36.12 cy/ft	35.36 cy/ft
Volume Change Above -19 ft NAVD88	-28.99 cy/ft	19.97 cy/ft
Volume Change Above -30 ft NAVD88	-22.67 cy/ft	-3.85 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
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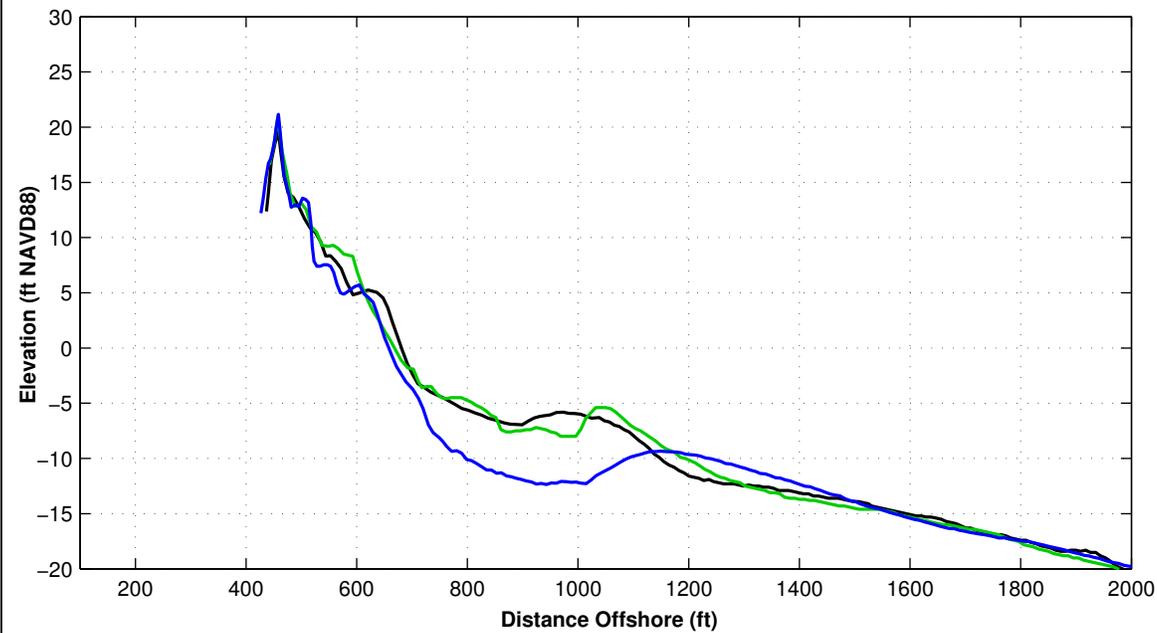
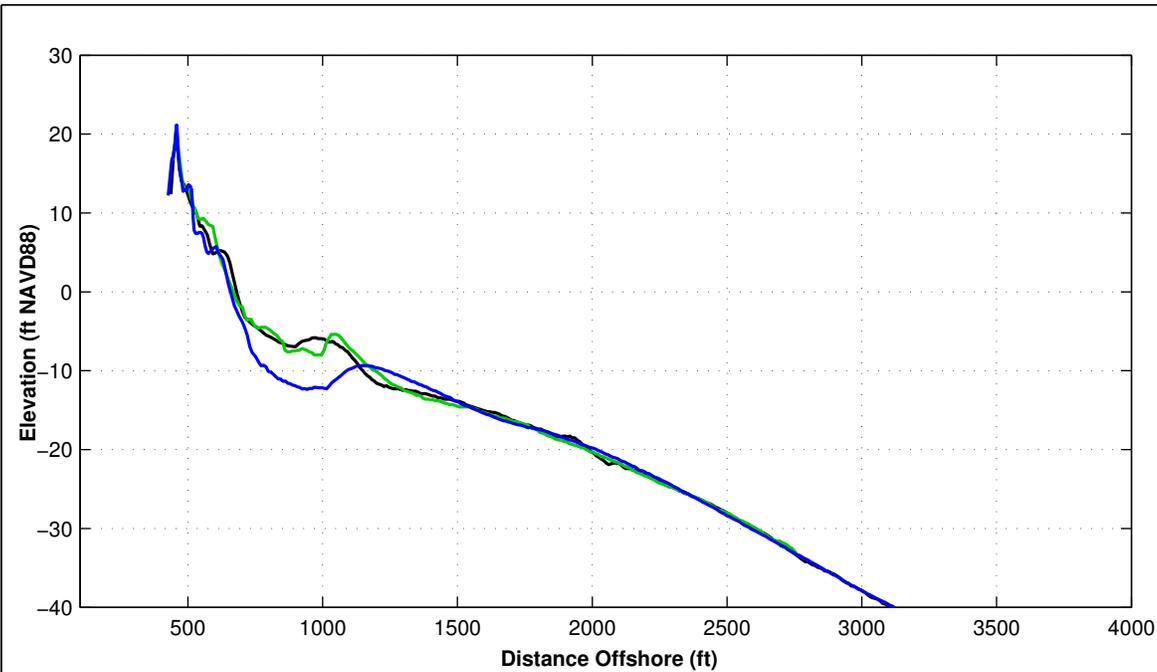
Survey Transect 987+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-36.77 ft	25.45 ft
Volume Change Above +6 ft NAVD88	-0.21 cy/ft	0.12 cy/ft
Volume Change Above 1.18 ft NAVD88	-5.58 cy/ft	4.72 cy/ft
Volume Change Above -6 ft NAVD88	-18.99 cy/ft	10.58 cy/ft
Volume Change Above -14 ft NAVD88	-44.63 cy/ft	35.53 cy/ft
Volume Change Above -19 ft NAVD88	-41.99 cy/ft	26.25 cy/ft
Volume Change Above -30 ft NAVD88	-33.36 cy/ft	6.24 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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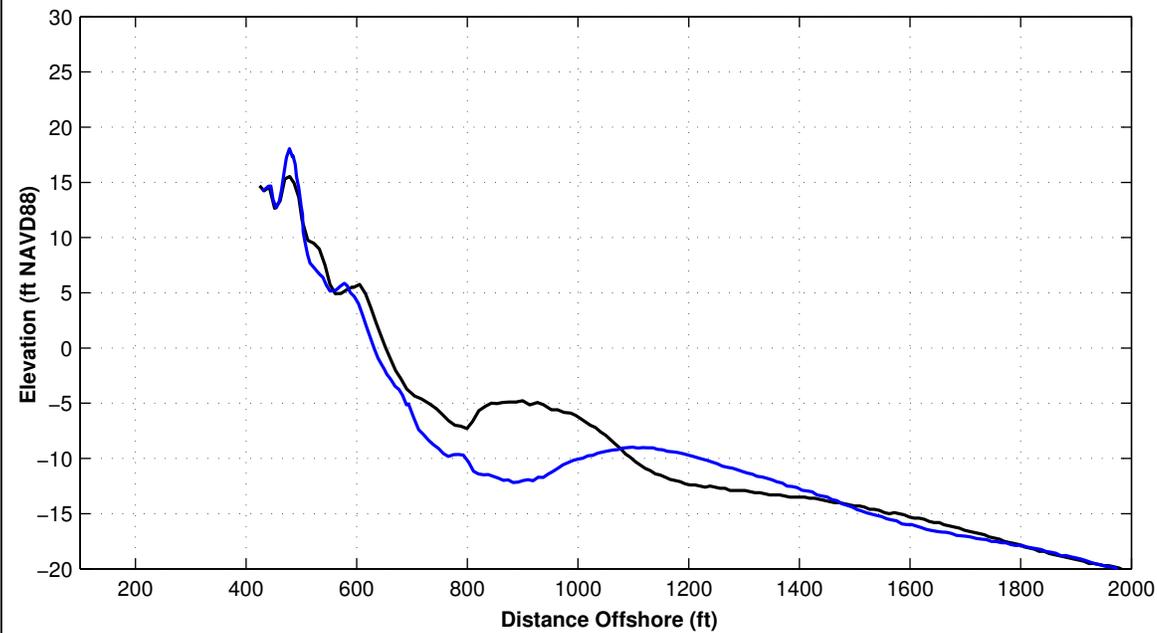
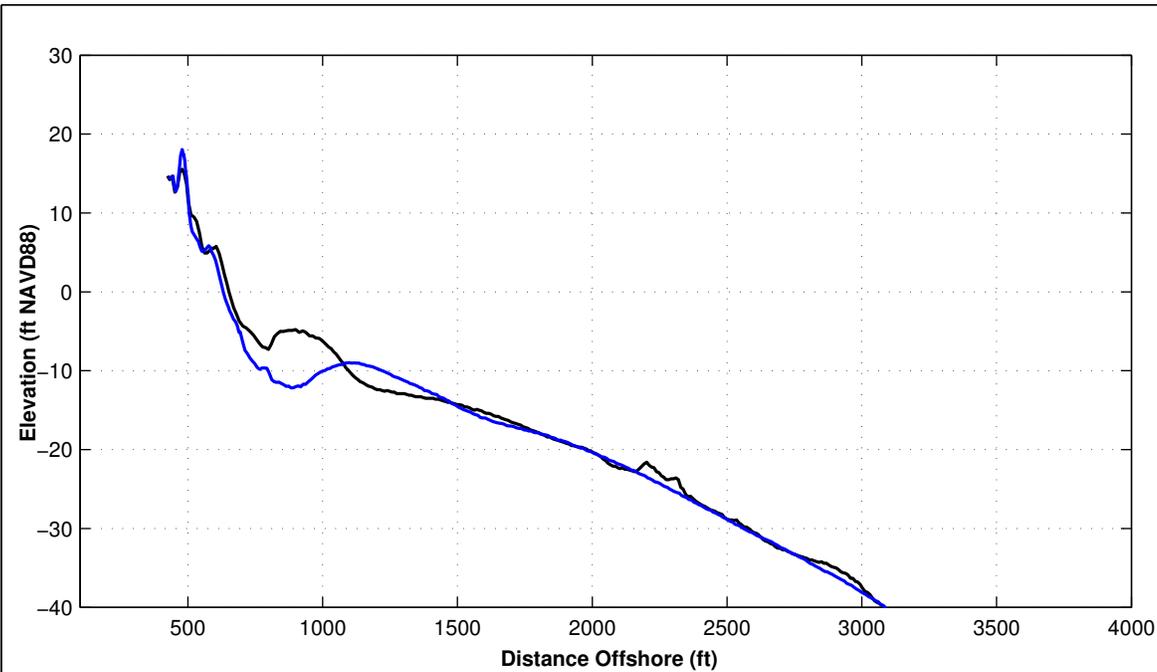
Survey Transect 990+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-24.04 ft	17.24 ft
Volume Change Above +6 ft NAVD88	-2.28 cy/ft	4.54 cy/ft
Volume Change Above 1.18 ft NAVD88	-5.99 cy/ft	9.48 cy/ft
Volume Change Above -6 ft NAVD88	-14.90 cy/ft	12.48 cy/ft
Volume Change Above -14 ft NAVD88	-63.50 cy/ft	58.51 cy/ft
Volume Change Above -19 ft NAVD88	-67.47 cy/ft	61.68 cy/ft
Volume Change Above -30 ft NAVD88	-62.74 cy/ft	41.15 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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Survey Transect 992+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-20.57 ft	-7.82 ft
Volume Change Above +6 ft NAVD88	-0.70 cy/ft	4.33 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.83 cy/ft	7.14 cy/ft
Volume Change Above -6 ft NAVD88	-15.30 cy/ft	10.82 cy/ft
Volume Change Above -14 ft NAVD88	-46.85 cy/ft	48.85 cy/ft
Volume Change Above -19 ft NAVD88	-52.50 cy/ft	66.73 cy/ft
Volume Change Above -30 ft NAVD88	-61.38 cy/ft	53.16 cy/ft

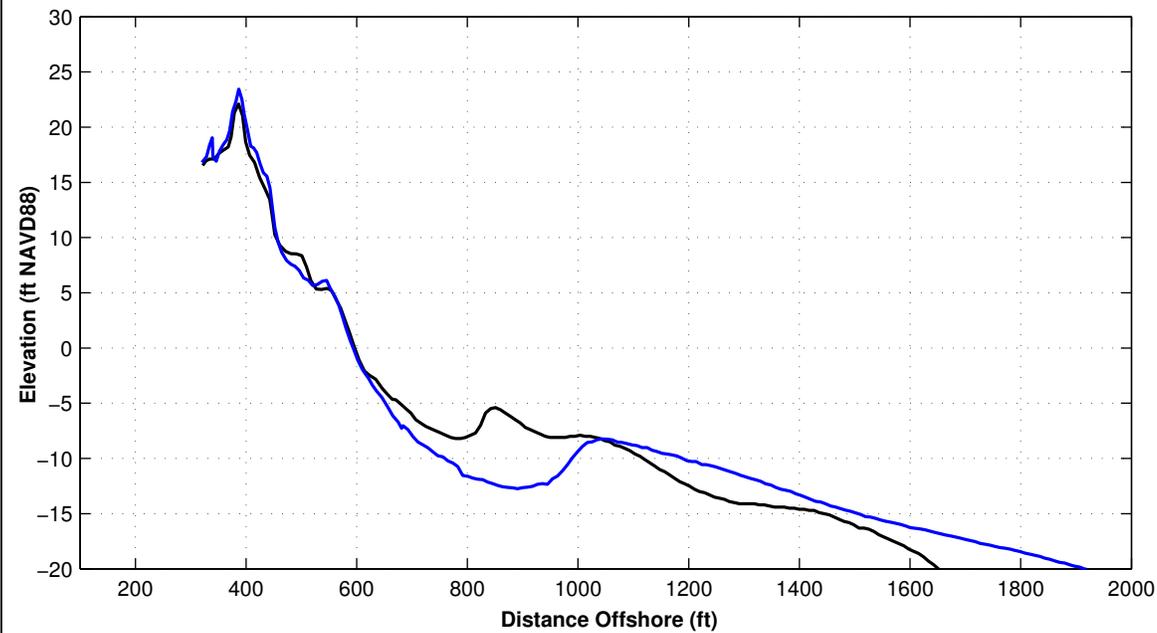
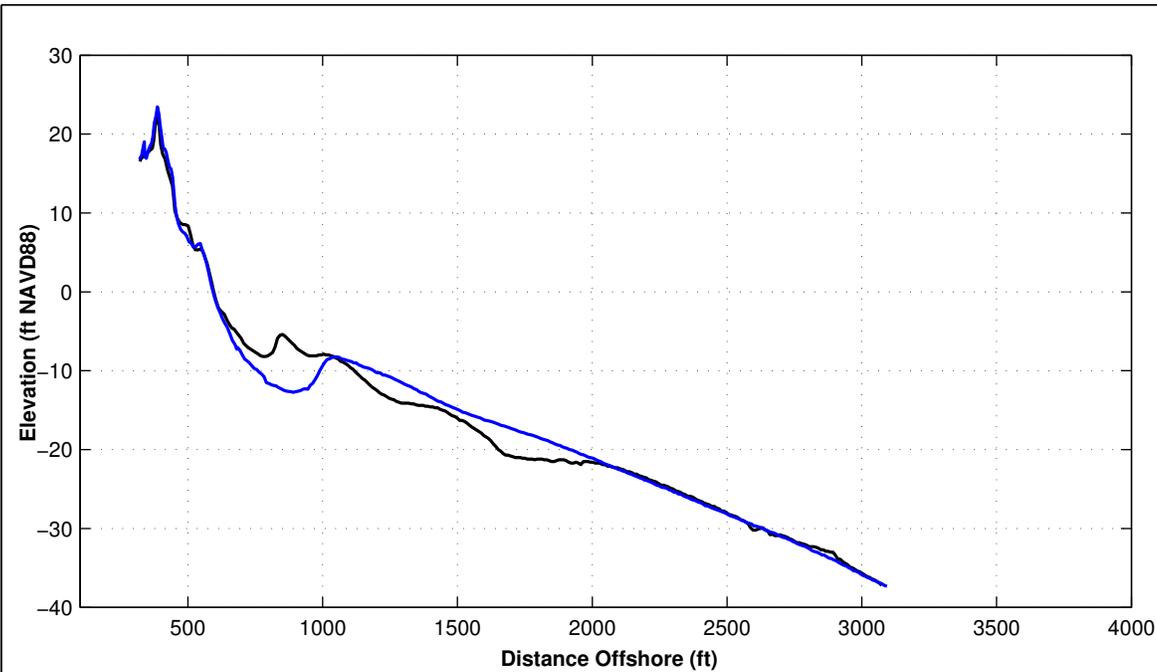
**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
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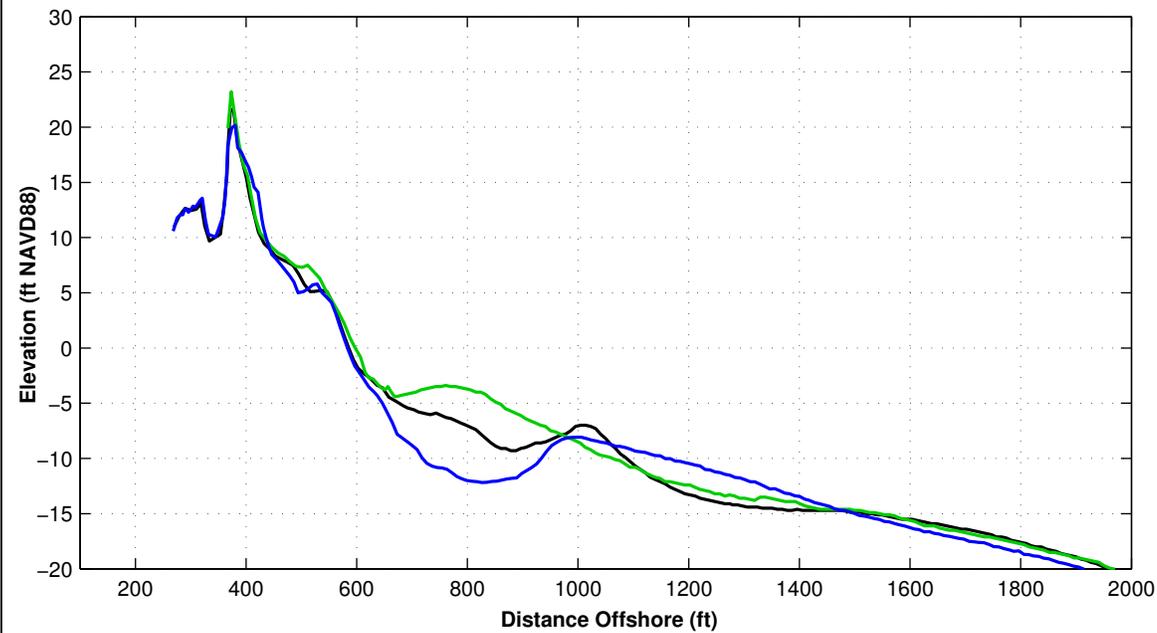
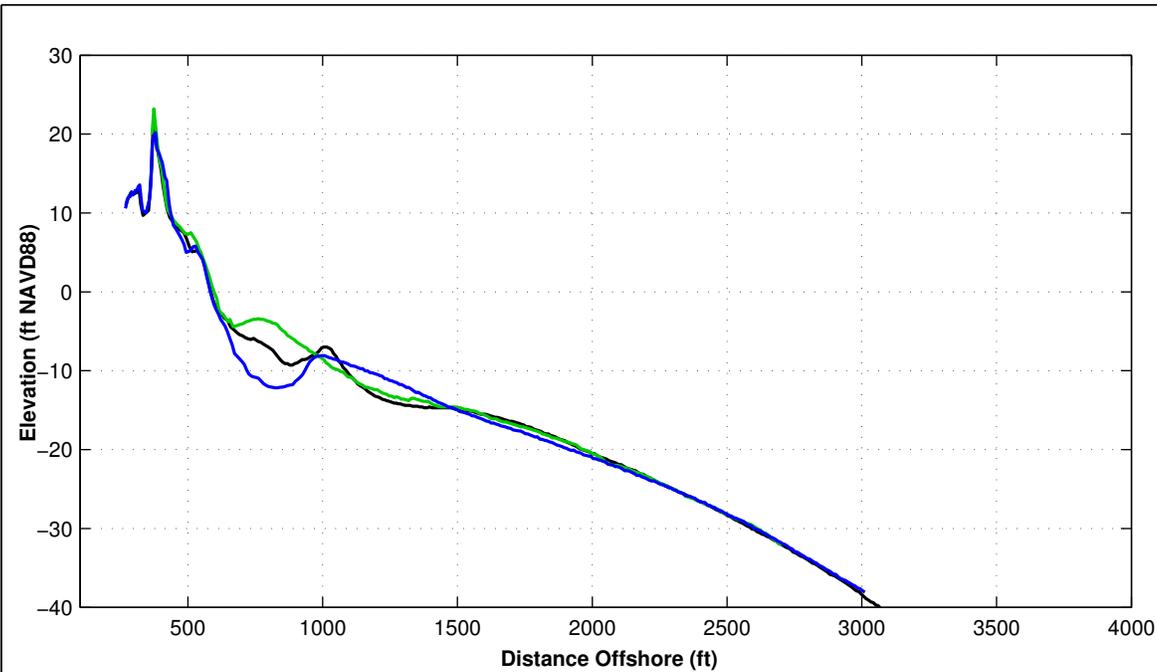
Survey Transect 997+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-3.65 ft	5.63 ft
Volume Change Above +6 ft NAVD88	1.23 cy/ft	5.74 cy/ft
Volume Change Above 1.18 ft NAVD88	1.49 cy/ft	8.85 cy/ft
Volume Change Above -6 ft NAVD88	-1.96 cy/ft	11.61 cy/ft
Volume Change Above -14 ft NAVD88	-25.23 cy/ft	47.21 cy/ft
Volume Change Above -19 ft NAVD88	-2.94 cy/ft	25.54 cy/ft
Volume Change Above -30 ft NAVD88	17.64 cy/ft	-39.67 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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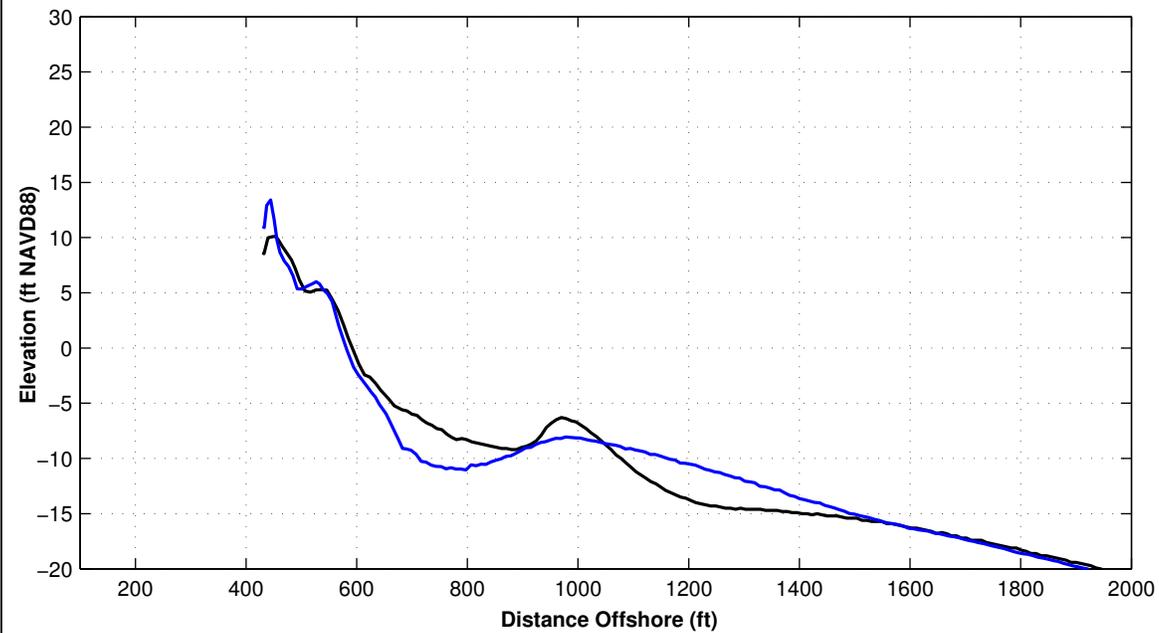
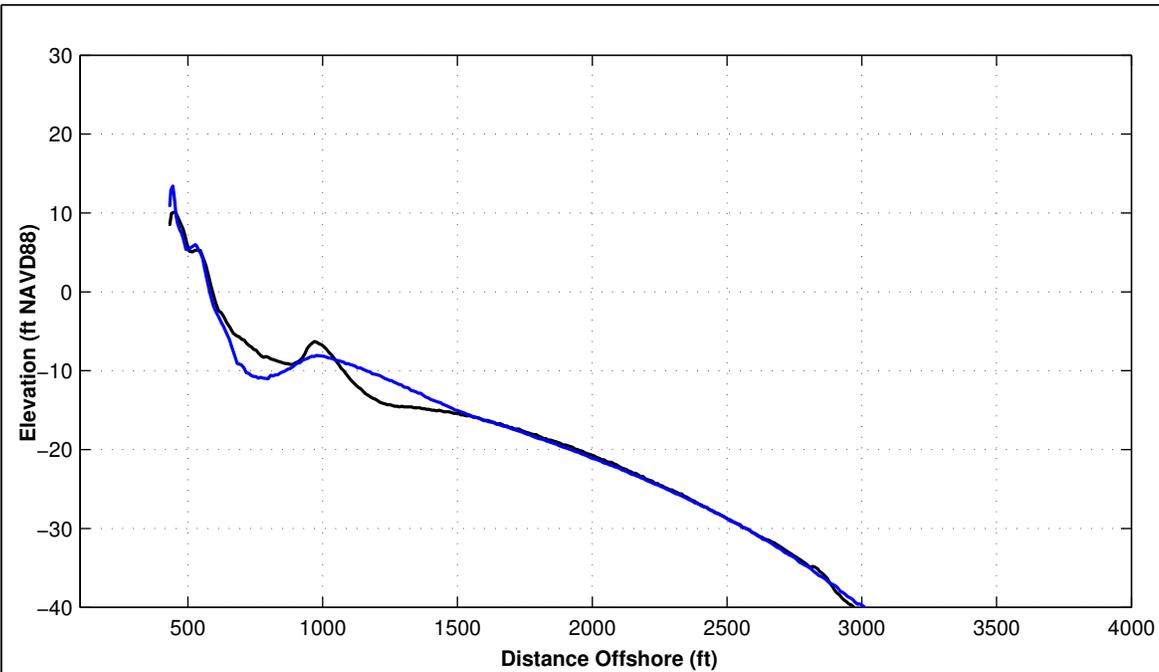
Survey Transect 1000+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-1.66 ft	16.89 ft
Volume Change Above +6 ft NAVD88	-0.54 cy/ft	3.58 cy/ft
Volume Change Above 1.18 ft NAVD88	-1.17 cy/ft	8.30 cy/ft
Volume Change Above -6 ft NAVD88	-5.10 cy/ft	15.78 cy/ft
Volume Change Above -14 ft NAVD88	-19.28 cy/ft	50.82 cy/ft
Volume Change Above -19 ft NAVD88	-26.57 cy/ft	64.94 cy/ft
Volume Change Above -30 ft NAVD88	-32.23 cy/ft	46.46 cy/ft

**LEGEND:**

JUNE 2024 —      OCTOBER 2023 —      JUNE 2023 —

- Notes:
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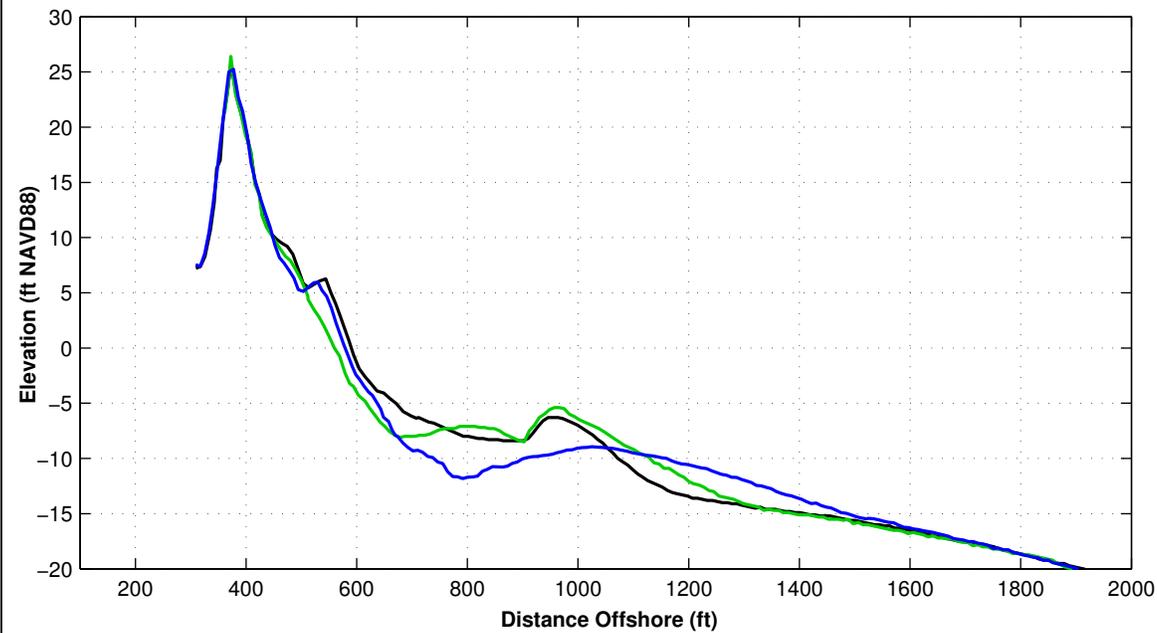
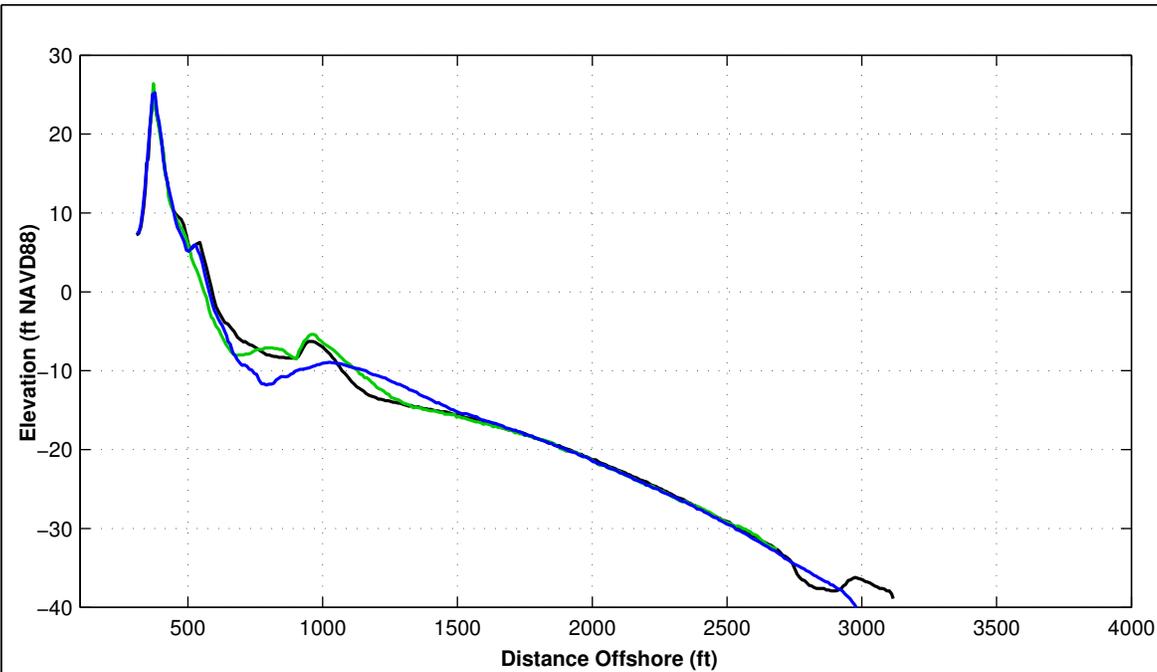
Survey Transect 1002+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-11.89 ft	20.37 ft
Volume Change Above +6 ft NAVD88	-2.47 cy/ft	3.17 cy/ft
Volume Change Above 1.18 ft NAVD88	-5.03 cy/ft	7.95 cy/ft
Volume Change Above -6 ft NAVD88	-9.89 cy/ft	14.10 cy/ft
Volume Change Above -14 ft NAVD88	-23.02 cy/ft	36.75 cy/ft
Volume Change Above -19 ft NAVD88	-15.54 cy/ft	57.44 cy/ft
Volume Change Above -30 ft NAVD88	-20.52 cy/ft	32.72 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

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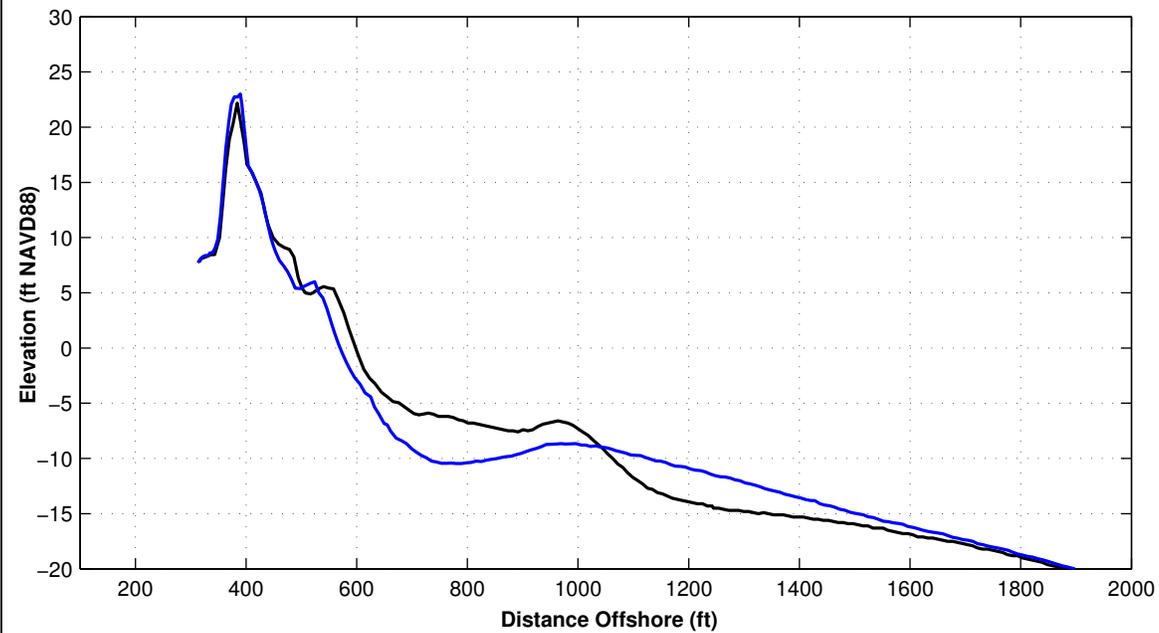
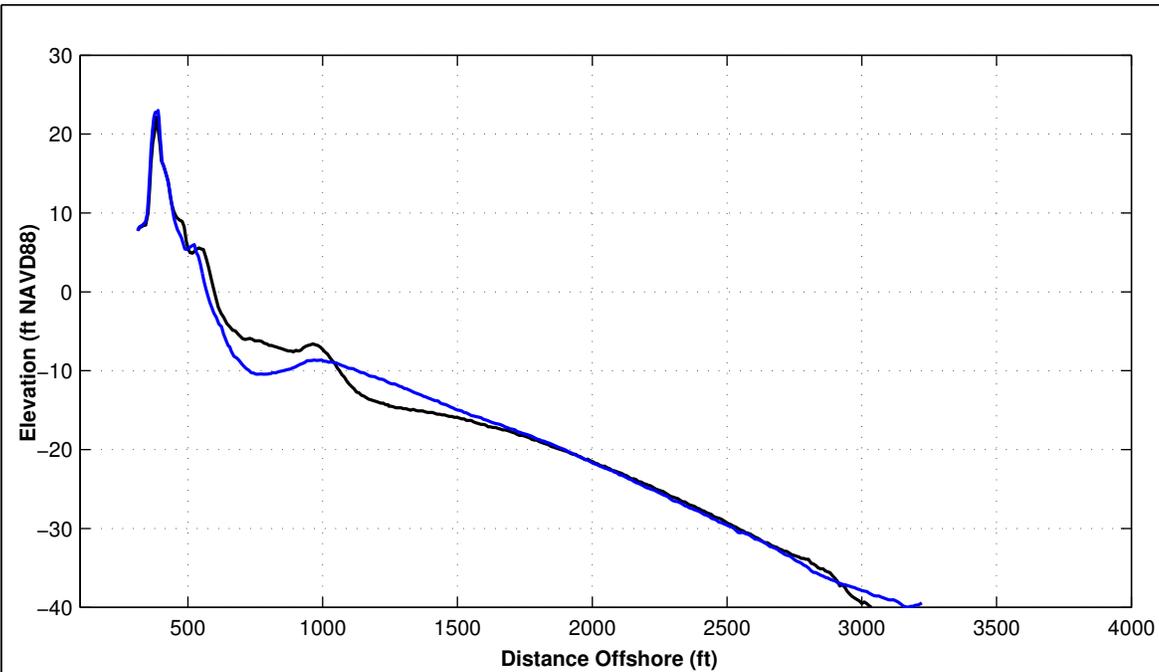
Survey Transect 1005+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-12.39 ft	-6.90 ft
Volume Change Above +6 ft NAVD88	-1.86 cy/ft	1.60 cy/ft
Volume Change Above 1.18 ft NAVD88	-5.01 cy/ft	2.72 cy/ft
Volume Change Above -6 ft NAVD88	-8.91 cy/ft	5.32 cy/ft
Volume Change Above -14 ft NAVD88	-26.12 cy/ft	37.20 cy/ft
Volume Change Above -19 ft NAVD88	-5.75 cy/ft	45.81 cy/ft
Volume Change Above -30 ft NAVD88	-7.21 cy/ft	21.60 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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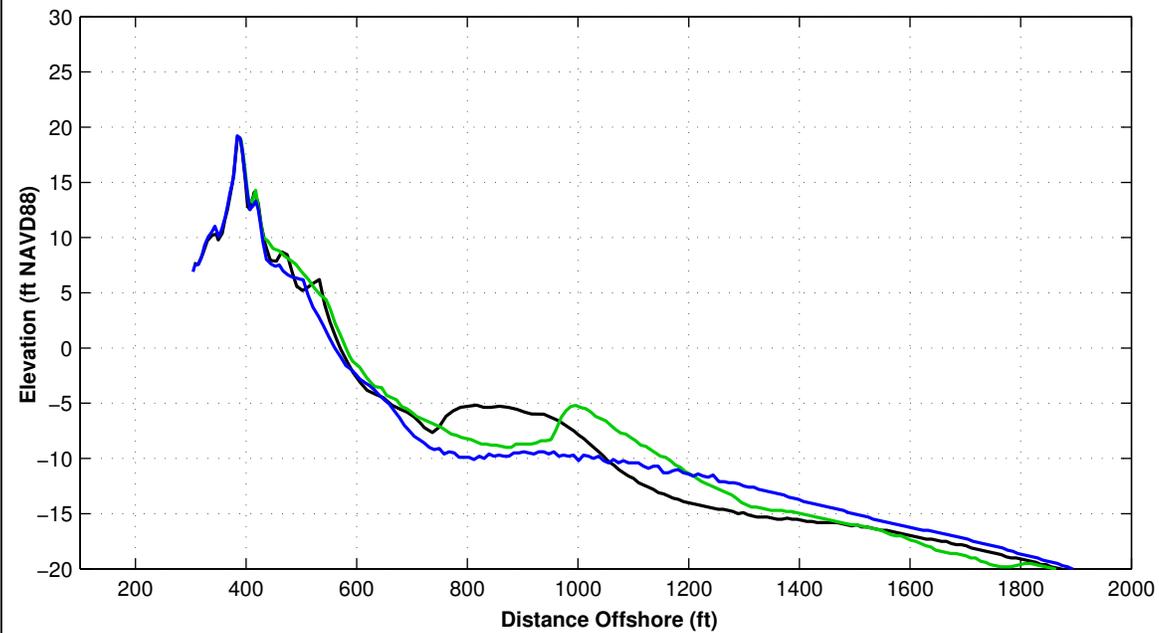
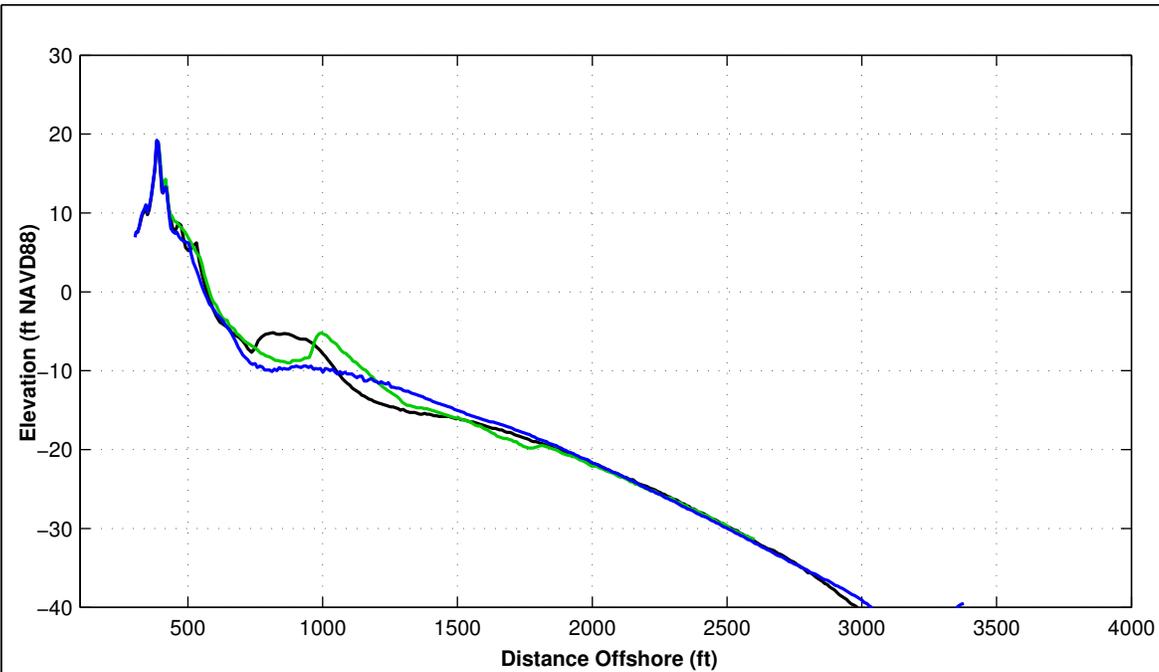
Survey Transect 1007+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-38.83 ft	-0.74 ft
Volume Change Above +6 ft NAVD88	-2.41 cy/ft	1.79 cy/ft
Volume Change Above 1.18 ft NAVD88	-10.18 cy/ft	3.93 cy/ft
Volume Change Above -6 ft NAVD88	-18.88 cy/ft	5.85 cy/ft
Volume Change Above -14 ft NAVD88	-34.34 cy/ft	22.44 cy/ft
Volume Change Above -19 ft NAVD88	-15.76 cy/ft	39.33 cy/ft
Volume Change Above -30 ft NAVD88	-17.86 cy/ft	19.60 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
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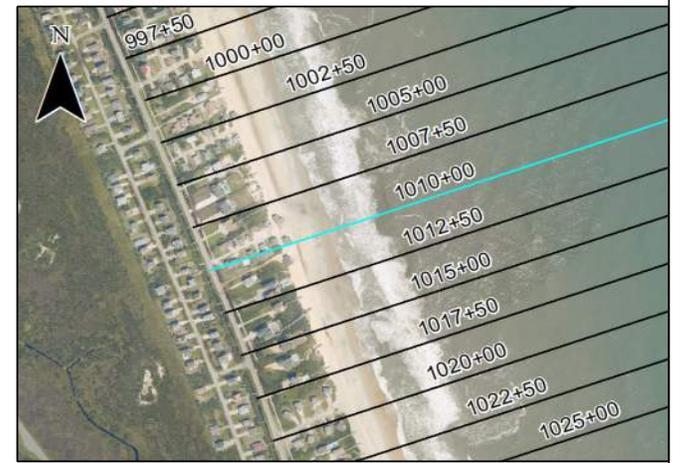


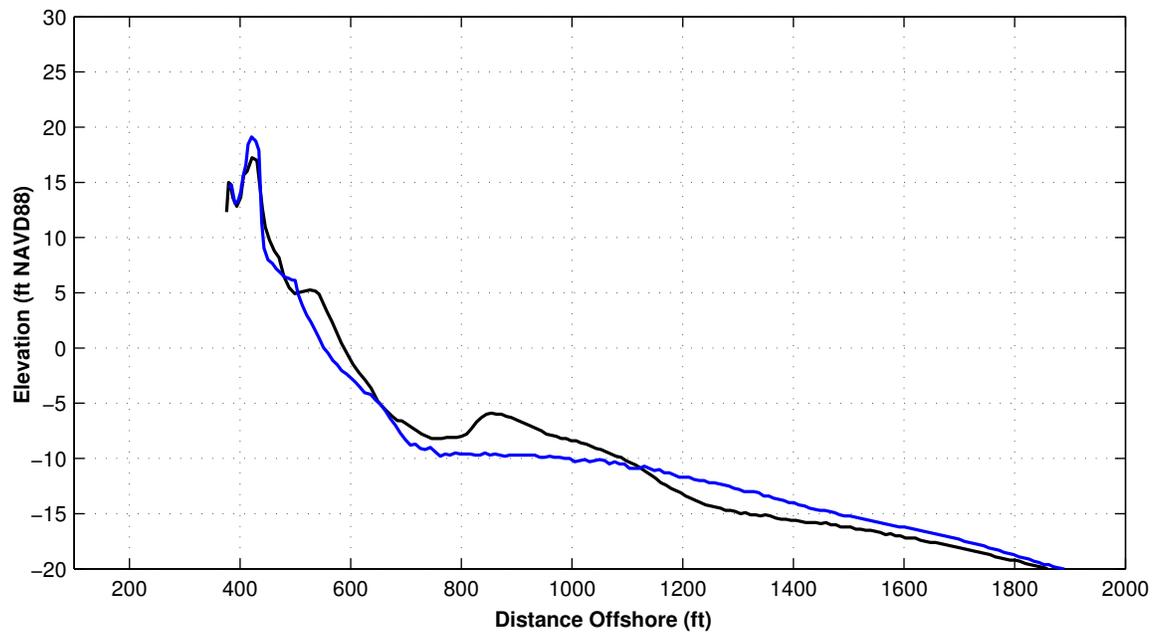
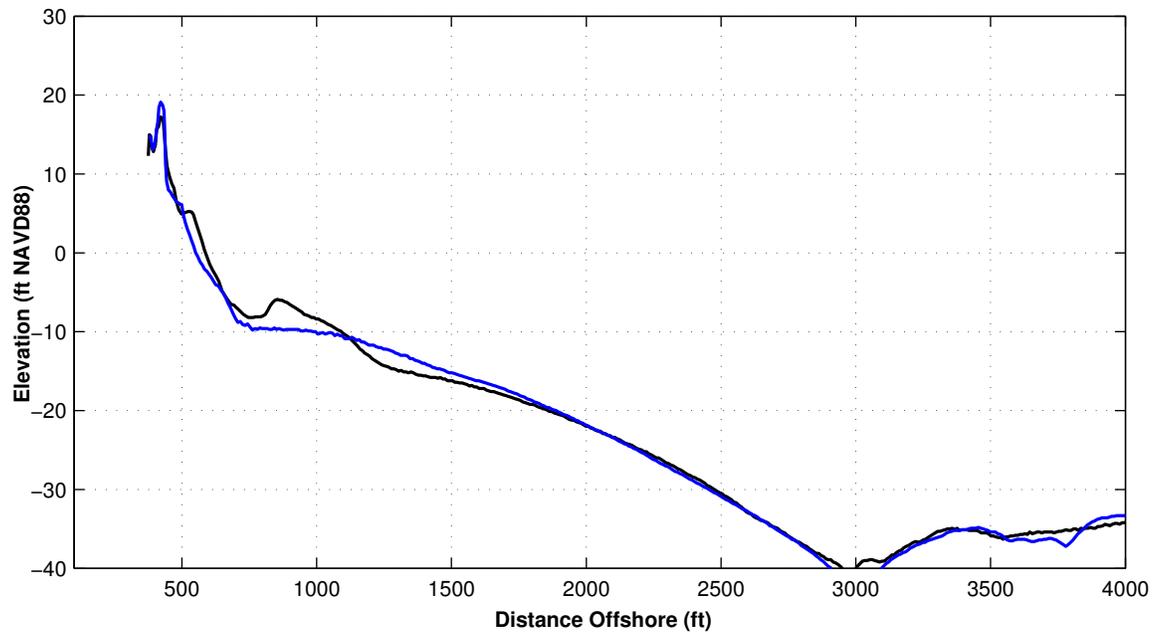
Survey Transect 1010+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-76.86 ft	-9.77 ft
Volume Change Above +6 ft NAVD88	-4.83 cy/ft	-0.77 cy/ft
Volume Change Above 1.18 ft NAVD88	-18.17 cy/ft	-1.73 cy/ft
Volume Change Above -6 ft NAVD88	-32.05 cy/ft	-3.39 cy/ft
Volume Change Above -14 ft NAVD88	-53.04 cy/ft	-0.85 cy/ft
Volume Change Above -19 ft NAVD88	-34.50 cy/ft	6.01 cy/ft
Volume Change Above -30 ft NAVD88	-37.78 cy/ft	-31.33 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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Survey Transect 1012+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-13.50 ft	-24.85 ft
Volume Change Above +6 ft NAVD88	-0.82 cy/ft	0.50 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.48 cy/ft	-2.24 cy/ft
Volume Change Above -6 ft NAVD88	4.71 cy/ft	-8.48 cy/ft
Volume Change Above -14 ft NAVD88	-7.12 cy/ft	1.37 cy/ft
Volume Change Above -19 ft NAVD88	8.65 cy/ft	17.26 cy/ft
Volume Change Above -30 ft NAVD88	13.73 cy/ft	-13.37 cy/ft

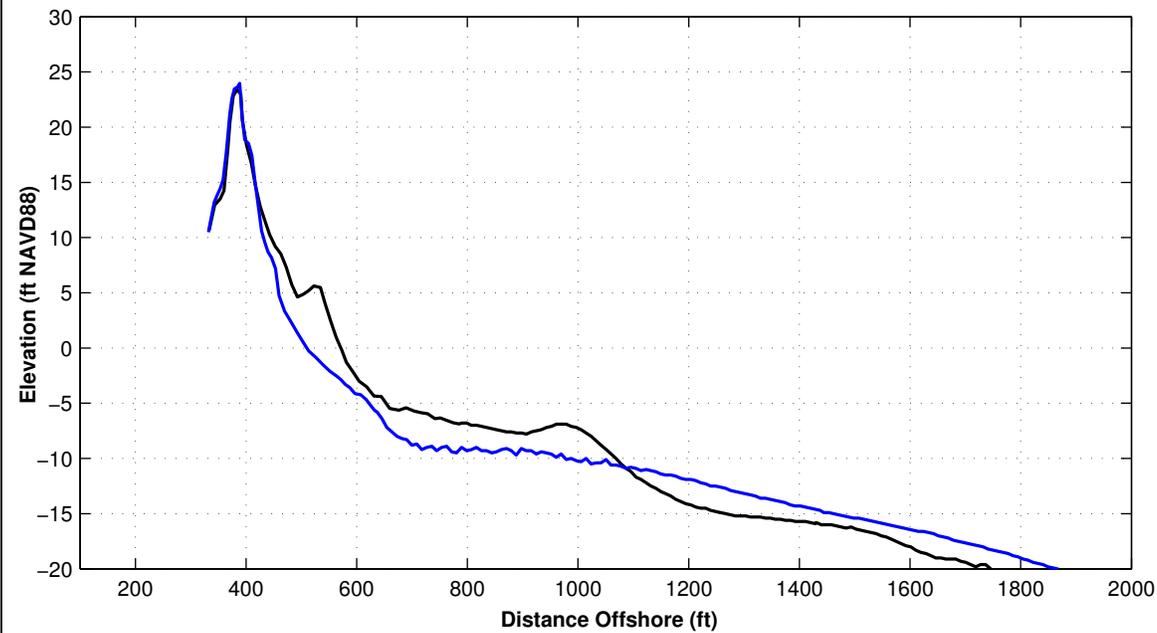
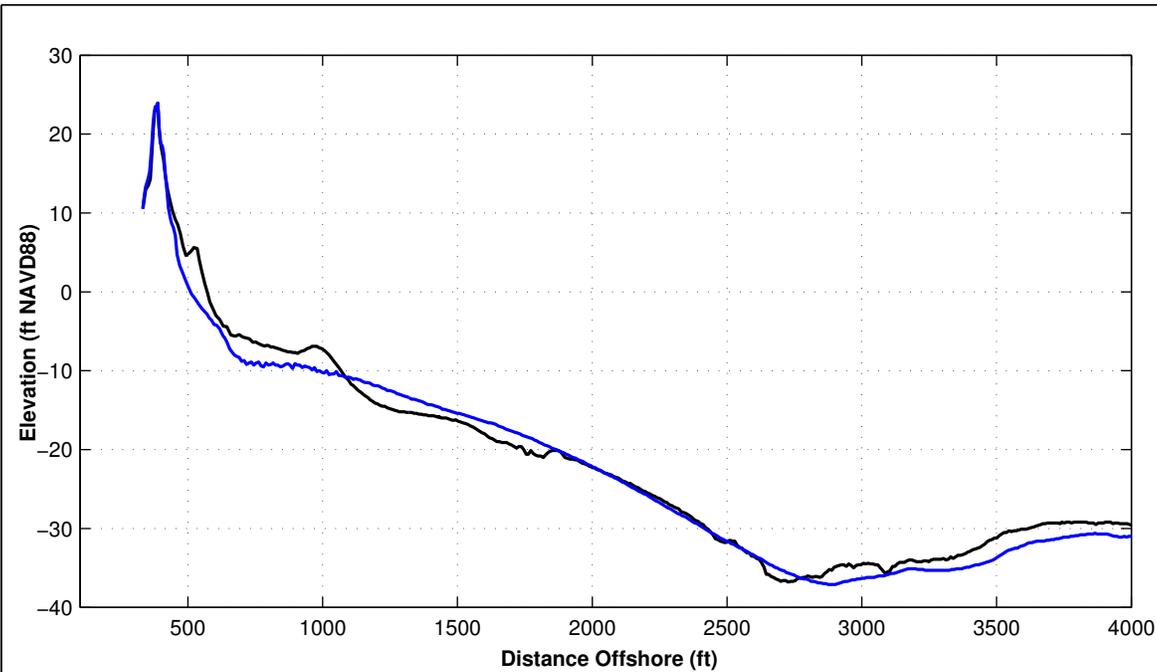
**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.







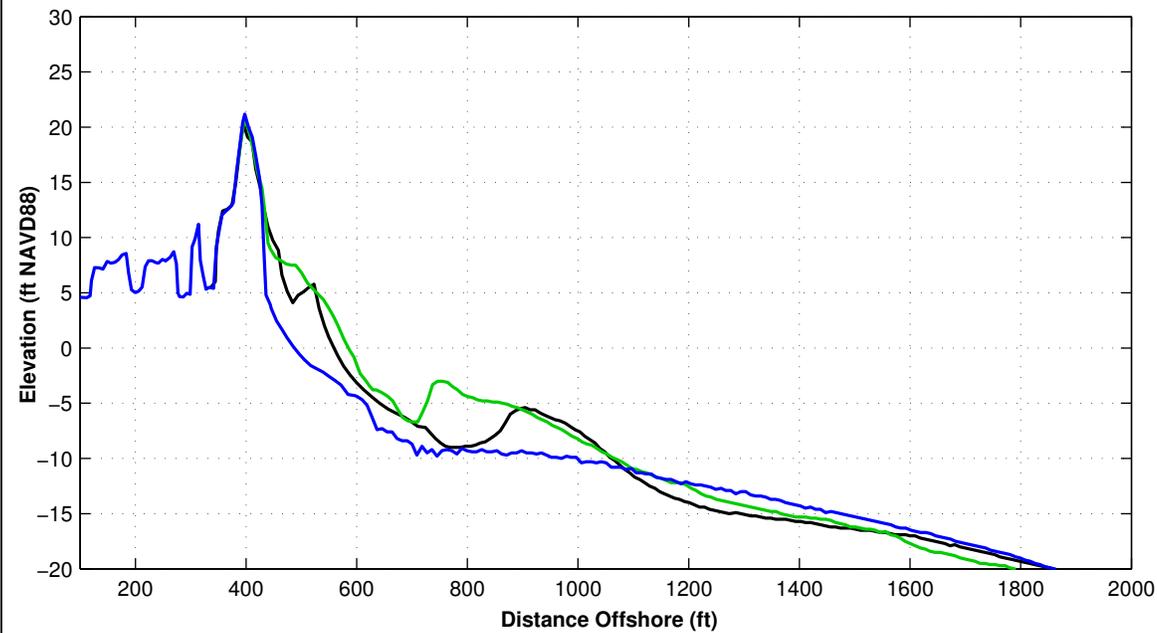
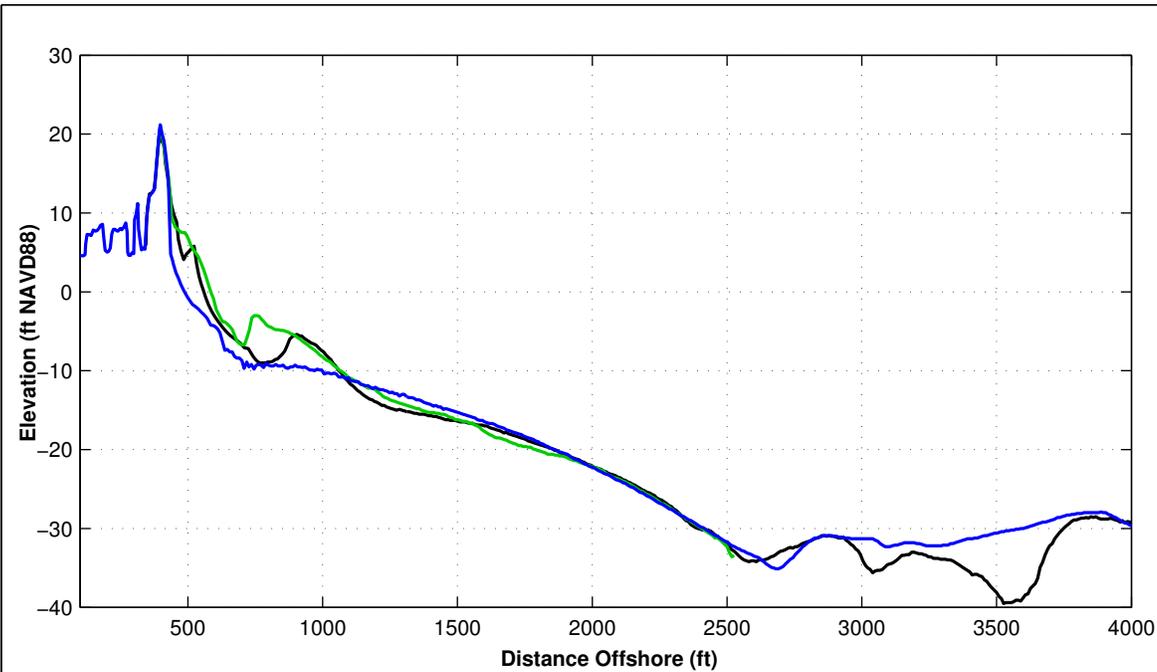
Survey Transect 1017+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-17.25 ft	43.45 ft
Volume Change Above +6 ft NAVD88	4.19 cy/ft	4.22 cy/ft
Volume Change Above 1.18 ft NAVD88	3.45 cy/ft	10.75 cy/ft
Volume Change Above -6 ft NAVD88	-18.69 cy/ft	46.23 cy/ft
Volume Change Above -14 ft NAVD88	-9.99 cy/ft	61.17 cy/ft
Volume Change Above -19 ft NAVD88	-25.05 cy/ft	76.80 cy/ft
Volume Change Above -30 ft NAVD88	-14.90 cy/ft	54.98 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



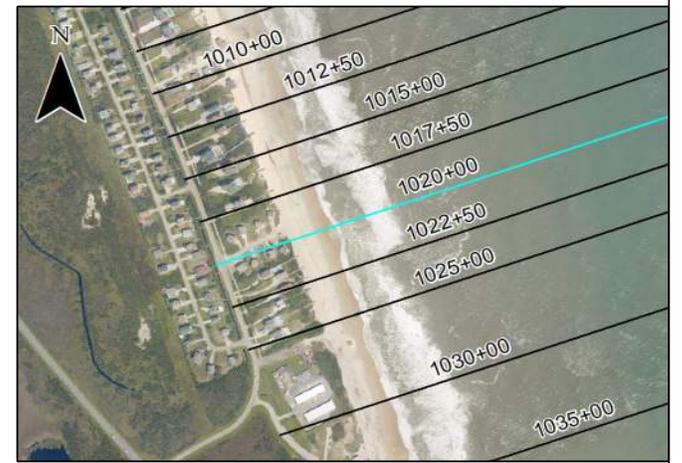


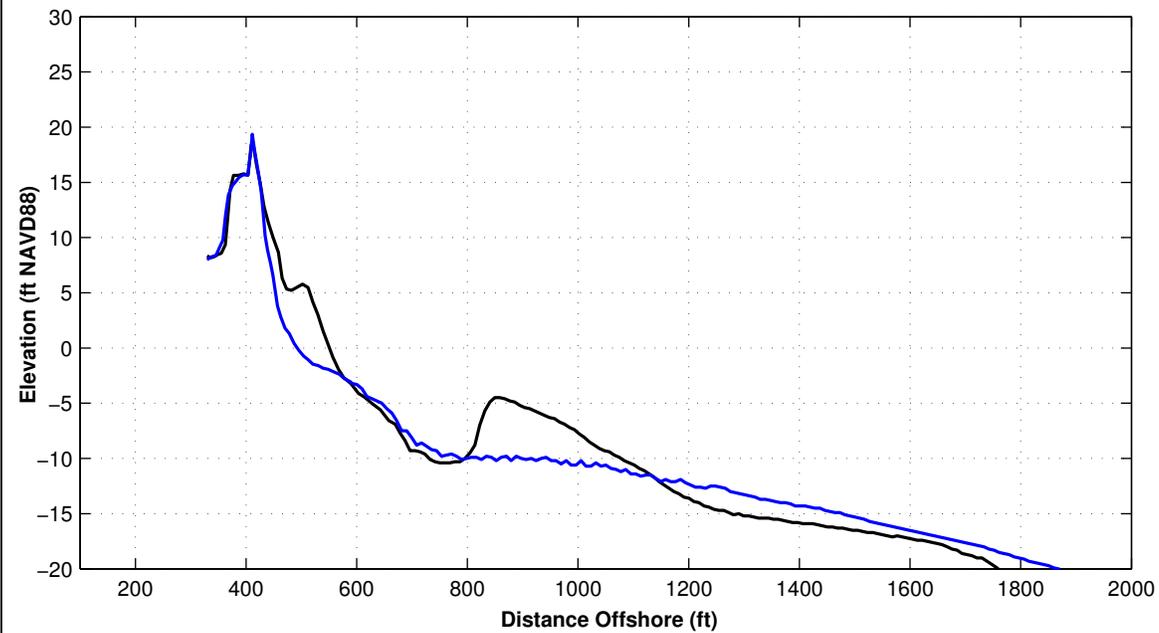
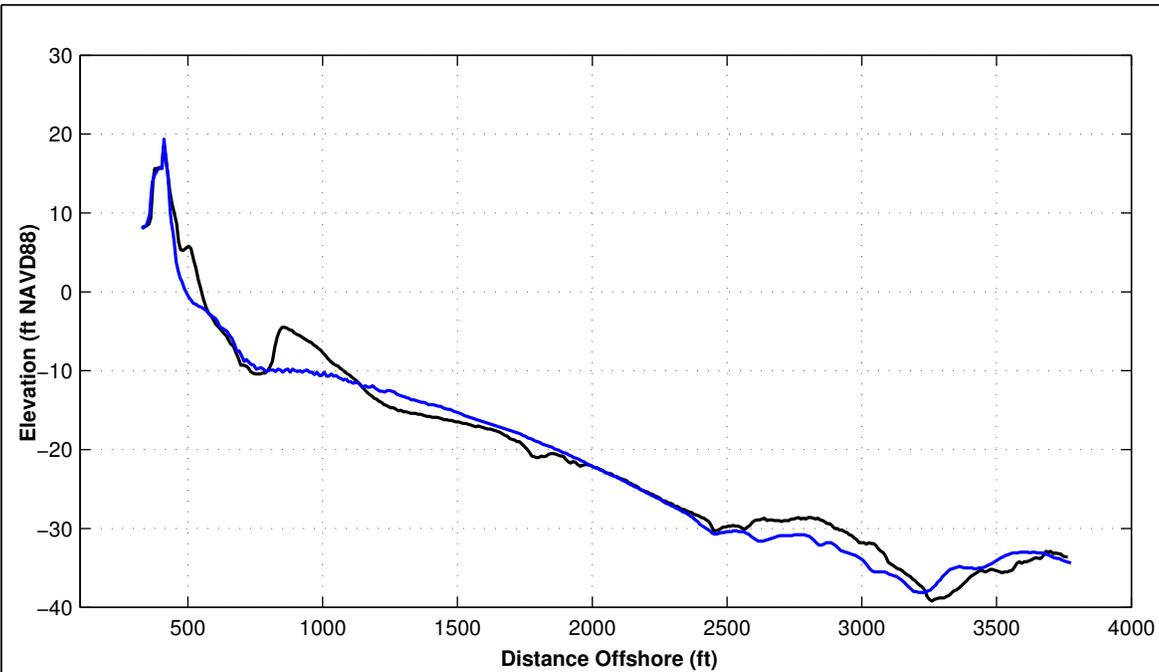
Survey Transect 1020+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	14.16 ft	9.37 ft
Volume Change Above +6 ft NAVD88	0.60 cy/ft	-1.33 cy/ft
Volume Change Above 1.18 ft NAVD88	2.51 cy/ft	-1.00 cy/ft
Volume Change Above -6 ft NAVD88	7.55 cy/ft	5.87 cy/ft
Volume Change Above -14 ft NAVD88	31.10 cy/ft	-3.38 cy/ft
Volume Change Above -19 ft NAVD88	30.37 cy/ft	2.27 cy/ft
Volume Change Above -30 ft NAVD88	41.53 cy/ft	-16.90 cy/ft

**LEGEND:**

JUNE 2024      ————      OCTOBER 2023      ————  
 JUNE 2023      ————      JUNE 2023      ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





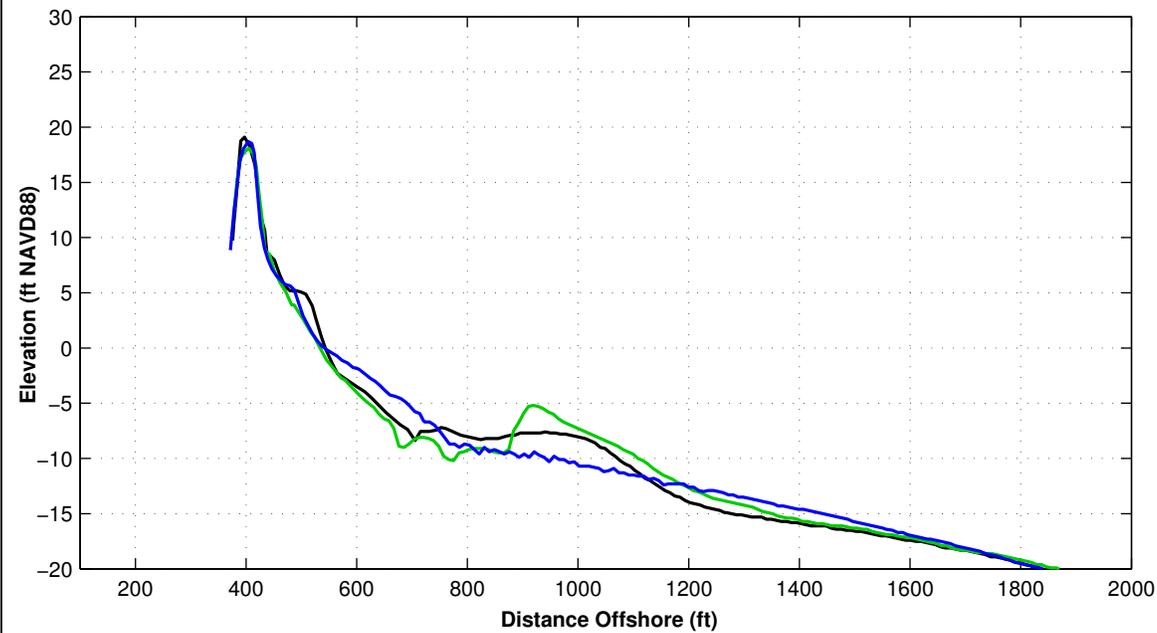
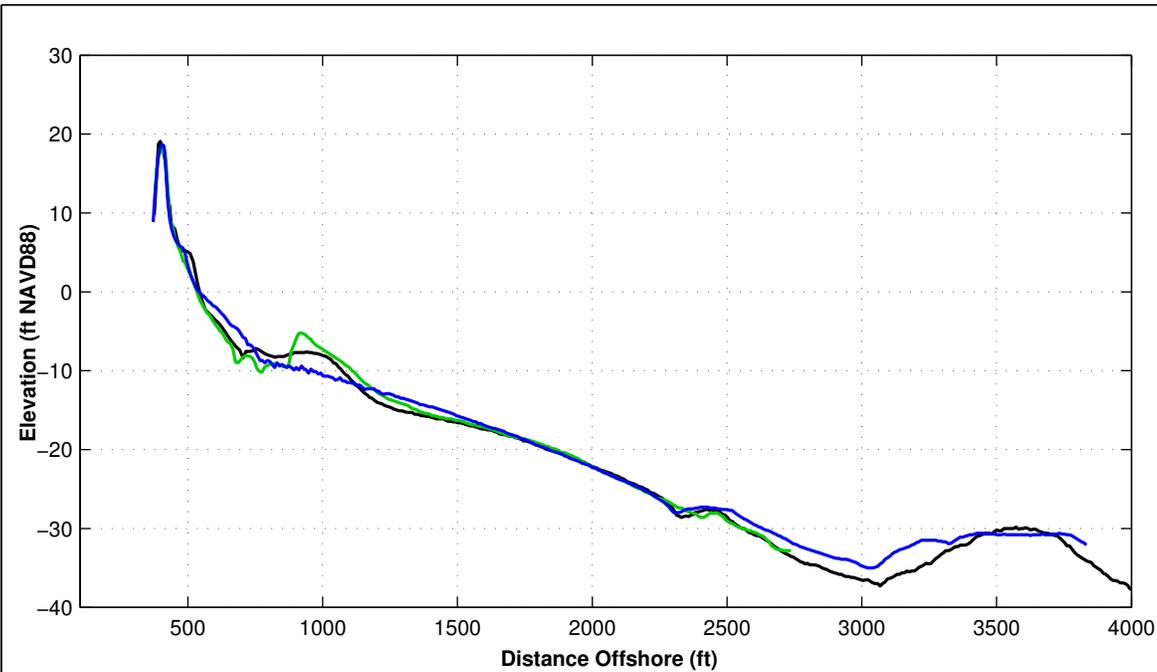
Survey Transect 1022+50	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-6.22 ft	-10.46 ft
Volume Change Above +6 ft NAVD88	-0.97 cy/ft	-2.90 cy/ft
Volume Change Above 1.18 ft NAVD88	-0.83 cy/ft	-4.81 cy/ft
Volume Change Above -6 ft NAVD88	-23.39 cy/ft	13.45 cy/ft
Volume Change Above -14 ft NAVD88	-7.35 cy/ft	9.78 cy/ft
Volume Change Above -19 ft NAVD88	9.91 cy/ft	-28.19 cy/ft
Volume Change Above -30 ft NAVD88	21.12 cy/ft	-26.68 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





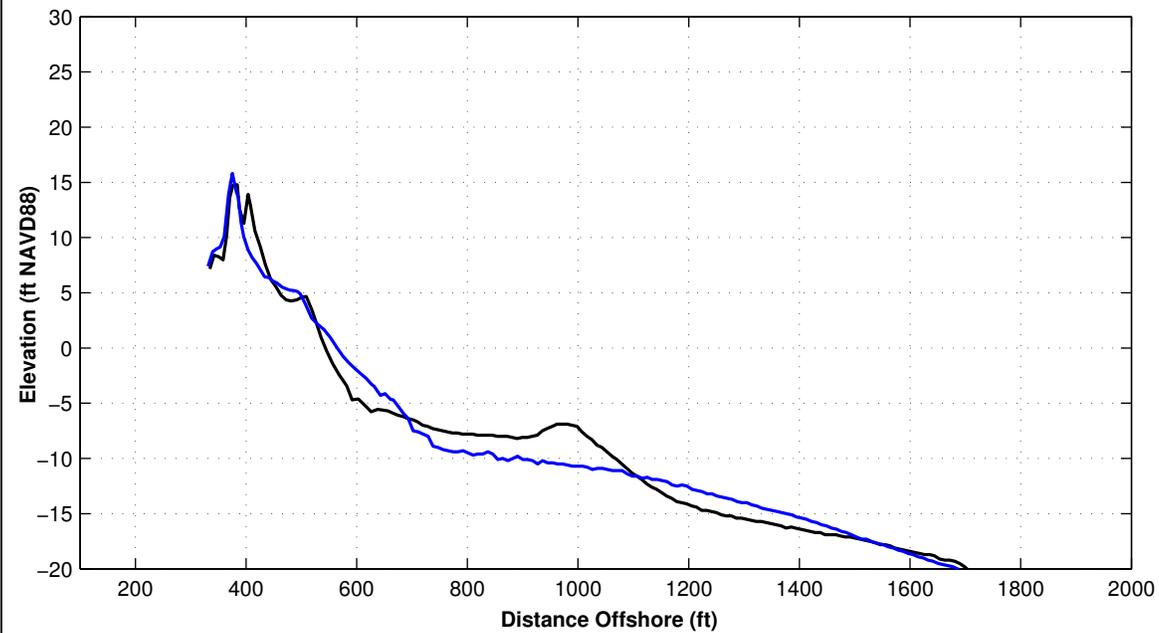
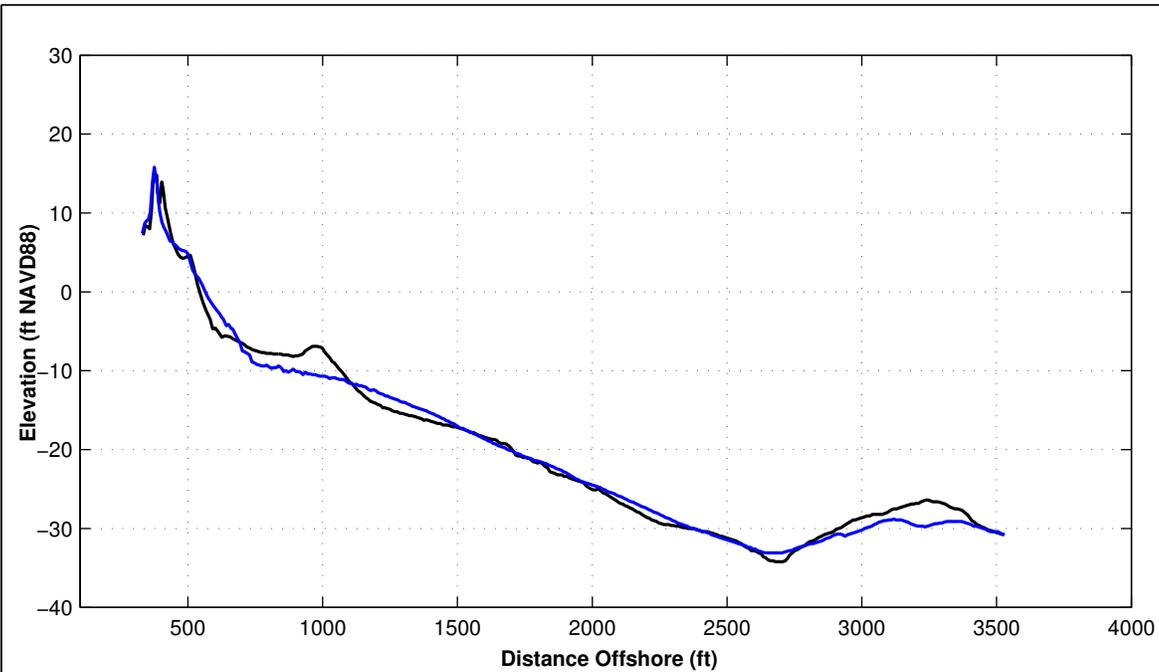
Survey Transect 1025+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	42.23 ft	-33.16 ft
Volume Change Above +6 ft NAVD88	5.79 cy/ft	-2.72 cy/ft
Volume Change Above 1.18 ft NAVD88	13.80 cy/ft	-9.37 cy/ft
Volume Change Above -6 ft NAVD88	26.12 cy/ft	-15.50 cy/ft
Volume Change Above -14 ft NAVD88	69.98 cy/ft	-24.13 cy/ft
Volume Change Above -19 ft NAVD88	73.62 cy/ft	-5.14 cy/ft
Volume Change Above -30 ft NAVD88	73.98 cy/ft	-14.79 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





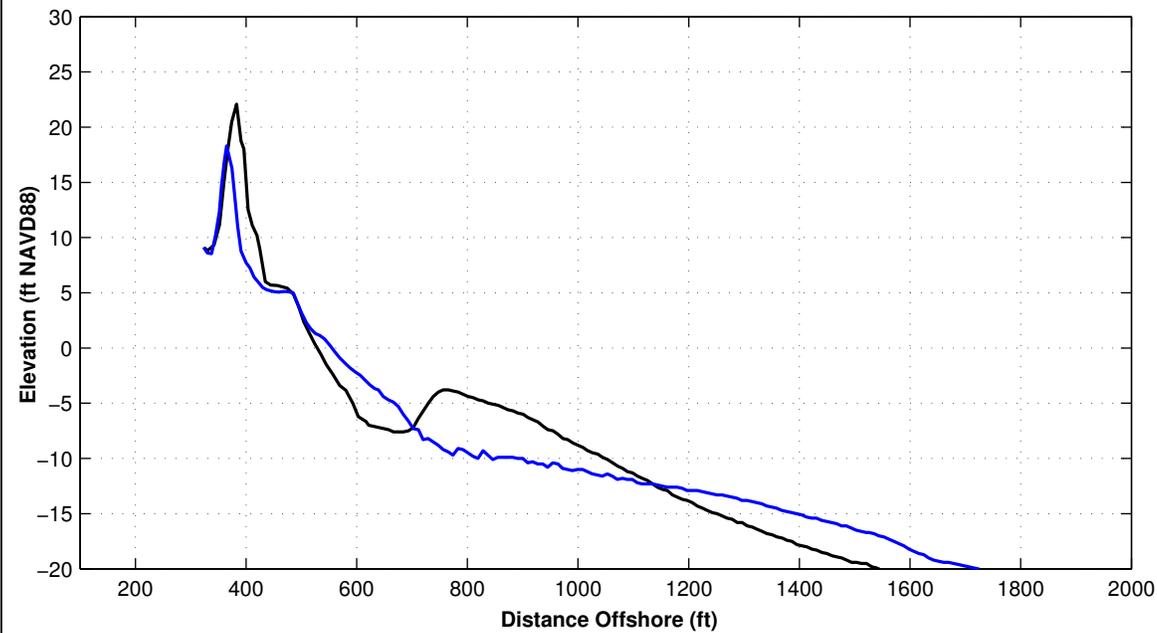
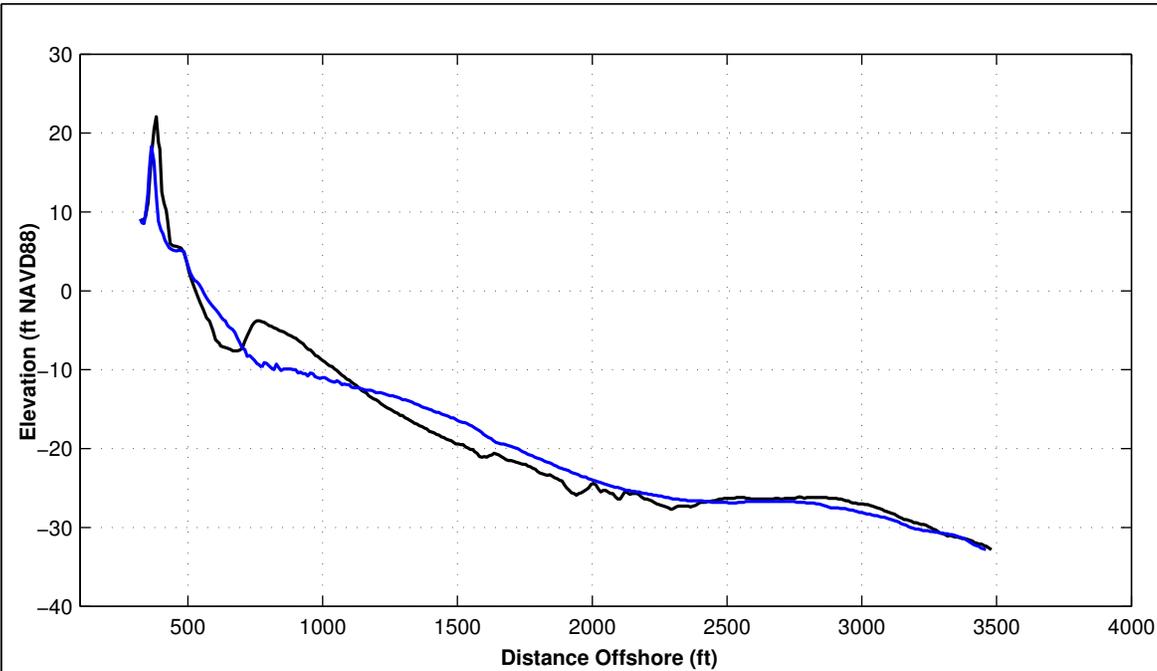
Survey Transect 1030+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-16.61 ft	19.46 ft
Volume Change Above +6 ft NAVD88	3.08 cy/ft	0.32 cy/ft
Volume Change Above 1.18 ft NAVD88	2.62 cy/ft	2.16 cy/ft
Volume Change Above -6 ft NAVD88	-3.49 cy/ft	22.06 cy/ft
Volume Change Above -14 ft NAVD88	30.32 cy/ft	10.02 cy/ft
Volume Change Above -19 ft NAVD88	39.49 cy/ft	-9.82 cy/ft
Volume Change Above -30 ft NAVD88	40.77 cy/ft	-20.75 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
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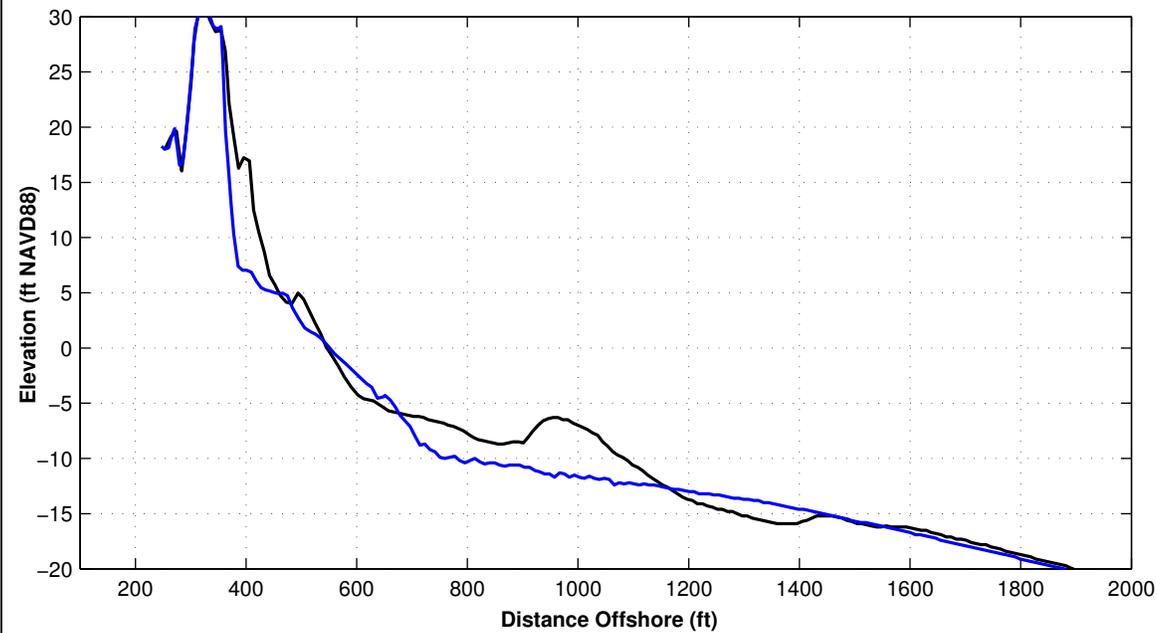
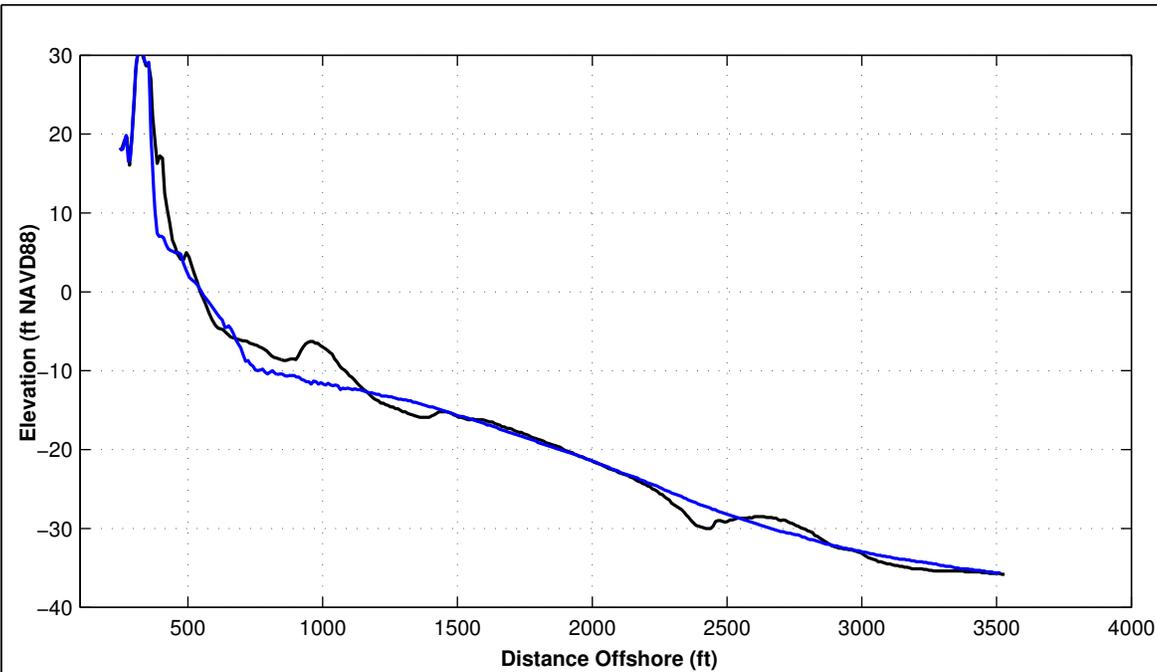
Survey Transect 1035+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-9.30 ft	15.93 ft
Volume Change Above +6 ft NAVD88	0.52 cy/ft	-2.26 cy/ft
Volume Change Above 1.18 ft NAVD88	0.34 cy/ft	0.00 cy/ft
Volume Change Above -6 ft NAVD88	-6.86 cy/ft	7.70 cy/ft
Volume Change Above -14 ft NAVD88	-0.53 cy/ft	55.64 cy/ft
Volume Change Above -19 ft NAVD88	-10.46 cy/ft	43.45 cy/ft
Volume Change Above -30 ft NAVD88	-6.40 cy/ft	28.09 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

Notes:  
 1. Station From North To South At Varying Intervals.  
 2. All Survey Elevations In Feet Referenced to NAVD88.





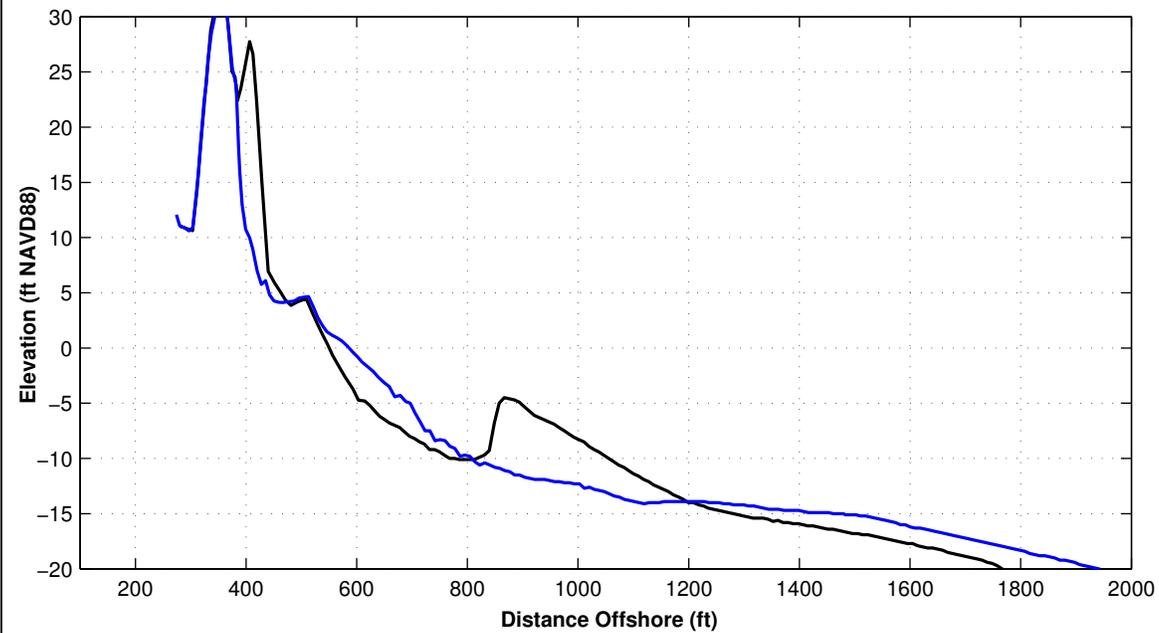
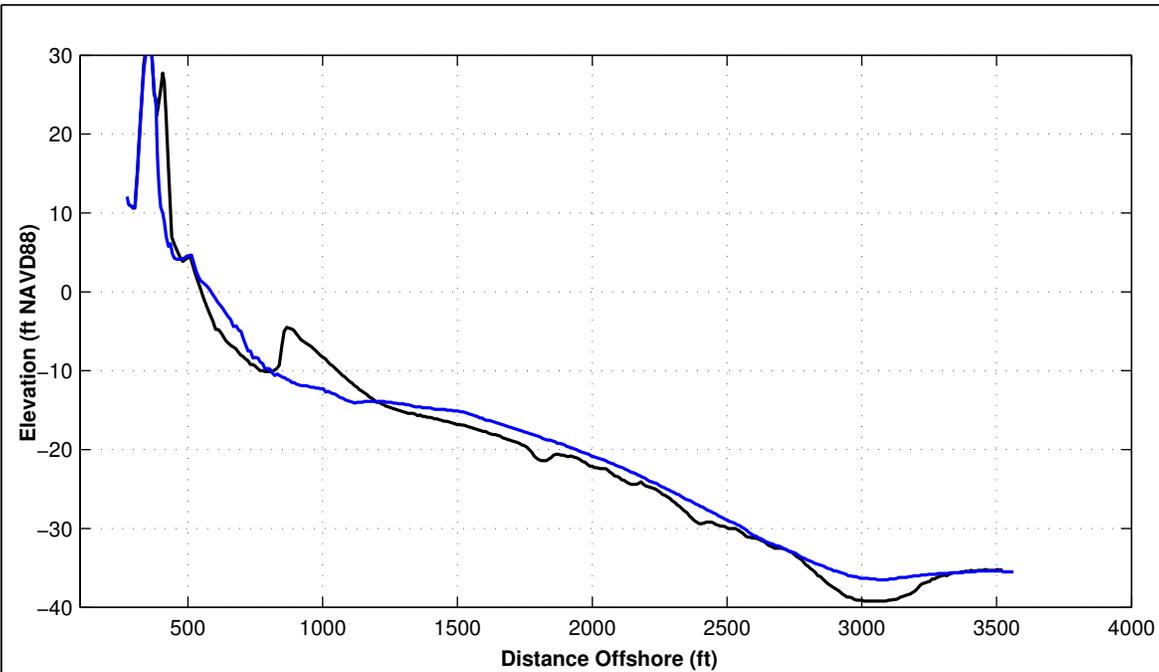
Survey Transect 1040+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-22.93 ft	12.98 ft
Volume Change Above +6 ft NAVD88	-0.36 cy/ft	-1.91 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.63 cy/ft	-1.78 cy/ft
Volume Change Above -6 ft NAVD88	-20.62 cy/ft	18.59 cy/ft
Volume Change Above -14 ft NAVD88	-11.97 cy/ft	30.95 cy/ft
Volume Change Above -19 ft NAVD88	-16.79 cy/ft	17.45 cy/ft
Volume Change Above -30 ft NAVD88	-14.68 cy/ft	2.17 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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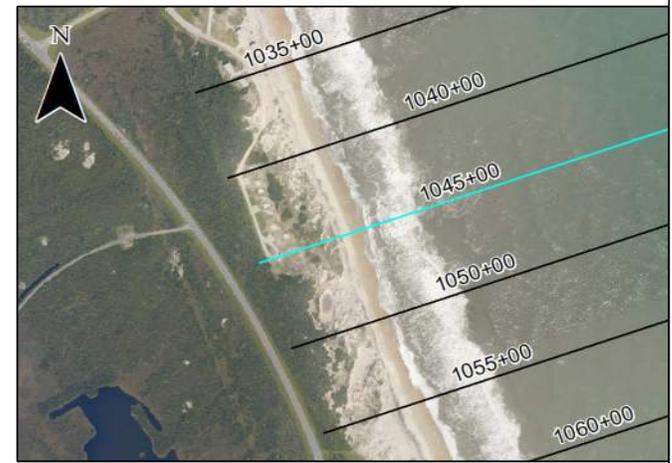
Survey Transect 1045+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-18.79 ft	-3.60 ft
Volume Change Above +6 ft NAVD88	-0.24 cy/ft	-0.90 cy/ft
Volume Change Above 1.18 ft NAVD88	-2.11 cy/ft	-2.83 cy/ft
Volume Change Above -6 ft NAVD88	-19.30 cy/ft	7.13 cy/ft
Volume Change Above -14 ft NAVD88	-36.83 cy/ft	38.06 cy/ft
Volume Change Above -19 ft NAVD88	-43.20 cy/ft	15.77 cy/ft
Volume Change Above -30 ft NAVD88	-40.53 cy/ft	-2.88 cy/ft

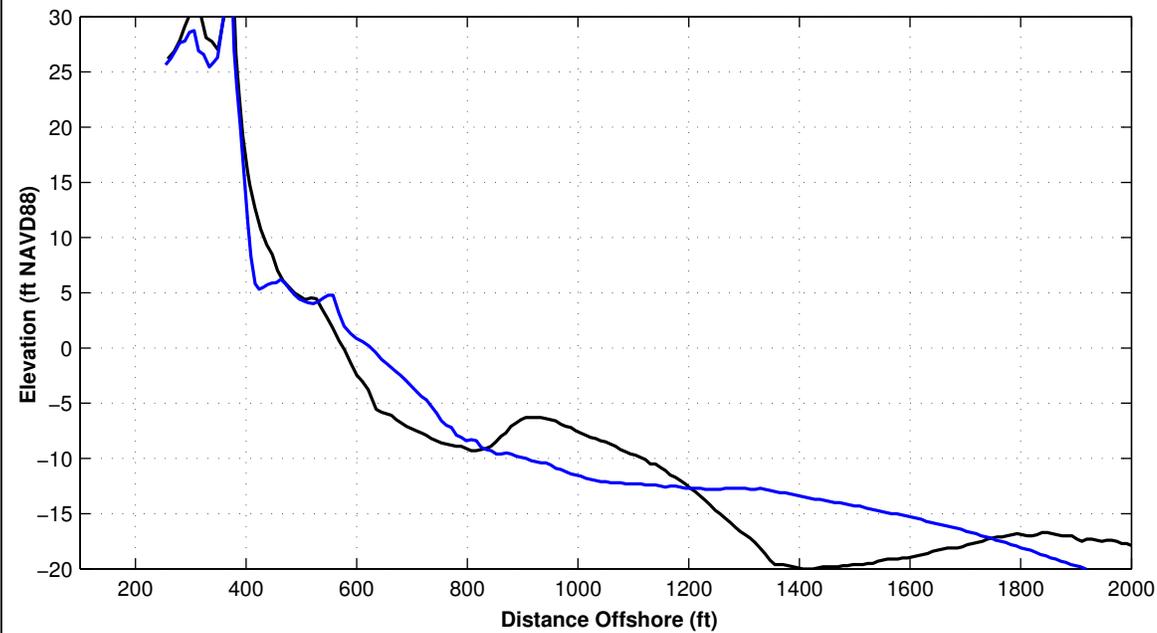
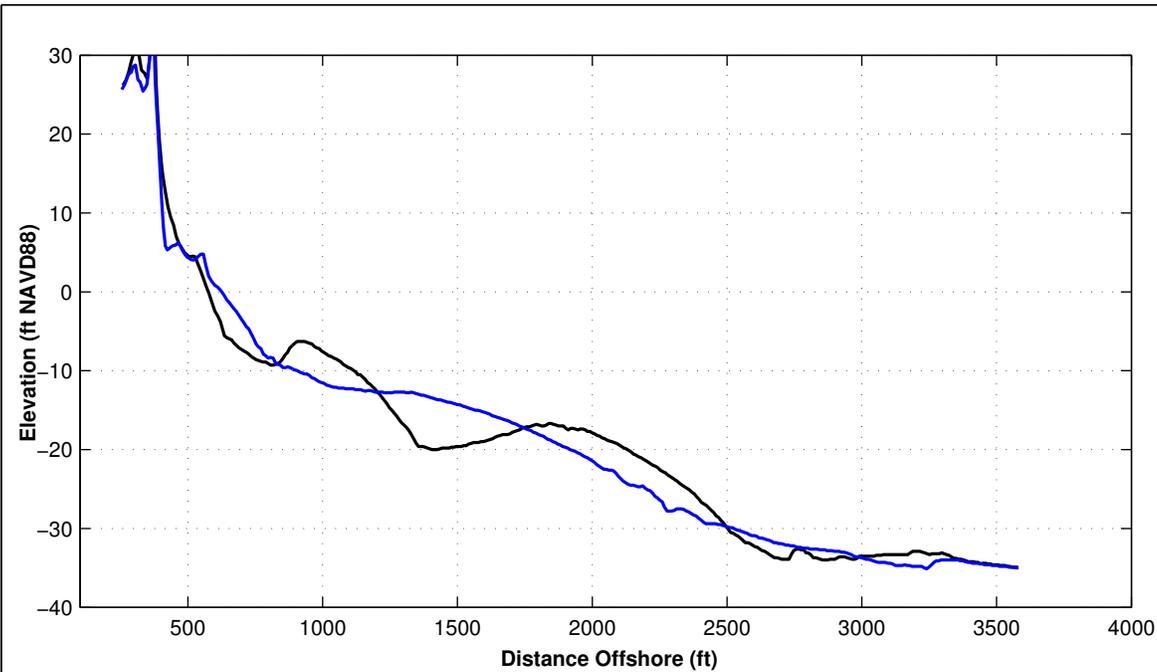
**LEGEND:**

JUNE 2024      ————      OCTOBER 2023

OCTOBER 2023  
JUNE 2023

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





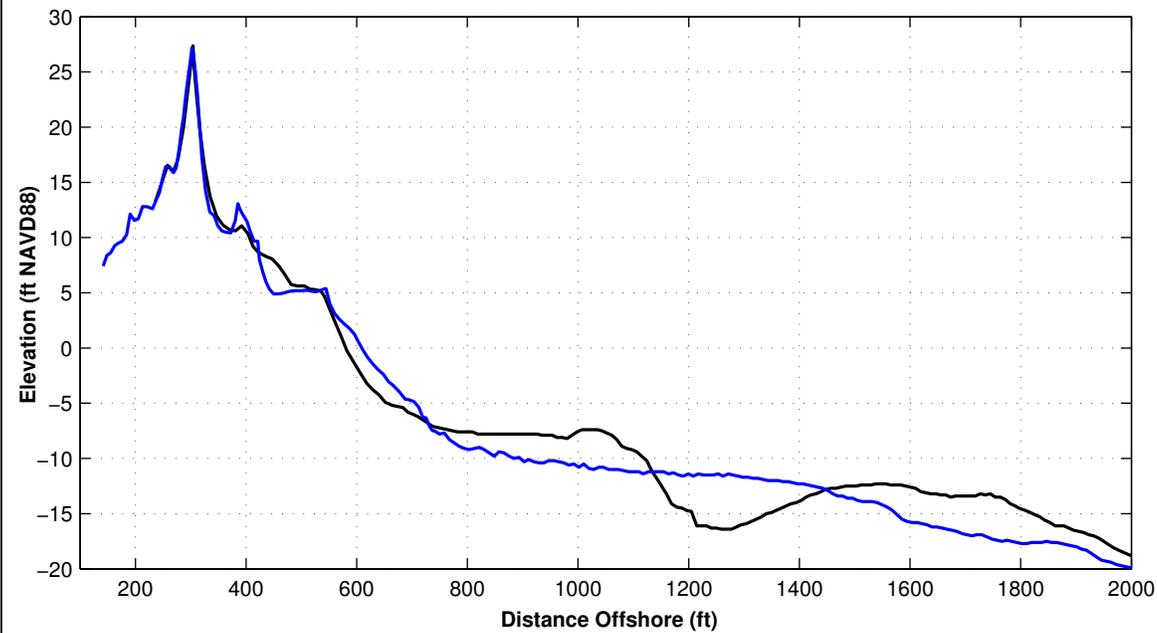
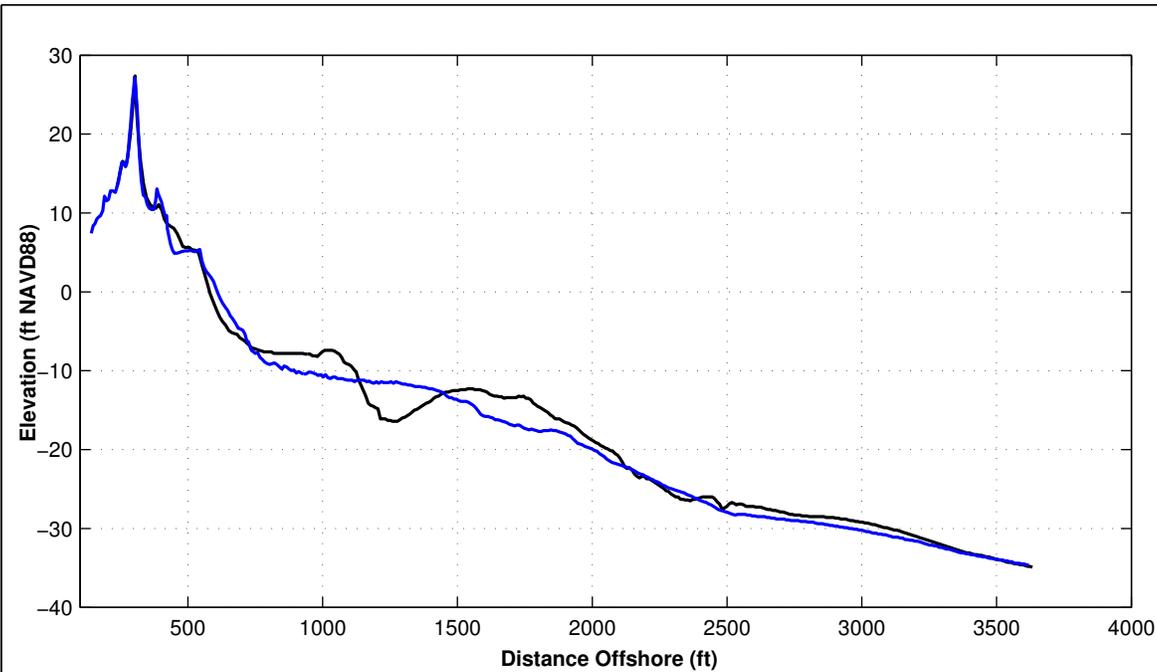
Survey Transect 1050+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-29.42 ft	-3.90 ft
Volume Change Above +6 ft NAVD88	-1.98 cy/ft	-1.72 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.82 cy/ft	-4.49 cy/ft
Volume Change Above -6 ft NAVD88	-16.99 cy/ft	0.11 cy/ft
Volume Change Above -14 ft NAVD88	-18.78 cy/ft	29.71 cy/ft
Volume Change Above -19 ft NAVD88	-17.73 cy/ft	3.83 cy/ft
Volume Change Above -30 ft NAVD88	-13.17 cy/ft	-15.12 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
1. Station From North To South At Varying Intervals.
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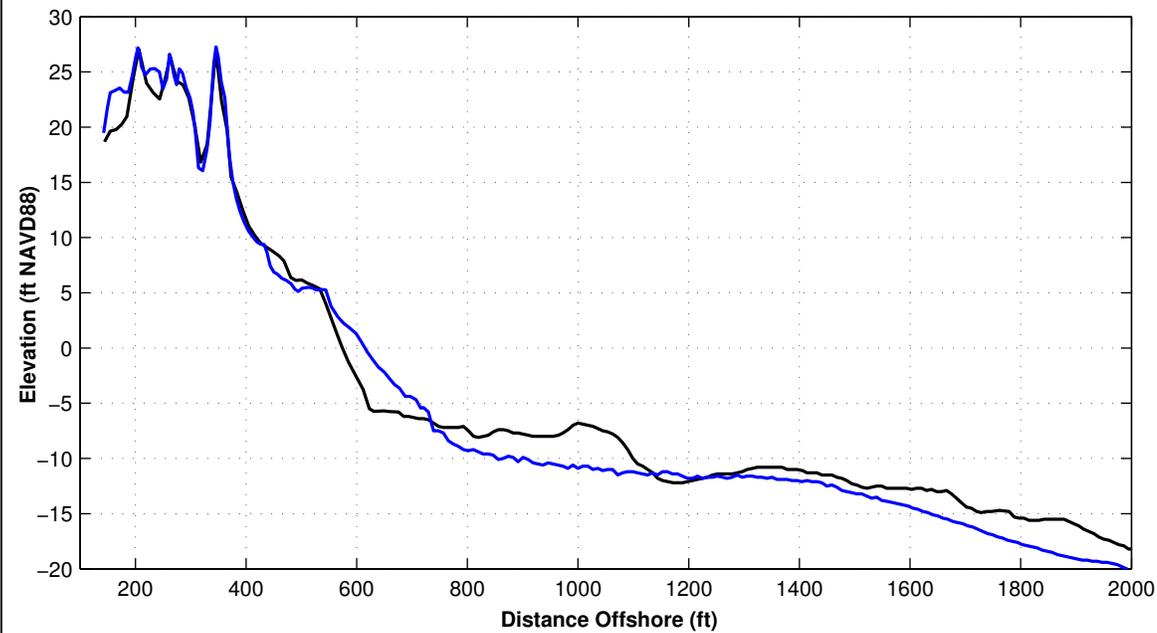
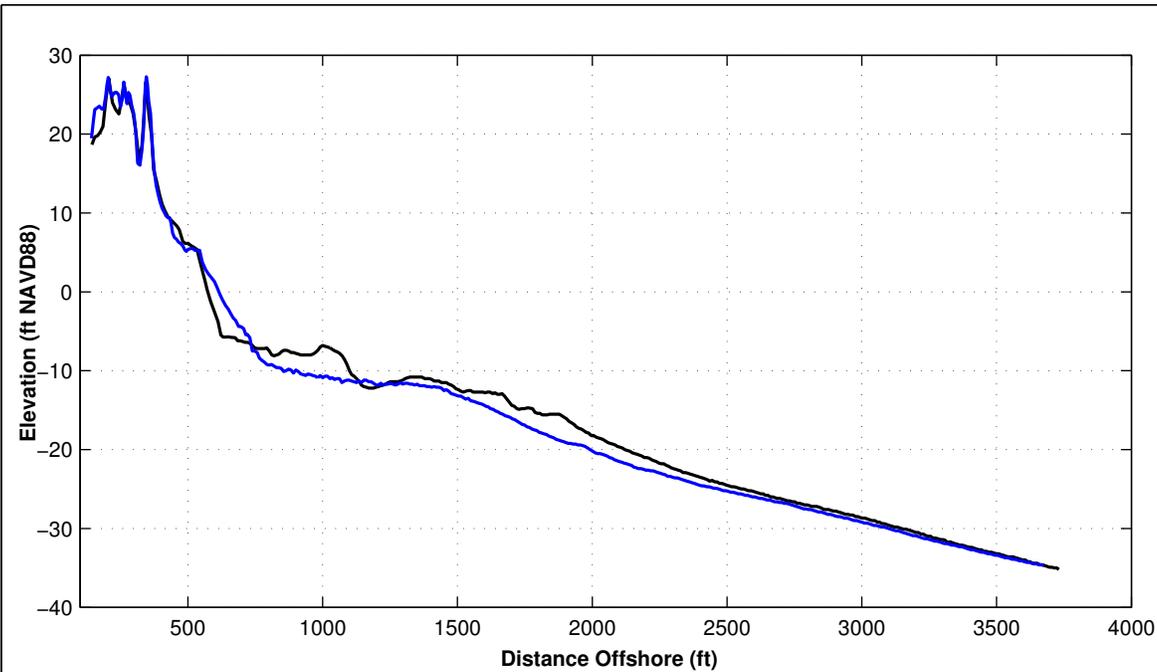
Survey Transect 1055+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-19.34 ft	-9.31 ft
Volume Change Above +6 ft NAVD88	2.52 cy/ft	-5.91 cy/ft
Volume Change Above 1.18 ft NAVD88	1.59 cy/ft	-8.01 cy/ft
Volume Change Above -6 ft NAVD88	-5.35 cy/ft	-3.48 cy/ft
Volume Change Above -14 ft NAVD88	12.26 cy/ft	14.48 cy/ft
Volume Change Above -19 ft NAVD88	15.71 cy/ft	-6.47 cy/ft
Volume Change Above -30 ft NAVD88	20.61 cy/ft	-25.20 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
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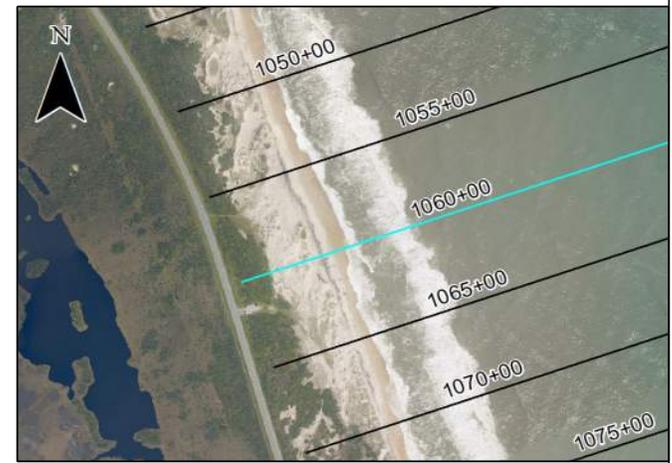
Survey Transect 1060+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-1.65 ft	-21.25 ft
Volume Change Above +6 ft NAVD88	2.66 cy/ft	-9.55 cy/ft
Volume Change Above 1.18 ft NAVD88	3.98 cy/ft	-13.59 cy/ft
Volume Change Above -6 ft NAVD88	13.62 cy/ft	-15.25 cy/ft
Volume Change Above -14 ft NAVD88	15.76 cy/ft	-0.55 cy/ft
Volume Change Above -19 ft NAVD88	20.48 cy/ft	-18.56 cy/ft
Volume Change Above -30 ft NAVD88	30.46 cy/ft	-37.88 cy/ft

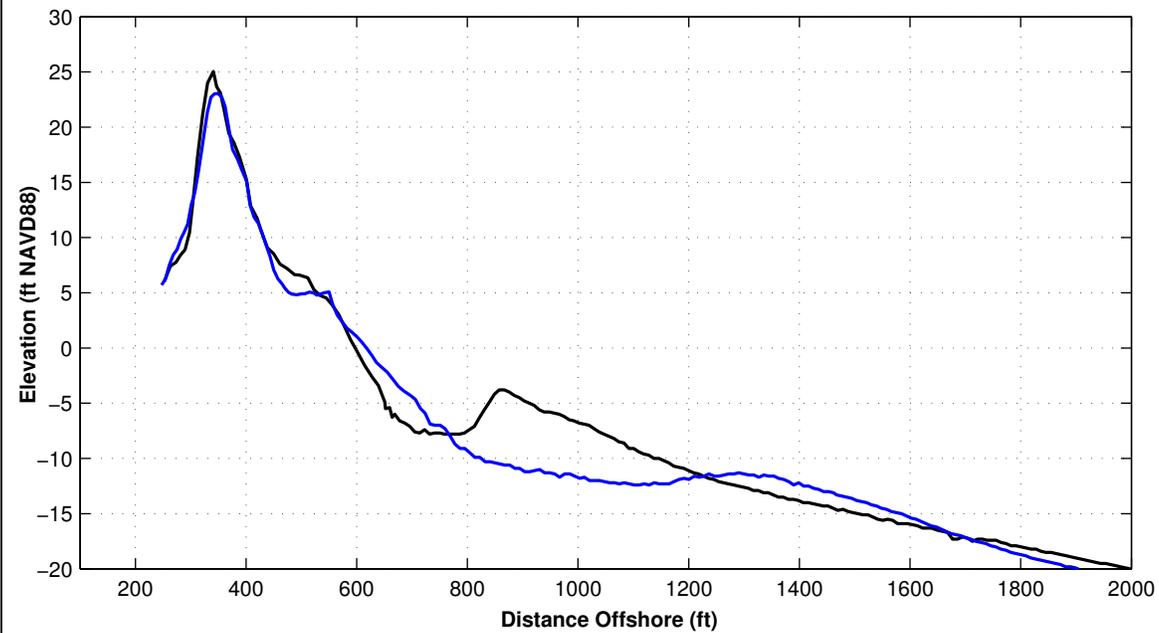
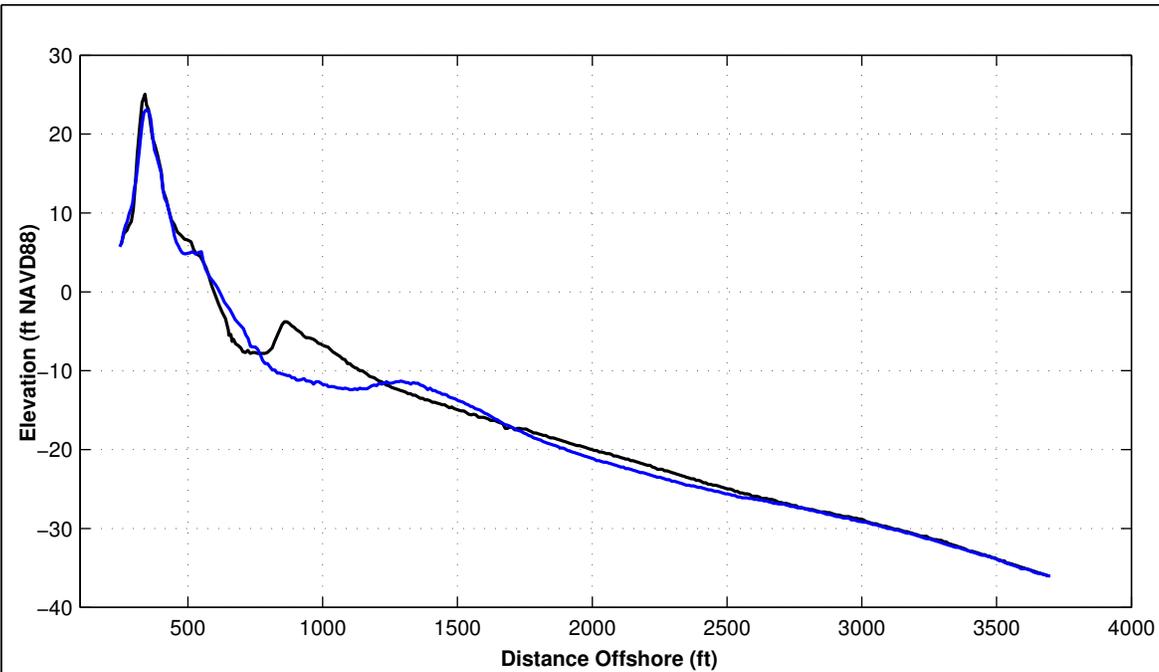
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023

JUNE 2024 ———— OCTOBER 2023

- Notes:
1. Station From North To South At Varying Intervals.
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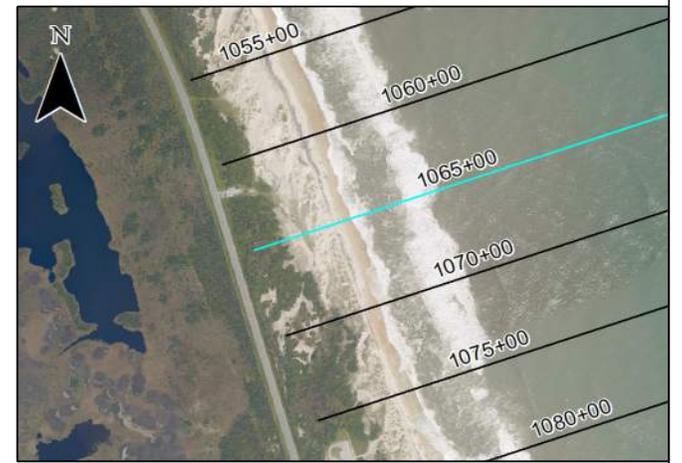


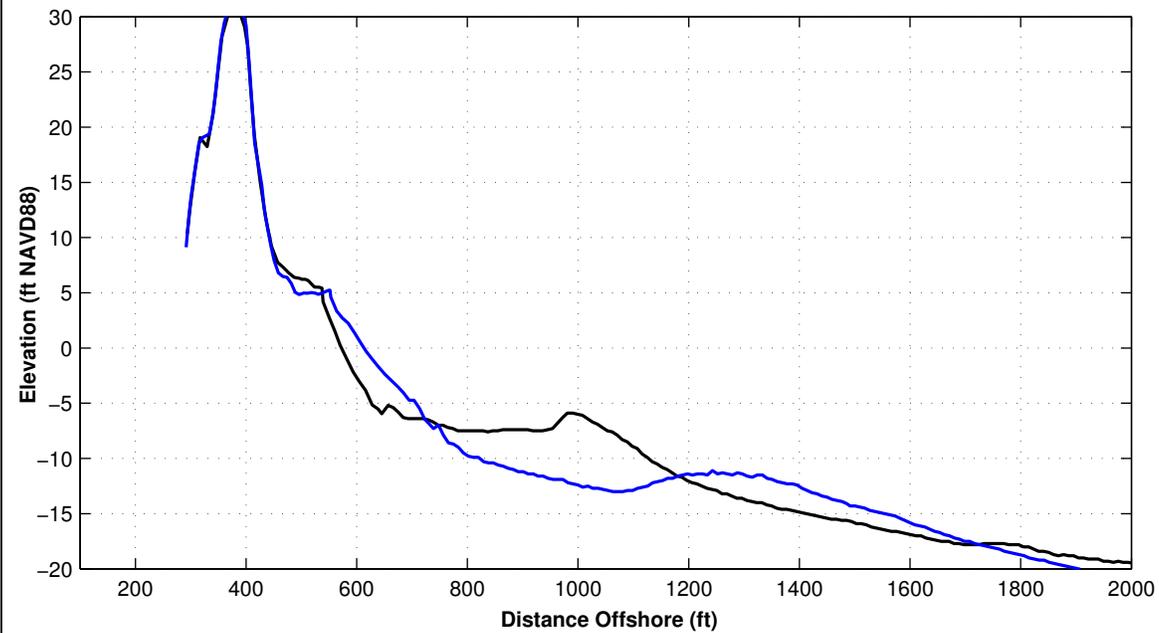
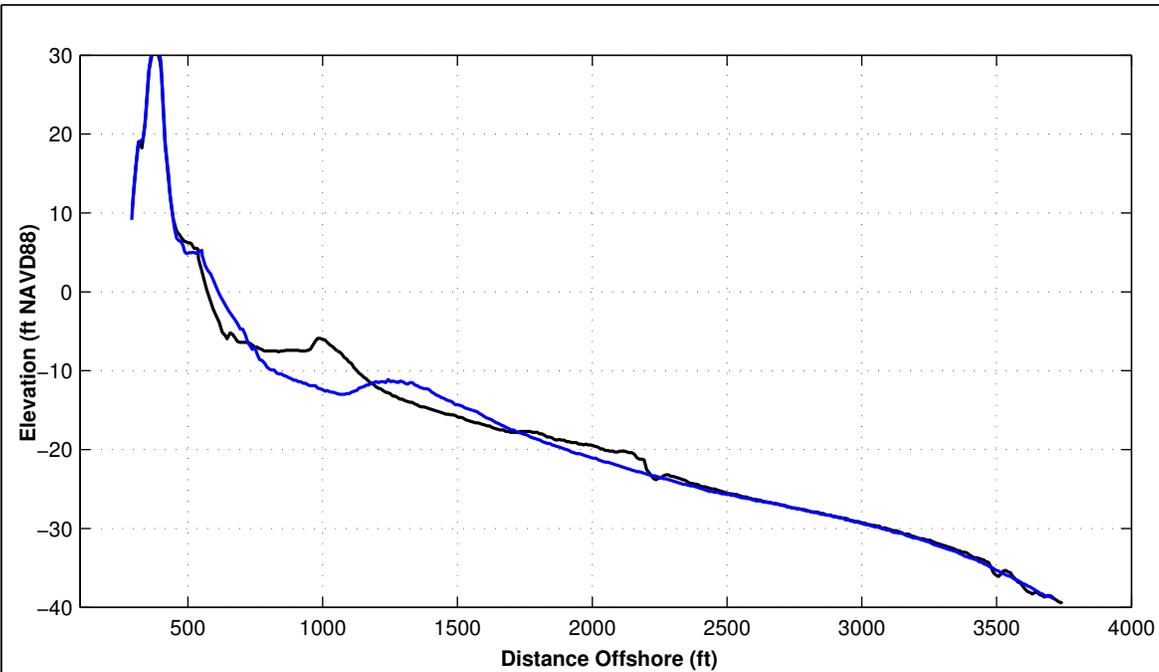
Survey Transect 1065+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-8.79 ft	-3.71 ft
Volume Change Above +6 ft NAVD88	1.43 cy/ft	-6.77 cy/ft
Volume Change Above 1.18 ft NAVD88	1.16 cy/ft	-9.25 cy/ft
Volume Change Above -6 ft NAVD88	-4.98 cy/ft	-4.44 cy/ft
Volume Change Above -14 ft NAVD88	-0.43 cy/ft	13.08 cy/ft
Volume Change Above -19 ft NAVD88	4.93 cy/ft	-0.68 cy/ft
Volume Change Above -30 ft NAVD88	15.90 cy/ft	-15.58 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
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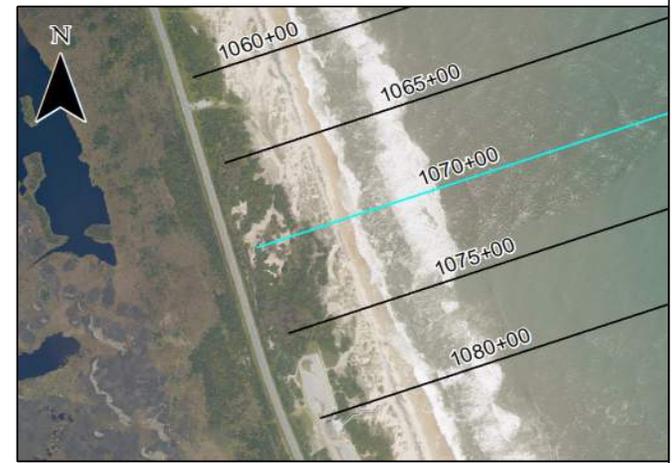


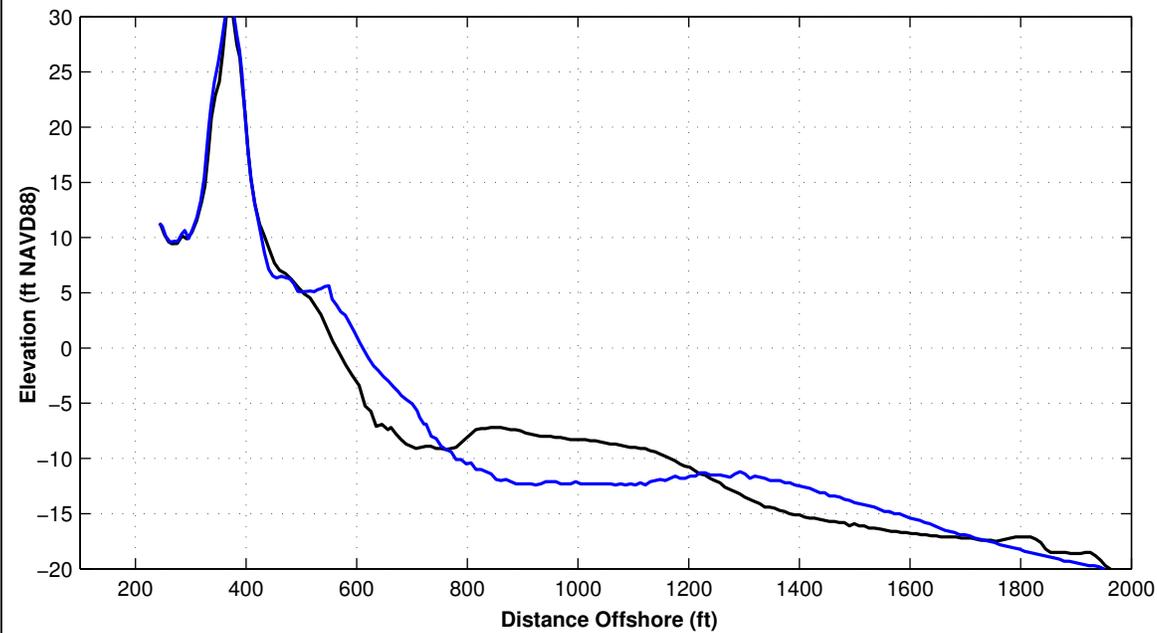
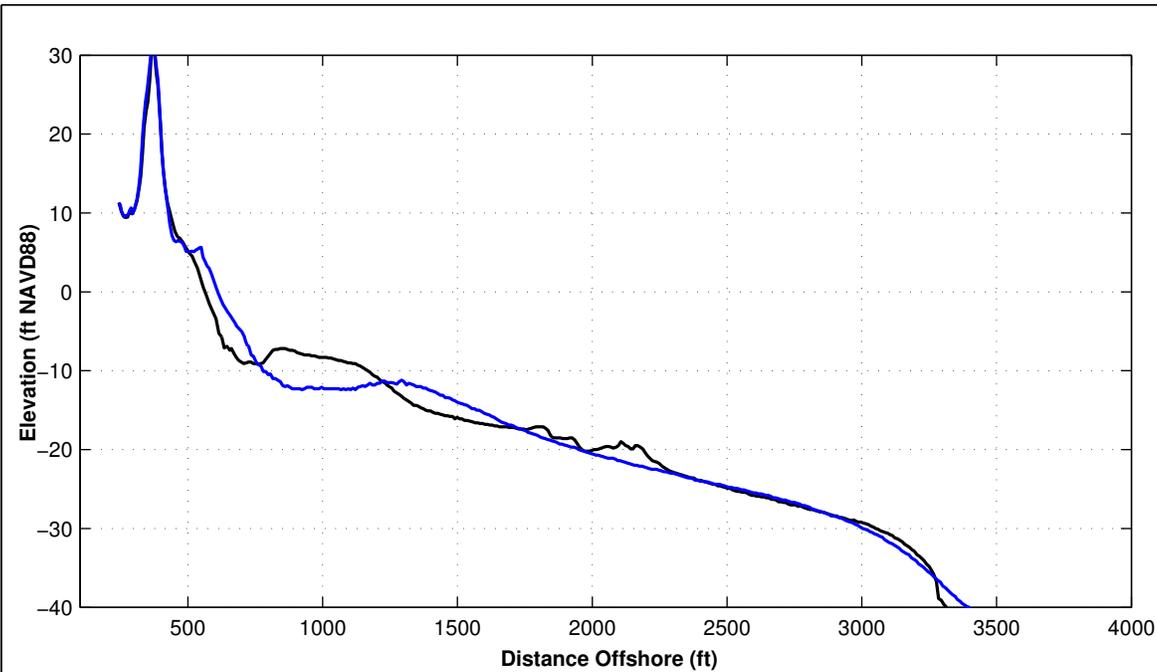
Survey Transect 1070+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	10.10 ft	-22.00 ft
Volume Change Above +6 ft NAVD88	1.82 cy/ft	-2.78 cy/ft
Volume Change Above 1.18 ft NAVD88	5.35 cy/ft	-6.90 cy/ft
Volume Change Above -6 ft NAVD88	3.60 cy/ft	-5.26 cy/ft
Volume Change Above -14 ft NAVD88	0.65 cy/ft	28.06 cy/ft
Volume Change Above -19 ft NAVD88	8.18 cy/ft	14.12 cy/ft
Volume Change Above -30 ft NAVD88	20.48 cy/ft	-1.40 cy/ft

**LEGEND:**

JUNE 2024		OCTOBER 2023	
		JUNE 2023	

- Notes:
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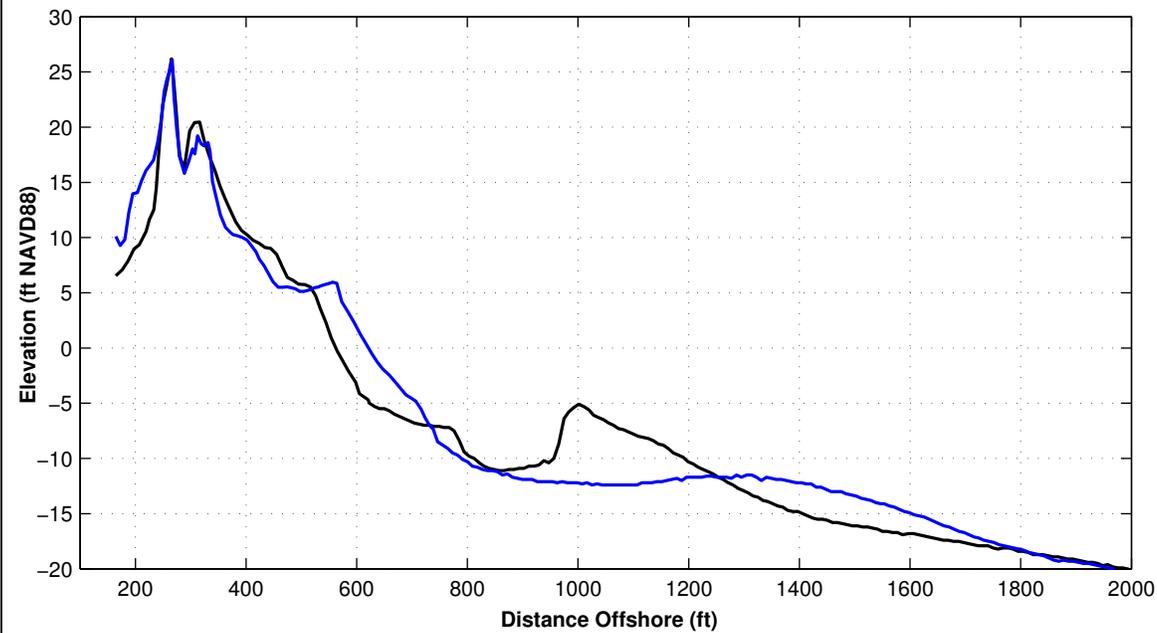
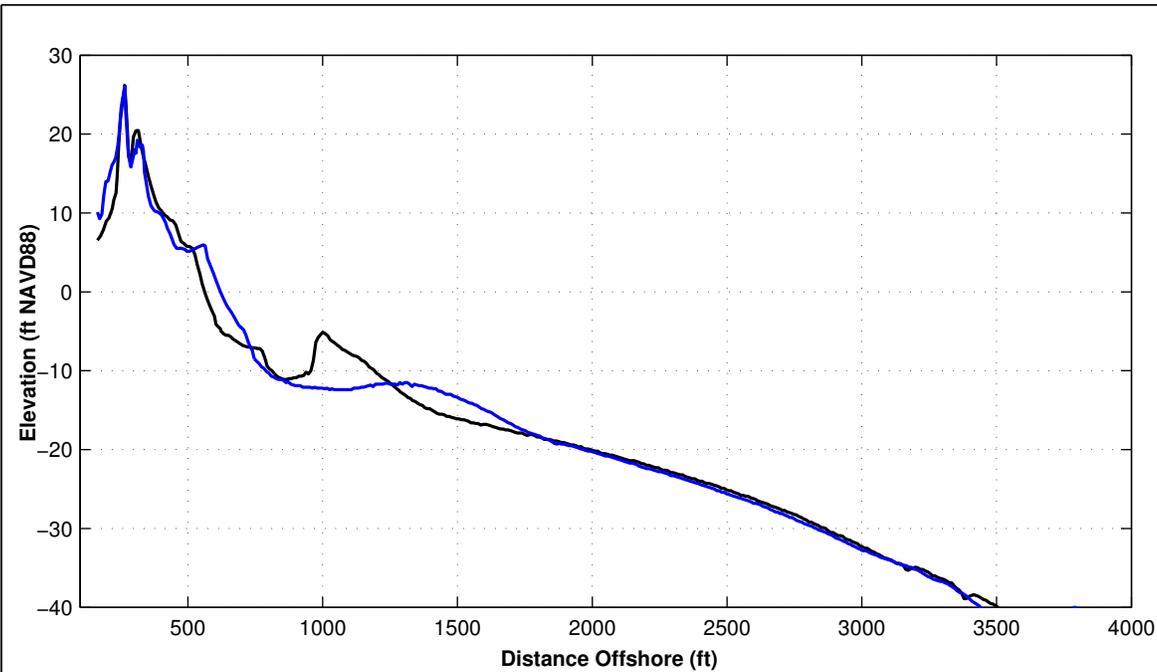
Survey Transect 1075+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	12.45 ft	-2.68 ft
Volume Change Above +6 ft NAVD88	2.99 cy/ft	-0.99 cy/ft
Volume Change Above 1.18 ft NAVD88	6.21 cy/ft	-1.94 cy/ft
Volume Change Above -6 ft NAVD88	5.26 cy/ft	2.89 cy/ft
Volume Change Above -14 ft NAVD88	20.82 cy/ft	30.53 cy/ft
Volume Change Above -19 ft NAVD88	29.09 cy/ft	9.60 cy/ft
Volume Change Above -30 ft NAVD88	38.55 cy/ft	-6.16 cy/ft

**LEGEND:**

JUNE 2024 —      OCTOBER 2023 —  
 JUNE 2023 —      JUNE 2023 —

- Notes:
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Survey Transect 1080+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	7.36 ft	-11.51 ft
Volume Change Above +6 ft NAVD88	0.90 cy/ft	-3.04 cy/ft
Volume Change Above 1.18 ft NAVD88	3.90 cy/ft	-5.86 cy/ft
Volume Change Above -6 ft NAVD88	1.41 cy/ft	-4.76 cy/ft
Volume Change Above -14 ft NAVD88	-11.46 cy/ft	43.38 cy/ft
Volume Change Above -19 ft NAVD88	-4.53 cy/ft	22.82 cy/ft
Volume Change Above -30 ft NAVD88	3.19 cy/ft	5.42 cy/ft

**LEGEND:**

JUNE 2024 ————

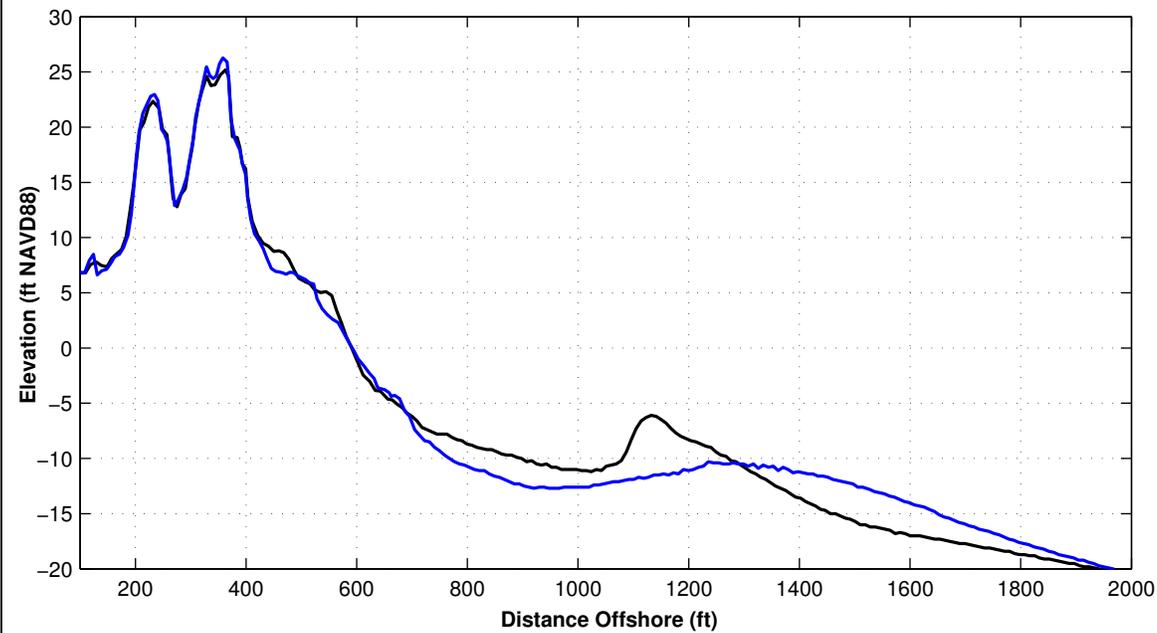
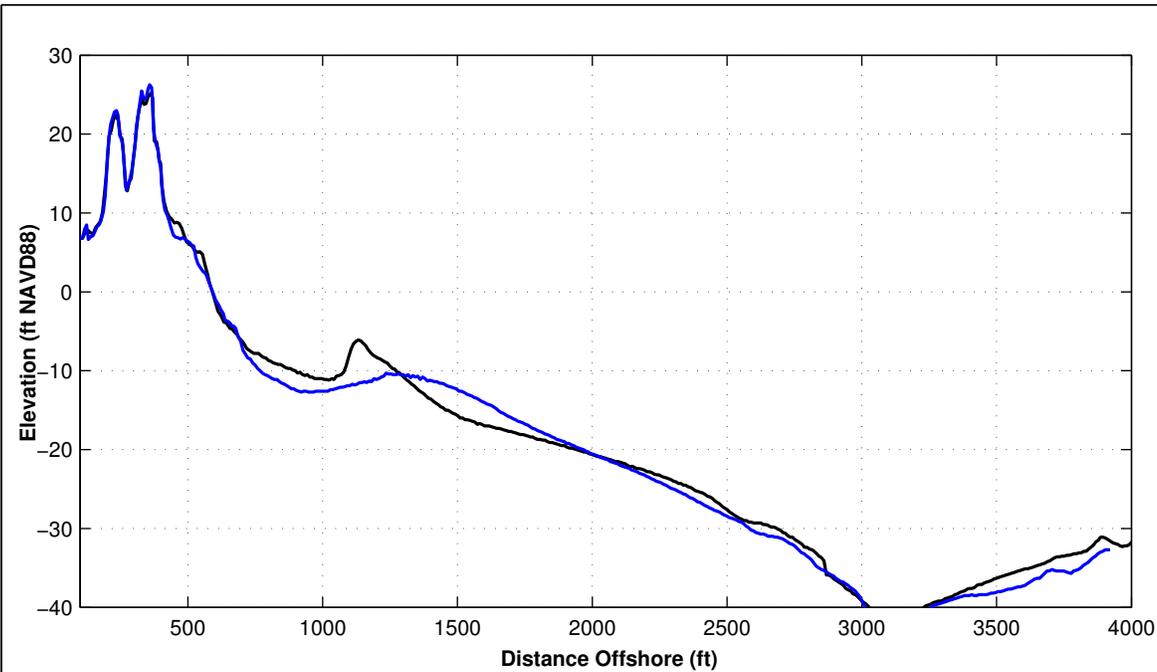
OCTOBER 2023 ————

JUNE 2023 ————

OCTOBER 2023 ————

- Notes:
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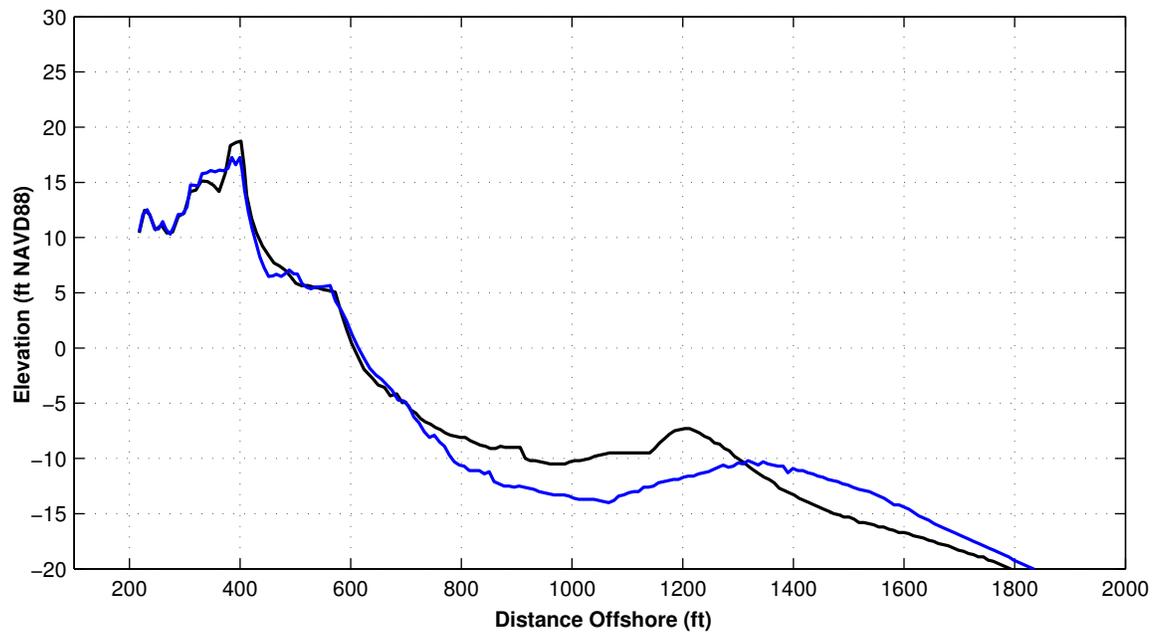
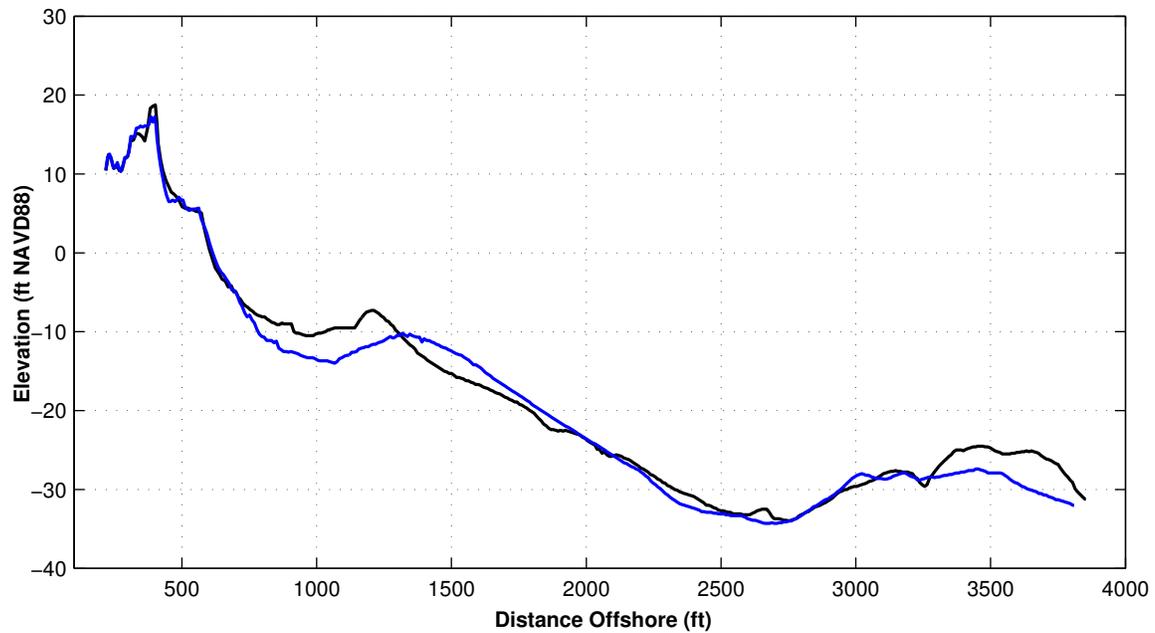
Survey Transect 1090+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-3.54 ft	9.31 ft
Volume Change Above +6 ft NAVD88	-0.37 cy/ft	-5.73 cy/ft
Volume Change Above 1.18 ft NAVD88	1.88 cy/ft	-6.17 cy/ft
Volume Change Above -6 ft NAVD88	-1.64 cy/ft	-5.41 cy/ft
Volume Change Above -14 ft NAVD88	1.92 cy/ft	32.65 cy/ft
Volume Change Above -19 ft NAVD88	8.93 cy/ft	14.45 cy/ft
Volume Change Above -30 ft NAVD88	20.59 cy/ft	-2.08 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





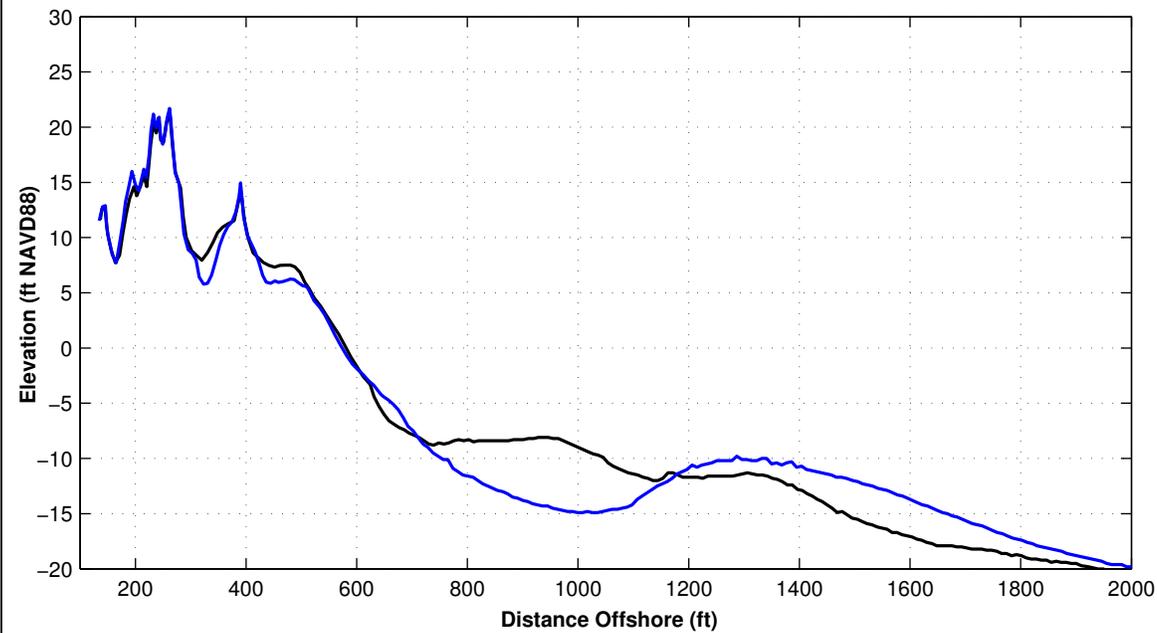
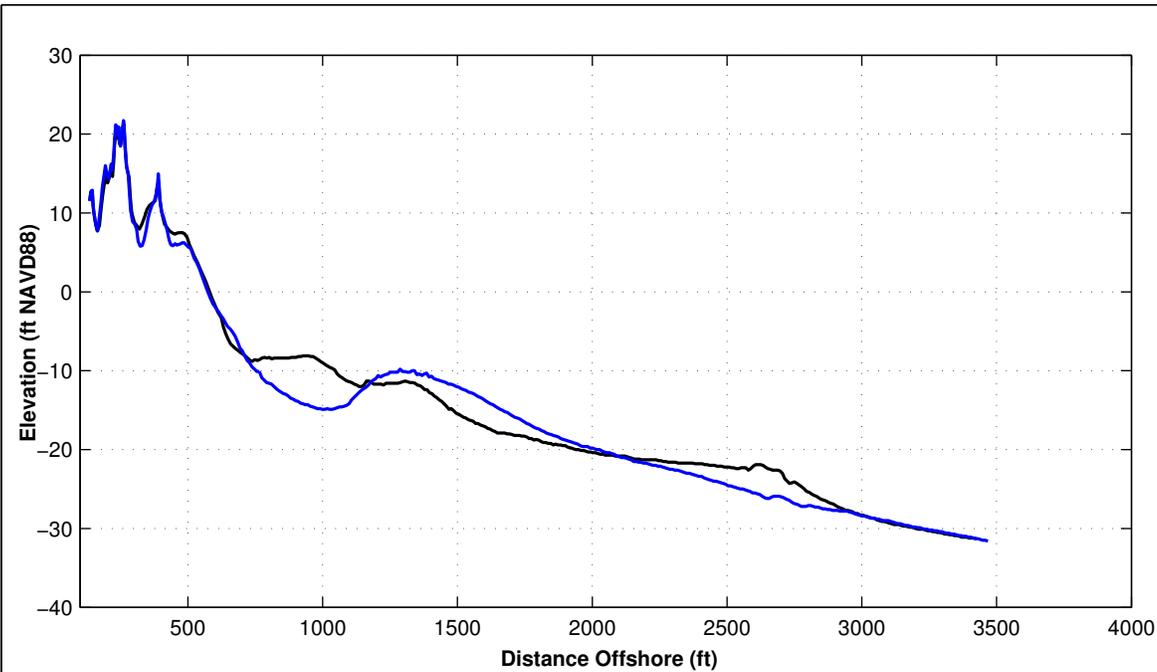
Survey Transect 1100+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-25.93 ft	15.43 ft
Volume Change Above +6 ft NAVD88	0.98 cy/ft	1.25 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.25 cy/ft	5.47 cy/ft
Volume Change Above -6 ft NAVD88	-11.07 cy/ft	3.10 cy/ft
Volume Change Above -14 ft NAVD88	-18.22 cy/ft	36.45 cy/ft
Volume Change Above -19 ft NAVD88	-9.84 cy/ft	16.21 cy/ft
Volume Change Above -30 ft NAVD88	4.28 cy/ft	-1.84 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 1110+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	7.74 ft	16.59 ft
Volume Change Above +6 ft NAVD88	-1.49 cy/ft	1.84 cy/ft
Volume Change Above 1.18 ft NAVD88	2.04 cy/ft	3.00 cy/ft
Volume Change Above -6 ft NAVD88	3.80 cy/ft	-1.95 cy/ft
Volume Change Above -14 ft NAVD88	-3.16 cy/ft	35.75 cy/ft
Volume Change Above -19 ft NAVD88	2.02 cy/ft	10.81 cy/ft
Volume Change Above -30 ft NAVD88	22.05 cy/ft	-9.60 cy/ft

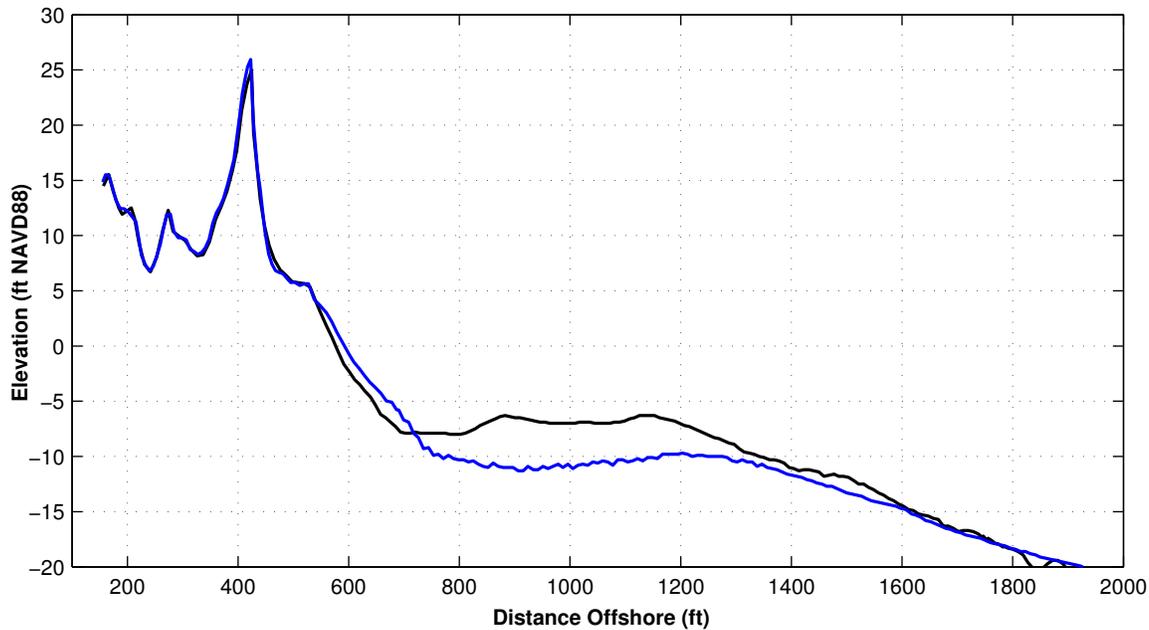
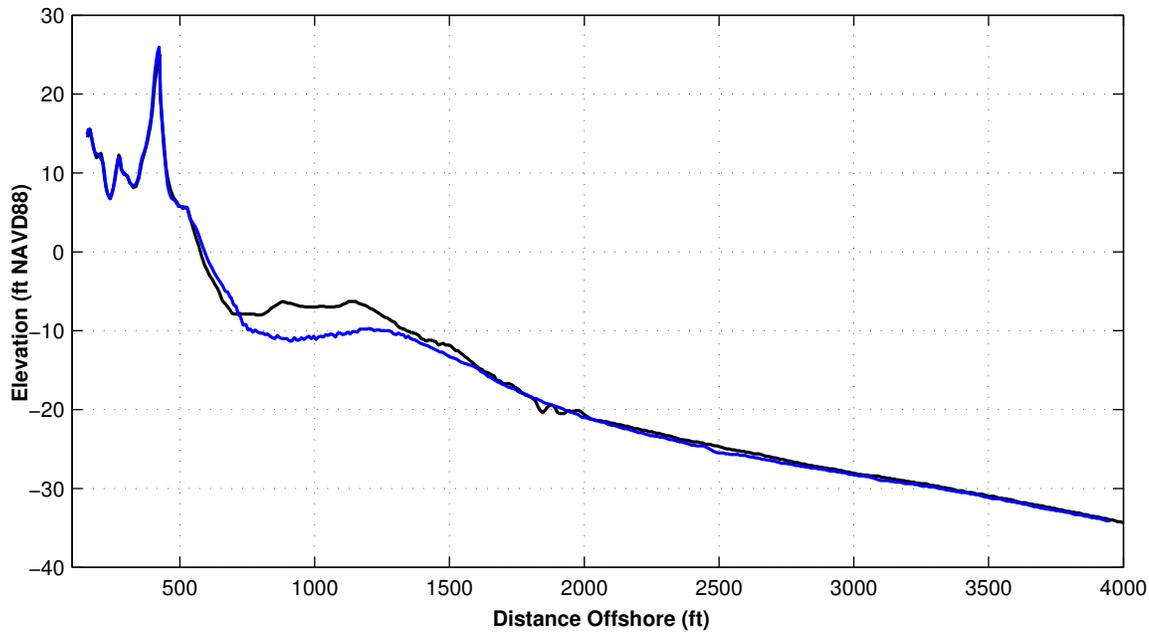
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 1120+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-9.49 ft	8.63 ft
Volume Change Above +6 ft NAVD88	-0.63 cy/ft	4.05 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.56 cy/ft	8.50 cy/ft
Volume Change Above -6 ft NAVD88	-8.40 cy/ft	1.97 cy/ft
Volume Change Above -14 ft NAVD88	-29.28 cy/ft	42.87 cy/ft
Volume Change Above -19 ft NAVD88	-25.07 cy/ft	17.09 cy/ft
Volume Change Above -30 ft NAVD88	-9.32 cy/ft	-0.40 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023  
 JUNE 2023 ————

**Notes:**

1. Station From North To South At Varying Intervals.
2. All Survey Elevations In Feet Referenced to NAVD88.

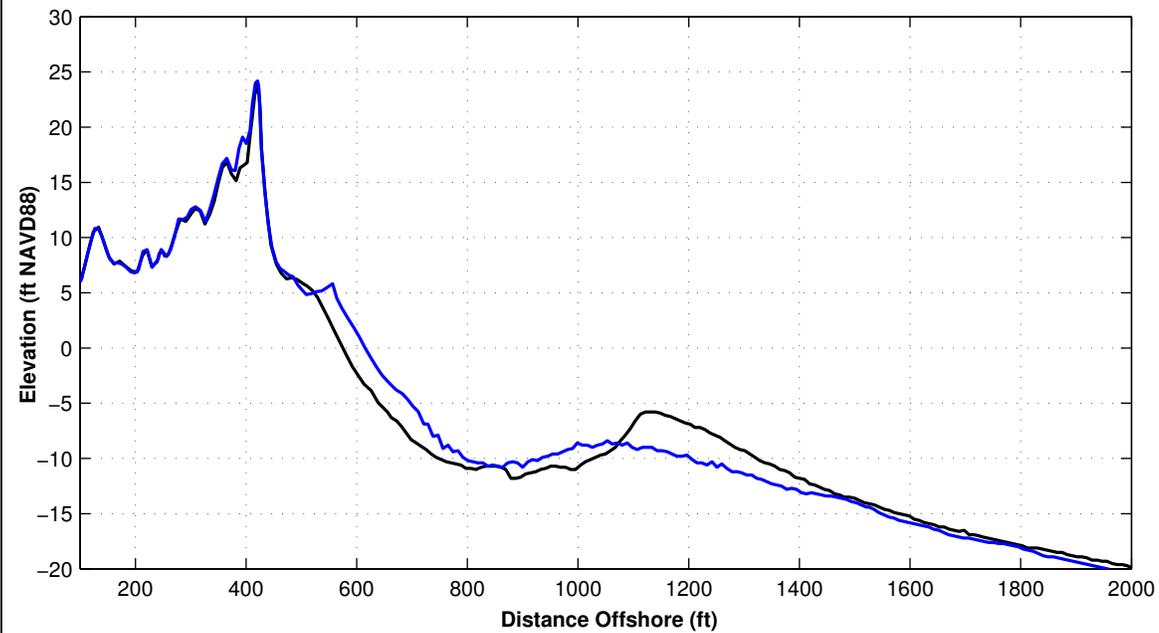
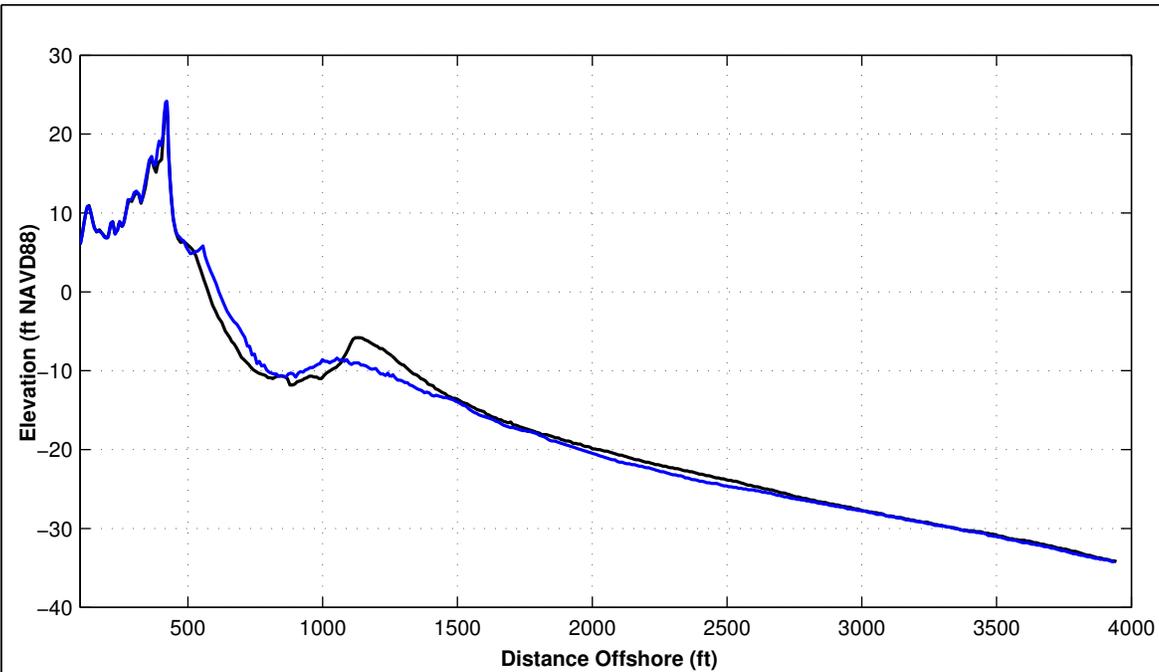


**Town of Nags Head Periodic Surveying Data Analysis**

ST 1120+00

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2024



Survey Transect 1130+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-2.44 ft	9.16 ft
Volume Change Above +6 ft NAVD88	0.65 cy/ft	1.86 cy/ft
Volume Change Above 1.18 ft NAVD88	-0.85 cy/ft	4.31 cy/ft
Volume Change Above -6 ft NAVD88	-1.66 cy/ft	-1.91 cy/ft
Volume Change Above -14 ft NAVD88	-21.51 cy/ft	47.26 cy/ft
Volume Change Above -19 ft NAVD88	-18.83 cy/ft	24.05 cy/ft
Volume Change Above -30 ft NAVD88	-2.50 cy/ft	5.12 cy/ft

**LEGEND:**

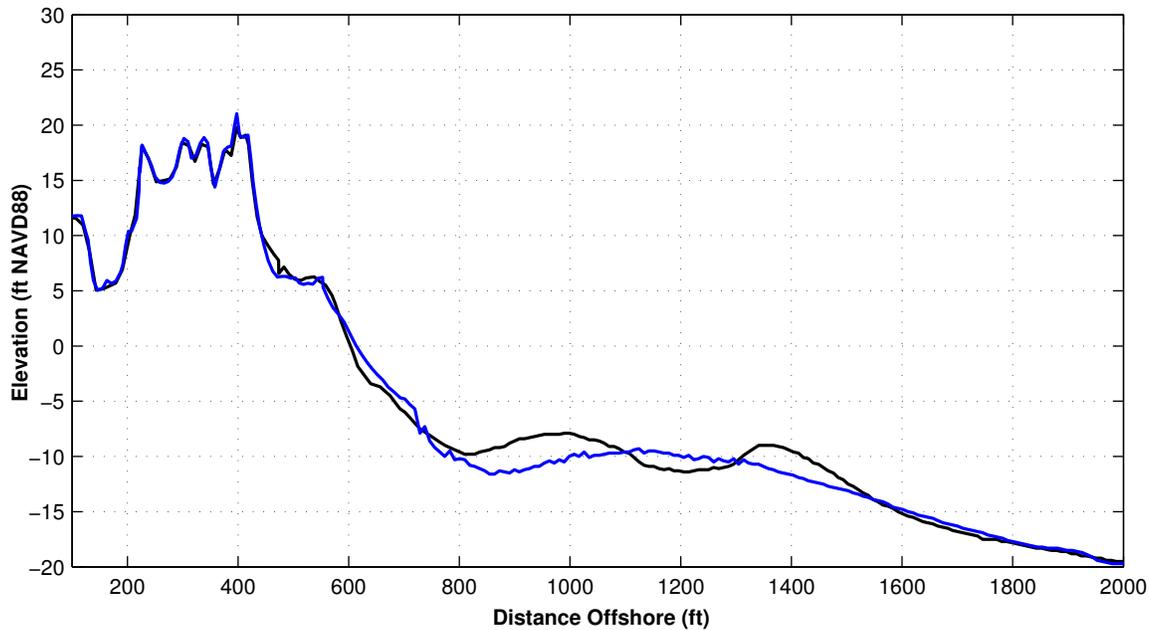
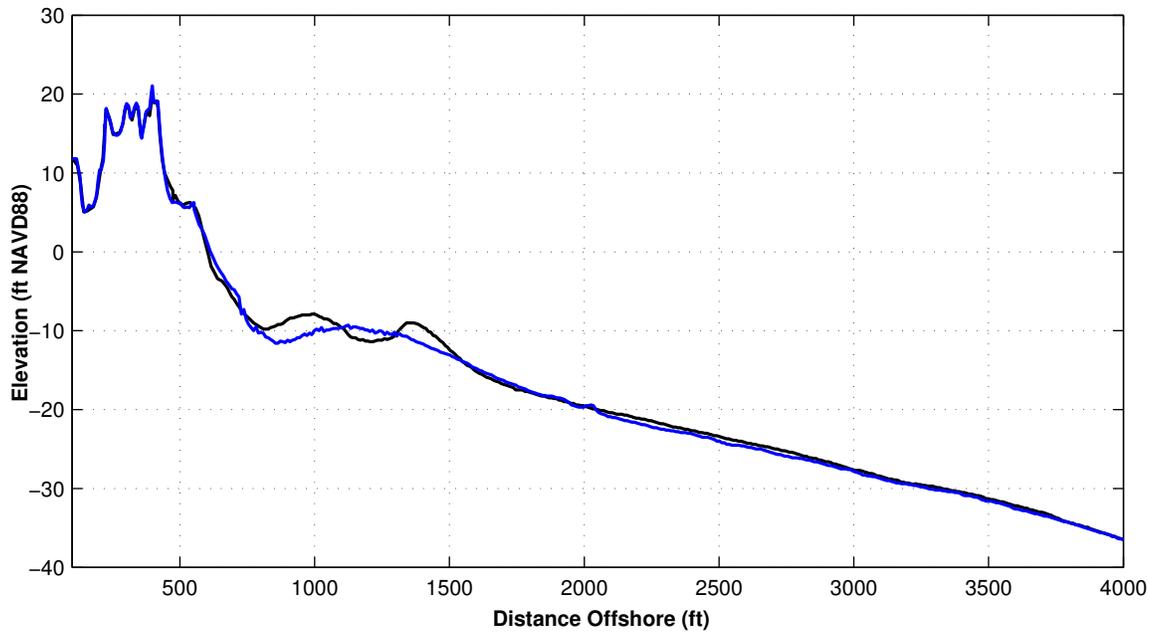
JUNE 2024 ————

OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 1140+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	6.51 ft	-5.62 ft
Volume Change Above +6 ft NAVD88	2.80 cy/ft	6.56 cy/ft
Volume Change Above 1.18 ft NAVD88	3.77 cy/ft	6.40 cy/ft
Volume Change Above -6 ft NAVD88	1.09 cy/ft	2.26 cy/ft
Volume Change Above -14 ft NAVD88	-27.60 cy/ft	64.88 cy/ft
Volume Change Above -19 ft NAVD88	-24.70 cy/ft	50.62 cy/ft
Volume Change Above -30 ft NAVD88	-11.11 cy/ft	36.49 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————  
 JUNE 2023 ————

**Notes:**

1. Station From North To South At Varying Intervals.
2. All Survey Elevations In Feet Referenced to NAVD88.

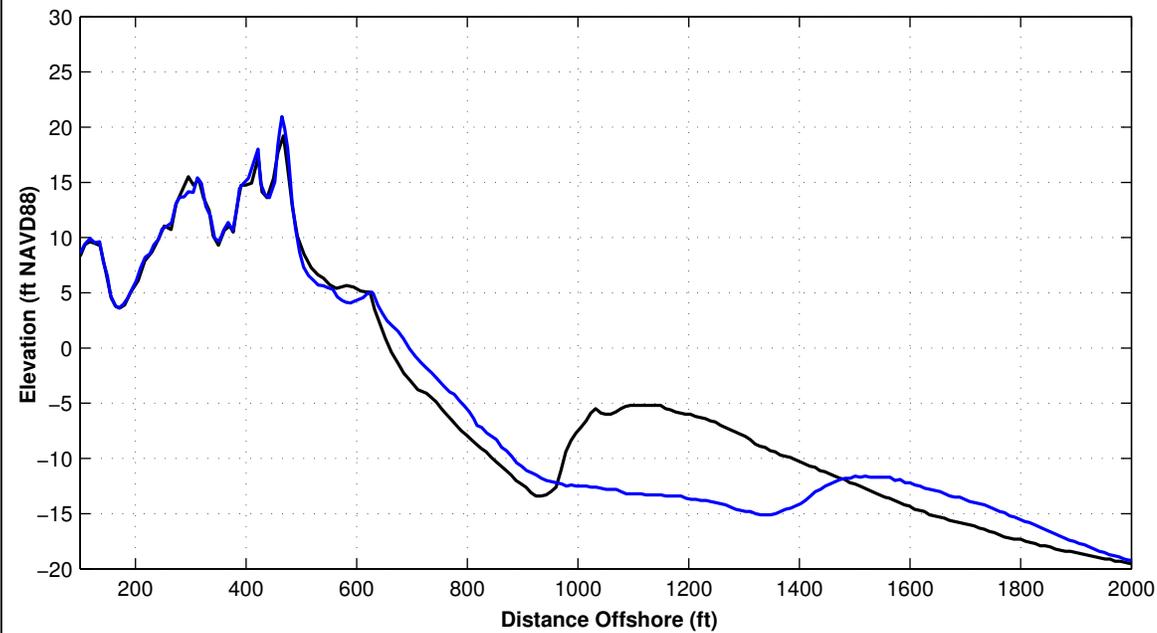
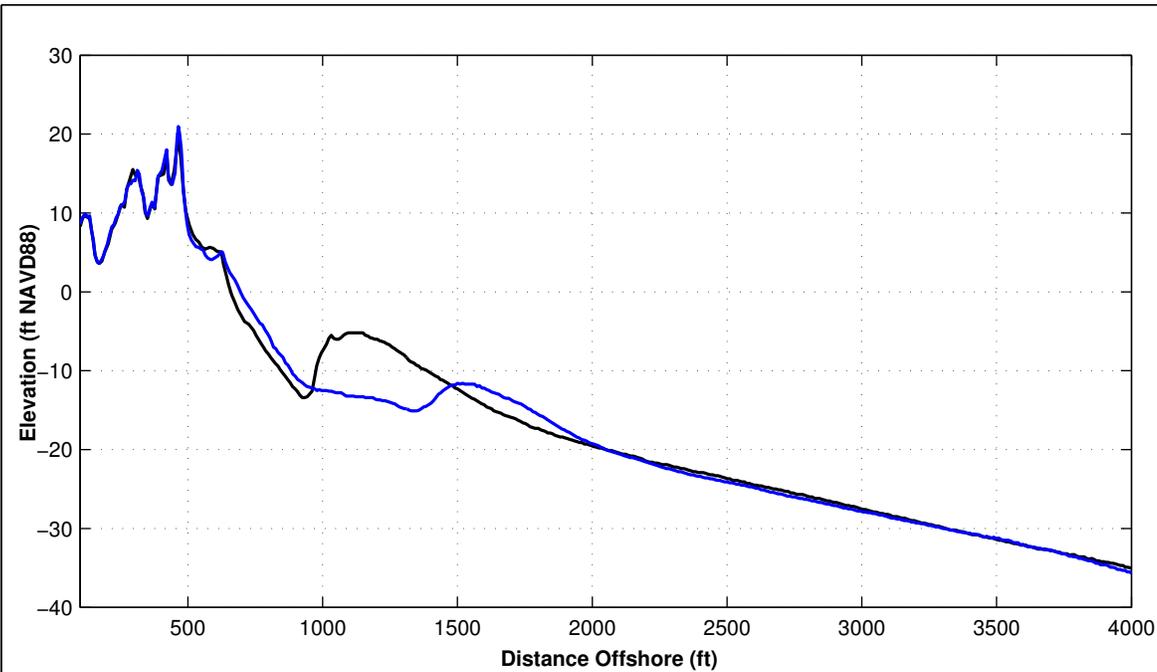


**Town of Nags Head Periodic Surveying Data Analysis**

ST 1140+00

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2024



Survey Transect 1150+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	34.23 ft	-40.84 ft
Volume Change Above +6 ft NAVD88	4.80 cy/ft	1.23 cy/ft
Volume Change Above 1.18 ft NAVD88	12.33 cy/ft	-5.65 cy/ft
Volume Change Above -6 ft NAVD88	16.47 cy/ft	-20.58 cy/ft
Volume Change Above -14 ft NAVD88	9.12 cy/ft	15.47 cy/ft
Volume Change Above -19 ft NAVD88	0.56 cy/ft	4.99 cy/ft
Volume Change Above -30 ft NAVD88	21.52 cy/ft	-13.61 cy/ft

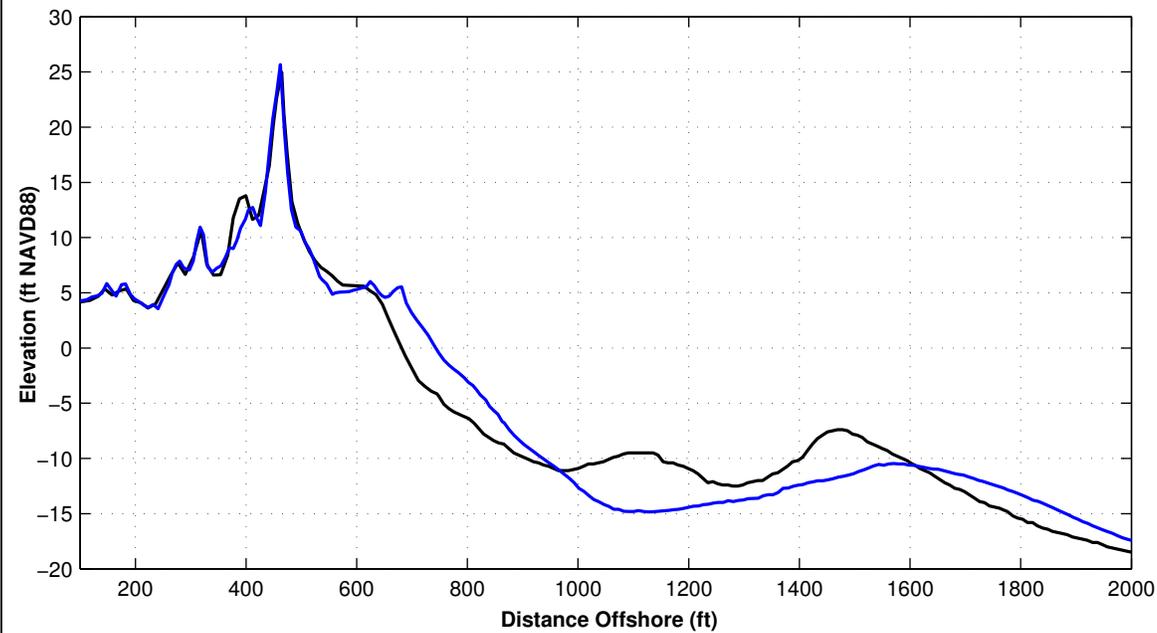
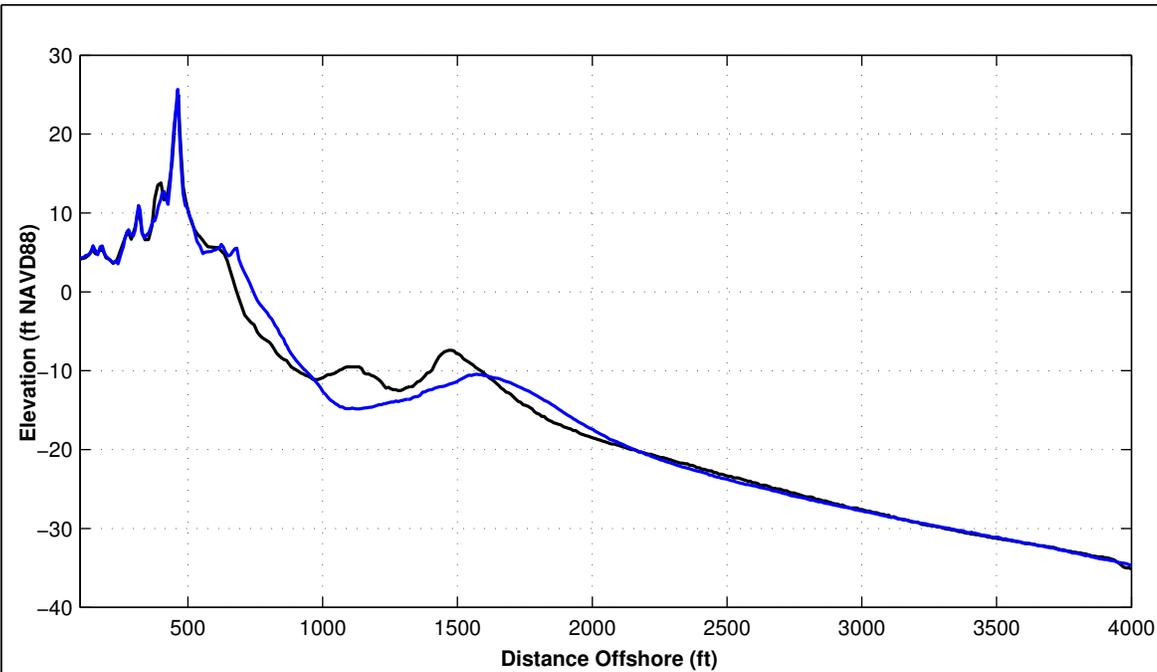
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





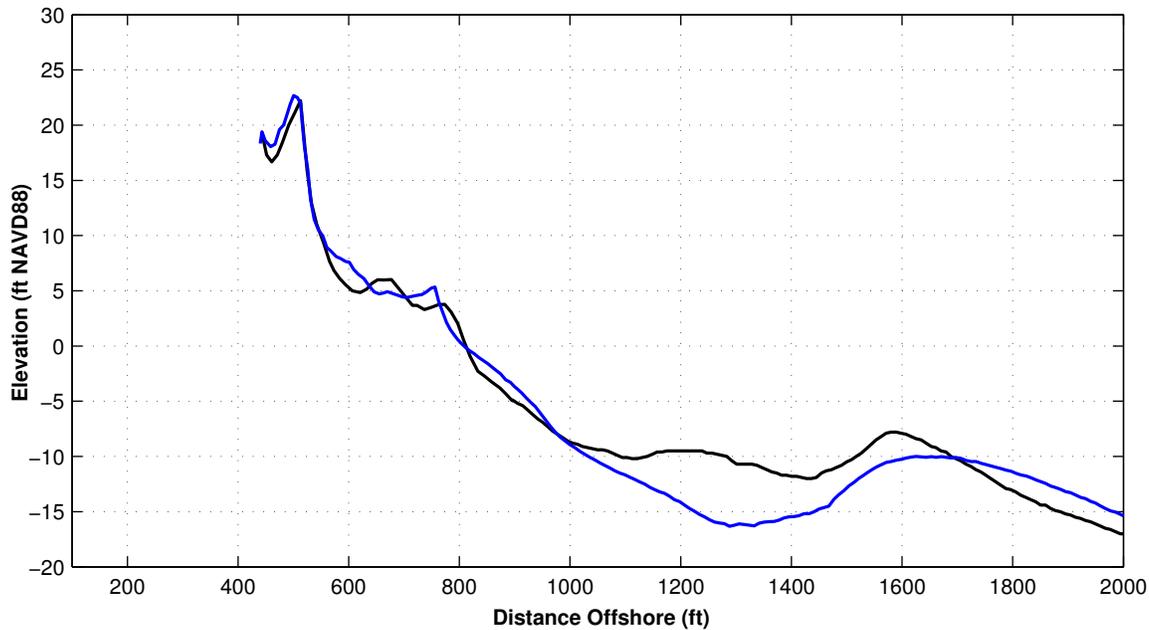
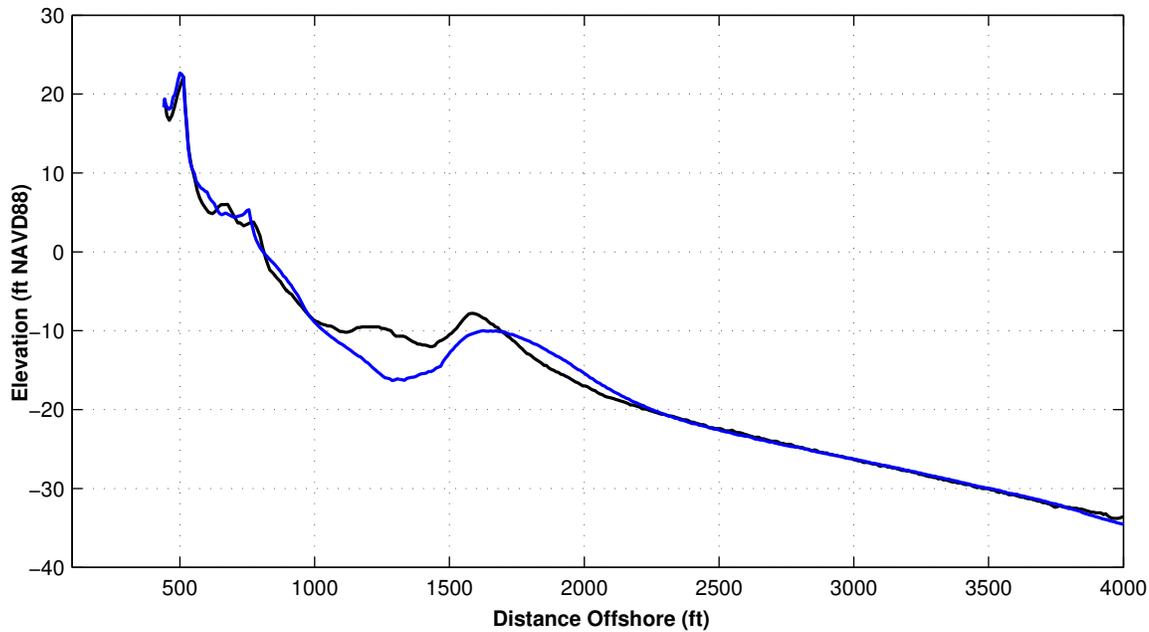
Survey Transect 1160+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	32.20 ft	-46.98 ft
Volume Change Above +6 ft NAVD88	3.89 cy/ft	-1.34 cy/ft
Volume Change Above 1.18 ft NAVD88	11.63 cy/ft	-10.03 cy/ft
Volume Change Above -6 ft NAVD88	10.38 cy/ft	-26.01 cy/ft
Volume Change Above -14 ft NAVD88	37.91 cy/ft	-12.53 cy/ft
Volume Change Above -19 ft NAVD88	35.93 cy/ft	-18.23 cy/ft
Volume Change Above -30 ft NAVD88	55.37 cy/ft	-30.75 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 1170+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	31.13 ft	-56.41 ft
Volume Change Above +6 ft NAVD88	2.83 cy/ft	1.89 cy/ft
Volume Change Above 1.18 ft NAVD88	10.37 cy/ft	-7.47 cy/ft
Volume Change Above -6 ft NAVD88	11.41 cy/ft	-30.60 cy/ft
Volume Change Above -14 ft NAVD88	13.74 cy/ft	-3.59 cy/ft
Volume Change Above -19 ft NAVD88	16.81 cy/ft	-16.12 cy/ft
Volume Change Above -30 ft NAVD88	41.73 cy/ft	-29.91 cy/ft

**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————  
 JUNE 2023 ————

**Notes:**

1. Station From North To South At Varying Intervals.
2. All Survey Elevations In Feet Referenced to NAVD88.

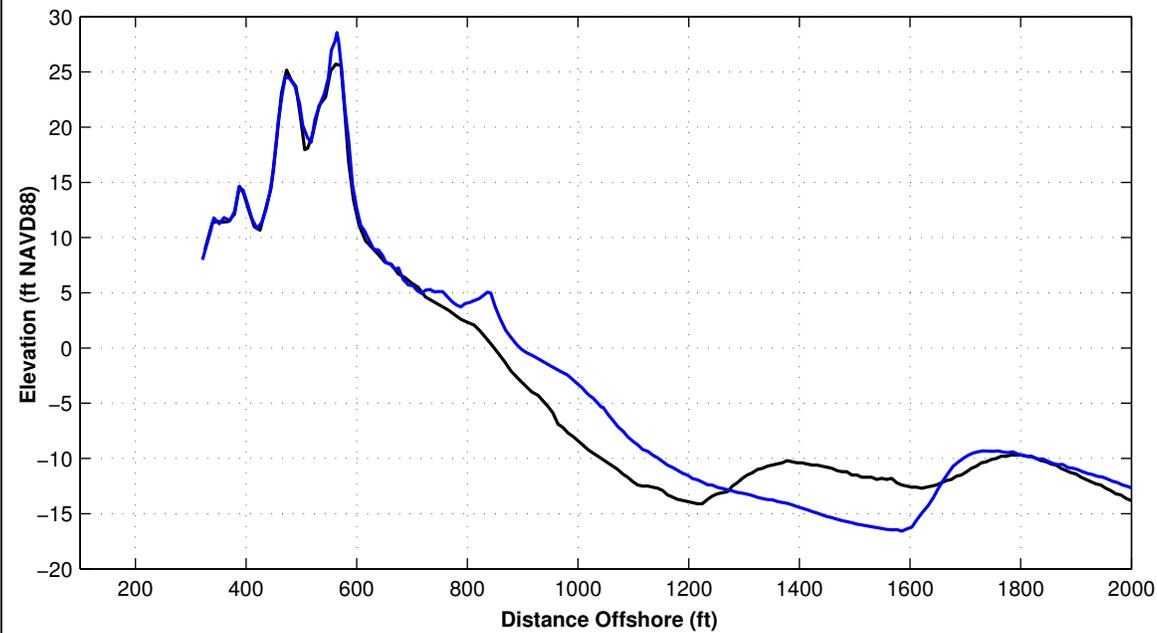
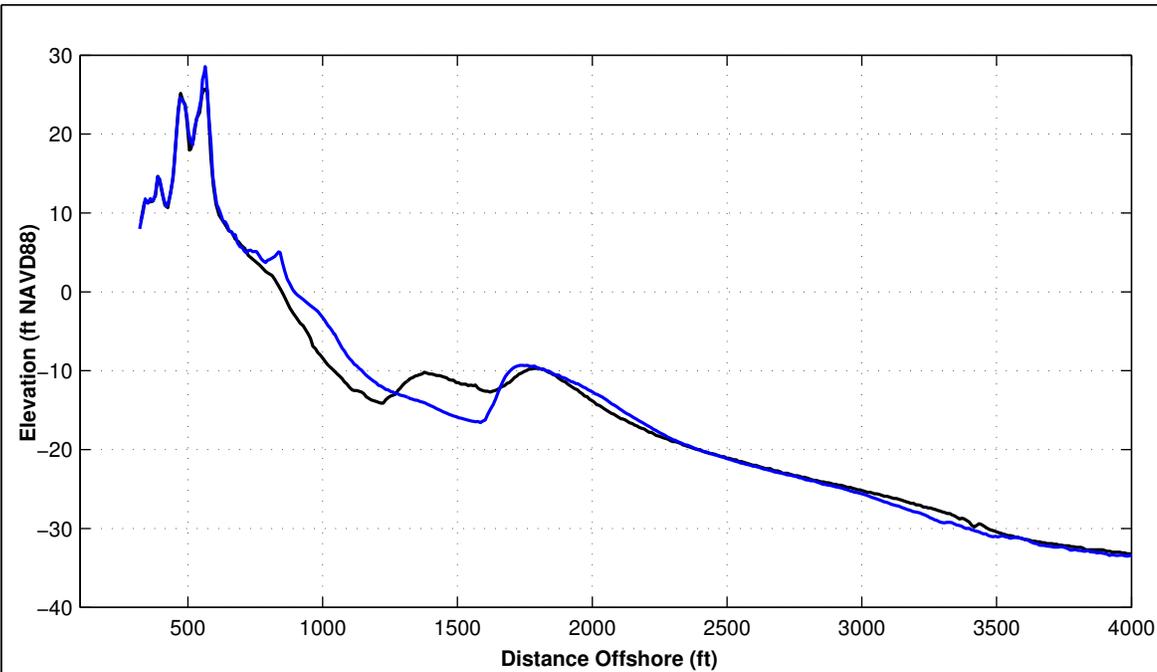


**Town of Nags Head Periodic Surveying Data Analysis**

ST 1170+00

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2024



Survey Transect 1180+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	55.42 ft	-16.76 ft
Volume Change Above +6 ft NAVD88	15.20 cy/ft	-0.32 cy/ft
Volume Change Above 1.18 ft NAVD88	23.17 cy/ft	-3.16 cy/ft
Volume Change Above -6 ft NAVD88	37.11 cy/ft	-9.48 cy/ft
Volume Change Above -14 ft NAVD88	64.79 cy/ft	-4.17 cy/ft
Volume Change Above -19 ft NAVD88	68.05 cy/ft	-17.75 cy/ft
Volume Change Above -30 ft NAVD88	97.30 cy/ft	-34.56 cy/ft

**LEGEND:**

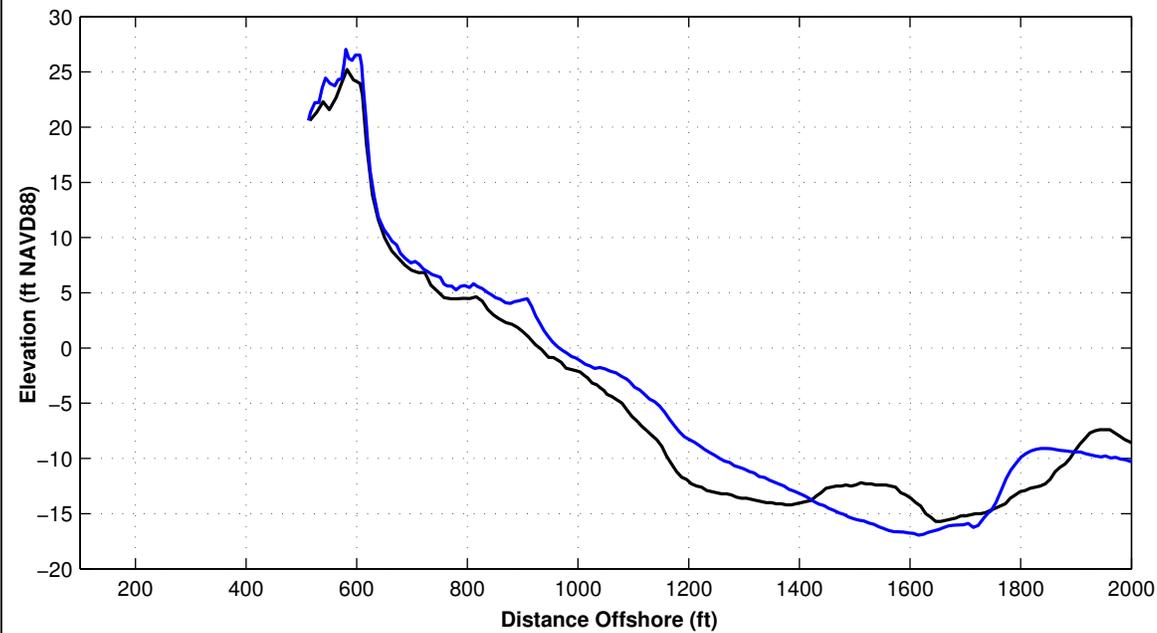
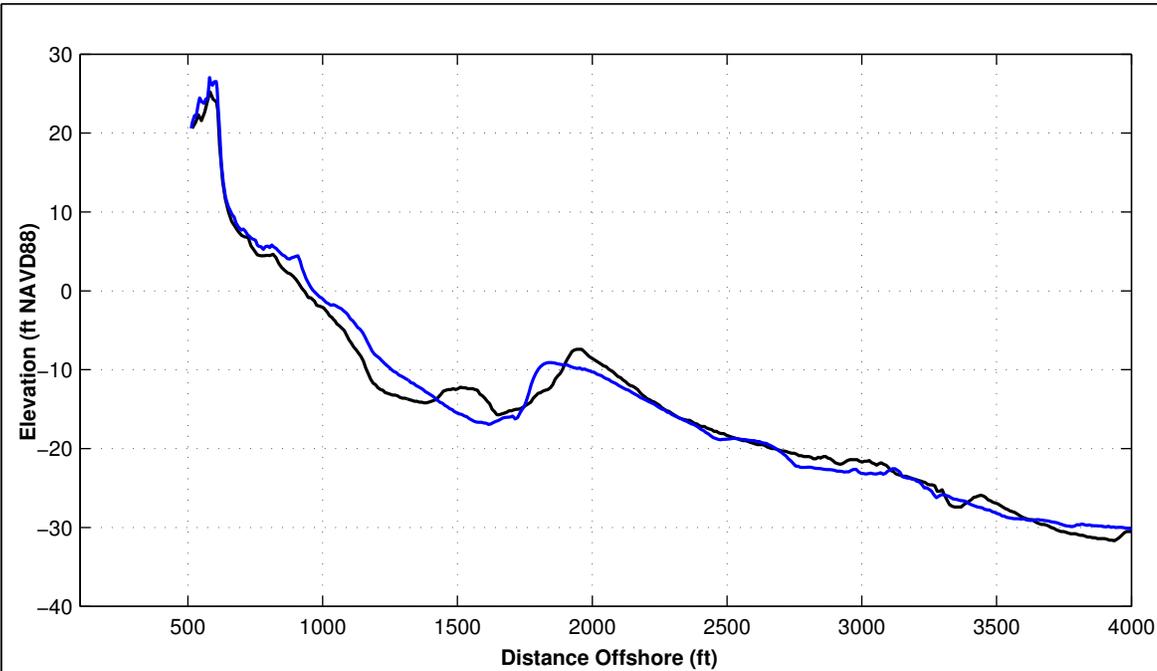
JUNE 2024 ————

OCTOBER 2023 ————

JUNE 2023 ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





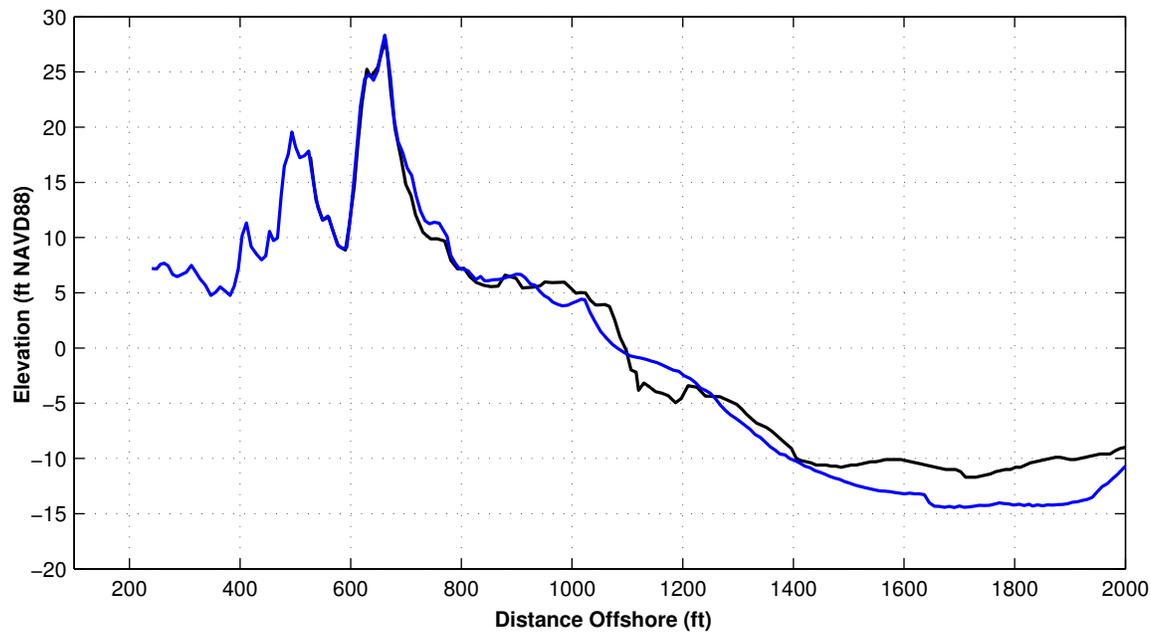
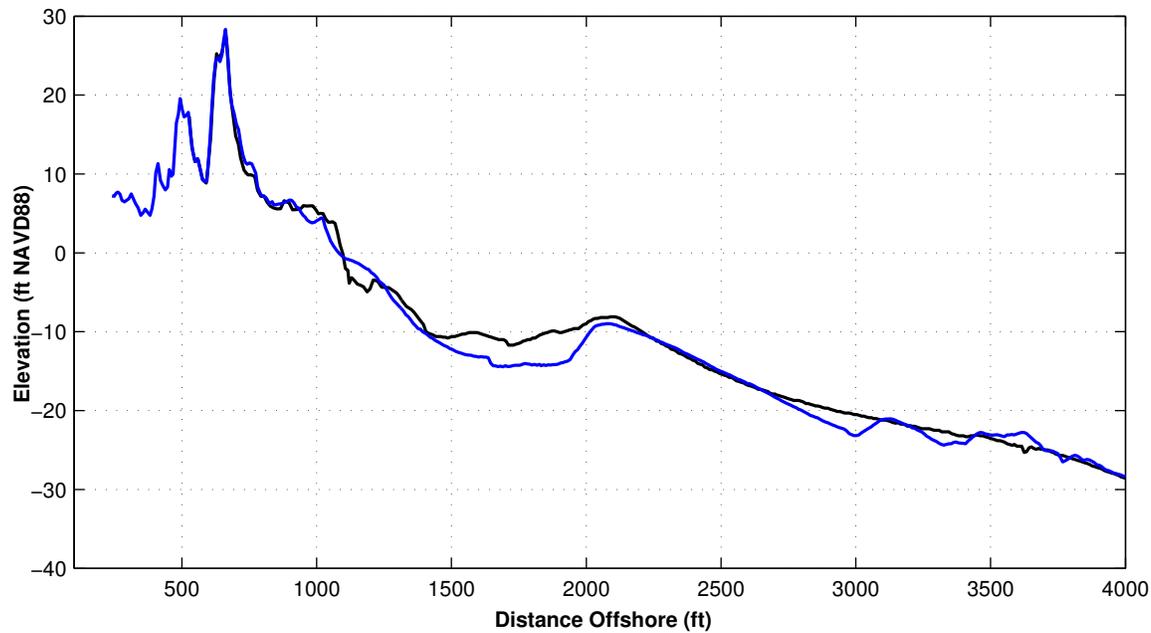
Survey Transect 1190+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-2.11 ft	1.58 ft
Volume Change Above +6 ft NAVD88	1.80 cy/ft	1.44 cy/ft
Volume Change Above 1.18 ft NAVD88	1.17 cy/ft	1.83 cy/ft
Volume Change Above -6 ft NAVD88	-5.37 cy/ft	-4.64 cy/ft
Volume Change Above -14 ft NAVD88	-1.25 cy/ft	20.59 cy/ft
Volume Change Above -19 ft NAVD88	-1.57 cy/ft	16.63 cy/ft
Volume Change Above -30 ft NAVD88	29.61 cy/ft	2.55 cy/ft

**LEGEND:**

JUNE 2024      ————      OCTOBER 2023      ————  
 JUNE 2023      ————      JUNE 2023      ————

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 1200+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	6.42 ft	-23.60 ft
Volume Change Above +6 ft NAVD88	4.13 cy/ft	3.29 cy/ft
Volume Change Above 1.18 ft NAVD88	6.83 cy/ft	-1.67 cy/ft
Volume Change Above -6 ft NAVD88	-2.05 cy/ft	-6.26 cy/ft
Volume Change Above -14 ft NAVD88	4.60 cy/ft	14.10 cy/ft
Volume Change Above -19 ft NAVD88	6.88 cy/ft	26.31 cy/ft
Volume Change Above -30 ft NAVD88	37.40 cy/ft	11.19 cy/ft

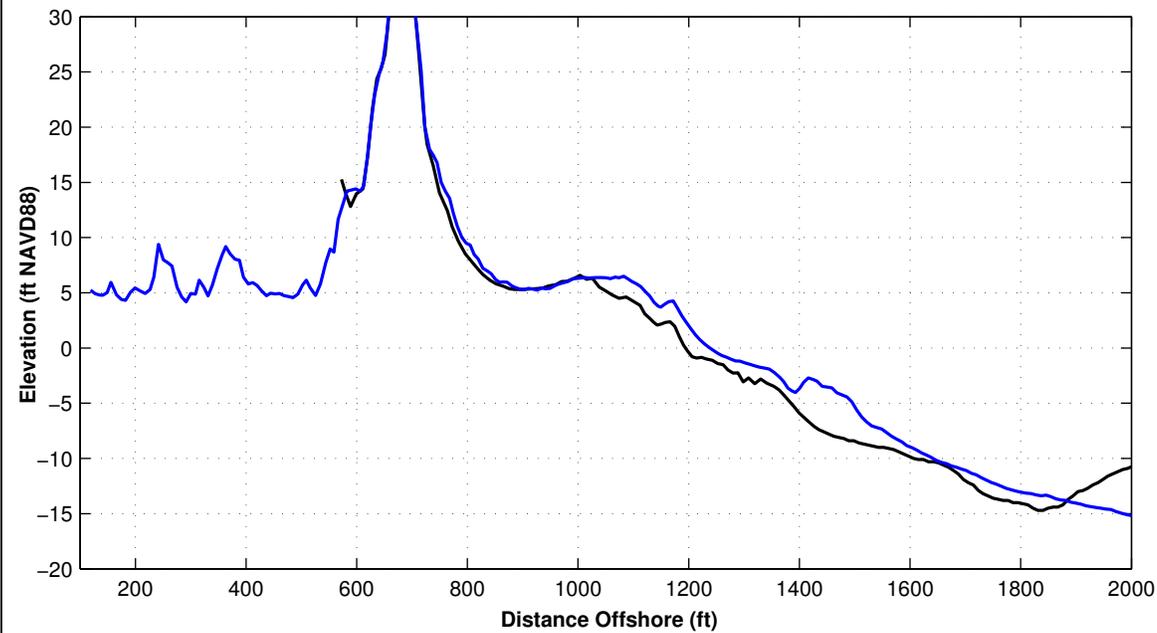
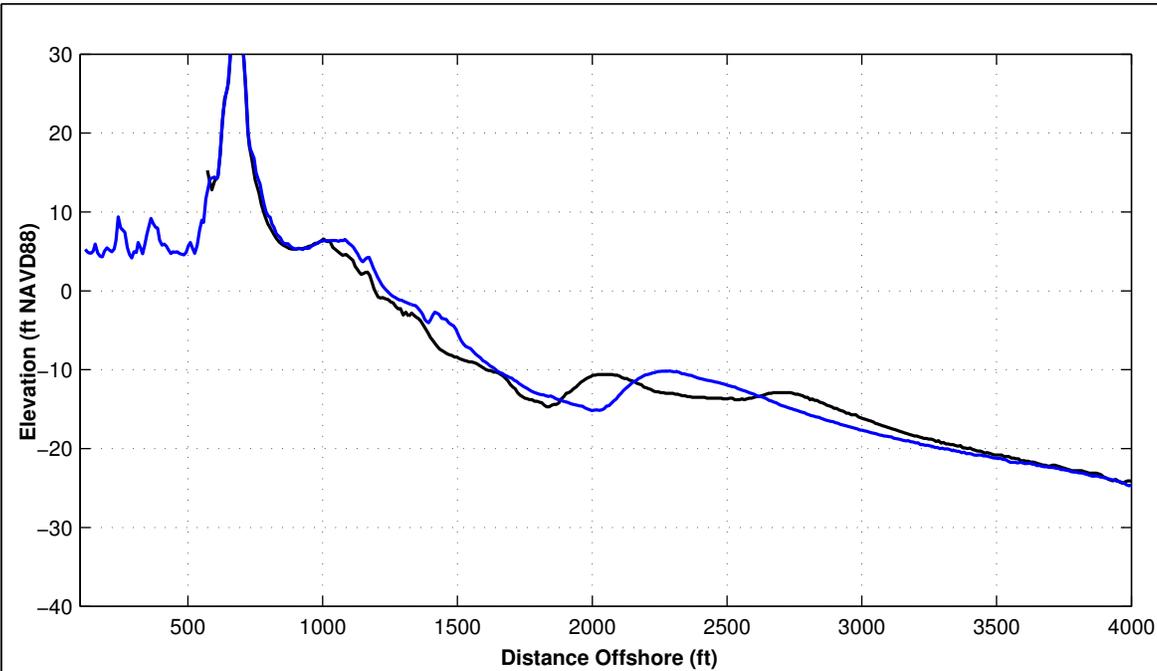
**LEGEND:**

JUNE 2024 ———— OCTOBER 2023 ————  
 JUNE 2023 ————

**Notes:**

1. Station From North To South At Varying Intervals.
2. All Survey Elevations In Feet Referenced to NAVD88.





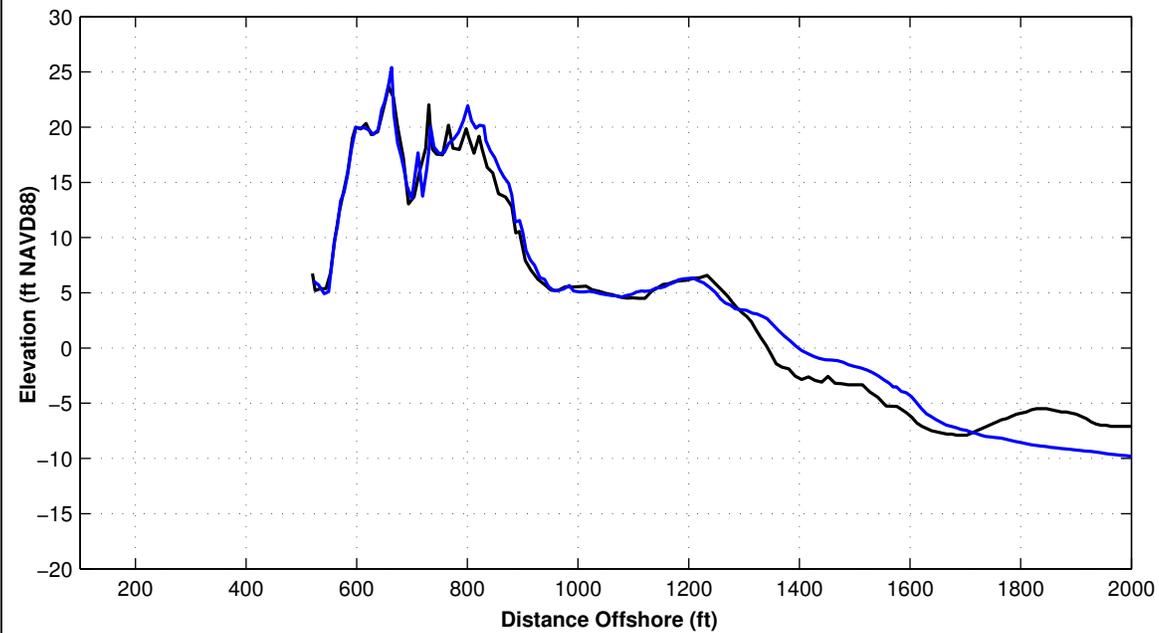
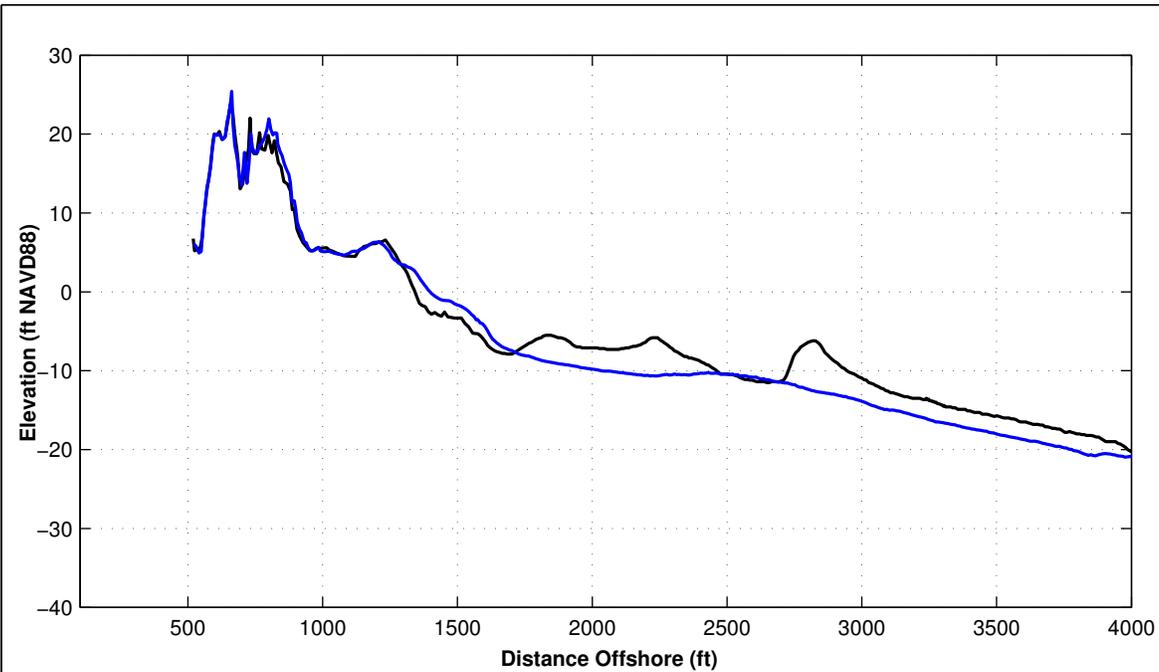
Survey Transect 1210+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-11.89 ft	6.29 ft
Volume Change Above +6 ft NAVD88	6.07 cy/ft	2.83 cy/ft
Volume Change Above 1.18 ft NAVD88	6.88 cy/ft	2.80 cy/ft
Volume Change Above -6 ft NAVD88	8.81 cy/ft	2.51 cy/ft
Volume Change Above -14 ft NAVD88	27.82 cy/ft	-2.46 cy/ft
Volume Change Above -19 ft NAVD88	67.64 cy/ft	2.13 cy/ft
Volume Change Above -30 ft NAVD88	93.79 cy/ft	-10.92 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 1220+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	48.31 ft	-10.79 ft
Volume Change Above +6 ft NAVD88	5.24 cy/ft	1.44 cy/ft
Volume Change Above 1.18 ft NAVD88	13.69 cy/ft	-2.38 cy/ft
Volume Change Above -6 ft NAVD88	16.74 cy/ft	-3.27 cy/ft
Volume Change Above -14 ft NAVD88	32.79 cy/ft	-18.54 cy/ft
Volume Change Above -19 ft NAVD88	55.22 cy/ft	-41.16 cy/ft
Volume Change Above -30 ft NAVD88	70.98 cy/ft	-45.31 cy/ft

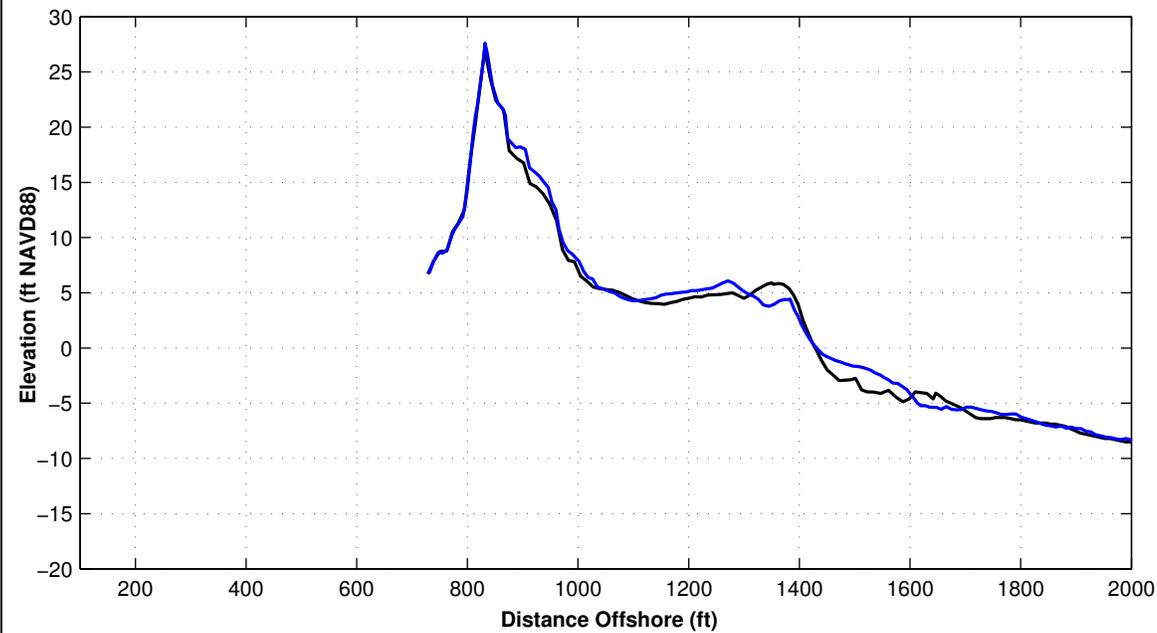
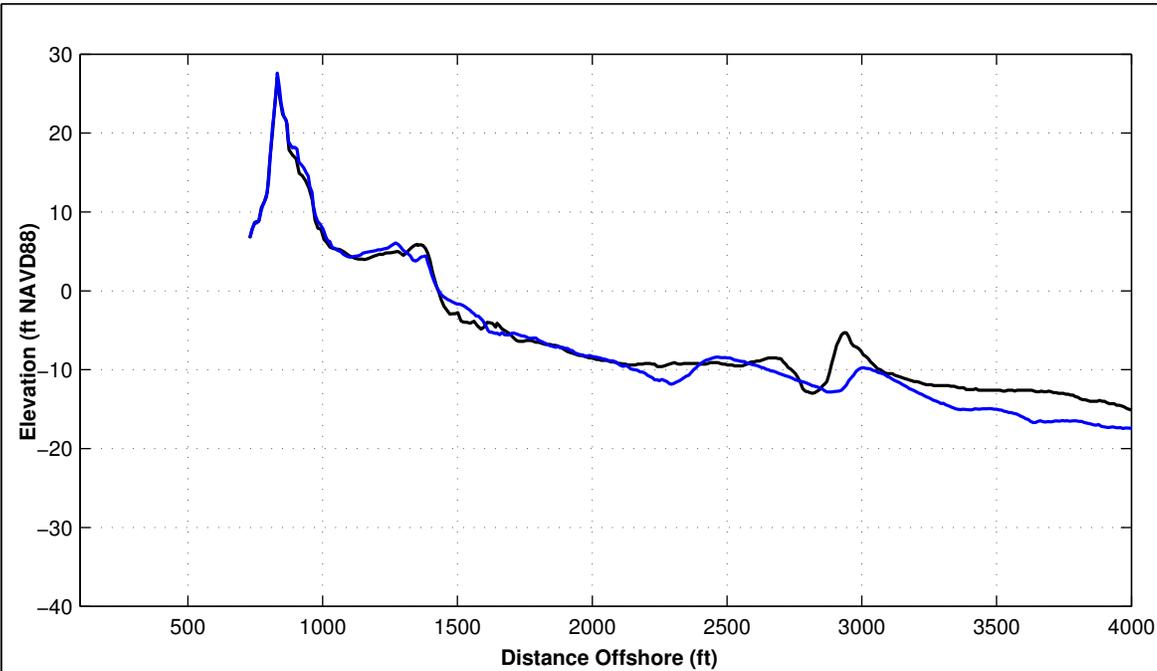
**LEGEND:**

JUNE 2024 OCTOBER 2023

JUNE 2023

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



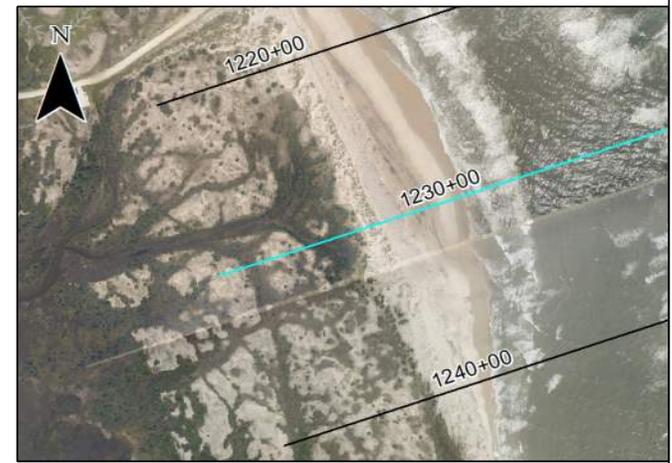


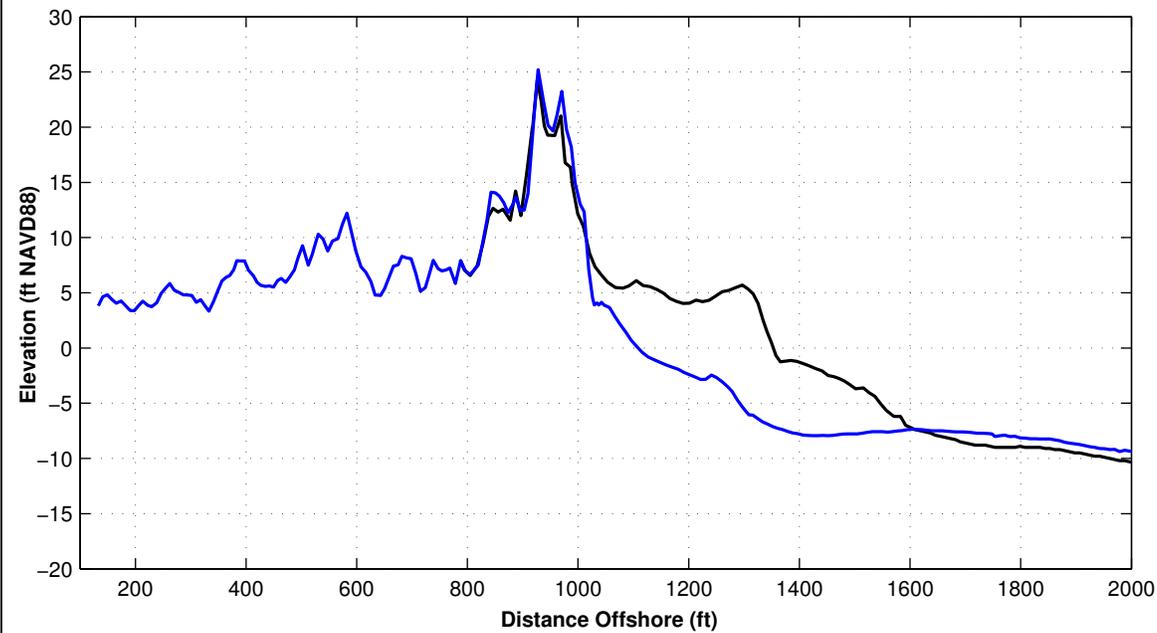
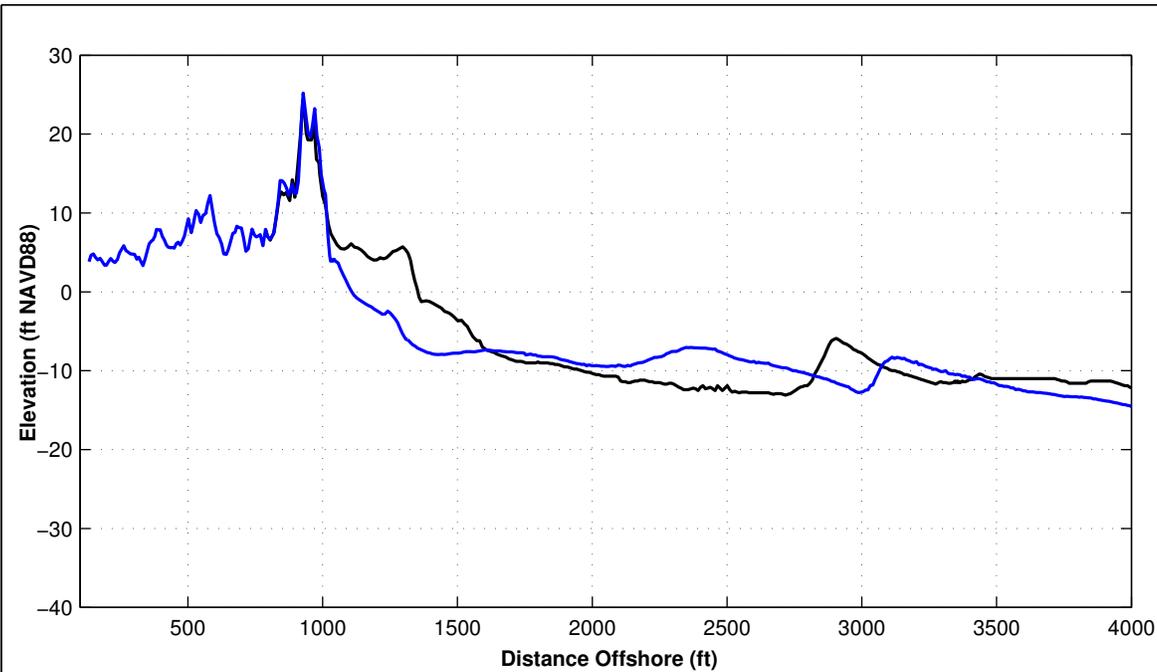
Survey Transect 1230+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	29.36 ft	-23.76 ft
Volume Change Above +6 ft NAVD88	4.81 cy/ft	4.49 cy/ft
Volume Change Above 1.18 ft NAVD88	10.29 cy/ft	0.11 cy/ft
Volume Change Above -6 ft NAVD88	20.67 cy/ft	-17.06 cy/ft
Volume Change Above -14 ft NAVD88	25.34 cy/ft	-6.49 cy/ft
Volume Change Above -19 ft NAVD88	31.92 cy/ft	-18.43 cy/ft
Volume Change Above -30 ft NAVD88	44.70 cy/ft	-34.30 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.





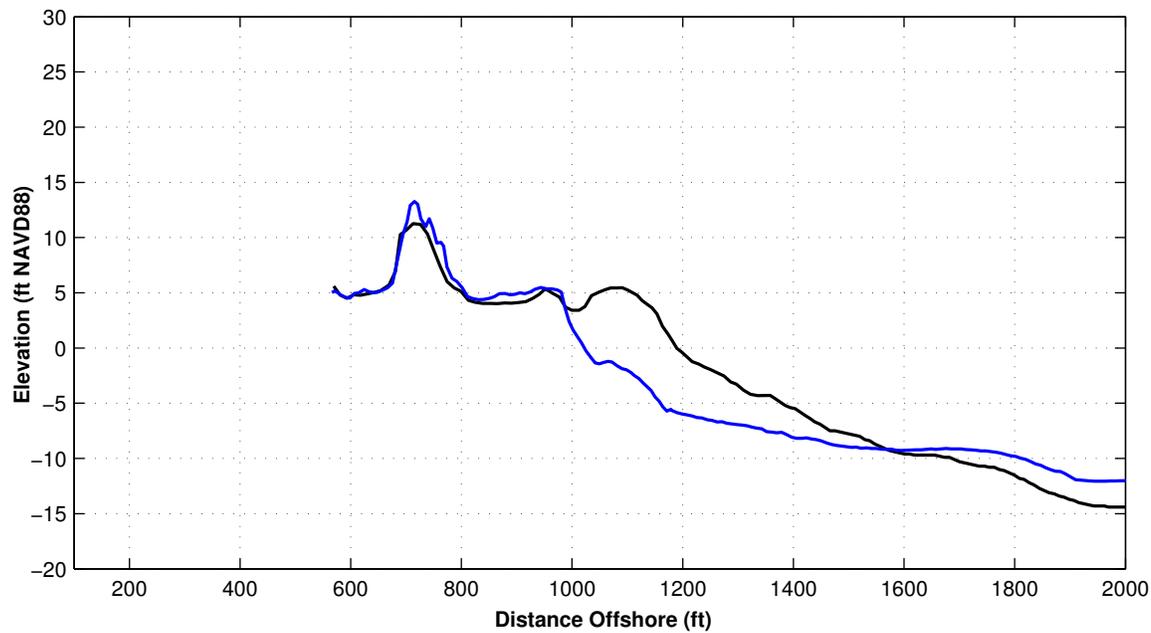
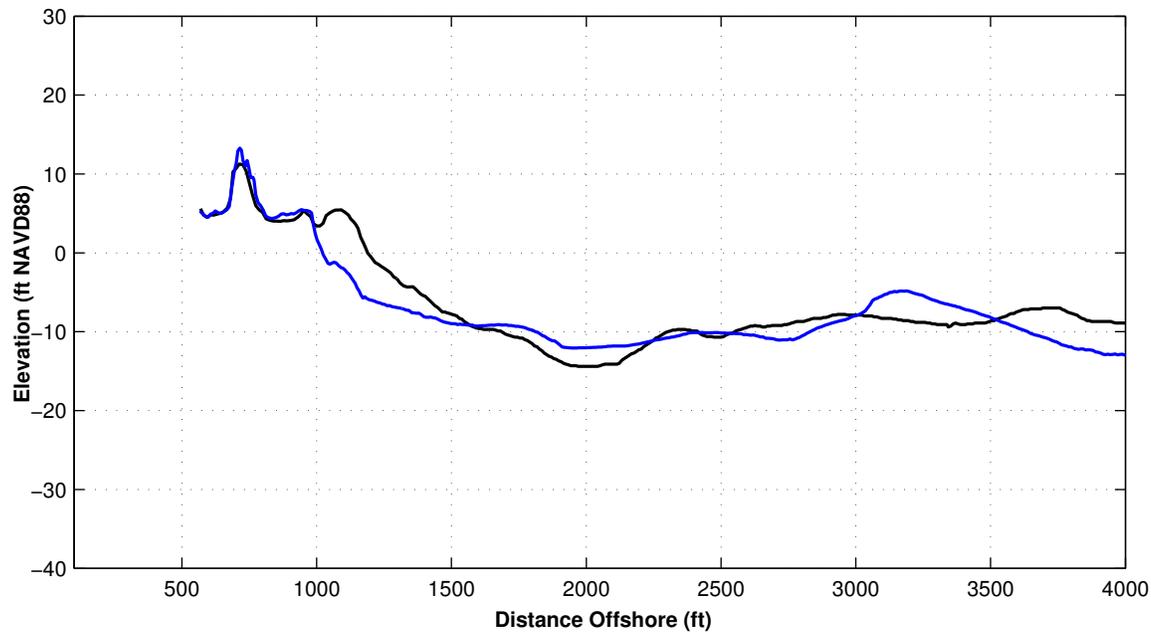
Survey Transect 1240+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-41.70 ft	7.71 ft
Volume Change Above +6 ft NAVD88	2.95 cy/ft	5.40 cy/ft
Volume Change Above 1.18 ft NAVD88	-3.91 cy/ft	7.44 cy/ft
Volume Change Above -6 ft NAVD88	-9.79 cy/ft	0.33 cy/ft
Volume Change Above -14 ft NAVD88	-20.18 cy/ft	7.67 cy/ft
Volume Change Above -19 ft NAVD88	11.26 cy/ft	-6.04 cy/ft
Volume Change Above -30 ft NAVD88	63.95 cy/ft	-101.22 cy/ft

**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



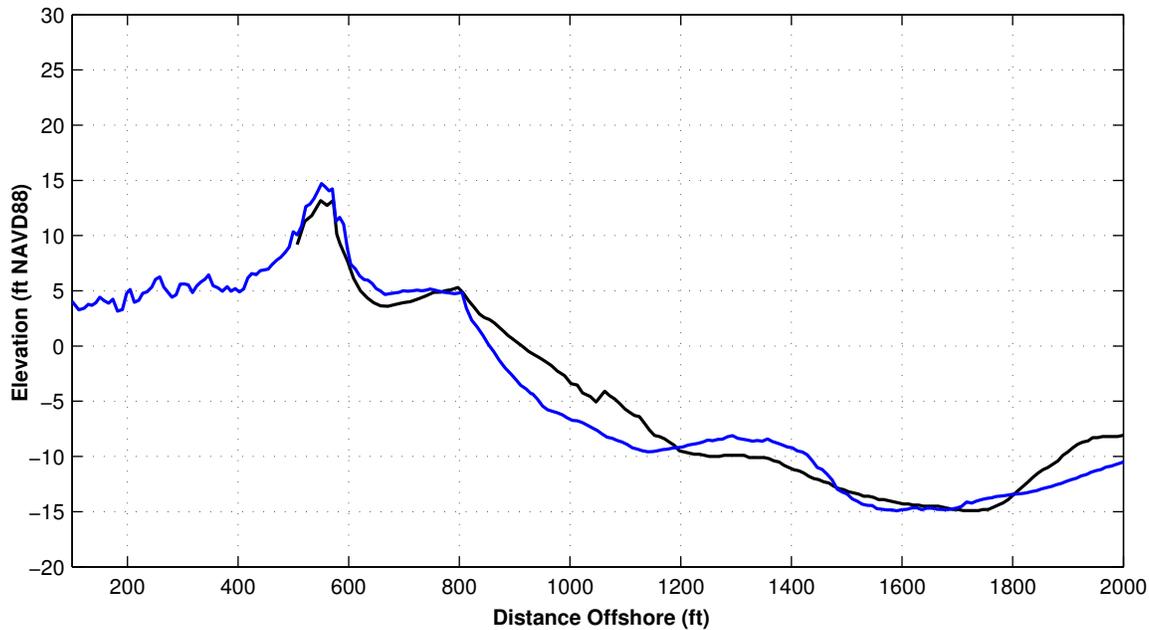
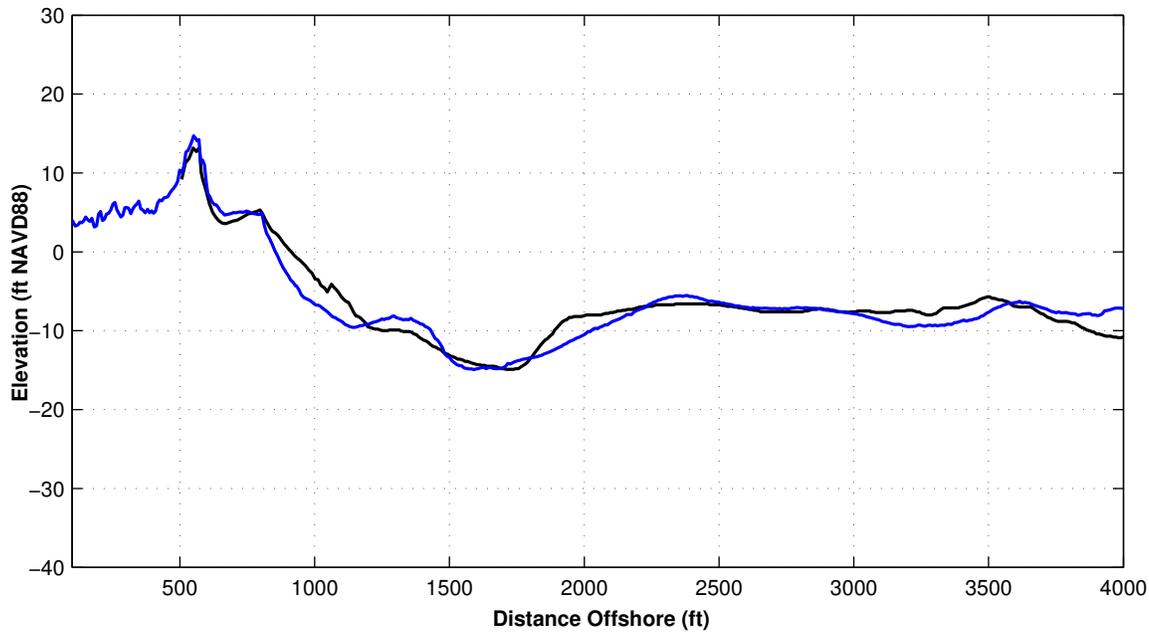


Survey Transect 1250+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-21.55 ft	8.06 ft
Volume Change Above +6 ft NAVD88	0.22 cy/ft	3.83 cy/ft
Volume Change Above 1.18 ft NAVD88	-2.61 cy/ft	5.65 cy/ft
Volume Change Above -6 ft NAVD88	-19.23 cy/ft	4.11 cy/ft
Volume Change Above -14 ft NAVD88	-29.49 cy/ft	4.03 cy/ft
Volume Change Above -19 ft NAVD88	-37.94 cy/ft	-15.81 cy/ft
Volume Change Above -30 ft NAVD88	-27.35 cy/ft	21.22 cy/ft

**LEGEND:**  
 JUNE 2024 ————  
 OCTOBER 2023 ————  
 JUNE 2023 ————

- Notes:  
 1. Station From North To South At Varying Intervals.  
 2. All Survey Elevations In Feet Referenced to NAVD88.





Survey Transect 1260+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-43.38 ft	-4.86 ft
Volume Change Above +6 ft NAVD88	5.62 cy/ft	5.06 cy/ft
Volume Change Above 1.18 ft NAVD88	0.91 cy/ft	3.70 cy/ft
Volume Change Above -6 ft NAVD88	-24.85 cy/ft	0.28 cy/ft
Volume Change Above -14 ft NAVD88	-43.62 cy/ft	19.54 cy/ft
Volume Change Above -19 ft NAVD88	-53.81 cy/ft	22.94 cy/ft
Volume Change Above -30 ft NAVD88	-17.00 cy/ft	-3.73 cy/ft

**LEGEND:**

JUNE 2024 OCTOBER 2023   
 JUNE 2023 OCTOBER 2023

**Notes:**

1. Station From North To South At Varying Intervals.
2. All Survey Elevations In Feet Referenced to NAVD88.

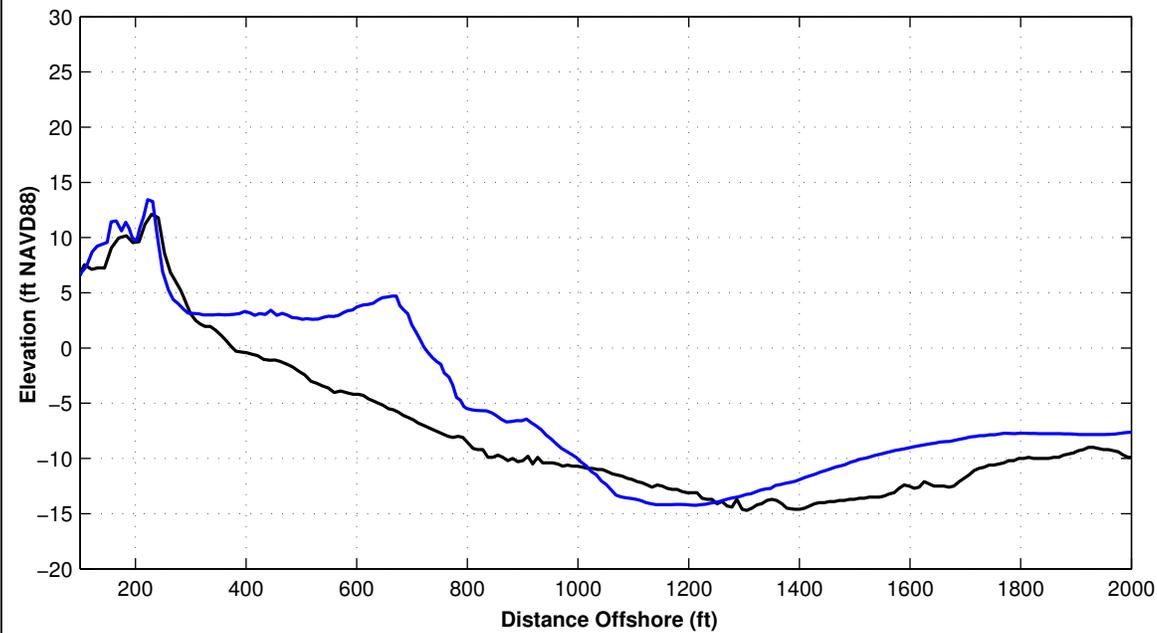
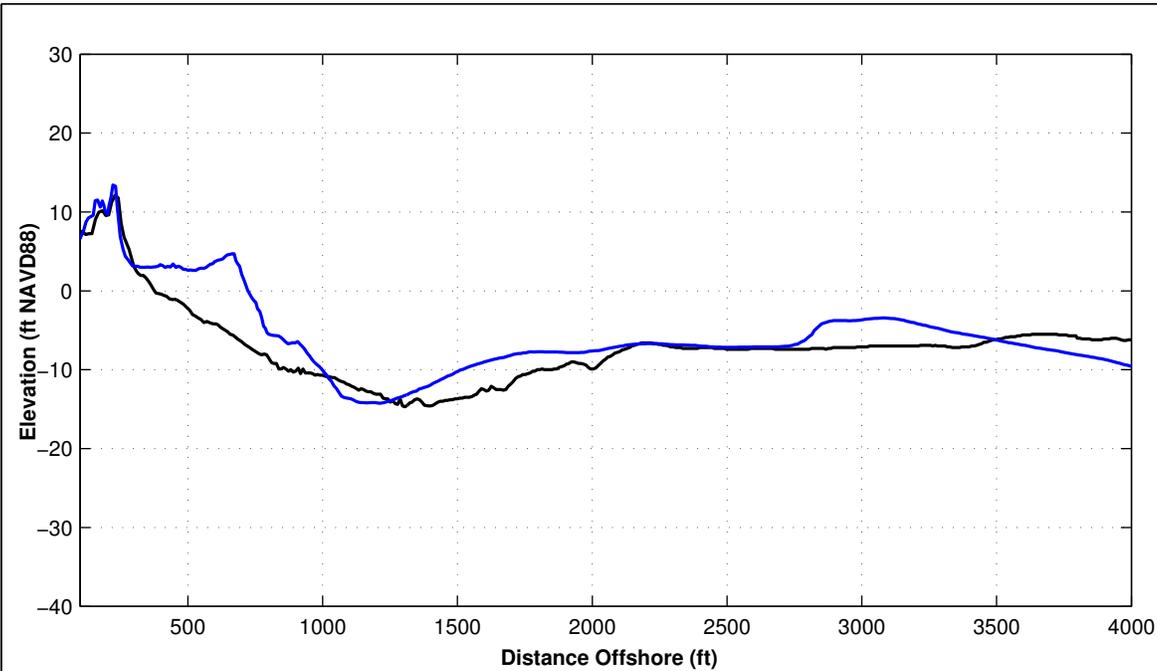


**Town of Nags Head Periodic Surveying Data Analysis**

ST 1260+00

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2024



Survey Transect 1270+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	61.27 ft	-17.50 ft
Volume Change Above +6 ft NAVD88	16.64 cy/ft	-0.53 cy/ft
Volume Change Above 1.18 ft NAVD88	26.10 cy/ft	-3.51 cy/ft
Volume Change Above -6 ft NAVD88	33.01 cy/ft	-7.92 cy/ft
Volume Change Above -14 ft NAVD88	30.41 cy/ft	-1.61 cy/ft
Volume Change Above -19 ft NAVD88	13.23 cy/ft	1.50 cy/ft
Volume Change Above -30 ft NAVD88	37.98 cy/ft	-12.79 cy/ft

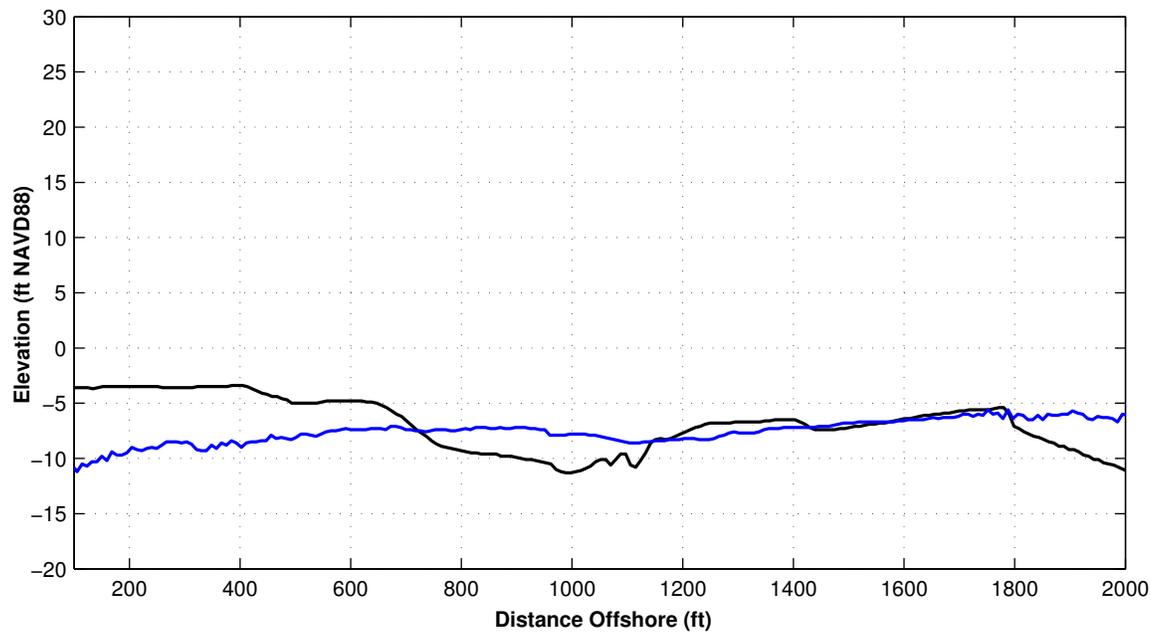
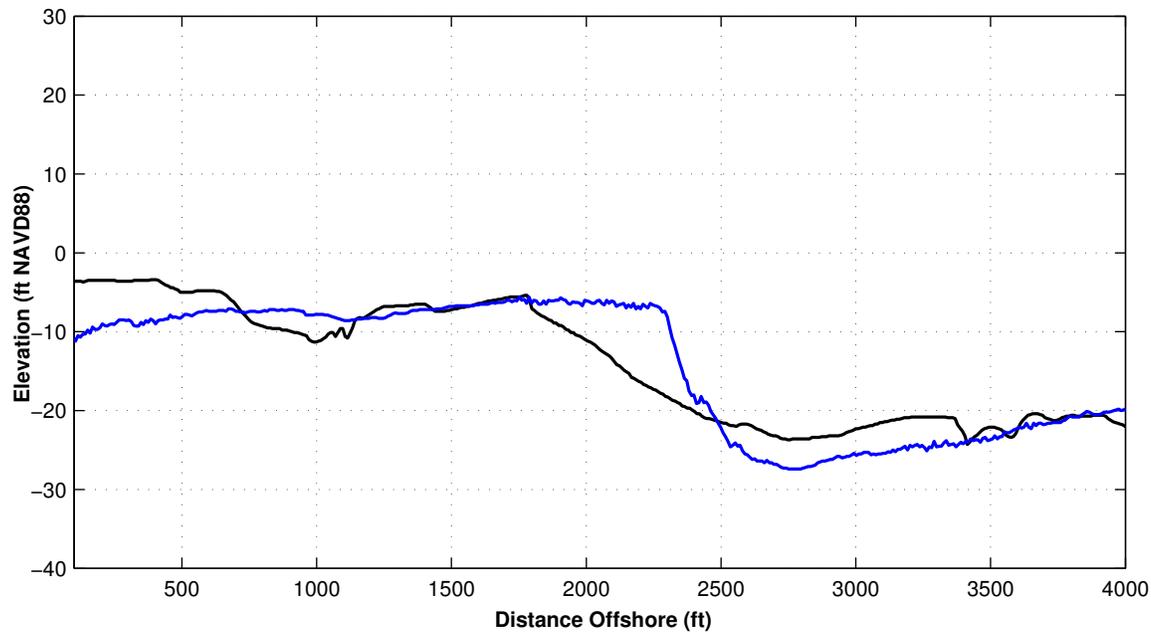
**LEGEND:**

JUNE 2024 — OCTOBER 2023 —  
 JUNE 2023 —

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.







Survey Transect 1290+00	JUNE 2023 – OCTOBER 2023	OCTOBER 2023 JUNE 2024
Shoreline Change at MHW (1.18 ft NAVD88)	-36.76 ft	27.40 ft
Volume Change Above +6 ft NAVD88	1.87 cy/ft	-0.34 cy/ft
Volume Change Above 1.18 ft NAVD88	-2.47 cy/ft	3.94 cy/ft
Volume Change Above -6 ft NAVD88	-24.01 cy/ft	14.32 cy/ft
Volume Change Above -14 ft NAVD88	-15.95 cy/ft	5.22 cy/ft
Volume Change Above -19 ft NAVD88	-41.74 cy/ft	32.08 cy/ft
Volume Change Above -30 ft NAVD88	-20.01 cy/ft	26.95 cy/ft

**LEGEND:**

JUNE 2024 —— OCTOBER 2023 ——  
 JUNE 2023 ——

- Notes:
1. Station From North To South At Varying Intervals.
  2. All Survey Elevations In Feet Referenced to NAVD88.



# APPENDIX C TABULATED SHORELINE AND VOLUME CHANGE DATA



NOTES:

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.

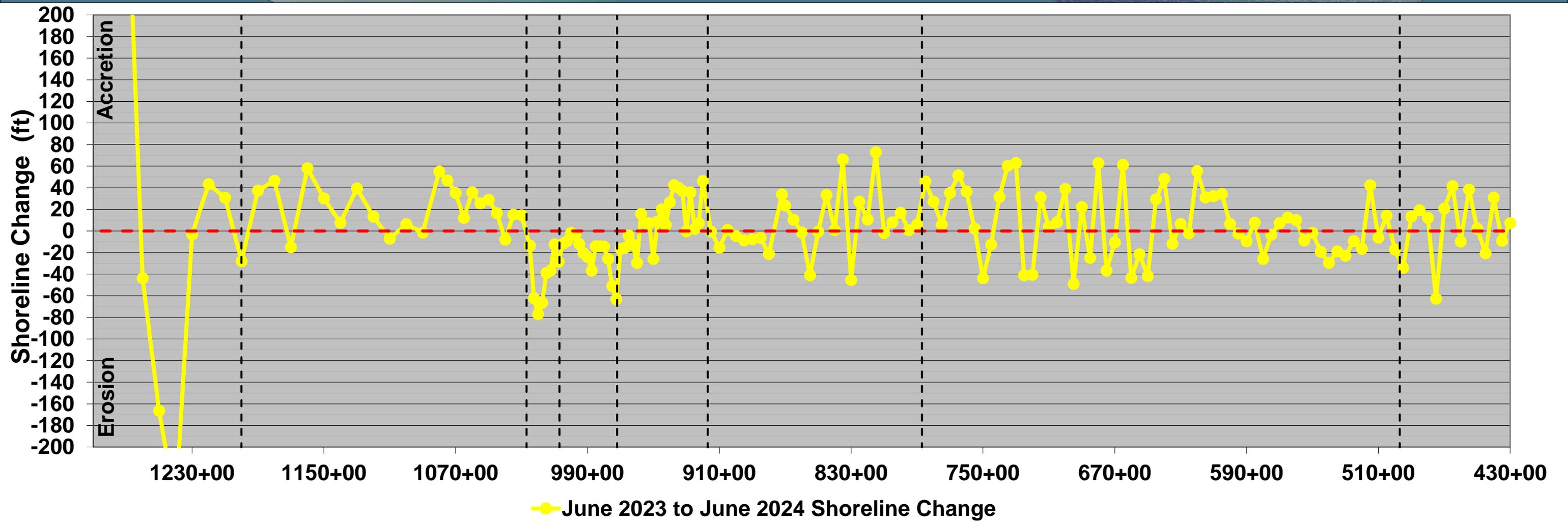
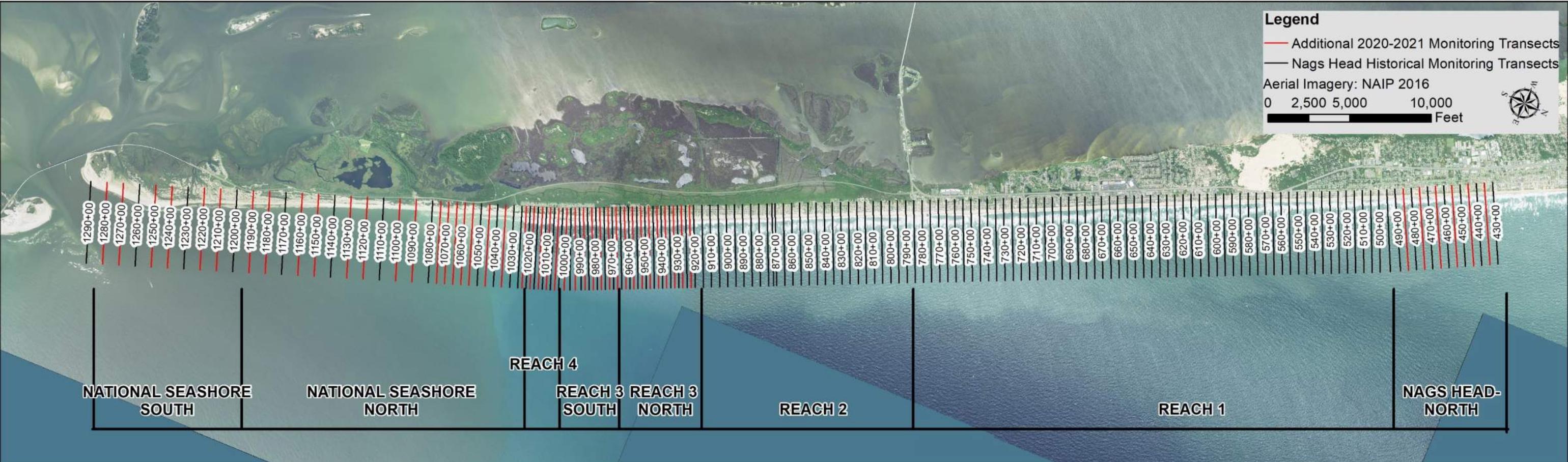
Reach	Transect Number	Station	Shoreline Change @ MHW (+1.18 ft NAVD)	Above Berm (+6 ft NAVD88)		Above MHW (+1.18 ft NAVD88)		Above -6 ft NAVD88		Above -14 ft NAVD88		Above -19 ft NAVD88		Above -30 ft NAVD88			
				2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)
				Nags Head - North	1	430+00	7.27	87.44	2.51	125.01	2.40	208.25	12.63	404.56	8.67	665.11	13.47
2	435+00	-9.18	23.57		0.73	48.00	-1.09	114.50	4.58	292.90	14.21	535.19	26.81	1377.30	44.11		
3	440+00	30.96	41.67		6.65	69.95	11.98	135.18	21.87	318.69	31.88	561.63	36.03	1409.39	52.72		
4	445+00	-20.73	24.98		1.12	46.68	-1.68	92.64	-20.52	270.96	-6.00	511.65	-6.15	1354.36	16.64		
5	450+00	2.19	31.47		1.40	55.73	2.21	104.32	-1.87	292.99	16.33	525.35	10.57	1364.57	29.78		
6	455+00	38.27	44.55		8.11	71.74	14.55	127.17	20.31	320.10	29.63	558.76	27.53	1402.46	51.57		
7	460+00	-9.71	43.71		3.24	68.70	2.83	118.61	-3.81	303.75	13.48	539.98	13.74	1379.19	33.62		
8	465+00	41.55	37.67		5.91	62.98	12.99	115.01	6.75	304.06	23.62	537.31	15.66	1375.92	38.20		
9	470+00	20.73	45.16		4.10	76.71	7.28	147.78	17.31	332.20	10.61	567.21	-2.51	1413.61	10.78		
10	475+00	-62.74	49.38		-0.10	76.60	-9.22	131.91	-36.32	320.91	-33.27	559.55	-42.50	1410.72	-27.79		
11	480+00	12.12	35.43		1.72	63.01	3.10	118.92	2.77	300.72	2.51	535.97	-9.74	1378.30	-2.53		
12	485+00	19.23	60.10		3.91	91.80	5.94	154.89	-6.24	348.27	13.75	590.69	17.64	1441.82	31.13		
13	490+00	13.32	58.66		5.60	92.27	7.94	160.42	-3.21	377.27	41.67	627.48	41.94	1479.38	52.61		
Reach 1	14	495+00	-34.16	53.30	6.45	84.28	3.77	144.95	-14.61	349.71	5.77	601.12	9.28	1450.97	23.57		
	15	500+00	-17.25	44.53	4.19	74.57	3.45	135.61	-18.69	332.81	-9.99	566.33	-25.05	1409.52	-14.90		
	16	505+00	14.16	40.69	0.60	69.05	2.51	133.80	7.55	329.85	31.10	571.34	30.37	1417.38	41.53		
	17	510+00	-6.22	29.82	-0.97	61.23	-0.83	123.30	-23.39	326.93	-7.35	535.56	9.91	1377.60	21.12		
	18	515+00	42.23	51.38	5.79	86.81	13.80	158.65	26.12	372.96	69.98	616.37	73.62	1465.86	73.98		
	19	520+00	-16.61	46.38	3.08	81.30	2.62	159.70	-3.49	383.94	30.32	632.80	39.49	1477.62	40.77		
	20	525+00	-9.30	21.25	0.52	53.97	0.34	118.26	-6.86	335.98	-0.53	577.64	-10.46	1414.15	-6.40		
	21	530+00	-22.93	26.52	-0.36	56.21	-3.63	122.45	-20.62	337.34	-11.97	582.23	-16.79	1415.20	-14.68		
	22	535+00	-18.79	35.66	-0.24	67.07	-2.11	129.55	-19.30	318.35	-36.83	561.92	-43.20	1401.41	-40.53		
	23	540+00	-29.42	42.08	-1.98	73.44	-3.82	135.94	-16.99	337.76	-18.78	585.89	-17.73	1431.69	-13.17		
	24	545+00	-19.34	42.90	2.52	75.12	1.59	142.38	-5.35	354.78	12.26	598.81	15.71	1440.92	20.61		
	25	550+00	-1.65	21.91	2.66	48.81	3.98	117.17	13.62	315.16	15.76	552.00	20.48	1377.24	30.46		
	26	555+00	-8.79	27.11	1.43	55.60	1.16	119.35	-4.98	316.76	-0.43	554.52	4.93	1379.93	15.90		
	27	560+00	10.10	18.42	1.82	44.71	5.35	104.01	3.60	298.93	0.65	535.74	8.18	1354.17	20.48		
	28	565+00	12.45	26.86	2.99	54.46	6.21	116.08	5.26	320.64	20.82	558.07	29.09	1381.25	38.55		
	29	570+00	7.36	27.00	0.90	53.66	3.90	113.05	1.41	307.66	-11.46	545.49	-4.53	1375.48	3.19		
	30	575+00	-3.54	12.79	-0.37	35.62	1.88	87.67	-1.64	279.76	1.92	514.36	8.93	1340.37	20.59		
	31	580+00	-25.93	21.45	0.98	42.71	-3.25	93.00	-11.07	270.39	-18.22	506.46	-9.84	1332.04	4.28		
	32	585+00	7.74	16.13	-1.49	43.54	2.04	103.78	3.80	297.12	-3.16	534.13	2.02	1358.69	22.05		
	33	590+00	-9.49	12.04	-0.63	37.72	-3.56	93.65	-8.40	283.64	-29.28	521.91	-25.07	1342.14	-9.32		
	34	595+00	-2.44	19.78	0.65	46.48	-0.85	104.15	-1.66	306.38	-21.51	545.93	-18.83	1366.78	-2.50		
	35	600+00	6.51	71.83	2.80	108.50	3.77	180.68	1.09	398.15	-27.60	653.45	-24.70	1502.76	-11.11		
	36	605+00	34.23	30.53	4.80	60.76	12.33	122.53	16.47	320.38	9.12	557.53	0.56	1391.12	21.52		
	37	610+00	32.20	31.96	3.89	59.58	11.63	115.89	10.38	319.48	37.91	566.13	35.93	1395.76	55.37		
	38	615+00	31.13	37.33	2.83	67.75	10.37	130.62	11.41	335.18	13.74	592.18	16.81	1429.37	41.73		
	39	620+00	55.42	42.07	15.20	79.06	23.17	165.63	37.11	380.34	64.79	633.70	68.05	1472.54	97.30		
	40	625+00	-2.11	40.56	1.80	72.99	1.17	139.72	-5.37	351.50	-1.25	601.68	-1.57	1442.58	29.61		
	41	630+00	6.42	51.99	4.13	85.40	6.83	154.05	-2.05	371.92	4.60	631.21	6.88	1474.20	37.40		
	42	635+00	-11.89	36.12	6.07	67.50	6.88	145.60	8.81	347.57	27.82	622.36	67.64	1445.18	93.79		
	43	640+00	48.31	58.52	5.24	100.28	13.69	190.90	16.74	403.14	32.79	656.67	55.22	1452.04	70.98		
	44	645+00	29.36	57.86	4.81	97.86	10.29	187.57	20.67	408.63	25.35	658.48	31.92	1407.24	44.70		
	45	650+00	-41.70	54.32	2.95	84.21	-3.91	160.97	-9.79	358.51	-20.18	618.36	11.26	1479.04	63.95		
	46	655+00	-21.55	36.21	0.22	63.29	-2.61	122.53	-19.23	308.61	-29.49	542.79	-37.94	1371.46	-27.35		
	47	660+00	-43.38	54.06	5.62	80.12	0.91	134.08	-24.85	330.70	-43.62	572.55	-53.81	1374.69	-17.00		
	48	665+00	61.27	68.91	16.64	107.68	26.10	186.50	33.01	381.08	30.41	622.27	13.23	1434.78	37.98		
	49	670+00	-10.60	36.04	0.69	62.83	-1.72	121.27	-11.34	313.87	-11.85	545.59	-31.55	1349.23	-8.27		
	50	675+00	-36.76	3.26	1.87	14.10	-2.47	44.53	-24.01	200.00	-15.95	403.61	-41.74	1173.25	-20.01		
	51	680+00	62.71	51.11	5.87	85.55	13.96	171.02	36.59	360.17	40.06	581.84	28.16	1397.51	48.16		
	52	685+00	-24.87	44.69	3.47	73.90	1.29	137.31	-10.86	330.72	0.56	561.34	-16.74	1385.81	1.80		
	53	690+00	22.14	51.37	2.35	79.51	5.20	145.69	5.54	339.65	7.30	565.35	-18.20	1385.30	-1.22		
	54	695+00	-49.04	50.85	0.42	75.44	-8.28	133.91	-19.45	326.53	-22.99	554.68	-48.51	1374.32	-27.44		
	55	700+00	38.88	49.13	-0.86	82.94	4.13	150.51	7.42	332.84	9.94	548.44	-15.15	1358.98	3.64		
	56	705+00	8.09	46.52	1.87	74.49	3.66	134.50	-6.74	329.25	14.36	538.37	-19.11	1345.37	-5.99		
	57	710+00	3.96	44.13	-1.04	70.05	-1.00	123.41	-10.59	311.90	7.62	542.71	3.04	1346.90	17.03		
	58	715+00	31.14	52.04	1.67	87.13	8.27	159.00	3.08	353.35	30.64	580.43	8.01	1384.52	21.05		
	59	720+00	-40.56	57.18	1.22	90.72	-3.17	160.68	-21.99	361.49	-36.92	591.58	-60.27	1398.69	-43.53		
	60	725+00	-41.03	37.67	3.69	65.78	-2.31	126.39	-15.61	317.57	-14.36	551.05	-26.02	1346.77	-10.93		
	61	730+00	62.85	45.67	1.91	80.05	9.56	157.79	28.44	364.56	33.05	591.27	7.07	1391.67	22.32		
	62	735+00	60.32	35.04	2.42	68.41	12.00	138.30	22.78	352.28	51.40	578.62	28.57	1377.70	50.41		
	63	740+00	31.51	43.80	0.23	78.12	4.90	146.24	4.73	343.77	-7.01	584.10	-13.98	1413.34	-2.52		
	64	745+00	-12.58	55.92	0.12	95.59	-1.60	173.45	-23.90	372.64	-29.72	606.27	-21.19	1436.87	-4.23		
	65	750+00	-43.77	73.02	-1.69	114.48	-7.67	195.62	-33.36	403.86	-99.84	640.73	-125.98	1477.73	-108.10		
	66	755+00	2.31	68.01	2.17	111.51	4.15	196.68	0.47	411.89	-28.04	653.20	-41.38	1484.75	-21.14		
	67	760+00	36.54	46.52	0.36	93.01	6.45	179.52	10.79	402.38	-12.86	661.38	-8.27	1493.72	14.42		
	68	765+00	51.50	25.29	3.10	62.77	13.15	135.39	19.95	357.63	26.67	613.11	37.32	1424.05	53.72		
	69	770+00	35.08	42.95	3.27	83.54	13.48	171.52	26.12	413.71	34.80	668.52	37.51	1497.65	51.90		
	70	775+00	5.86	63.97	3.47	105.36	4.66	205.66	1.89	434.48	-13.72	654.51	-53.28	1480.62	-39.91		
	71	780+00	27.15	26.10	2.94	71.60	6.52	174.60	21.09	413.82	14.22	687.09	29.15	1503.49	41.41		
	72	785+00	45.79	45.68	2.85	93.79	8.83	187.60	9.31	410.36	-23.95	681.26	-22.07	1506.96	-11.98		

Reach	Transect Number	Station	Shoreline Change @ MHW (+1.18 ft NAVD)	Above Berm (+6 ft NAVD88)		Above MHW (+1.18 ft NAVD88)		Above -6 ft NAVD88		Above -14 ft NAVD88		Above -19 ft NAVD88		Above -30 ft NAVD88			
				2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)	2024 Measured Volume (cy/ft)	2023-2024 Volume Change (cy/ft)
Reach 2	73	790+00	5.93	5.32	1.04	33.51	1.74	94.04	-7.60	291.07	-42.66	540.07	-38.41	1324.21	-28.98		
	74	795+00	0.71	57.28	0.61	95.87	1.53	168.30	-18.68	382.14	-33.05	638.46	-35.45	1451.58	-29.26		
	75	800+00	16.82	23.57	2.21	63.70	7.12	150.21	16.09	354.17	-3.70	600.97	-8.60	1395.20	-0.13		
	76	805+00	8.05	45.29	3.04	82.25	4.87	151.98	-1.37	364.96	-11.33	615.29	-12.93	1409.55	-4.82		
	77	810+00	-1.86	62.18	4.51	98.04	6.19	182.08	4.40	384.32	-6.91	637.80	-5.08	1433.44	6.29		
	78	815+00	72.97	54.34	5.36	95.49	15.42	186.64	25.59	367.11	-7.44	617.66	-7.57	1408.74	4.49		
	79	820+00	10.62	50.21	2.81	91.48	5.16	175.74	2.30	375.56	-15.78	624.96	-21.66	1421.19	-16.20		
	80	825+00	27.16	47.27	4.85	79.82	8.53	152.64	6.90	352.05	1.58	599.93	-2.23	1388.78	6.44		
	81	830+00	-45.40	43.03	4.50	69.90	-0.23	128.08	-21.88	318.91	-30.72	572.26	-29.52	1356.46	-18.35		
	82	835+00	66.19	22.28	3.79	55.78	13.92	130.90	25.31	306.20	5.36	543.27	-1.16	1301.26	8.26		
	83	840+00	0.89	33.05	3.65	60.95	4.83	117.37	-18.03	322.74	7.35	561.11	5.55	1321.23	17.83		
	84	845+00	33.35	59.97	8.92	106.59	16.28	205.46	21.44	420.54	37.39	675.10	45.75	1448.83	63.29		
	85	850+00	-0.67	28.00	7.63	56.90	9.26	132.54	8.42	332.19	25.72	575.96	29.17	1302.12	62.32		
	86	855+00	-41.02	51.14	7.25	87.94	5.45	172.18	-8.31	378.90	-20.95	633.69	-17.32	1416.37	-20.06		
	87	860+00	-1.25	36.11	8.22	73.94	10.21	158.17	3.41	363.00	-17.40	602.59	-23.46	1357.33	-12.40		
	88	865+00	10.39	51.56	6.40	94.20	12.24	189.75	16.29	403.63	22.77	655.30	31.42	1418.91	46.15		
	89	870+00	23.53	45.67	4.33	88.08	9.76	178.38	10.77	388.10	31.37	641.15	42.03	1401.07	57.63		
	90	872+00	33.74	33.69	5.32	73.96	13.76	153.10	11.94	352.19	16.92	597.74	23.98	1348.07	41.27		
	91	880+00	-21.33	44.75	4.20	82.34	4.27	151.88	-18.69	361.63	-29.72	609.81	-27.32	1367.67	-20.41		
	92	885+00	-6.44	47.26	7.17	87.60	11.45	166.75	-1.55	385.72	3.25	636.32	7.24	1422.46	21.53		
93	890+00	-7.56	43.27	7.46	84.41	11.61	160.83	-6.01	376.08	-8.81	618.95	-10.42	1406.59	6.22			
94	895+00	-8.73	48.06	6.48	86.62	7.61	158.64	-10.45	369.76	-19.77	617.50	-14.39	1391.35	-2.80			
95	900+00	-4.64	55.07	5.18	96.24	9.93	172.34	-12.30	386.31	-21.01	634.65	-16.18	1415.09	-0.69			
96	905+00	0.88	16.13	0.40	45.06	6.37	102.69	-12.21	296.88	-2.81	532.51	-0.75	1278.73	13.30			
97	910+00	-15.49	30.20	4.57	62.57	4.37	125.04	-13.16	312.22	-38.87	544.33	-43.10	1296.56	-27.72			
98	915+00	-0.50	8.03	3.43	33.09	6.50	84.56	-11.07	274.45	-16.14	498.72	-19.16	1237.71	-1.64			
Reach 3 - North	99	920+00	46.20	57.91	4.61	100.67	13.15	179.99	1.29	388.16	-3.16	633.16	-1.21	1414.50	3.41		
	100	922+50	7.30	68.17	8.24	110.37	12.84	188.21	-1.91	394.12	-12.09	635.90	-14.89	1419.64	2.01		
	101	925+00	1.87	61.85	5.12	104.96	8.88	183.43	-10.47	387.85	-17.62	631.94	-19.92	1411.58	-7.43		
	102	927+50	35.78	48.53	4.75	88.63	11.61	161.56	-11.10	358.59	-44.81	601.23	-50.65	1371.31	-42.44		
	103	930+00	-0.27	39.82	2.87	80.09	6.43	154.13	-15.73	338.72	-50.53	582.32	-52.14	1351.07	-42.75		
	104	932+50	37.21	57.21	6.76	96.74	14.21	170.56	9.27	355.46	-11.13	589.07	-20.52	1350.86	-16.18		
	105	935+00	40.13	58.56	3.85	106.52	9.88	193.26	-0.55	412.65	-14.18	664.92	-17.70	1437.86	-18.12		
	106	937+50	42.43	35.39	5.80	70.54	12.95	137.07	9.99	338.61	2.26	575.51	0.99	1310.99	-3.46		
	107	940+00	26.63	59.20	4.55	109.71	9.13	201.87	-6.23	414.27	-34.06	663.33	-39.61	1422.60	-41.97		
	108	942+50	5.57	52.73	2.71	94.95	4.66	171.97	-14.33	369.95	-42.82	611.83	-44.91	1353.35	-38.18		
	109	945+00	20.05	45.69	0.48	92.41	3.81	177.03	-13.08	383.22	-45.25	631.11	-48.49	1396.33	-42.77		
	110	947+50	8.79	27.08	3.62	58.96	6.77	121.52	-19.53	302.04	-61.75	536.71	-62.52	1292.30	-57.46		
	111	950+00	-25.81	55.82	4.83	93.65	4.07	162.31	-28.92	352.78	-67.08	594.86	-65.94	1380.03	-55.09		
	112	952+50	7.23	34.97	-1.62	77.76	0.53	156.51	-17.91	338.97	-61.12	582.05	-62.08	1376.03	-51.92		
	113	955+00	7.48	63.70	2.92	114.49	4.75	204.50	-11.80	404.69	-39.06	650.54	-40.51	1459.10	-28.65		
	114	957+50	15.84	50.59	3.09	92.75	4.78	171.67	-6.05	369.88	-19.42	608.94	-12.50	1393.78	1.47		
	115	960+00	-29.42	75.04	5.38	123.28	1.23	209.58	-21.43	432.82	-27.79	690.16	-4.57	1497.01	-2.97		
	116	962+50	-12.48	36.54	2.61	70.11	0.60	133.08	-7.84	344.86	5.75	597.07	22.68	1366.48	26.91		
	117	965+00	-4.09	51.52	5.27	98.35	4.12	184.28	1.43	380.59	-49.41	638.00	-52.94	1423.61	-51.56		
	118	967+50	-15.73	30.68	2.19	64.68	-2.54	132.04	-11.70	314.20	-54.64	546.25	-84.06	1302.80	-79.13		
119	970+00	-16.64	45.06	-0.17	84.19	-5.17	158.12	-28.58	351.26	-92.24	580.36	-113.63	1345.53	-114.19			
Reach 3 - South	120	972+50	-63.16	68.19	1.03	111.53	-7.70	190.30	-27.55	399.83	-64.13	645.85	-72.21	1435.83	-69.08		
	121	975+00	-50.98	55.91	1.68	95.68	-7.48	169.40	-24.34	374.41	-64.35	620.33	-69.71	1386.20	-72.48		
	122	977+50	-25.84	76.44	4.08	121.03	-1.00	203.38	-9.37	402.74	-64.41	657.29	-64.61	1443.72	-75.48		
	123	980+00	-14.38	17.84	-3.96	50.14	-7.48	114.30	-14.86	295.02	-62.35	539.53	-61.09	1308.31	-57.06		
	124	982+50	-14.08	37.64	3.49	67.87	1.30	128.46	-9.07	314.72	-32.74	555.96	-29.92	1319.04	-23.53		
	125	985+00	-14.11	6.76	-0.25	27.39	-3.06	72.79	-11.80	237.21	-36.12	469.14	-28.99	1208.07	-22.67		
	126	987+50	-36.77	0.00	-0.21	7.57	-5.58	34.01	-18.99	166.46	-44.63	381.86	-41.99	1088.25	-33.36		
	127	990+00	-24.04	9.02	-2.28	32.31	-5.99	83.14	-14.90	237.94	-63.50	462.71	-67.47	1192.15	-62.75		
	128	992+50	-20.57	18.22	-0.70	43.50	-3.83	96.86	-15.30	263.93	-46.85	486.94	-52.50	1217.25	-61.38		
	129	995+00	-11.96	2.00	0.17	19.61	-1.18	59.63	-14.72	216.84	-44.86	432.41	-43.45	1147.35	-20.91		
	130	997+50	-3.65	33.16	1.23	65.66	1.49	128.08	-1.96	305.84	-25.23	536.74	-2.94	1292.47	17.64		
	131	1000+00	-1.66	5.86	-0.54	28.45	-1.17	78.50	-5.10	245.39	-19.28	468.38	-26.57	1211.98	-32.24		
	132	1002+50	-9.48	2.55	-1.36	20.38	-1.86	61.45	-6.47	228.78	-5.17	445.97	0.52	1169.81	-4.56		
	133	1005+00	-11.89	14.89	-2.47	40.50	-5.03	93.50	-9.89	265.54	-23.02	490.57	-15.54	1221.40	-20.52		
Reach 4	134	1007+50	-28.48	28.46	-1.59	57.43	-5.58	115.40	-14.21	300.04	-25.00	531.10	-8.36	1265.62	-13.70		
	135	1010+00	-12.39	4.38	-1.86	22.43	-5.01	70.59	-8.91	238.73	-26.12	461.67	-5.75	1175.10	-7.21		
	136	1012+50	-36.69	25.19	-0.14	49.81	-5.30	107.86	-11.17	283.92	-30.31	513.12	-11.21	1235.00	-14.03		
	137	1015+00	-38.83	13.44	-2.41	30.16	-10.18	77.36	-18.88	246.06	-34.34	468.81	-15.76	1175.10	-17.86		
	138	1017+50	-66.43	25.63	-3.44	42.21	-15.29	91.30	-27.32	264.00	-49.50	490.07	-23.43	1201.64	-20.60		
	139	1020+00	-76.86	1.90	-4.83	5.97	-18.17	38.14	-32.05	192.05	-53.04	409.52	-34.50	1100.61	-37.78		
	140	1022+50	-62.17	14.85	-3.26	26.15	-14.06	70.72	-22.30	230.44	-43.63	452.92	-22.24	1161.95	-17.72		
	141	1025+00	-13.50	1.19	-0.82	12.49	-3.48	60.02	4.71	216.46	-7.12	425.67	8.65	1133.36	13.73		



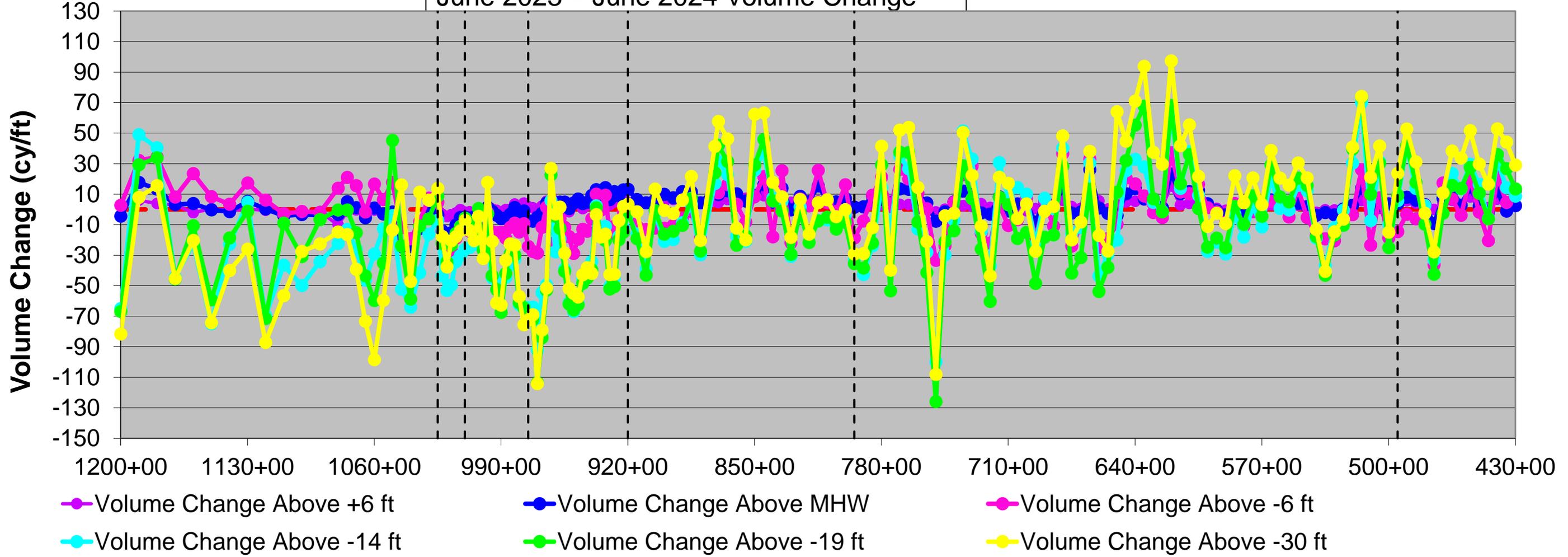
# APPENDIX D SHORELINE AND VOLUME CHANGE PLOTS







June 2023 – June 2024 Volume Change



# APPENDIX E REACH 4 OBSERVED ESCARPMENT SURVEY ANALYSIS



## MEMORANDUM

To: David Ryan, Town Engineer, Town of Nags Head

From: Ayse Karanci, Project Manager & Beth Sciaudone, Assistant Project Manager

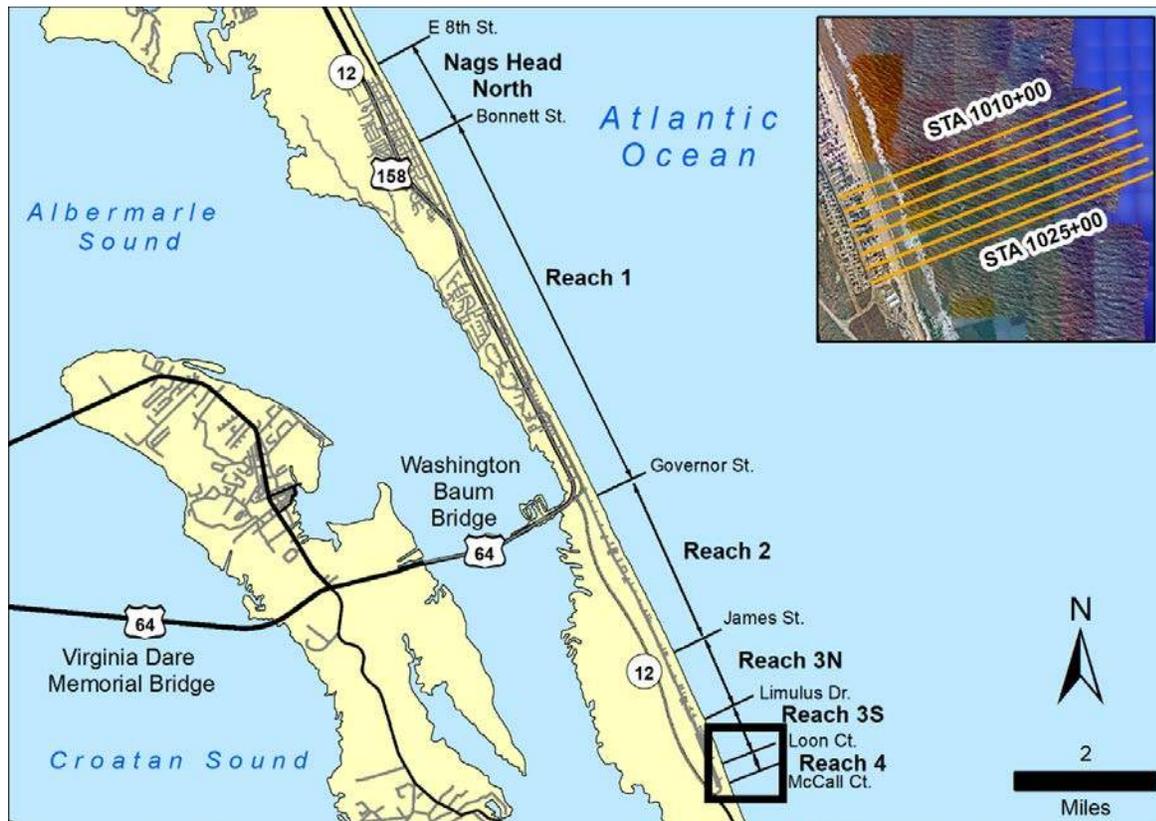
Date: September 24, 2024

Subject: Observed Escarpment Survey Analysis at McCall Ct. (Reach 4) Memo Report

This memo provides survey data and brief analysis of volumetric changes observed from late June to late July, 2024, in South Nags Head adjacent to McCall Ct. This segment of shoreline is within Reach 4 of the monitoring area, and was initially surveyed June 24-25, 2024. Due to observed erosion and escarpment formation (Figure 1), the Town of Nags Head requested that McKim and Creed resurvey the transects from STA 1010+00 to STA 1025+00 to quantify the volumetric changes. The second survey of those transect lines was completed on July 31, 2024. A location map of the surveyed transect lines is presented in Figure 2.



**Figure 1. Scarping observed adjacent to McCall Ct. on July 27, 2024. (D. Ryan Photo)**



**Figure 2. Location map of surveyed transect lines 1010+00 to 1025+00.**

The computed profile volumes above the varying datums developed for the annual monitoring program for the late June survey are presented in Table 1. Note that the profile volume above the -19 ft NAVD88 elevation at Transects 1020+00 and 1025+00 were below the reach trigger volume, 446 cy/ft, during this survey.

**Table 1. Profile Volumes, June 2024 (cubic yards per linear foot)  
[Reach 3&4 Trigger Volume above -19 ft: 446 cy/ft]**

	Above Berm Height (+6 ft NAVD88)	Above MHW (+1.18 ft NAVD88)	Above -6 ft NAVD88	Above -14 ft NAVD88	Above -19 ft NAVD88	Above -30 ft NAVD88
	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
<b>1010+00</b>	4.43	24.65	70.79	235.67	459.73	1172.46
<b>1012+50</b>	24.98	52.28	111.41	288.65	518.87	1240.89
<b>1015+00</b>	13.43	34.51	82.64	255.89	478.41	1183.62
<b>1017+50</b>	26.65	49.42	100.28	277.38	504.49	1216.38
<b>1020+00</b>	4.98	15.97	49.41	206.69	<b>424.96</b>	1116.54
<b>1022+50</b>	15.70	33.24	78.55	239.92	463.75	1172.86
<b>1025+00</b>	1.26	16.80	63.97	223.07	<b>433.28</b>	1141.60

The computed profile volumes above the varying datums developed for the annual monitoring program for the late July survey are presented in Table 2. The profile volume above the -19 ft NAVD88 elevation at Transects 1020+00 and 1025+00 were further below the reach trigger volume during this survey. The computed volume changes are presented in Table 3. The largest volume changes were observed at STA 1017+50 and STA 1020+00, and it is noted that with the exception of STA 1010+00, net volume loss was observed at all of the surveyed transects. This suggests that sediment removed from the dry sand beach/berm was not simply deposited locally offshore but rather there was significant longshore transport removing sand from the surveyed area. Plots of the surveyed profiles are shown in Figure 3 to Figure 9. There is some nearshore deposition shown in some of the profiles, generally between the -5 ft and -10 ft NAVD88 elevations, however as indicated by the volume change analysis, there is net loss of sand from all of the profiles except STA 1010+00.

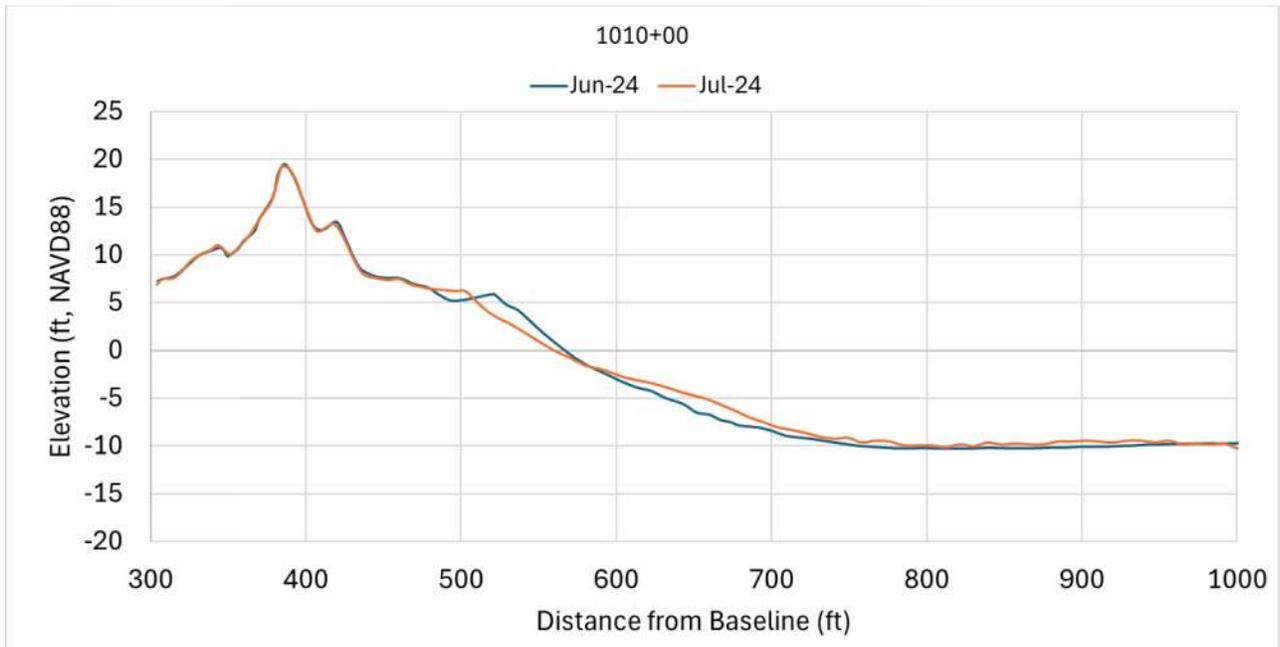
For comparison purposes, the average annual volume change in Reach 4 above -19 ft NAVD88 is -48,699 cy over 2,000 ft alongshore, or approximately -24.3 cy/ft. The changes over this June-July timeframe are on the order of half of the expected annual losses.

**Table 2. Profile Volumes, July 2024 (cubic yards per linear foot)  
[Reach 3&4 Trigger Volume above -19 ft: 446 cy/ft]**

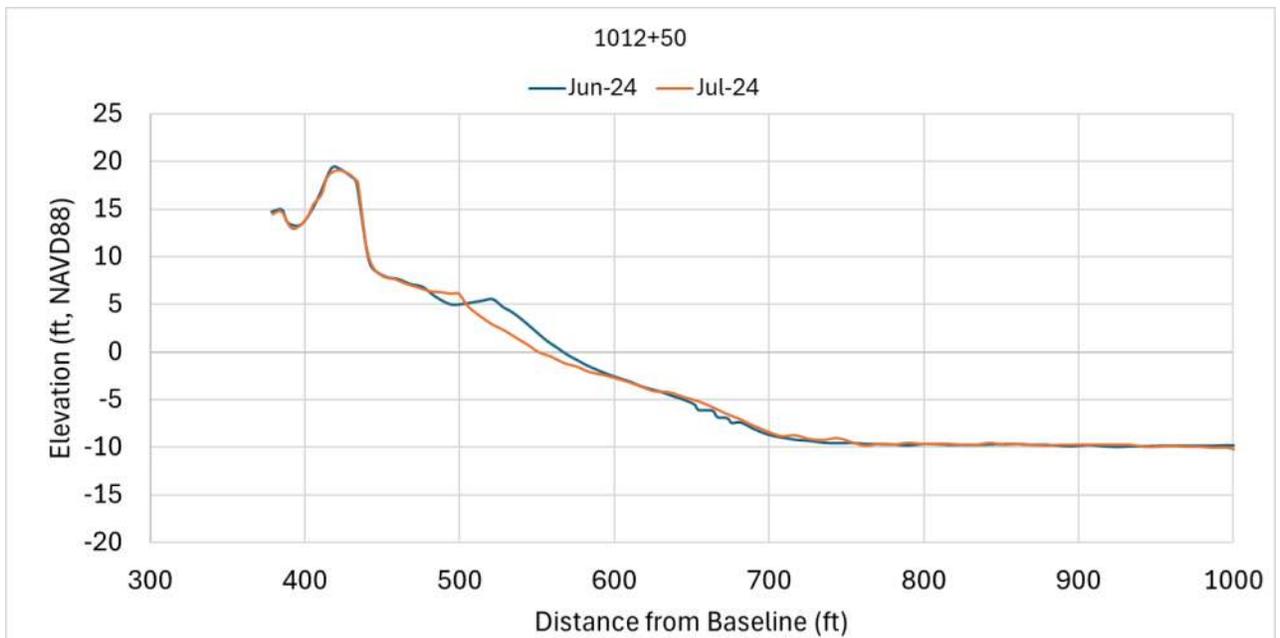
	<b>Above Berm Height (+6 ft NAVD88)</b>	<b>Above MHW (+1.18 ft NAVD88)</b>	<b>Above -6 ft NAVD88</b>	<b>Above -14 ft NAVD88</b>	<b>Above -19 ft NAVD88</b>	<b>Above -30 ft NAVD88</b>
	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
<b>1010+00</b>	4.38	22.43	70.59	238.73	461.67	1175.10
<b>1012+50</b>	25.19	49.81	107.86	283.92	513.12	1235.00
<b>1015+00</b>	13.44	30.16	77.36	246.06	468.81	1175.10
<b>1017+50</b>	25.63	42.21	91.30	264.00	490.07	1201.64
<b>1020+00</b>	1.90	5.97	38.14	192.05	<b>409.52</b>	1100.61
<b>1022+50</b>	14.85	26.15	70.72	230.44	452.92	1161.95
<b>1025+00</b>	1.19	12.49	60.02	216.46	<b>425.67</b>	1133.36

**Table 3. Volume Change, June to July 2024 (cubic yards per linear foot)**

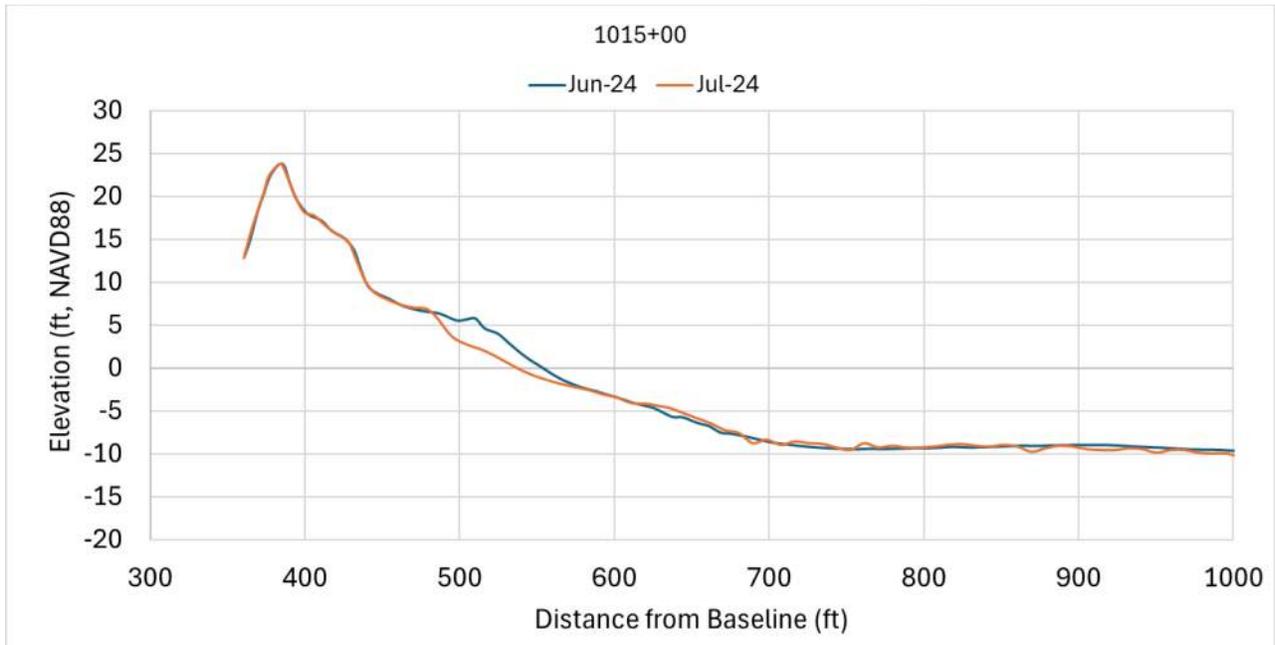
	<b>Above Berm Height (+6 ft NAVD88)</b>	<b>Above MHW (+1.18 ft NAVD88)</b>	<b>Above -6 ft NAVD88</b>	<b>Above -14 ft NAVD88</b>	<b>Above -19 ft NAVD88</b>	<b>Above -30 ft NAVD88</b>
	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft	cy/ft
<b>1010+00</b>	-0.05	-2.22	-0.20	3.06	1.93	2.64
<b>1012+50</b>	0.21	-2.48	-3.56	-4.73	-5.75	-5.89
<b>1015+00</b>	0.01	-4.34	-5.28	-9.83	-9.60	-8.52
<b>1017+50</b>	-1.02	-7.21	-8.98	-13.38	-14.42	-14.74
<b>1020+00</b>	-3.08	-10.00	-11.27	-14.63	-15.44	-15.93
<b>1022+50</b>	-0.86	-7.09	-7.84	-9.47	-10.83	-10.91
<b>1025+00</b>	-0.07	-4.31	-3.95	-6.61	-7.61	-8.23



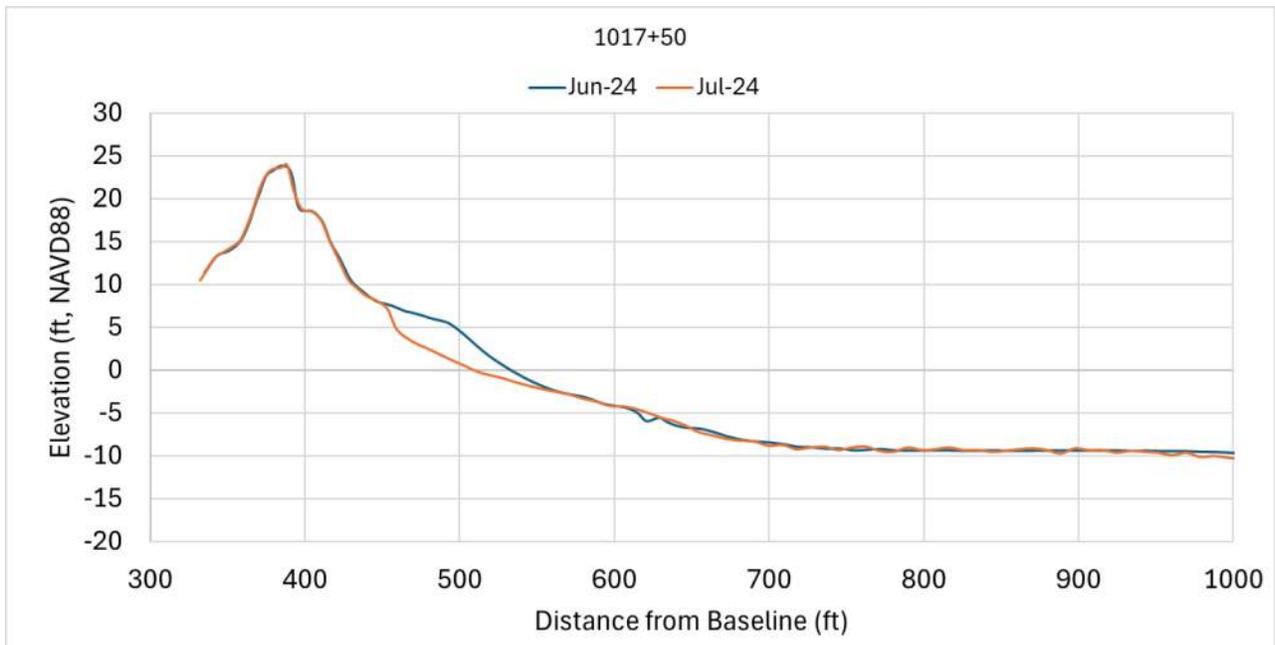
**Figure 3. Transect STA 1010+00 Observed Change, June to July 2024.**



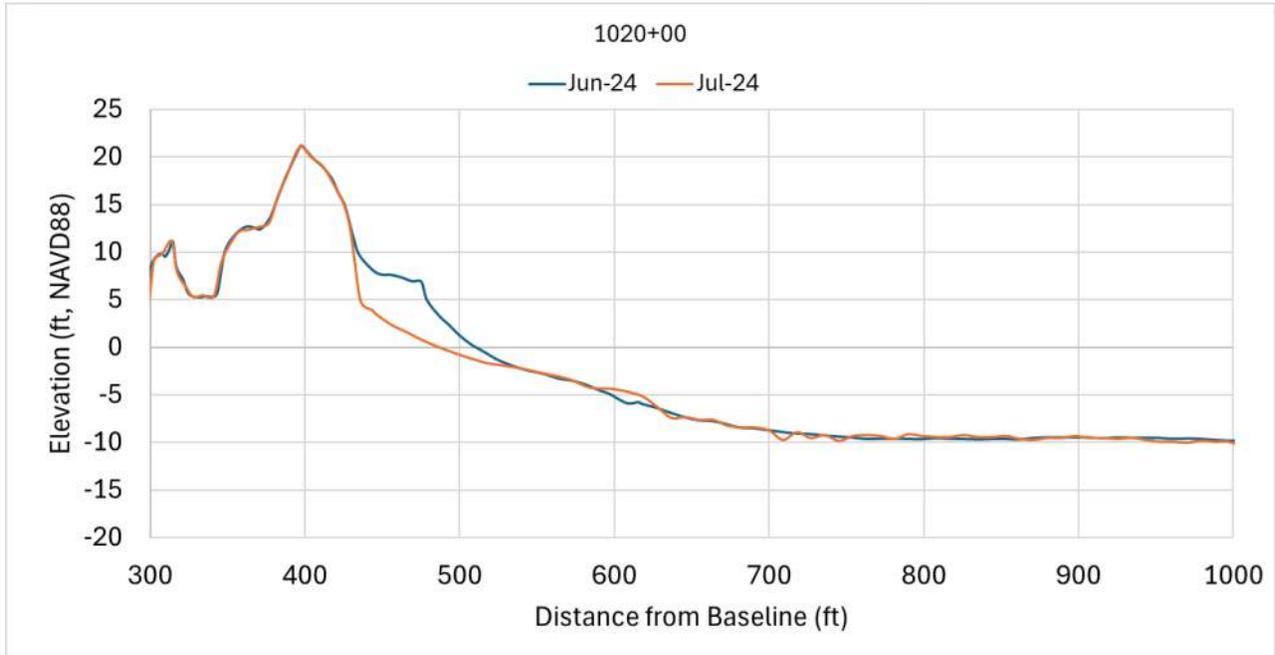
**Figure 4. Transect STA 1012+50 Observed Change, June to July 2024.**



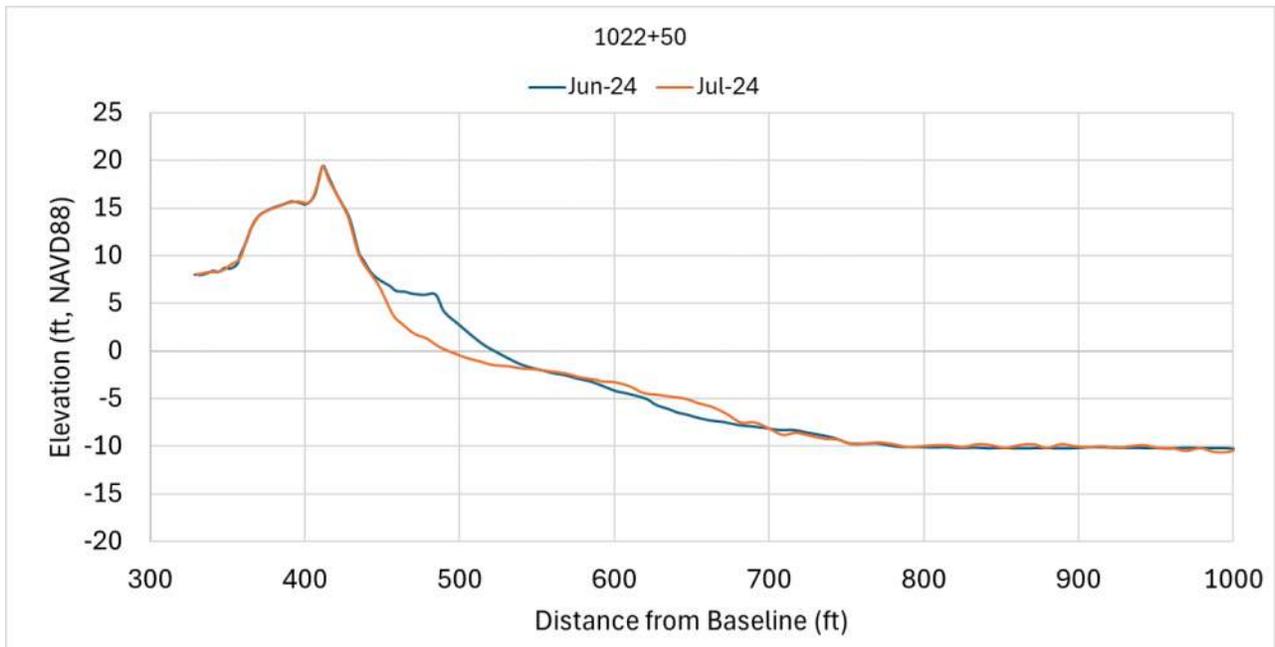
**Figure 5. Transect STA 1015+00 Observed Change, June to July 2024.**



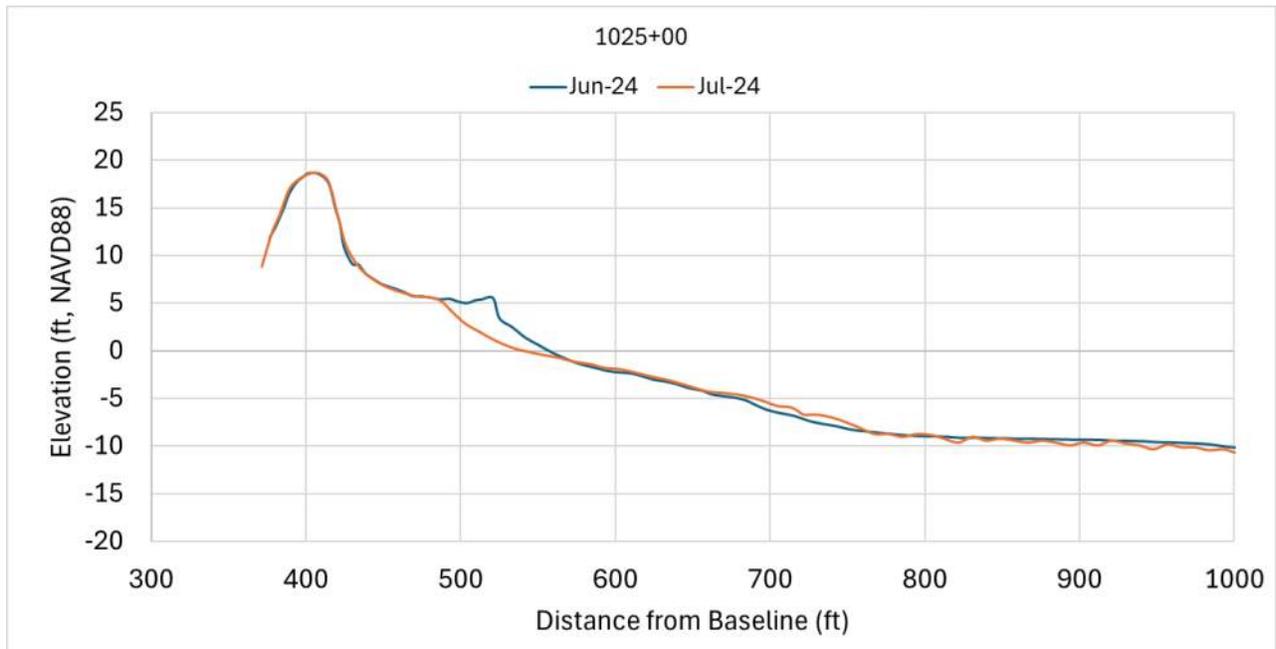
**Figure 6. Transect STA 1017+50 Observed Change, June to July 2024.**



**Figure 7. Transect STA 1020+00 Observed Change, June to July 2024.**

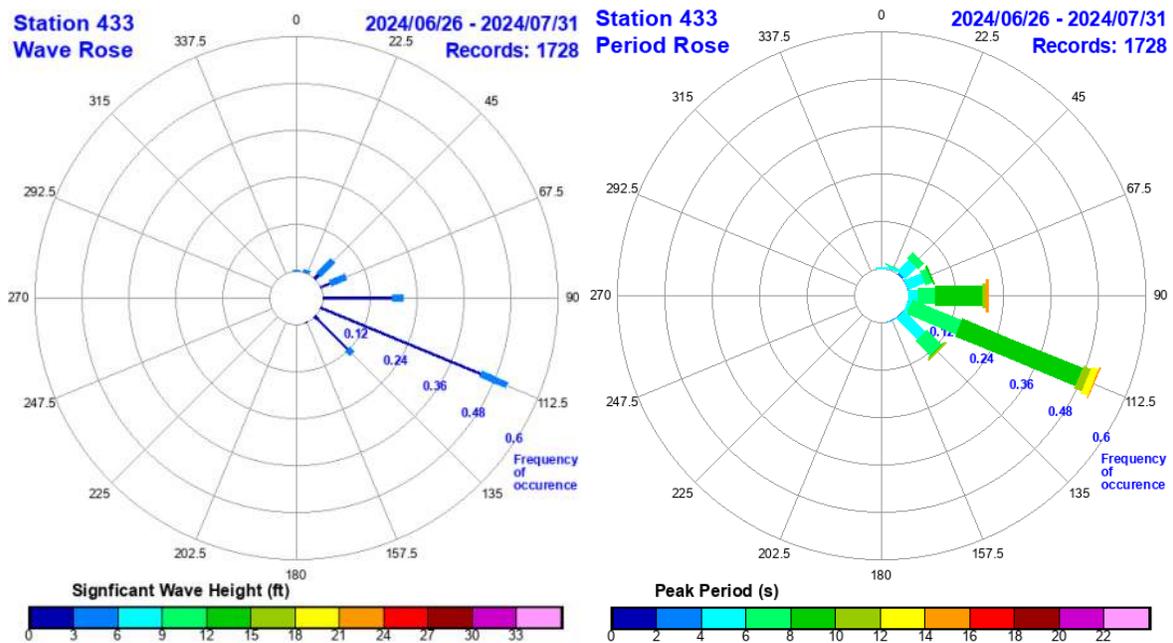


**Figure 8. Transect STA 1022+50 Observed Change, June to July 2024.**



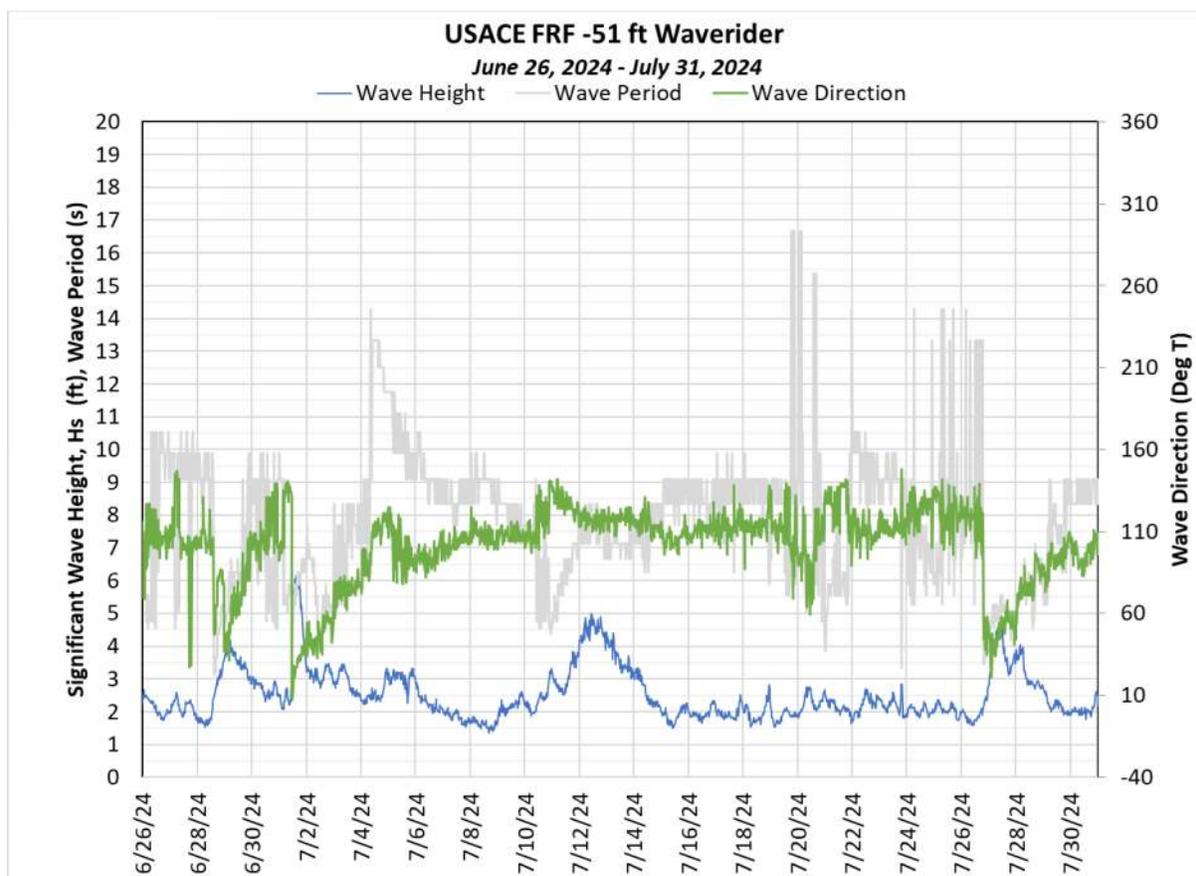
**Figure 9. Transect STA 1025+00 Observed Change, June to July 2024.**

Wave height and period rose plots for the time period between surveys are shown in Figure 10. As shown in the figure, waves were predominantly from the east-southeast during this time period, with wave periods generally from 8 to 10 seconds.



**Figure 10. Wave Height (left) and Wave Period (right) Roses for June 26, 2024 to July 31, 2024, at Station 433 (Duck -51ft waverider buoy).**

The wave properties time series is presented in Figure 11. This time series shows that although the predominant wave direction over this time frame was from the east-southeast, there were a number of higher wave events (~4-5 ft wave heights) coming from the northeast. Several of these events, including the event occurring immediately prior to and during the observed scarping, were characterized by shorter wave periods, resulting in more choppy conditions rather than swell. One hypothesis may be that these shorter-term events moved sand from the dry sand beach and dune to the nearshore, where the east-southeasterly waves then transported it alongshore to the north. There may also be some sand waves or other bathymetric features offshore of the surveyed areas that are concentrating wave energy within the area where the scarping has been observed.



**Figure 11. Wave Height (blue), Period (gray), and Direction (green) Time Series for June 26, 2024 to July 31, 2024, at Duck -51ft waverider buoy.**

The shoreline change at the mean high water (MHW) elevation was also examined and is presented in Table 4. The largest changes were observed at Stations 1017+50, 1020+00, and 1022+50, with approximately 30 ft of shoreline erosion observed at those transects. At the time of the survey, and subsequently during a site visit on August 2, 2024, there was little to no dry beach present at the site during high tide.

**Table 4. Shoreline Change, June to July 2024**

	<b>June Shoreline Position @ MHW (+1.18 ft NAVD88)</b>	<b>July Shoreline Position @ MHW (+1.18 ft NAVD88)</b>	<b>Shoreline Change @ MHW (+1.18 ft NAVD88)</b>
	ft	ft	ft
<b>1010+00</b>	557.664	547.957	-9.707
<b>1012+50</b>	556.098	540.023	-16.075
<b>1015+00</b>	543.696	525.737	-17.959
<b>1017+50</b>	522.53	495.096	-27.434
<b>1020+00</b>	500.518	471.063	-29.455
<b>1022+50</b>	511.544	479.555	-31.989
<b>1025+00</b>	544.228	521.64	-22.588

Summary

The transects STA 1010+00 to 1025+00 were surveyed at the end of June 2024 and again at the end of July 2024 after significant erosion and scarping were reported. Examination of the profile survey data indicates that there was net loss of volume above the -30 ft NAVD88 elevation contour in all of the profiles except STA 1010+00. Some deposition was observed in the nearshore on the majority of the profiles, however, most of the sand eroded from these profiles was transported alongshore out of the immediate area and based on a qualitative assessment of the wave directions, it seems likely that it may have been transported to the north. Observations in late July and early August suggest that in this section of Reach 4, there is little to no dry beach during high tides. Additionally, reach trigger volumes are exceeded at two of the surveyed transects (1020+00 and 1025+00). The combination of these observations along with continued high wave and water level events, merit continued monitoring to assess and determine appropriate next steps.