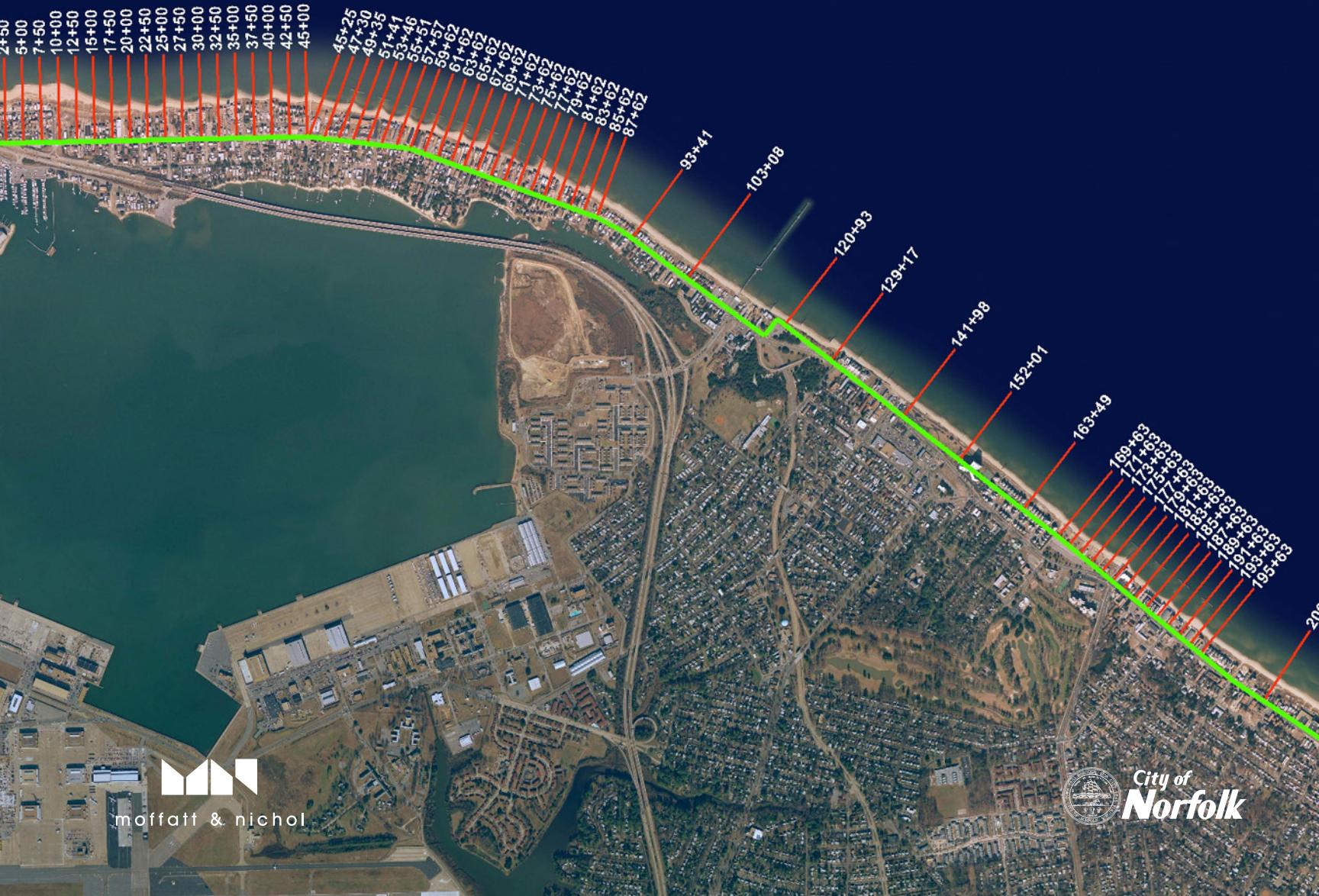


PERIODIC SURVEY EVALUATION: OCEAN VIEW BEACH



City of Norfolk, Virginia | Fall 2017 | PN: 9169-25



moffatt & nichol



City of
Norfolk

Periodic Survey Evaluation: Ocean View Beach Fall 2017

Presented to:

City of Norfolk

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Prepared by:



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1. Executive Summary

The twenty-fifth consecutive twice-yearly survey of the Ocean View shoreline was conducted on October 13 - 16, 2017. The study area extends from the western end of Willoughby Spit to the western edge of Little Creek Inlet in East Ocean View. The periodic surveys are typically collected bi-annually in March/April and September/October to monitor the condition of the shoreline and the state of existing shore protection projects. The Federal coastal storm damage reduction project was constructed by Norfolk District U.S. Army Corps of Engineers (USACE) in mid-May 2017. This report documents the first monitoring survey following the initial adjustment period of the Federal Project, illustrating changes in the Federal Project beach and nearshore conditions approximately five months post-construction.

A baseline and transect locations were established with the first survey in September 2005 and have been used for each subsequent survey. Shoreline changes at Mean High Water (MHW) and volumetric changes above 0 feet NAVD88 and -15 feet NAVD88 are calculated at each transect. Differences in the region above 0 feet NAVD88 are indicative of changes to the dune and subaerial beach berm, while the differences above -15 feet NAVD88 indicate changes in the nearshore zone. Comparison of seasonal surveys (i.e. October 2016 to October 2017) eliminates seasonal variation of profiles in volumetric change analyses. Consecutive survey comparisons (fall to spring, and spring to fall) are useful to assess the direct impact of extreme events which have occurred during the five months between surveys. This report documents the data sources, methods, and results of a periodic surveying evaluation performed to compare the October 2017 survey data with previous surveys taken in October 2016 (fall to fall comparison) and May 2017 (most recent periodic survey comparison) in the Ocean View Beach area between Willoughby Spit and Little Creek Inlet.

Comparison	Parameter	Quantity
October 2016 vs. October 2017	Average Shoreline Change Rate at MHW (+0.98 ft NAVD88)	80.04 ft/yr
	Cumulative Volume Change Rate Above 0 ft NAVD88	515,276 cy/yr
	Cumulative Volume Change Rate Above -15 ft NAVD88	1,098,216 cy/yr
May 2017 vs. October 2017	Average Shoreline Change at MHW (+0.98 ft NAVD88)	-15.67 ft
	Cumulative Volume Change Above 0 ft NAVD88	14,931 cy
	Cumulative Volume Change Above -15 ft NAVD88	10,919 cy

Since the Federal Project placed approximately 1.2 million cubic yards after October 2016, the standard comparisons over the past year show very high magnitudes of volume gain and shoreline advance across the Ocean View monitoring area. In addition, the Federal Project represents a step-change in the shoreline position and overall volume in the profile. Since the present survey in May 2017 captured the immediate post-nourishment conditions of the initial Federal Project, future monitoring survey reports will be able to evaluate the performance of the Federal Project and will help the City and USACE to track project conditions, document damage associated with specific storms, and effectively plan for future renourishment needs.

The behavior in each of the shoreline reaches for the October 2016 to October 2017, May 2017 to October 2017 periods are summarized in Table 1-1, and Table 1-2 respectively.

As illustrated in Table 1-1, the Ocean View shoreline has experienced overall gain at MHW from October 2016 to October 2017 with a length-weighted average change rate of 80.04 ft/yr due to the Federal Project construction. The beach and dune above 0 feet NAVD88 gained sediment at a rate of 515,276 cy/yr from October 2016 to October 2017. The beach and dune above -15 feet NAVD88 gained sediment at a rate of 1,098,216 cy/yr from October 2016 to October 2017.

From May 2017 to October 2017, the MHW shoreline retreated on average by -15.67 feet, as shown in Table 1-2. The volumetric change over the same period showed gain above 0 feet NAVD88 and above -15 feet NAVD88 of 14,931 cy and 10,919 cy, respectively.

The Ocean View shoreline overall gained 10,919 cy above -15 feet NAVD88 between May 2017 and October 2017, and it had a net 1,098,216 cy gain of sand volume above -15 feet NAVD88 over the year between October 2016 and October 2017.

Table 1-1: Regional Shoreline and Volume Change Statistics (October 2016 to October 2017)

Region	Average Shoreline Change	Average Volume Change Rate Above 0 ft NAVD88	Cumulative Volume Change Rate Above 0 ft NAVD88	Average Volume Change Rate Above -15 ft NAVD88	Cumulative Volume Change Rate Above -15 ft NAVD88
	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
Willoughby Spit (0+00 to 45+00)	107.78	16.27	73,420	29.76	134,310
800 Block Breakwaters (45+25 to 87+62)	138.27	20.11	91,281	46.89	212,839
West Ocean View (93+41 to 163+49)	84.47	15.16	107,909	36.15	248,114
Central Ocean View Breakwaters (169+63 to 195+63)	98.22	17.11	59,358	36.09	125,170
Central Ocean View (206+86 to 323+09)	27.16	6.22	77,802	14.68	183,646
East Ocean View (329+63 to 383+58)	110.72	18.44	105,505	33.93	194,137
OVERALL	Weighted Avg (ft/yr)	Weighted Avg (cy/ft/yr)	Total (cy/yr)	Weighted Avg (cy/ft/yr)	Total (cy/yr)
	80.04	13.63	515,276	29.33	1,098,216

Table 1-2: Regional Shoreline and Volume Change Statistics (May 2017 to October 2017)

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
Willoughby Spit (0+00 to 45+00)	3.47	2.32	10,449	4.51	20,332
800 Block Breakwaters (45+25 to 87+62)	-13.30	-0.48	-2,178	2.54	11,541
West Ocean View (93+41 to 163+49)	-23.94	0.54	4,134	1.11	8,459
Central Ocean View Breakwaters (169+63 to 195+63)	-39.47	-1.28	-4,444	-3.47	-12,035
Central Ocean View (206+86 to 323+09)	-7.34	0.72	9,024	-0.09	-1,121
East Ocean View (329+63 to 383+58)	-25.41	-0.36	-2,054	-2.84	-16,257
OVERALL	Weighted Avg (ft)	Weighted Avg (cy/ft)	Total (cy)	Weighted Avg (cy/ft)	Total (cy)
	-15.67	0.39	14,931	0.28	10,919

2. Objective

The City of Norfolk, Virginia has maintained a program of periodic surveying of the Ocean View shoreline since 2005. The periodic surveying data collection dates are shown in Table 2-1. This report documents the data sources, methods, and results of a periodic surveying evaluation performed to compare the October 2017 survey data with previous surveys taken in October 2016 (fall to fall comparison) and May 2017 (most recent periodic survey comparison) in the Ocean View Beach area between Willoughby Spit and Little Creek Inlet.

Table 2-1: Surveyors and Collection Dates

Data Collection Date	Surveyor
September 2005	McKim & Creed
March 2006	McKim & Creed
October 2006	McKim & Creed
March 2007	McKim & Creed
October 2007	McKim & Creed
March 2008	McKim & Creed
October 2008	McKim & Creed
April 2009	McKim & Creed
October 2009	Geodynamics, LLC
March 2010	Geodynamics, LLC
October 2010	Geodynamics, LLC
April 2011	Geodynamics, LLC
October 2011	Geodynamics, LLC
March 2012	Geodynamics, LLC
September 2012	Geodynamics, LLC
April 2013	Geodynamics, LLC
October 2013	Geodynamics, LLC
March 2014	Geodynamics, LLC
October 2014	Geodynamics, LLC
April 2015	Geodynamics, LLC
October 2015	Geodynamics, LLC
May 2016	Geodynamics, LLC
October 2016	Geodynamics, LLC
February 2017	USACE (Great Lakes Dredge & Dock)
May 2017	USACE (Great Lakes Dredge & Dock)
May 2017	Geodynamics, LLC
October 2017	Geodynamics, LLC

3. Data Sources

Geodynamics, LLC, conducted the most recent survey of Ocean View Beach on October 13-16, 2017. The baseline and transects established for the September 2005 survey were used for the most recent survey. Figure 3-1 shows the location of the baseline, transects and the stationing applied by Geodynamics for the surveying. As shown in Figure 3-1, transects were stationed from west to east along the Ocean View shoreline. The survey data were provided in xyz and shapefile formats allowing for compatibility with multiple programs.

Geodynamics noted that typical vertical survey accuracy along the hydrographic portions of the profiles is approximately ± 1 cm. This ‘margin of error’, if applied over the entire length of the hydrographic profiles can potentially result in significant volumetric differences, in particular on the shallow-sloped and long profiles near Willoughby Spit. Therefore, volumetric changes discussed herein are analyzed with regard to potential volumetric margins of error.

On October 27, 2017, the Virginia Institute of Marine Science (VIMS) flew aerial photography of the Ocean View shoreline, georectified the images, and digitized the apparent MHW shoreline position from the images. The October 2017 aerial photos with the digitized shoreline positions from October 2017, June 2017, and November 2016. Since these photos cover a limited portion of area landward and seaward of the shoreline, a previous image (2009) is underlain for presentation purposes.



Figure 3-1: Survey Baseline and Transects

4. Methods

Survey comparisons and respective analysis were performed using a combination of Microsoft Excel, Golden Software Surfer, ESRI ArcGIS, and the USACE's Beach Morphology Analysis Package (BMAP). Surfer is a contouring and 3D surface mapping program utilized to create 3D surfaces for analysis. BMAP is a program developed by the USACE to analyze morphologic and dynamic properties of beach profiles.

The horizontal coordinate system used was Virginia South State Plane NAD 1983 (HARN), US Survey feet with a vertical datum of NAVD88. Individual profile plots showing the survey profile at each transect for each date are presented in Appendix B. From the profiles, shoreline changes and volumetric changes were then calculated at each transect for the following time periods:

1. October 2016 to October 2017 (Entire Shoreline)
2. May 2017 to October 2017 (Entire Shoreline)

First, the change in shoreline based on the survey profiles at mean high water (MHW) was calculated at each transect for each time period mentioned. MHW along Ocean View beaches is defined as +0.98 feet NAVD88 based on NOAA tidal benchmark at Sewells Point. The resulting value represents the shoreline change (feet) over the time period between surveys. The shoreline change rate (ft/yr) was then calculated by dividing by the amount of time between survey dates.

Representative volume changes were also calculated at each transect for all time periods. Volume changes were calculated for two different extents in order to better understand the processes occurring onshore and offshore of the Ocean View beach area. Calculations included volume changes above -15 feet NAVD88 and volume changes above 0 feet NAVD88. The results represent volume change per linear foot of shoreline (cy/ft) over the period of time between surveys. The volume change rate (cy/ft/yr) was then calculated by dividing by the amount of time between survey dates. In addition, the volume changes were converted to cumulative changes over the entire shoreline. This was done by applying the average end area method to the unit volume changes (cy/ft) and unit volume change rates (cy/ft/yr) computed at each transect and summing the total volume changes over the entire shoreline. The resulting value indicated the total loss or gain of material (cy) between surveys based on the applicable profile extents.

Volume changes calculated for portions of the profiles above 0 feet NAVD88 are representative of changes in the amount of material in the dune system and on the subaerial beach. These areas are highly influenced by the performance of coastal structures and the impact of storm activity. Volume changes calculated for portions of the profiles above -15 feet NAVD88 allow for the tracking of sand movement in the submerged active profile; removing profile data deeper than the -15 feet NAVD88 contour from the analysis reduces uncertainty that would be associated with hydrographic data beyond this depth.

5. Discussion of Periodic Surveying Evaluation

This section discusses differences observed between the noted surveys, overall shoreline trends, regional shoreline trends and comparison with the pre- and post-construction surveys of the Federal Project. The computed shoreline changes and volume changes at each individual transect for the time periods covered are tabulated in Appendix C.

5.1. Differences in Survey Coverage

Variation in profile positions between surveys taken as part of the ongoing program of periodic surveying of the Ocean View shoreline (October 2016, May 2017, and October 2017) were minimal in the topographic portion of the survey due to use of the same baseline and transects put in place for the initial survey in September 2005. Profile extents and alignment were virtually the same when comparing the survey data.

5.2. Key Events During the Reporting Period

Beach processes are greatly influenced by natural and engineering processes. This section describes key events that happened during the present reporting period which likely had an impact on shoreline position changes and profile volume gains and/or losses.

5.2.1. Storm Wave Events

Understanding of the wave climate immediately offshore of the Norfolk shoreline is vital for the design, monitoring, and understanding of projects along the shoreline and the behavior of the beach. The data used were collected from the City's AWAC (Acoustic Wave and Current) gage, which was deployed in 2006 directly offshore of the Norfolk Shoreline in approximately 23 feet of water. Wave data were collected throughout this survey period up to October 12, 2017.

A summary of the observed conditions during this monitoring period yields the following general observations:

- The average significant wave height and peak period over this monitoring period (May 25, 2017 to October 12, 2017) was approximately 1.2 feet and 5.4 seconds.
- The largest significant wave height observed during this monitoring period was approximately 5.9 feet with a corresponding peak period of approximately 6.3 seconds and mean direction of 13 degrees (August 29, 2017).
- Waves approach from the northwest to southeast, with more than 85.0% approaching from 0 to 120 degrees North.

Thirty-one storm events occurred during October 2016 and October 2017 for which the significant wave height at the wave gauge exceeded 3.3 feet (1.0 meter). These events are shown in Figure 5-1 through Figure 5-31.

The overall trends remained consistent with prior measurement periods with waves during calm periods being predominantly swell traveling into the bay from the ocean and having longer wave periods and

lower wave heights. Typically, the larger wave height events are driven by northerly and northeasterly storm winds within the bay and tend to have shorter wave periods. There were nine storm events identified during the Spring 2017 to Fall 2017 monitoring period, and, as observed in the prior measurement periods, the wind data indicate that for large and sustained wind events there is a corresponding increase in significant wave height. A summary of wave statistics by month during October 2016 and September 2017 (since only two weeks of October 2017 data are currently available) is given in Table 5-1.

Table 5-1: Monthly Wave Statistics Summary

Wave Statistic	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17
Average Significant Wave Height, H_s (ft)	1.8	1.3	1.3	1.2	0.9	1.4	1.2
Average Wave Period, T_m (s)	2.8	2.7	2.6	2.7	2.7	2.5	2.5
Average Peak Wave Period, T_p (s)	5.4	5.3	4.6	4.6	5.1	4.1	4.8
Maximum Observed Significant Wave Height, H_s (ft)	7.6	3.9	4.3	5.2	4.2	4.7	4.4
Maximum Observed Wave Height, H_{max} (ft)	12.7	6.5	7.3	8.7	7.6	7.4	7.8

Wave Statistic	May-17	Jun-17	July-17	Aug-17	Sep-17		
Average Significant Wave Height, H_s (ft)	1.2	0.9	0.9	1.3	1.7		
Average Wave Period, T_m (s)	2.4	2.3	2.4	2.7	2.9		
Average Peak Wave Period, T_p (s)	4.0	5.2	5.5	5.1	5.9		
Maximum Observed Significant Wave Height, H_s (ft)	3.9	3.2	5.0	5.9	4.6		
Maximum Observed Wave Height, H_{max} (ft)	6.3	5.7	7.7	10.5	7.9		

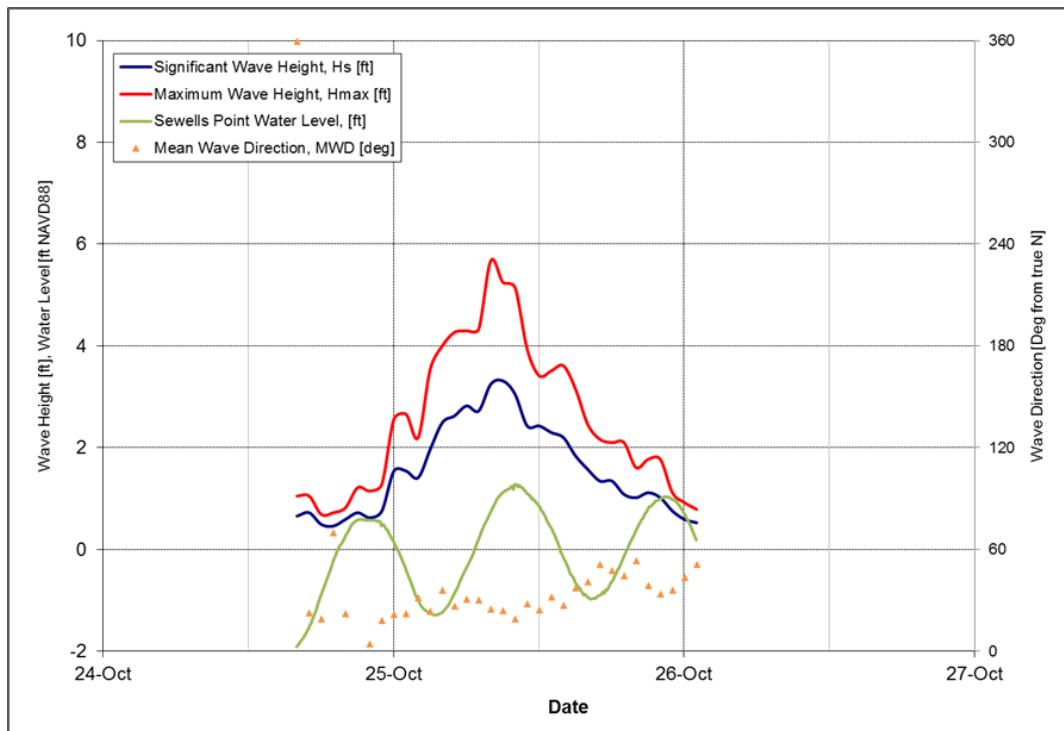


Figure 5-1: October 25, 2016 Storm

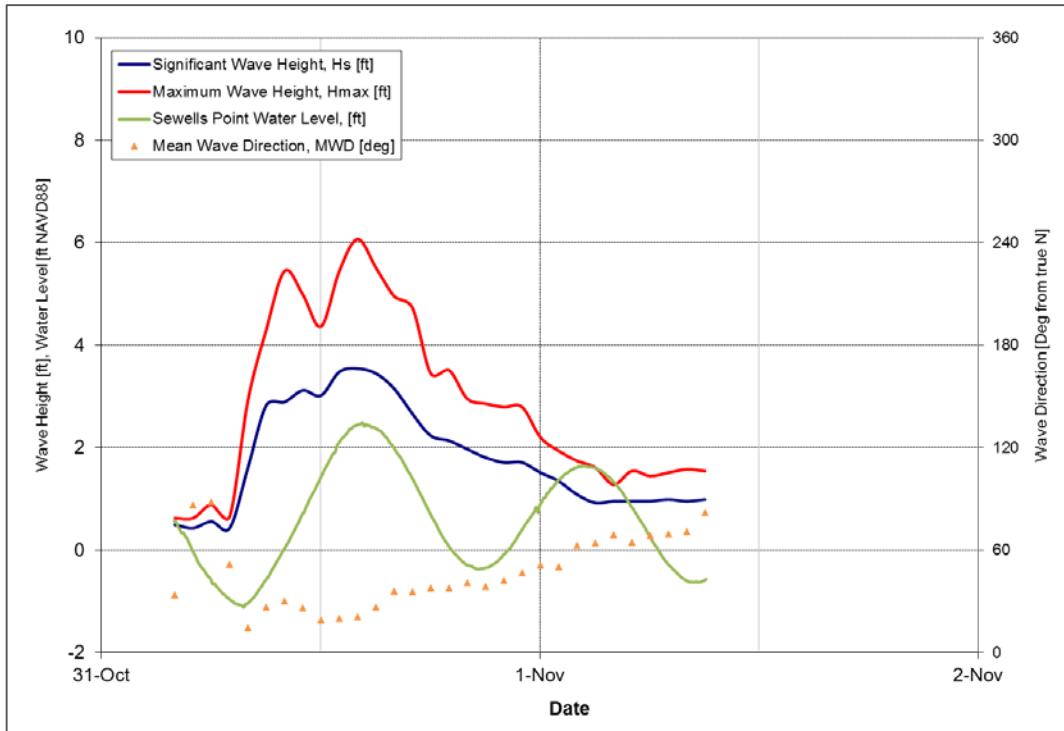


Figure 5-2: October 31, 2016 Storm

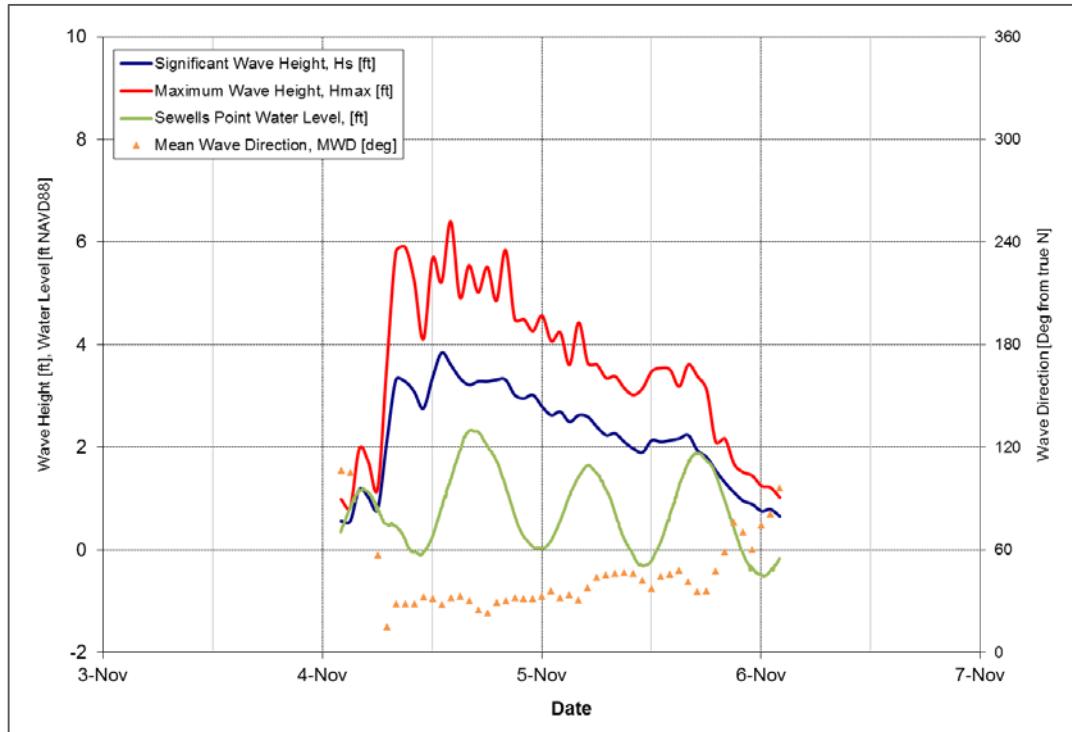


Figure 5-3: November 4, 2016 Storm

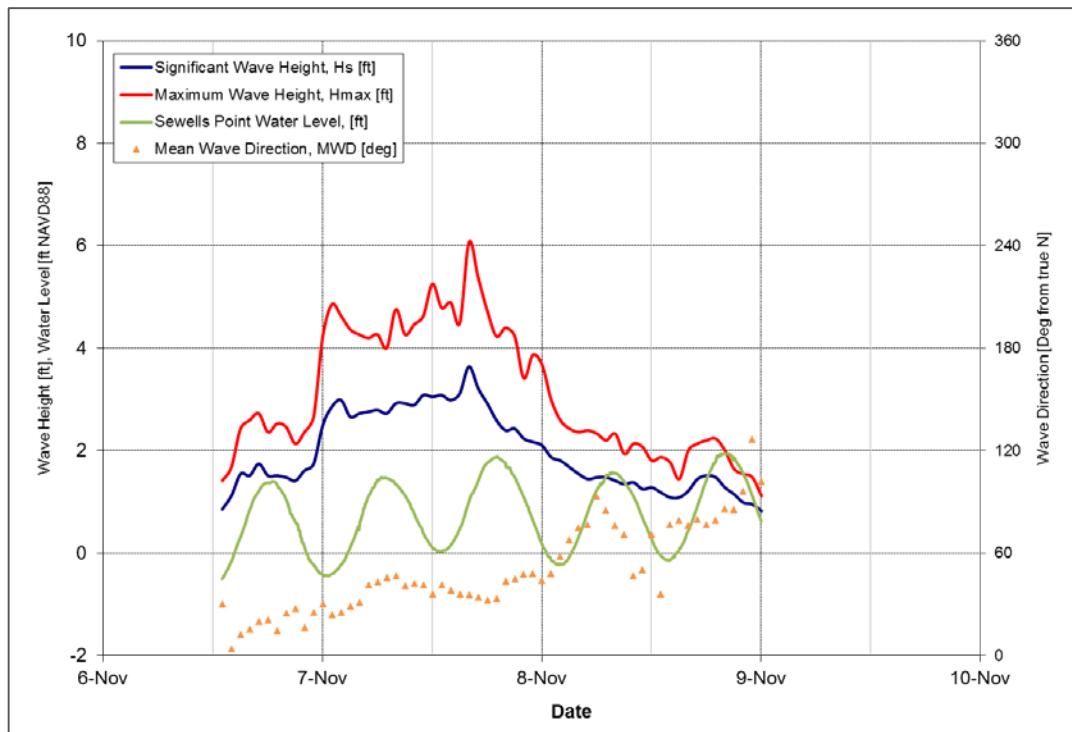


Figure 5-4: November 7, 2016 Storm

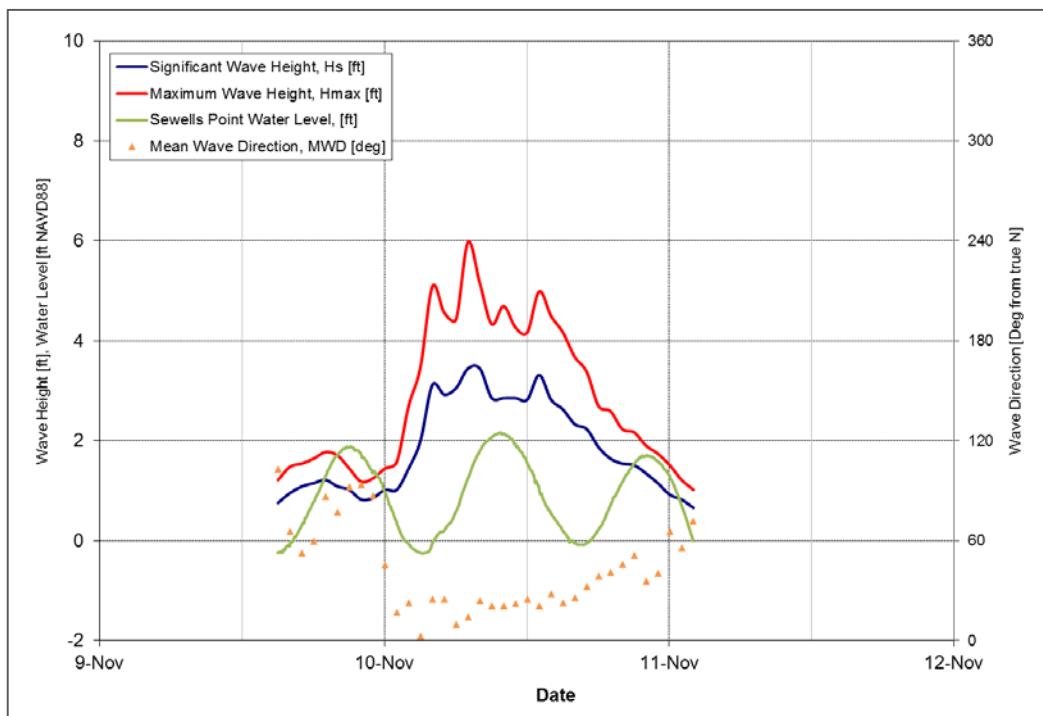


Figure 5-5: November 10, 2016 Storm

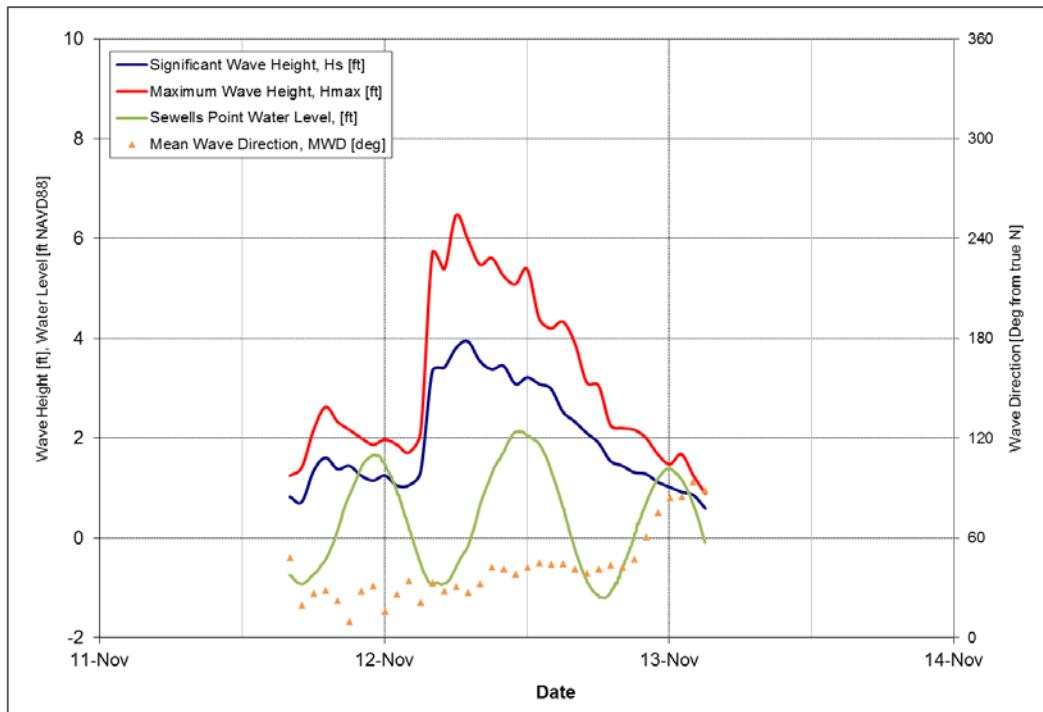


Figure 5-6: November 12, 2016 Storm

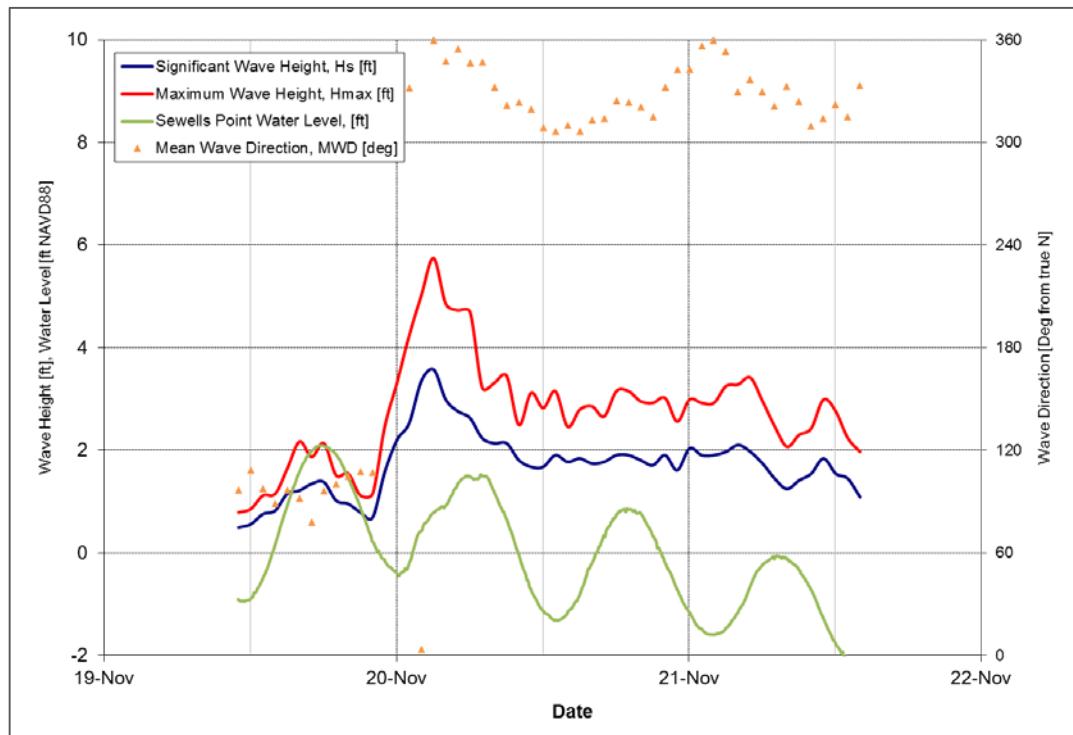


Figure 5-7: November 20, 2016 Storm

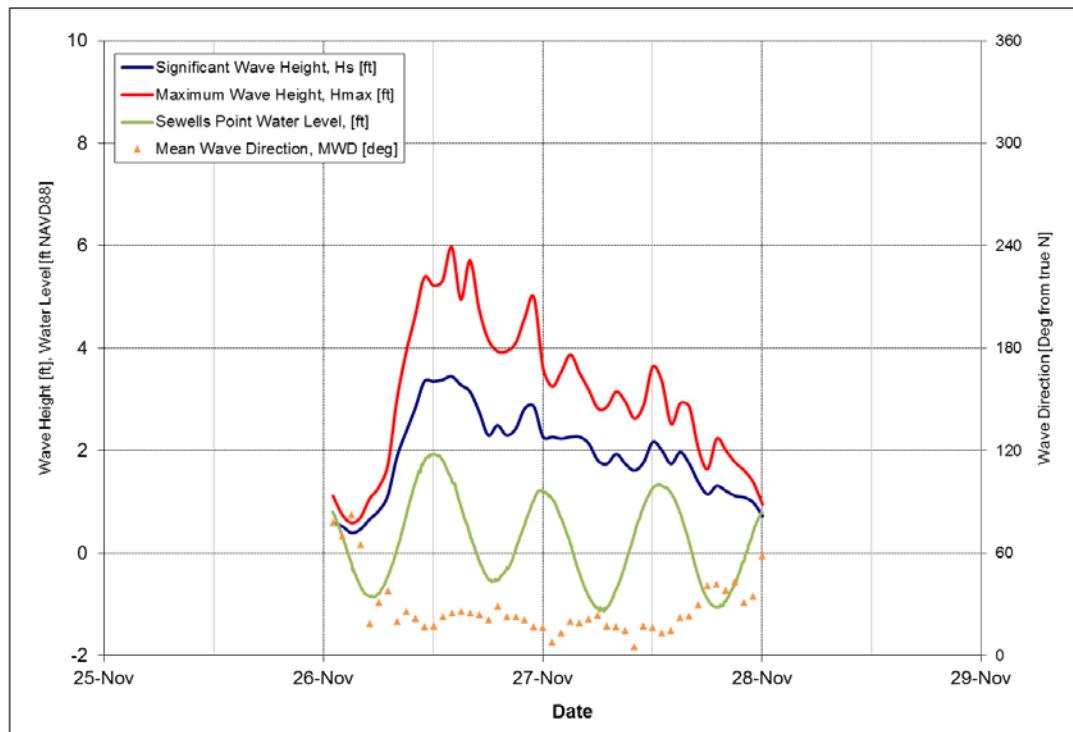


Figure 5-8: November 26, 2016 Storm

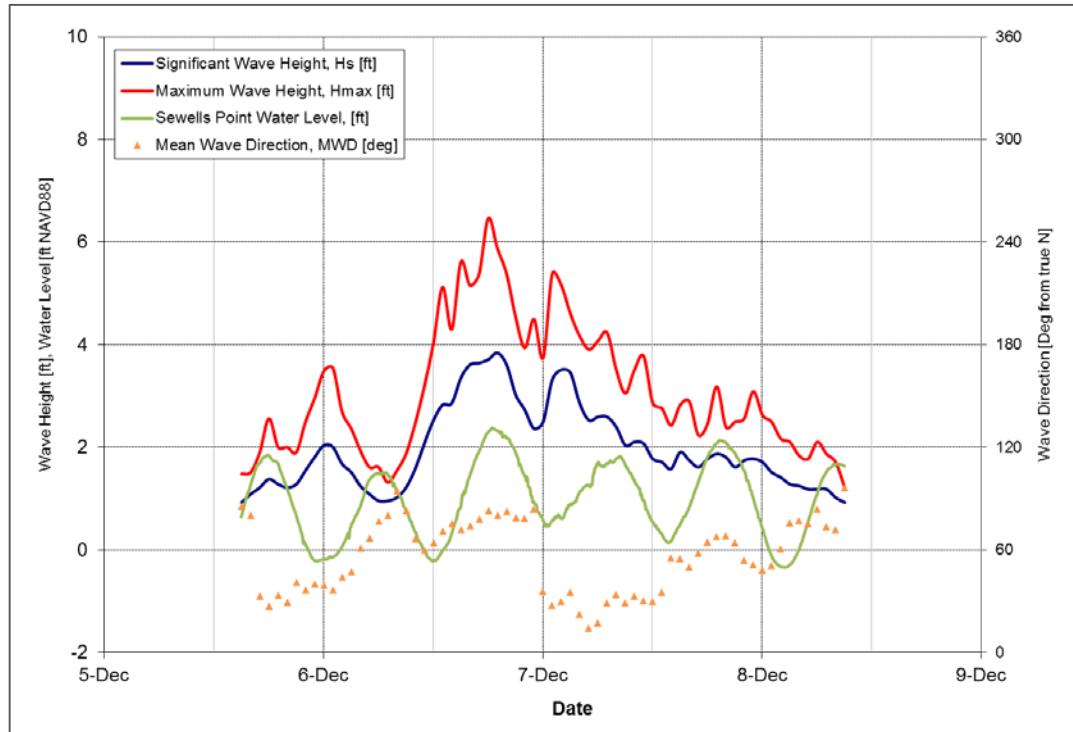


Figure 5-9: December 6, 2016 Storm

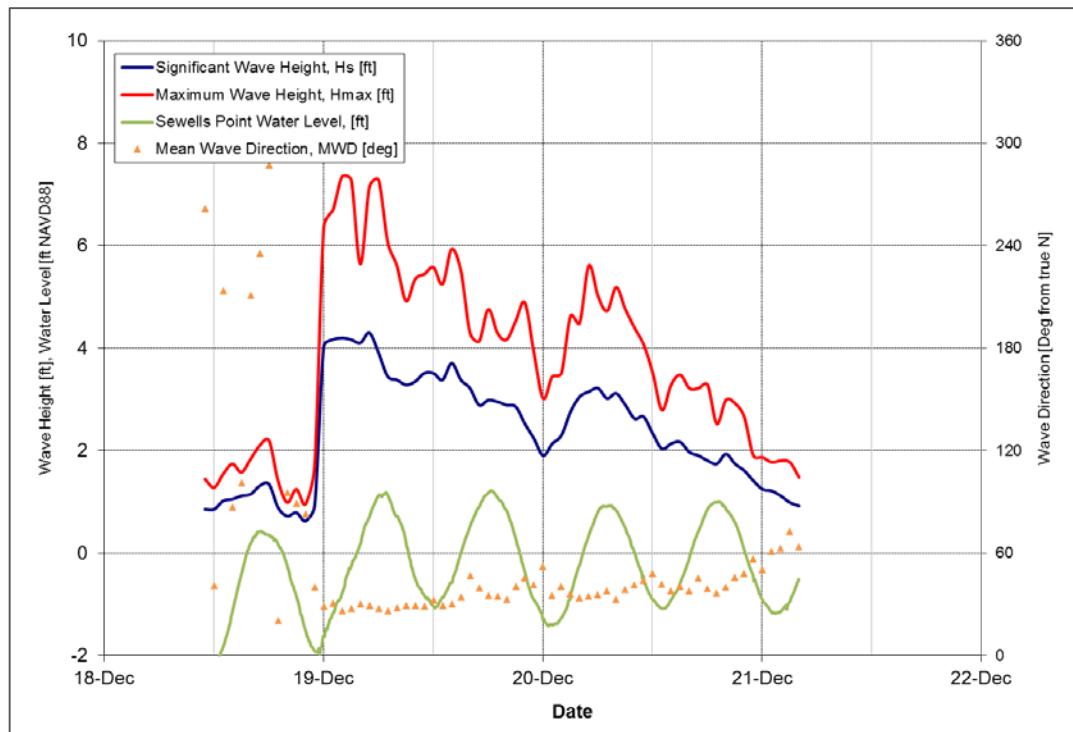


Figure 5-10: December 19, 2016 Storm

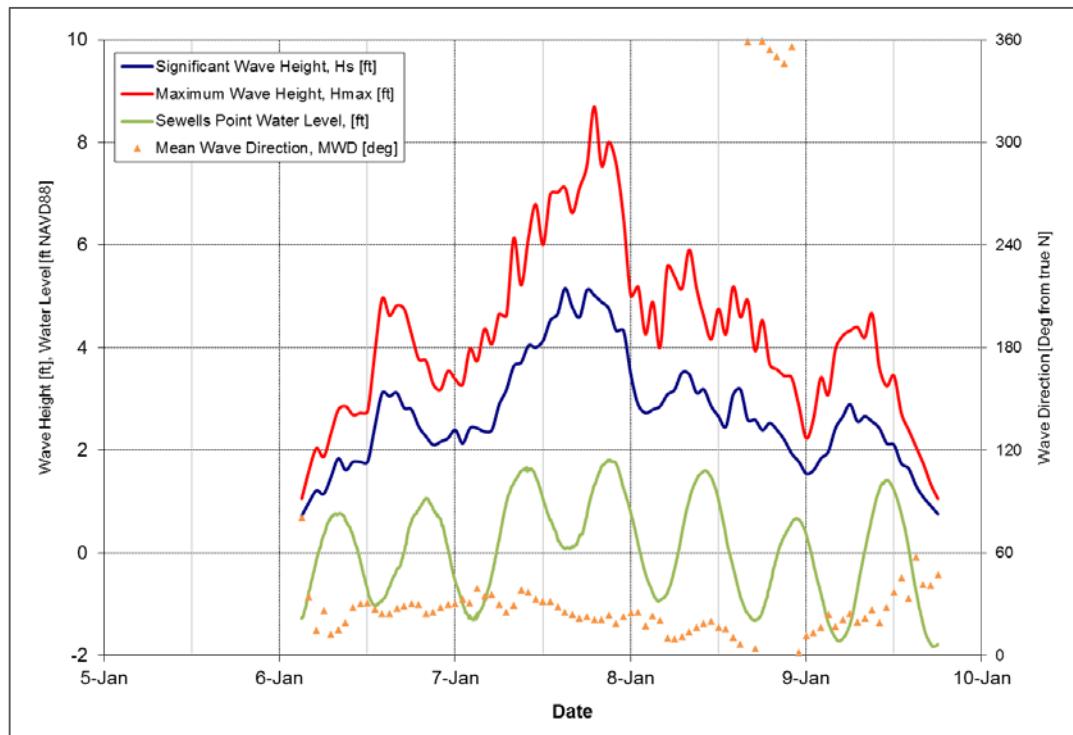


Figure 5-11: January 7, 2017 Storm

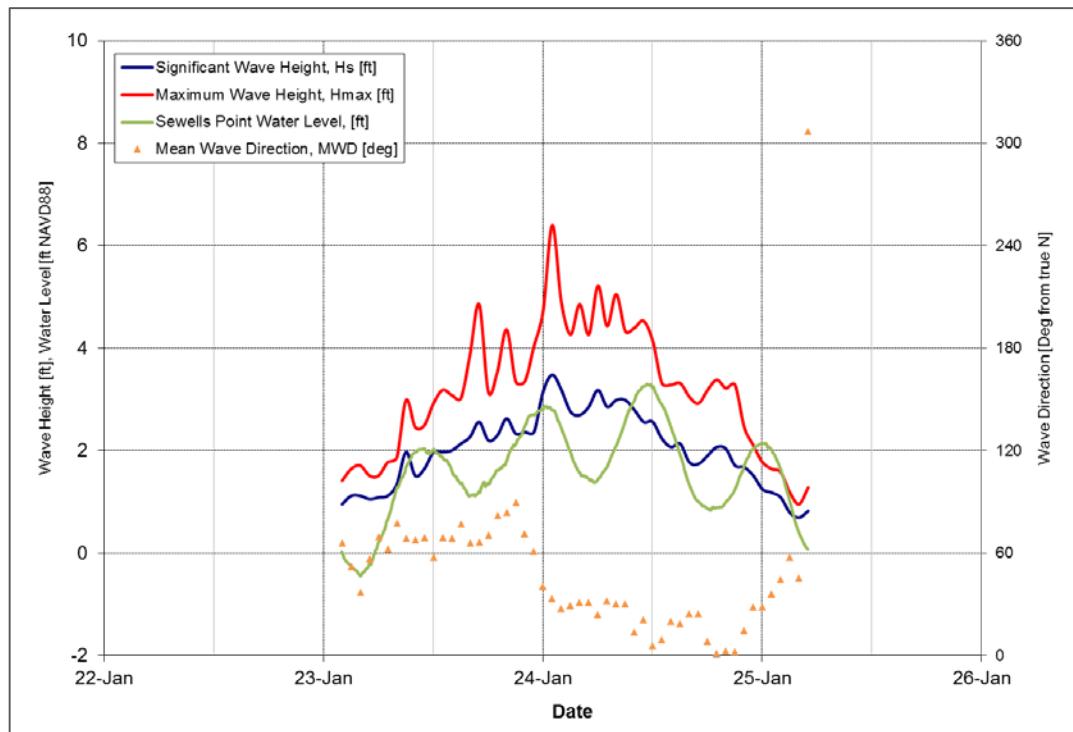


Figure 5-12: January 24, 2017 Storm

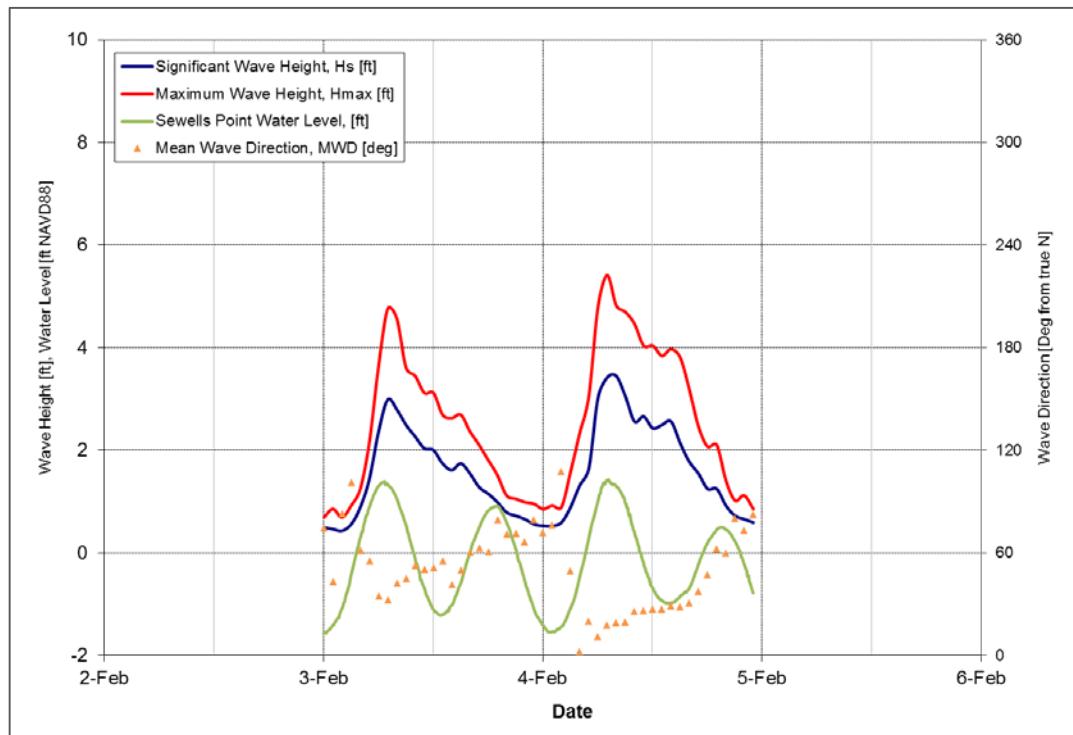


Figure 5-13: February 4, 2017 Storm

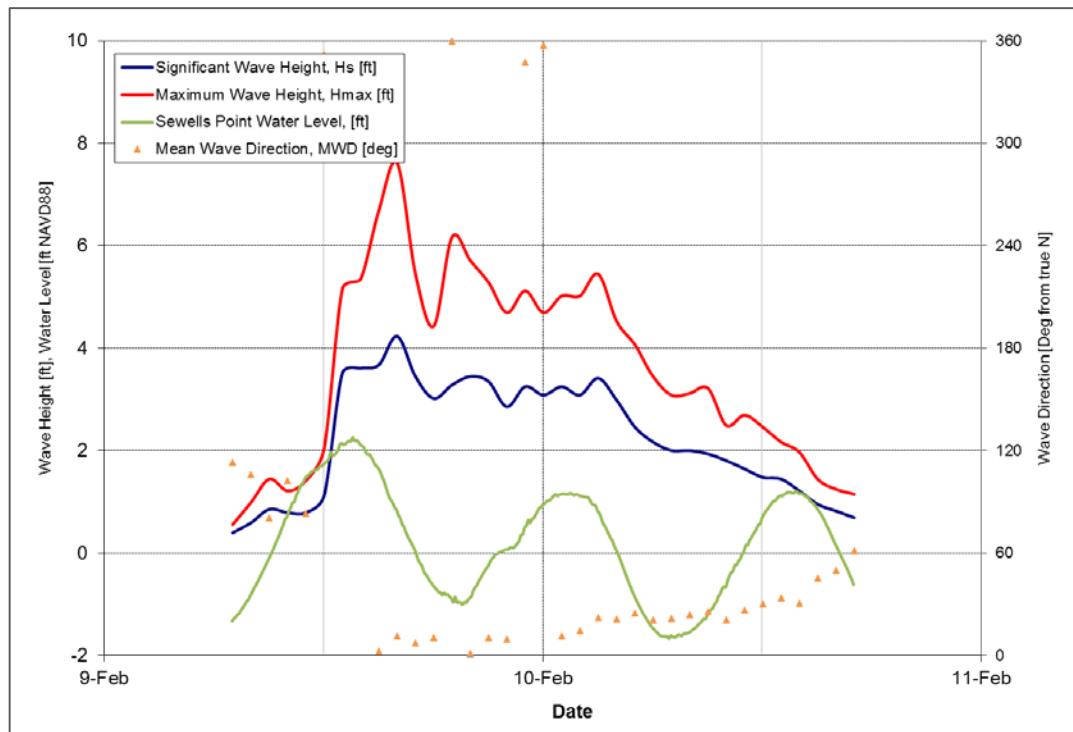


Figure 5-14: February 9, 2017 Storm

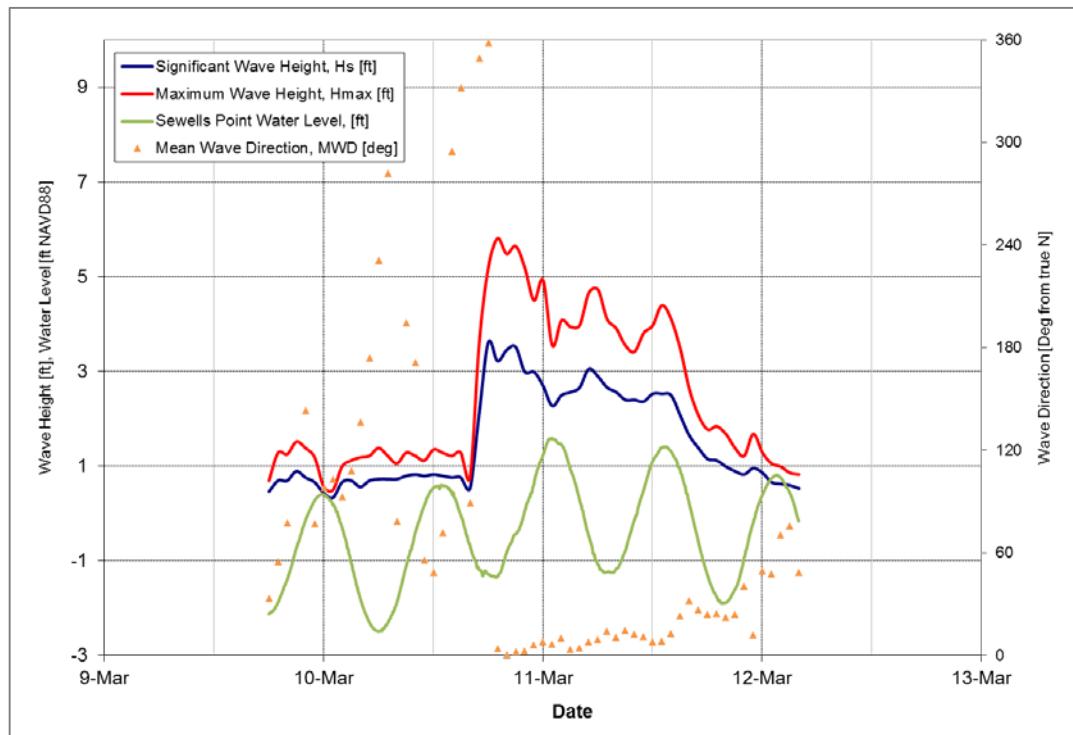


Figure 5-15: March 10, 2017 Storm

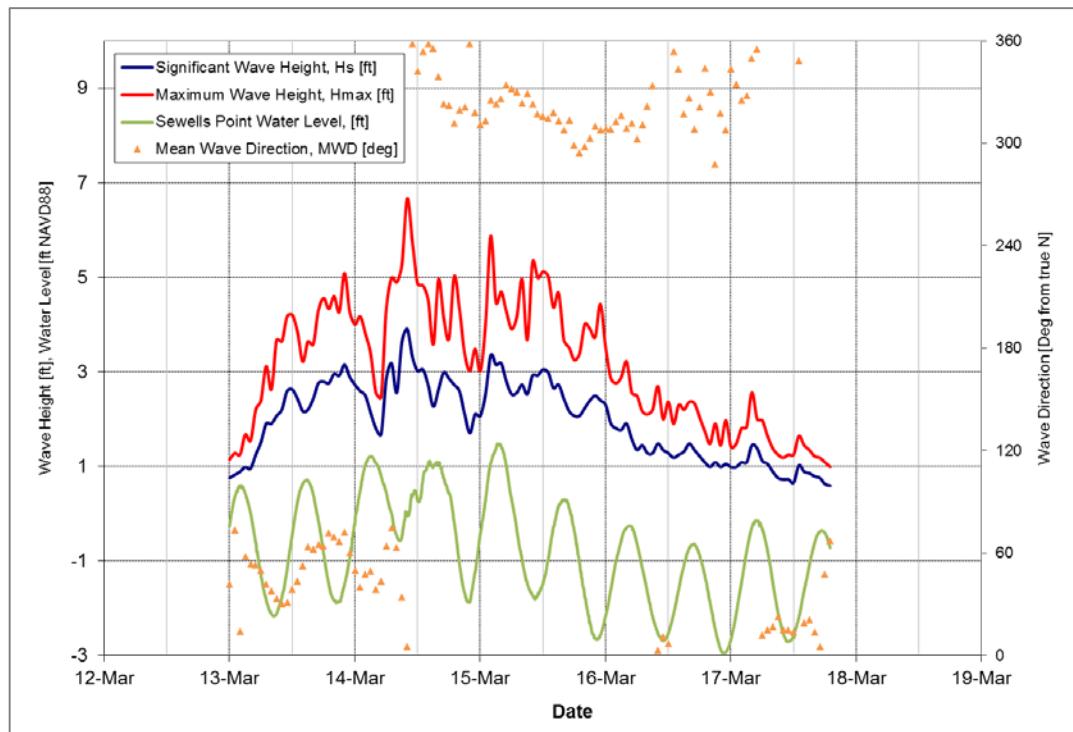


Figure 5-16: March 14, 2017 Storm

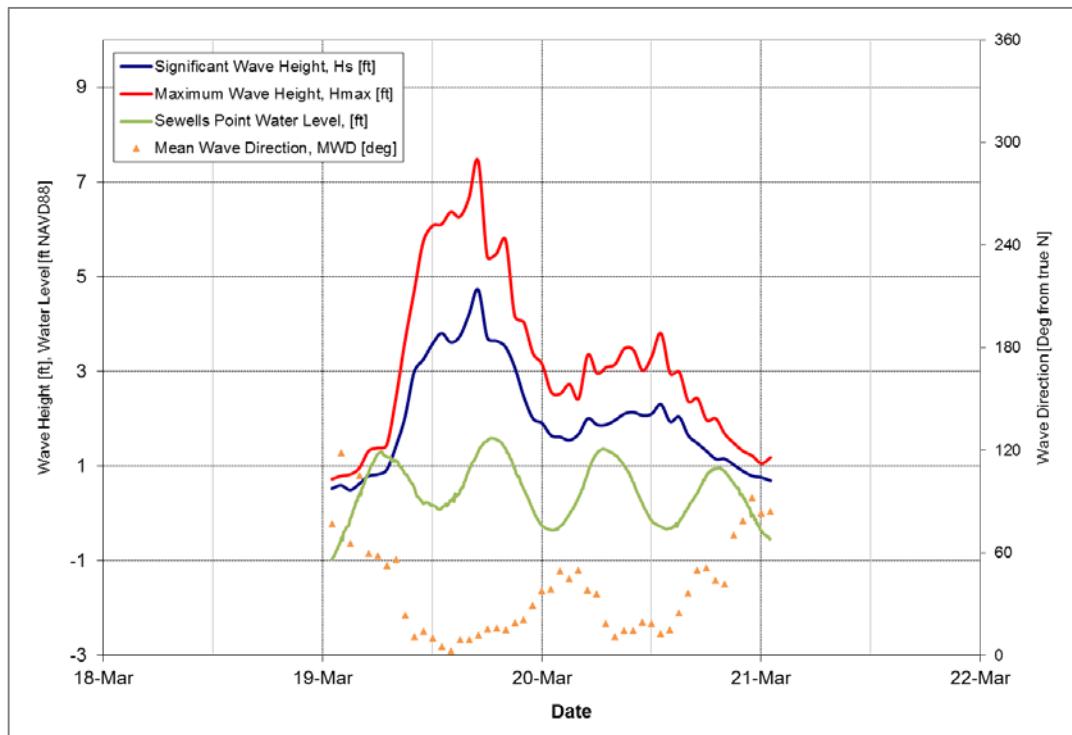


Figure 5-17: March 19, 2017 Storm

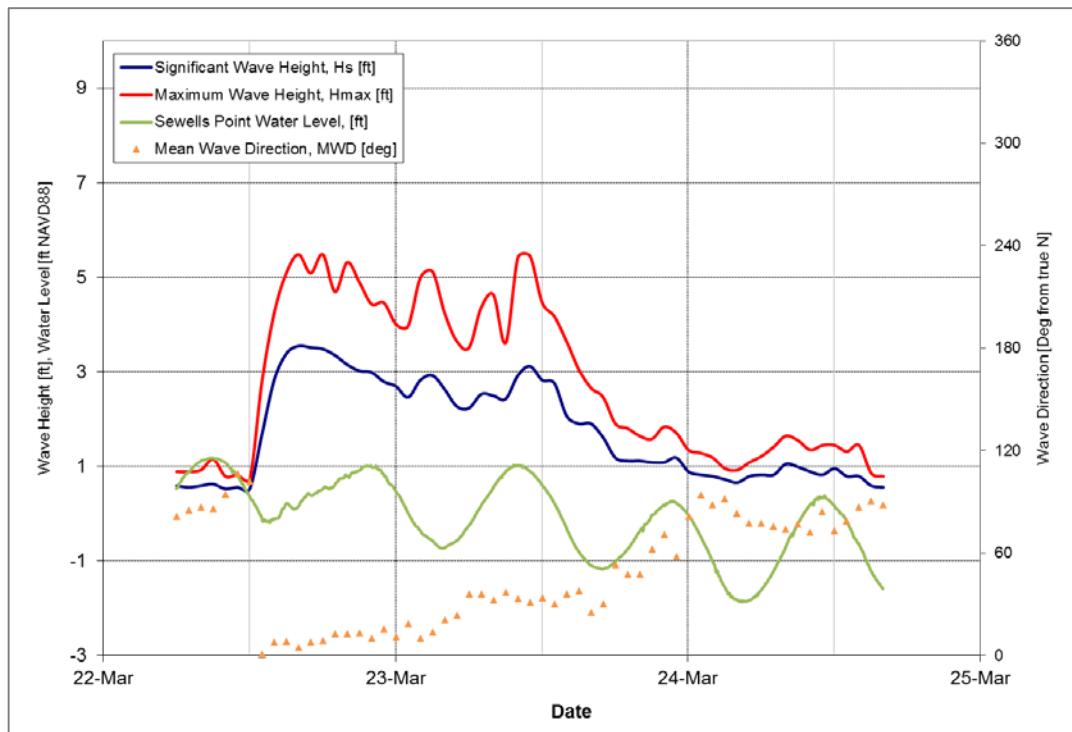


Figure 5-18: March 22, 2017 Storm

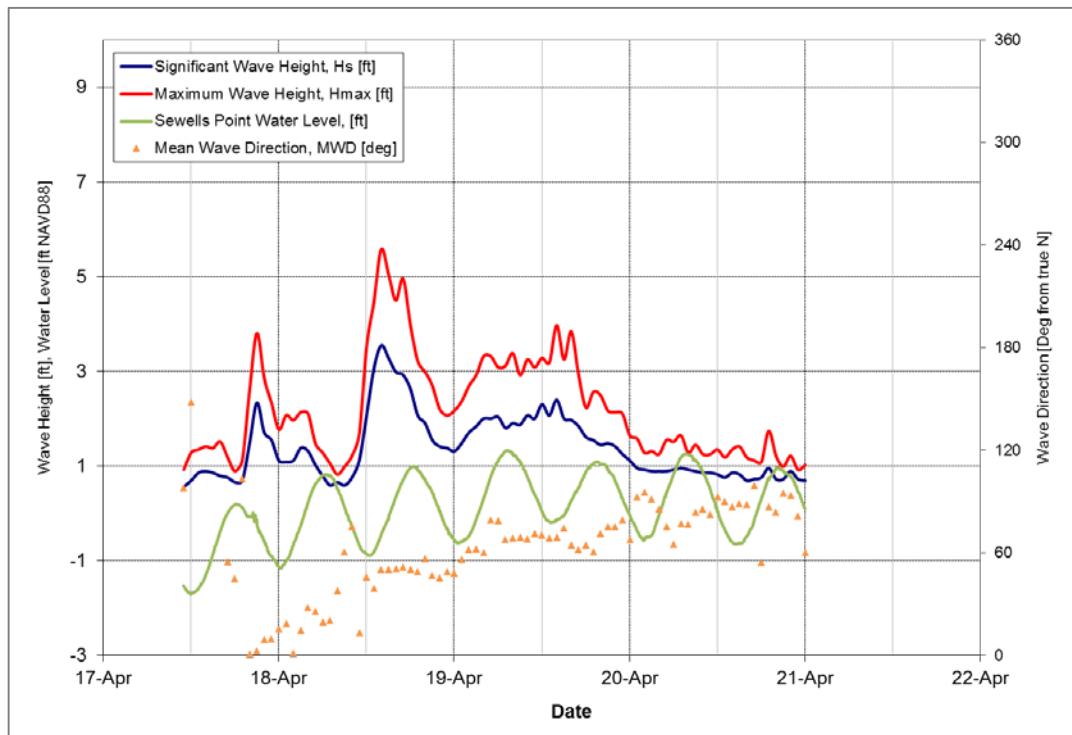


Figure 5-19: April 18, 2017 Storm

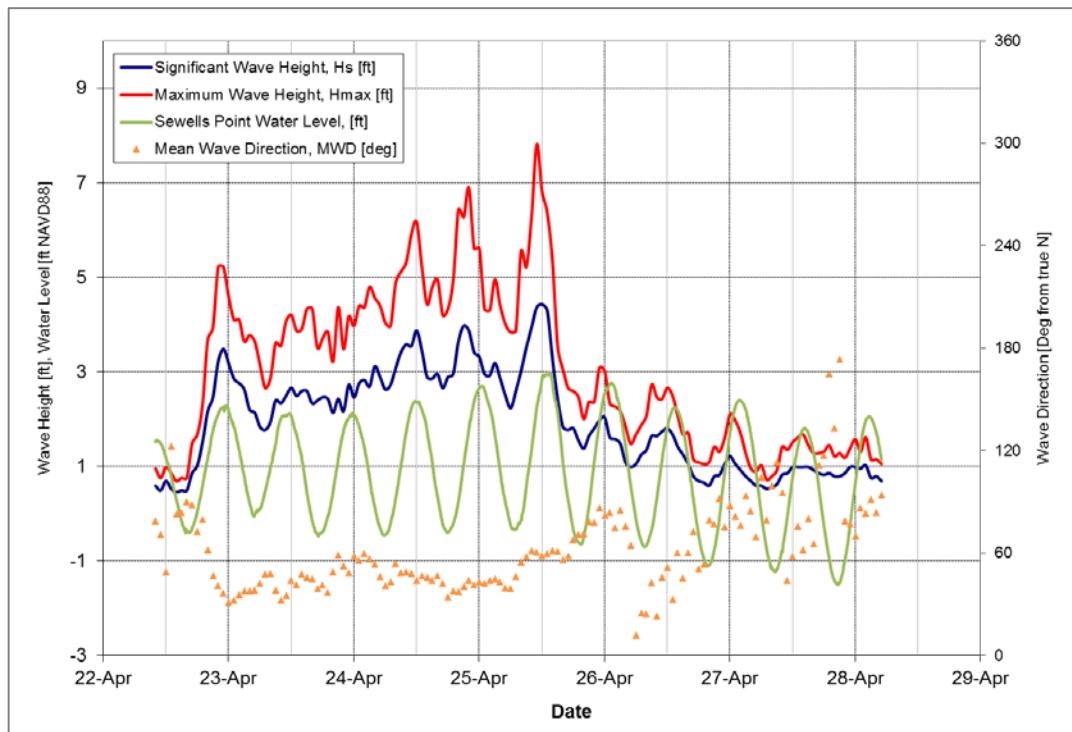


Figure 5-20: April 25, 2017 Storm

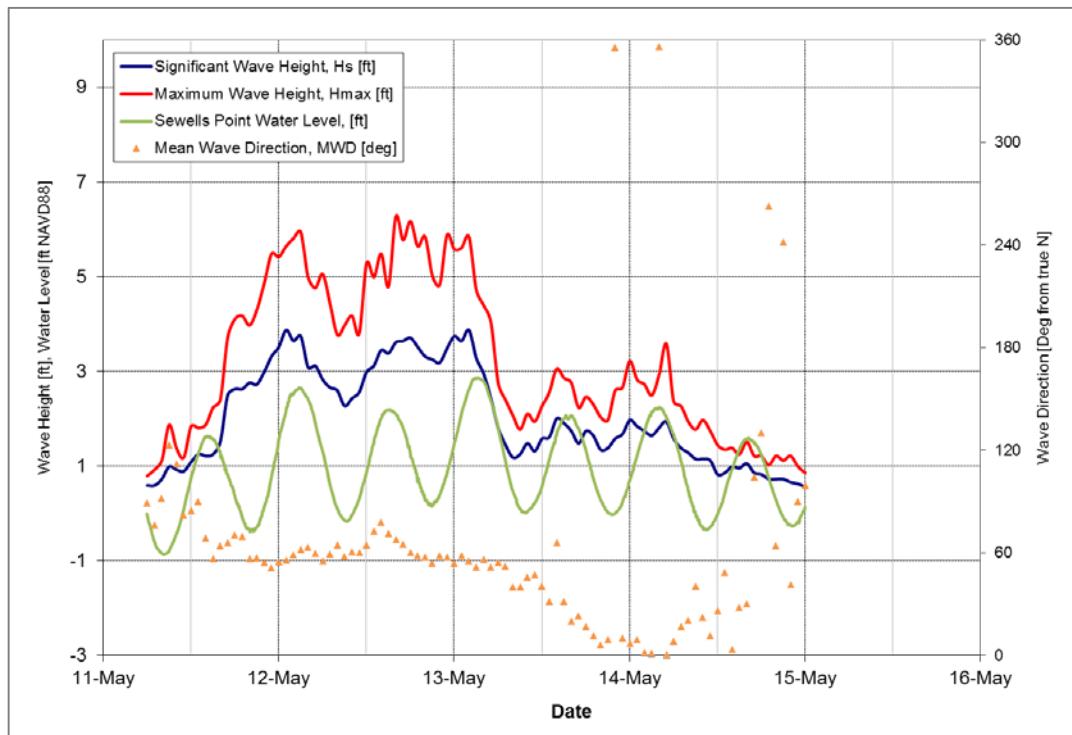


Figure 5-21: May 12, 2017 Storm

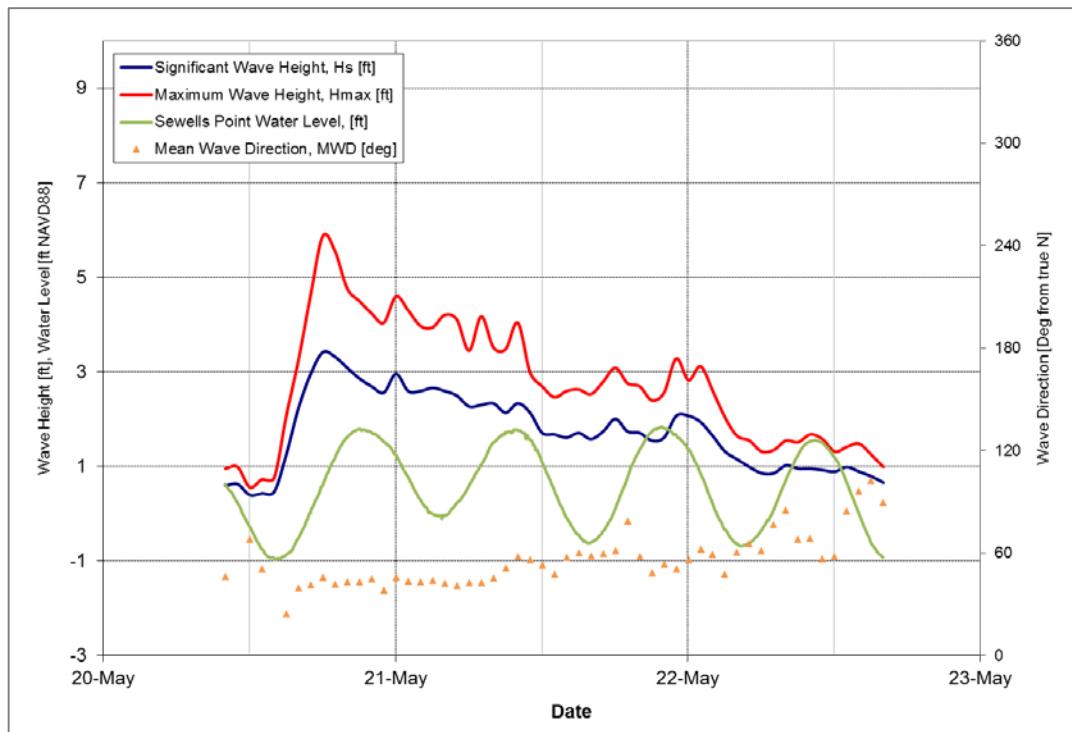


Figure 5-22: May 20, 2017 Storm

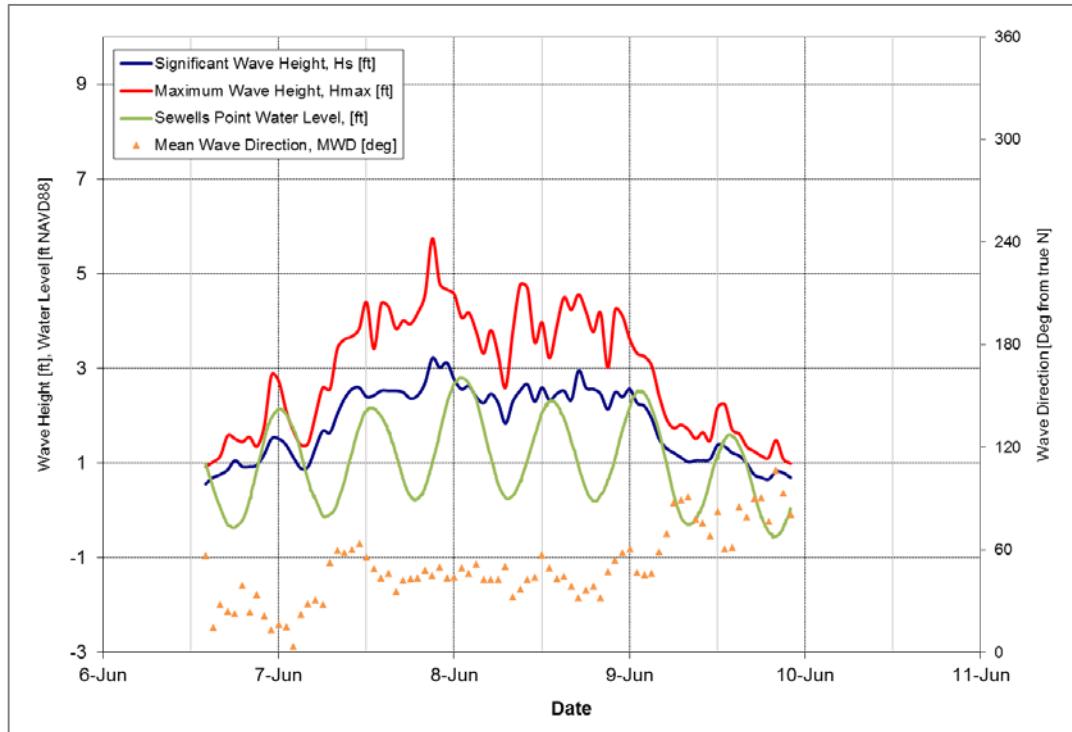


Figure 5-23: June 7, 2017 Storm

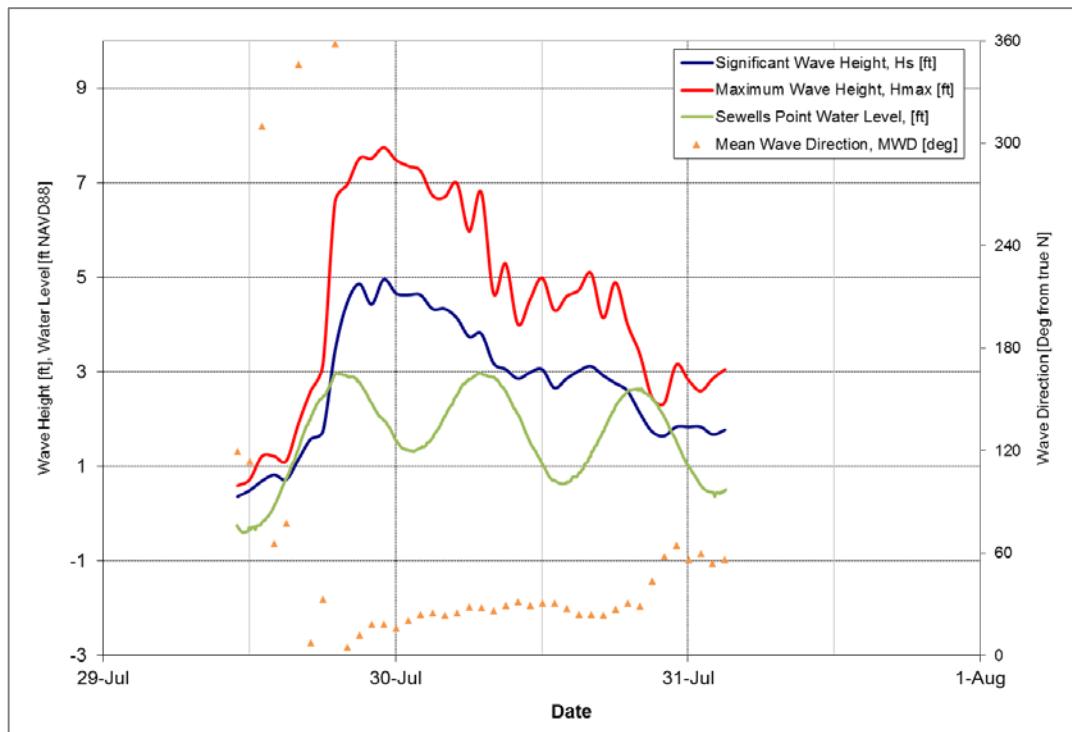


Figure 5-24: July 29, 2017 Storm

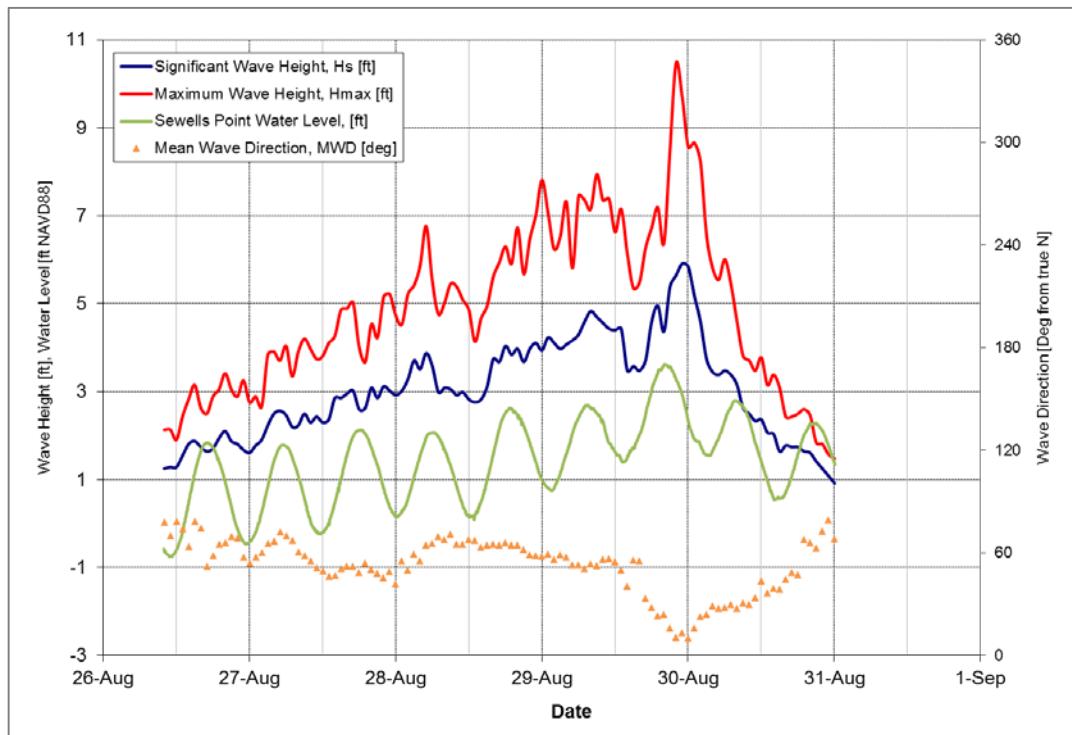


Figure 5-25: August 29, 2017 Storm

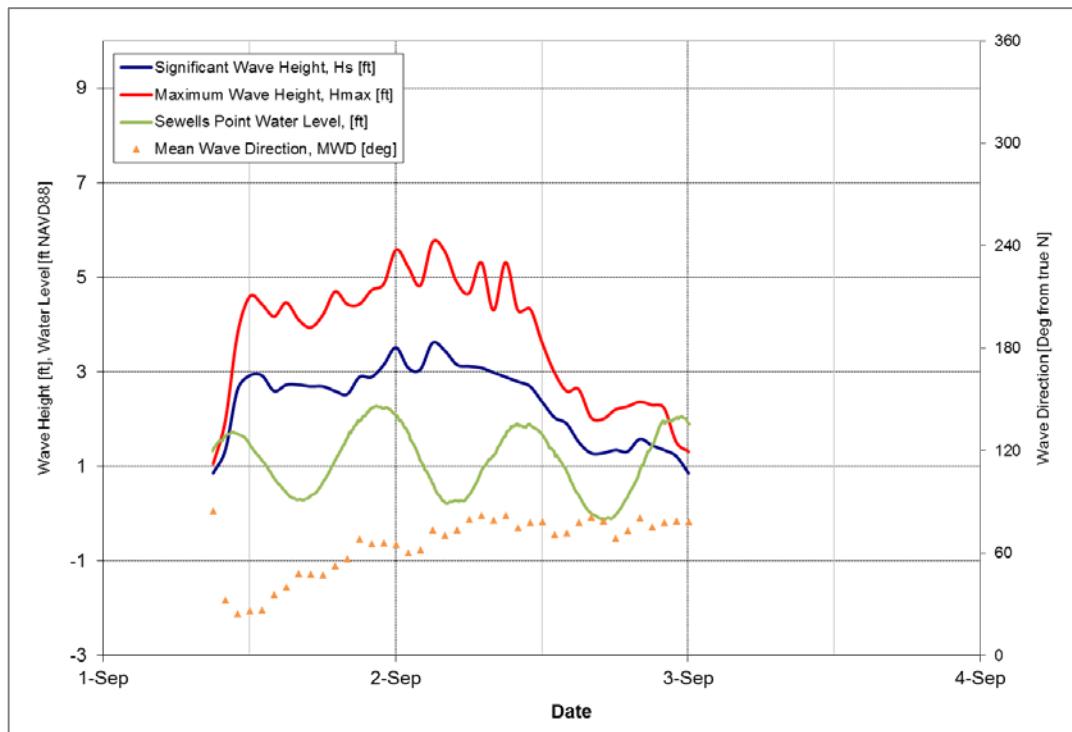


Figure 5-26: September 2, 2017 Storm

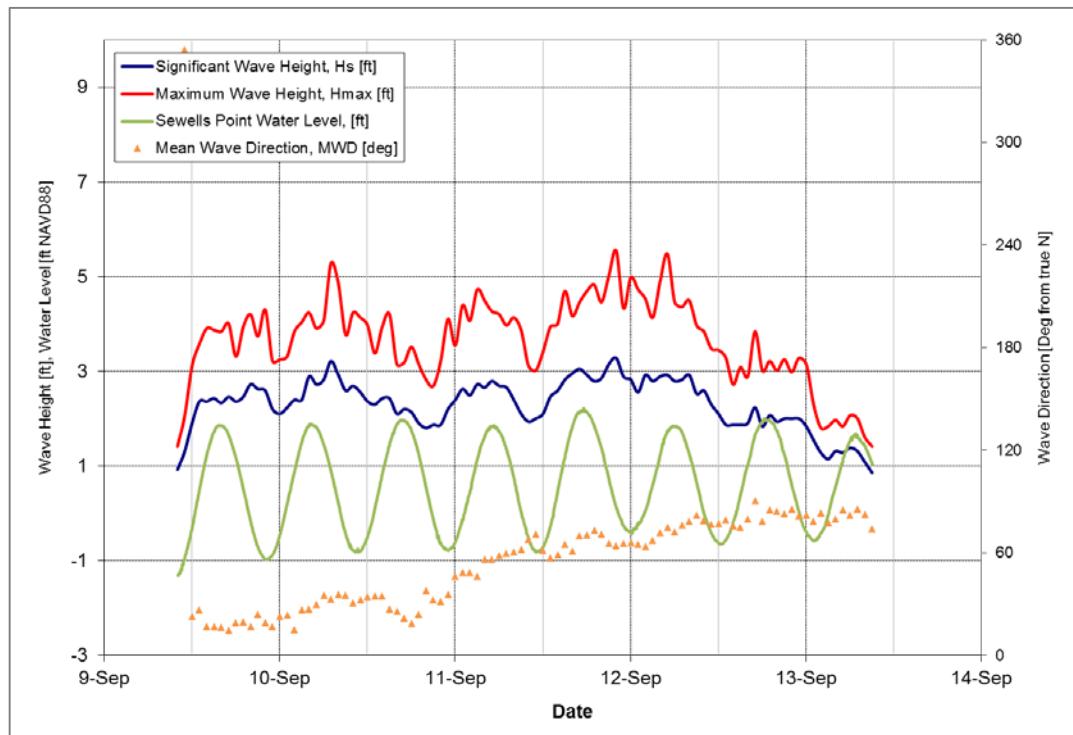


Figure 5-27: September 11, 2017 Storm

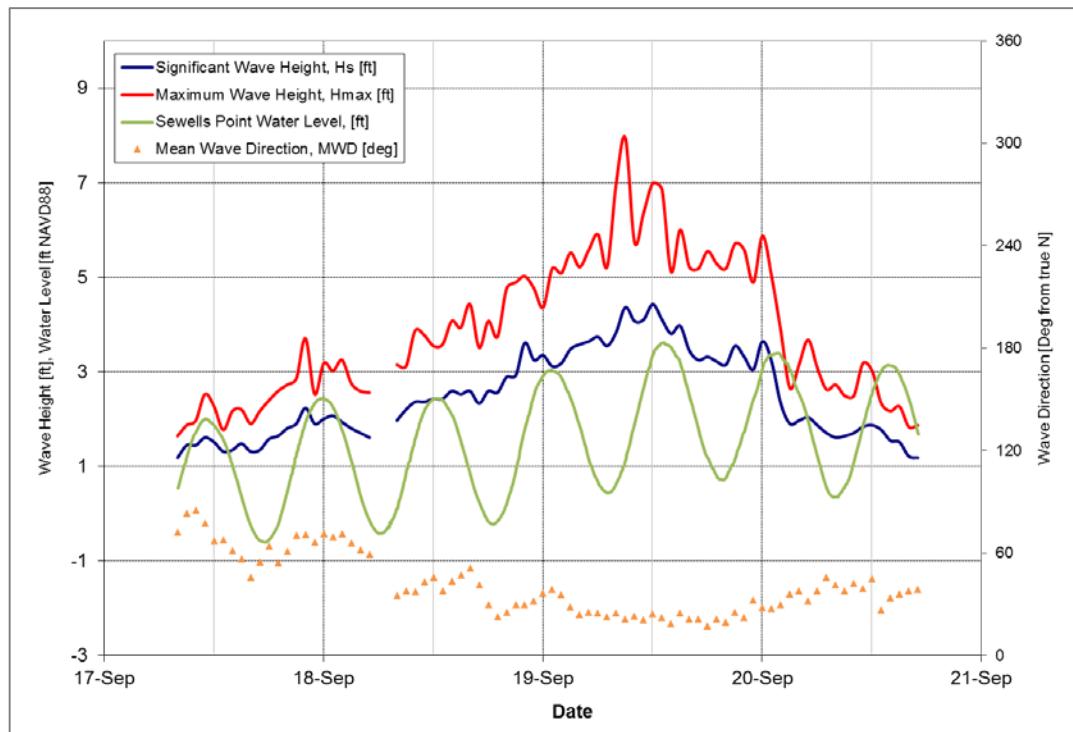


Figure 5-28: September 19, 2017 Storm

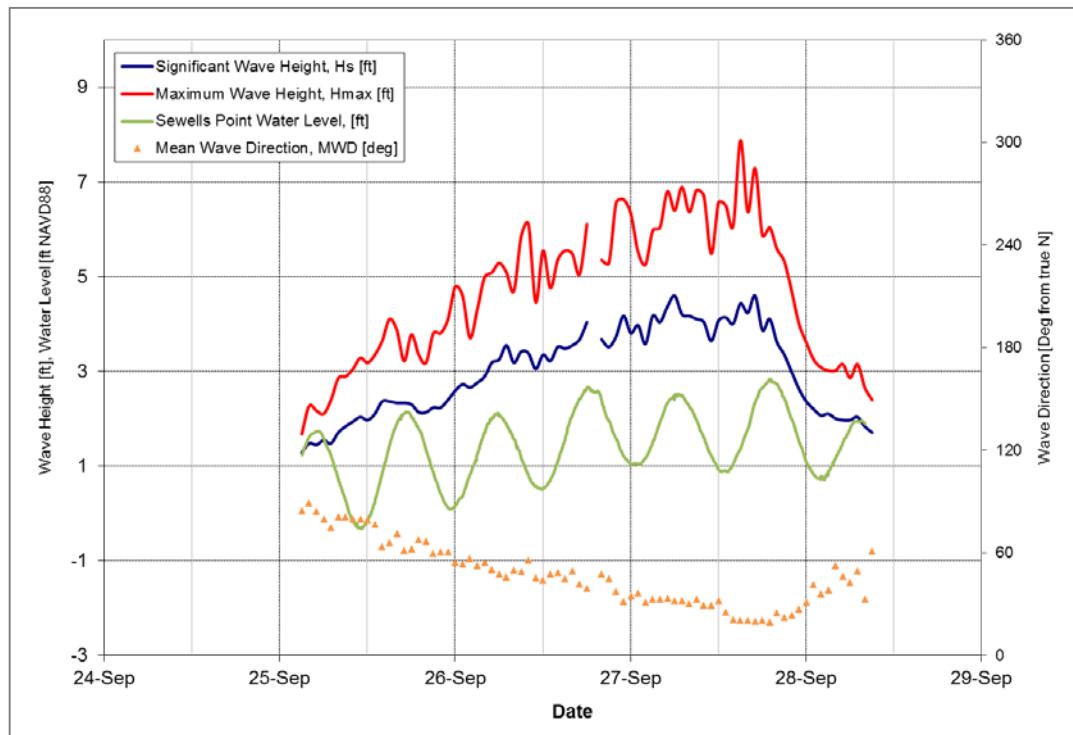


Figure 5-29: September 27, 2017 Storm

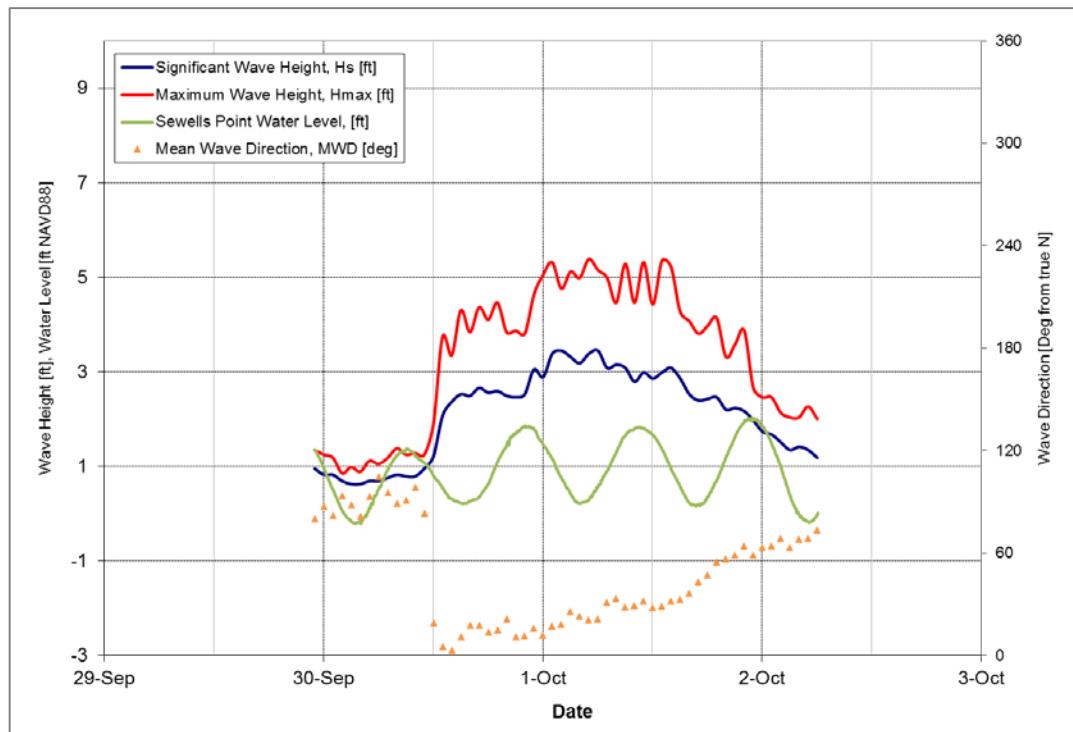


Figure 5-30: October 1, 2017 Storm

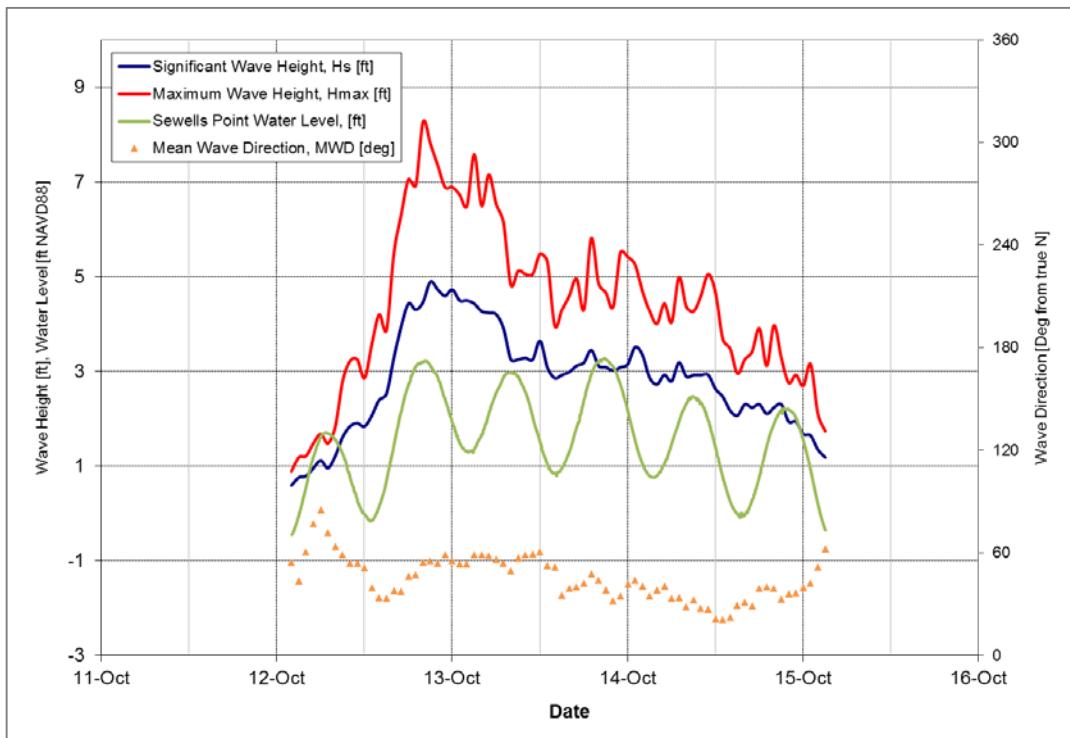


Figure 5-31: October 12, 2017 Storm

5.2.2. Engineering Activities

No significant engineering activities occurred in the monitoring area during this five months' monitoring period.

Immediately prior to this monitoring period, the Federal Willoughby and Vicinity Coastal Storm Damage Reduction Project (Federal Project) was constructed in March, April and May 2017. The Federal Project placed approximately 1.2 million cubic yards of sand from the Thimble Shoals Auxiliary Channel along most of the Ocean View shoreline. An exception is that the Federal Project did not place sand between Warwick Avenue (station 206+86) and 1st Bay Street (station 274+53).

5.3. General Shoreline Trends

Key statistics were calculated to describe the shoreline and volume change trends over the entire shoreline as well as for each region of the shoreline as defined in Figure 3-1. The computed statistics include average shoreline change, average volume change, and cumulative volume change (e.g. total volume of material lost or gained along a section of shoreline). A summary of the resulting statistics for the October 2016 to October 2017 comparison are presented in Table 5-2. A summary of the resulting statistics for the May 2017 to October 2017 comparison are presented in Table 5-3.

As illustrated in Table 5-2, the Ocean View shoreline has experienced overall gain at MHW during October 2016 and October 2017 with a length-weighted average change rate of 80.04 ft/yr due to the Federal Project construction. The beach and dune above 0 feet NAVD88 gained sediment at a rate of

515,276 cy/yr from October 2016 to October 2017. The beach and dune above -15 feet NAVD88 gained sediment at a rate of 1,098,216 cy/yr from October 2016 to October 2017.

From May 2017 to October 2017, the MHW shoreline retreated on average by -15.67 feet, as shown in Table 5-3. The volumetric change over the same period showed slight gains above 0 feet NAVD88 and above -15 feet NAVD88 of 14,931 cy and 10,919 cy, respectively.

The Ocean View shoreline overall gained 10,919 cy above -15 feet NAVD88 between May 2017 and October 2017, and it had a net 1,098,216 cy gain of sand volume above -15 feet NAVD88 over the year between October 2016 and October 2017. These overall trends and the behavior of the system are better understood by looking at patterns of change on a reach-by-reach basis, as discussed in more detail in the following section.

Table 5-2: Regional Shoreline and Volume Change Statistics (October 2016 to October 2017)

Region	Average Shoreline Change	Average Volume Change Rate Above 0 ft NAVD88	Cumulative Volume Change Rate Above 0 ft NAVD88	Average Volume Change Rate Above -15 ft NAVD88	Cumulative Volume Change Rate Above -15 ft NAVD88
	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
Willoughby Spit (0+00 to 45+00)	107.78	16.27	73,420	29.76	134,310
800 Block Breakwaters (45+25 to 87+62)	138.27	20.11	91,281	46.89	212,839
West Ocean View (93+41 to 163+49)	84.47	15.16	107,909	36.15	248,114
Central Ocean View Breakwaters (169+63 to 195+63)	98.22	17.11	59,358	36.09	125,170
Central Ocean View (206+86 to 323+09)	27.16	6.22	77,802	14.68	183,646
East Ocean View (329+63 to 383+58)	110.72	18.44	105,505	33.93	194,137
OVERALL	Weighted Avg (ft/yr)	Weighted Avg (cy/ft/yr)	Total (cy/yr)	Weighted Avg (cy/ft/yr)	Total (cy/yr)
	80.04	13.63	515,276	29.33	1,098,216

Table 5-3: Regional Shoreline and Volume Change Statistics (May 2017 to October 2017)

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
Willoughby Spit (0+00 to 45+00)	3.47	2.32	10,449	4.51	20,332
800 Block Breakwaters (45+25 to 87+62)	-13.30	-0.48	-2,178	2.54	11,541
West Ocean View (93+41 to 163+49)	-23.94	0.54	4,134	1.11	8,459
Central Ocean View Breakwaters (169+63 to 195+63)	-39.47	-1.28	-4,444	-3.47	-12,035
Central Ocean View (206+86 to 323+09)	-7.34	0.72	9,024	-0.09	-1,121
East Ocean View (329+63 to 383+58)	-25.41	-0.36	-2,054	-2.84	-16,257
OVERALL	Weighted Avg (ft)	Weighted Avg (cy/ft)	Total (cy)	Weighted Avg (cy/ft)	Total (cy)
	-15.67	0.39	14,931	0.28	10,919

5.4. Regional Shoreline Trends

Regional shoreline trends are discussed below for the defined regions between Willoughby Spit and Little Creek Inlet (see Figure 3-1). A summary of the information in Table 5-2 and Table 5-3 has been created for each region of study Figure 5-32 through Figure 5-35, following the discussion of regional shoreline trends, present the shoreline and volume change at each transect within the defined regions.

5.4.1. Willoughby Spit

The western end of the Willoughby Spit region has, since regular monitoring started in 2005, been a relatively stable and accreting region. The eastern end of this region contained an erosional hot spot that was studied in 2010, and that study recommended improvements to manage erosion rates. Prior to December 2012, coastal structures in this region included two offshore breakwaters, a rock terminal groin, and several timber groins. Construction of the Willoughby Spit Shoreline Improvement Project was completed by December 2013, and it included sand nourishment, the removal of the existing timber groin field, relocation of a prior existing breakwater in the 800 Block breakwater field, and addition of seven new detached breakwaters connecting the 800 Block breakwaters with the two prior existing Willoughby Spit breakwaters. A summary of average shoreline and volume change rates for the Willoughby Spit region between October 2016 and October 2017 and between May 2017 and October 2017 are presented in Table 5-4.

Table 5-4: Average Shoreline and Volume Change Rates for Willoughby Spit

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2016 vs. October 2017 Comparison					
Willoughby Spit (0+00 to 45+00)	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
May 2017 vs. October 2017 Comparison					
Willoughby Spit (0+00 to 45+00)	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)

On average, this region gained volume in the beach and dune above 0 feet NAVD88 over the seasonal comparison (May 2017 - October 2017). Willoughby Spit gained volume in the beach above 0 feet NAVD88 over the yearly comparison (October 2016 - October 2017). This region gained volume in the subaerial beach and in the submerged profile over the seasonal comparison (May 2017 - October 2017) and the yearly comparison (October 2016 - October 2017). For the yearly comparison, the MHW shoreline gained at a rate of 107.78 ft/yr while gaining volume above 0 feet and gaining volume above -15 feet NAVD88 at a rate of 73,420 cy/yr and 134,310 cy/yr, respectively. The seasonal comparison showed gain of the MHW shoreline of 3.47 feet on average and a cumulative sediment gain above 0 feet and -15 feet NAVD88 of 10,449 cy and 20,332 cy, respectively. The breakwaters that were part of the 2013 shoreline improvement project that connected to the previously existing 800 Block breakwaters have continued to provide stability to the majority of the Willoughby Spit reach as shown in Figure 5-32 and Figure 5-34. As an exception, the relatively short segment between the two sets of breakwaters has experienced significantly greater shoreline retreat than the adjacent shorelines within

the breakwater fields. This area adjacent to Toler Place and 11th View Street will continue to be closely tracked in future monitoring events.

5.4.2. 800 Block Breakwaters

The 800 Block Breakwaters region (Sta 45+25 to Sta 87+62) is characterized by a field of eight breakwaters. The easternmost breakwater was relocated in February 2006 along with removal of a pre-existing groin spur and toe extension. This relocated breakwater was placed further offshore to mitigate an excessive salient / tombolo formation, caused by the prior structural configuration that had impaired natural sediment transport to the west. In conjunction with the 2013 Willoughby Spit shoreline improvement project, the second easternmost breakwater in the 800 Block set was also relocated further offshore to enhance natural sediment transport in the region. A summary of average shoreline and volume change rates for the 800 Block Breakwaters region between October 2016 and October 2017 and between May 2017 and October 2017 are presented in Table 5-5.

Table 5-5: Average Shoreline and Volume Change Rates for 800 Block Breakwaters

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2016 vs. October 2017 Comparison					
800 Block Breakwaters (45+25 to 87+62)	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
	138.27	20.11	91,281	46.89	212,839
May 2017 vs. October 2017 Comparison					
800 Block Breakwaters (45+25 to 87+62)	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
	-13.30	-0.48	-2,178	2.54	11,541

The 800 Block region gained volume over the seasonal comparison (May 2017 - October 2017) and over the yearly comparison (October 2016 - October 2017). Over the past year, there has been gain of the MHW shoreline of 138.27 ft/yr as well as an overall volume gain above 0 feet NAVD88 and overall volume gain above -15 ft NAVD88 of 91,281 cy/yr and 212,839 cy/yr, respectively. The seasonal comparison showed there was loss of the MHW shoreline of -13.30 feet and a loss of sediment volume above 0 feet NAVD88 and a gain of sediment volume -15 feet NAVD88 of -2,178 cy and 11,541 cy, respectively.

5.4.3. West Ocean View

The West Ocean View area (Sta 93+41 to Sta 163+49), between the 800 Block and Central Ocean View breakwaters, was historically characterized by a series of timber groins. The 2013 West Ocean View Shoreline Improvement Project included the removal of all timber groins located between the Ocean View Fishing Pier and Station 141+98, the reconstruction of a rock groin at station 129+17, and 73,600 cy of sand nourishment placed in front of Sarah Constant Beach Park. A summary of average shoreline and volume change rates for the West Ocean View region between October 2016 and October 2017 and between May 2017 and October 2017 are presented in Table 5-6.

Table 5-6: Average Shoreline and Volume Change Rates for West Ocean View

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2016 vs. October 2017 Comparison					
West Ocean View (93+41 to 163+49)	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
May 2017 vs. October 2017 Comparison					
West Ocean View (93+41 to 163+49)	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)

This region had gain over the yearly comparison (October 2016 - October 2017) with gain of the MHW shoreline at a rate of 84.47 ft/yr, and a volume gain above 0 feet NAVD88 and -15 feet NAVD88 at a rate of 107,909 cy/yr and 238,114 cy/yr respectively. The seasonal comparison (May 2017 - October 2017) showed a loss of the MHW shoreline of -23.94 feet, a gain of material above 0 feet NAVD88 of 4,134 cy and a gain of material above -15 feet NAVD88 of 8,459 cy.

5.4.4. Central Ocean View Breakwaters

The Central Ocean View Breakwaters region covers the four offshore breakwaters at Central Ocean View and approximately 800 feet westward (Sta 169+63 to Sta 195+63). A summary of average shoreline and volume change rates for the Central Ocean View Breakwaters region between October 2016 and October 2017 and between May 2017 and October 2017 are presented in Table 5-7.

Table 5-7: Average Shoreline and Volume Change Rates for Central Ocean View Breakwaters

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2016 vs. October 2017 Comparison					
Central Ocean View Breakwaters (169+63 to 195+63)	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
May 2017 vs. October 2017 Comparison					
Central Ocean View Breakwaters (169+63 to 195+63)	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)

This region was on average gain over the yearly comparison (October 2016 - October 2017) and loss seasonal comparison (May 2017 – October 2017) above -15 feet NAVD88. The yearly comparison showed overall gain of the MHW shoreline at a rate of 98.22 ft/yr and an overall volume gain above 0 feet NAVD88 and an overall volume gain above -15 feet NAVD88 at a rate of 59,358 cy/yr and 125,170 cy/yr. The seasonal comparison showed loss of the MHW shoreline of -39.47 feet and a loss of material above 0 feet NAVD88 and -15 feet NAVD88 of -4,444 cy and -12,035 cy respectively.

5.4.5. Central Ocean View

Central Ocean View (Sta 206+86 to Sta 323+09) is historically a stable region with slight accretion despite the absence of engineering interventions (e.g. beach fill or structures). A summary of average

shoreline and volume change rates for the Central Ocean View region between October 2016 and October 2017 and between May 2017 and October 2017 are presented in Table 5-8.

Table 5-8: Average Shoreline and Volume Change Rates for Central Ocean View

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2016 vs. October 2017 Comparison					
Central Ocean View (206+86 to 323+09)	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
Central Ocean View (206+86 to 323+09)	27.16	6.22	77,802	14.68	183,646
May 2017 vs. October 2017 Comparison					
Central Ocean View (206+86 to 323+09)	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
Central Ocean View (206+86 to 323+09)	-7.34	0.72	9,024	-0.09	-1,121

As shown in Table 5-8, the yearly comparison (October 2016 - October 2017) for the Central Ocean View region showed volume gain above 0 feet NAVD88. The seasonal comparison (May 2017 - October 2017) indicated volume loss. The volume gain over the current survey above 0 feet NAVD88 and the volume loss above -15 feet NAVD88 was 9,024 cy and -1,121 cy respectively. The average yearly shoreline gain rate was 27.16 ft/yr with an average of -7.34 ft of loss occurring over the reach during the current survey period.

The Central Ocean View shoreline and volume change rates shown in Figure 5-32 and Figure 5-33 Figure 5-35 are significantly less positive in magnitude than the adjacent reaches of Ocean View. This is due to the fact that the Federal Project did not place nourishment sand directly in the Central Ocean View region – partly due to the stable nature of that shoreline – and it does not imply any negative performance of the beach in Central Ocean View during the monitoring period.

5.4.6. East Ocean View

The East Ocean View region (Sta 329+63 to Sta 383+58) is characterized by 15 breakwaters of which the 5 westernmost were built in August 2009. Prior to the breakwater construction, a beach renourishment project took place in March 2009, adding approximately 196,000 cy of material to the beach. Table 5-9 summarizes average shoreline and volume change rates for the East Ocean View region between October 2016 and October 2017 and between May 2017 and October 2017.

Table 5-9: Average Shoreline and Volume Change Rates for East Ocean View

Region	Average Shoreline Change	Average Volume Change Above 0 ft NAVD88	Cumulative Volume Change Above 0 ft NAVD88	Average Volume Change Above -15 ft NAVD88	Cumulative Volume Change Above -15 ft NAVD88
October 2016 vs. October 2017 Comparison					
East Ocean View (329+63 to 383+58)	(ft/yr)	(cy/ft/yr)	(cy/yr)	(cy/ft/yr)	(cy/yr)
East Ocean View (329+63 to 383+58)	110.72	18.44	105,505	33.93	194,137
May 2017 vs. October 2017 Comparison					
East Ocean View (329+63 to 383+58)	(ft)	(cy/ft)	(cy)	(cy/ft)	(cy)
East Ocean View (329+63 to 383+58)	-25.41	-0.36	-2,054	-2.84	-16,257

This region is normally characterized by a consistent erosional pattern due to sediment movement along the shoreline from east to west with no external sand source due to the terminal groin at Little Creek Inlet. East Ocean View experienced volume gain over the yearly (October 2016 - October 2017) comparison and over the seasonal (May 2017 – October 2017) comparison. The MHW shoreline yearly comparison showed an overall gain of the MHW shoreline at a rate of 110.72 ft/yr and an overall volume gain above 0 feet NAVD88 and -15 feet NAVD88 at a rate of 105,505 cy/yr and 194,137 cy/yr respectively. The seasonal comparison showed a loss of the MHW shoreline of -25.41 feet and a loss of material above 0 feet NAVD88 and -15 feet NAVD88 of -2,054 cy and -16,257 cy respectively.

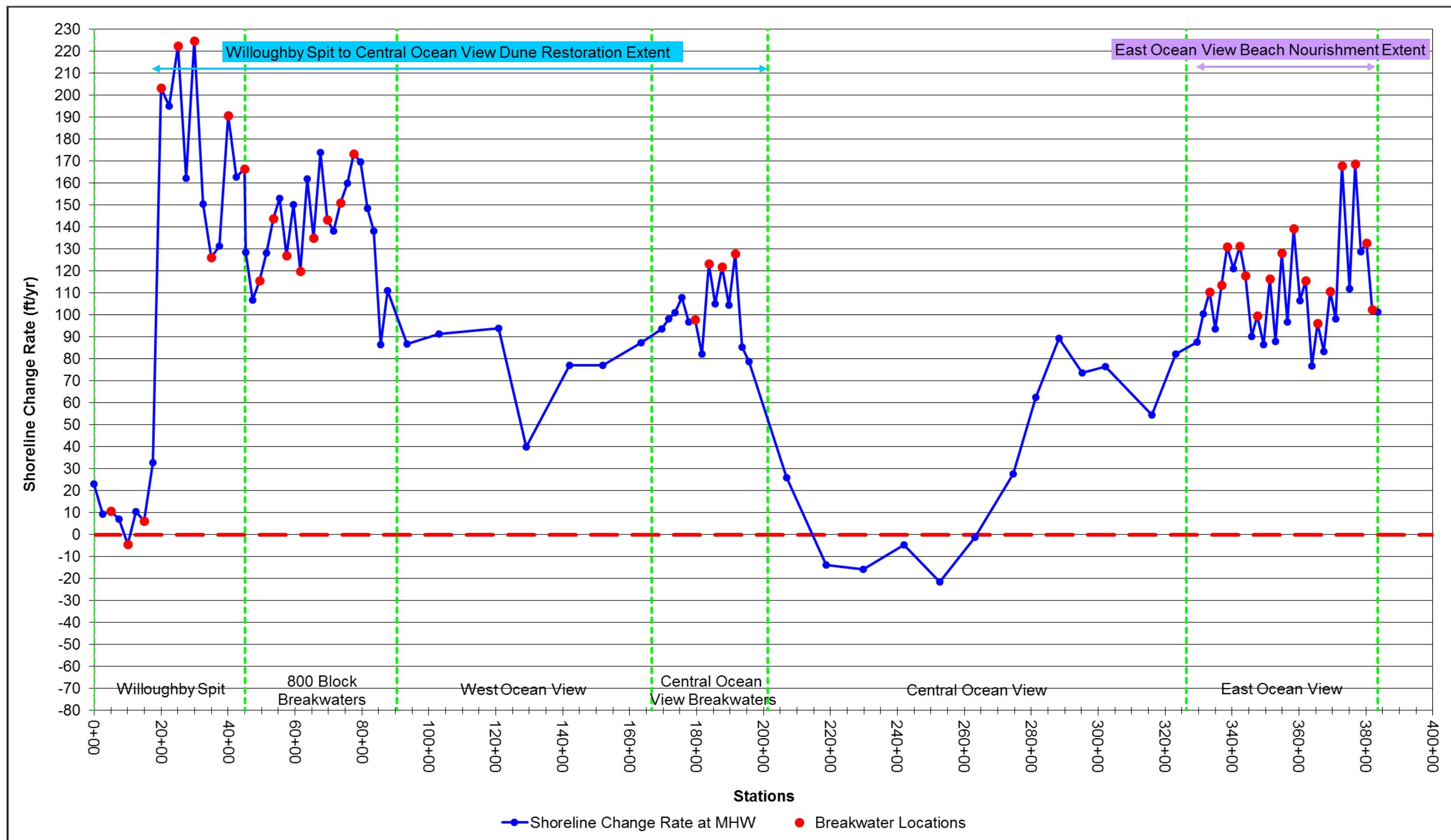


Figure 5-32: Shoreline Change Rate (ft/yr) at Mean High Water (+0.98 ft NAVD88) for October 2016 to October 2017 (Note: Positive = Accretion, Negative = Erosion)

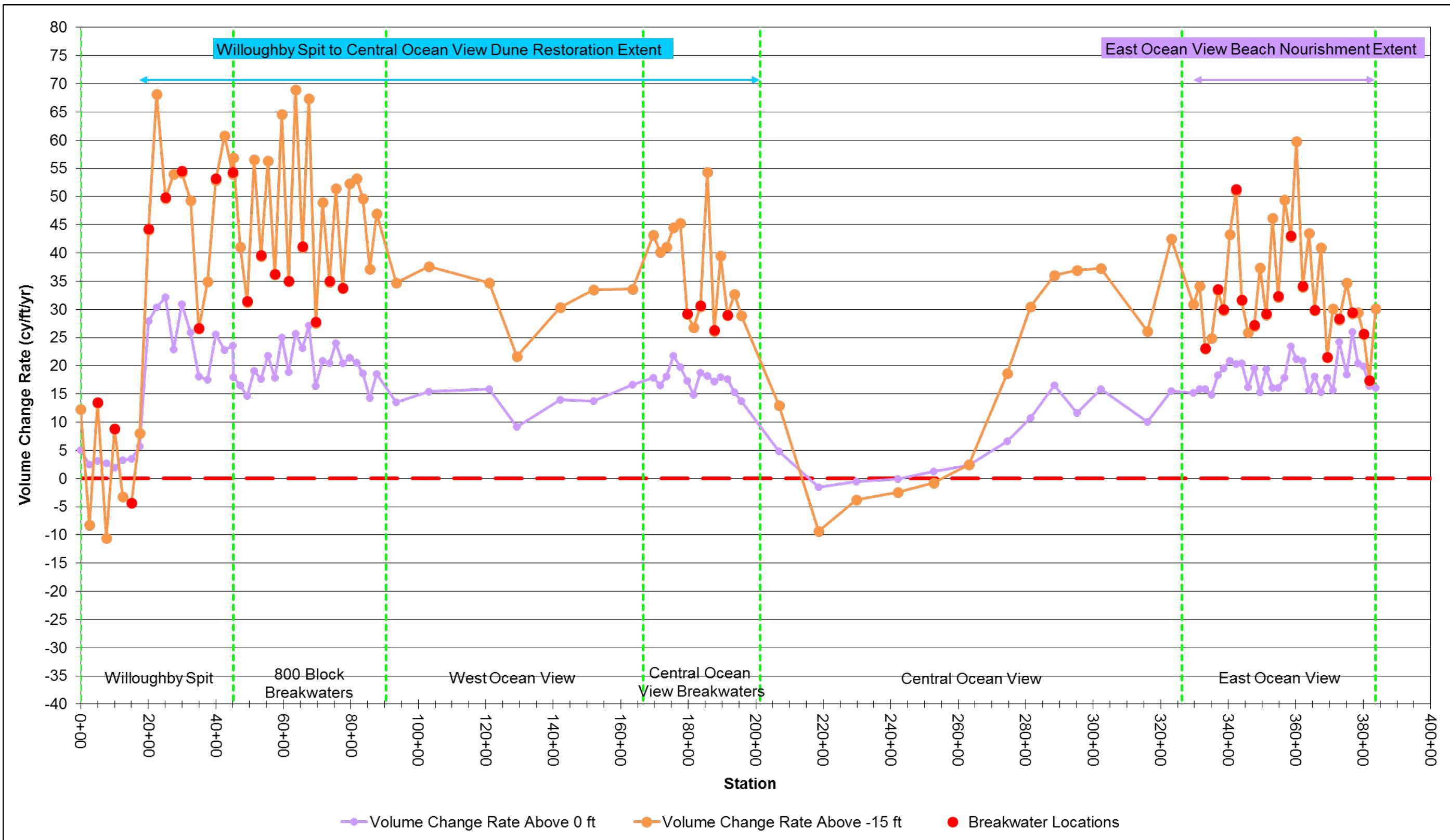


Figure 5-33: Volume Change Rate Above 0 ft NAVD88 and -15 ft NAVD88 (cy/ft/yr) for October 2016 to October 2017 (Note: Positive = Accretion, Negative = Erosion)

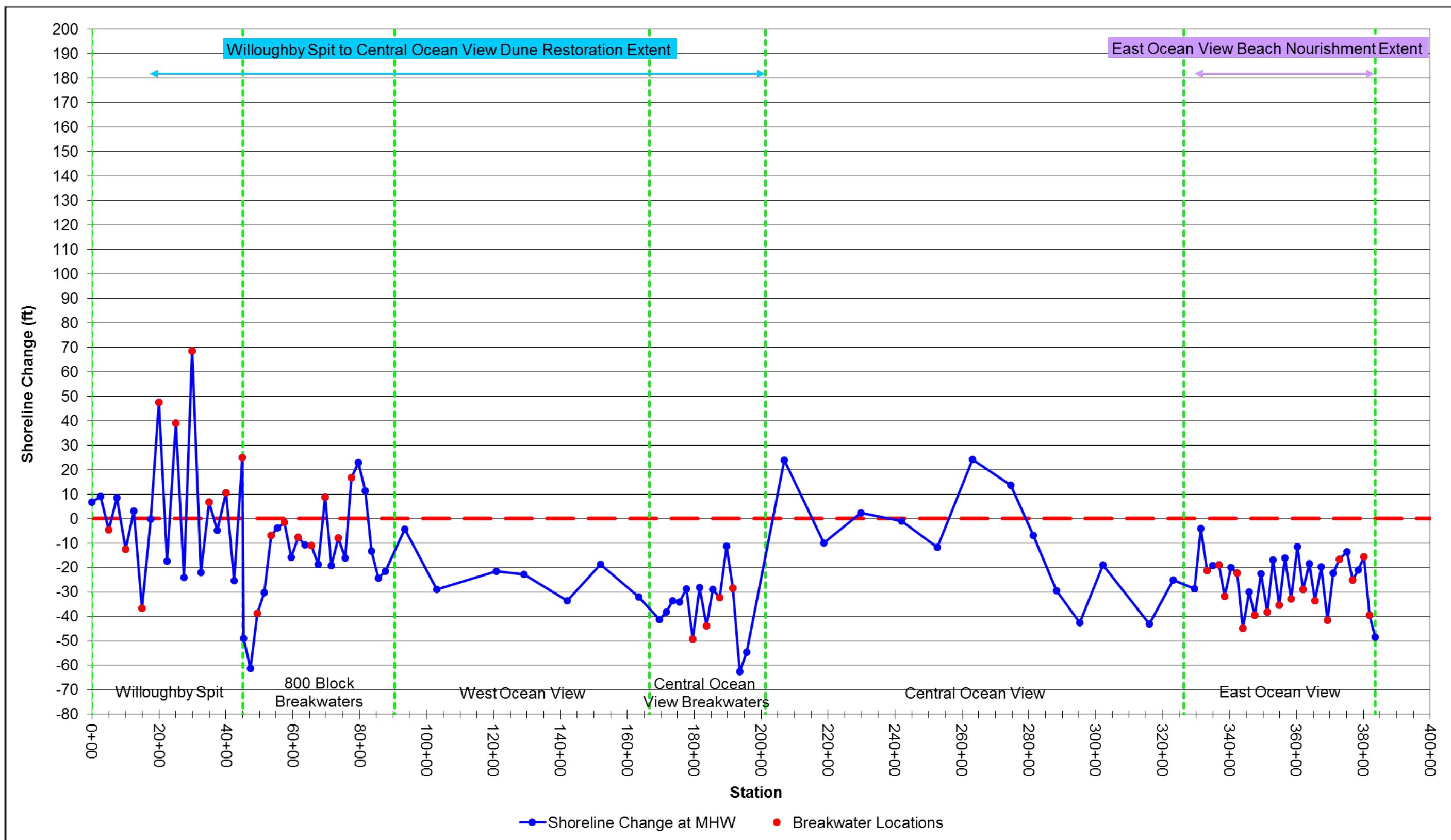


Figure 5-34: Shoreline Change (ft) at Mean High Water (+0.98 ft NAVD88) for May 2017 to October 2017 (Note: Positive = Accretion, Negative = Erosion)

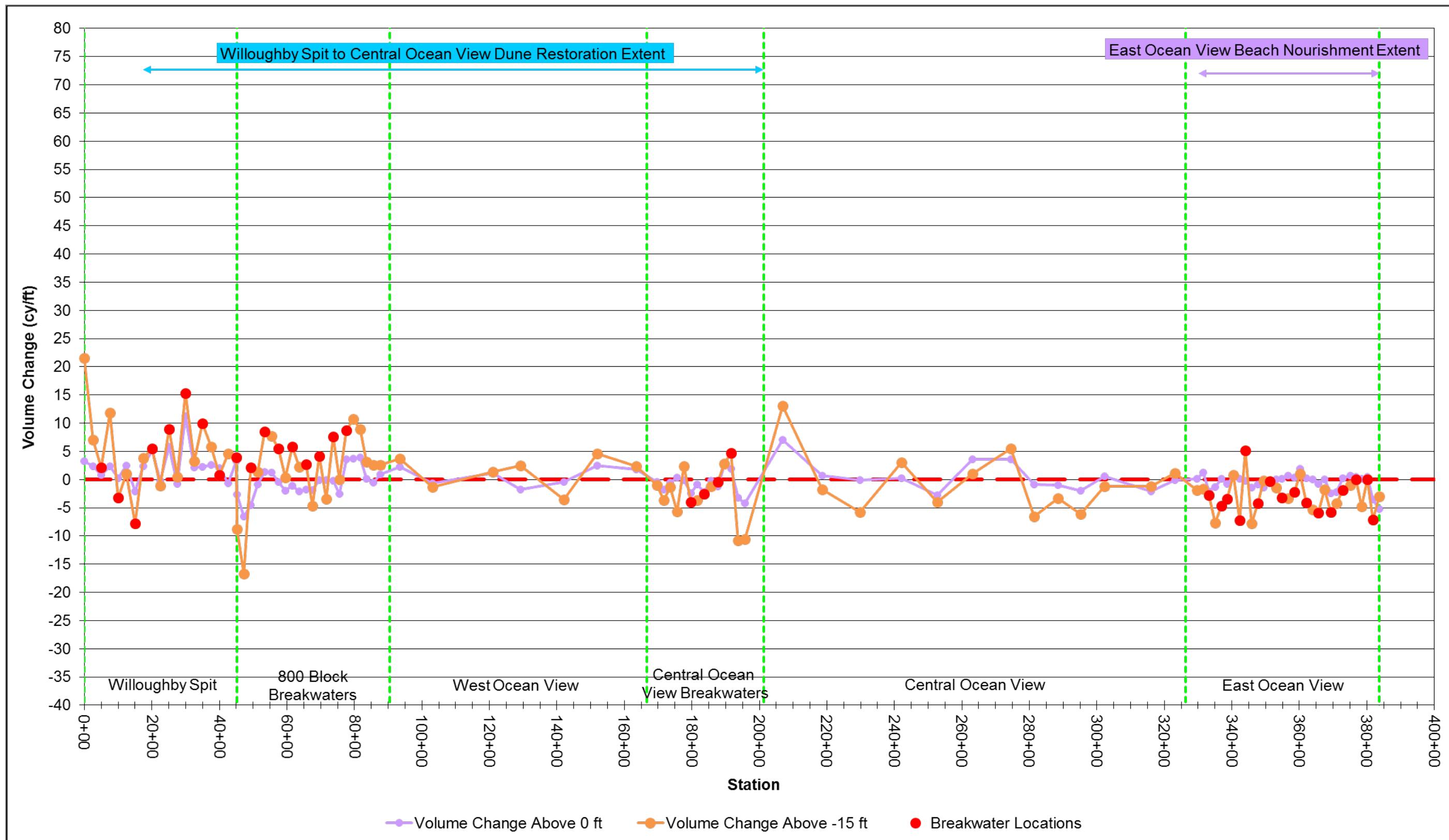


Figure 5-35: Volume Change Above 0 ft NAVD88 and -15 ft NAVD88 (cy/ft) for May 2017 to October 2017 (Note: Positive = Accretion, Negative = Erosion)

6. Federal Coastal Storm Damage Reduction Project

6.1. Initial Construction of the Federal Project

The initial nourishment of the Federal Willoughby and Vicinity Coastal Storm Damage Reduction Project (Federal Project) was constructed in March, April and May 2017. The Federal Project placed approximately 1.2 million cubic yards of sand from the Thimble Shoals Auxiliary Channel along most of the Ocean View shoreline. An exception is that the Federal Project did not place sand between Warwick Avenue (station 206+86) and 1st Bay Street (station 274+53). The Spring 2017 survey (done in late May 2017 after all of the Federal Project beach fill had been placed) captured the project's beach and nearshore condition very soon after construction was completed.

6.2. Shoreline Beach Berm Contour Changes Relative to the May 2017 Post-Construction Condition of the Federal Project

The most recent Fall 2017 periodic survey, taken in October 2017, illustrates the evolution of the Federal Project through initial adjustment and background erosion / accretion due to coastal processes occurring from May 2017 through early October 2017. Figure 6-1 shows the position of the Mean High Water (MHW) contour line extracted from Digital Elevation Models (DEMs) of the October 2016 (approximately six months pre-construction), May 2017 (post-construction) and October 2017 (approximately five months post-construction) surveys. The movement of the shoreline is consistent with the shoreline changes tabulated by Ocean View region earlier in this report (Table 1-2).

The amount of shoreline change post-construction of the Federal Project varied widely throughout the study area. The median shoreline change among the 106 transects (without any length-weighting) was approximately -20 feet, with 90% of transects having change between +10 and -40 feet. While this is a larger magnitude of change than is typically observed along Ocean View in a six-month period, it is typical and expected that the MHW contour of a nourishment project changes in this way in the several months post-construction, as the beach profile and planform readjusts. Noticeable areas where the Federal Project's constructed shoreline retreated more quickly than in Ocean View as a whole included:

- stations 45+25 to 49+35, between 11th View Street and the 800 Block Breakwaters; the MHW contour in this reach retreated 40 to 60 feet
- stations 163+49 to 177+63, immediately west of the Central Ocean View breakwaters; shoreline retreat in this reach averaged approximately 33 feet
- station 193+63 and station 195+63, immediately east of the Central Ocean View breakwaters; the shoreline retreated between 30 and 60 feet
- 295+27 to 329+63 west of the Bay Oaks Breakwaters in East Ocean View; shoreline retreat in this reach averaged approximately 30 feet

The Federal Project authorized beach template is not defined by the shoreline position, but by the beach width (seaward of the dune toe) at or above a beach berm elevation of +3.5 feet NAVD88. Figure 6-2

shows the position of the most bayward +3.5 ft NAVD88 elevation contour (representing the authorized Federal beach berm elevation) as extracted from the October 2016, May 2017 and October 2017 survey DEMs. Significant berm retreat is seen from stations 45+25 to 49+35, in the same area that greater shoreline retreat rates were noted east of 11th View Street. It is worth noting that the more than typical MHW and +3.5 ft contour retreat rates appear to be in the gap between the Willoughby Spit Breakwaters and the 800 Block Breakwaters, but do not extend, according to the data, into the adjacent Toler Place reach. Future monitoring events will need to pay close attention to this area to track this trend. Noticeable retreat of the +3.5 ft contour also occurred within the 800 Block Breakwaters, adjacent to the east end of the Central Ocean View Breakwaters, and west of the Bay Oaks Breakwaters in East Ocean View. The median +3.5 ft NAVD88 contour change rate was approximately -21 ft/yr, with 60% of the transects having rates between -13 and -35 ft/yr.

In future monitoring reports, it is recommended to include the position of a contour representing a threshold criteria for renourishment of the Federal Project. The published documents presently available relative to the Federal Project do not define a particular shoreline or beach berm position in physical space that represents such a threshold condition. Instead, the threshold is discussed in the project's authorizing documents as a percentage of the authorized beach width at +3.5 feet NAVD88. Since the beach is not likely to hold a constant elevation across the berm from the dune toe bayward, it is difficult to choose a single contour representing the landward edge of the beach berm that can be consistently extracted from subsequent survey profiles and DEMs to calculate the remaining beach width. It is recommended that a fixed line in space be developed, in collaboration with USACE Norfolk District, that can be used to track the relative position of surveyed beach contours to the renourishment threshold.

6.3. Beach and Nearshore Elevation Changes Relative to the May 2017 Post-Construction Condition of the Federal Project

The map plots in Appendix E shows areas of elevation change between the dates indicated in the map Legends. Elevation gains (accretion) are shown in green shades, and elevation losses (erosion) are shown in yellow to red shades. The maps were prepared by subtracting elevations in each grid cell within survey Digital Elevation Models (DEMs) between May 2017 and October 2017 surveys, and between October 2016 and May 2017 surveys.

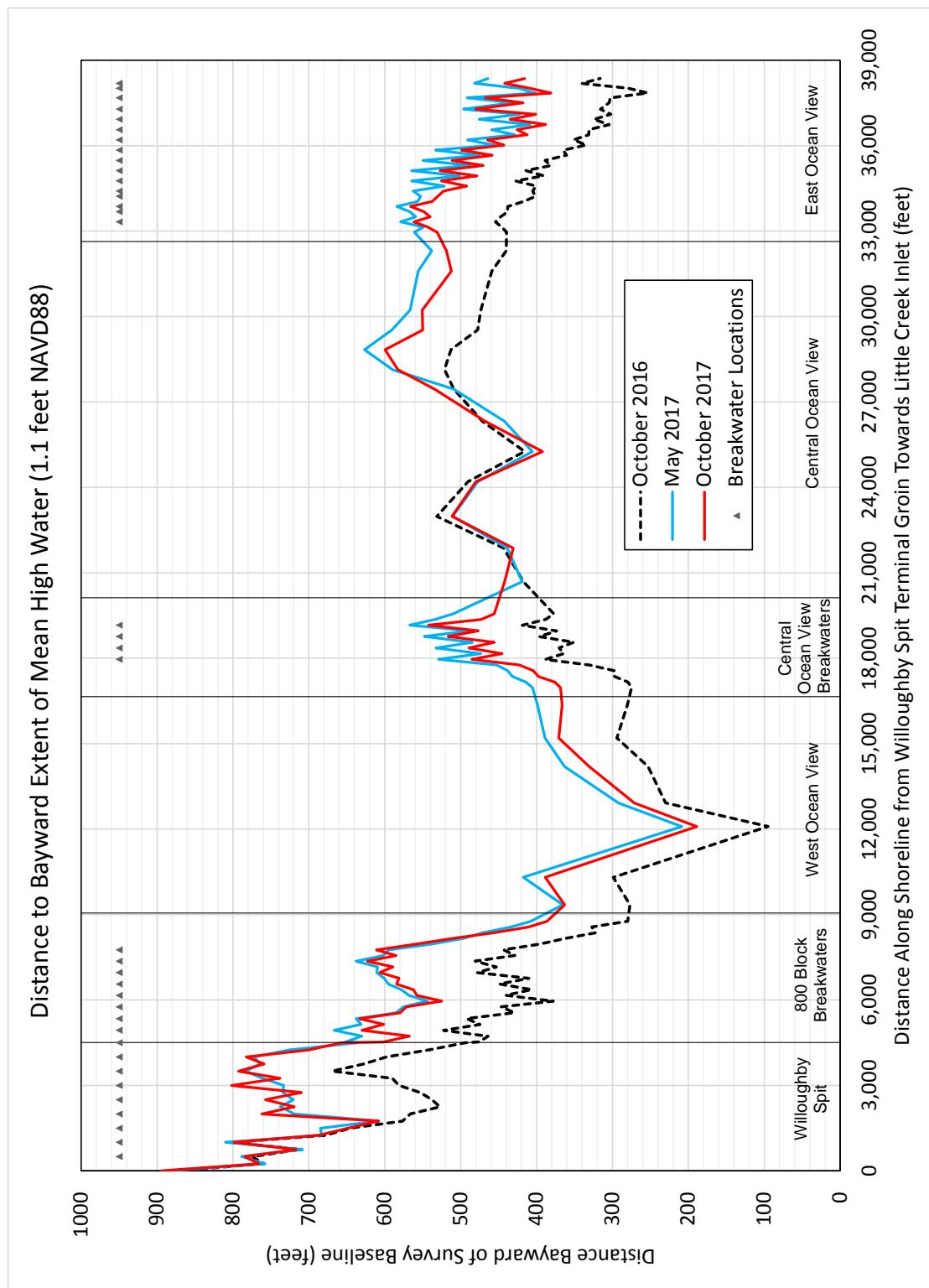


Figure 6-1: Position of the Mean High Water (+1.1 ft NAVD88) Contour Relative to Pre- and Post-Construction of the Federal Project

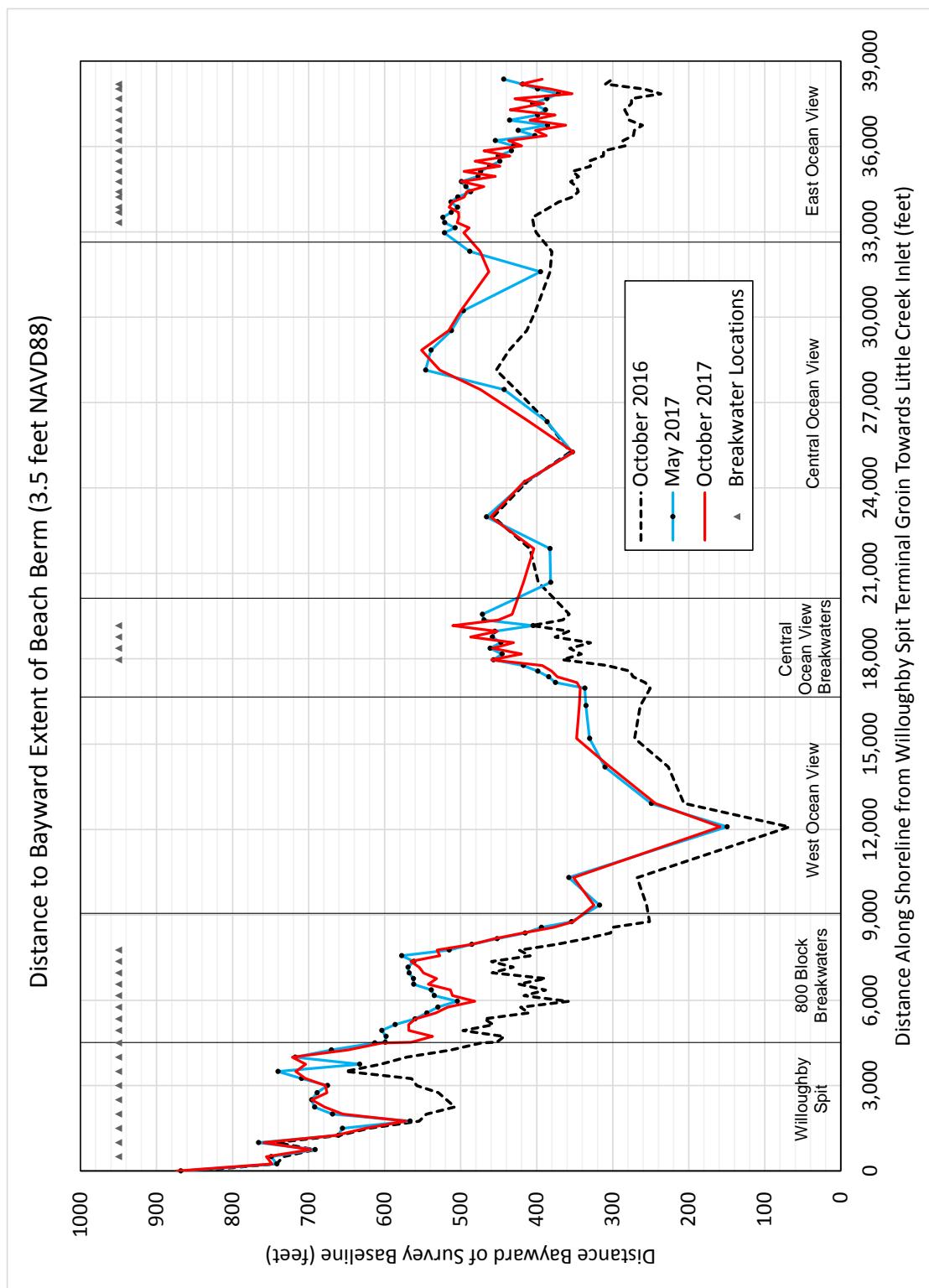


Figure 6-2: Position of the Bayward Extent of the +3.5 ft NAVD88 Beach Berm Contour Relative to Pre- and Post-Construction of the Federal Project

7. Summary

Comprehensive periodic surveying of the entire Ocean View shoreline began with an initial survey in September 2005. The most recent survey was completed in October 2017. The beach and bathymetric surveys performed by Geodynamics utilized baseline and transect positions established in September 2005 which are used for all periodic surveys. For this periodic evaluation, the October 2017 survey was compared with both the prior year and prior five months' surveys (October 2017 compared to October 2016 and May 2017, respectively). The surveys were used to compute shoreline change at MHW and volume change above 0 feet NAVD88 and above -15 feet NAVD88.

Key statistics were computed for defined regions along Ocean View and the entire shoreline for the time period between the October 2016 and October 2017 surveys and between the May 2017 and October 2017 surveys.

Comparison	Parameter	Quantity
October 2016 vs. October 2017	Average Shoreline Change Rate at MHW (+0.98 ft NAVD88)	80.04 ft/yr
	Cumulative Volume Change Rate Above 0 ft NAVD88	515,276 cy/yr
	Cumulative Volume Change Rate Above -15 ft NAVD88	1,098,216 cy/yr
May 2017 vs. October 2017	Average Shoreline Change at MHW (+0.98 ft NAVD88)	-15.67 ft
	Cumulative Volume Change Above 0 ft NAVD88	14,931 cy
	Cumulative Volume Change Above -15 ft NAVD88	10,919 cy

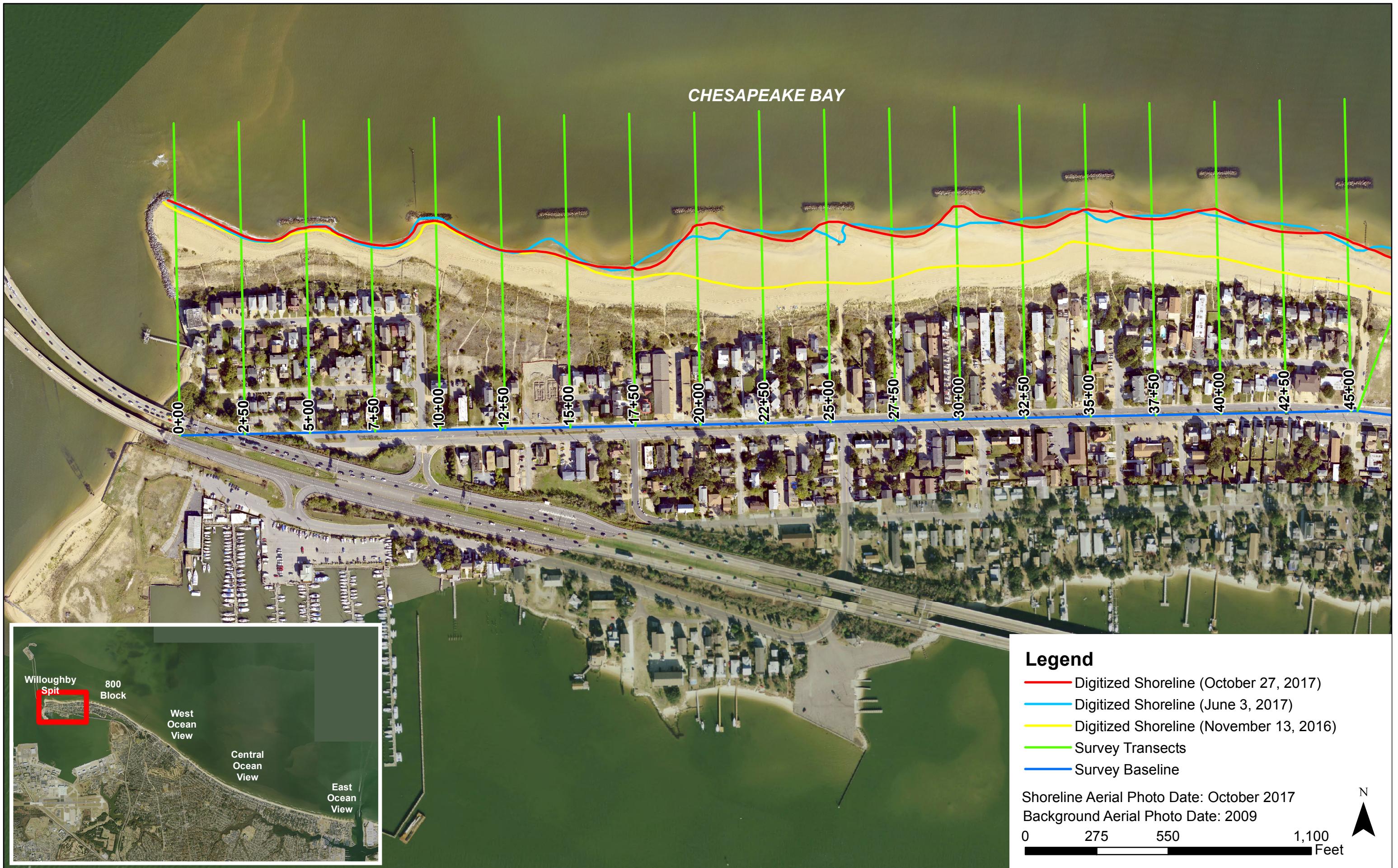
The average shoreline change rate for the entire shoreline at MHW between the October 2016 and October 2017 surveys was 80.04 ft/yr of bayward advance, and the cumulative volume changes above 0 feet NAVD88 and -15 feet NAVD88 were approximately 515,276 cy/yr and 1,098,216 cy/yr, respectively. The shoreline advancement and volume gain were due to the placement of 1.2 million cubic yards in March, April and May 2017 during construction of the Federal Project.

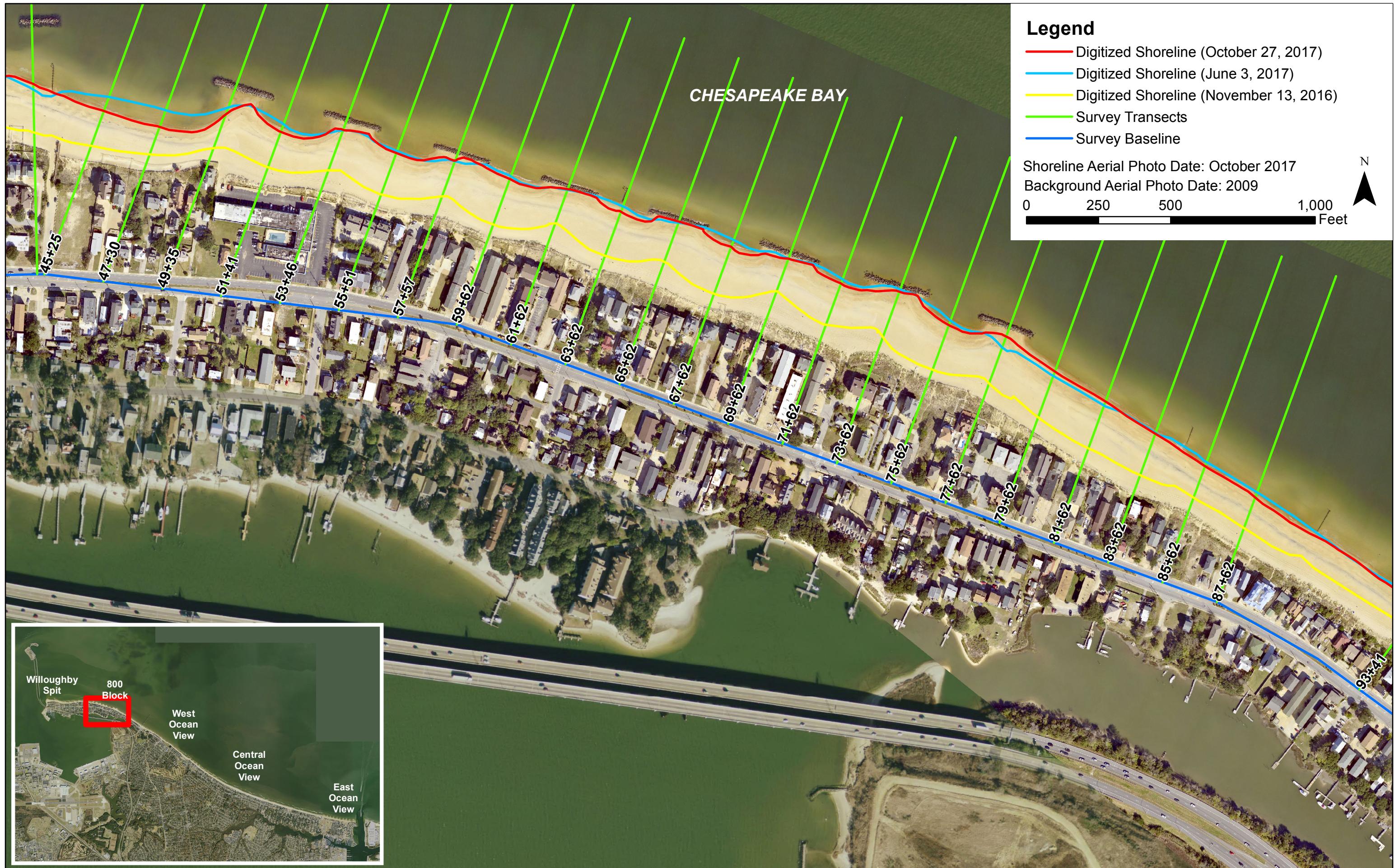
Most of the transects in the monitoring area experienced shoreline retreat in the past five months following the initial construction of the Federal Project. The average shoreline change rate for the entire shoreline at MHW between the May 2017 and October 2017 surveys was -15.67 ft/yr, and the cumulative volume changes above 0 feet NAVD88 and -15 feet NAVD88 were approximately 14,931 cy/yr and 10,919 cy/yr, respectively. The small positive volume changes coupled with the clear signal of shoreline retreat illustrates the readjustment of the shoreline and beach face following the nourishment project.

Areas of greater shoreline retreat (compared to average rates along Ocean View as a whole) include: between 11th View Street and the 800 Block Breakwaters; adjacent to the west and east ends of the Central Ocean View Breakwaters; and west of the Bay Oaks Breakwaters in East Ocean View. Shoreline change rates varied widely on a transect by transect basis. The median shoreline change among the 106 transects (without any length-weighting) was approximately -20 feet, with 90% of transects having change between +10 and -40 feet. For greater benefit in using future monitoring reports to track the performance and remaining "service life" of the Federal Project, it is recommended to establish a fixed line in space that can be plotted on charts similar to Figure 6-1 and Figure 6-2. This line should be developed in collaboration with USACE Norfolk District.

This is the twenty-fifth periodic survey report completed to date, and the twenty-fifth evaluation of a consistent survey period utilizing beach and bathymetric surveys. As noted, there are inevitable margins of error associated with the survey data that may reduce the accuracy of volumetric change analyses. Therefore, it is essential to thoroughly review the beach and bathymetric profiles using various analytical techniques and general engineering judgment to assure that results are not falsely interpreted. Comparison of surveys taken at the same season of the year (i.e. October 2016 to October 2017) mitigates seasonal variation of profiles in volumetric change analyses. Consecutive spring-fall or fall-spring survey comparisons are useful to assess the direct impact of extreme events which may occur during the approximate six month period between surveys.

Future periodic survey evaluations will continue to improve on analysis techniques and will track changes in and the condition of the Federal Project, to assist the City to manage these beaches and coordinate with USACE regarding Federal Project maintenance.

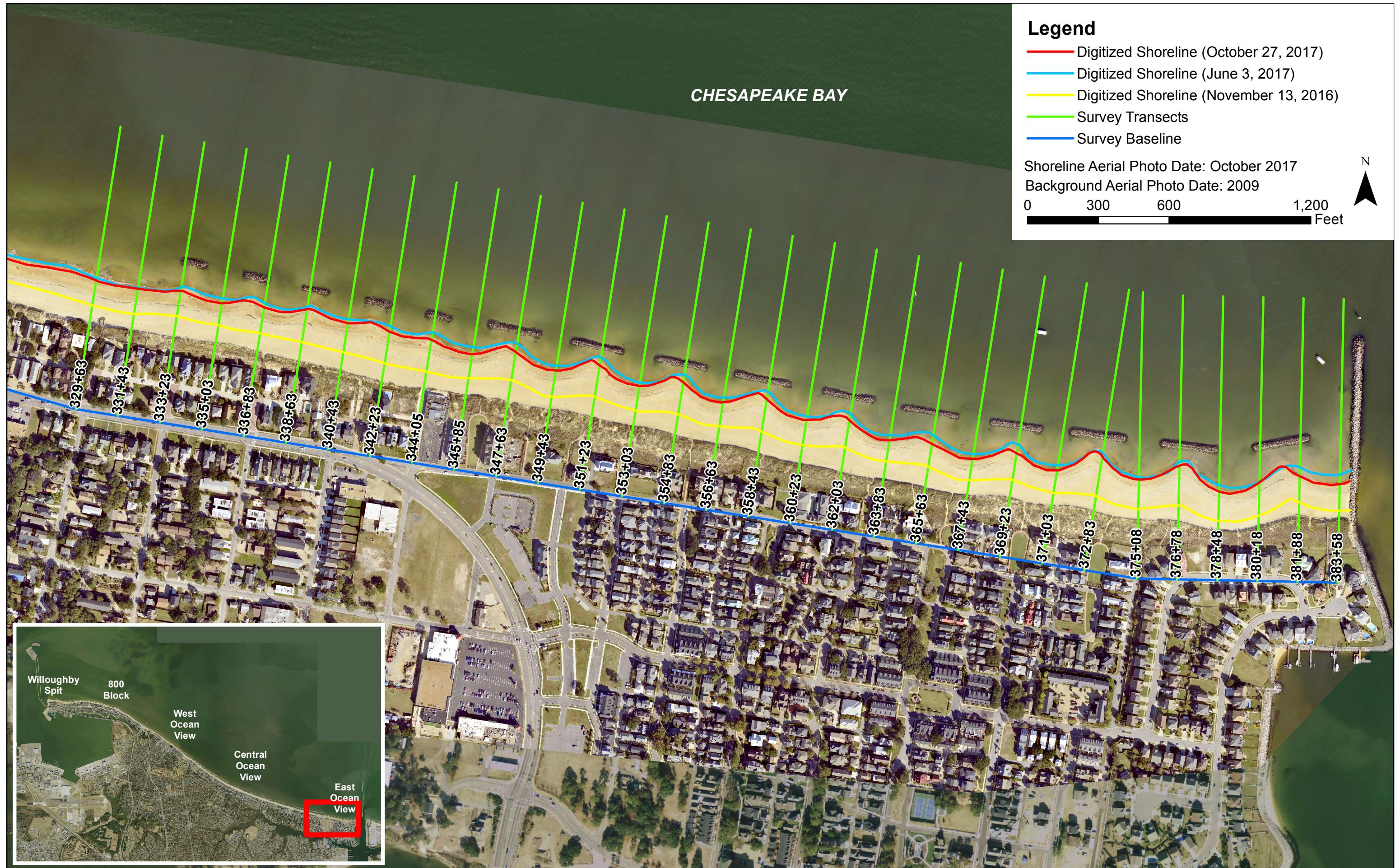


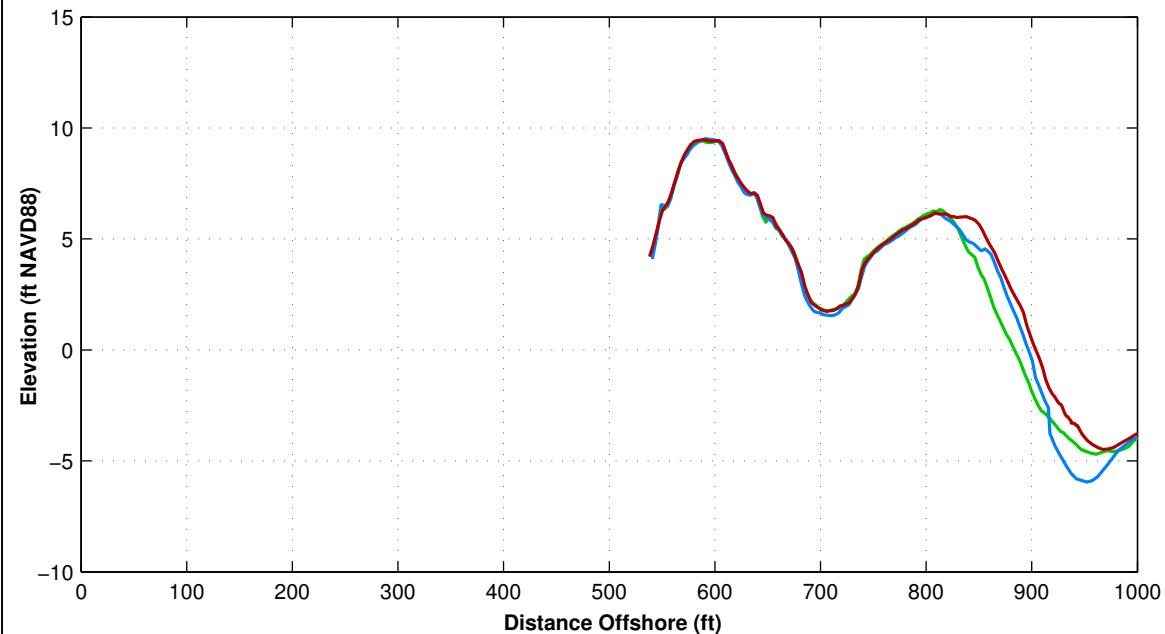
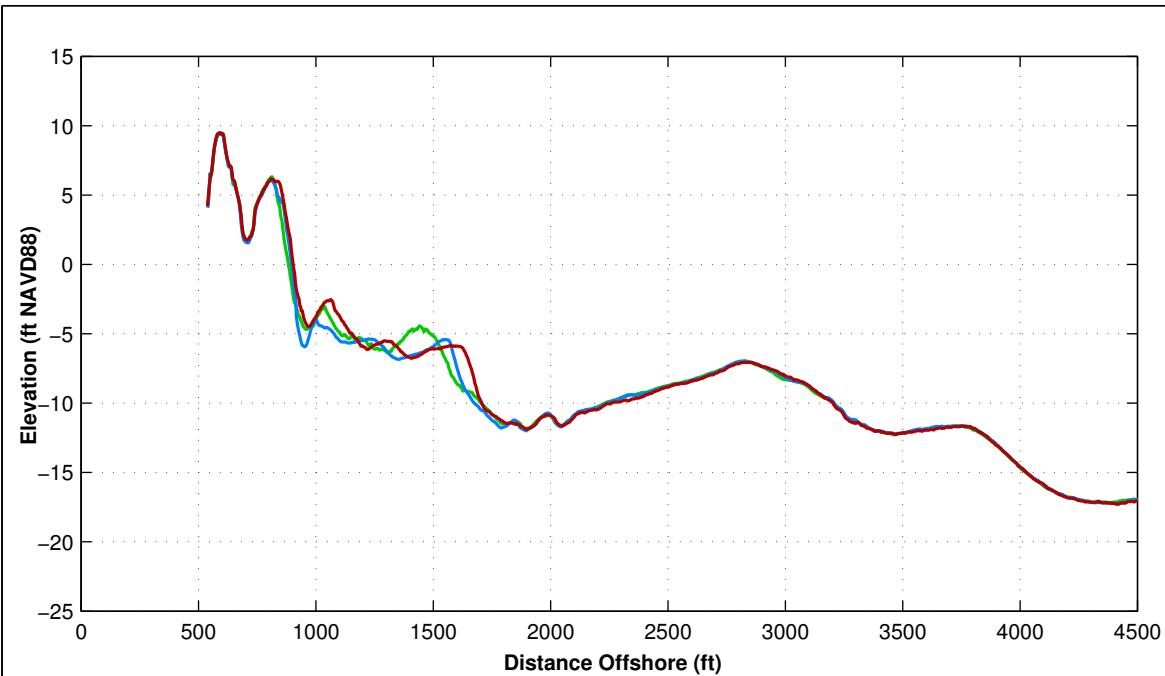












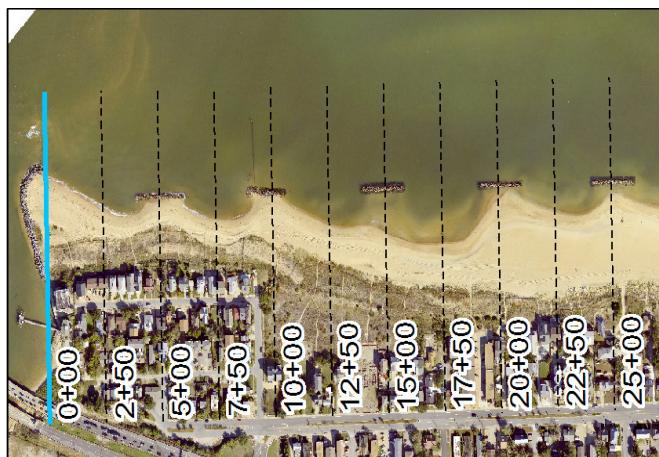
Survey Transect 0+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	23.07 ft/yr	6.75 ft
Volume Change Above -15 ft NAVD88	12.36 cy/ft/yr	21.56 cy/ft
Volume Change Above 0 ft NAVD88	5.05 cy/ft/yr	3.29 cy/ft

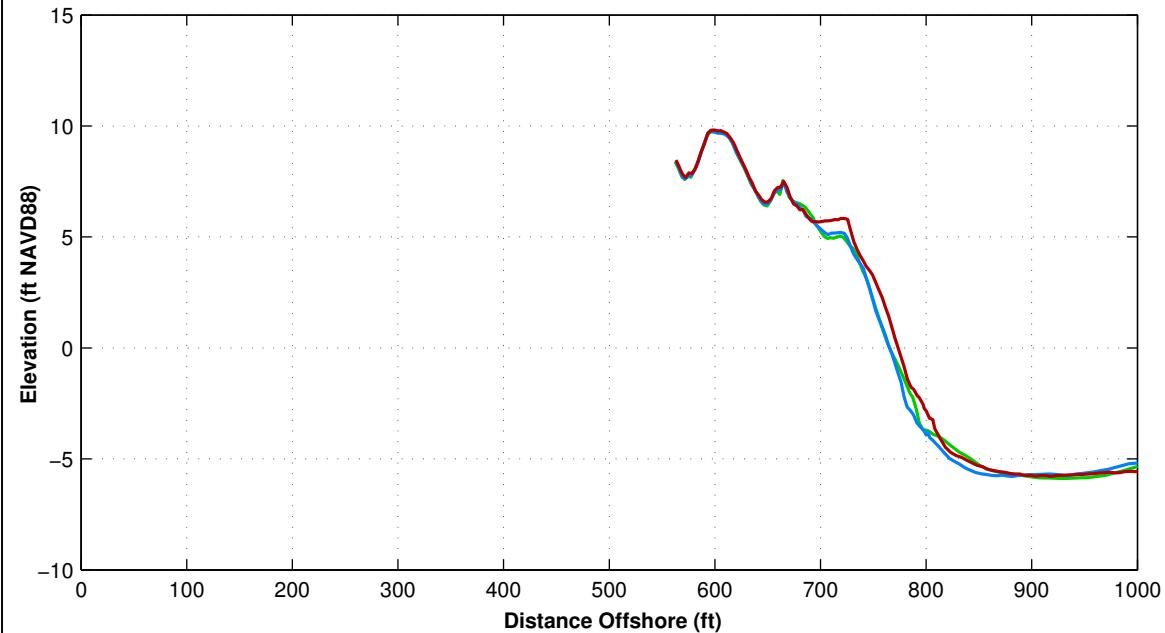
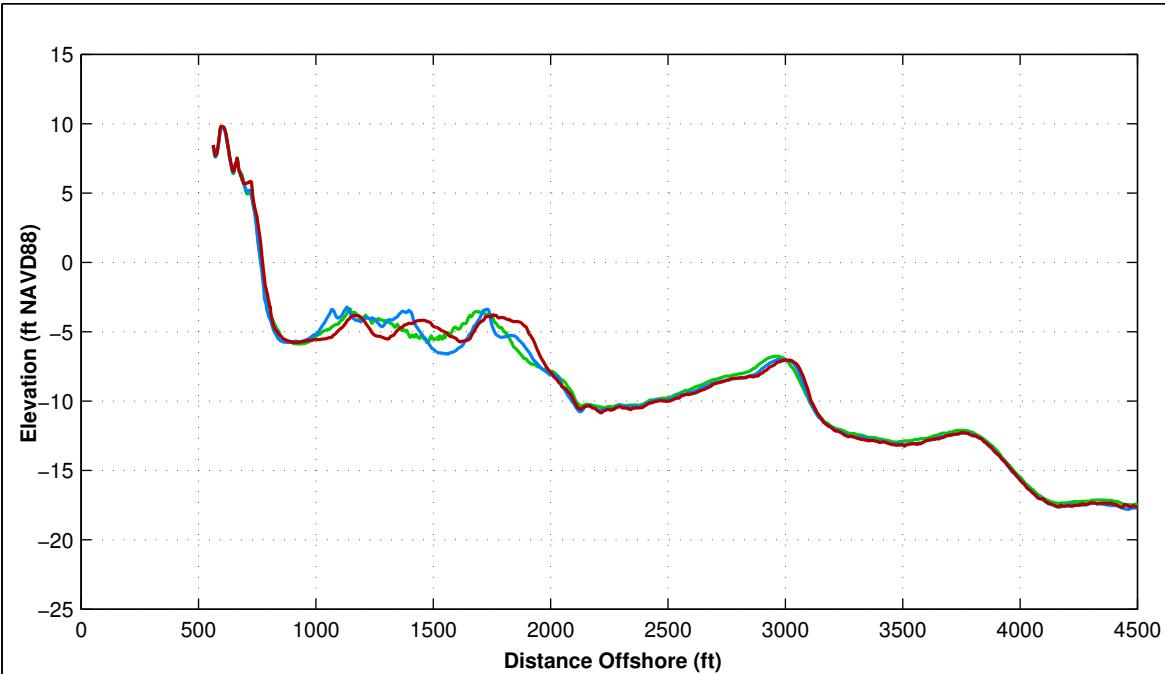
LEGEND:

OCT 2017	—
MAY 2017	—
OCT 2016	—

Notes:

1. Station From West To East At Varying Intervals.
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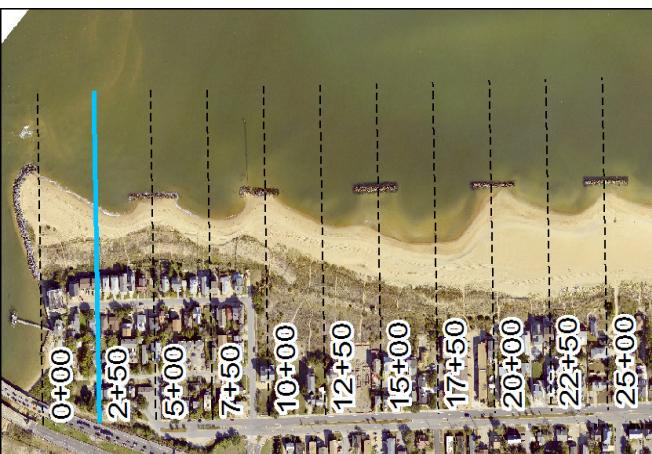


Survey Transect 2+50	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	9.49 ft/yr	9.02 ft
Volume Change Above -15 ft NAVD88	-8.28 cy/ft/yr	7.06 cy/ft
Volume Change Above 0 ft NAVD88	2.44 cy/ft/yr	2.35 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



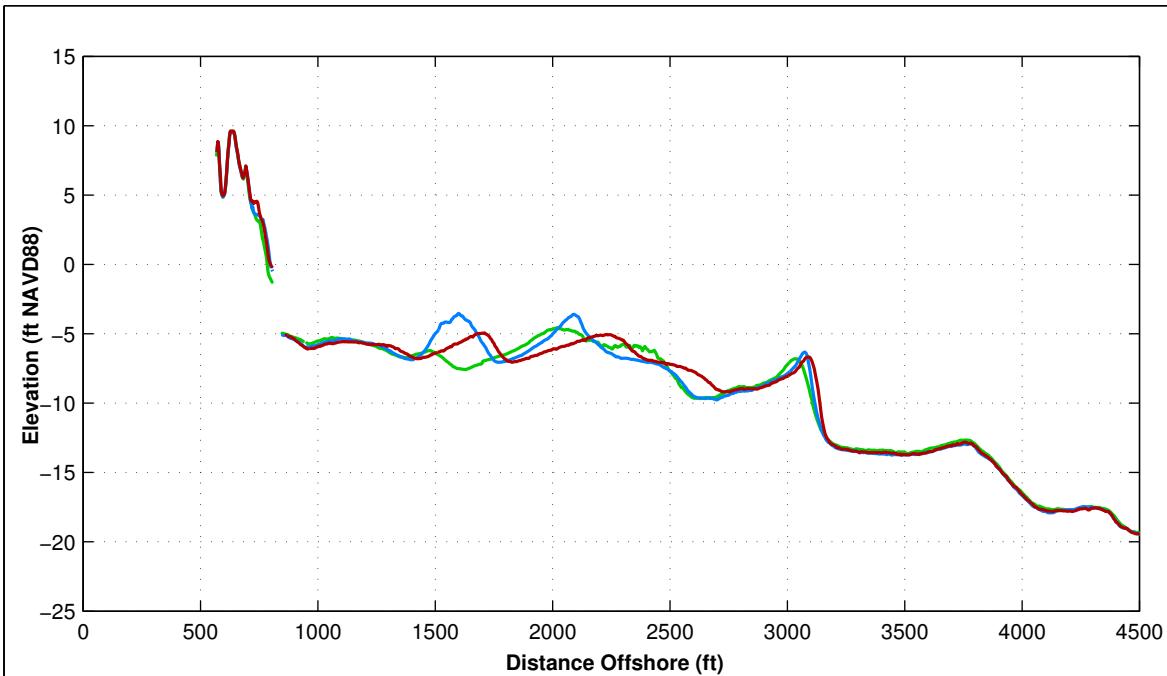
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ST 2+50

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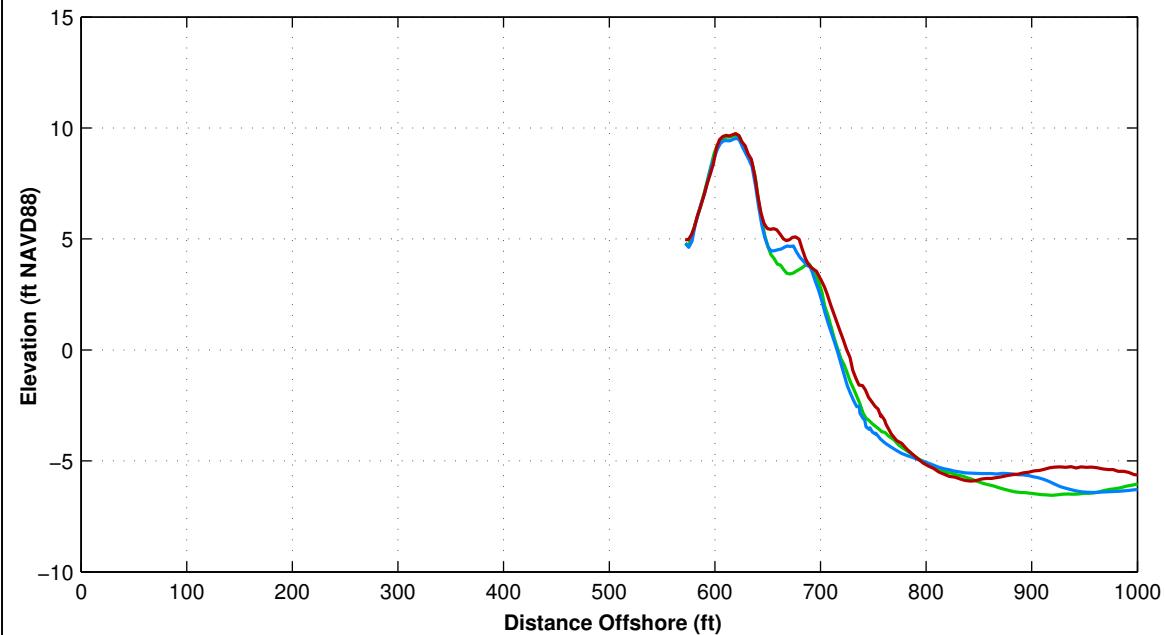
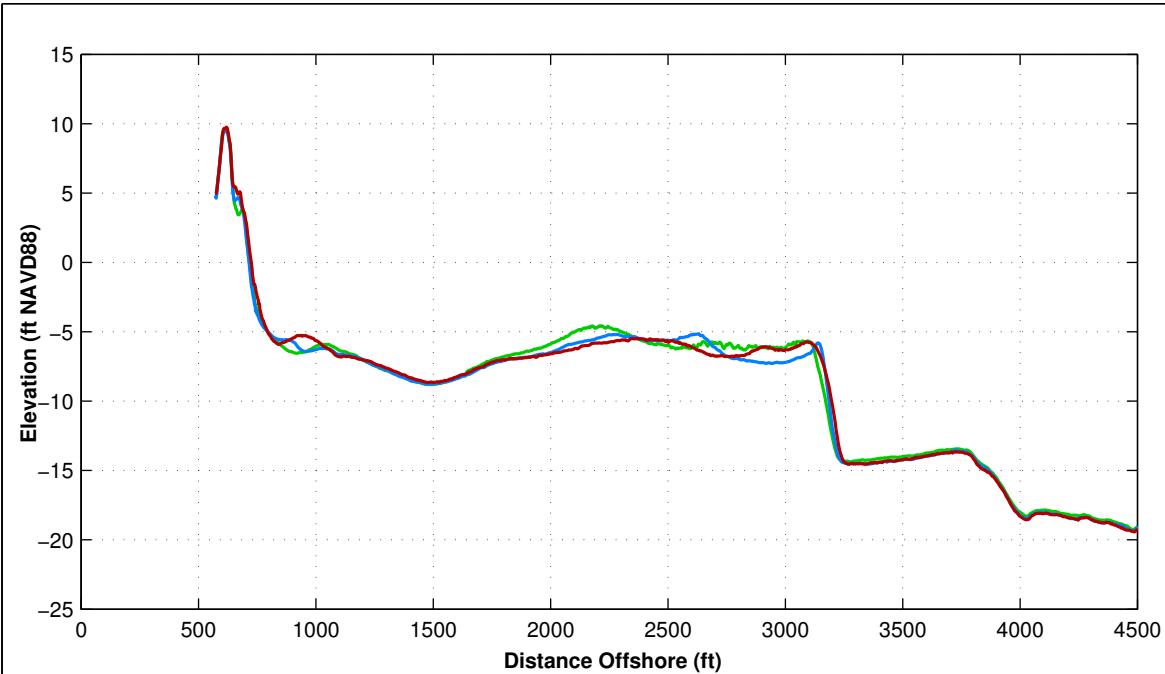
Survey Transect 5+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	10.69 ft/yr	-4.61 ft
Volume Change Above -15 ft NAVD88	13.50 cy/ft/yr	2.17 cy/ft
Volume Change Above 0 ft NAVD88	3.14 cy/ft/yr	0.80 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



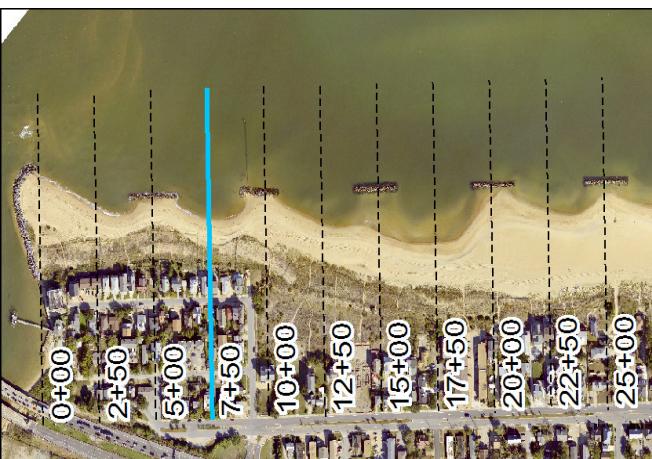


Survey Transect 7+50	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	7.07 ft/yr	8.63 ft
Volume Change Above -15 ft NAVD88	-10.66 cy/ft/yr	11.86 cy/ft
Volume Change Above 0 ft NAVD88	2.68 cy/ft/yr	2.36 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
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3. All Survey Elevations In Feet Referenced to NAVD88.
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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



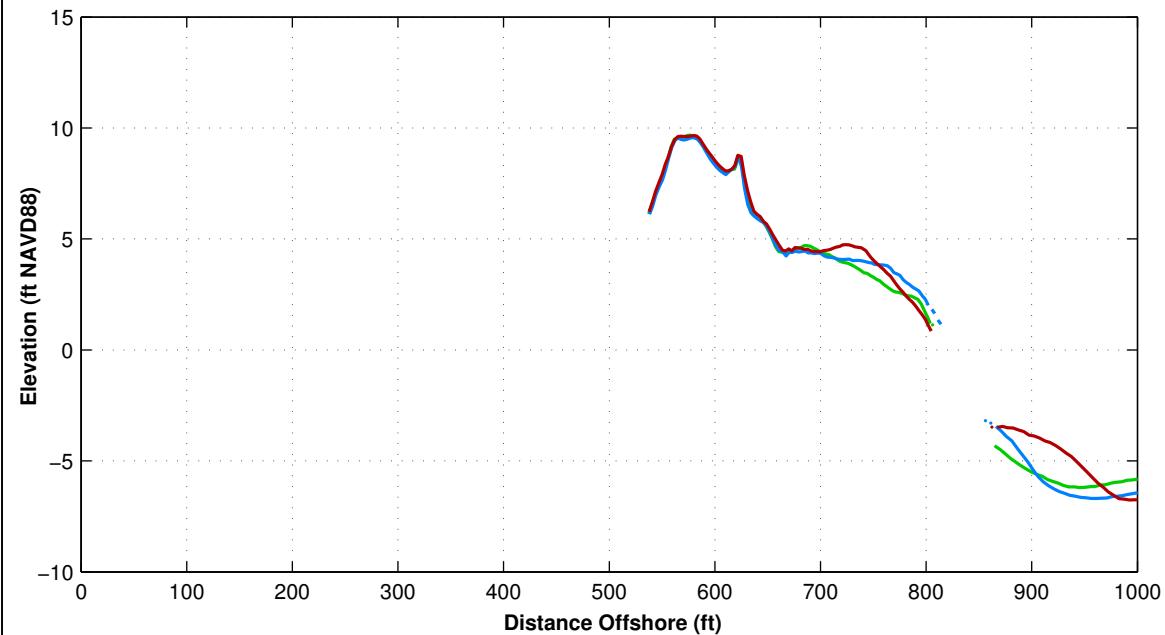
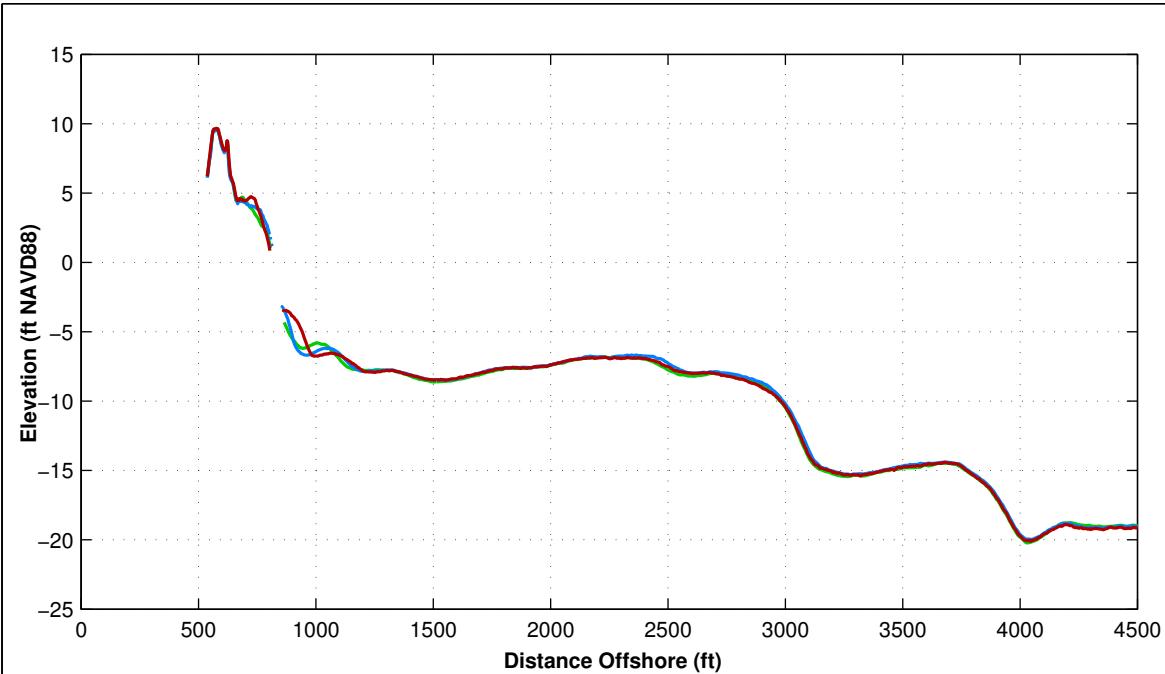
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ST 7+50

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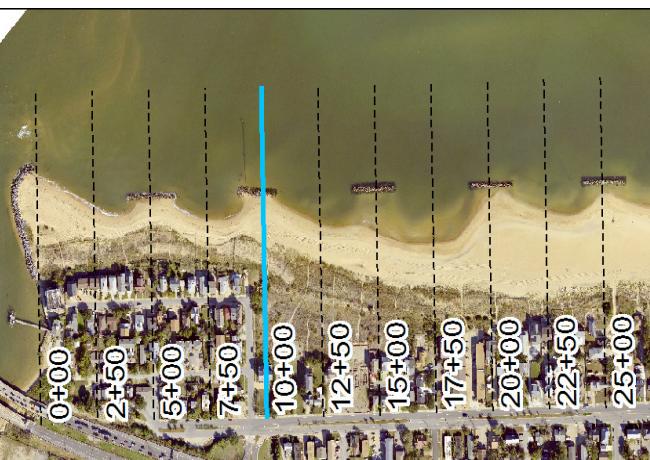


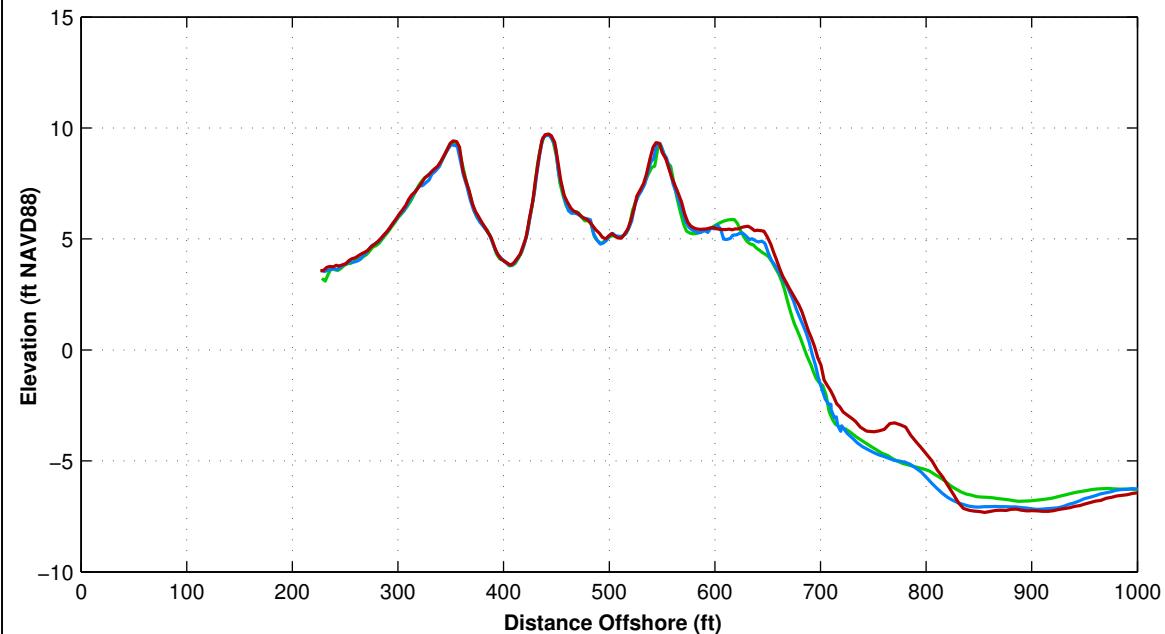
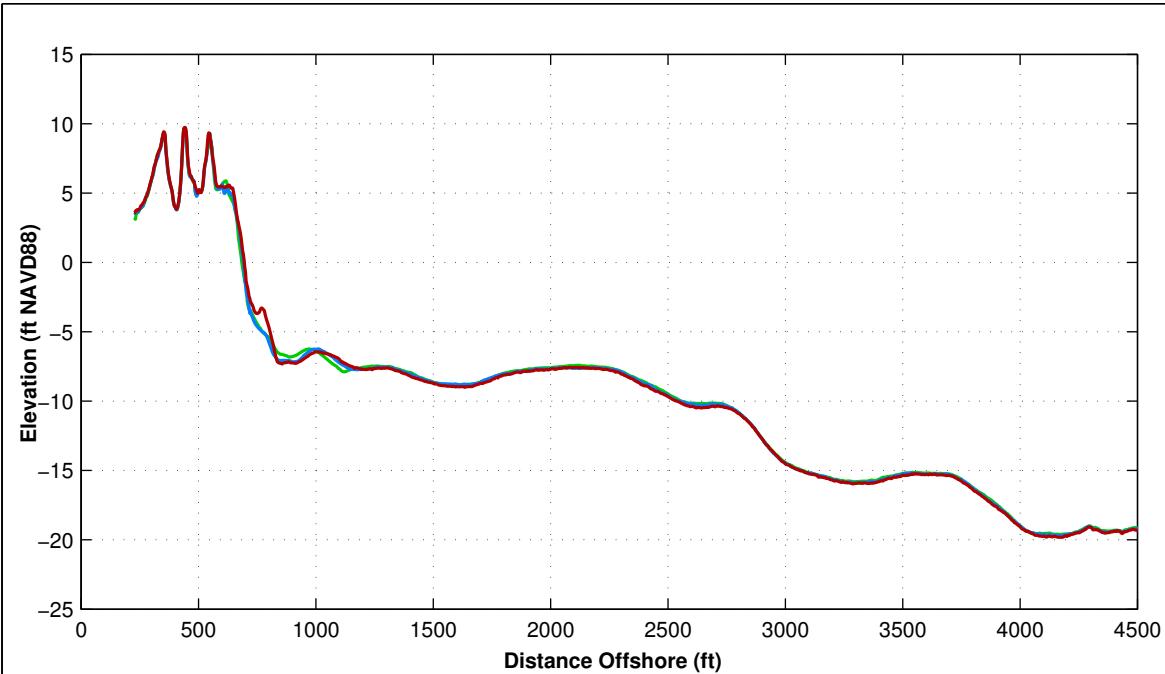
Survey Transect 10+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	-4.28 ft/yr	-12.46 ft
Volume Change Above -15 ft NAVD88	8.86 cy/ft/yr	-3.22 cy/ft
Volume Change Above 0 ft NAVD88	1.88 cy/ft/yr	0.24 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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3. All Survey Elevations In Feet Referenced to NAVD88.
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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





Survey Transect 12+50	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	10.50 ft/yr	3.01 ft
Volume Change Above -15 ft NAVD88	-3.28 cy/ft/yr	1.06 cy/ft
Volume Change Above 0 ft NAVD88	3.32 cy/ft/yr	2.53 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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3. All Survey Elevations In Feet Referenced to NAVD88.
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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



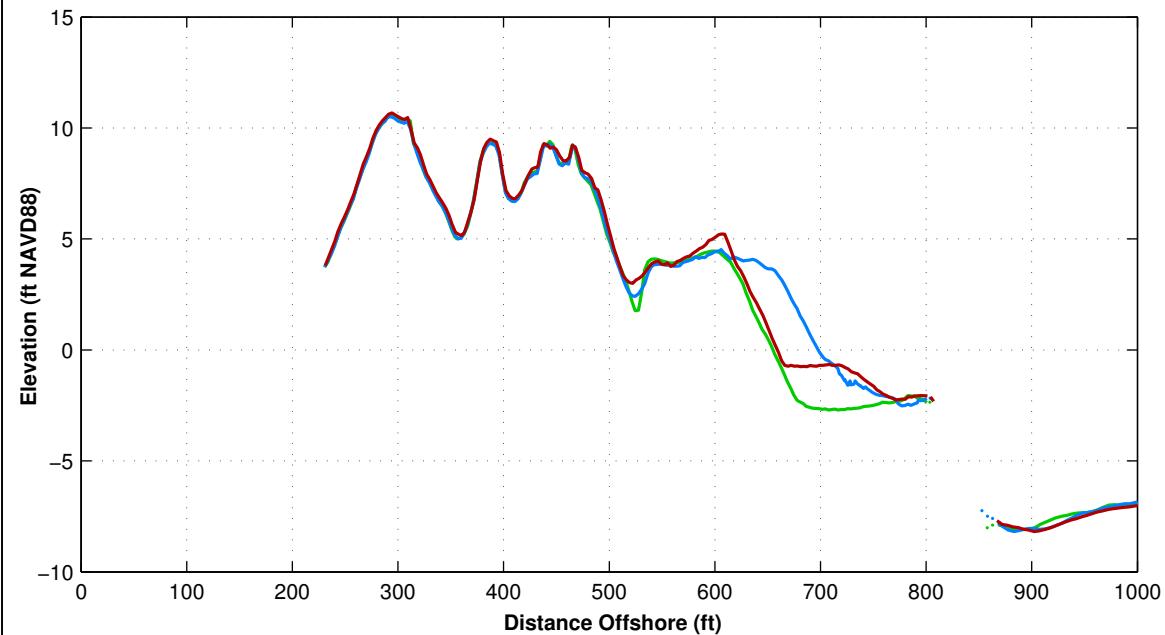
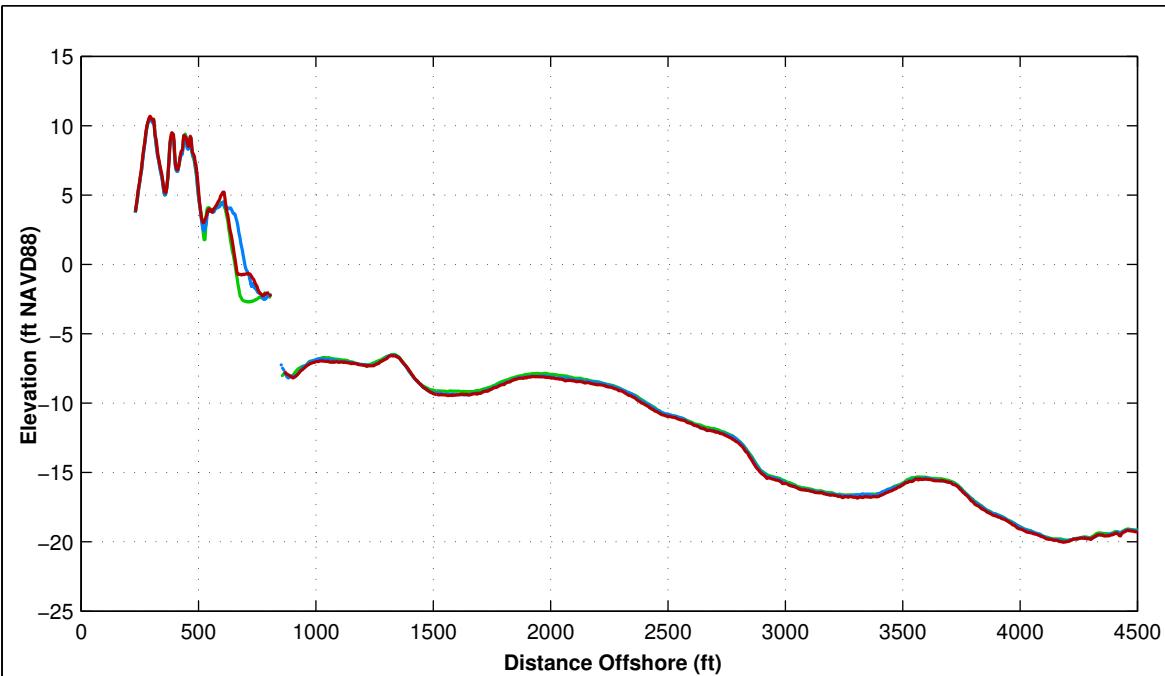
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ST 12+50

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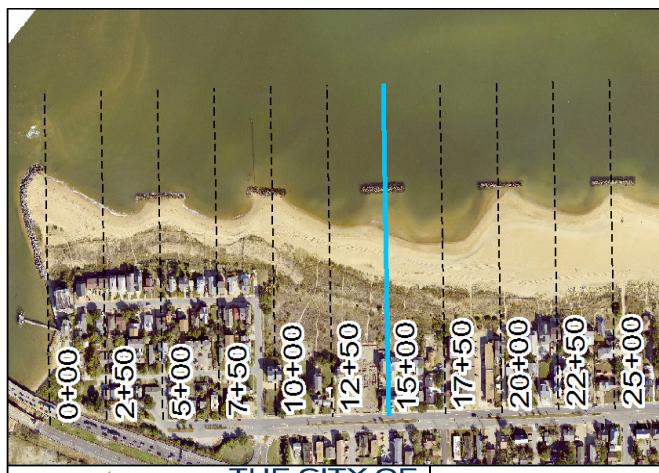


Survey Transect 15+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	6.22 ft/yr	-36.73 ft
Volume Change Above -15 ft NAVD88	-4.33 cy/ft/yr	-7.84 cy/ft
Volume Change Above 0 ft NAVD88	3.51 cy/ft/yr	-2.10 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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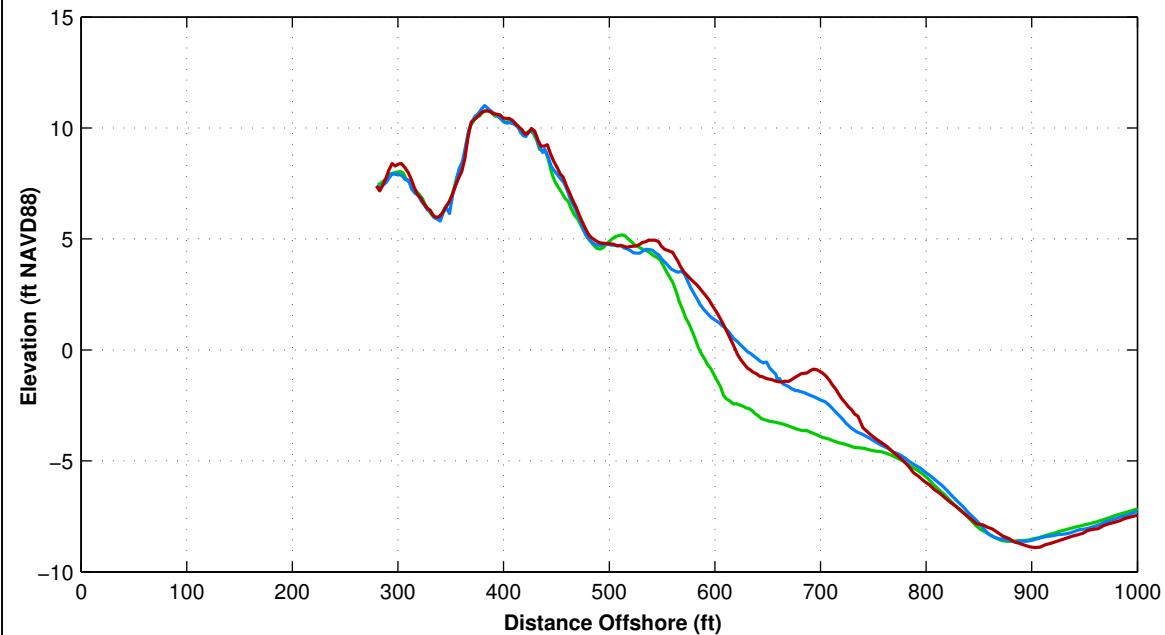
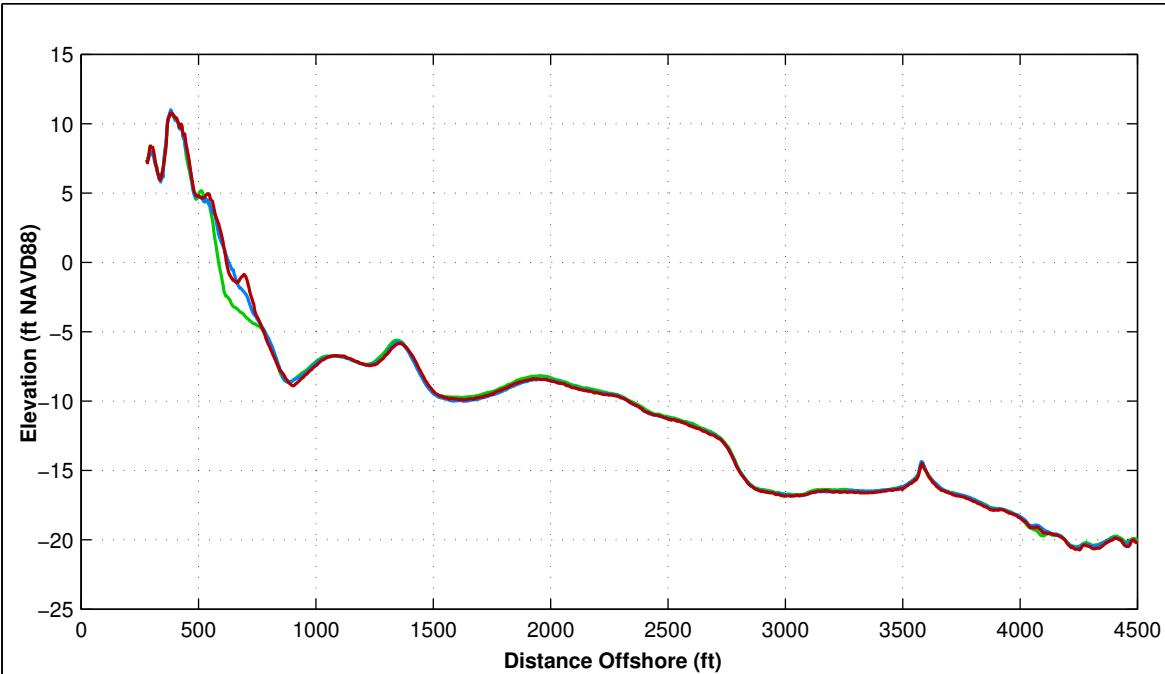
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ST 15+00

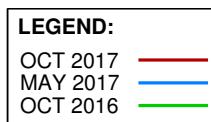
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ANALYSIS

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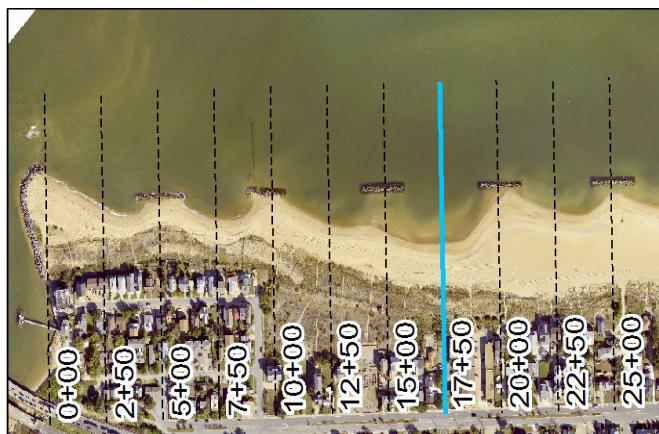


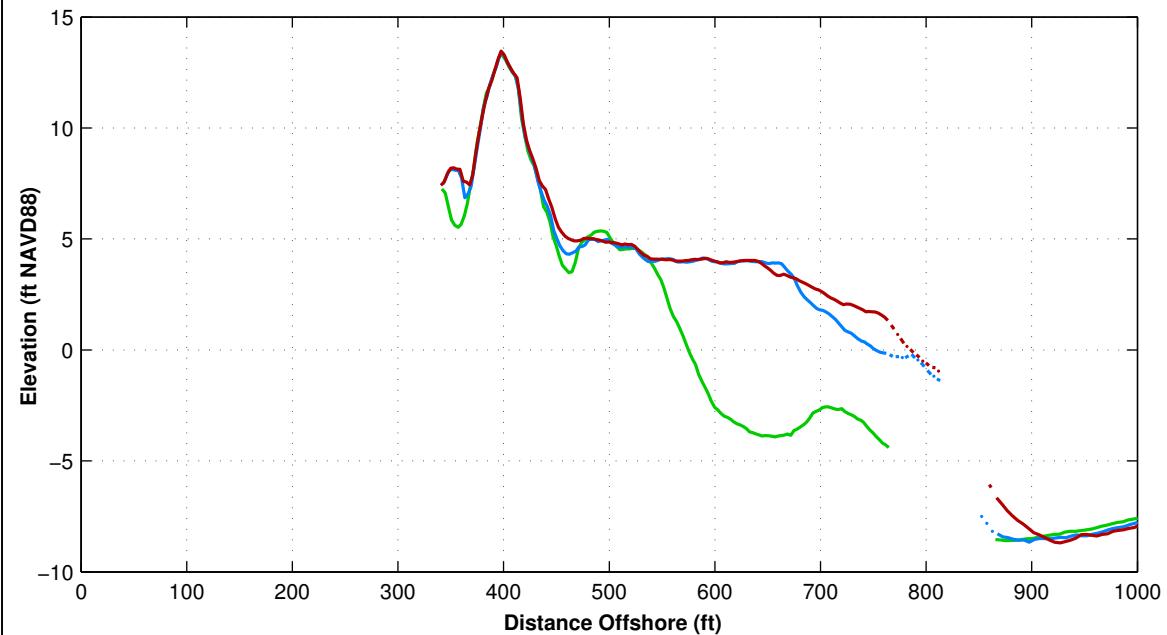
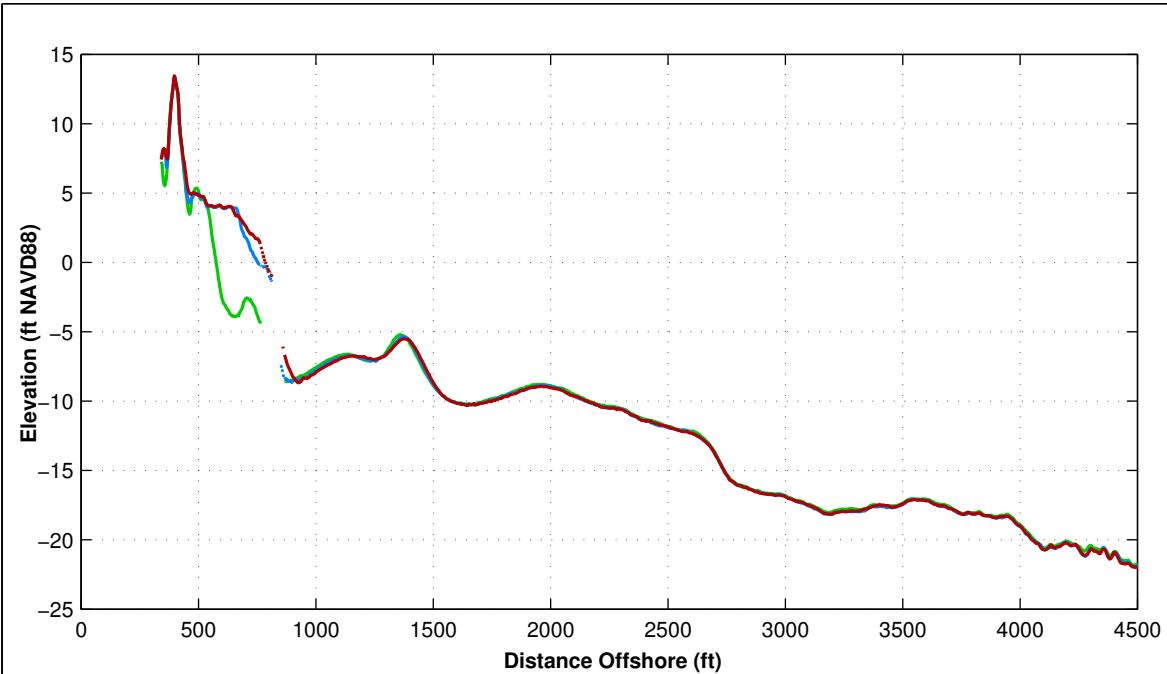
Survey Transect 17+50	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	32.67 ft/yr	-0.19 ft
Volume Change Above -15 ft NAVD88	8.05 cy/ft/yr	3.79 cy/ft
Volume Change Above 0 ft NAVD88	5.75 cy/ft/yr	2.41 cy/ft



Notes:

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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



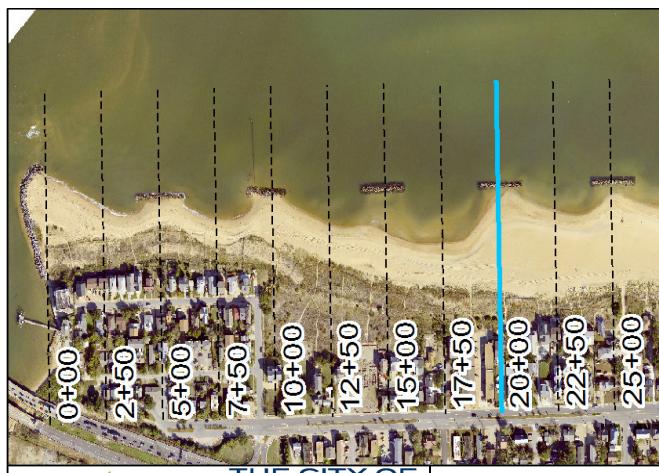


Survey Transect 20+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	203.38 ft/yr	47.66 ft
Volume Change Above -15 ft NAVD88	44.27 cy/ft/yr	5.47 cy/ft
Volume Change Above 0 ft NAVD88	28.10 cy/ft/yr	5.20 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



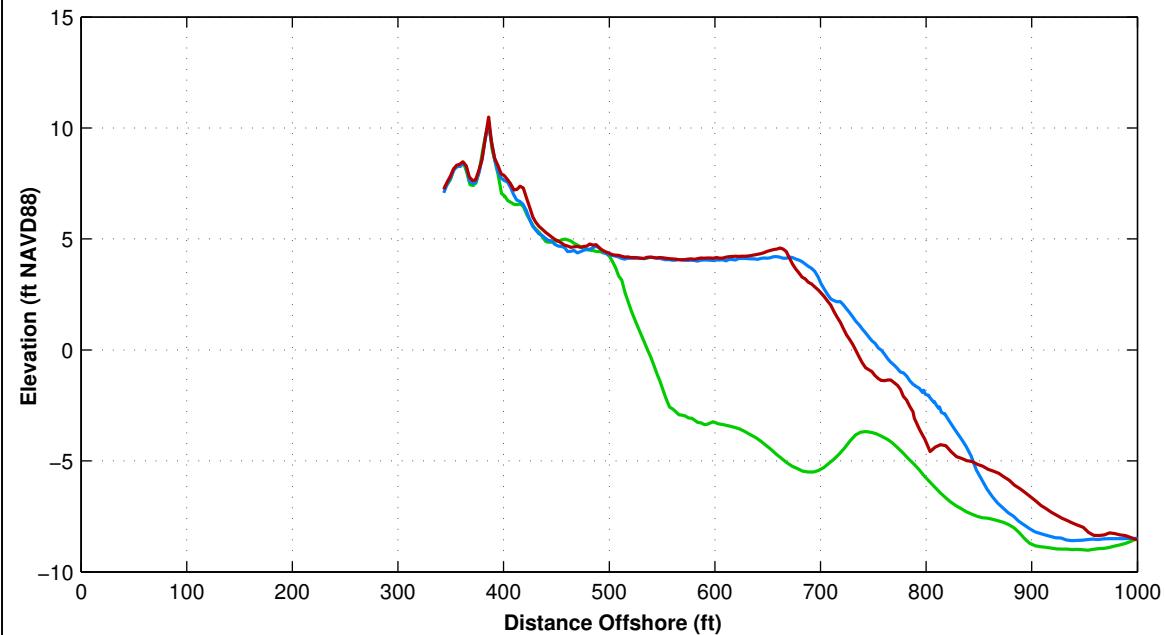
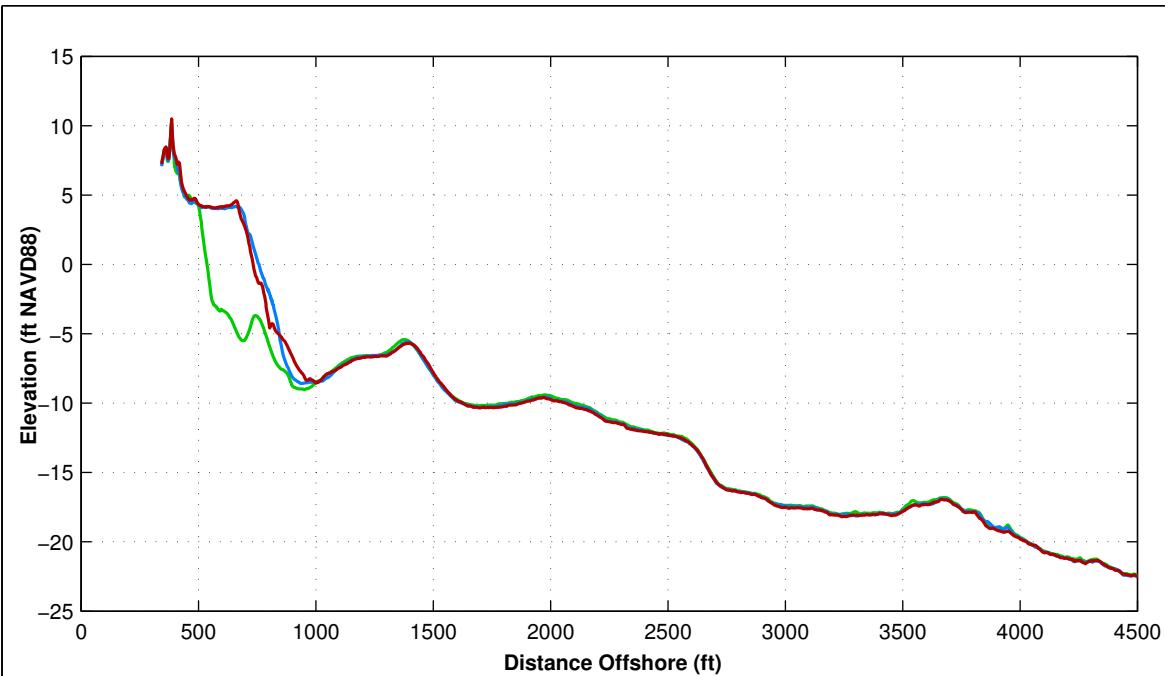
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ST 20+00

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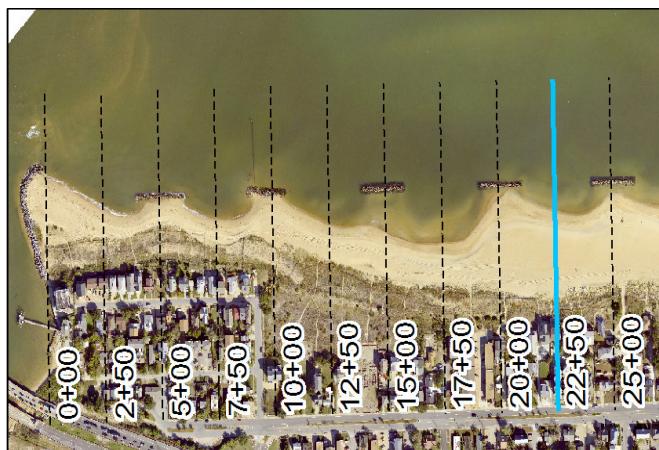


Survey Transect 22+50	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	195.04 ft/yr	-17.41 ft
Volume Change Above -15 ft NAVD88	68.56 cy/ft/yr	-1.09 cy/ft
Volume Change Above 0 ft NAVD88	30.48 cy/ft/yr	-0.23 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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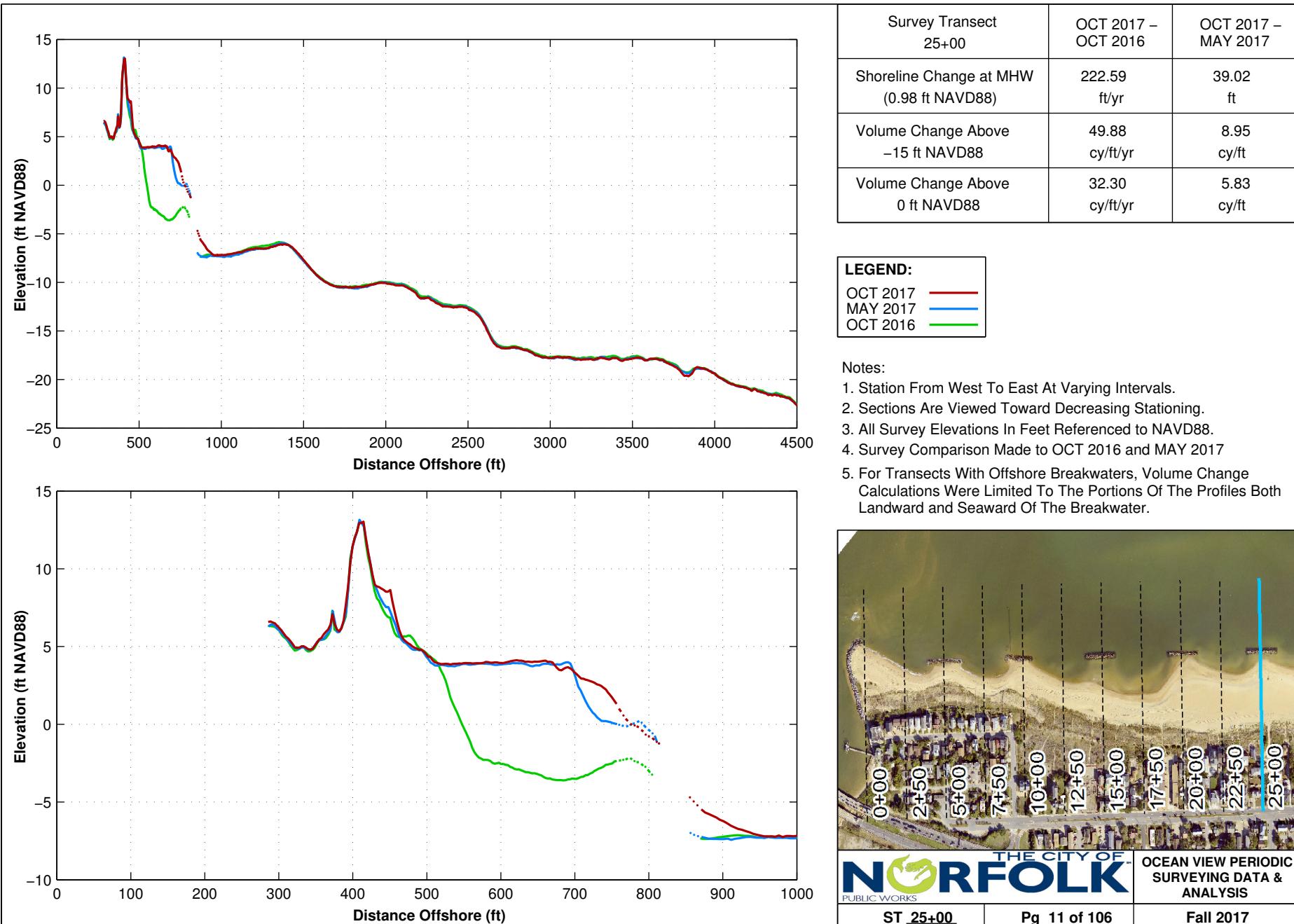
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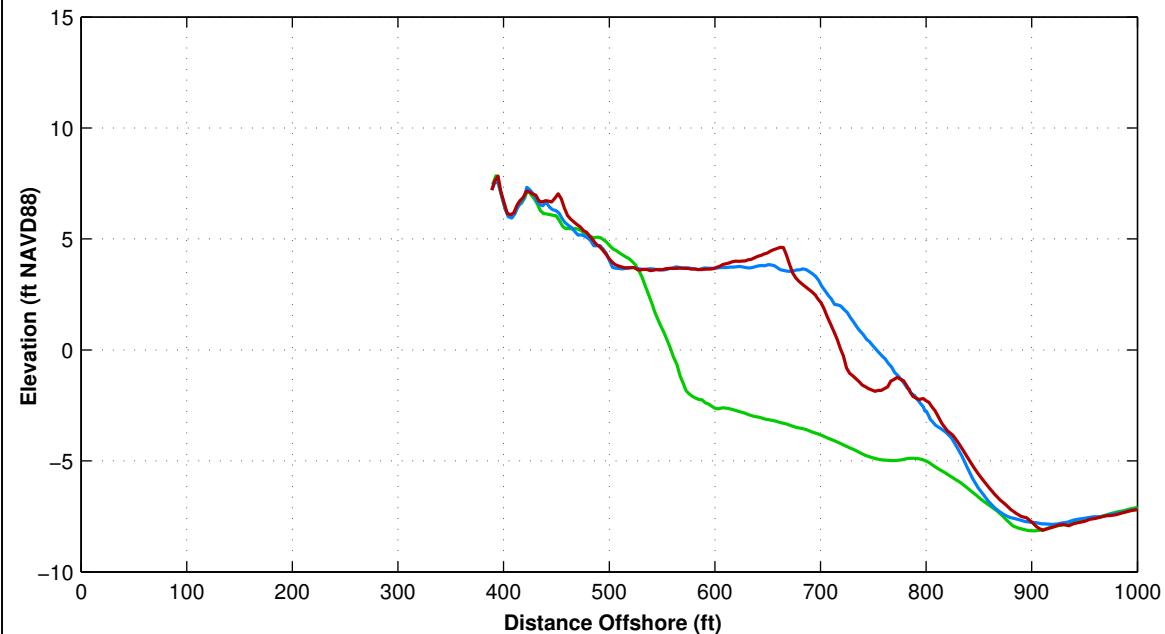
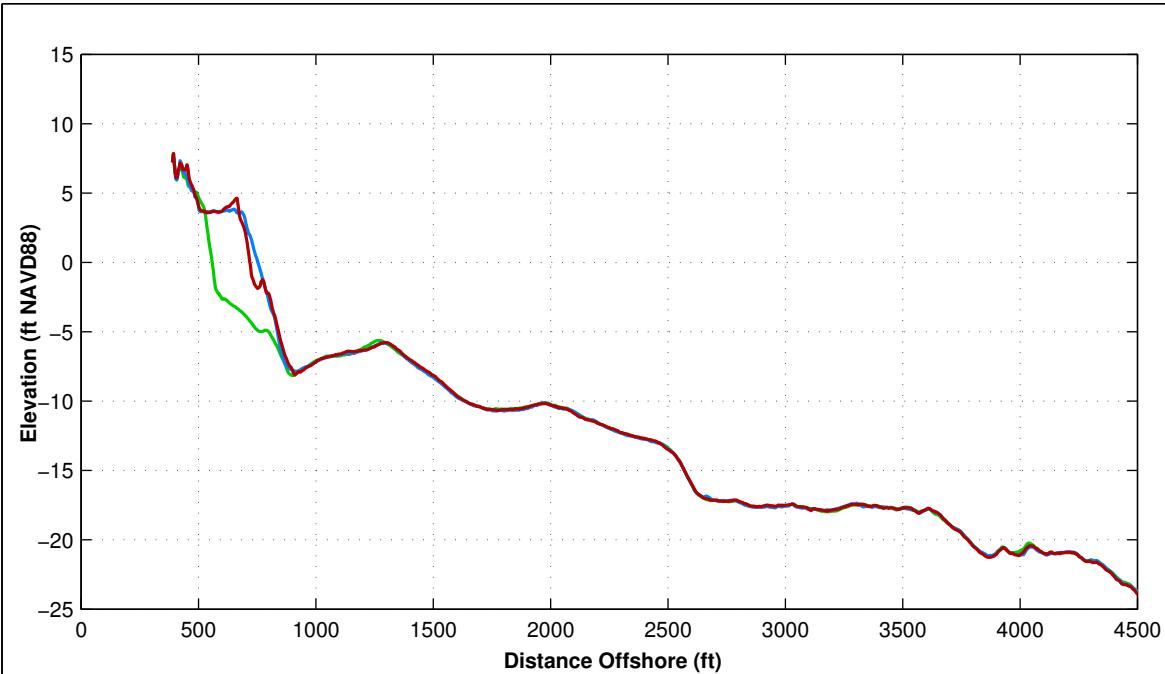
ST 22+50

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Survey Transect	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	162.27 ft/yr	-24.14 ft
Volume Change Above -15 ft NAVD88	54.36 cy/ft/yr	0.50 cy/ft
Volume Change Above 0 ft NAVD88	23.02 cy/ft/yr	-0.76 cy/ft

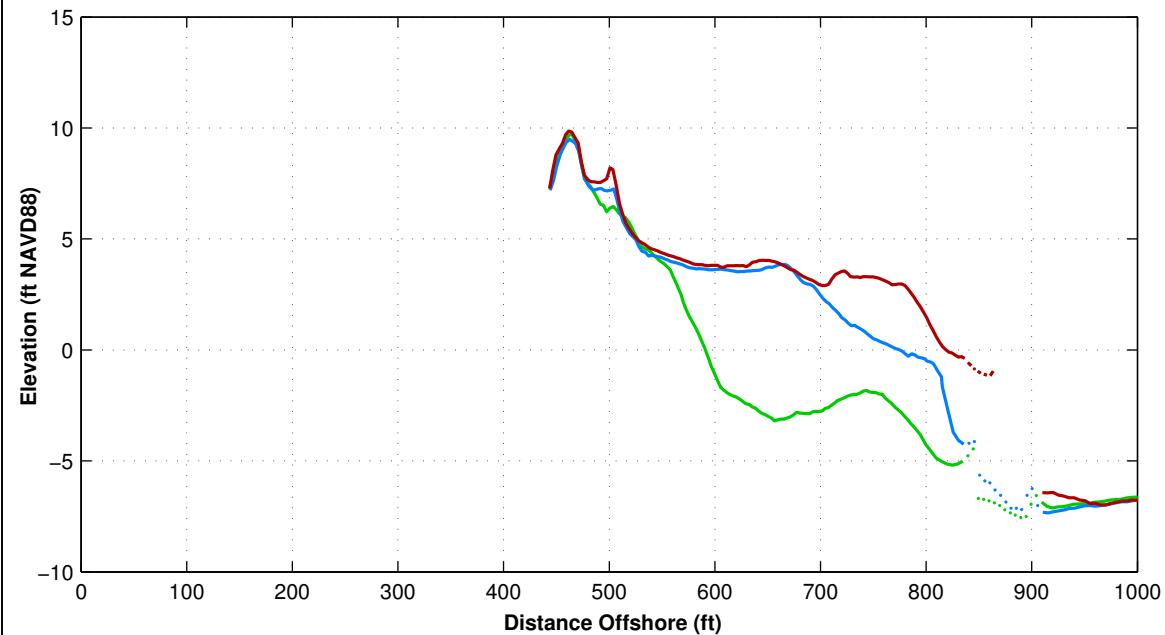
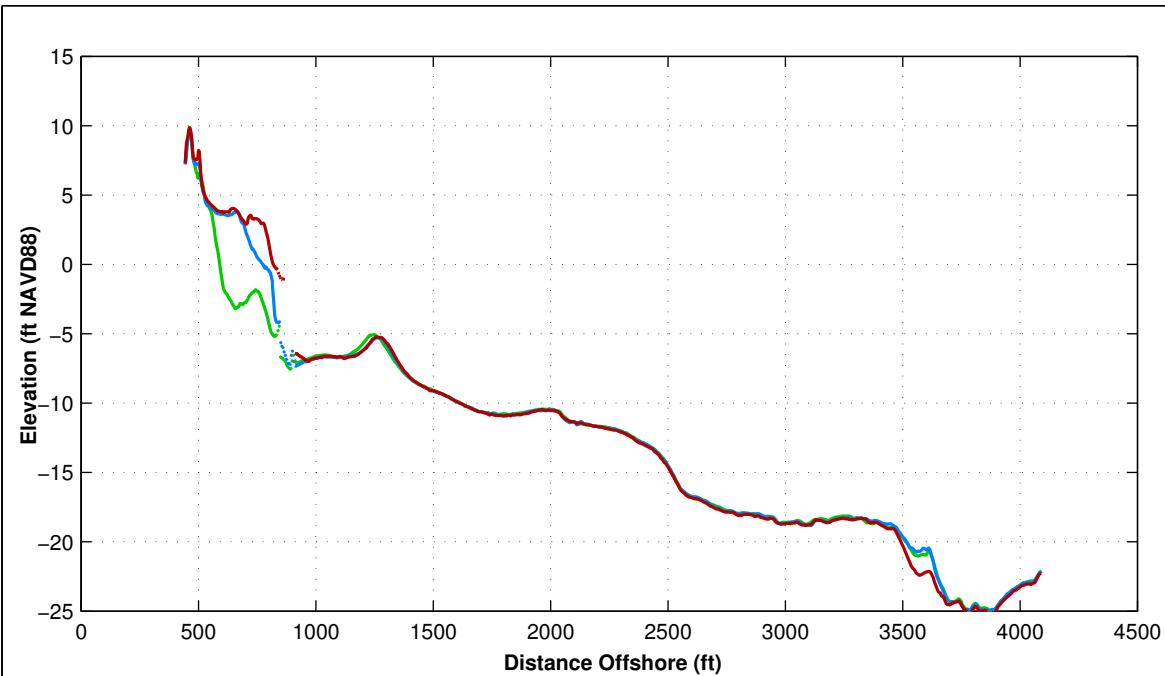
LEGEND:

OCT 2017	—
MAY 2017	—
OCT 2016	—

Notes:

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Survey Transect 30+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	224.74 ft/yr	68.56 ft
Volume Change Above -15 ft NAVD88	54.52 cy/ft/yr	15.34 cy/ft
Volume Change Above 0 ft NAVD88	31.08 cy/ft/yr	11.29 cy/ft

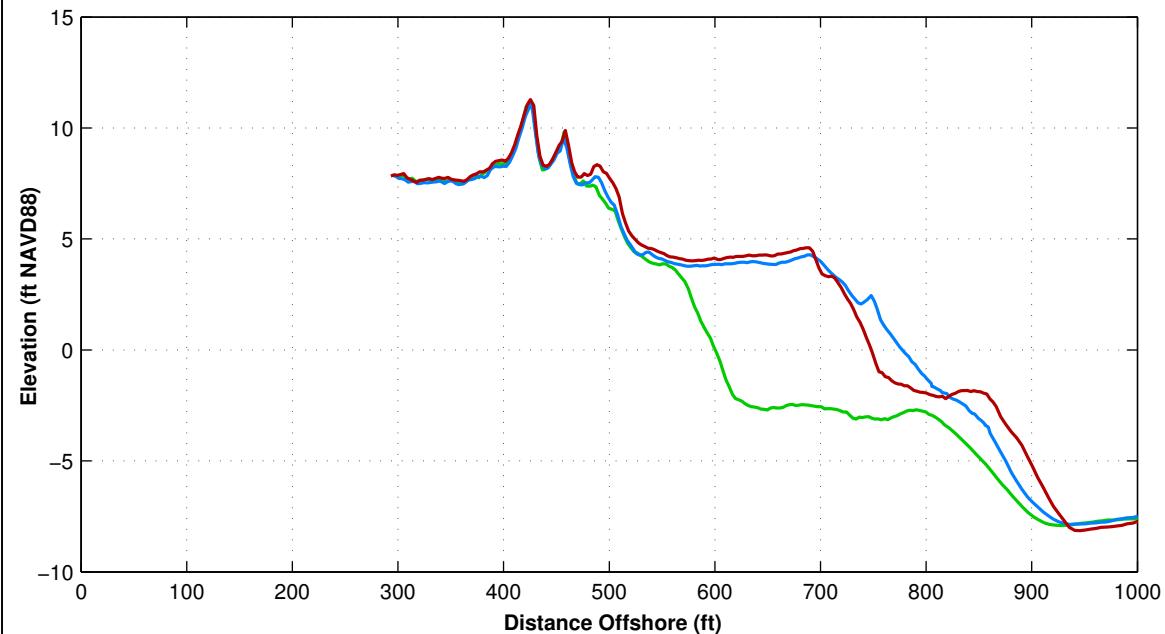
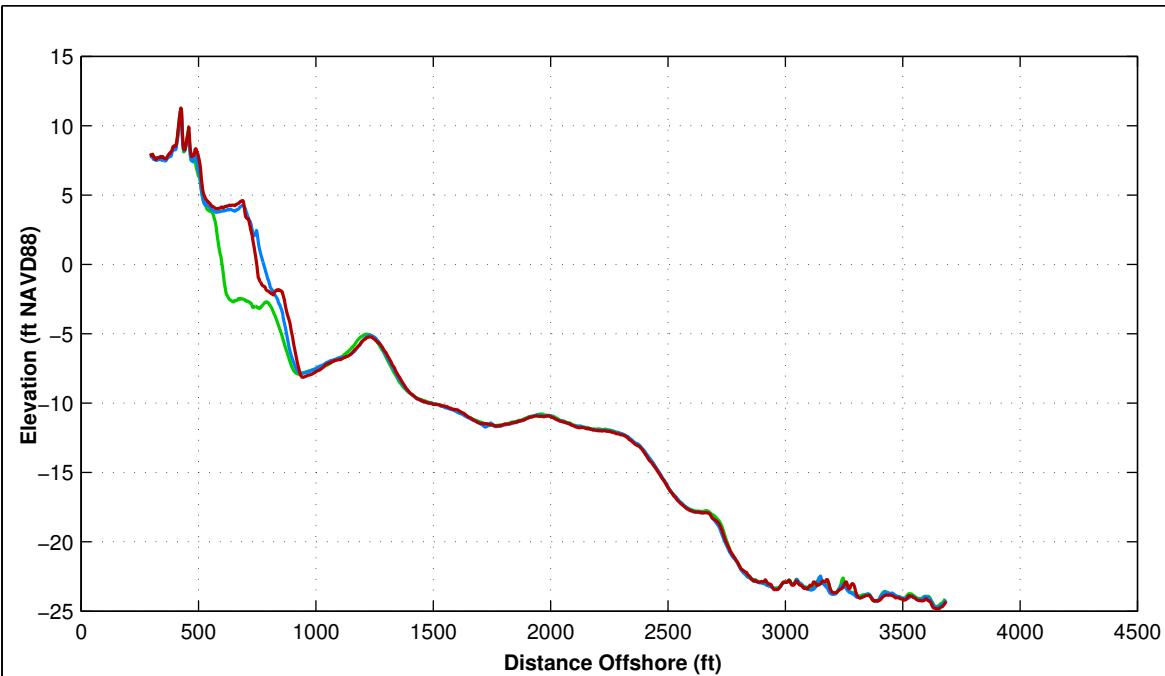
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
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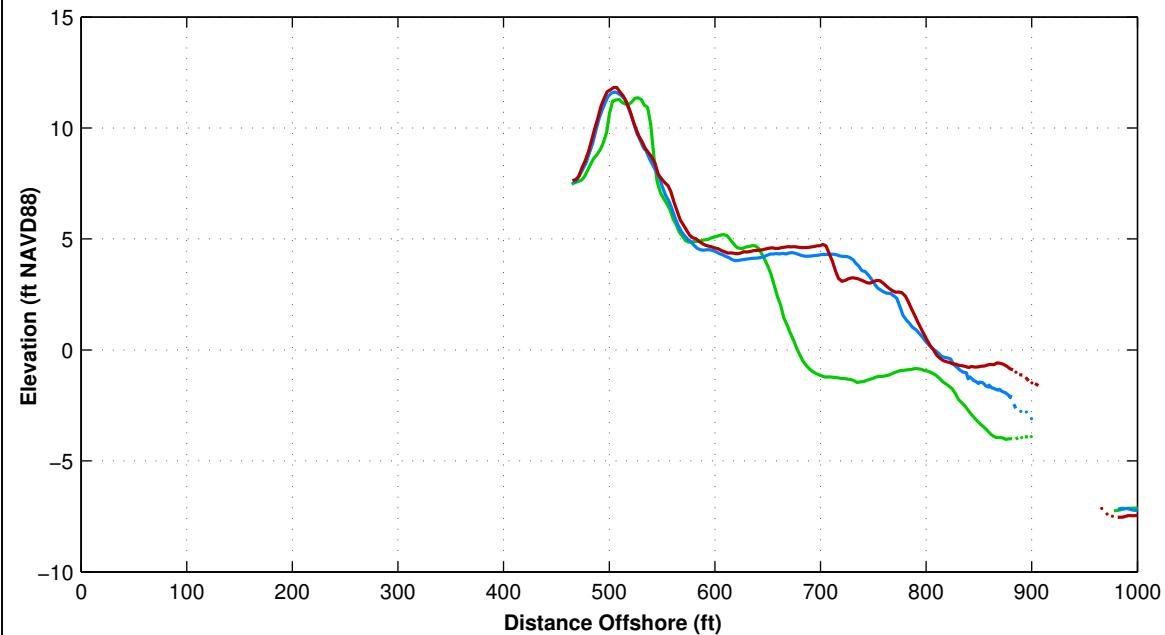
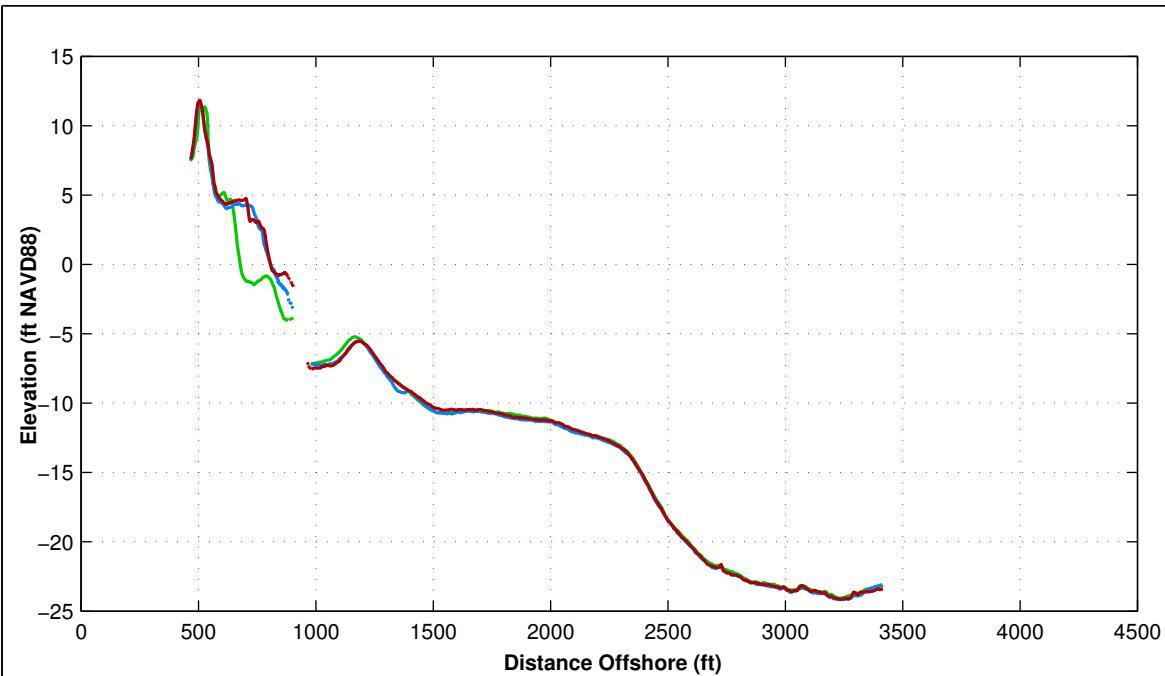
Survey Transect 32+50	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	150.45 ft/yr	-22.06 ft
Volume Change Above -15 ft NAVD88	49.54 cy/ft/yr	3.21 cy/ft
Volume Change Above 0 ft NAVD88	26.04 cy/ft/yr	2.18 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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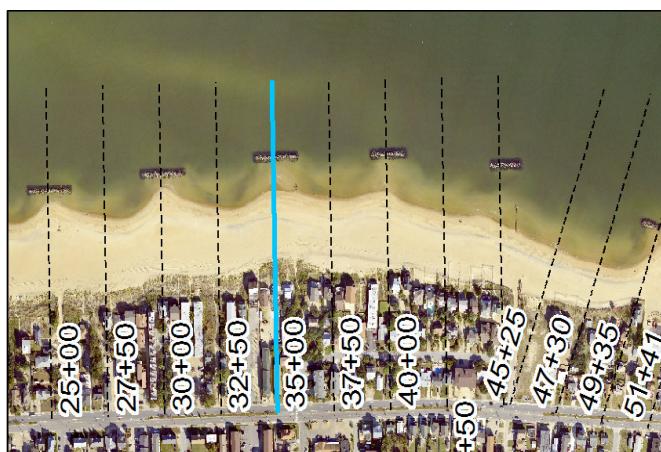
Survey Transect 35+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	126.17 ft/yr	6.75 ft
Volume Change Above -15 ft NAVD88	26.67 cy/ft/yr	9.97 cy/ft
Volume Change Above 0 ft NAVD88	18.14 cy/ft/yr	2.29 cy/ft

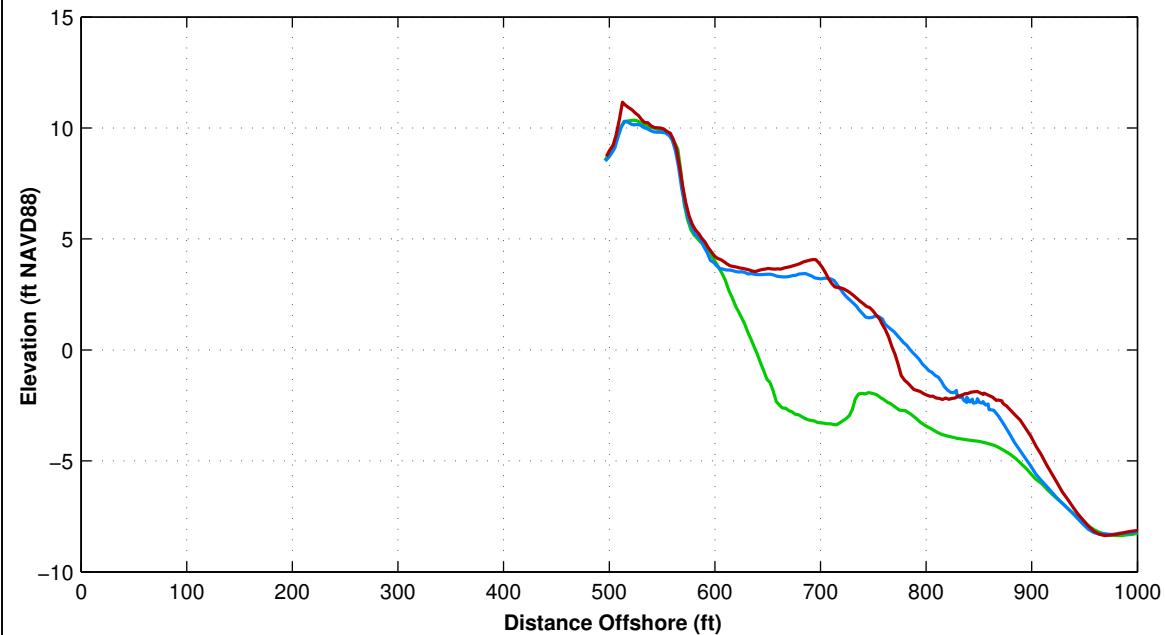
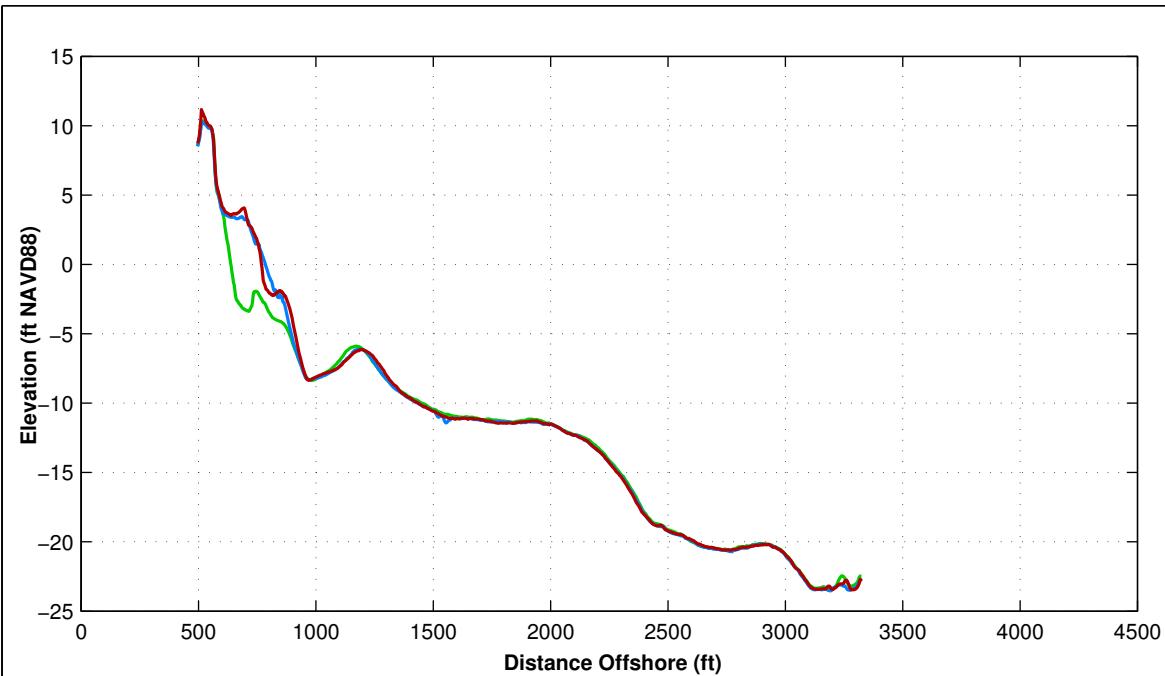
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

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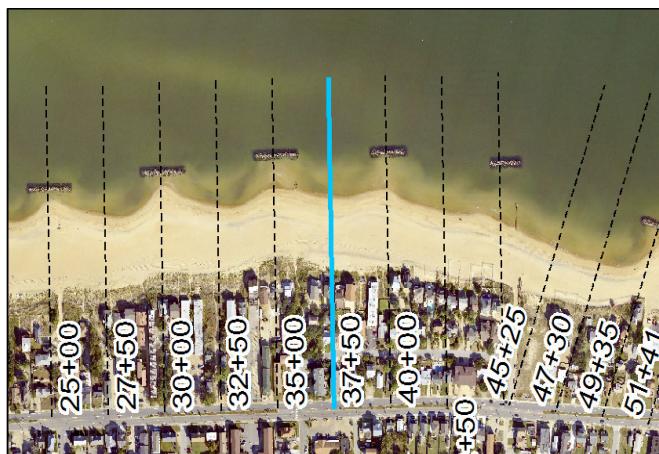
Survey Transect 37+50	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	131.49 ft/yr	-4.89 ft
Volume Change Above -15 ft NAVD88	35.14 cy/ft/yr	5.79 cy/ft
Volume Change Above 0 ft NAVD88	17.59 cy/ft/yr	2.59 cy/ft

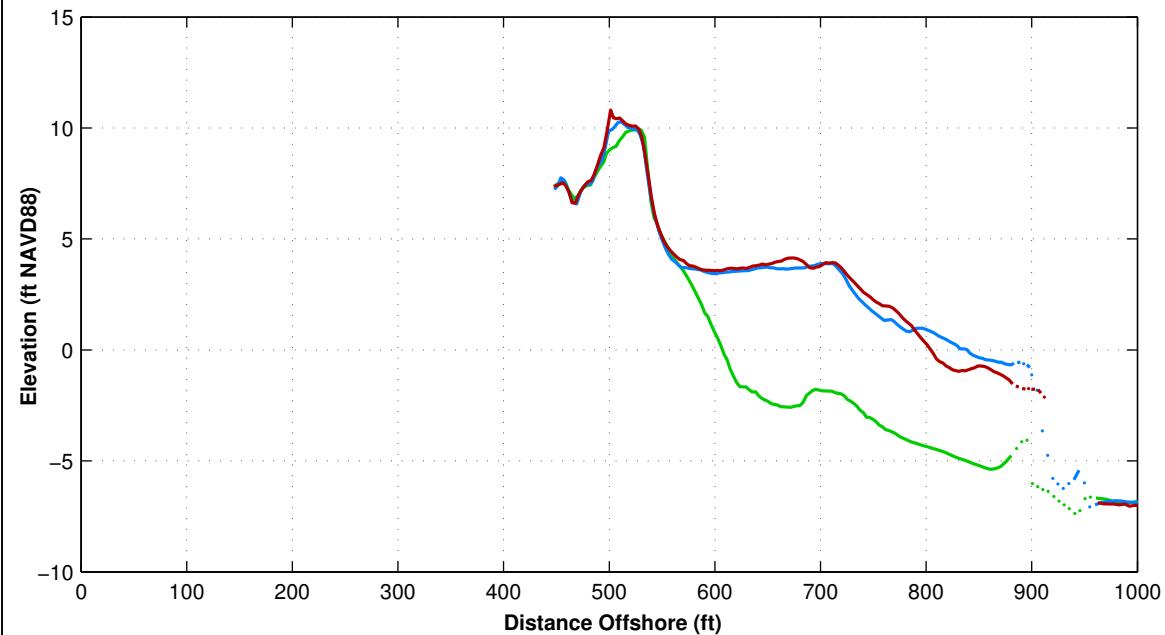
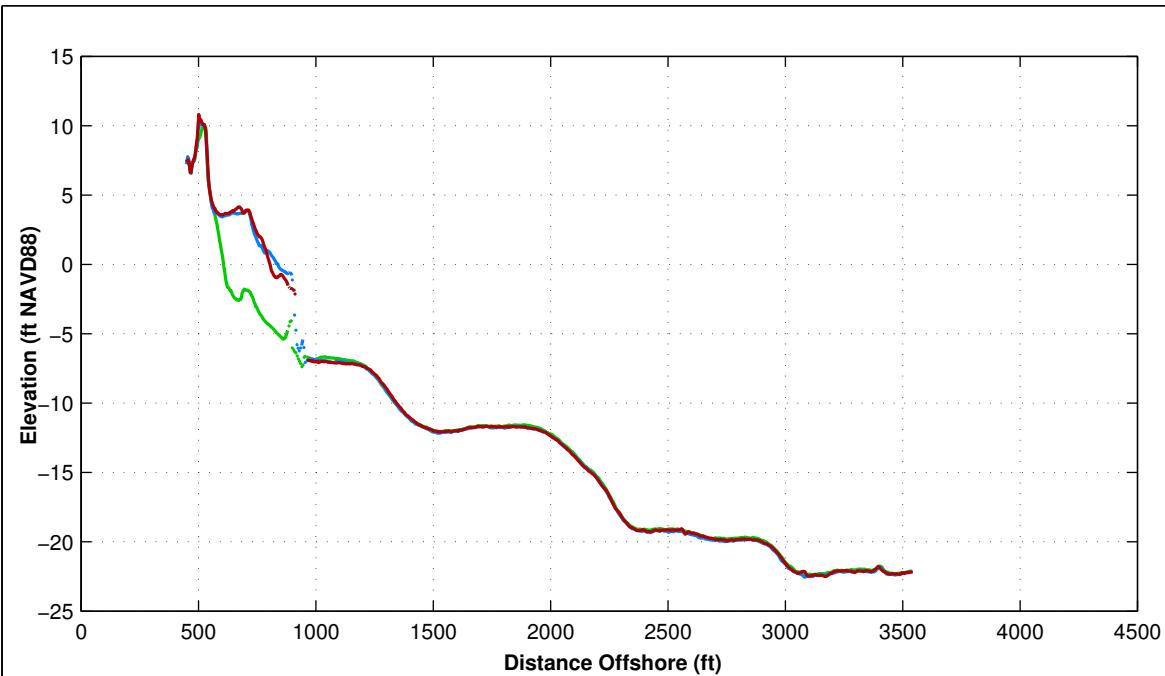
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





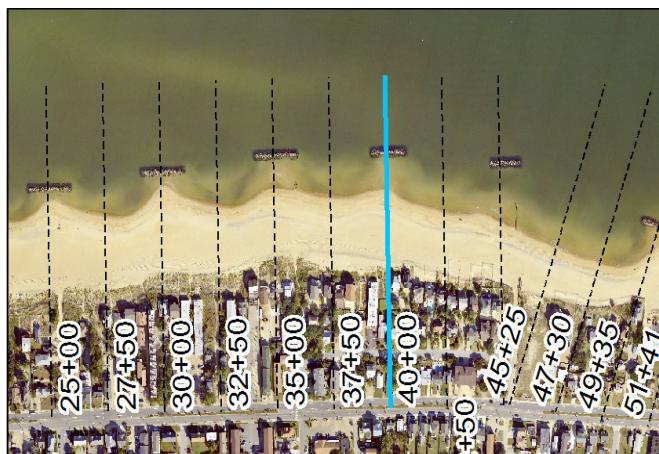
Survey Transect 40+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	190.84 ft/yr	10.68 ft
Volume Change Above -15 ft NAVD88	53.22 cy/ft/yr	0.83 cy/ft
Volume Change Above 0 ft NAVD88	25.72 cy/ft/yr	1.99 cy/ft

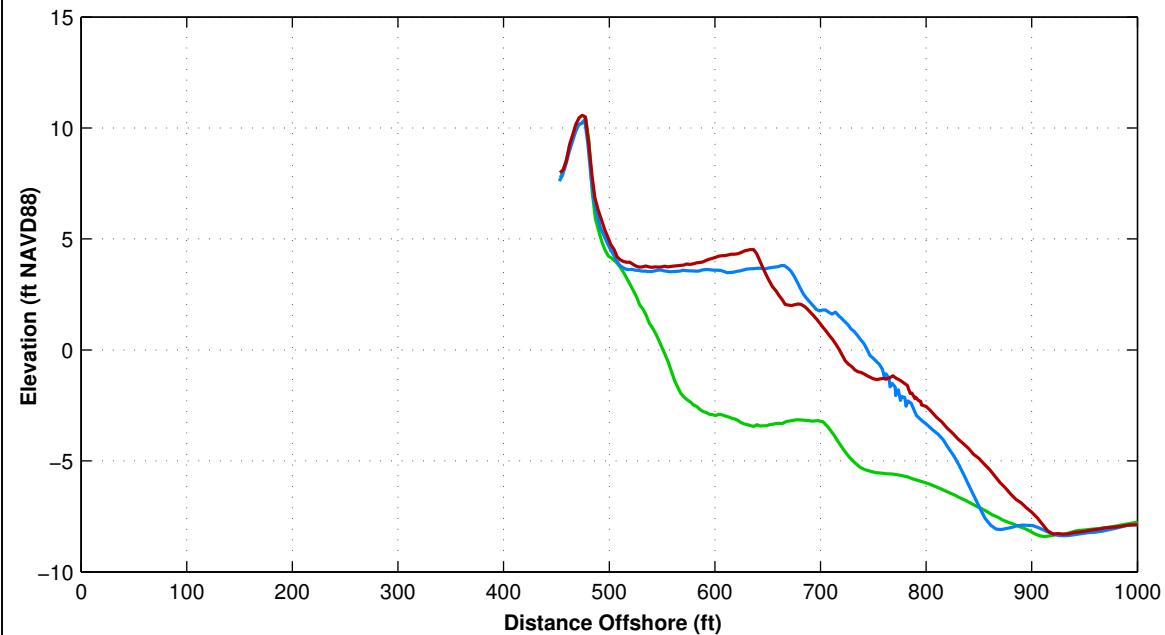
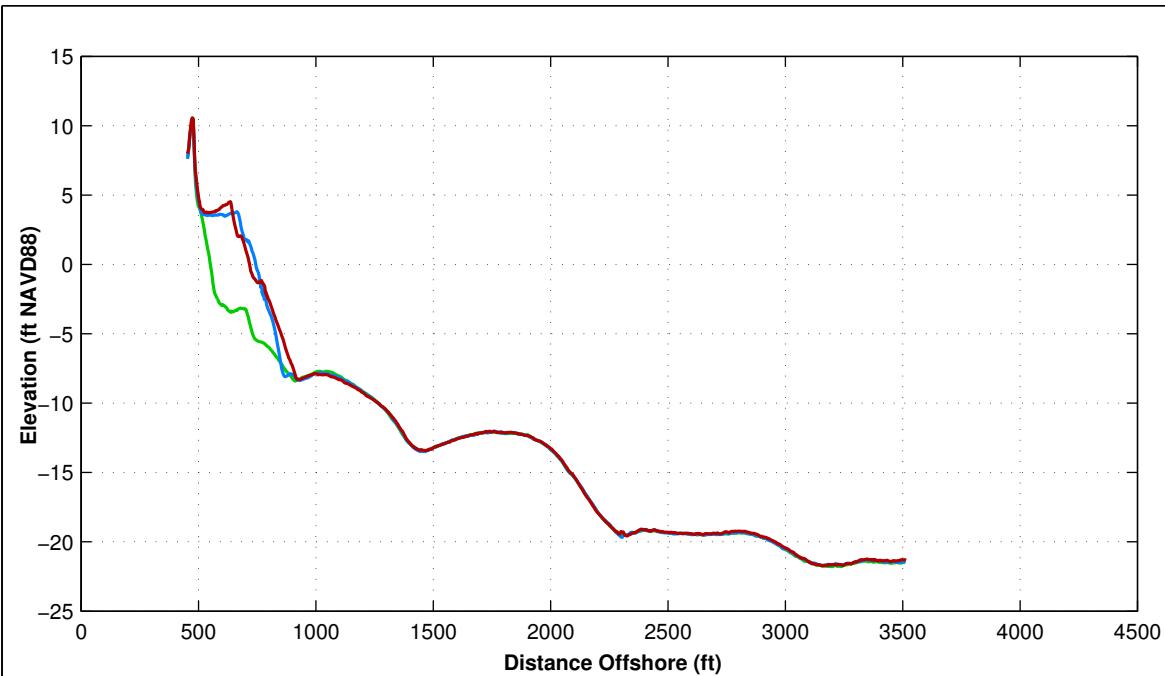
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





Survey Transect 42+50	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	162.94 ft/yr	-25.29 ft
Volume Change Above -15 ft NAVD88	61.17 cy/ft/yr	4.55 cy/ft
Volume Change Above 0 ft NAVD88	22.95 cy/ft/yr	-0.61 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



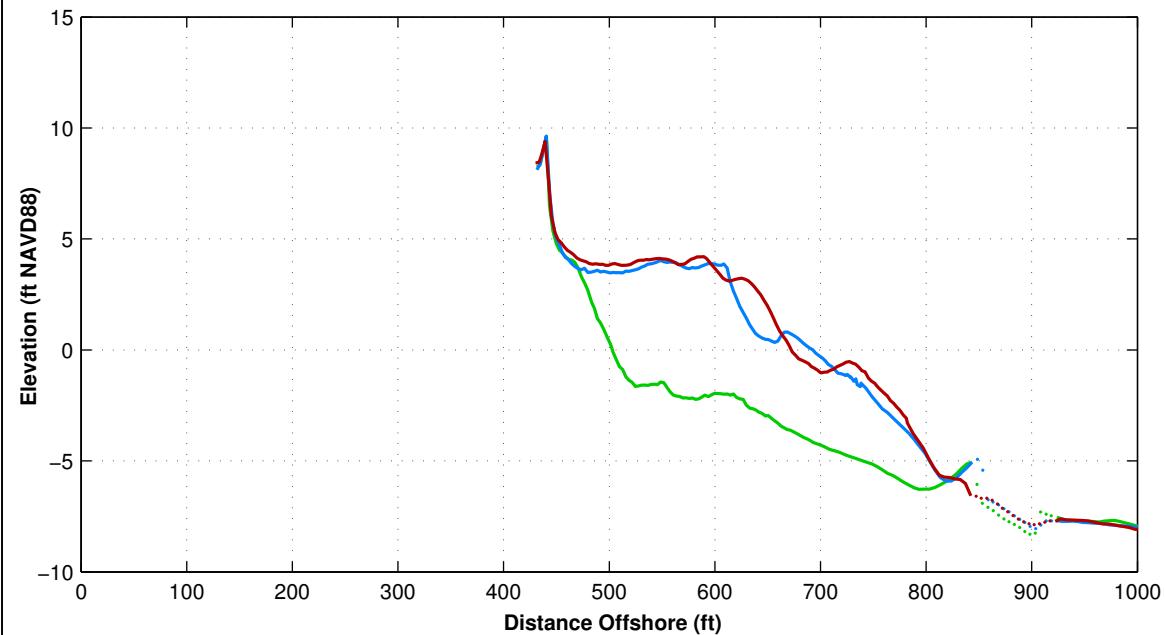
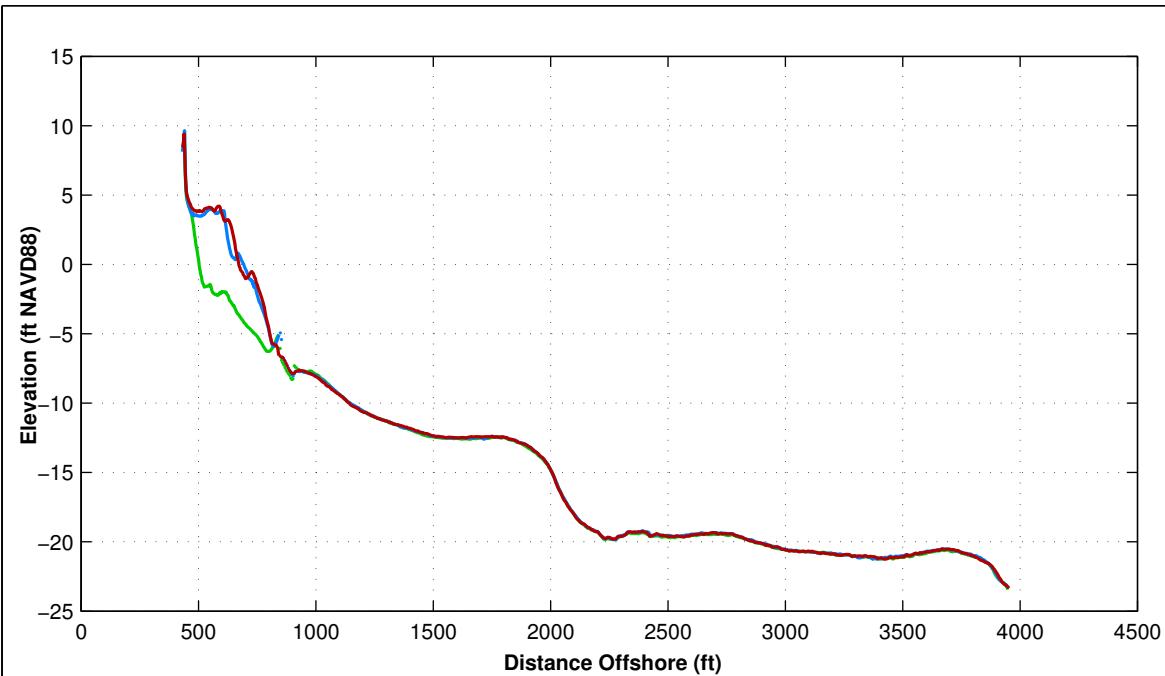
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ST 42+50

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Fall 2017



Survey Transect 45+00	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	166.58 ft/yr	24.97 ft
Volume Change Above -15 ft NAVD88	54.29 cy/ft/yr	3.94 cy/ft
Volume Change Above 0 ft NAVD88	23.66 cy/ft/yr	3.28 cy/ft

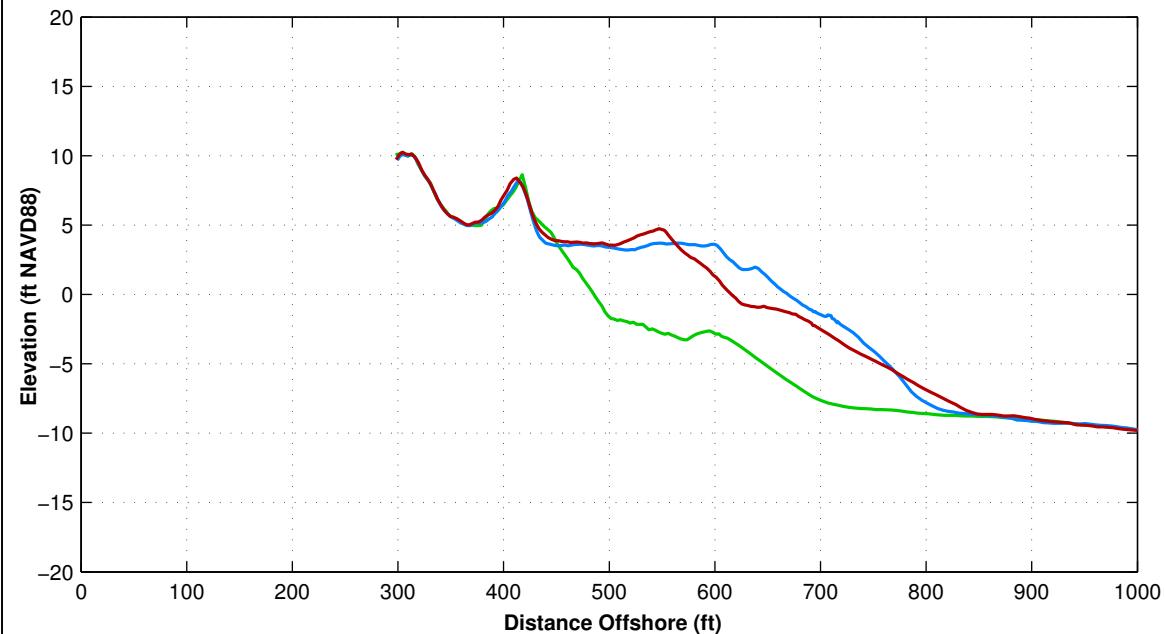
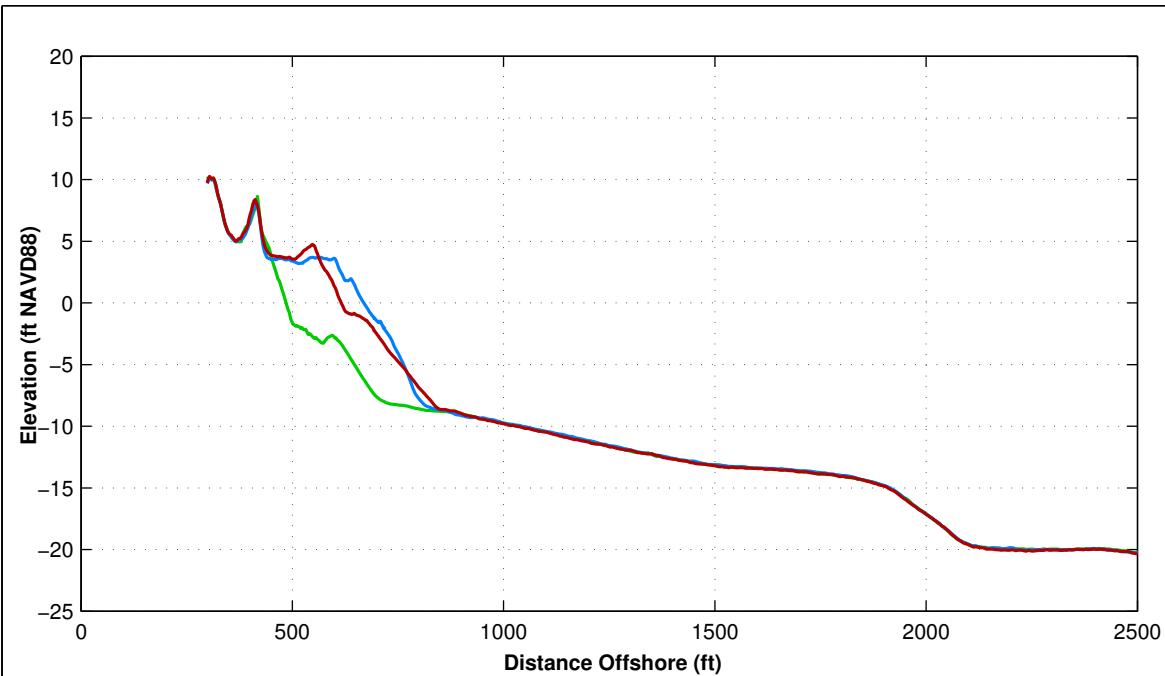
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





Survey Transect 45+25	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	128.52 ft/yr	-49.05 ft
Volume Change Above -15 ft NAVD88	57.17 cy/ft/yr	-8.80 cy/ft
Volume Change Above 0 ft NAVD88	18.09 cy/ft/yr	-2.66 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



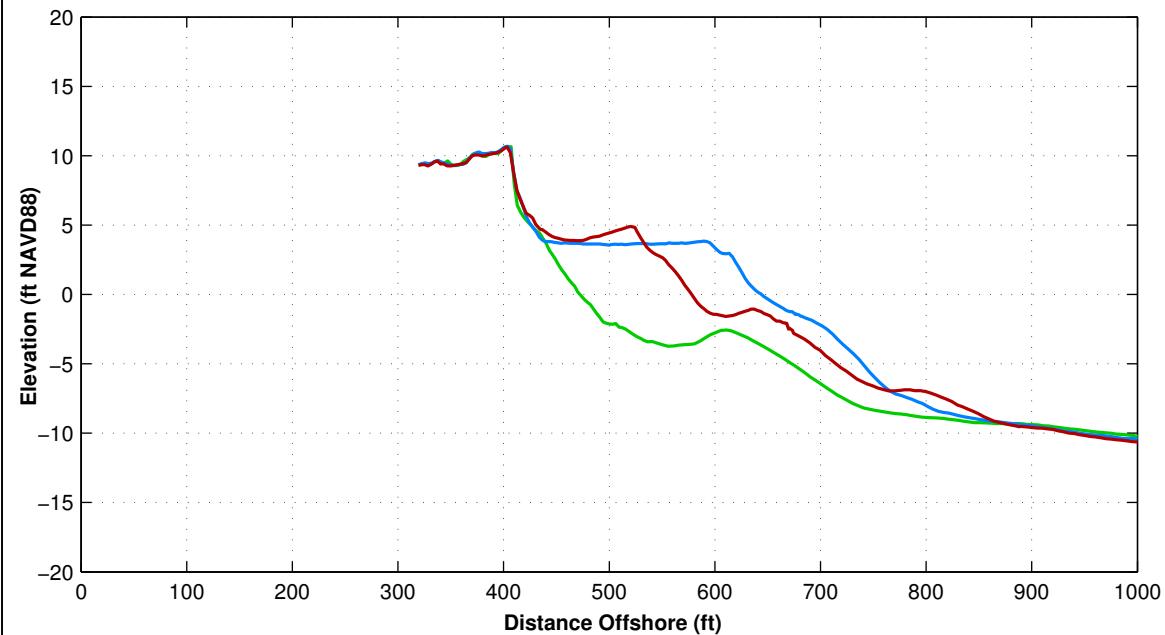
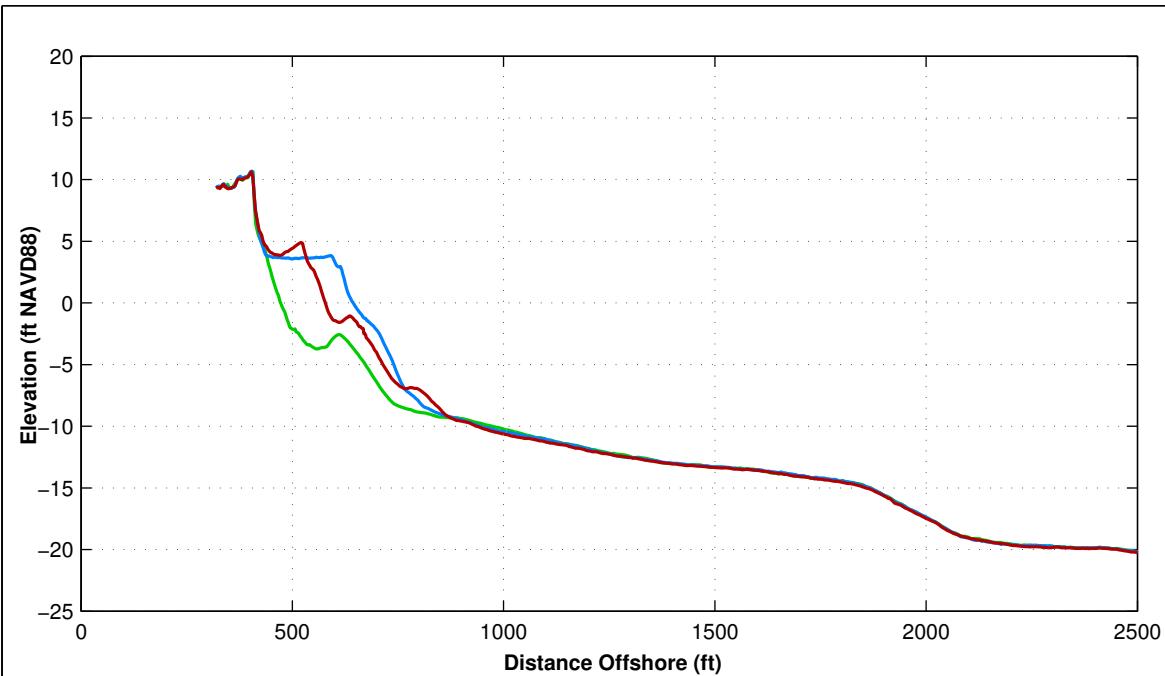
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PUBLIC WORKS

ST 45+25

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Fall 2017



Survey Transect 47+30	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	106.80 ft/yr	-61.24 ft
Volume Change Above -15 ft NAVD88	41.34 cy/ft/yr	-16.75 cy/ft
Volume Change Above 0 ft NAVD88	16.58 cy/ft/yr	-6.52 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



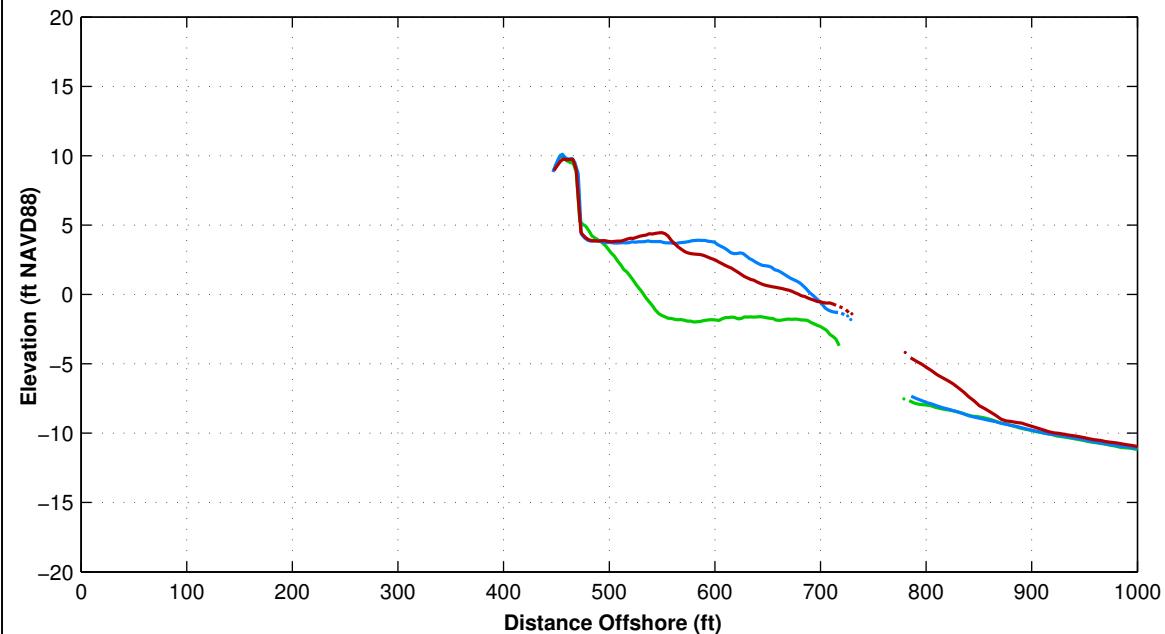
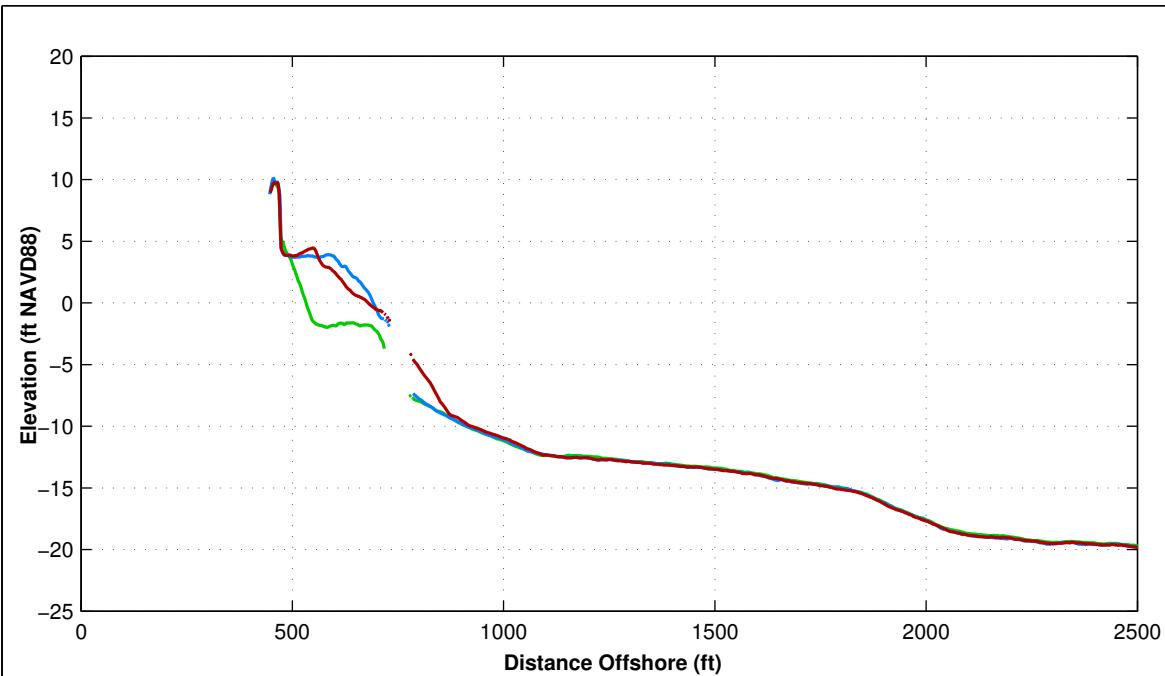
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 PUBLIC WORKS

ST 47+30

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 ANALYSIS

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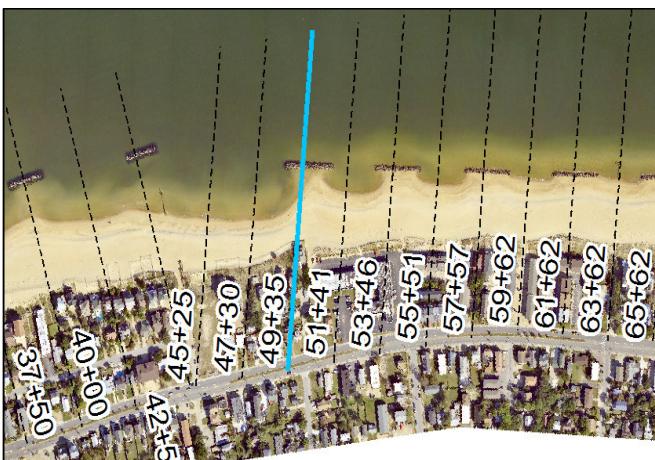
Survey Transect 49+35	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	115.64 ft/yr	-38.82 ft
Volume Change Above -15 ft NAVD88	31.45 cy/ft/yr	2.12 cy/ft
Volume Change Above 0 ft NAVD88	14.68 cy/ft/yr	-4.56 cy/ft

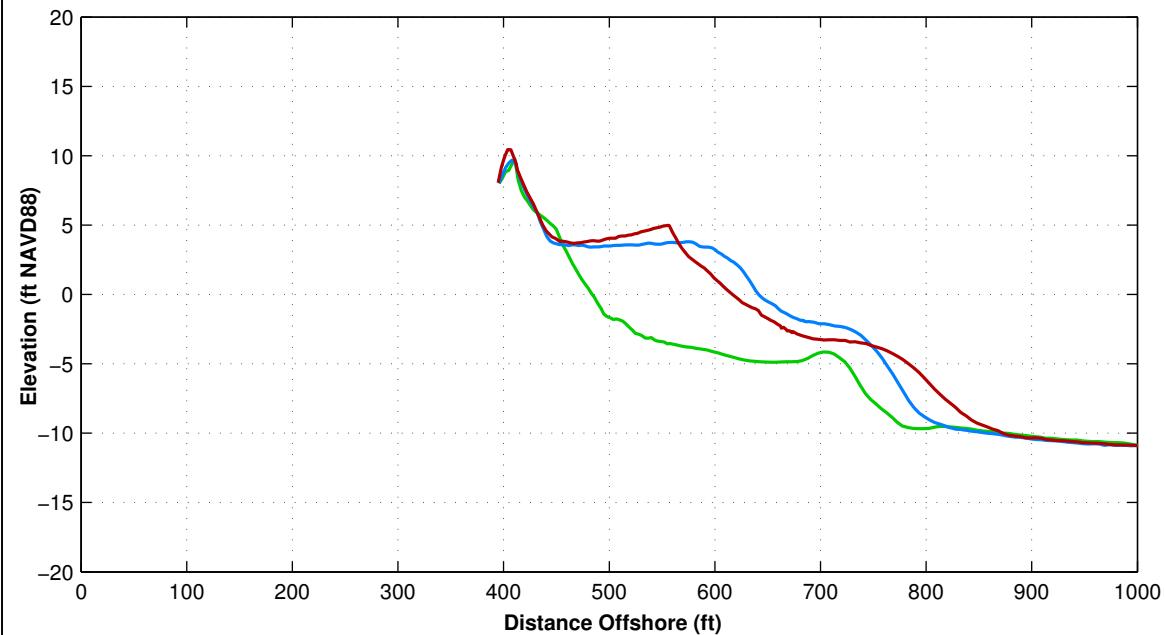
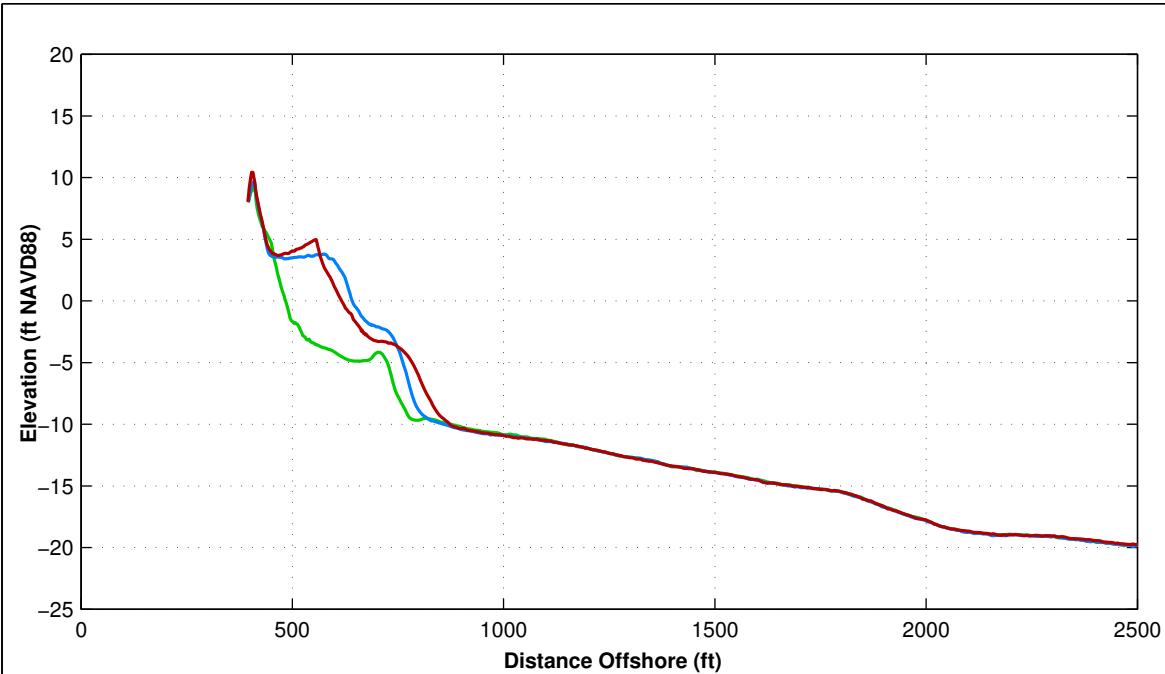
LEGEND:

OCT 2017 — Red Line
MAY 2017 — Blue Line
OCT 2016 — Green Line

Notes:

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Survey Transect	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	128.28 ft/yr	-30.35 ft
Volume Change Above -15 ft NAVD88	56.92 cy/ft/yr	1.33 cy/ft
Volume Change Above 0 ft NAVD88	19.20 cy/ft/yr	-0.87 cy/ft

LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

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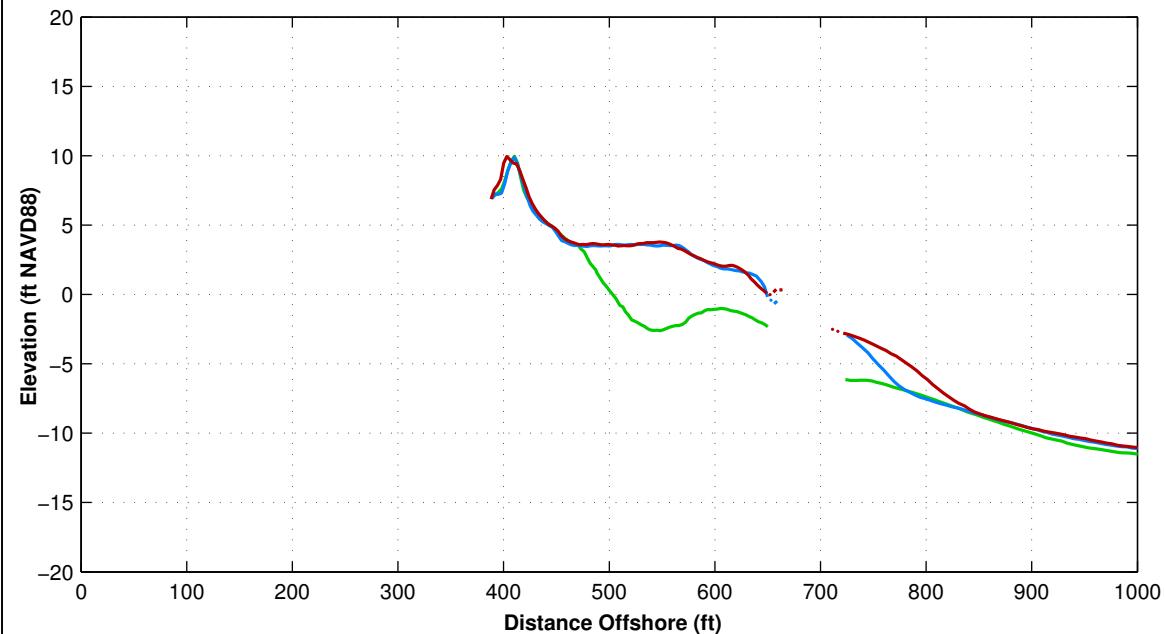
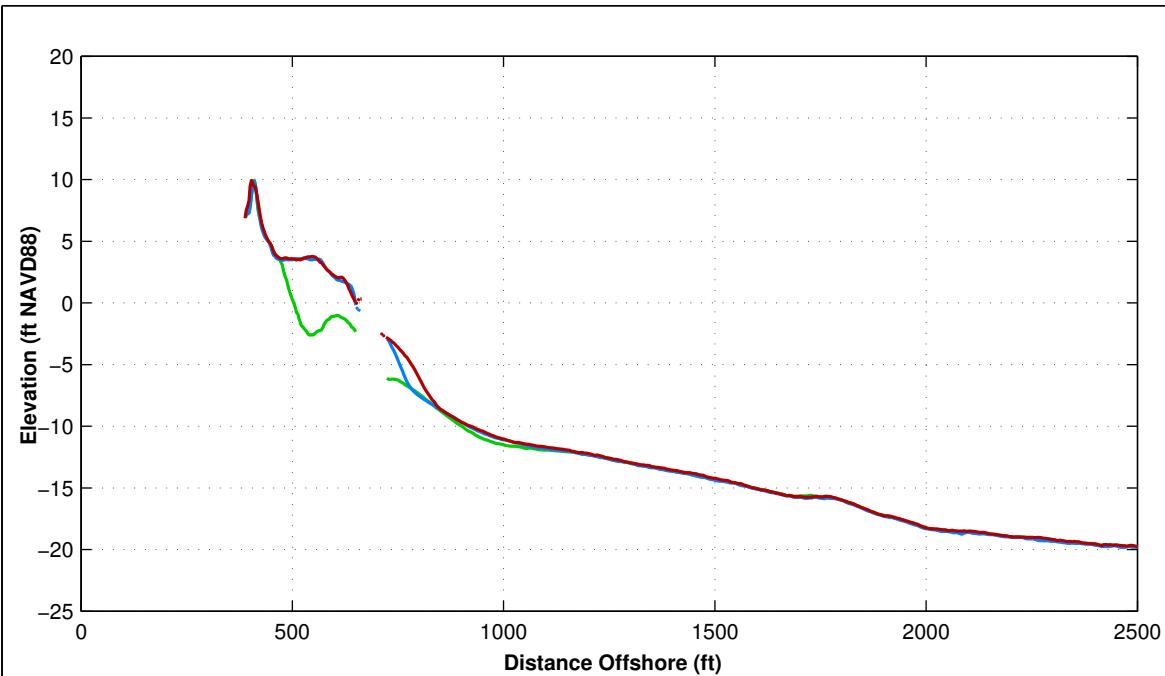
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PUBLIC WORKS

ST 51+41

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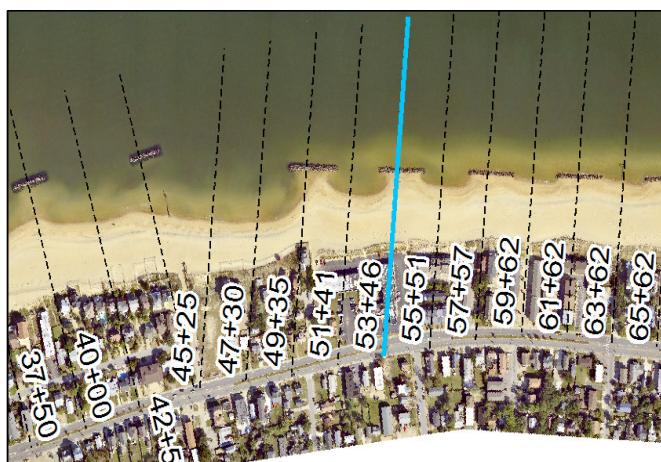
Fall 2017

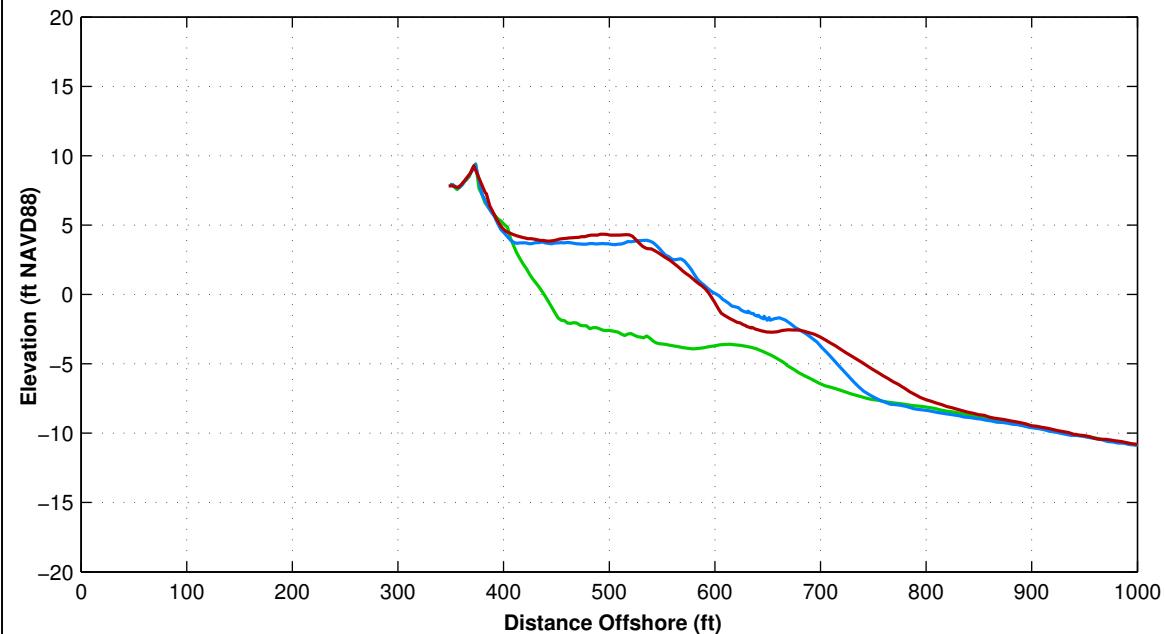
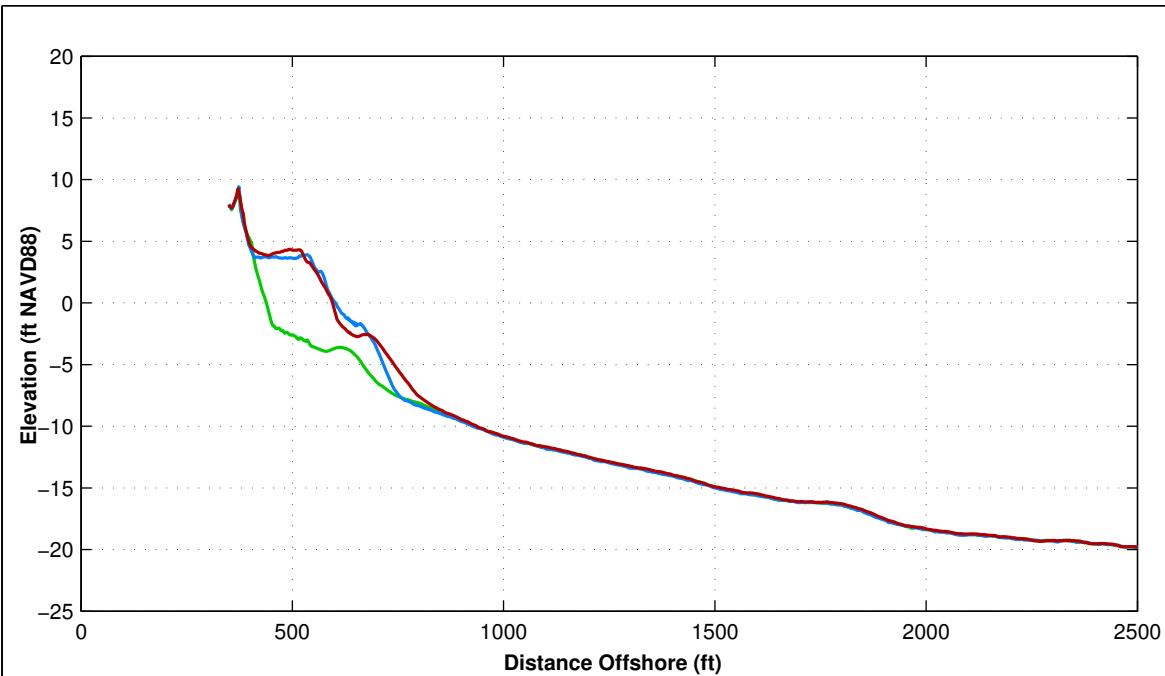


Survey Transect 53+46	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	144.08 ft/yr	-6.89 ft
Volume Change Above -15 ft NAVD88	39.59 cy/ft/yr	8.52 cy/ft
Volume Change Above 0 ft NAVD88	17.73 cy/ft/yr	1.37 cy/ft

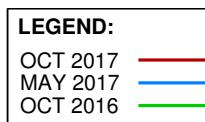
Notes:

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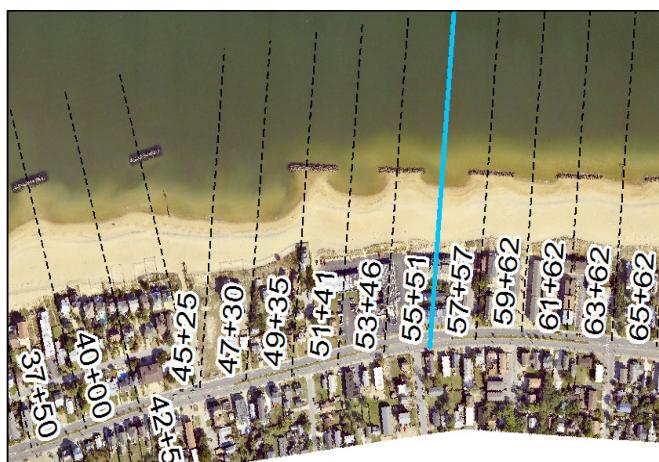


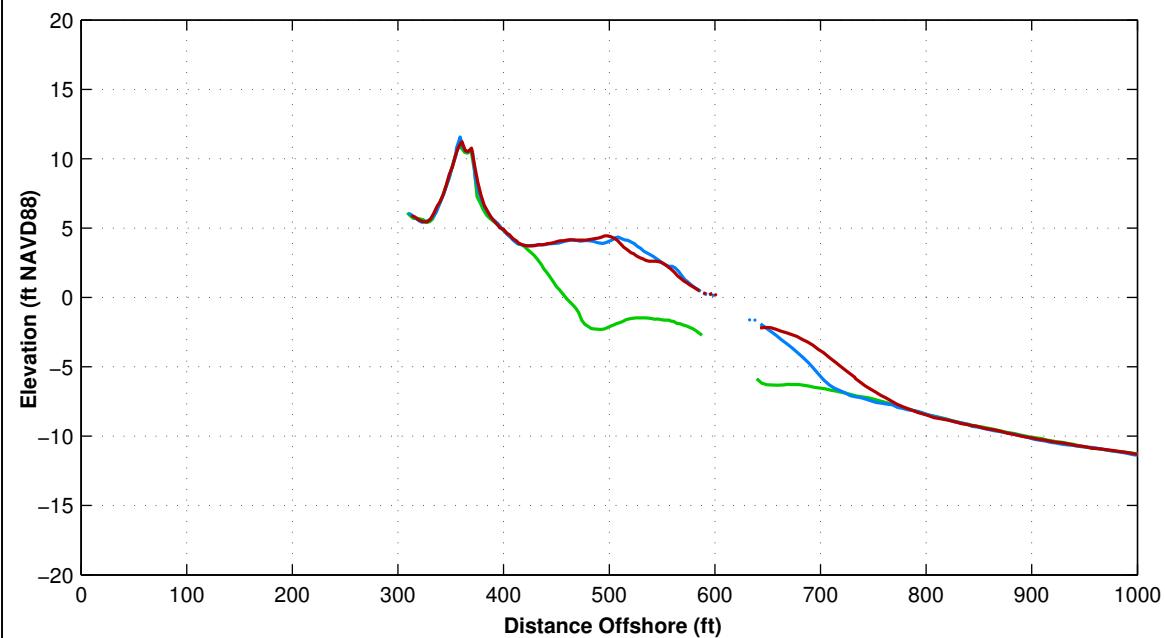
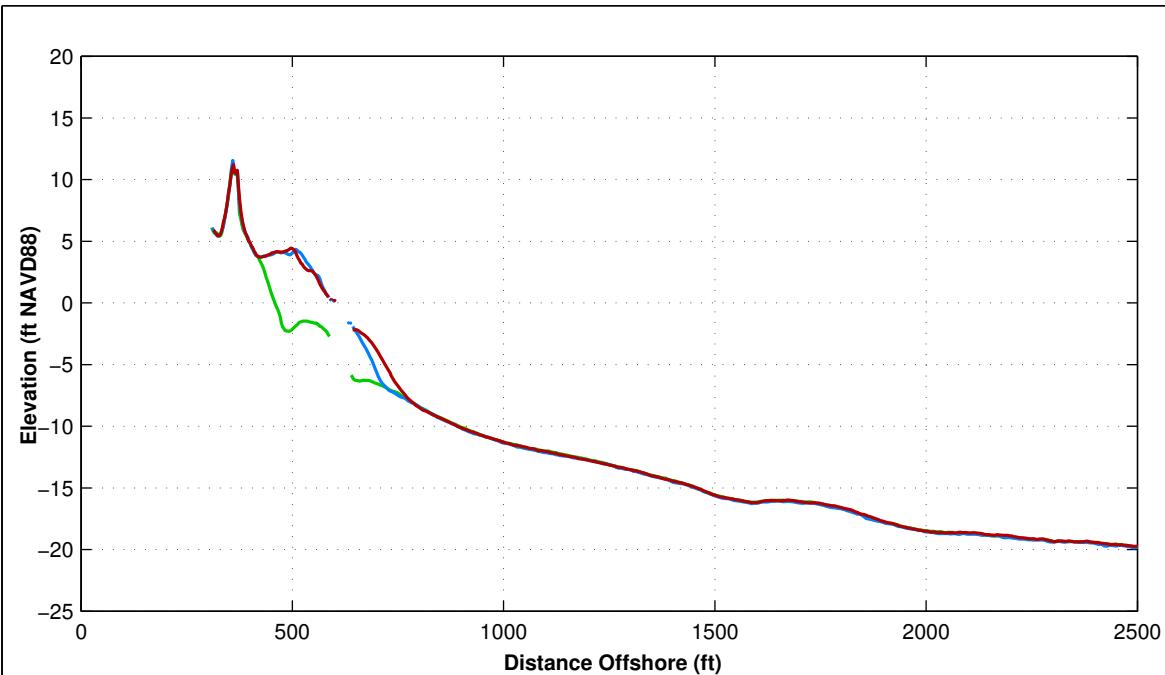
Survey Transect 55+51	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	153.19 ft/yr	-3.76 ft
Volume Change Above -15 ft NAVD88	56.65 cy/ft/yr	7.76 cy/ft
Volume Change Above 0 ft NAVD88	21.91 cy/ft/yr	1.23 cy/ft



Notes:

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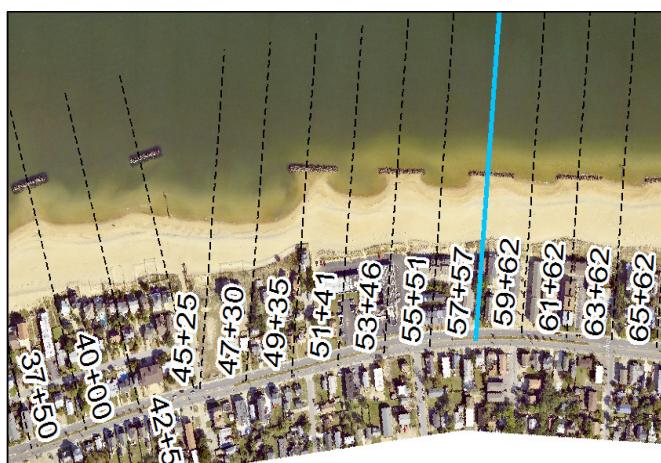
Survey Transect 57+57	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	127.07 ft/yr	-1.60 ft
Volume Change Above -15 ft NAVD88	36.32 cy/ft/yr	5.53 cy/ft
Volume Change Above 0 ft NAVD88	17.98 cy/ft/yr	-0.40 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

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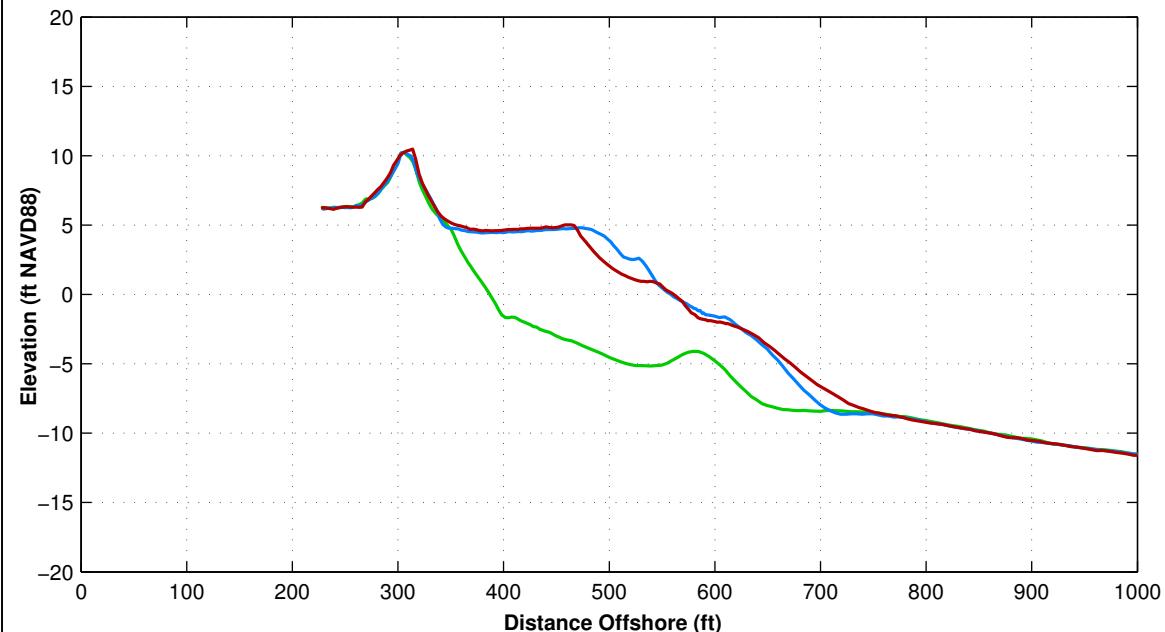
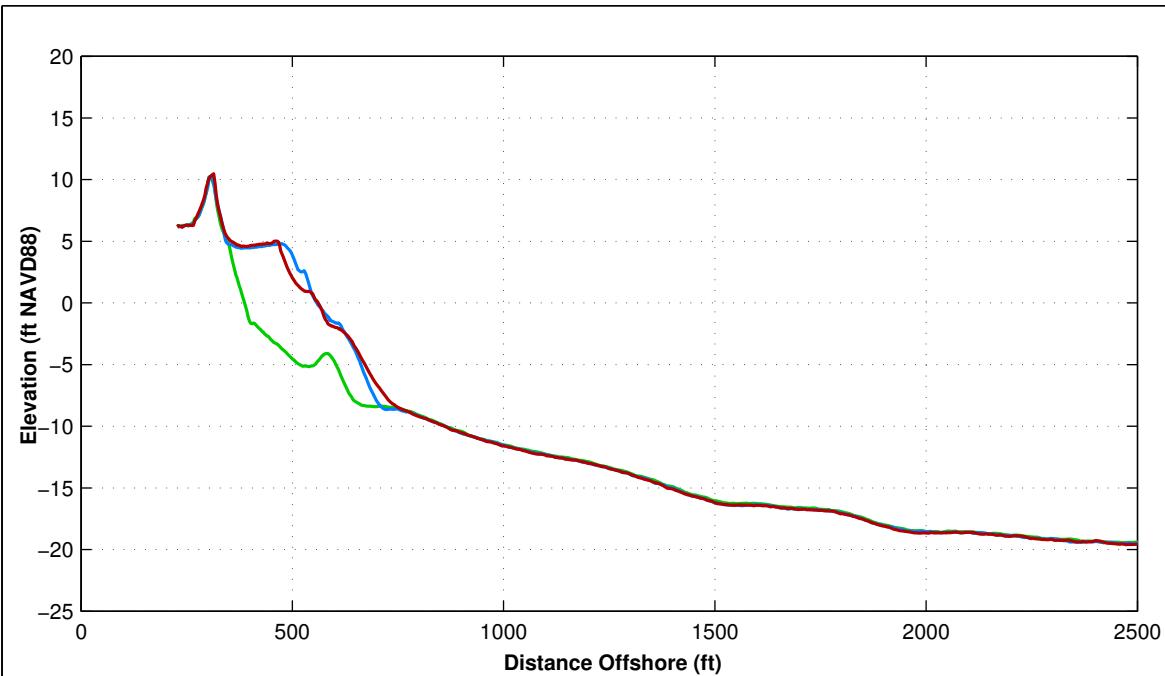
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NORFOLK
PUBLIC WORKS

ST 57+57

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SURVEYING DATA &
ANALYSIS

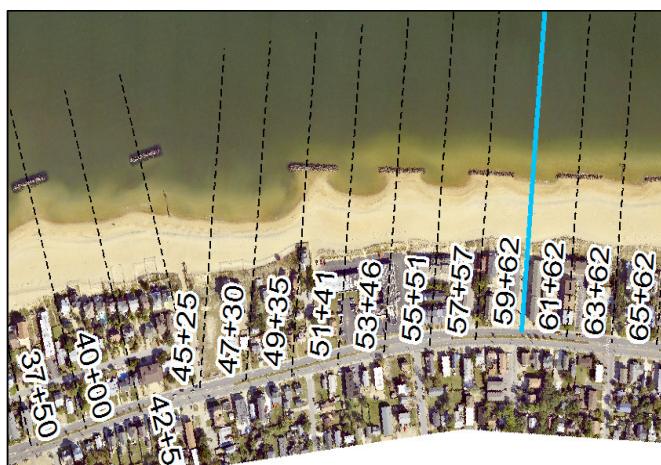
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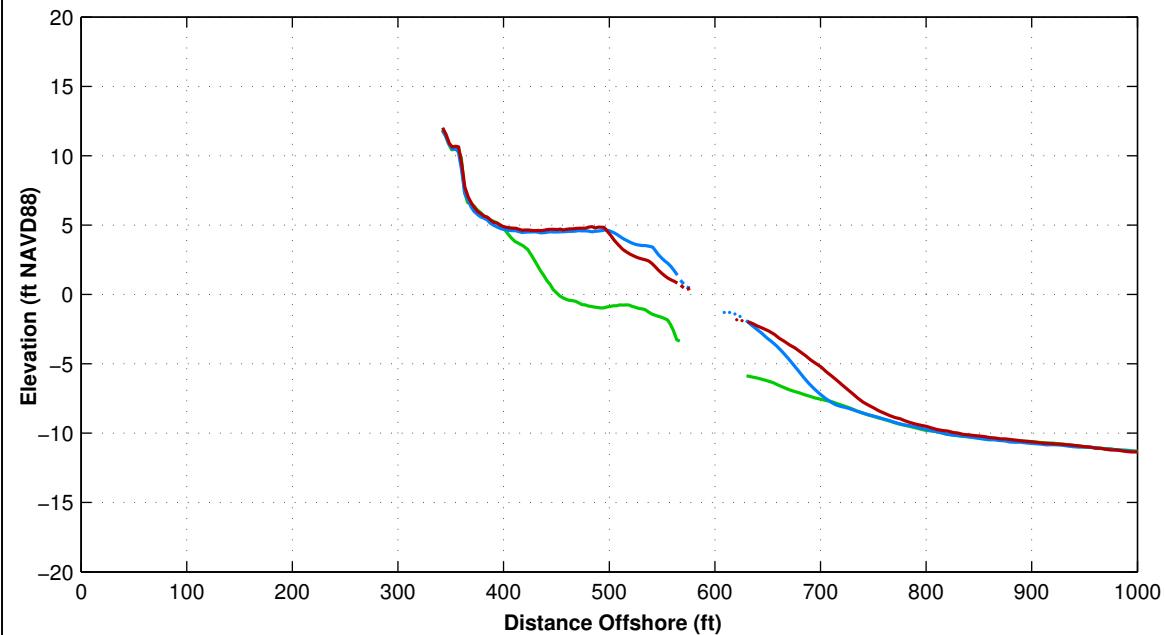
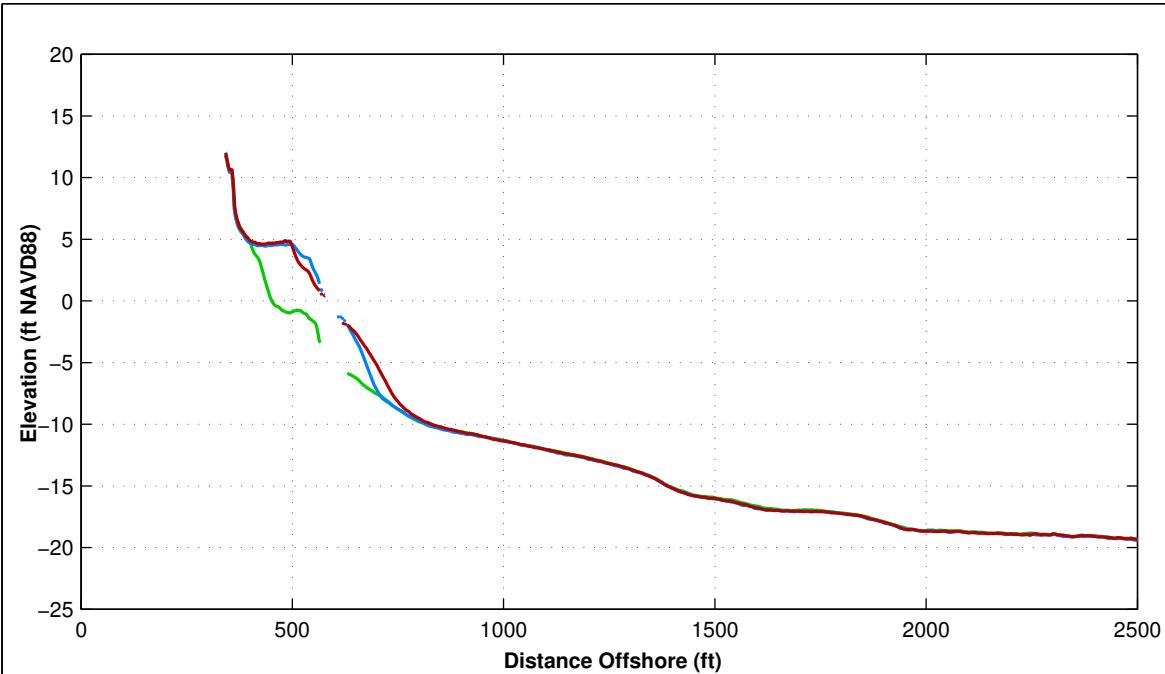
Fall 2017



Notes:

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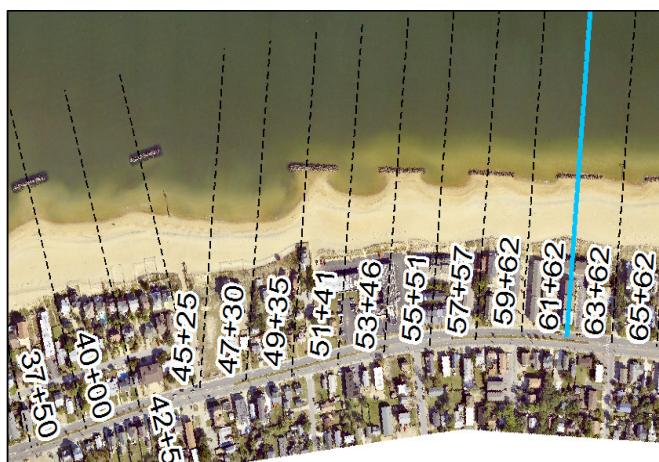
Survey Transect 61+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	120.06 ft/yr	-7.54 ft
Volume Change Above -15 ft NAVD88	35.07 cy/ft/yr	5.84 cy/ft
Volume Change Above 0 ft NAVD88	19.03 cy/ft/yr	-1.08 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

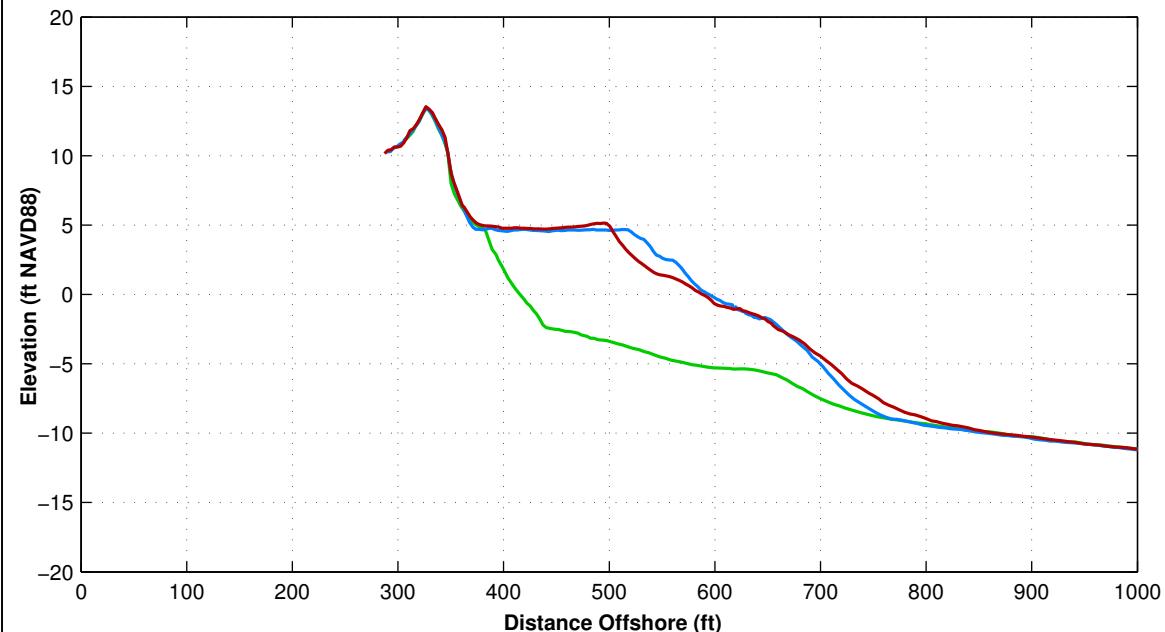
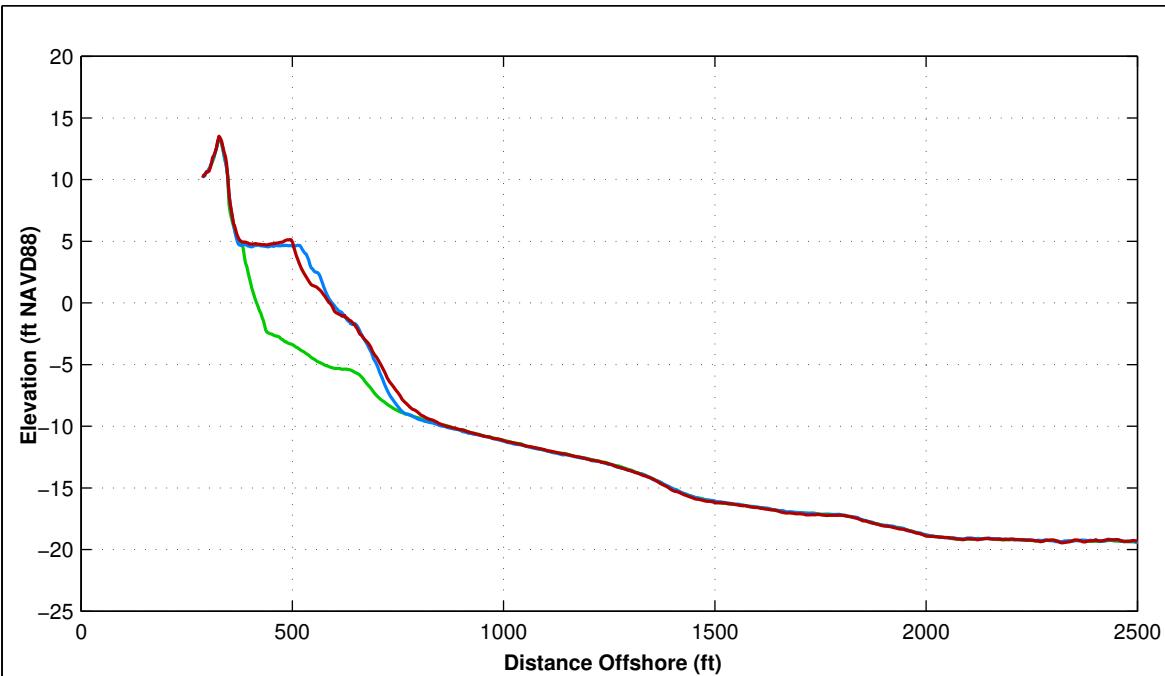
Notes:

1. Station From West To East At Varying Intervals.
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ANALYSIS



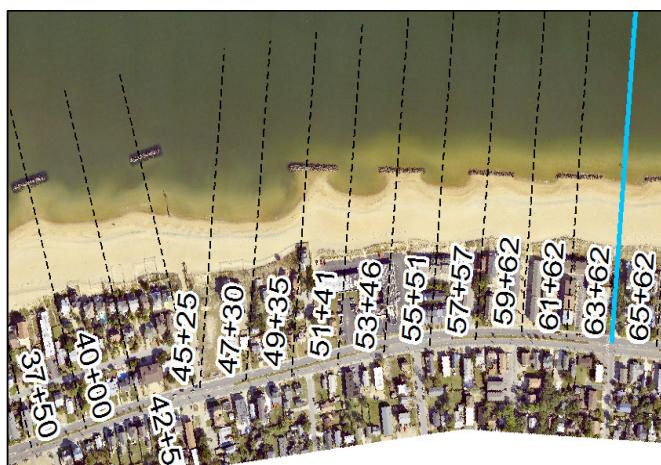
Survey Transect 63+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	162.00 ft/yr	-10.78 ft
Volume Change Above -15 ft NAVD88	69.36 cy/ft/yr	2.23 cy/ft
Volume Change Above 0 ft NAVD88	25.76 cy/ft/yr	-2.12 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

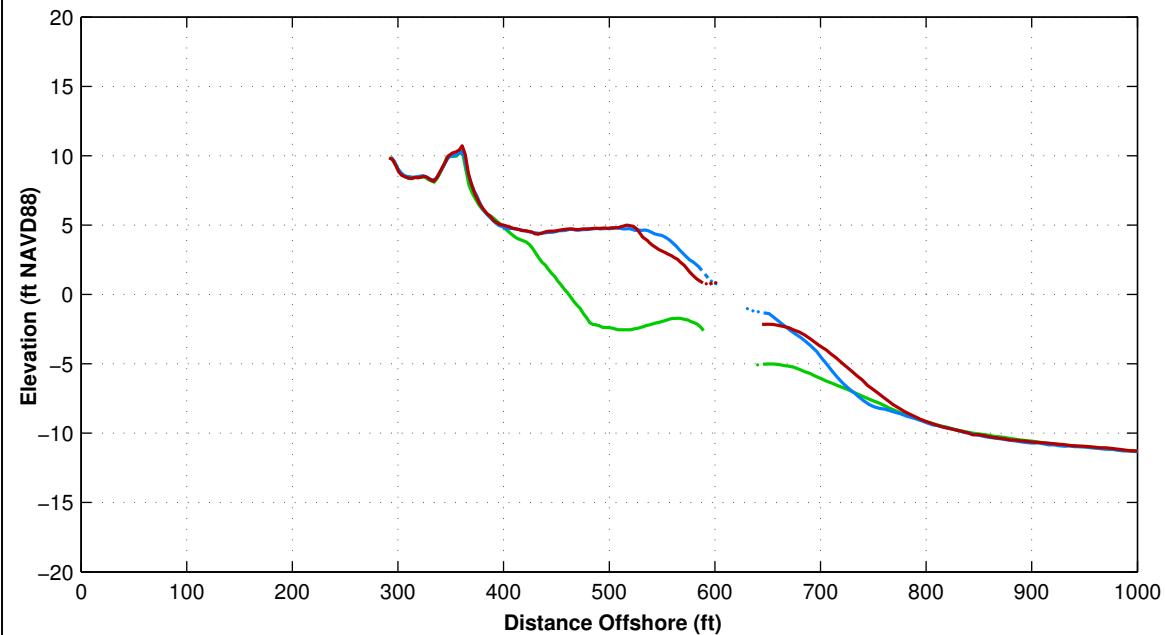
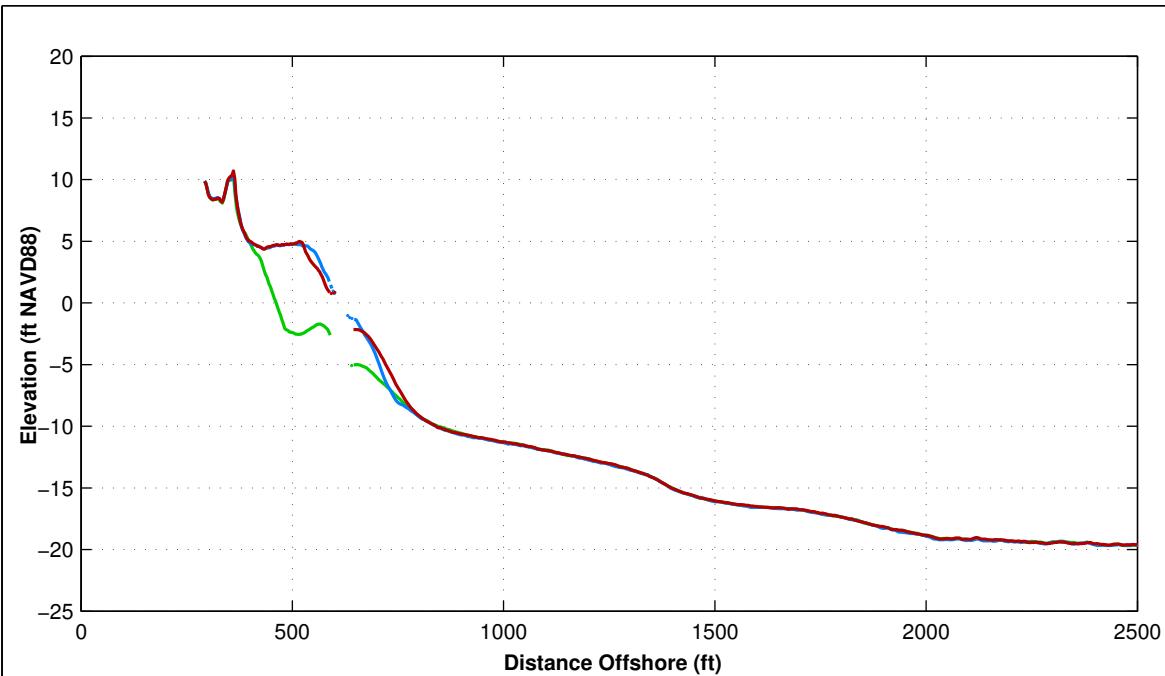
Notes:

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OCEAN VIEW PERIODIC
SURVEYING DATA &
ANALYSIS



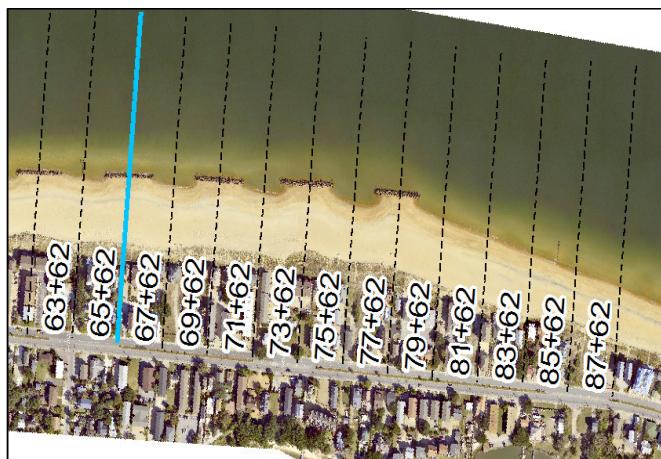
Survey Transect 65+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	135.07 ft/yr	-11.02 ft
Volume Change Above -15 ft NAVD88	41.22 cy/ft/yr	2.67 cy/ft
Volume Change Above 0 ft NAVD88	23.26 cy/ft/yr	-1.73 cy/ft

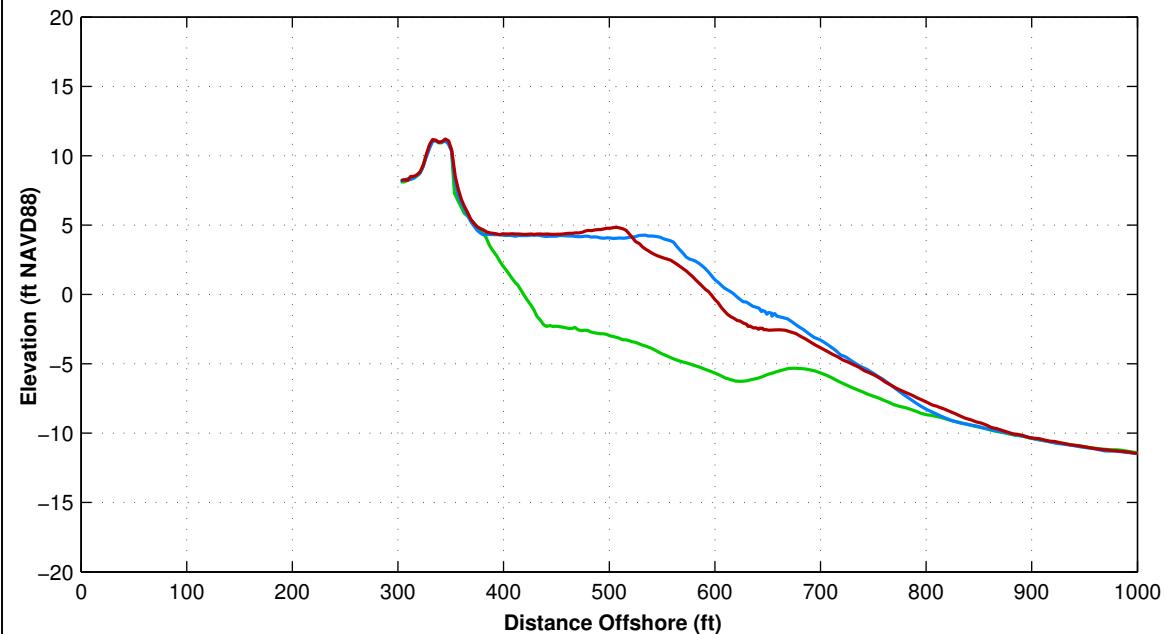
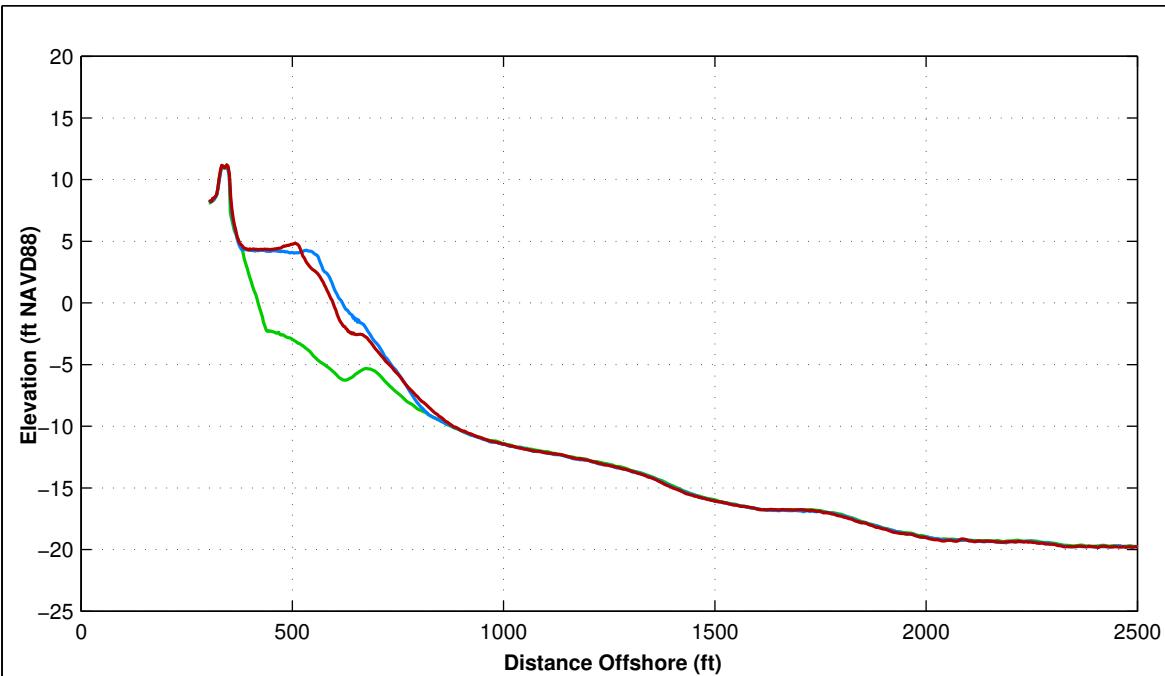
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

1. Station From West To East At Varying Intervals.
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3. All Survey Elevations In Feet Referenced to NAVD88.
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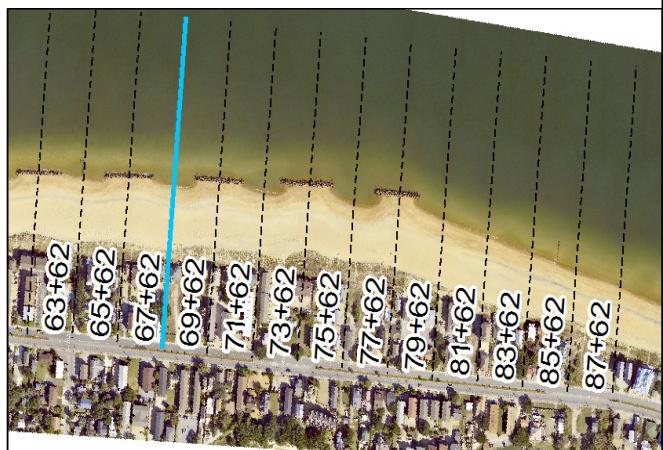


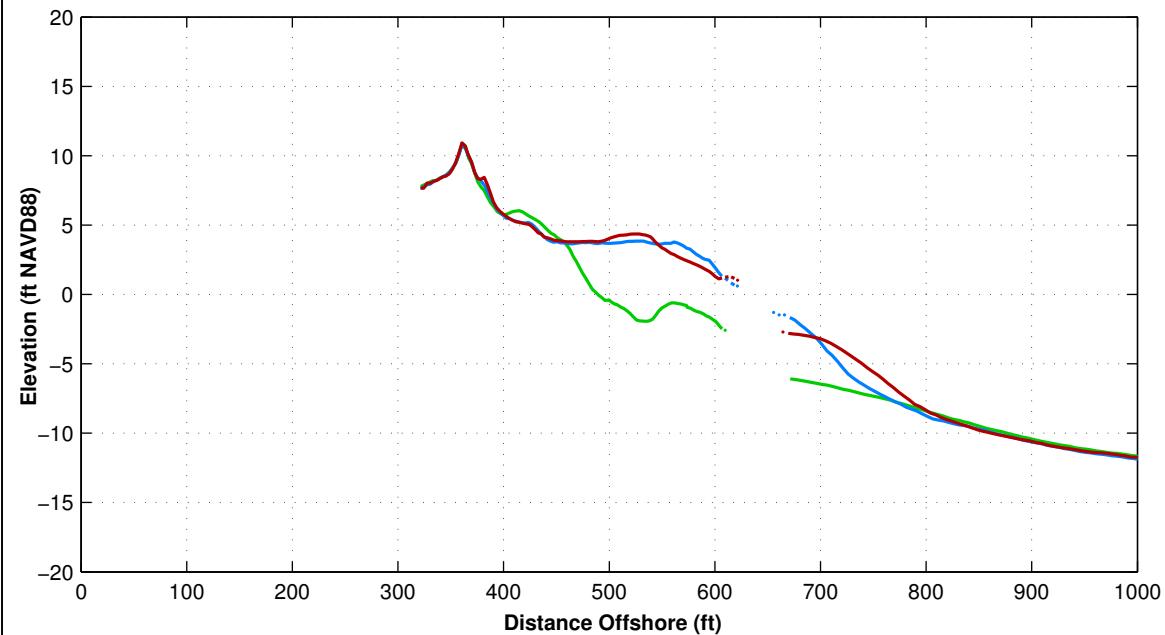
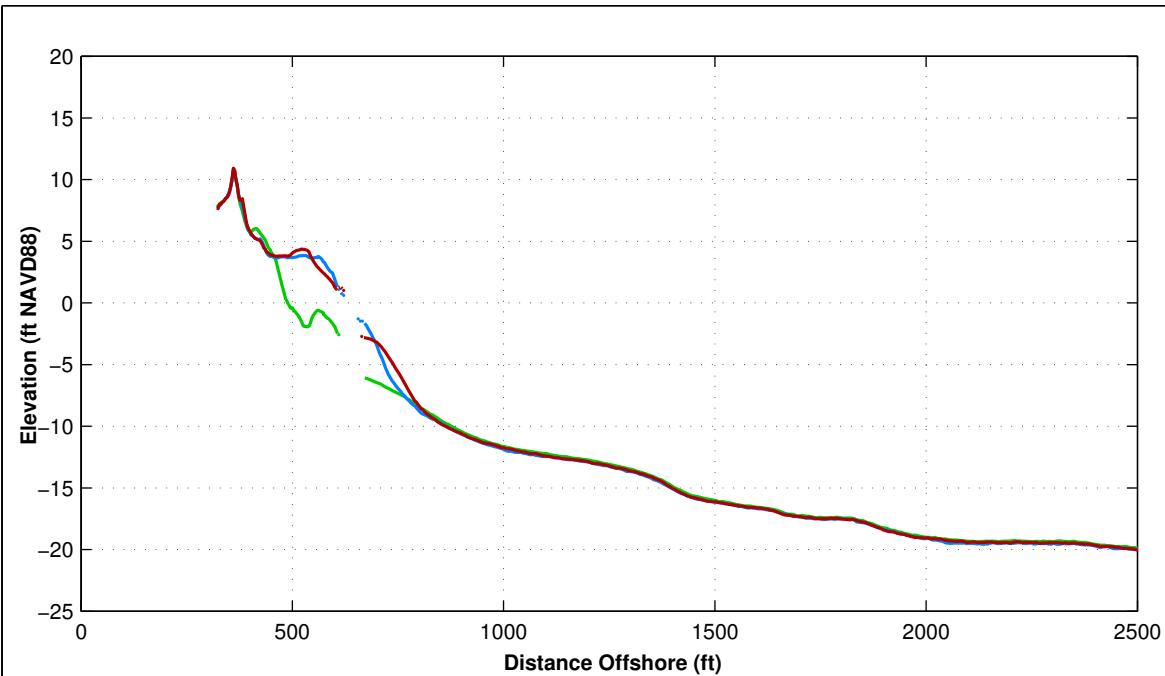


Survey Transect 67+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	173.91 ft/yr	-18.59 ft
Volume Change Above -15 ft NAVD88	67.78 cy/ft/yr	-4.67 cy/ft
Volume Change Above 0 ft NAVD88	27.22 cy/ft/yr	-1.83 cy/ft

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



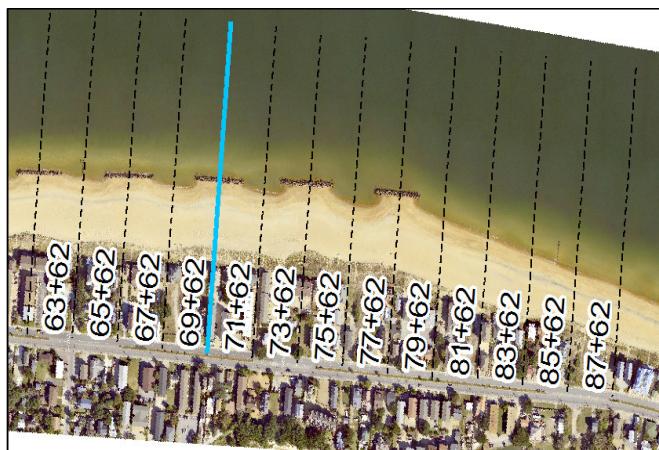


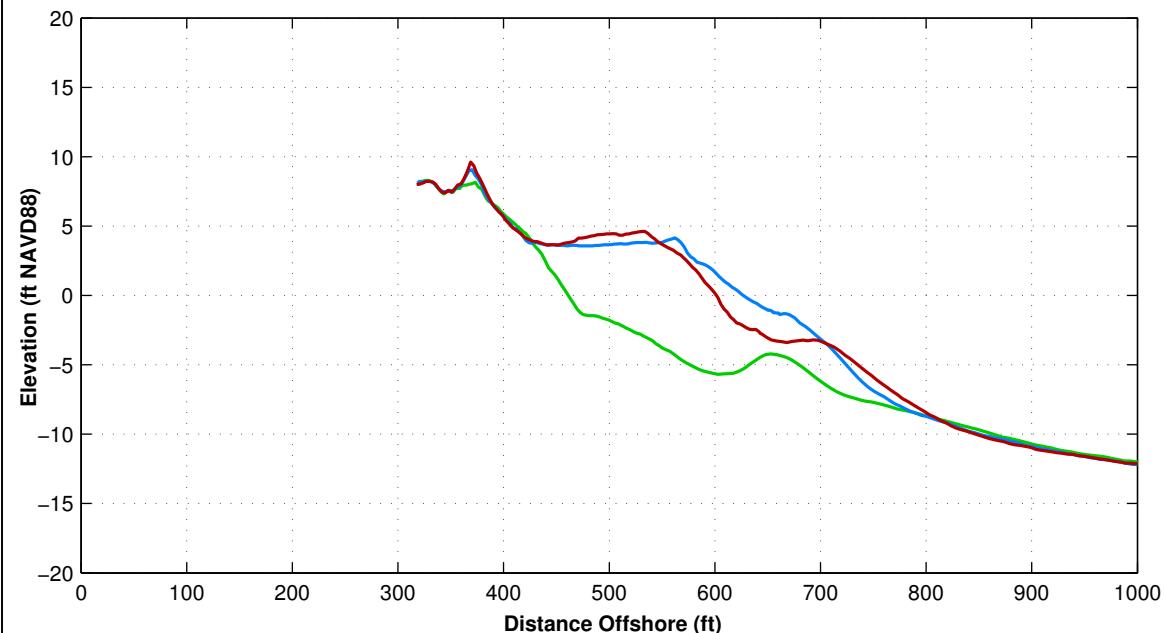
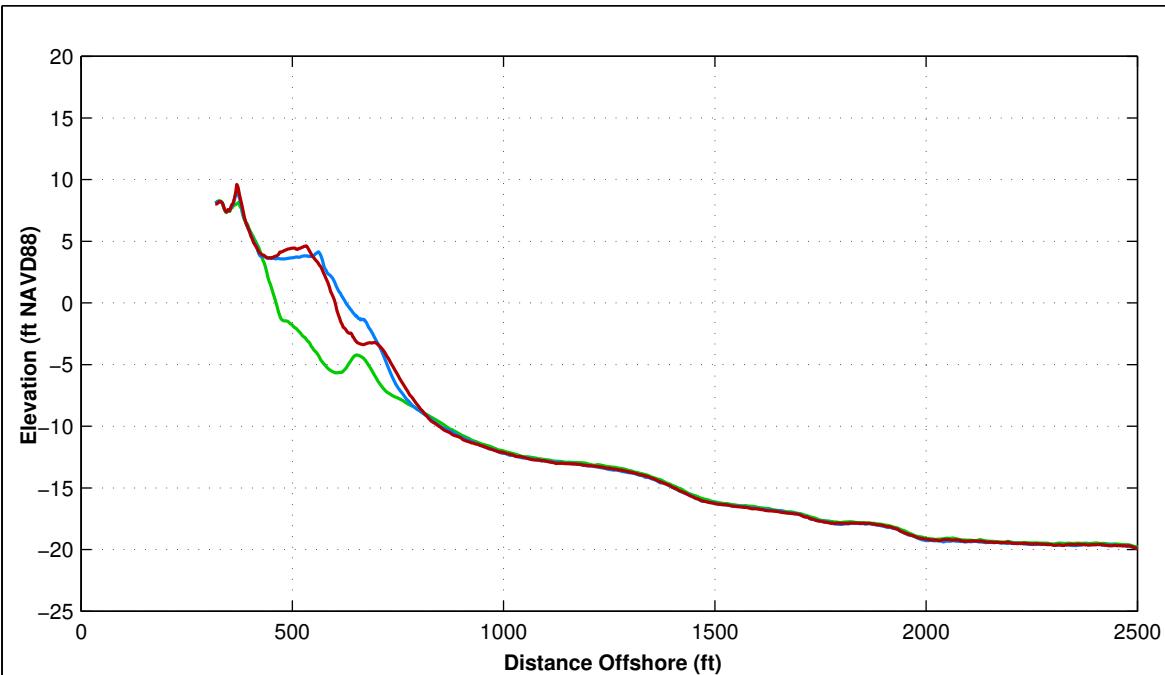
Survey Transect 69+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	143.53 ft/yr	8.85 ft
Volume Change Above -15 ft NAVD88	27.74 cy/ft/yr	4.19 cy/ft
Volume Change Above 0 ft NAVD88	16.54 cy/ft/yr	-0.12 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
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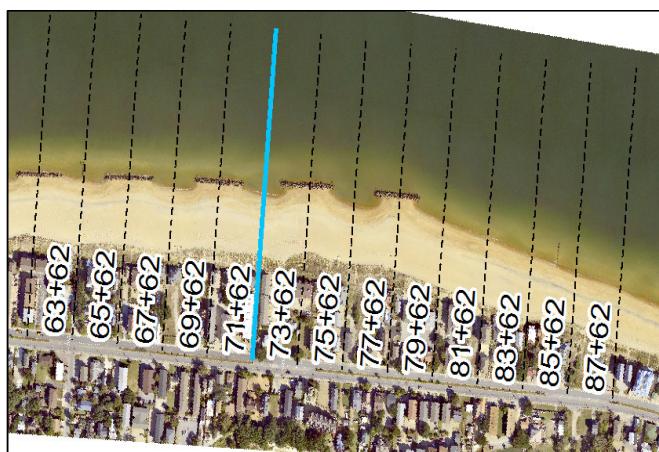


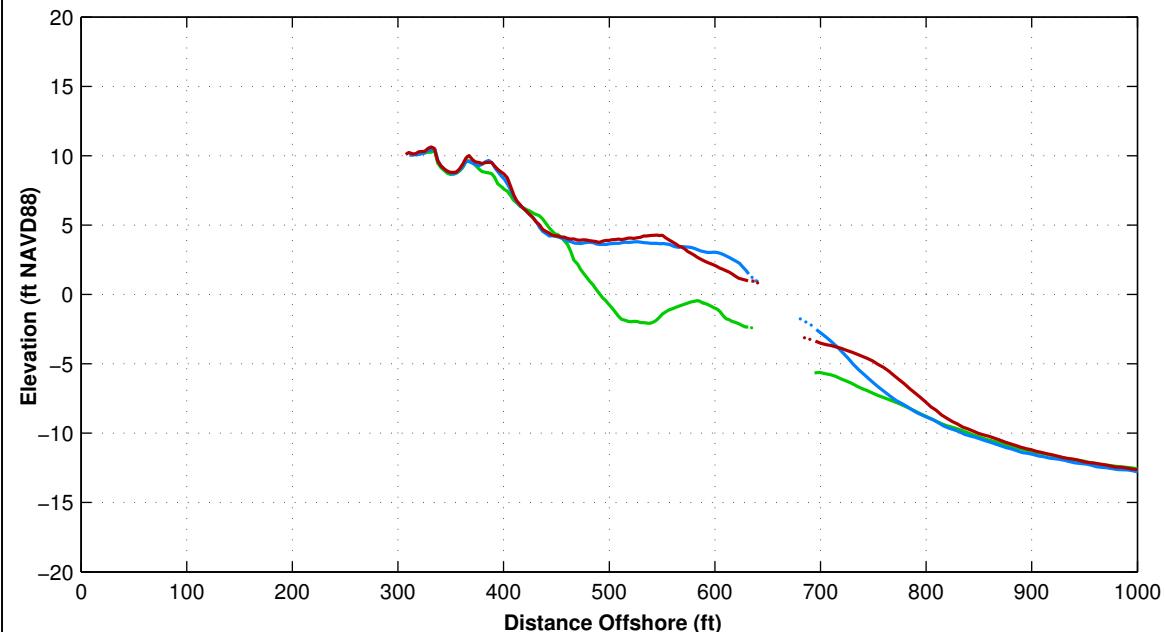
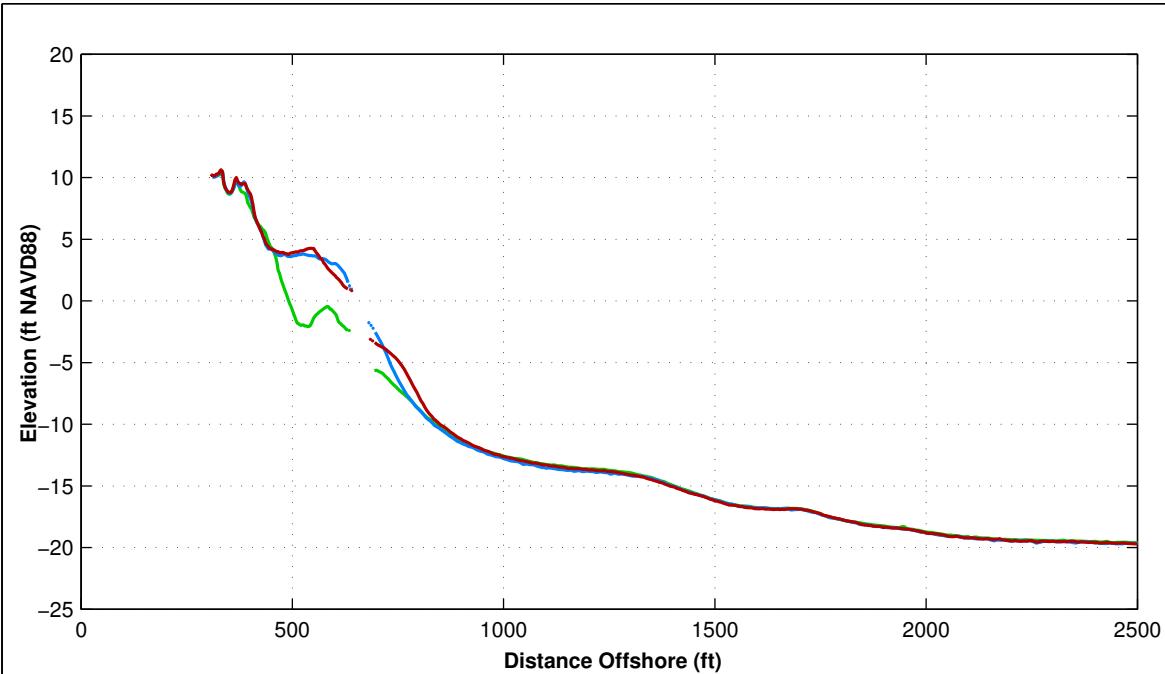
Survey Transect 71+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	138.18 ft/yr	-19.32 ft
Volume Change Above -15 ft NAVD88	49.24 cy/ft/yr	-3.40 cy/ft
Volume Change Above 0 ft NAVD88	21.00 cy/ft/yr	-0.08 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

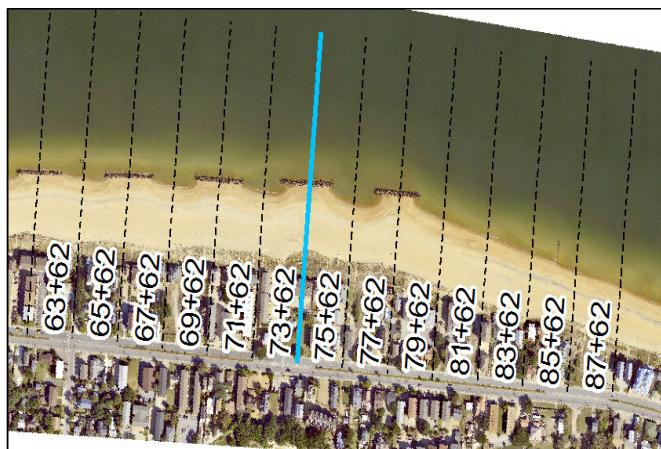
1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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4. Survey Comparison Made to OCT 2016 and MAY 2017
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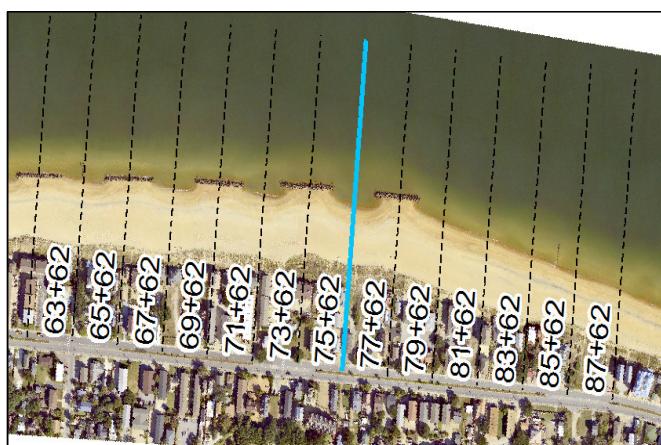
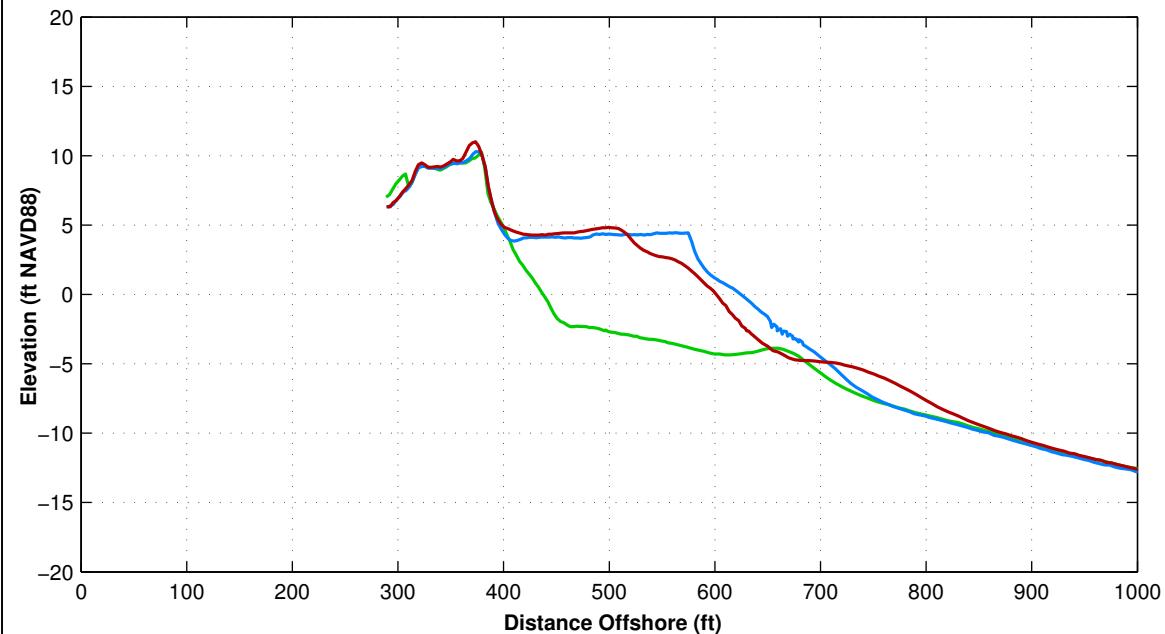
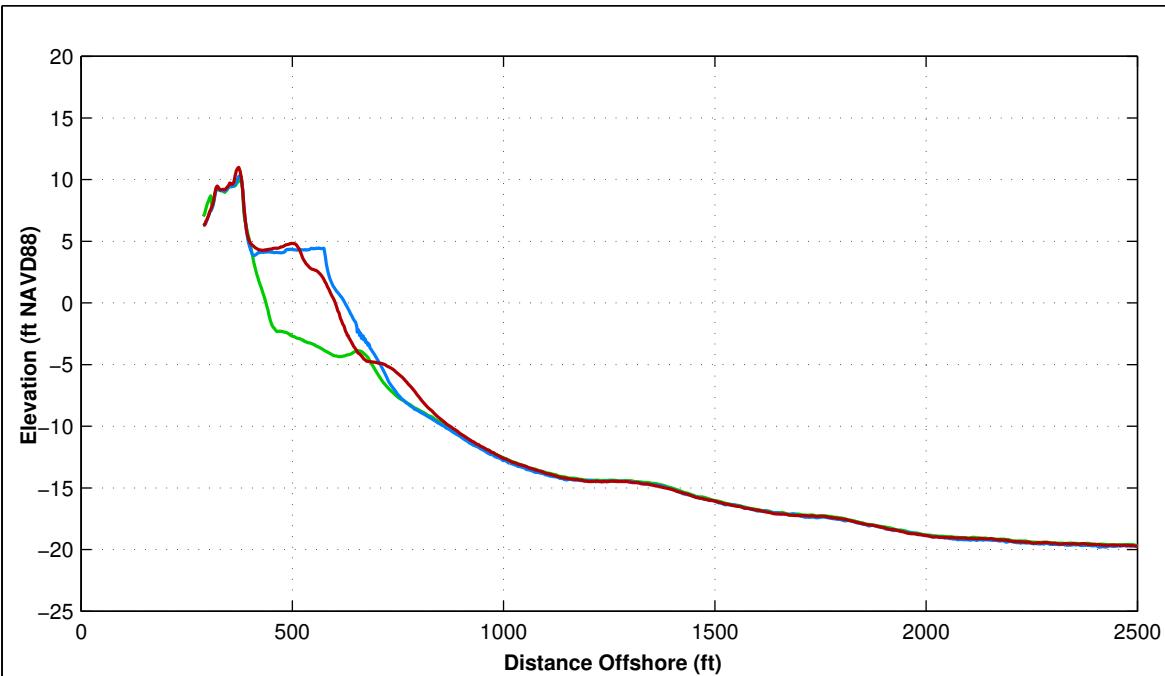


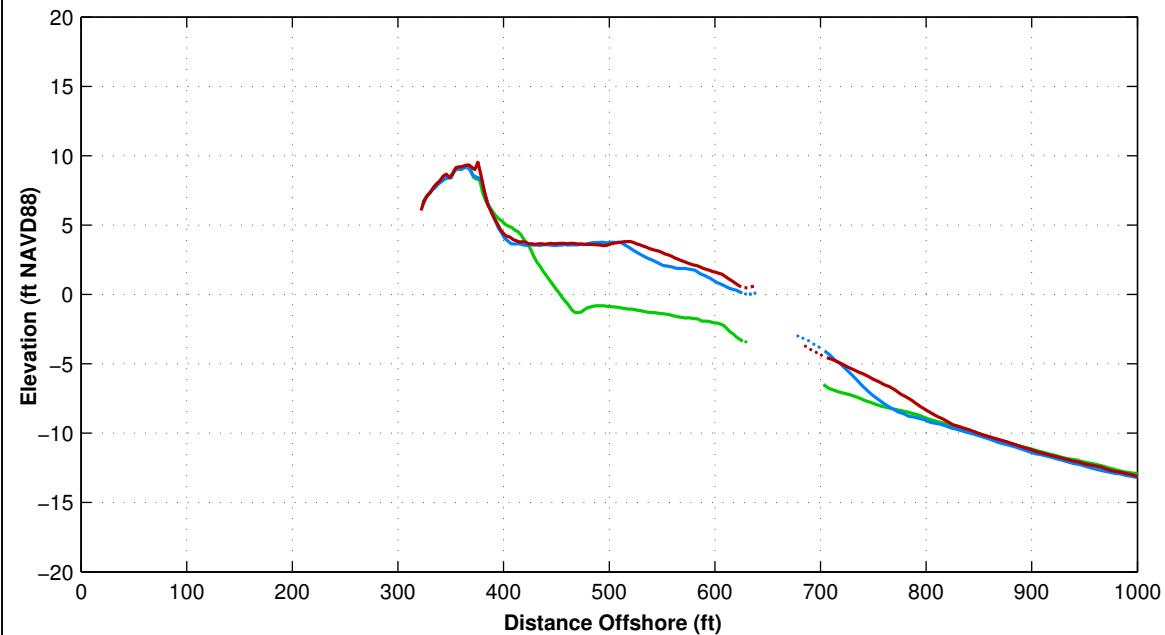
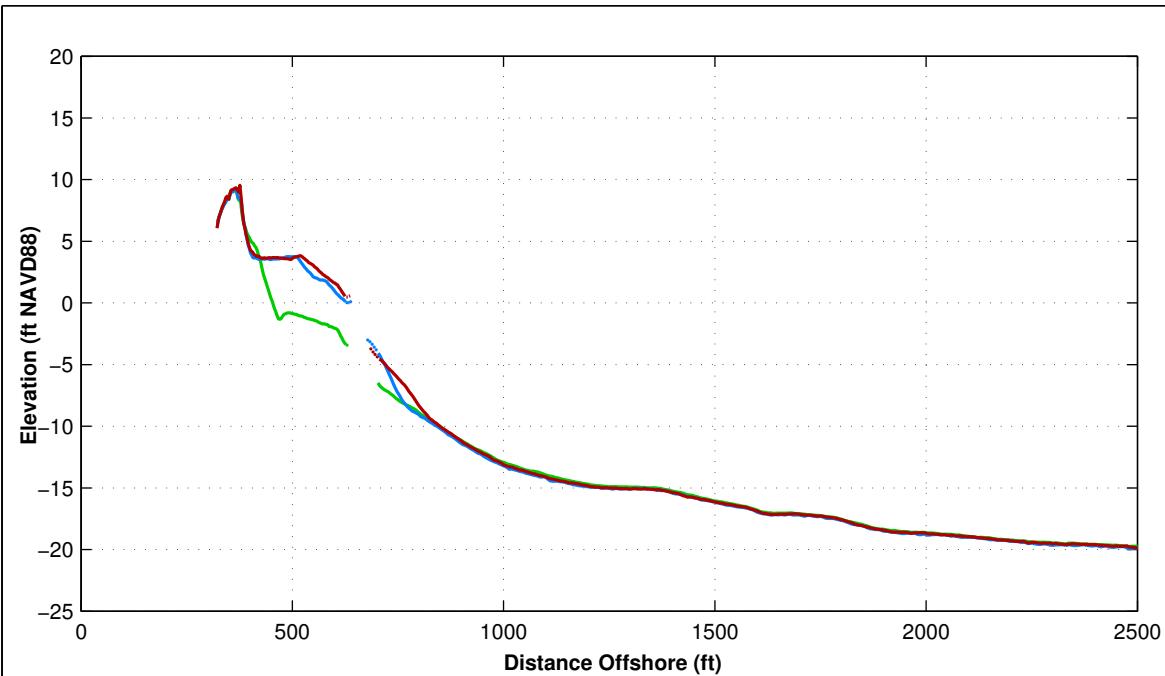


Notes:

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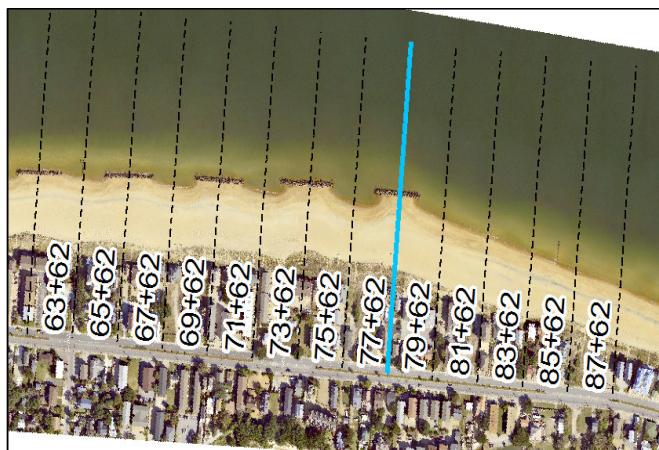


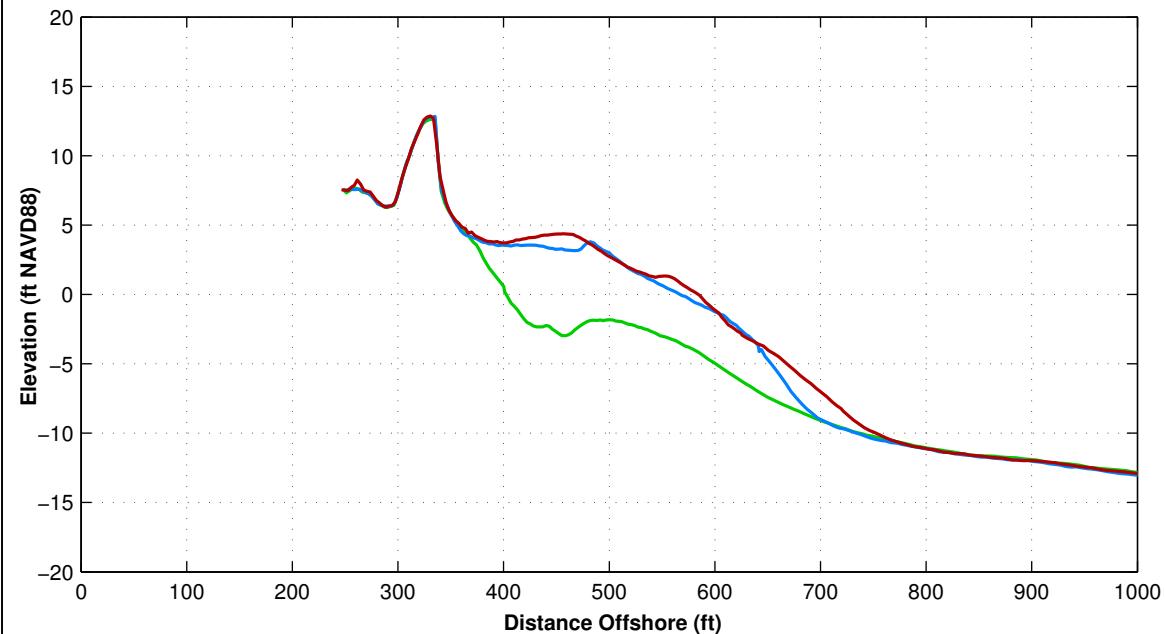
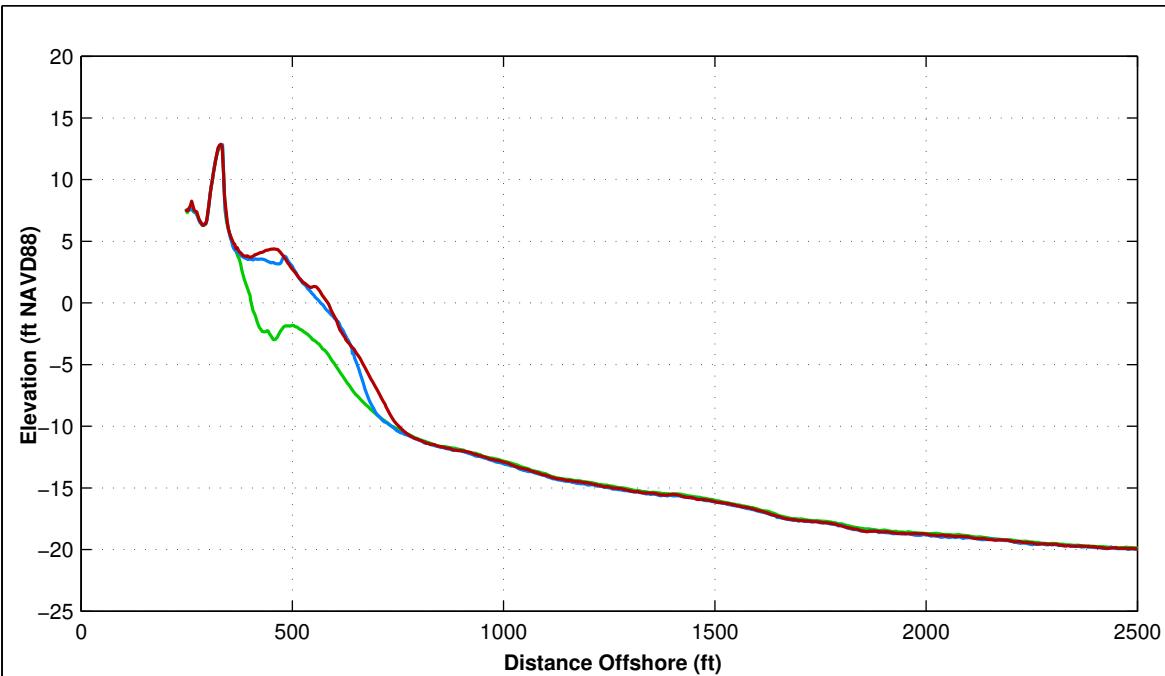
Survey Transect 77+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	173.29 ft/yr	16.72 ft
Volume Change Above -15 ft NAVD88	33.85 cy/ft/yr	8.70 cy/ft
Volume Change Above 0 ft NAVD88	20.57 cy/ft/yr	3.54 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made To OCT 2016 and MAY 2017
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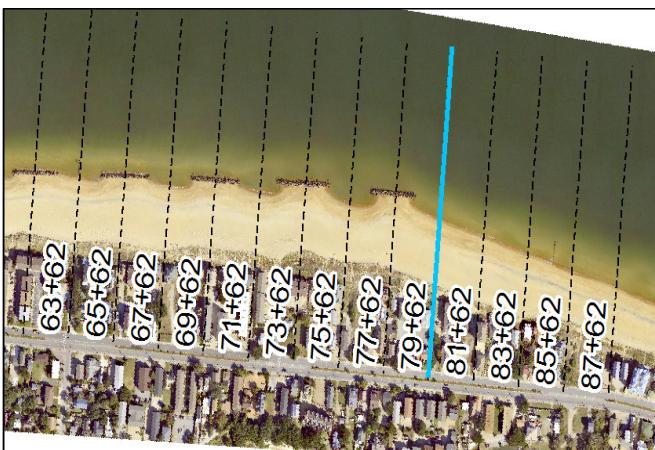
Survey Transect 79+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	169.68 ft/yr	22.83 ft
Volume Change Above -15 ft NAVD88	52.59 cy/ft/yr	10.77 cy/ft
Volume Change Above 0 ft NAVD88	21.54 cy/ft/yr	3.66 cy/ft

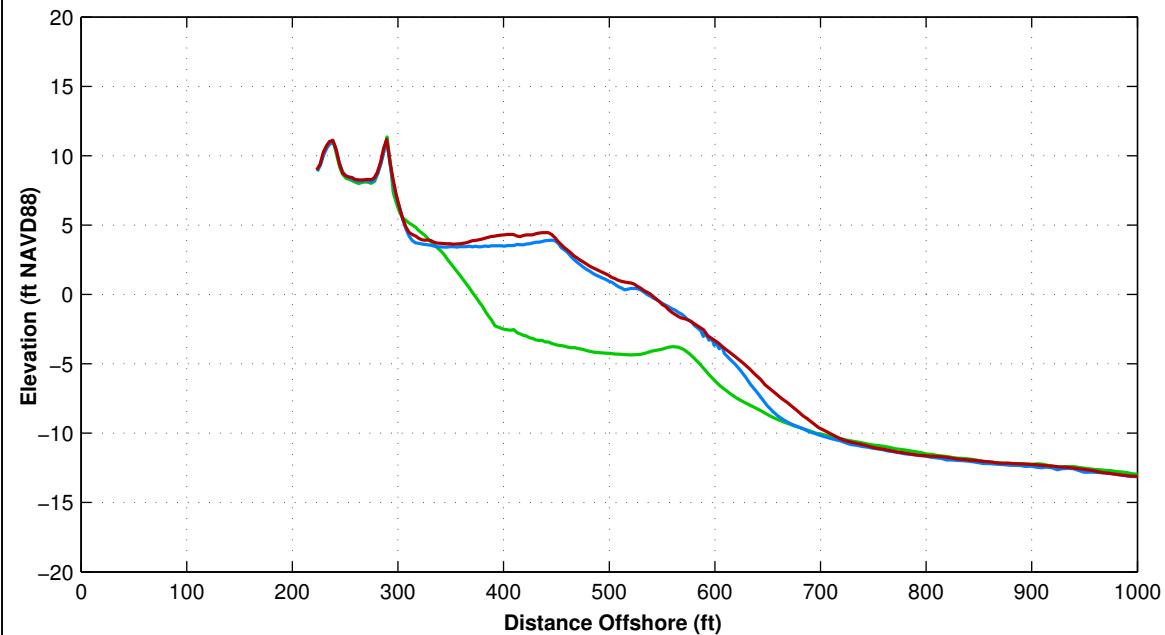
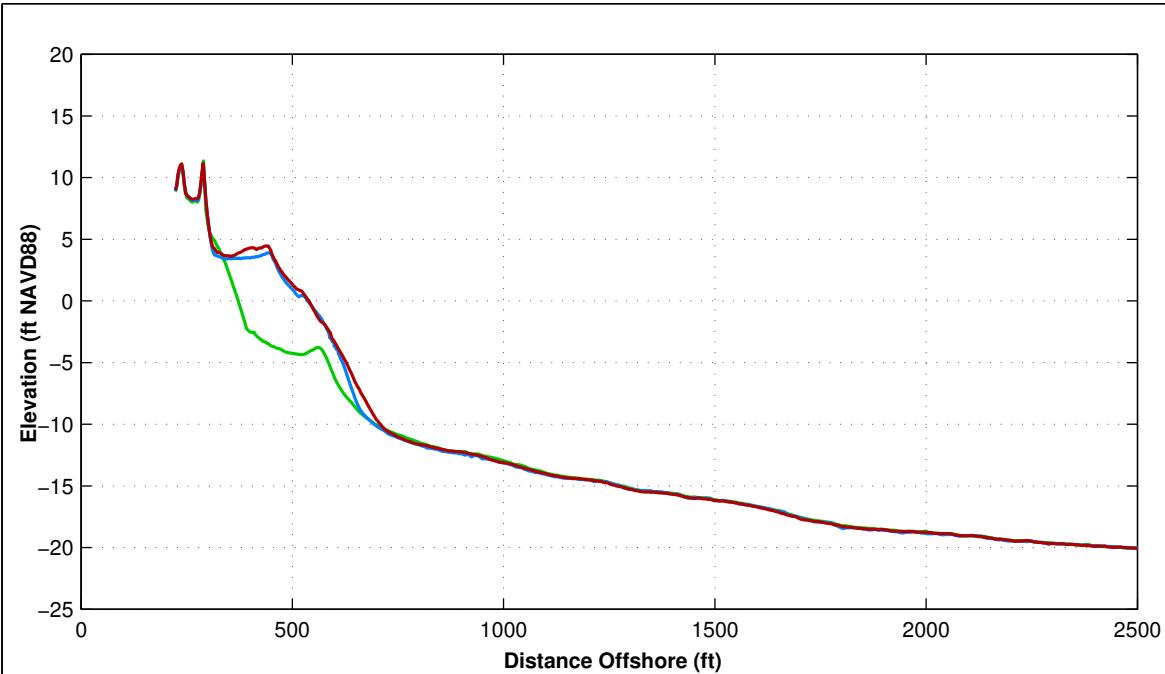
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
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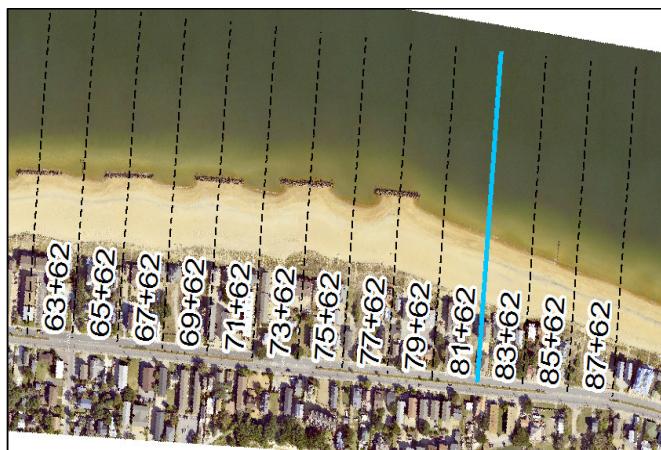
Survey Transect 81+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	148.47 ft/yr	11.25 ft
Volume Change Above -15 ft NAVD88	53.47 cy/ft/yr	8.96 cy/ft
Volume Change Above 0 ft NAVD88	20.66 cy/ft/yr	3.88 cy/ft

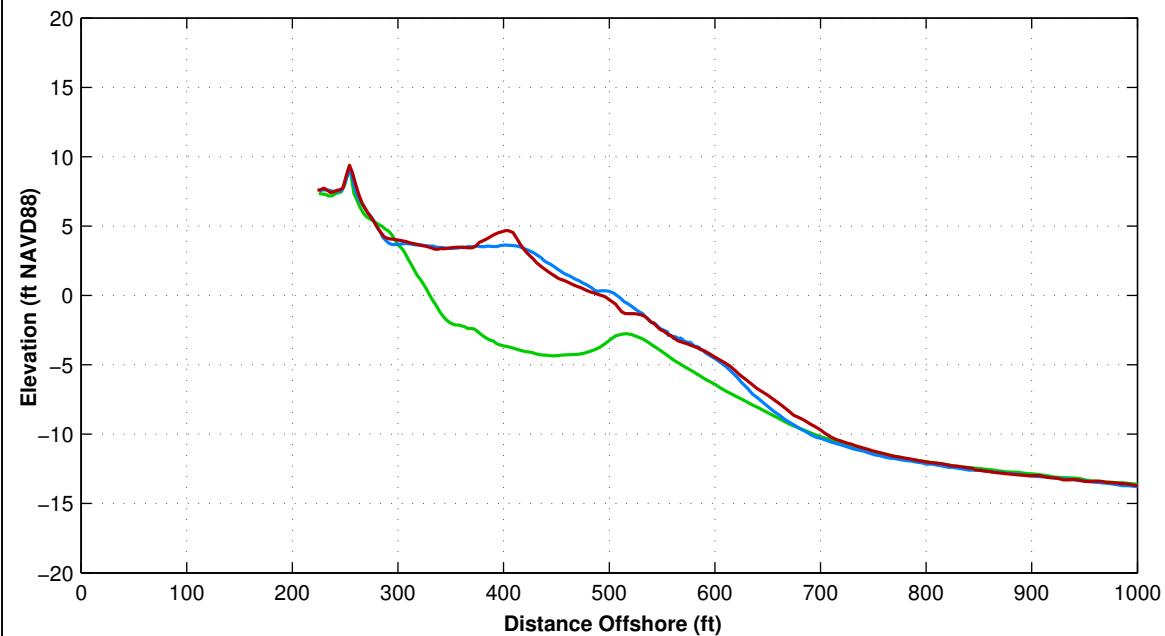
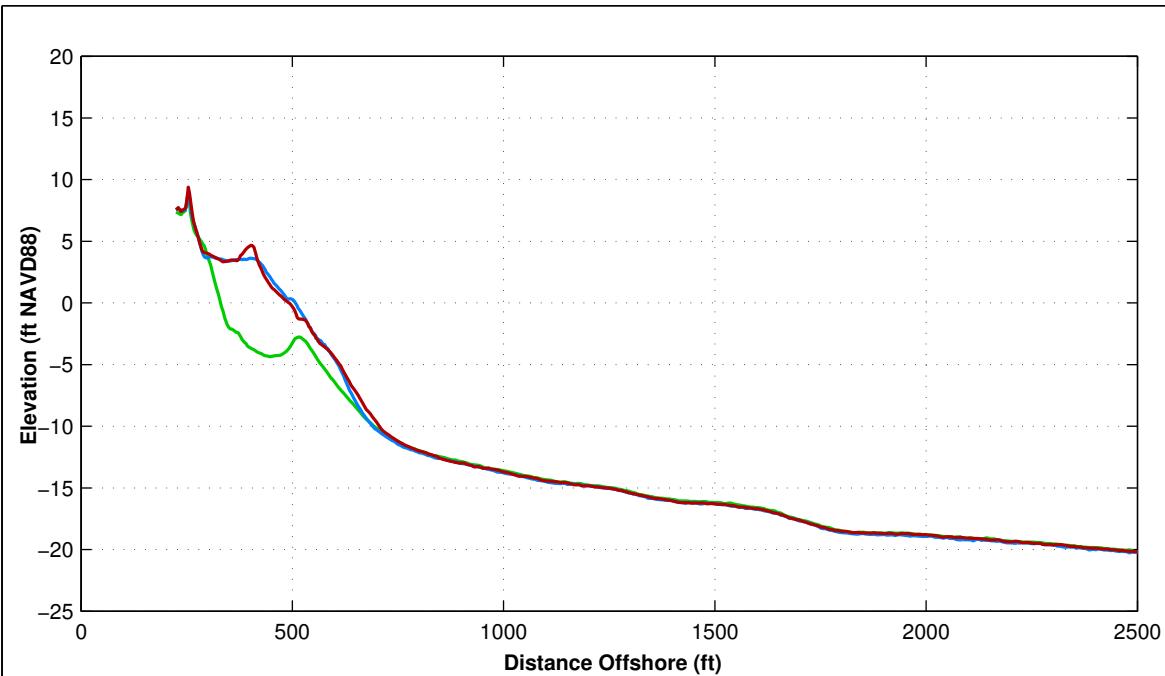
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
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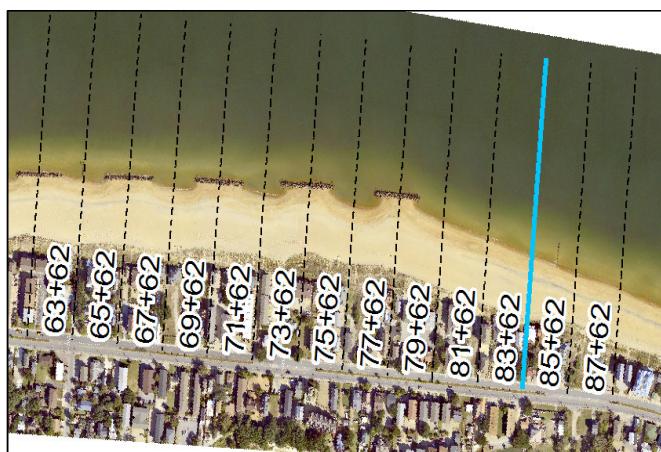


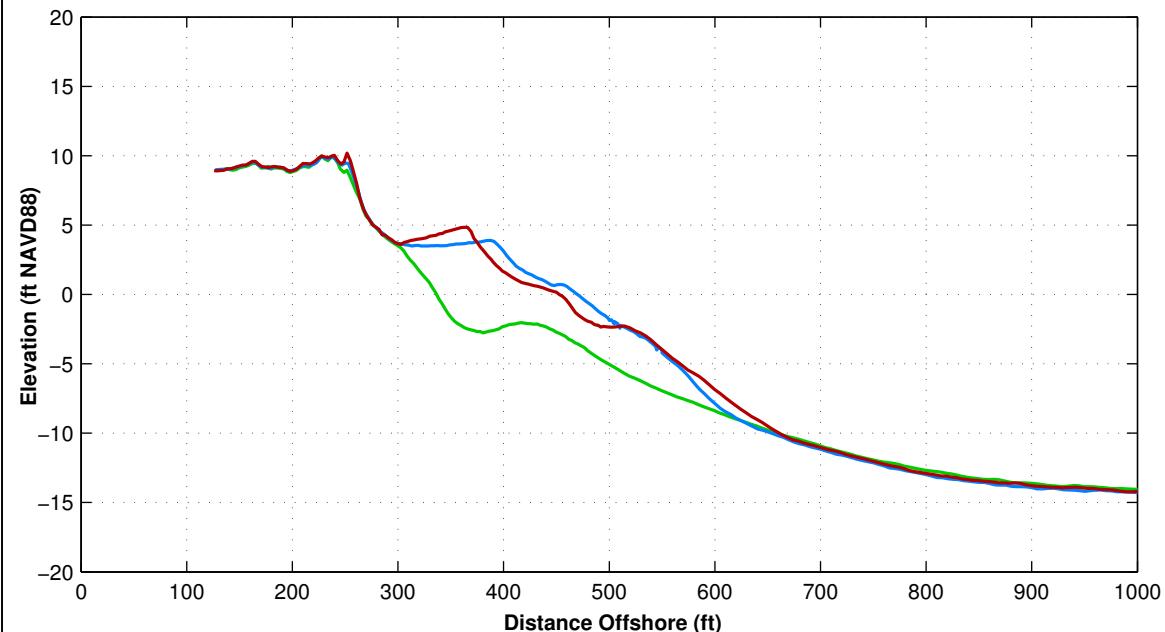
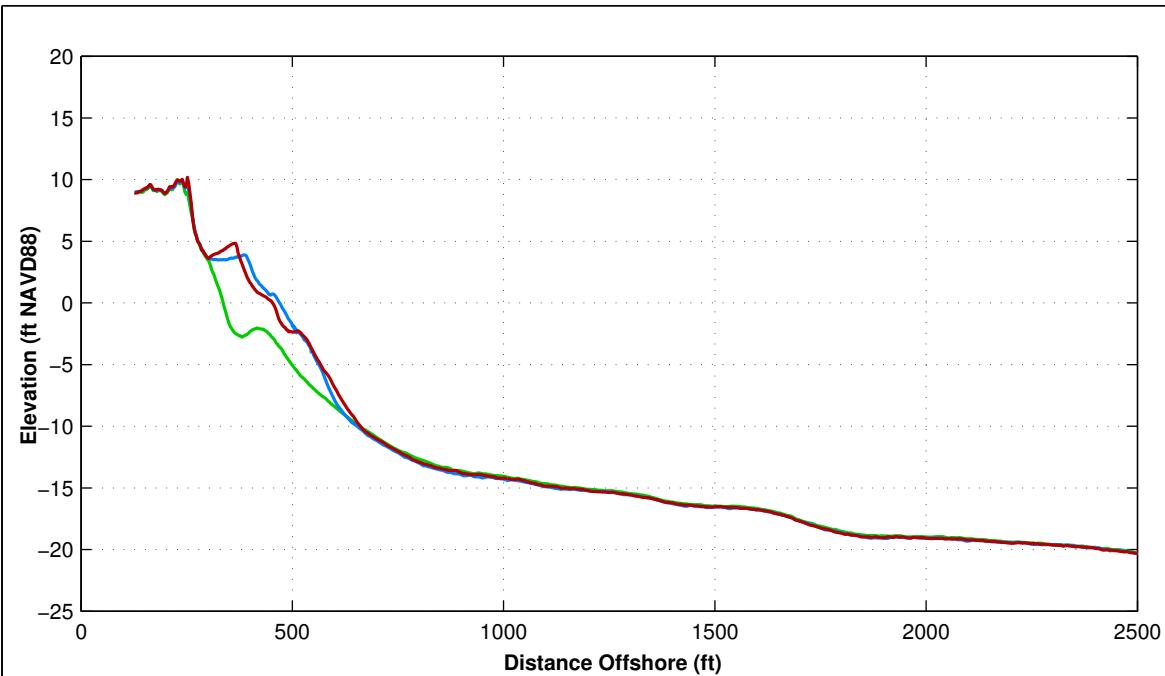


Survey Transect 83+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	138.17 ft/yr	-13.17 ft
Volume Change Above -15 ft NAVD88	49.96 cy/ft/yr	3.13 cy/ft
Volume Change Above 0 ft NAVD88	18.72 cy/ft/yr	0.11 cy/ft

Notes:

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4. Survey Comparison Made to OCT 2016 and MAY 2017
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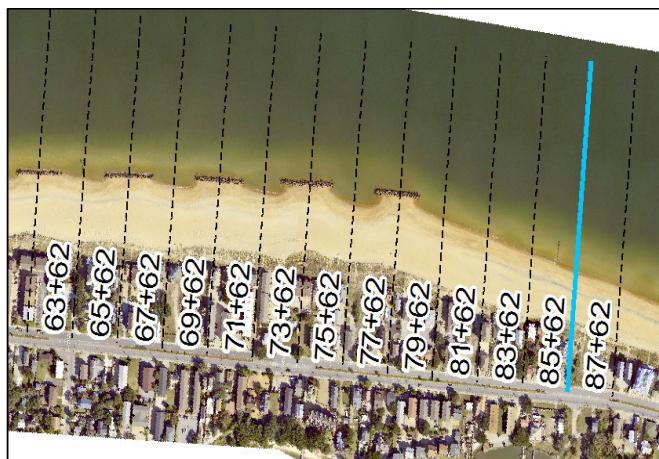
Survey Transect 85+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	86.38 ft/yr	-24.41 ft
Volume Change Above -15 ft NAVD88	37.38 cy/ft/yr	2.57 cy/ft
Volume Change Above 0 ft NAVD88	14.36 cy/ft/yr	-0.56 cy/ft

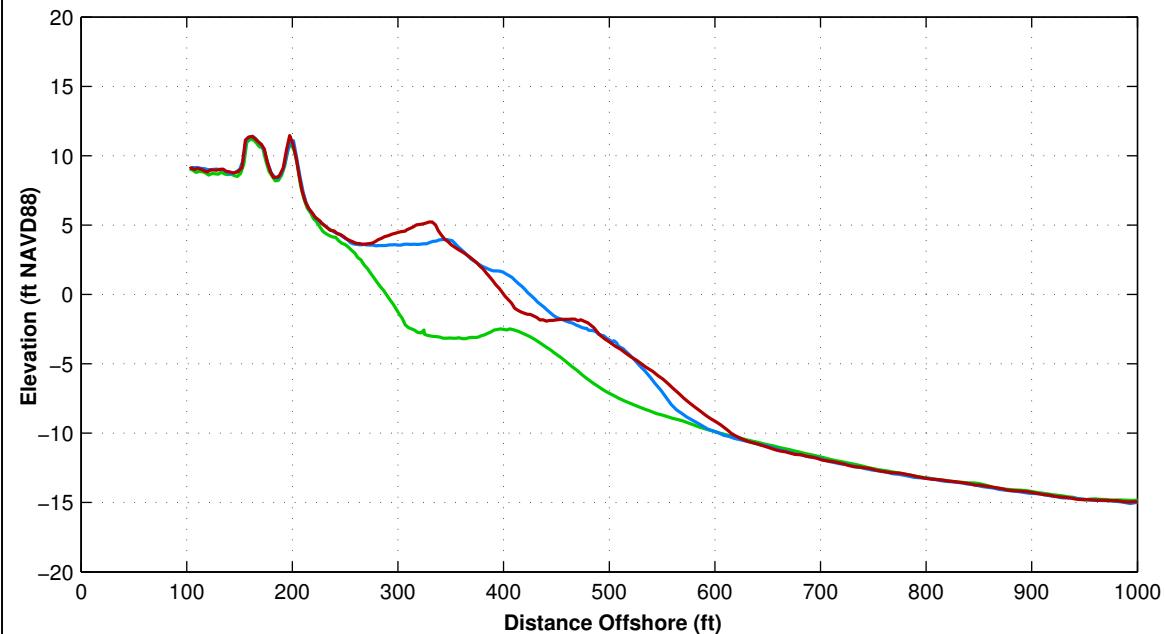
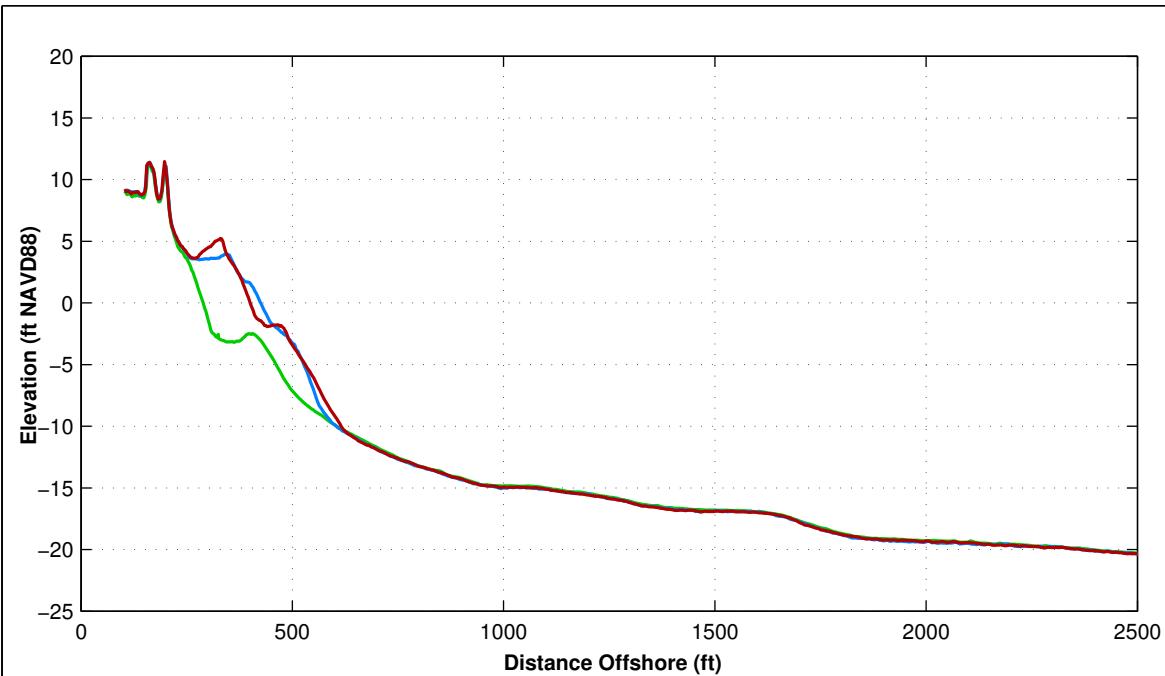
LEGEND:

OCT 2017 — Red Line
MAY 2017 — Blue Line
OCT 2016 — Green Line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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4. Survey Comparison Made To OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





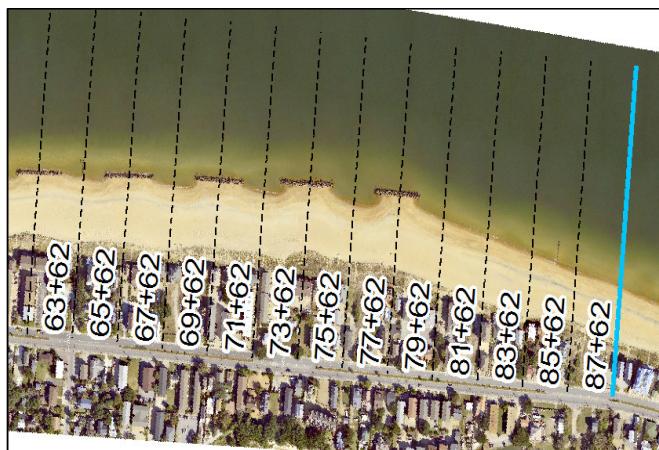
Survey Transect 87+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	111.17 ft/yr	-21.50 ft
Volume Change Above -15 ft NAVD88	47.19 cy/ft/yr	2.57 cy/ft
Volume Change Above 0 ft NAVD88	18.63 cy/ft/yr	0.88 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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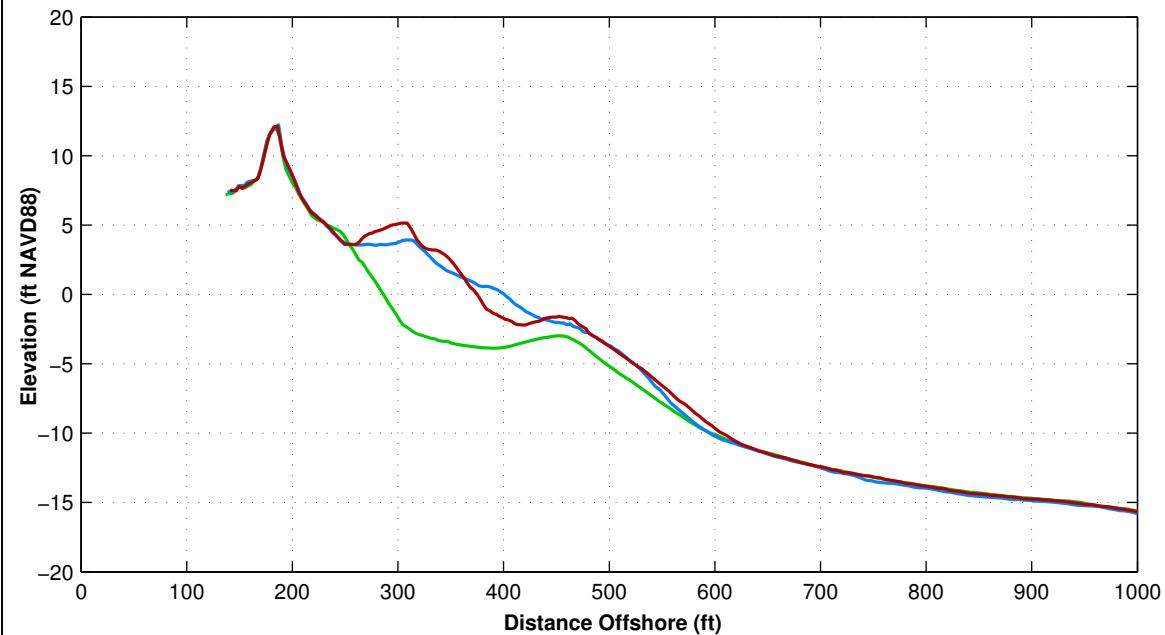
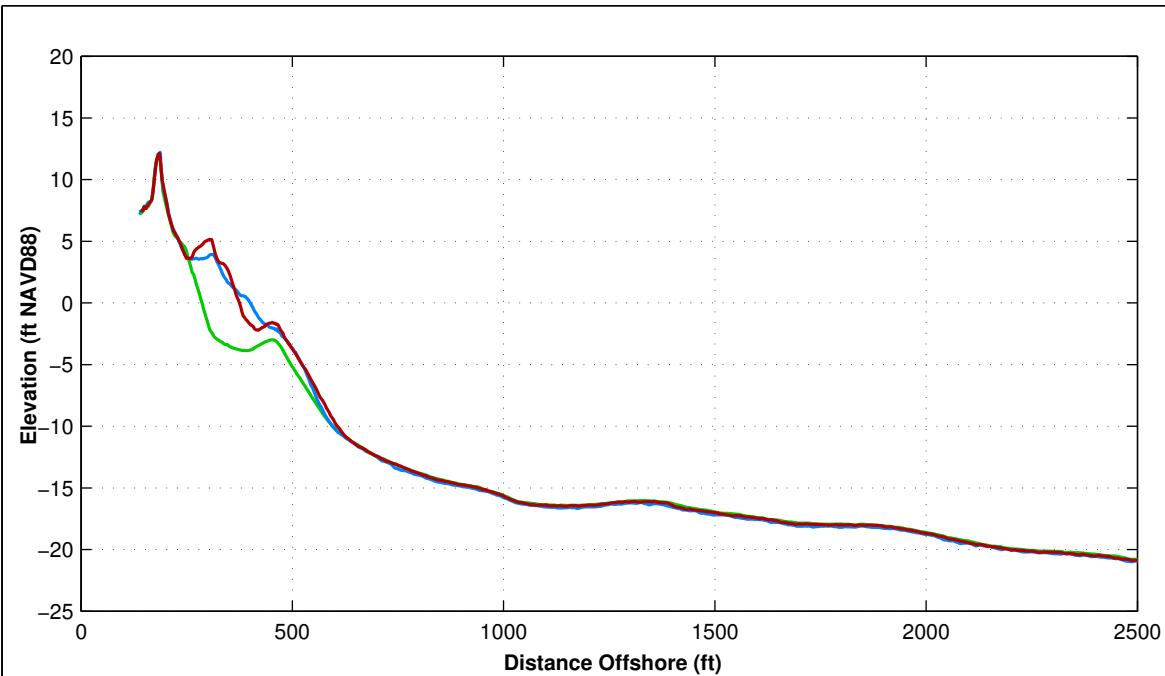
THE CITY OF
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PUBLIC WORKS

ST 87+62

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SURVEYING DATA &
ANALYSIS

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Fall 2017



Survey Transect 93+41	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	86.80 ft/yr	-4.42 ft
Volume Change Above -15 ft NAVD88	34.87 cy/ft/yr	3.72 cy/ft
Volume Change Above 0 ft NAVD88	13.59 cy/ft/yr	2.24 cy/ft

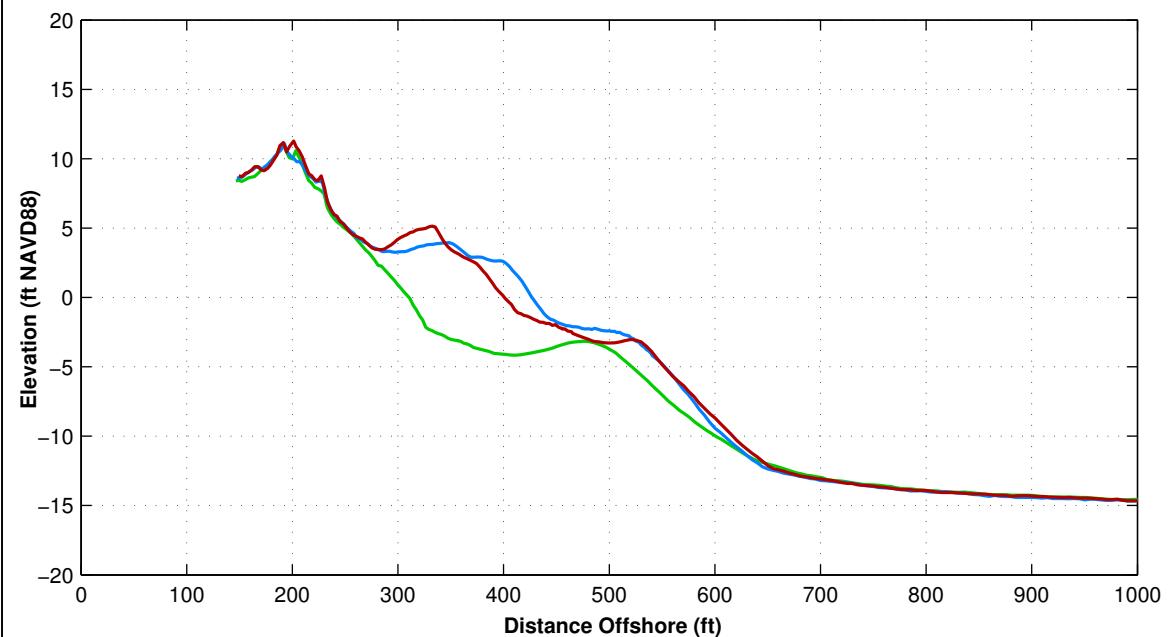
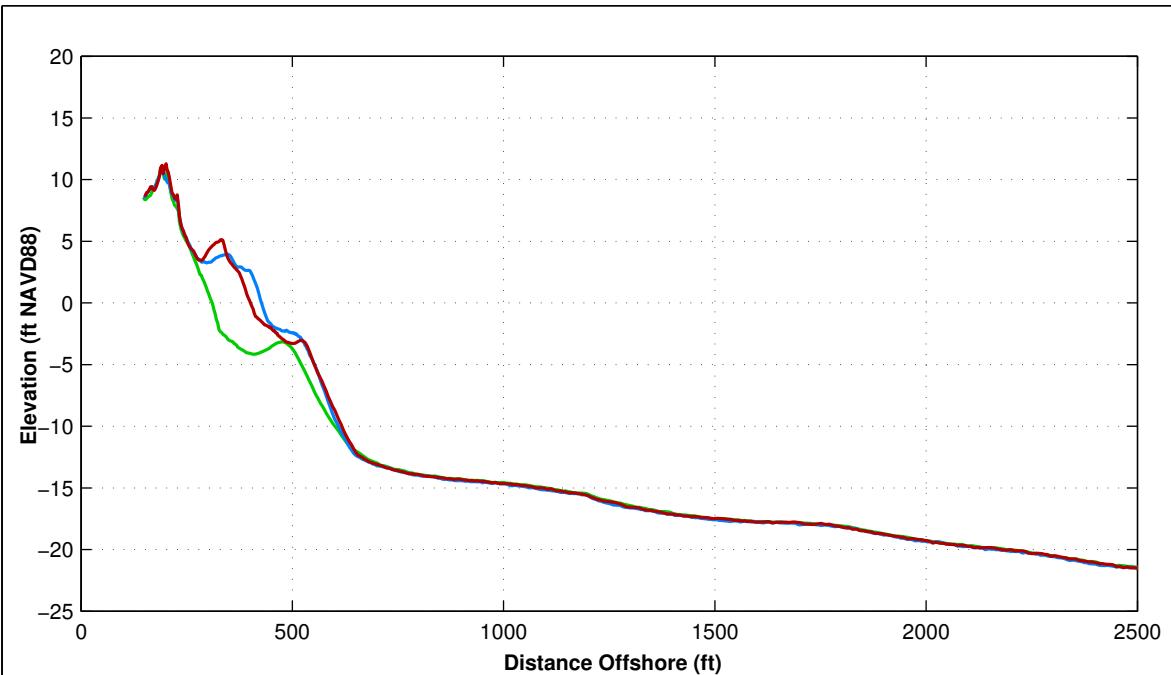
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

1. Station From West To East At Varying Intervals.
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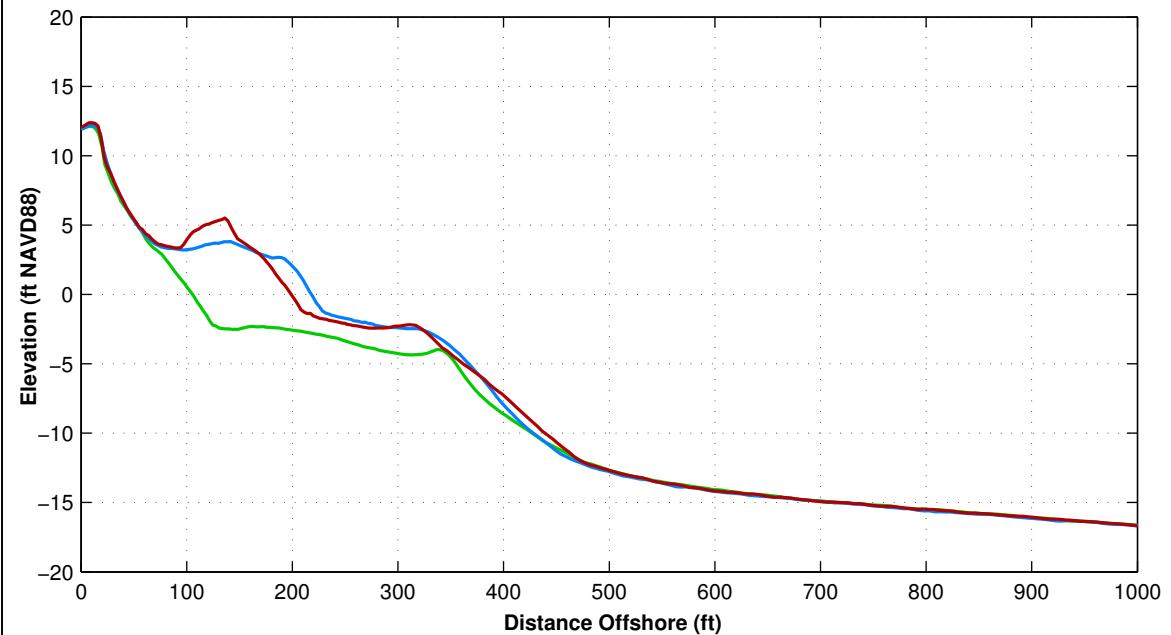
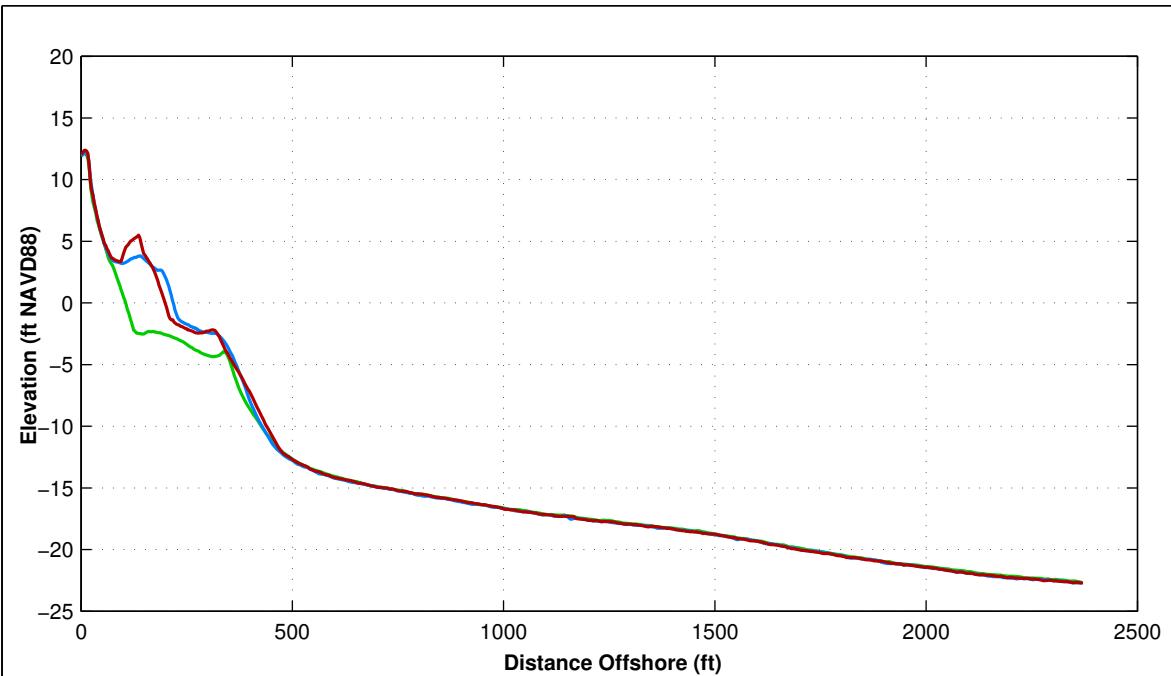




Notes:

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Survey Transect 120+93	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	93.86 ft/yr	-21.54 ft
Volume Change Above -15 ft NAVD88	34.87 cy/ft/yr	1.36 cy/ft
Volume Change Above 0 ft NAVD88	15.93 cy/ft/yr	1.16 cy/ft

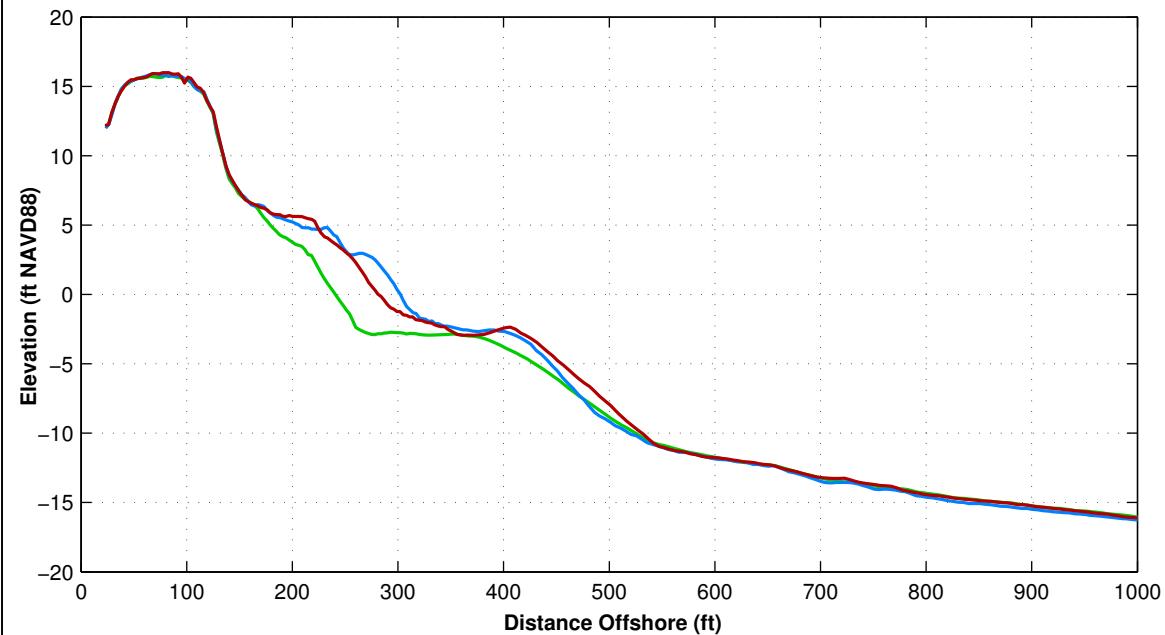
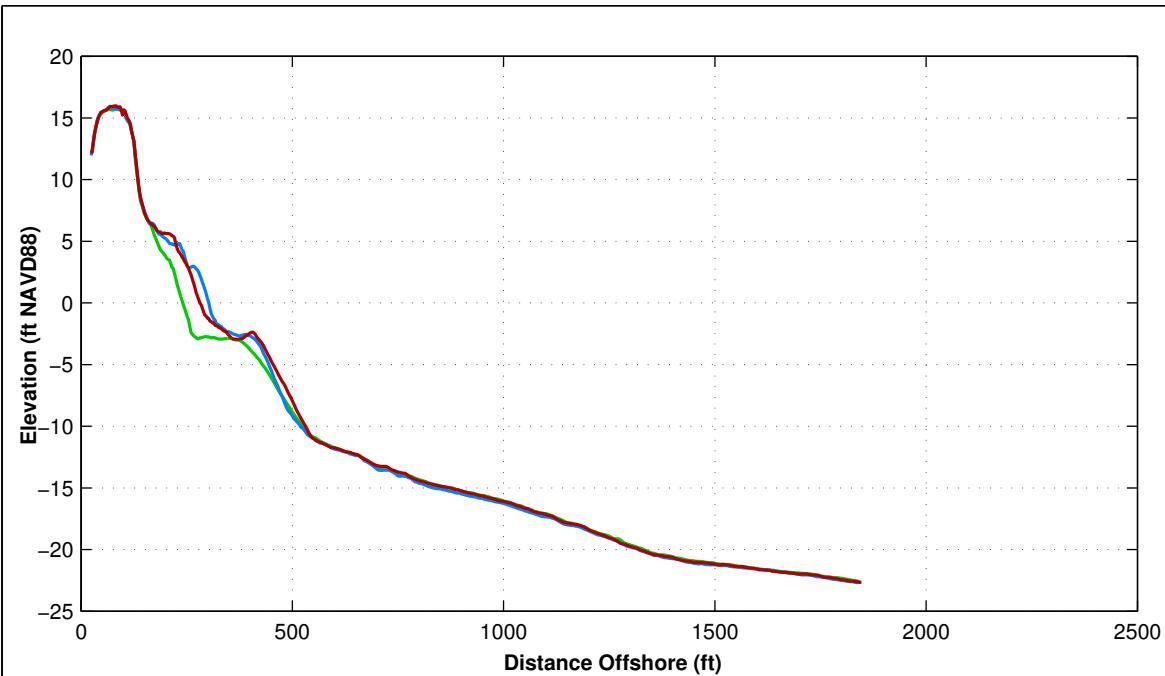
LEGEND:

OCT 2017 — Red Line
MAY 2017 — Blue Line
OCT 2016 — Green Line

Notes:

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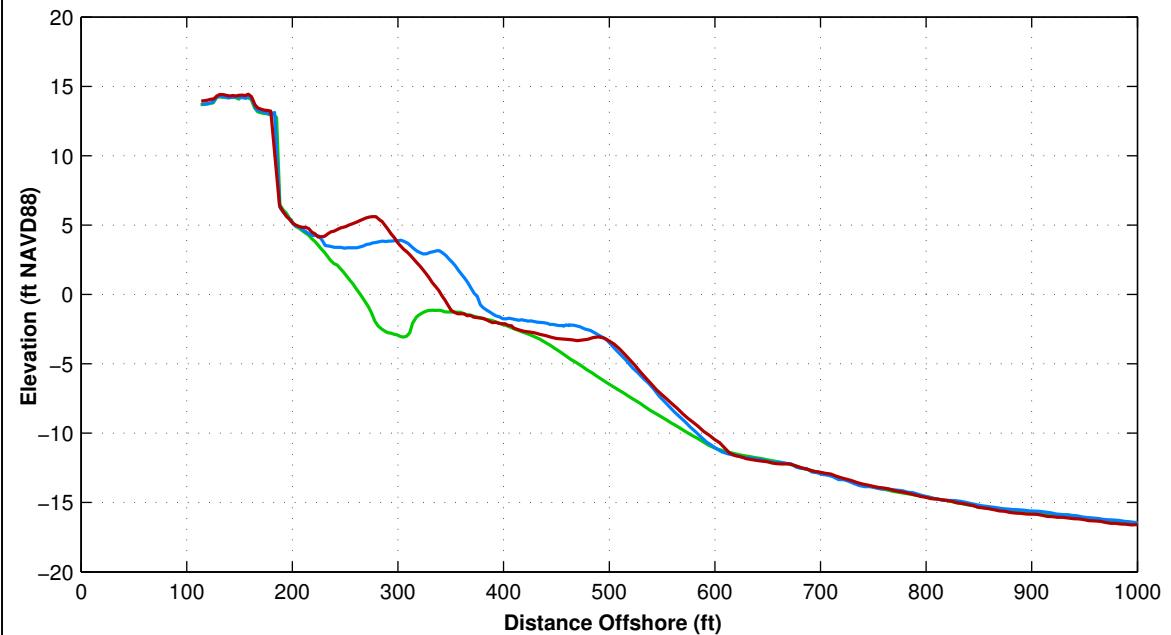
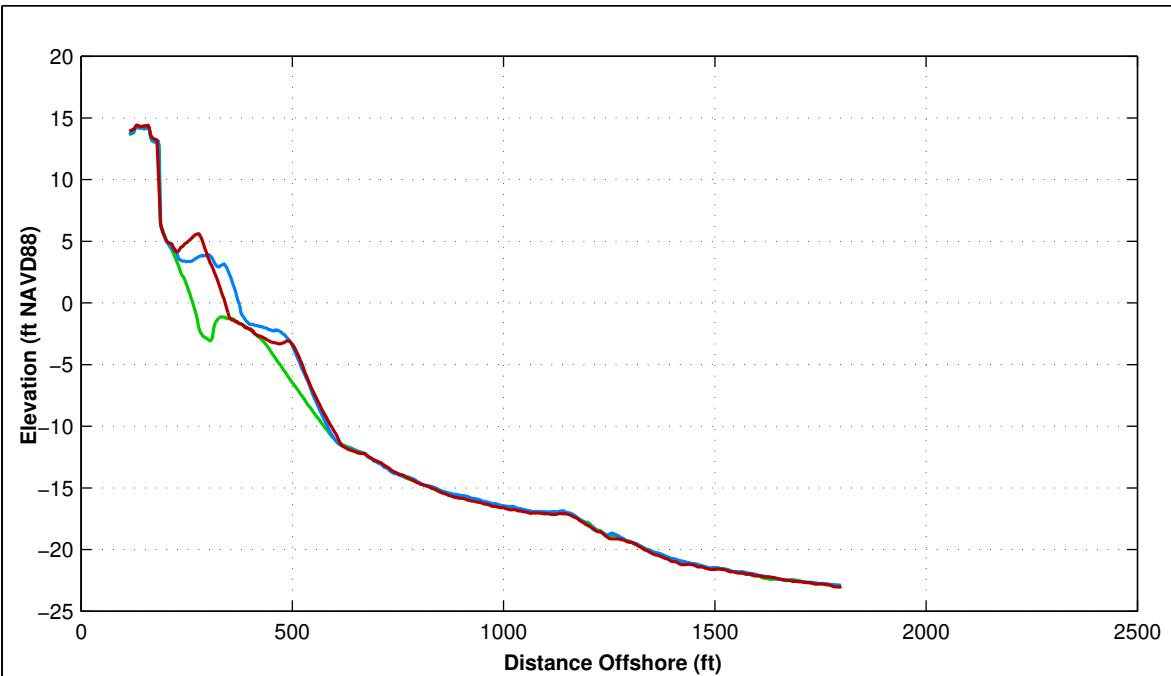
Survey Transect	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
129+17		
Shoreline Change at MHW (0.98 ft NAVD88)	39.80 ft/yr	-22.82 ft
Volume Change Above -15 ft NAVD88	21.77 cy/ft/yr	2.50 cy/ft
Volume Change Above 0 ft NAVD88	9.20 cy/ft/yr	-1.82 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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Survey Transect 141+98	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	76.95 ft/yr	-33.44 ft
Volume Change Above -15 ft NAVD88	30.47 cy/ft/yr	-3.57 cy/ft
Volume Change Above 0 ft NAVD88	14.03 cy/ft/yr	-0.43 cy/ft

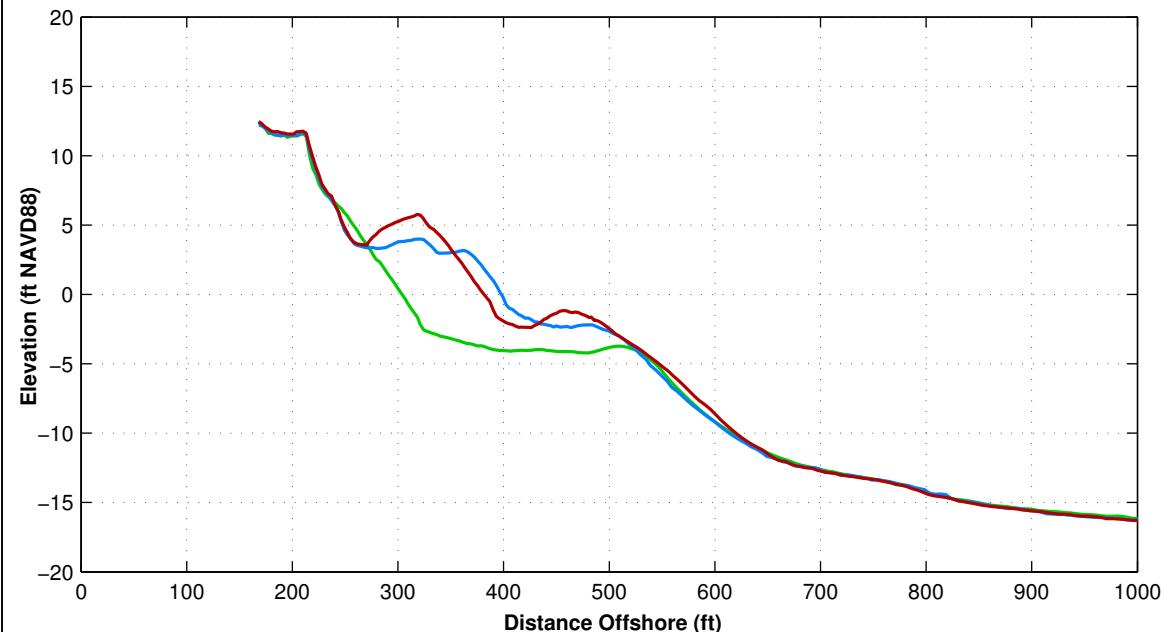
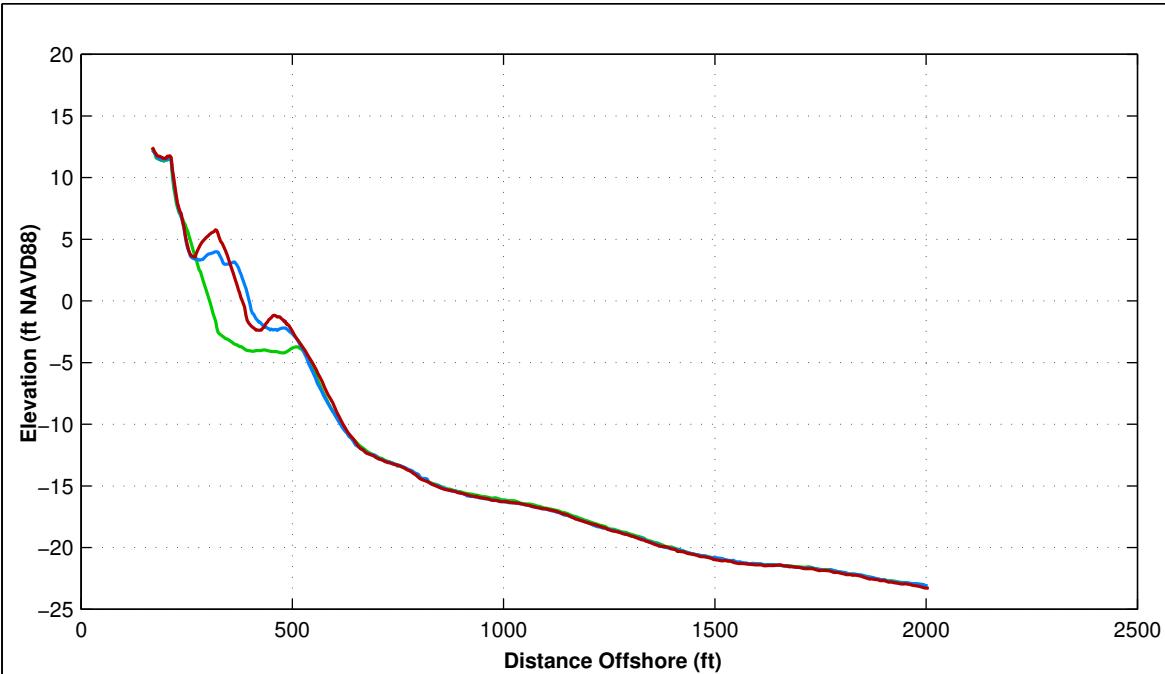
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

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Survey Transect	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
152+01		
Shoreline Change at MHW (0.98 ft NAVD88)	76.98 ft/yr	-18.66 ft
Volume Change Above -15 ft NAVD88	33.71 cy/ft/yr	4.62 cy/ft
Volume Change Above 0 ft NAVD88	13.84 cy/ft/yr	2.43 cy/ft

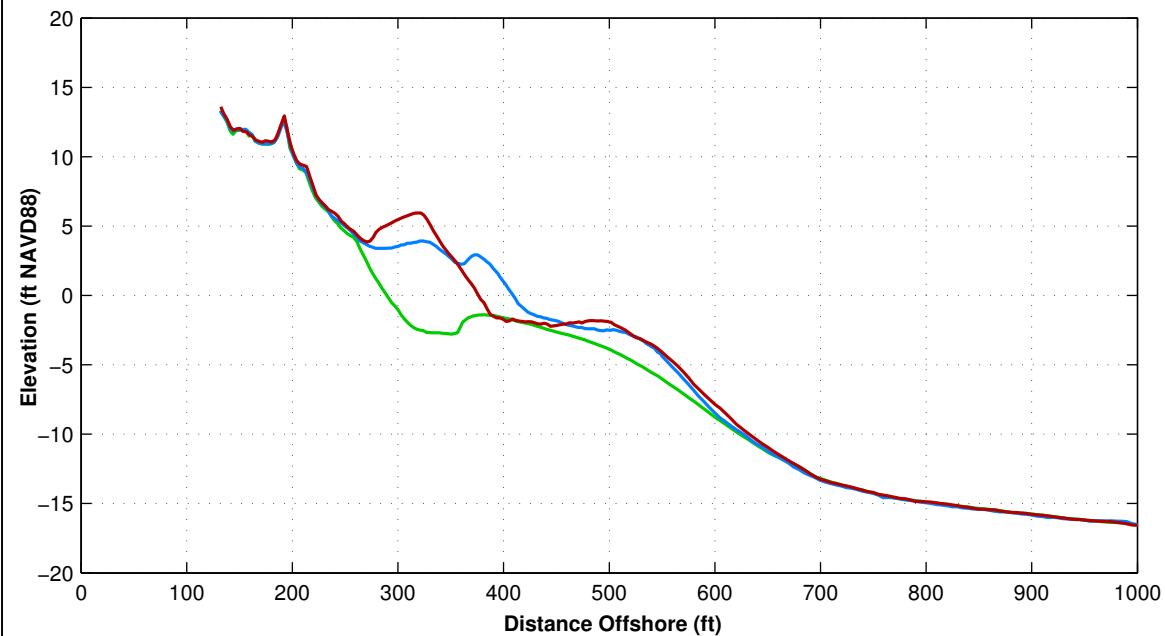
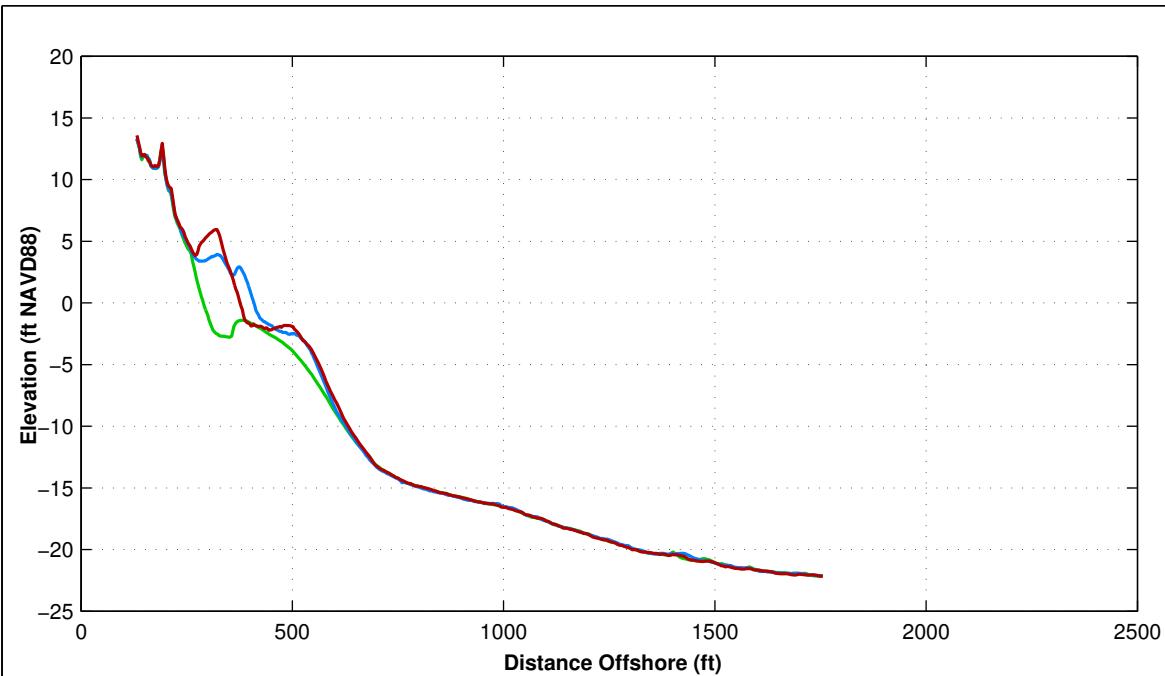
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

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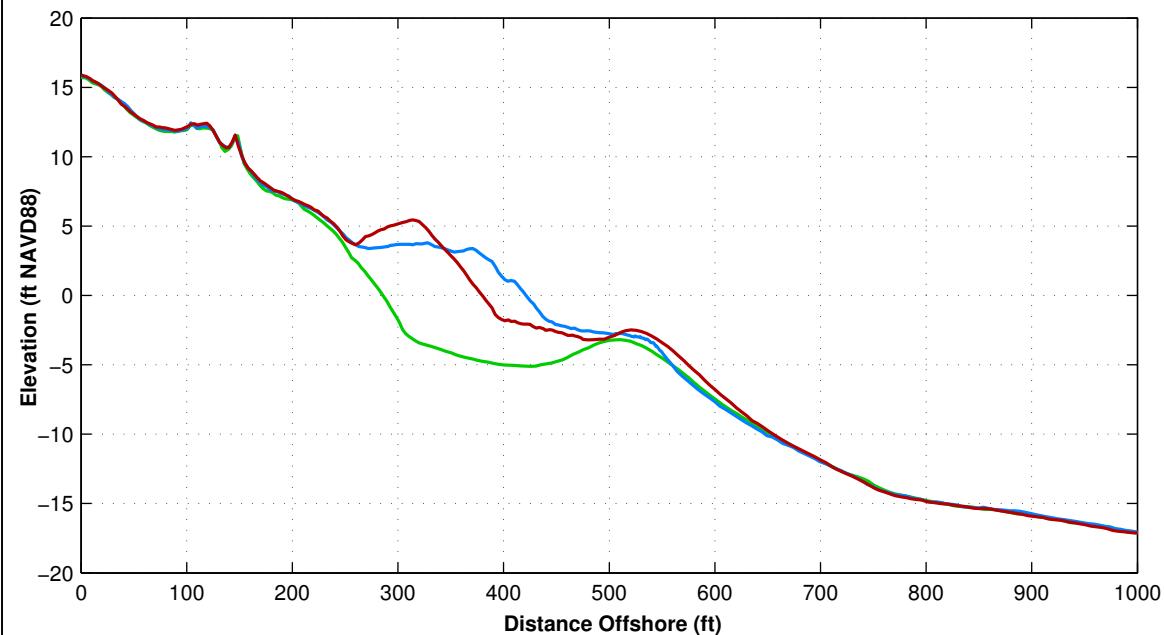
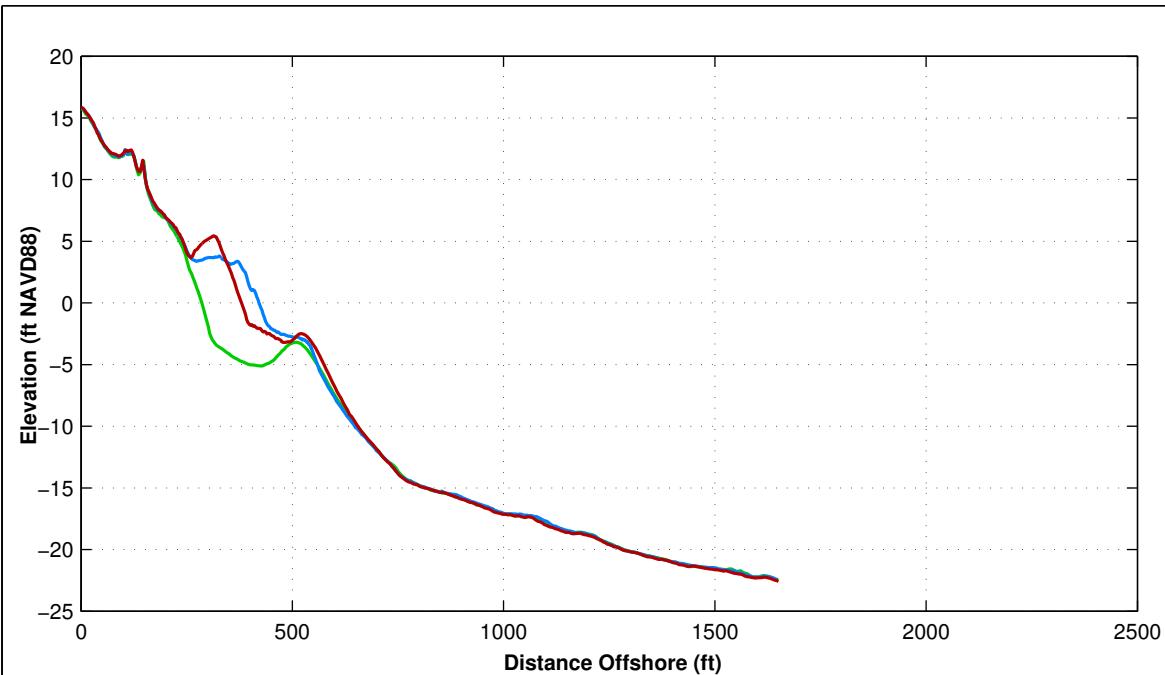
THE CITY OF
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PUBLIC WORKS

ST 163+49

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Fall 2017



Survey Transect 169+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	93.60 ft/yr	-41.35 ft
Volume Change Above -15 ft NAVD88	43.38 cy/ft/yr	-0.98 cy/ft
Volume Change Above 0 ft NAVD88	17.99 cy/ft/yr	-0.39 cy/ft

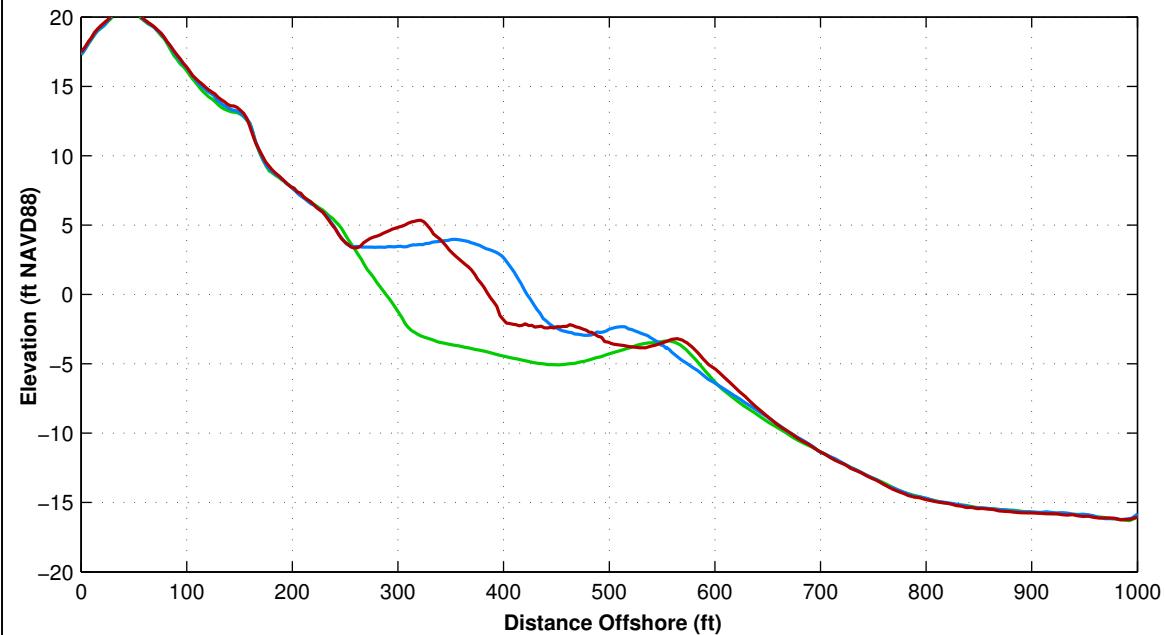
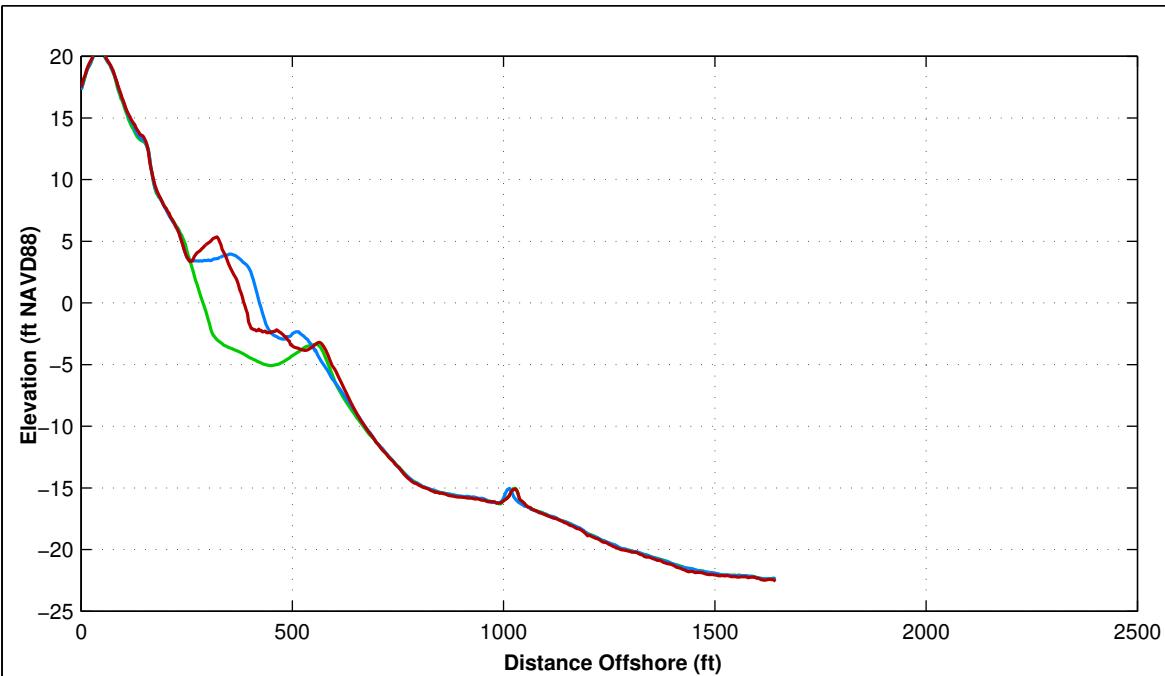
LEGEND:

- OCT 2017 — Red line
- MAY 2017 — Blue line
- OCT 2016 — Green line

Notes:

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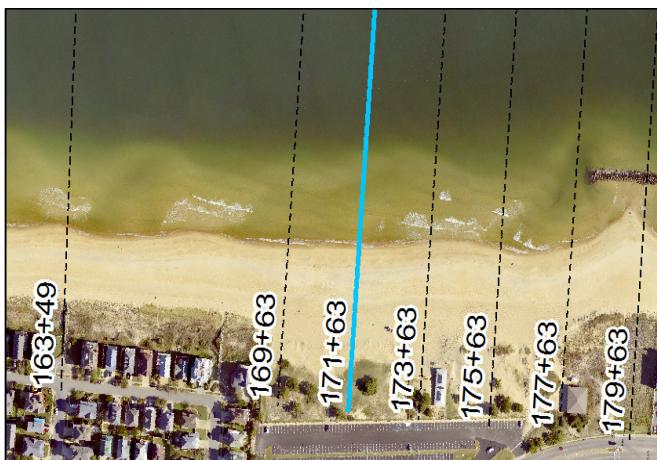
Survey Transect 171+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	98.29 ft/yr	-38.14 ft
Volume Change Above -15 ft NAVD88	40.43 cy/ft/yr	-3.66 cy/ft
Volume Change Above 0 ft NAVD88	16.63 cy/ft/yr	-1.72 cy/ft

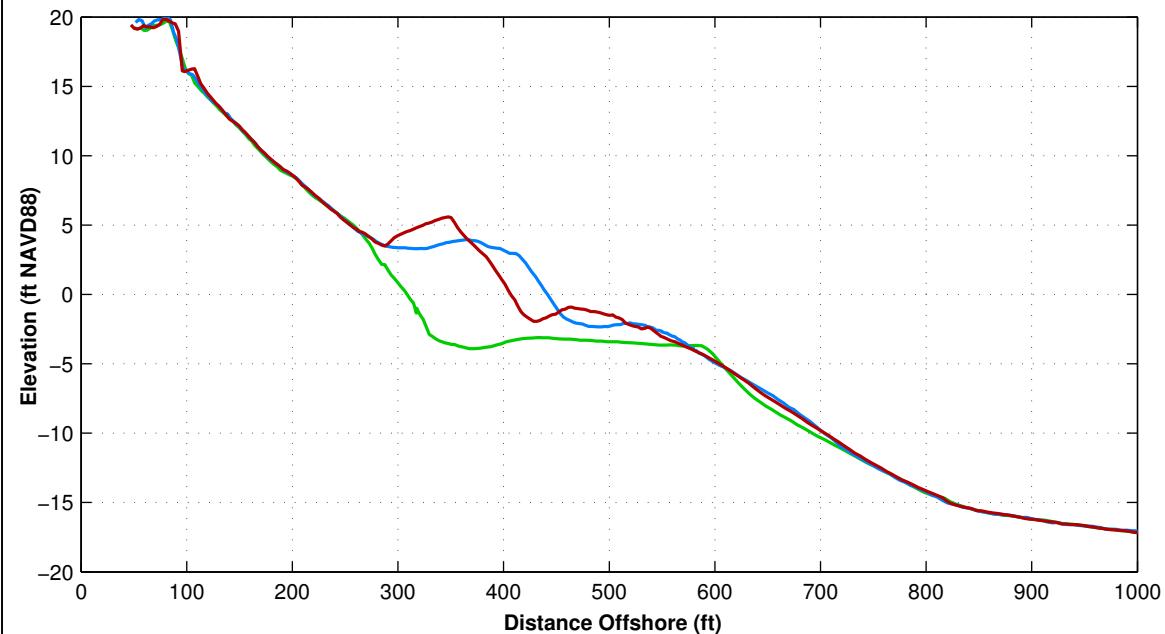
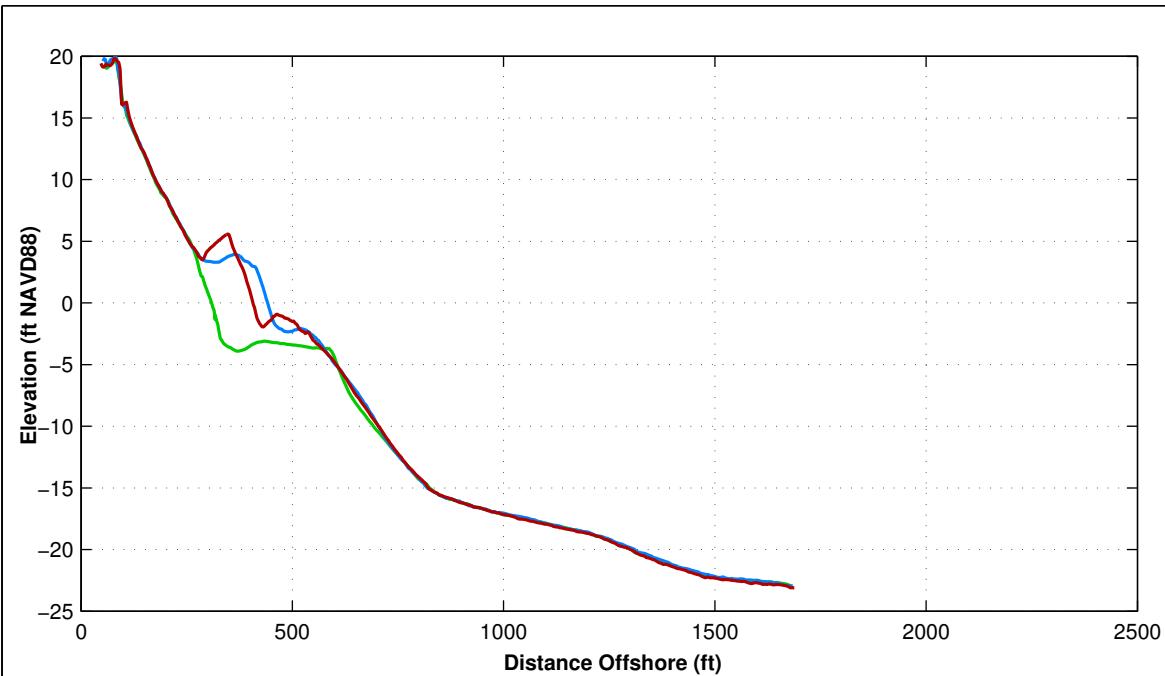
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

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Survey Transect	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
173+63		
Shoreline Change at MHW (0.98 ft NAVD88)	101.16 ft/yr	-33.69 ft
Volume Change Above -15 ft NAVD88	41.33 cy/ft/yr	-1.29 cy/ft
Volume Change Above 0 ft NAVD88	18.19 cy/ft/yr	-0.52 cy/ft

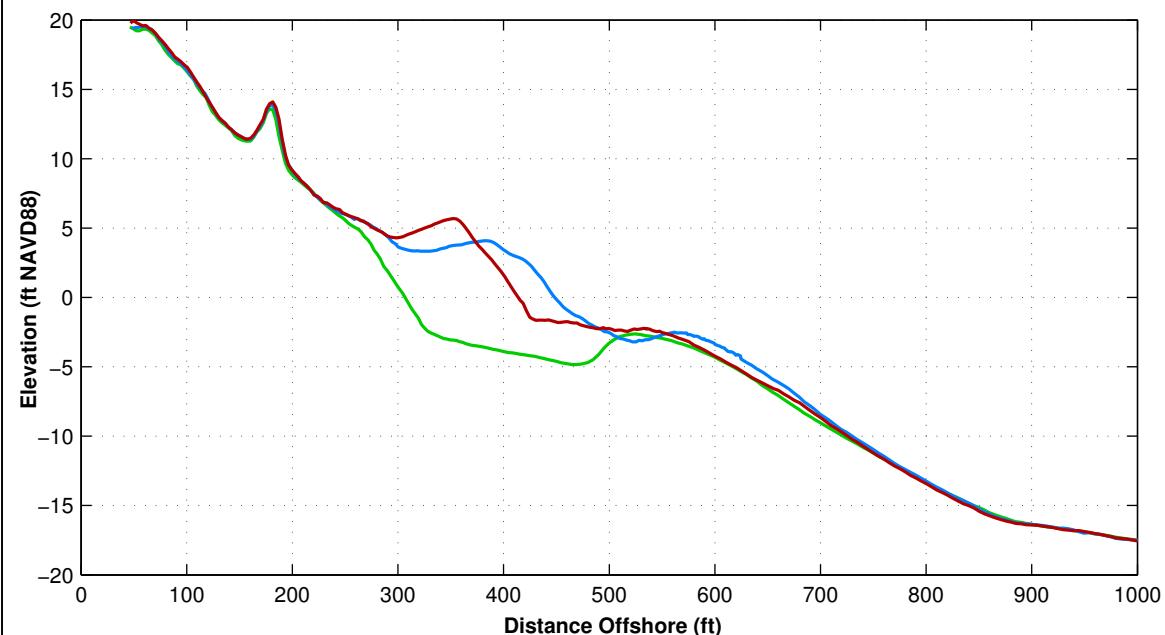
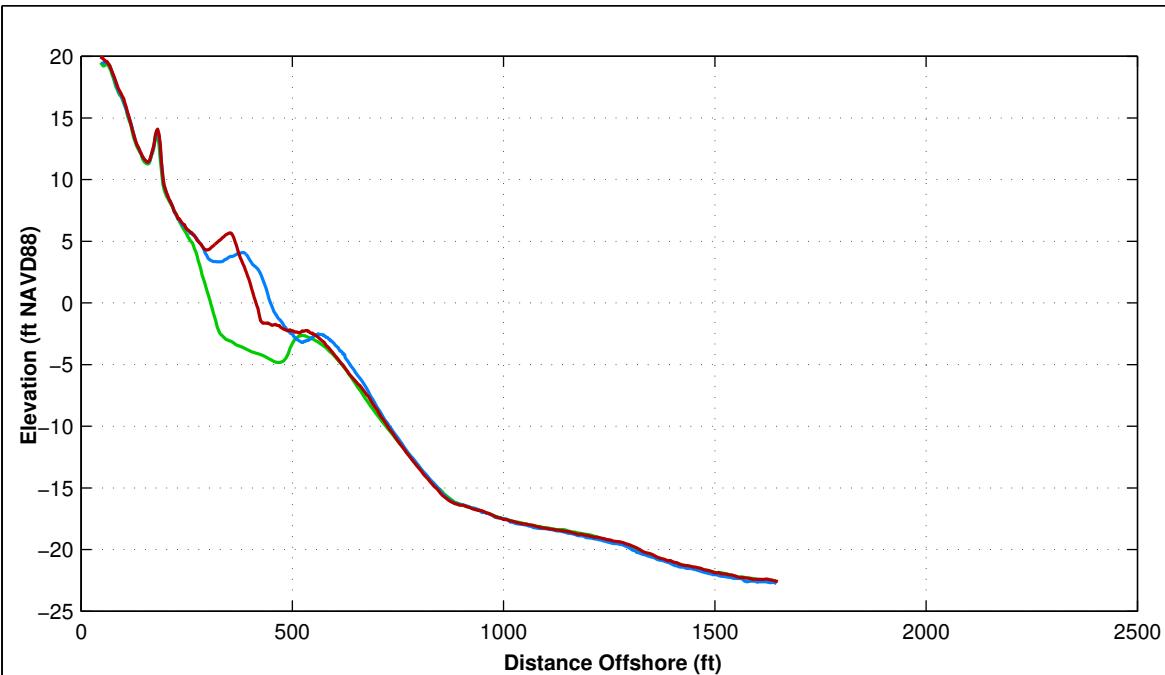
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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4. Survey Comparison Made to OCT 2016 and MAY 2017
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Survey Transect	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
175+63		
Shoreline Change at MHW (0.98 ft NAVD88)	107.92 ft/yr	-34.19 ft
Volume Change Above -15 ft NAVD88	44.76 cy/ft/yr	-5.68 cy/ft
Volume Change Above 0 ft NAVD88	21.95 cy/ft/yr	0.33 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

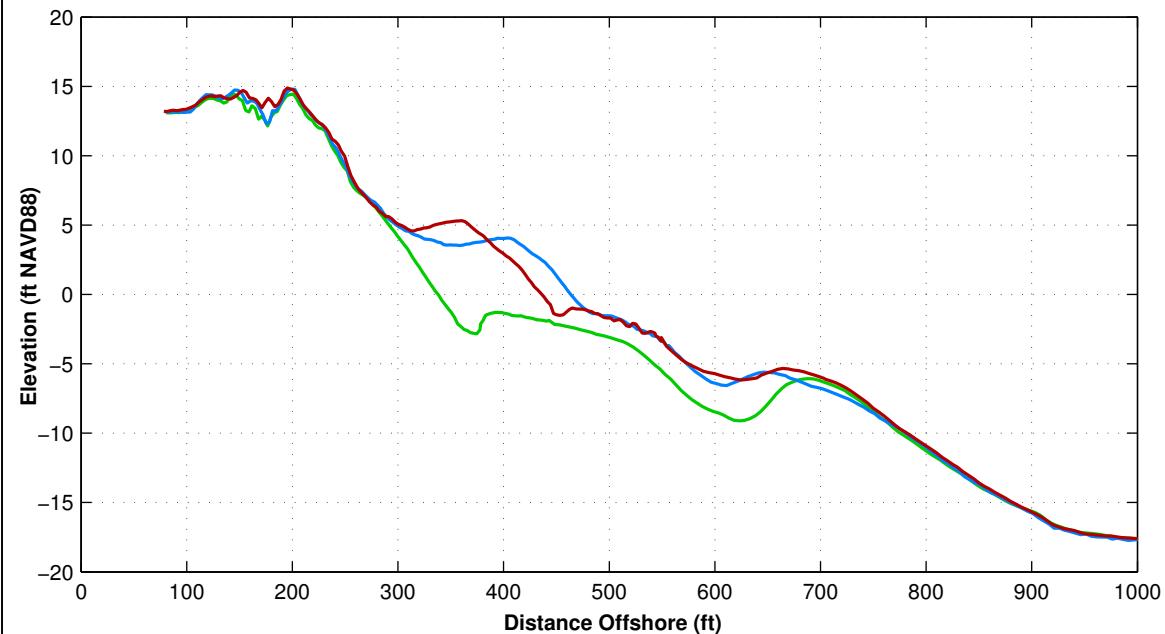
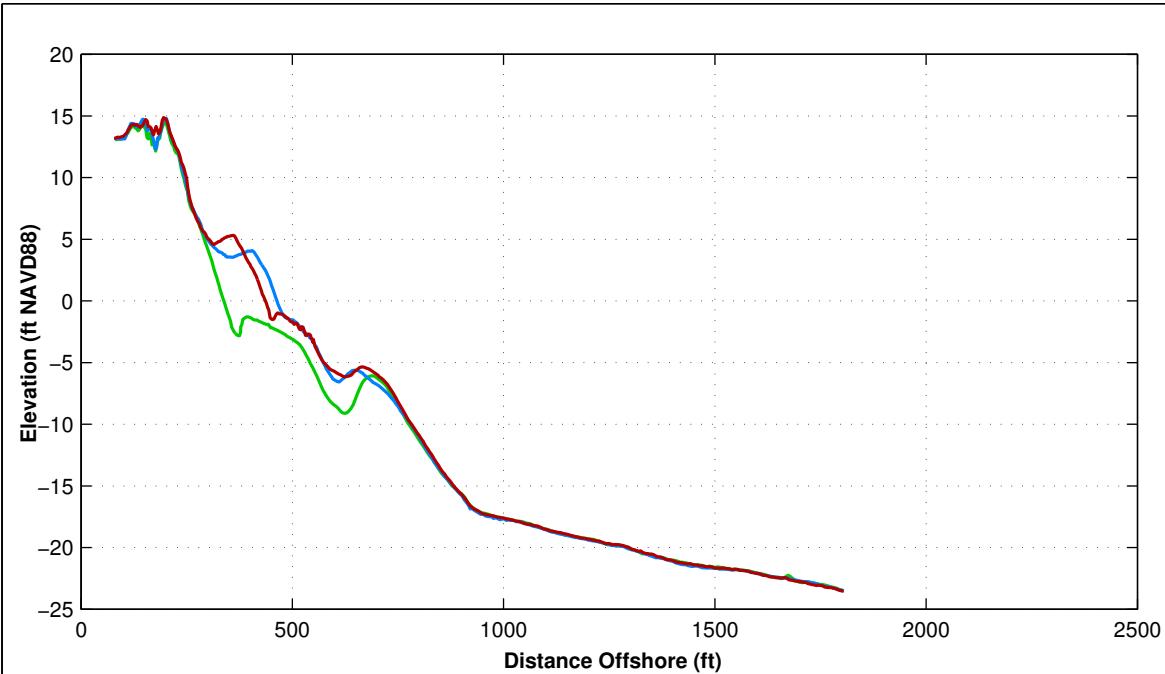
Notes:

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Survey Transect 177+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	96.68 ft/yr	-28.66 ft
Volume Change Above -15 ft NAVD88	45.51 cy/ft/yr	2.35 cy/ft
Volume Change Above 0 ft NAVD88	19.86 cy/ft/yr	-0.03 cy/ft

LEGEND:

OCT 2017 — Red Line
MAY 2017 — Blue Line
OCT 2016 — Green Line

Notes:

1. Station From West To East At Varying Intervals.
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3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
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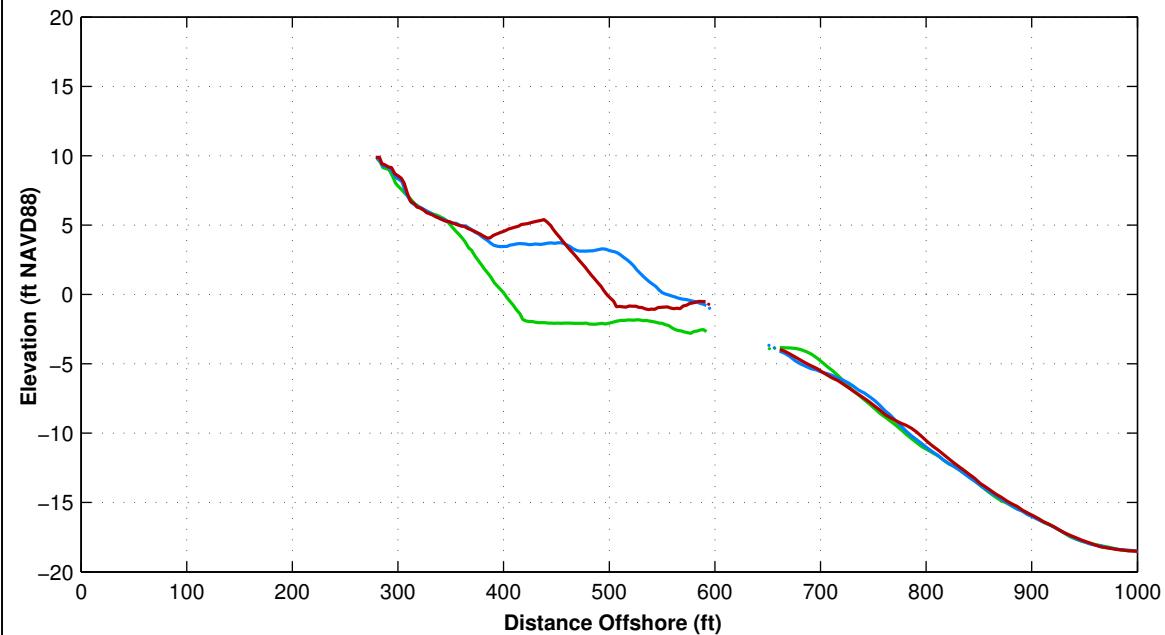
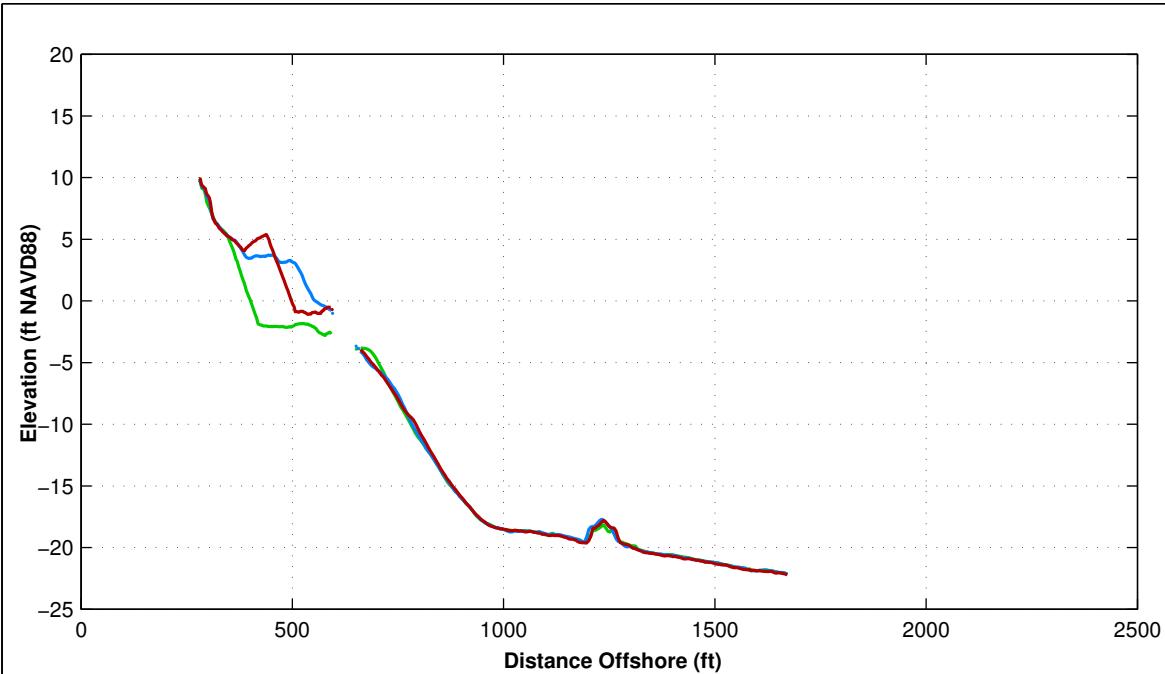
THE CITY OF
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PUBLIC WORKS

ST 177+63

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ANALYSIS

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Fall 2017



Survey Transect 179+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	98.09 ft/yr	-49.29 ft
Volume Change Above -15 ft NAVD88	29.27 cy/ft/yr	-4.02 cy/ft
Volume Change Above 0 ft NAVD88	17.39 cy/ft/yr	-2.46 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

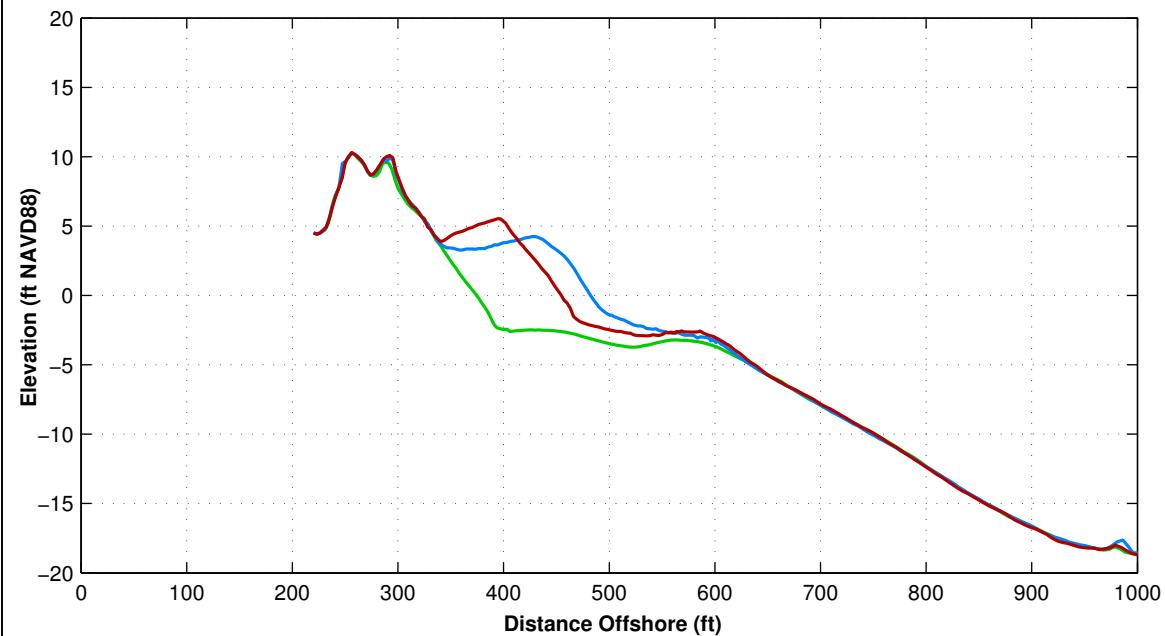
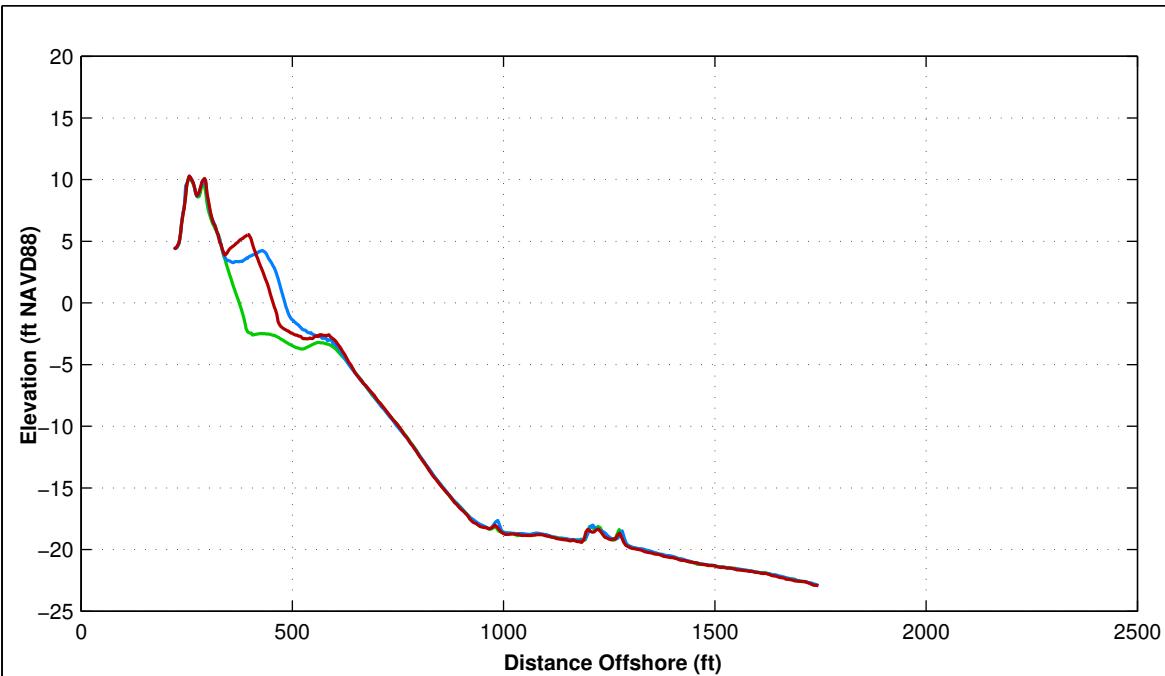
Notes:

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SURVEYING DATA &
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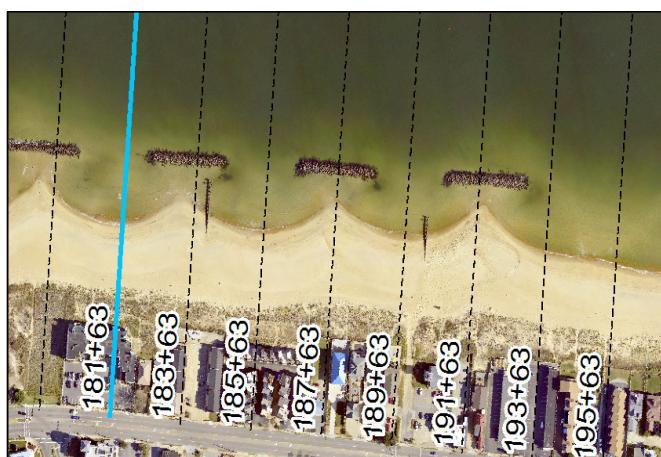
Survey Transect 181+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	82.32 ft/yr	-28.26 ft
Volume Change Above -15 ft NAVD88	26.95 cy/ft/yr	-3.61 cy/ft
Volume Change Above 0 ft NAVD88	14.97 cy/ft/yr	-0.84 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

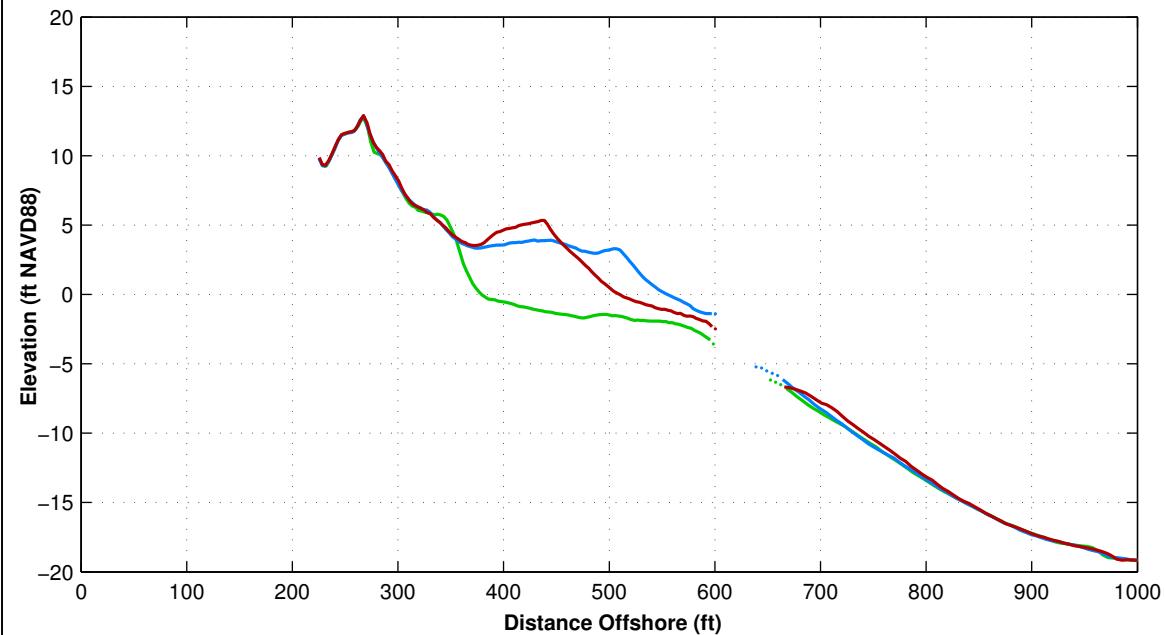
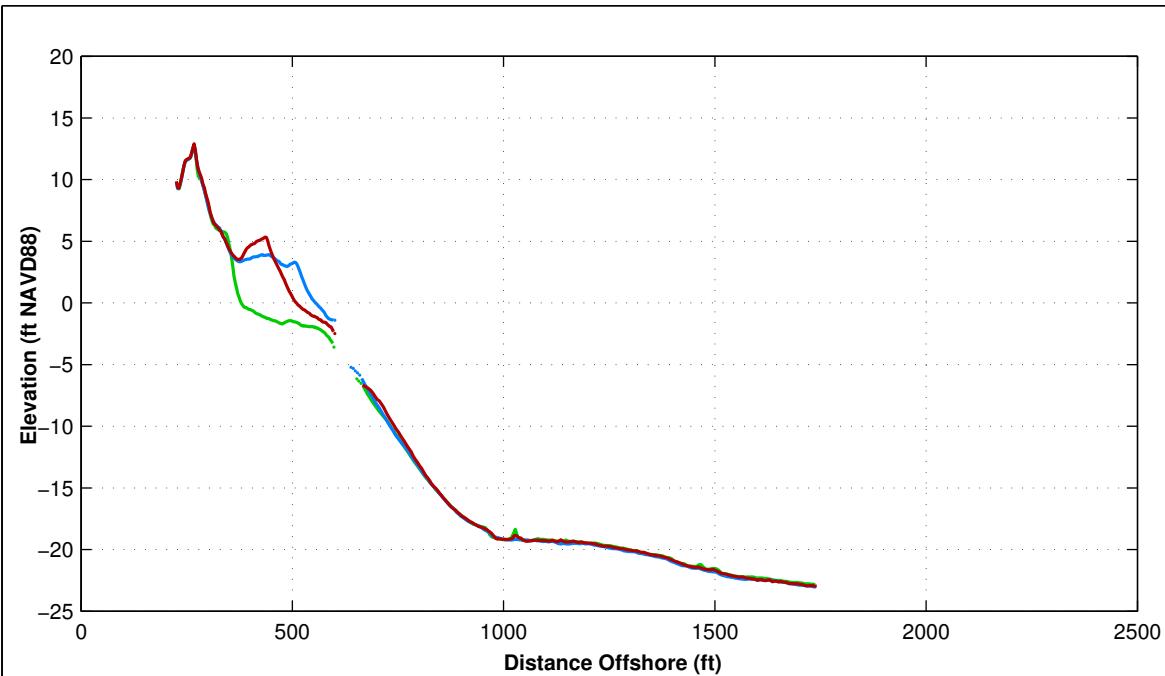
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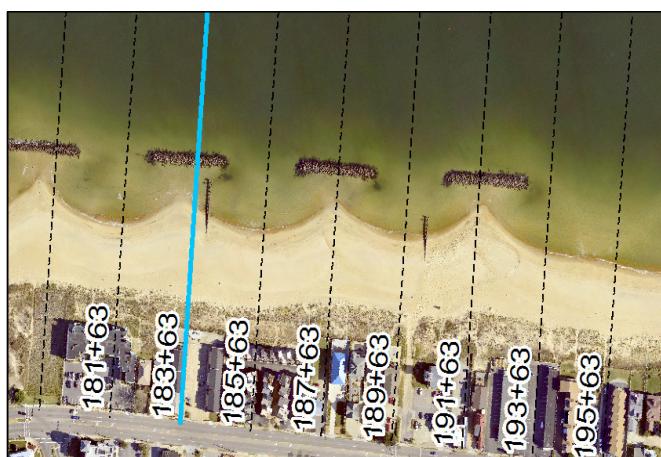
Survey Transect 183+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	123.30 ft/yr	-43.83 ft
Volume Change Above -15 ft NAVD88	30.69 cy/ft/yr	-2.50 cy/ft
Volume Change Above 0 ft NAVD88	18.91 cy/ft/yr	-2.20 cy/ft

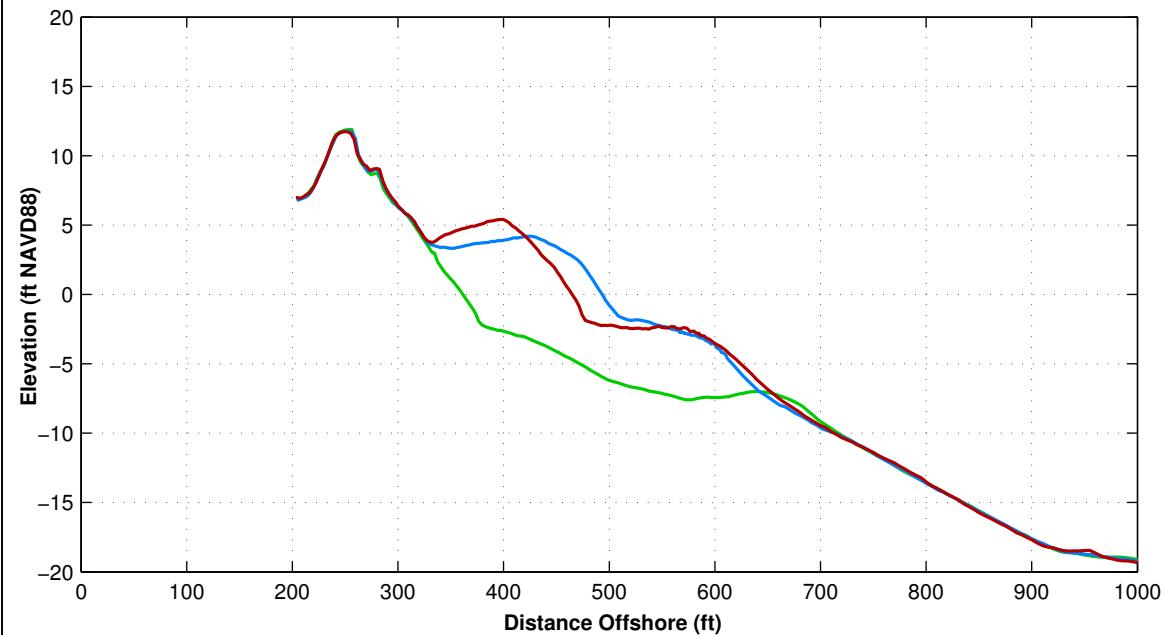
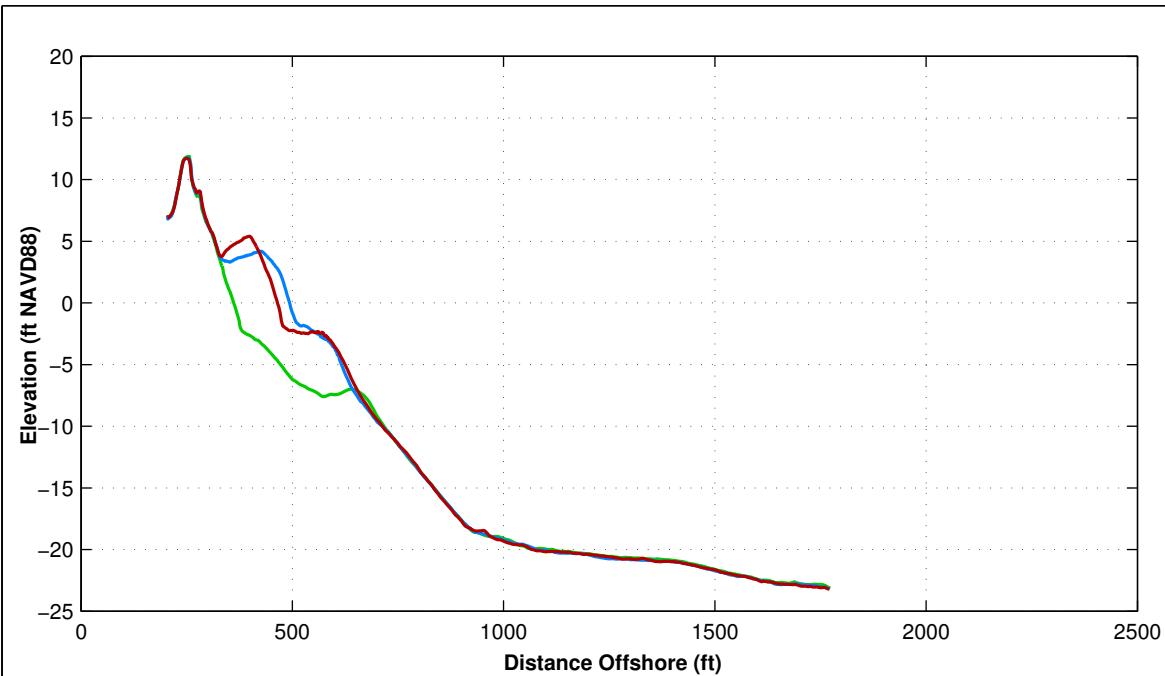
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

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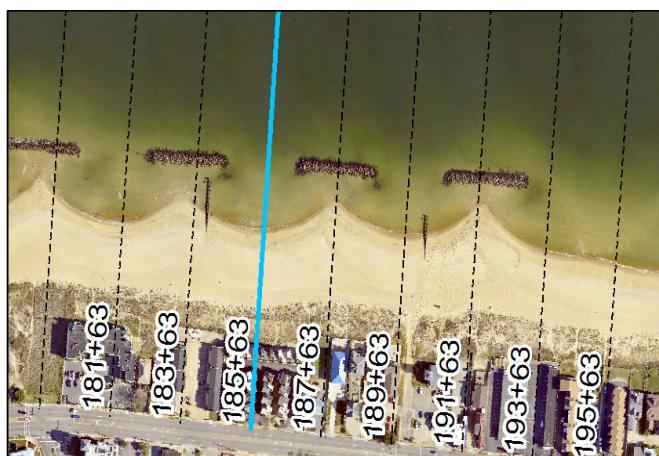


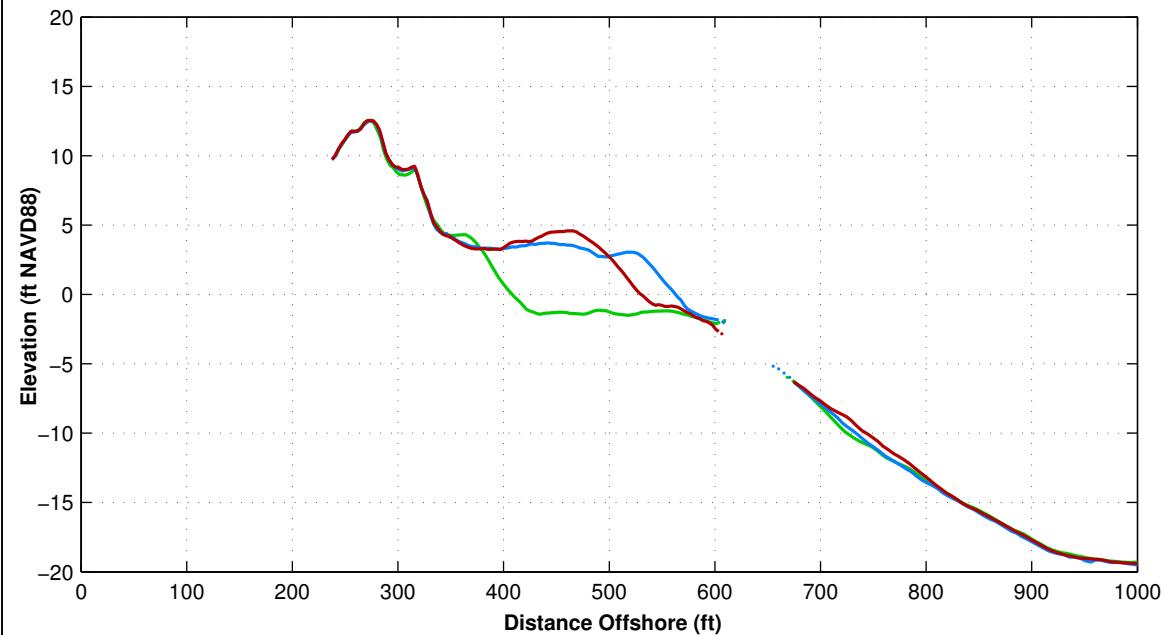
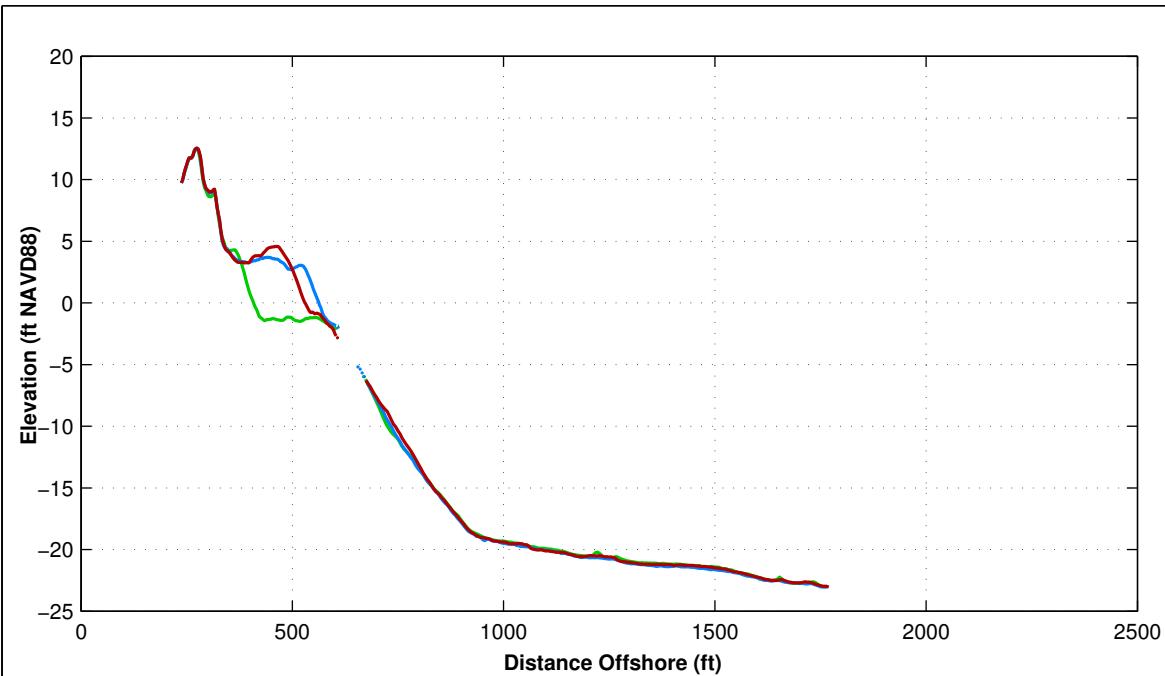
Survey Transect 185+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	105.19 ft/yr	-28.83 ft
Volume Change Above -15 ft NAVD88	54.63 cy/ft/yr	-1.17 cy/ft
Volume Change Above 0 ft NAVD88	18.30 cy/ft/yr	-0.20 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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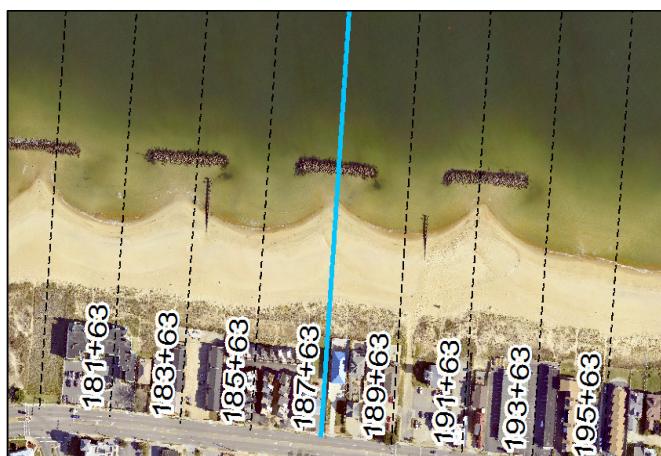
Survey Transect 187+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	121.98 ft/yr	-32.40 ft
Volume Change Above -15 ft NAVD88	26.29 cy/ft/yr	-0.47 cy/ft
Volume Change Above 0 ft NAVD88	17.25 cy/ft/yr	-1.19 cy/ft

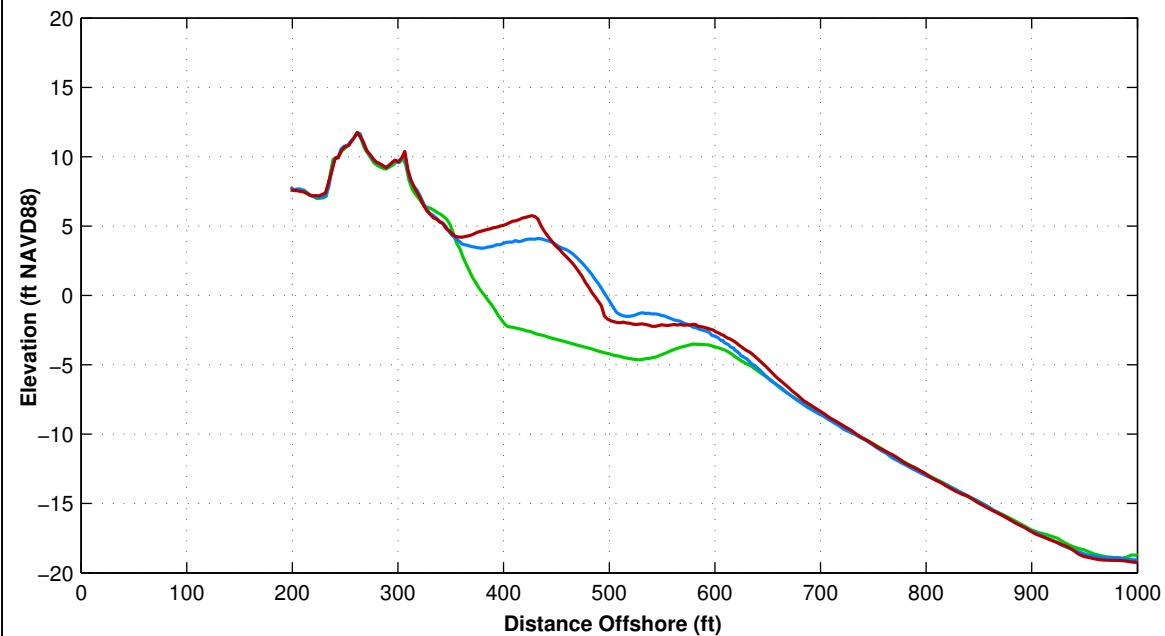
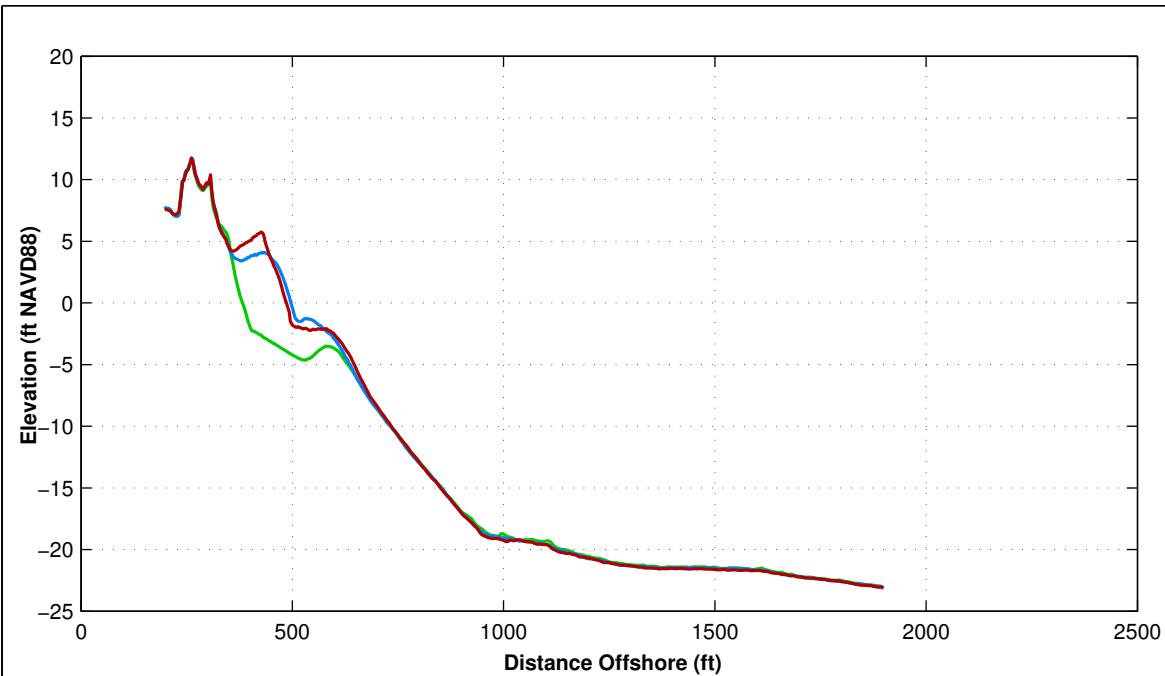
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

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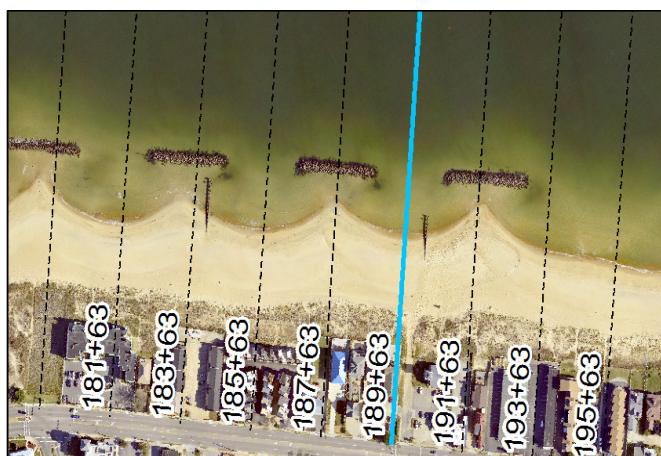
Survey Transect 189+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	104.51 ft/yr	-11.21 ft
Volume Change Above -15 ft NAVD88	39.73 cy/ft/yr	2.80 cy/ft
Volume Change Above 0 ft NAVD88	18.03 cy/ft/yr	2.52 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

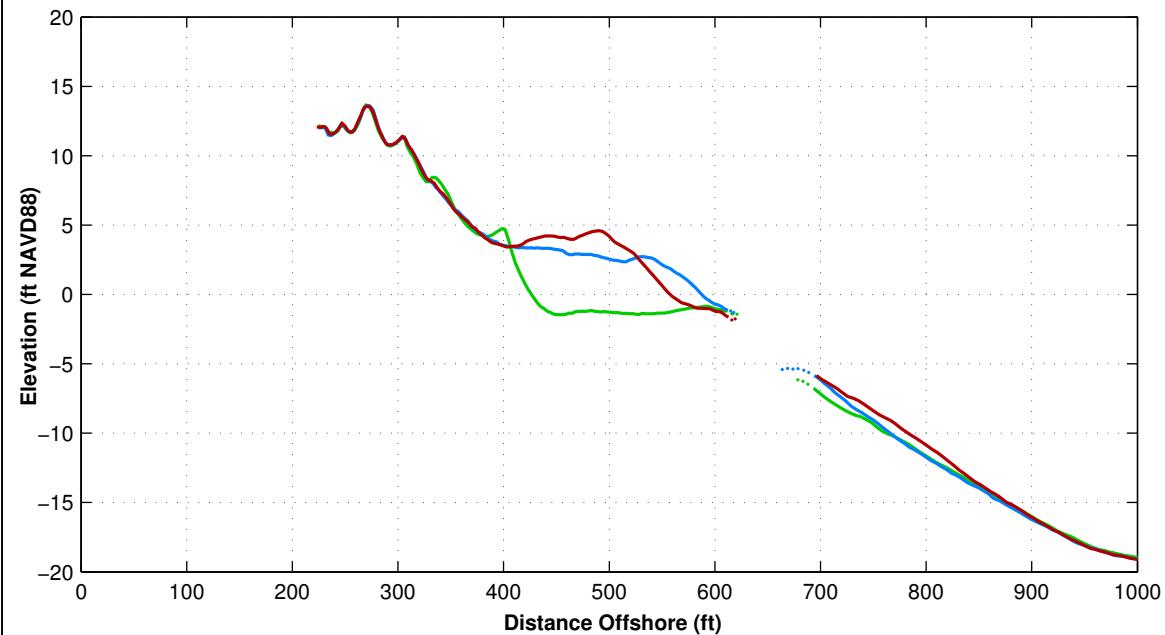
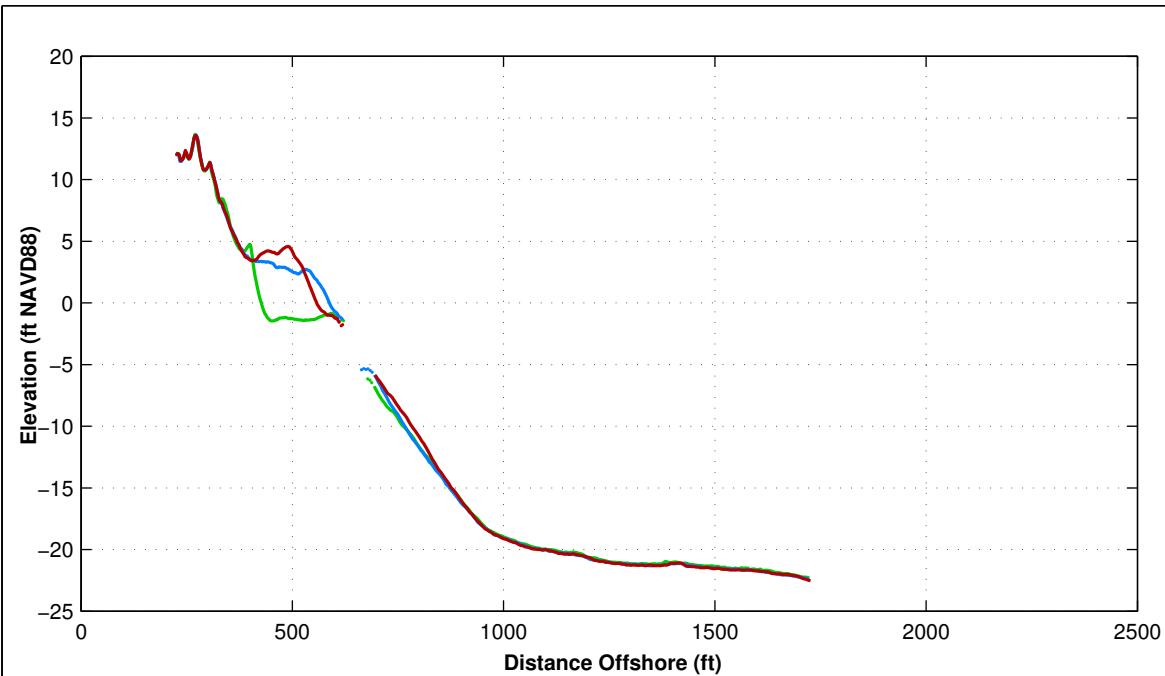
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PUBLIC WORKS

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ANALYSIS



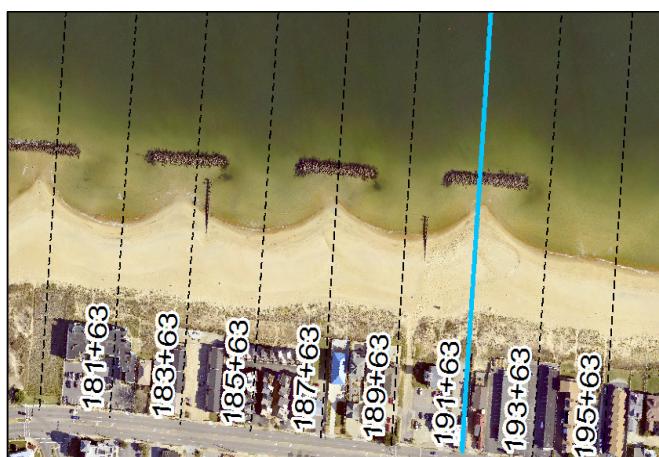
Survey Transect 191+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	127.91 ft/yr	-28.44 ft
Volume Change Above -15 ft NAVD88	29.04 cy/ft/yr	4.69 cy/ft
Volume Change Above 0 ft NAVD88	17.72 cy/ft/yr	1.96 cy/ft

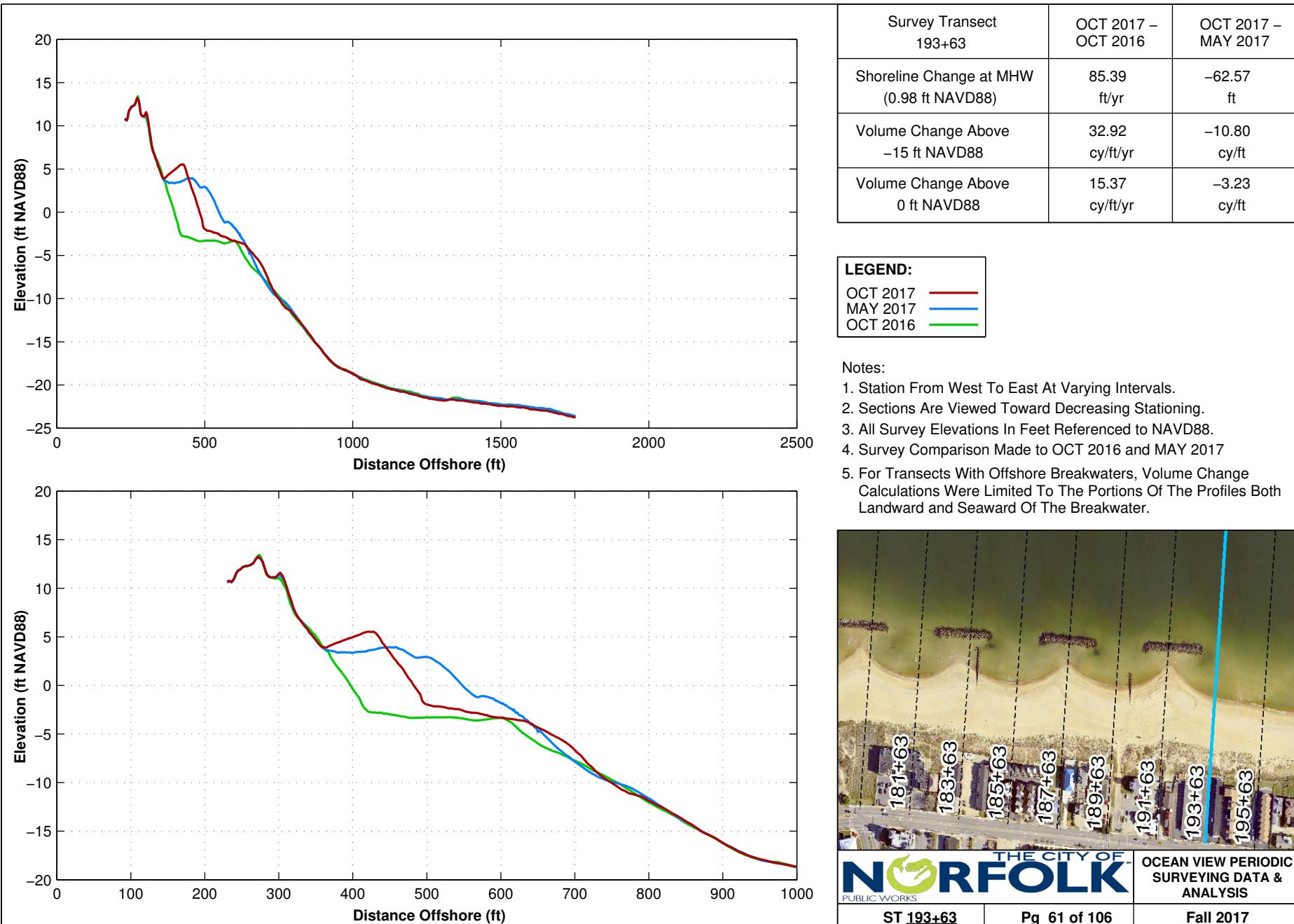
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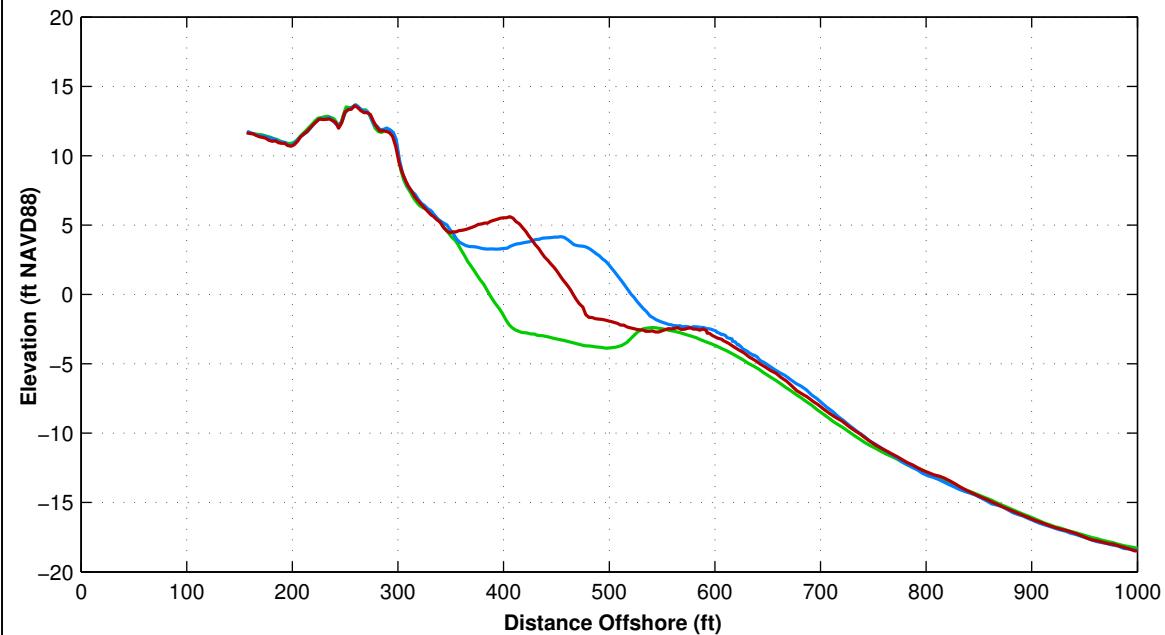
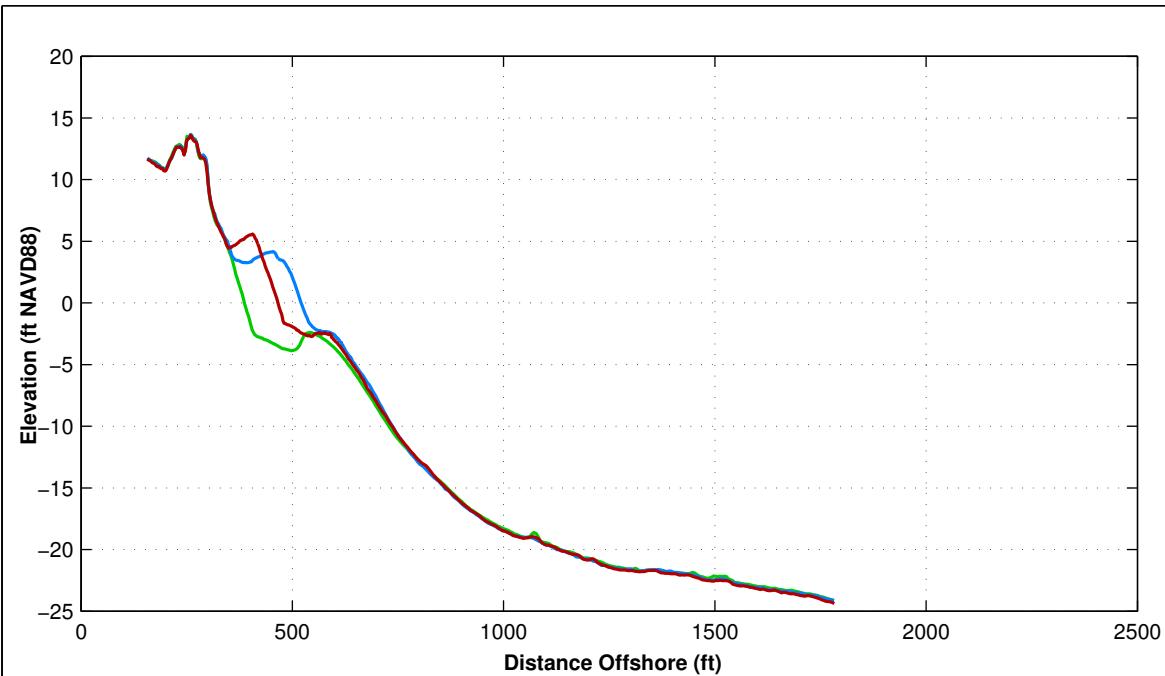
OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

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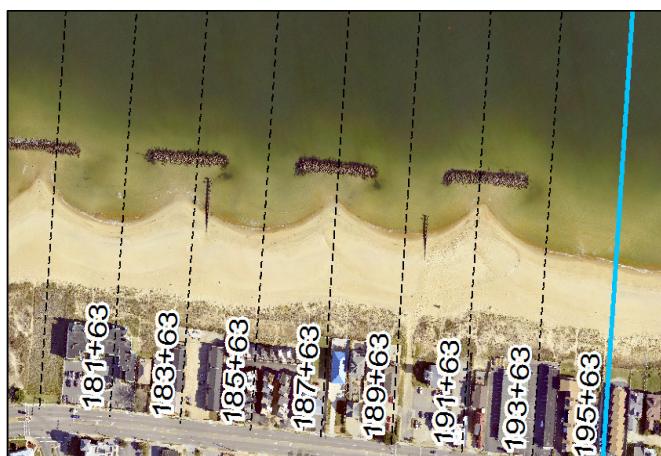


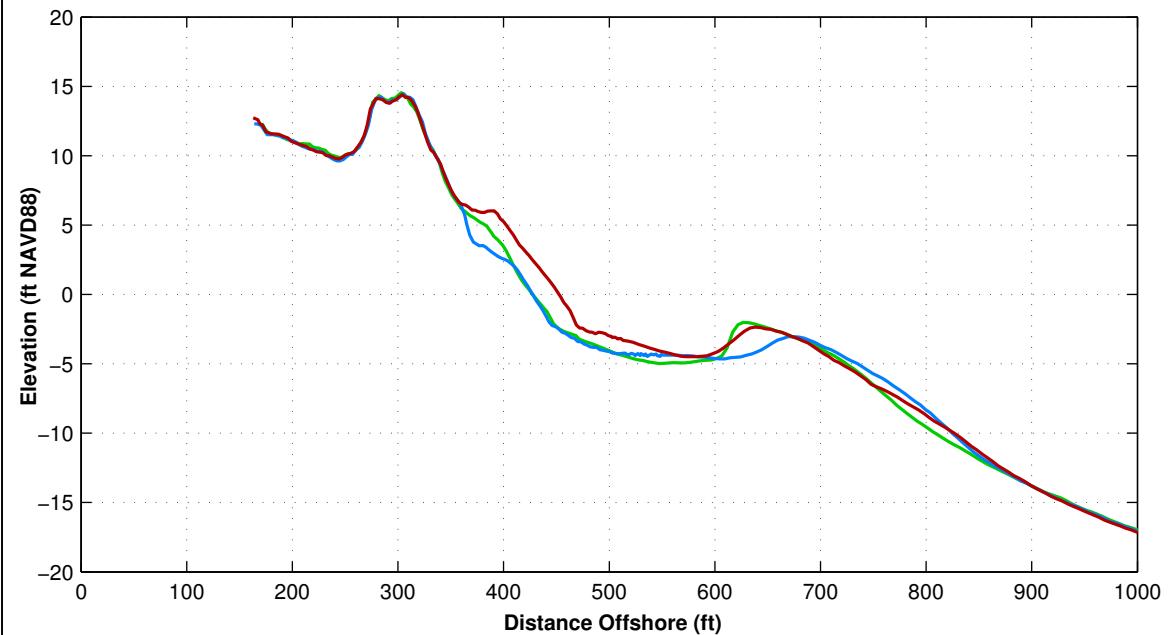
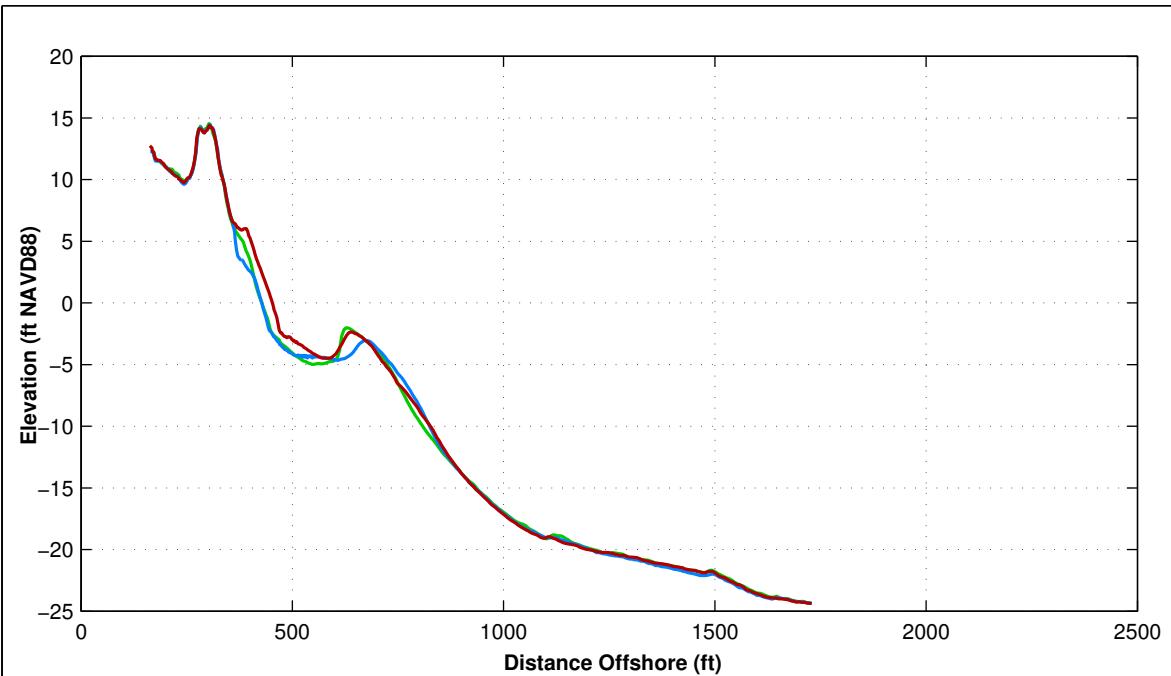


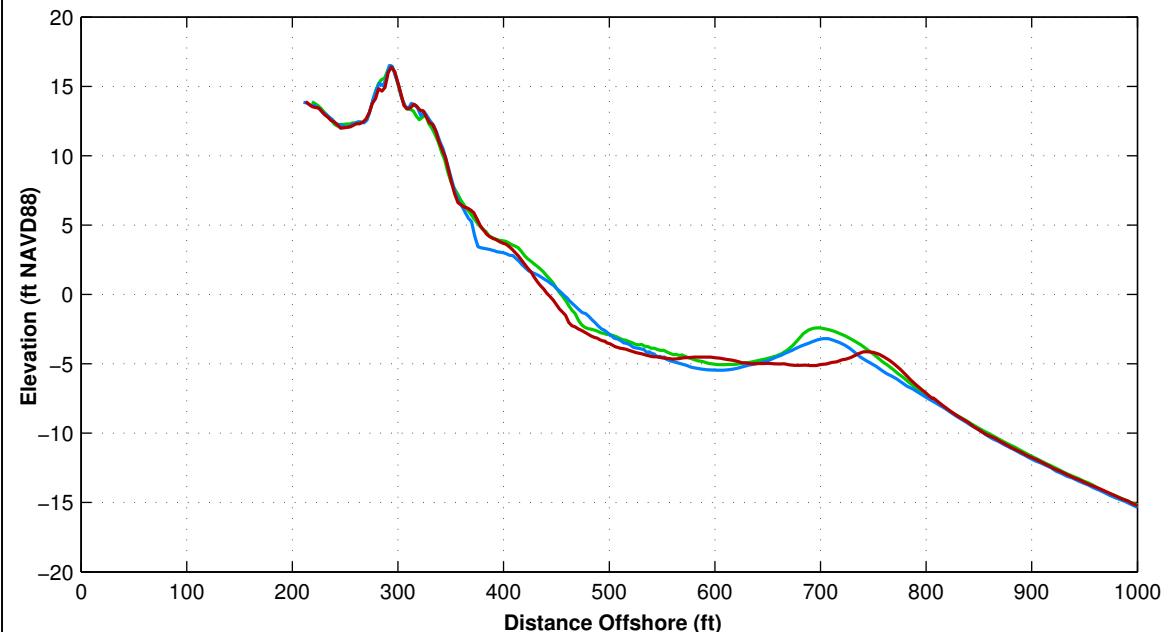
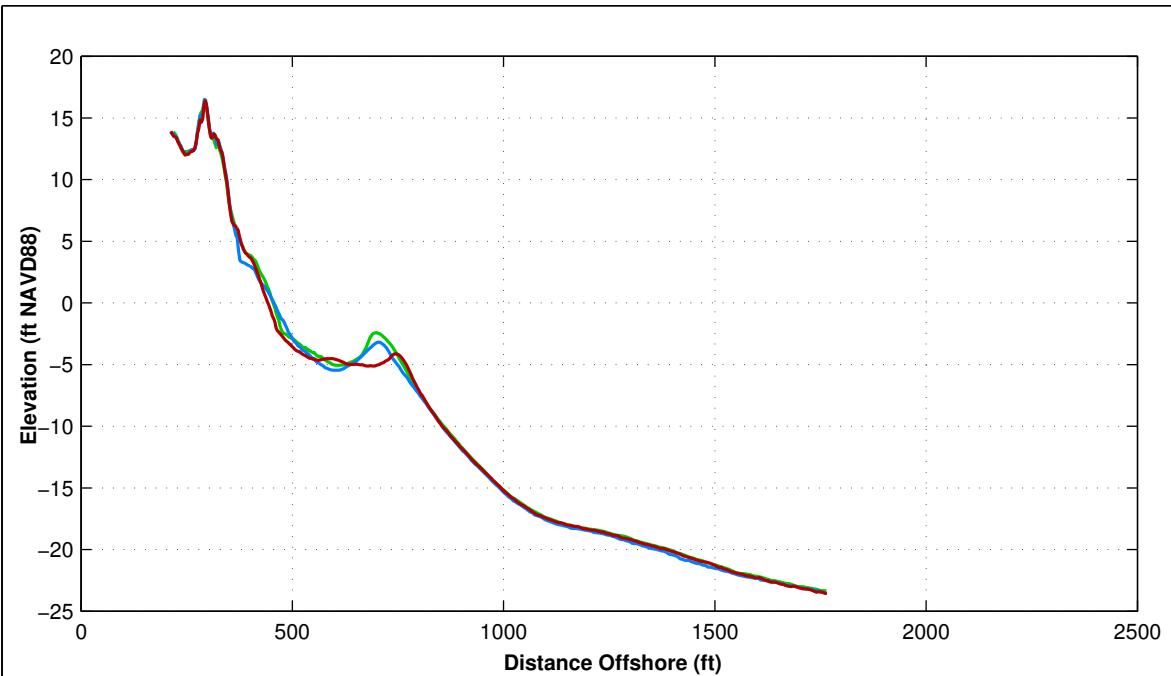


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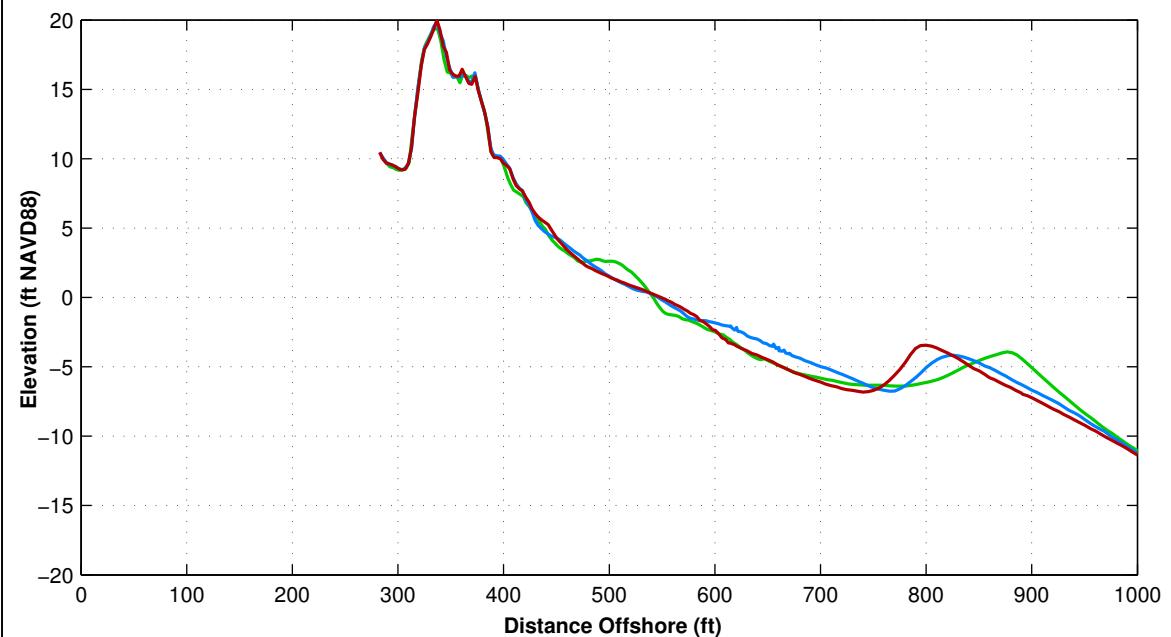
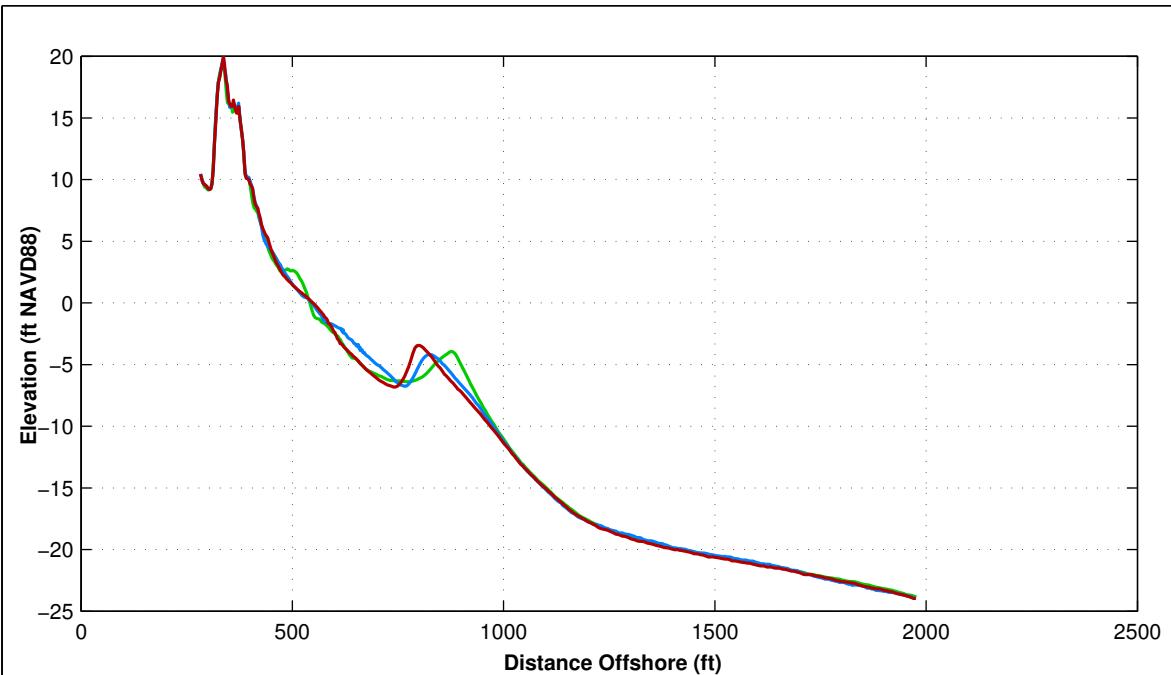




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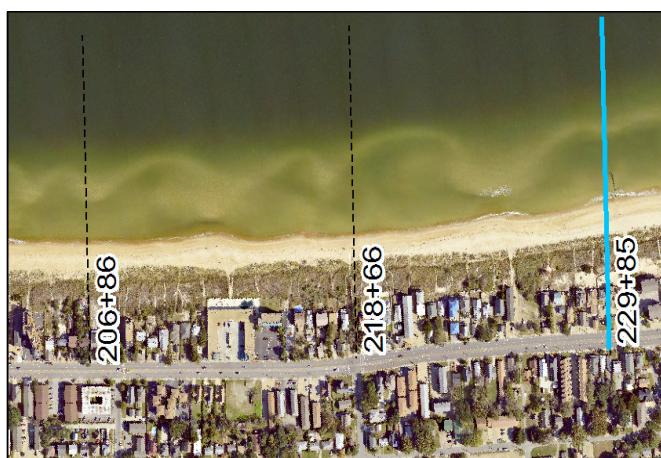
Survey Transect 229+85	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	-15.78 ft/yr	2.36 ft
Volume Change Above -15 ft NAVD88	-3.79 cy/ft/yr	-5.76 cy/ft
Volume Change Above 0 ft NAVD88	-0.57 cy/ft/yr	-0.12 cy/ft

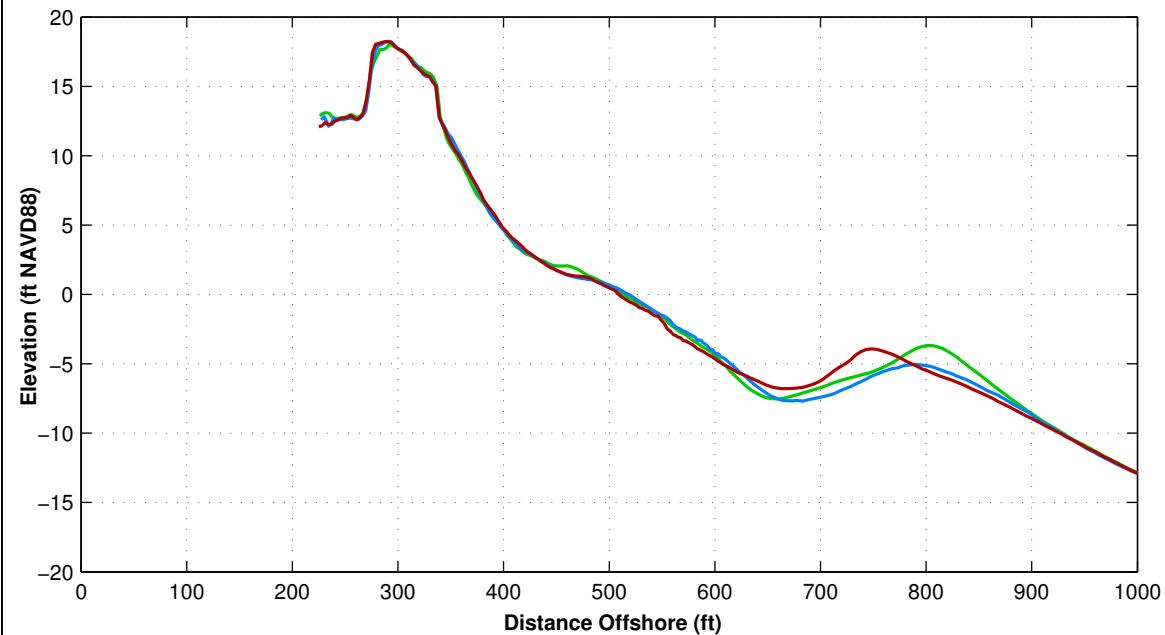
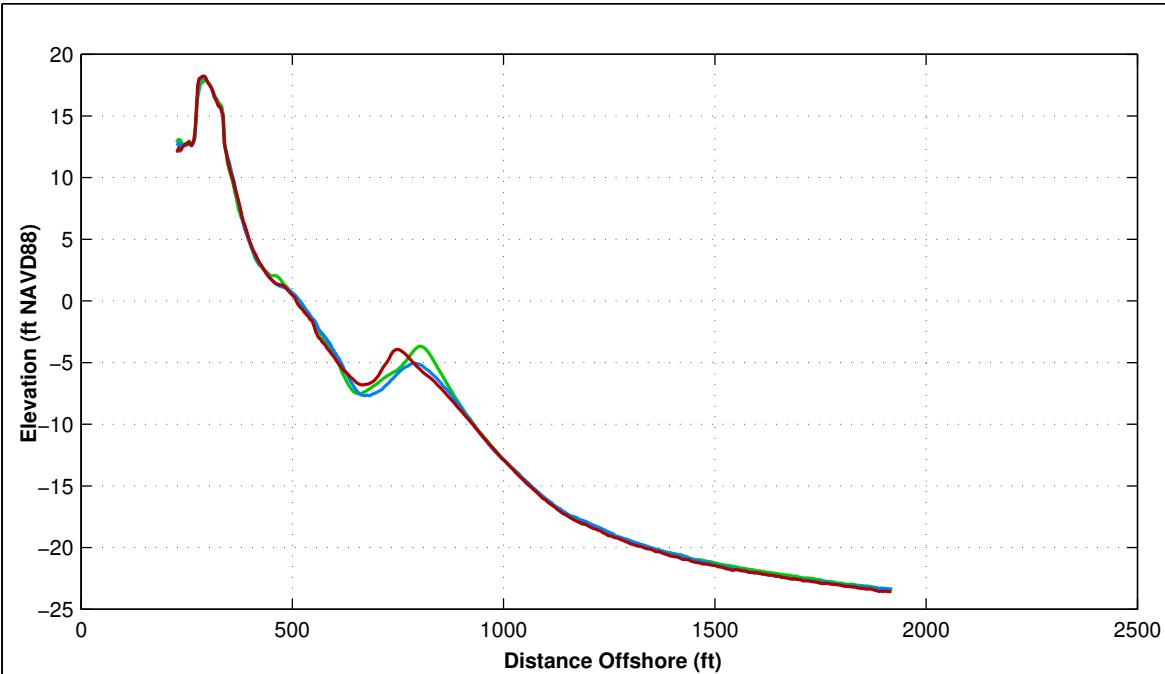
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

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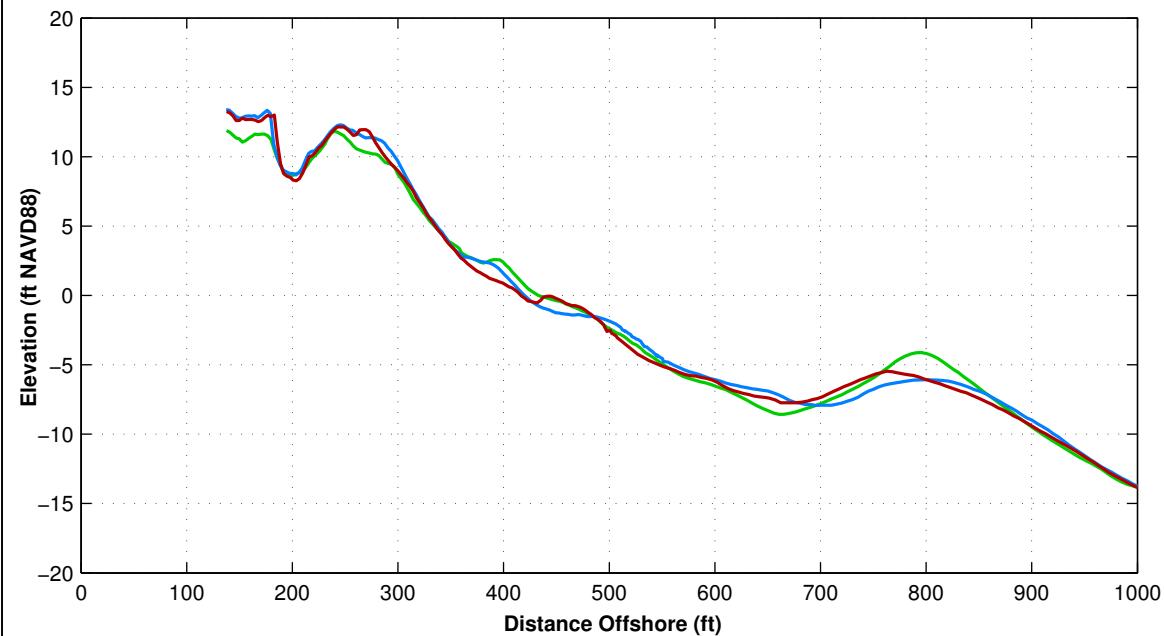
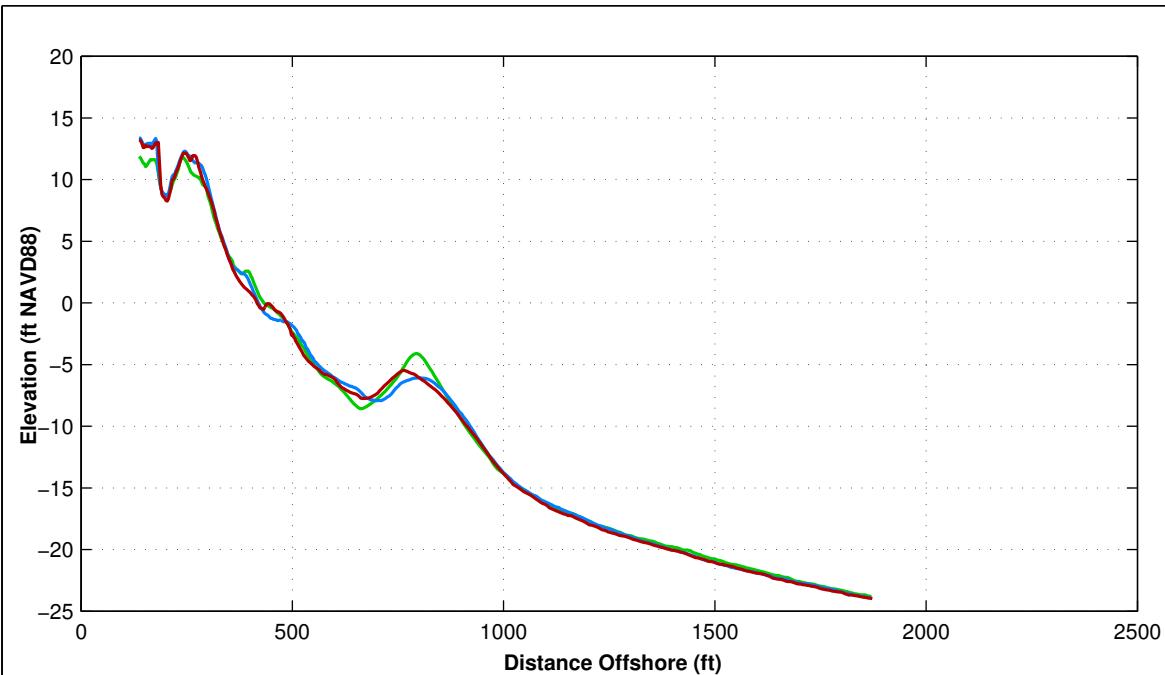
Survey Transect 242+03	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	-4.61 ft/yr	-0.98 ft
Volume Change Above -15 ft NAVD88	-2.40 cy/ft/yr	3.07 cy/ft
Volume Change Above 0 ft NAVD88	-0.10 cy/ft/yr	0.25 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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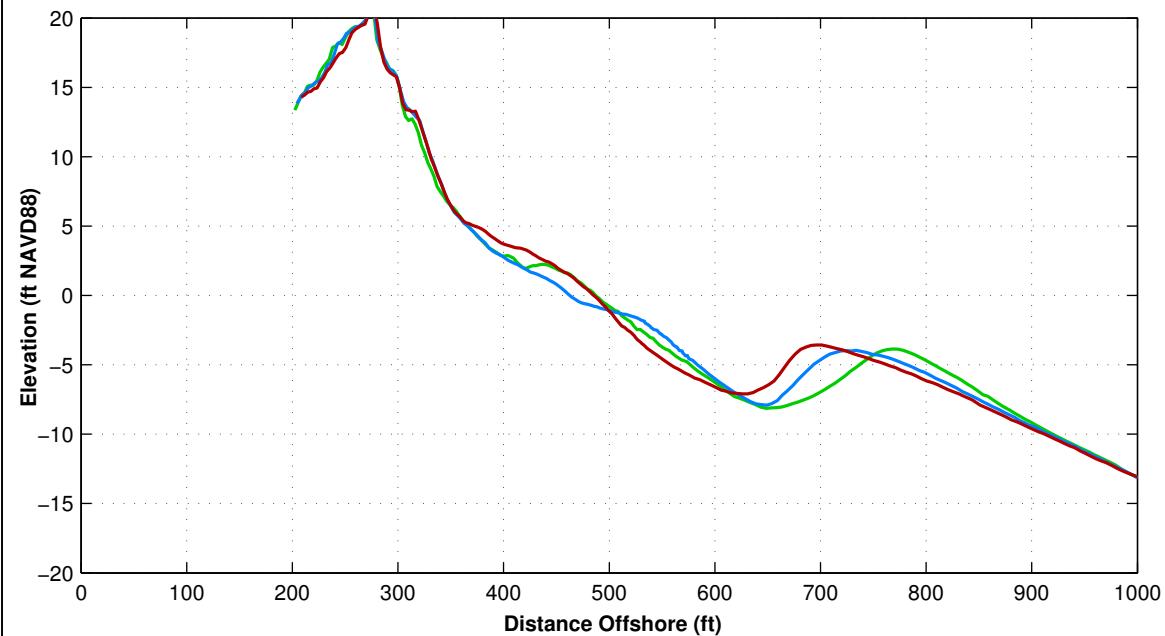
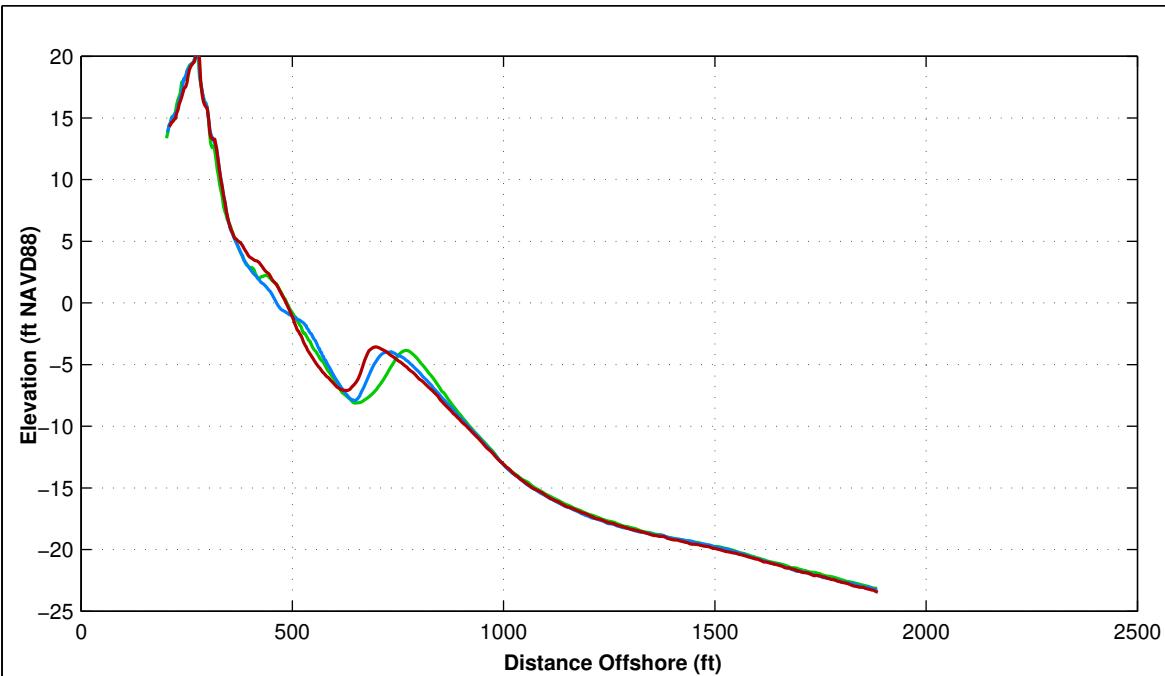
Survey Transect 252+62	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	-21.42 ft/yr	-11.76 ft
Volume Change Above -15 ft NAVD88	-0.71 cy/ft/yr	-3.97 cy/ft
Volume Change Above 0 ft NAVD88	1.20 cy/ft/yr	-2.74 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

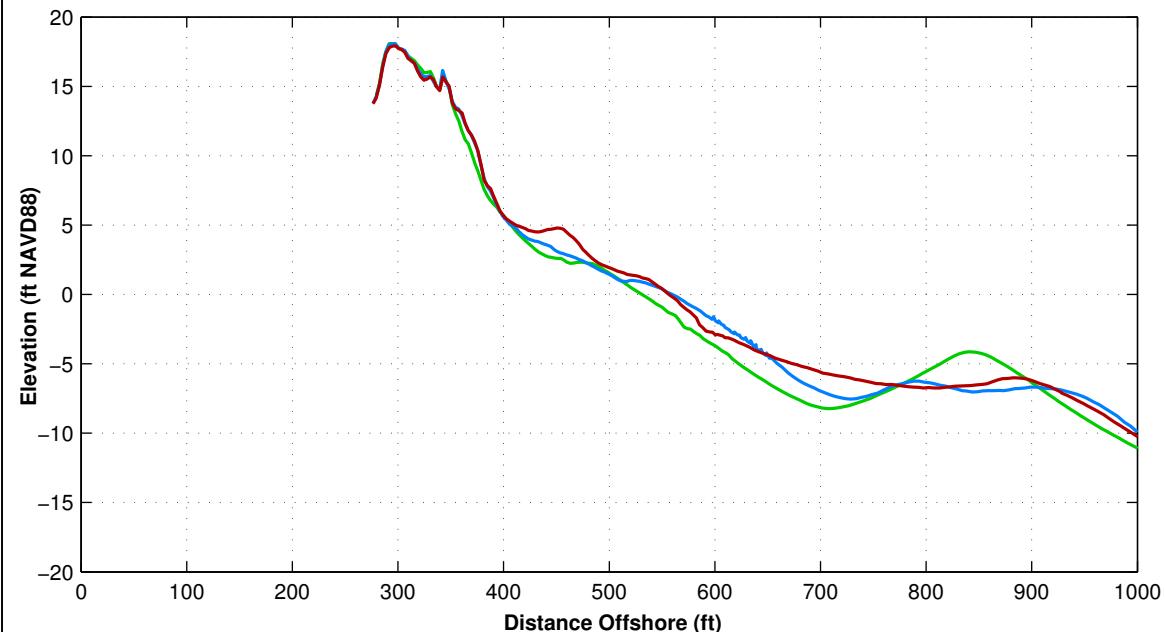
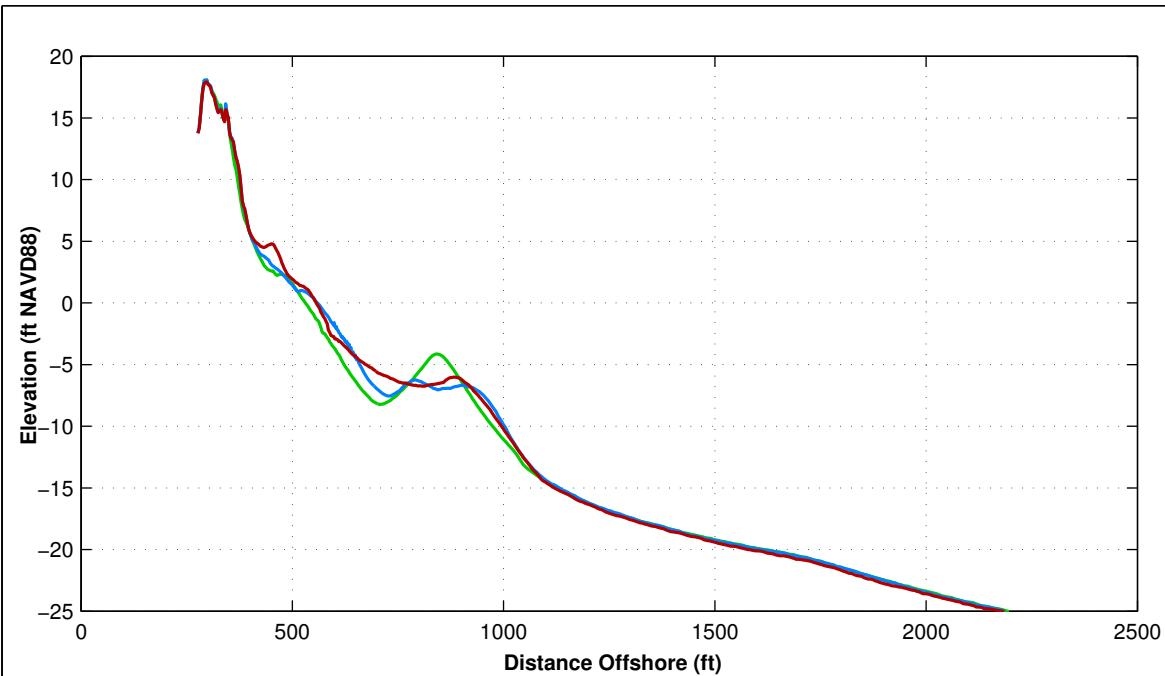
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Survey Transect 274+53	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	27.76 ft/yr	13.69 ft
Volume Change Above -15 ft NAVD88	18.75 cy/ft/yr	5.52 cy/ft
Volume Change Above 0 ft NAVD88	6.65 cy/ft/yr	3.60 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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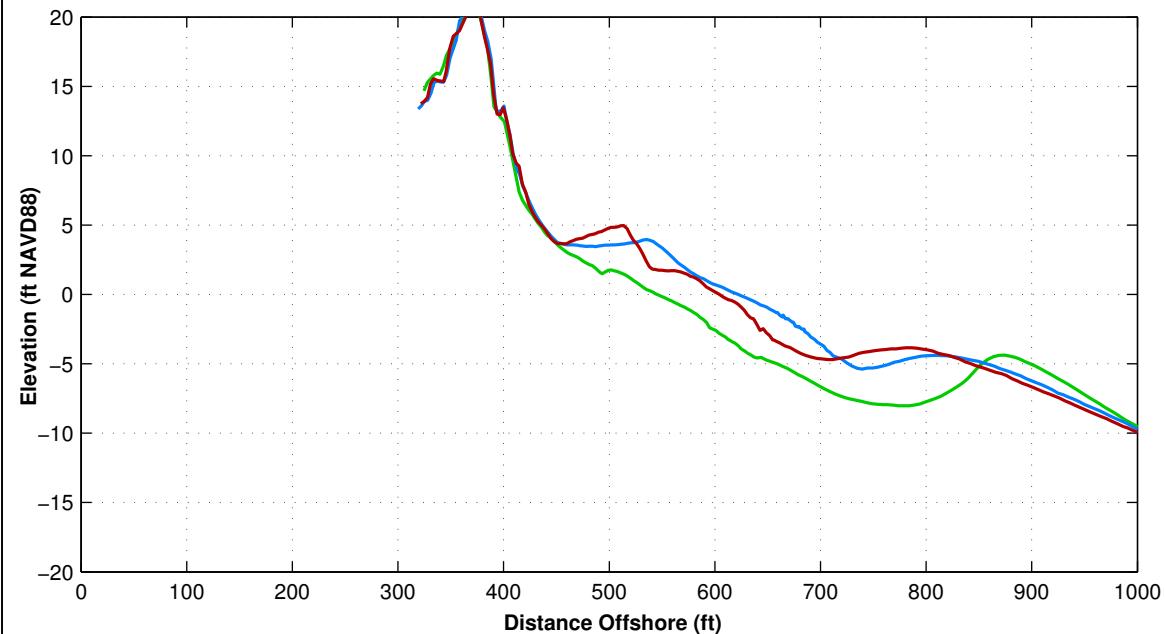
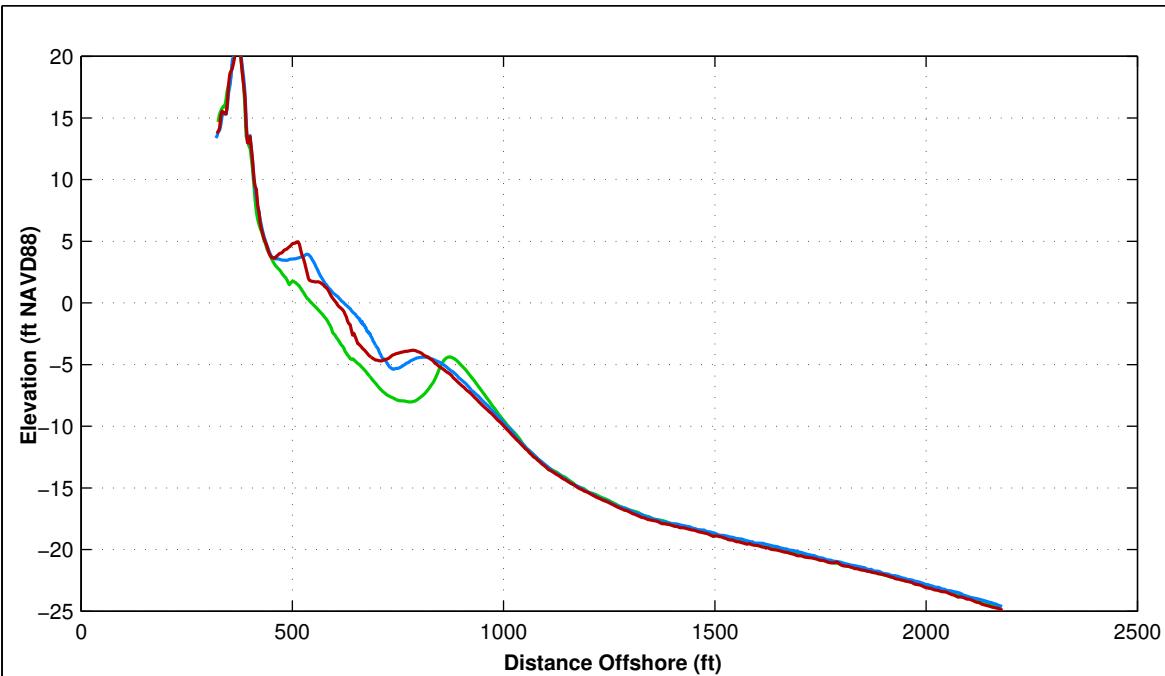
THE CITY OF
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 PUBLIC WORKS

ST 274+53

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Survey Transect 281+40	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	62.47 ft/yr	-6.79 ft
Volume Change Above -15 ft NAVD88	30.64 cy/ft/yr	-6.58 cy/ft
Volume Change Above 0 ft NAVD88	10.76 cy/ft/yr	-0.92 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

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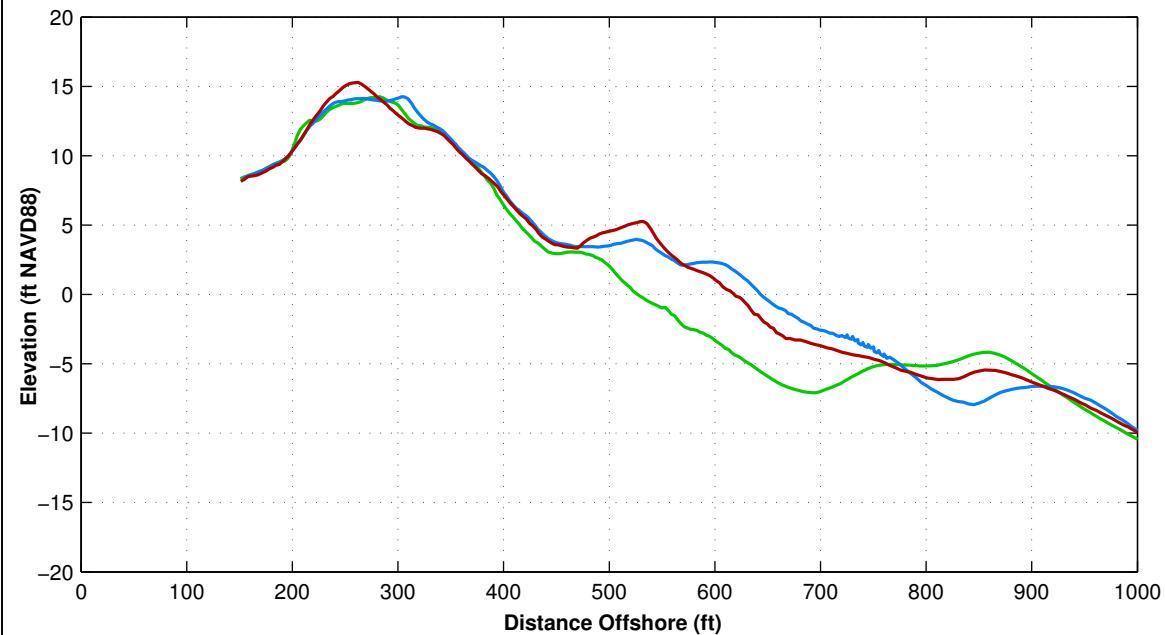
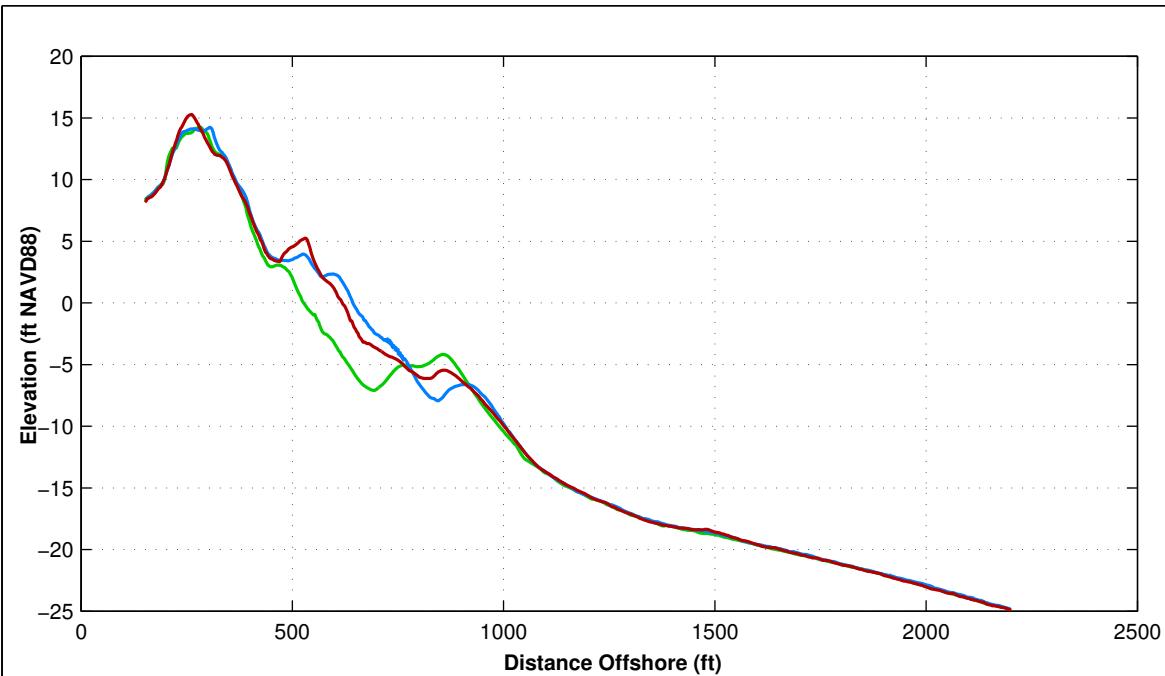
THE CITY OF
NORFOLK
PUBLIC WORKS

ST 281+40

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Fall 2017



Survey Transect 288+39	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	89.49 ft/yr	-29.37 ft
Volume Change Above -15 ft NAVD88	36.24 cy/ft/yr	-3.31 cy/ft
Volume Change Above 0 ft NAVD88	16.57 cy/ft/yr	-1.04 cy/ft

LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

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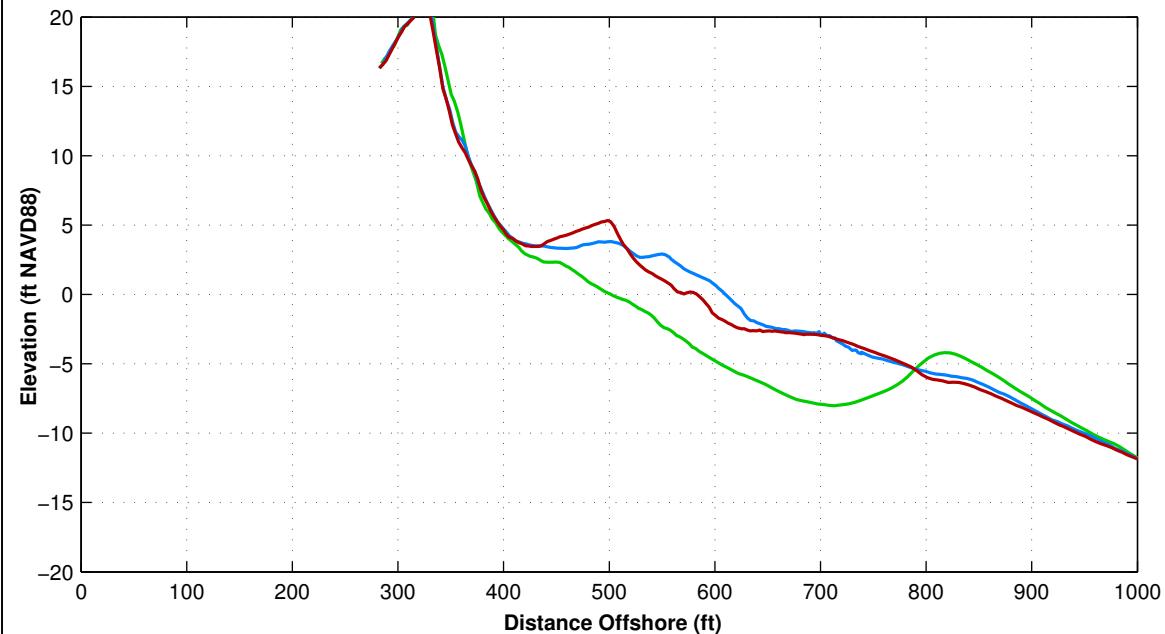
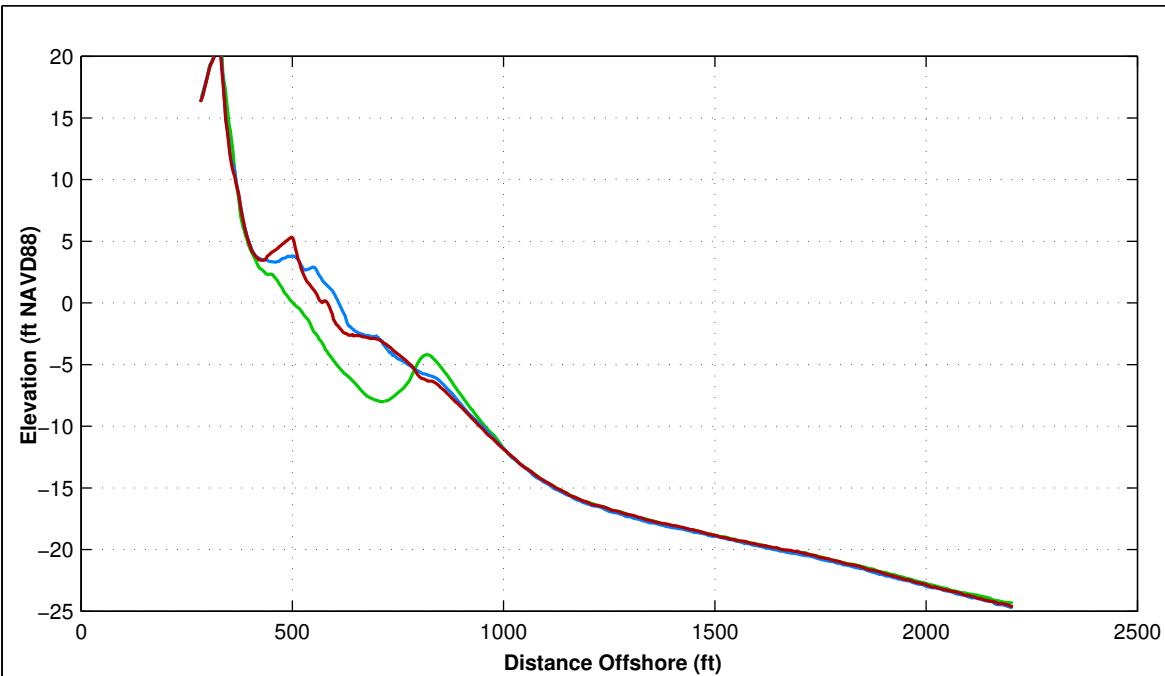
THE CITY OF
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PUBLIC WORKS

ST 288+39

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Fall 2017



Survey Transect 295+27	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	73.62 ft/yr	-42.61 ft
Volume Change Above -15 ft NAVD88	37.18 cy/ft/yr	-6.09 cy/ft
Volume Change Above 0 ft NAVD88	11.71 cy/ft/yr	-2.03 cy/ft

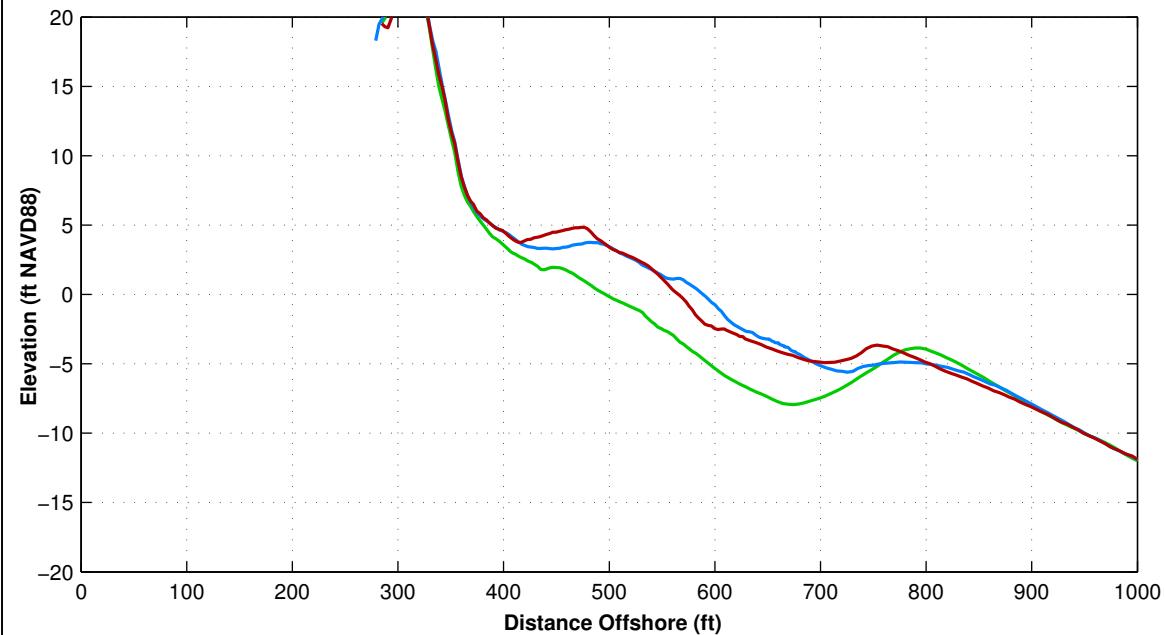
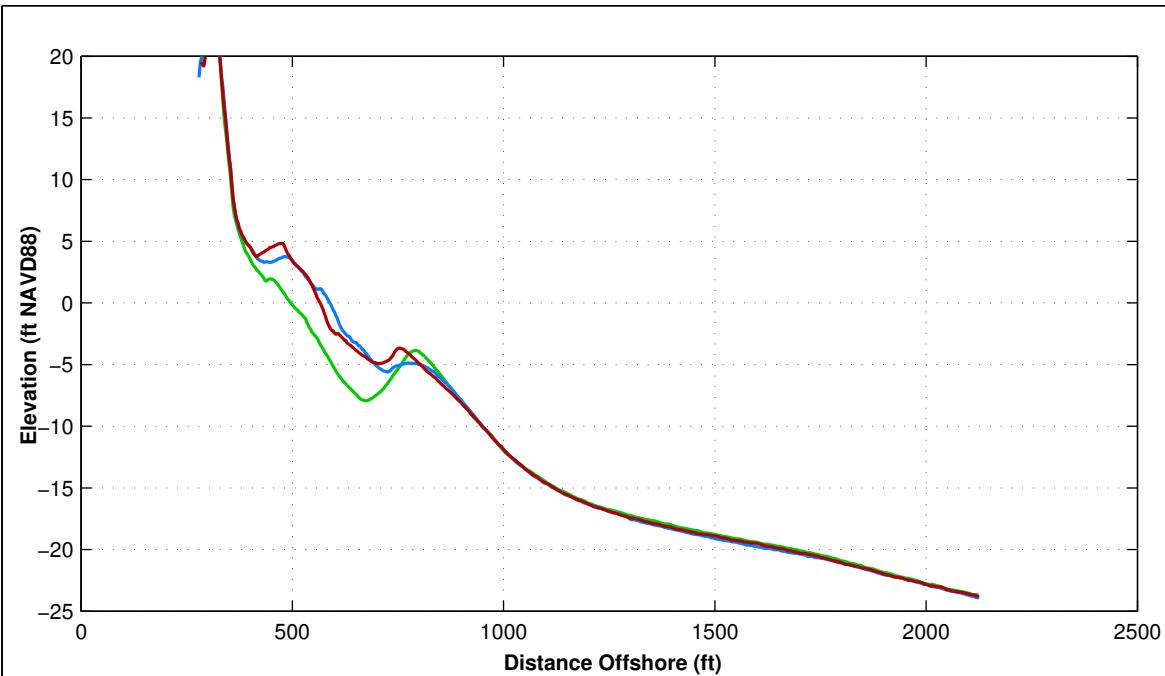
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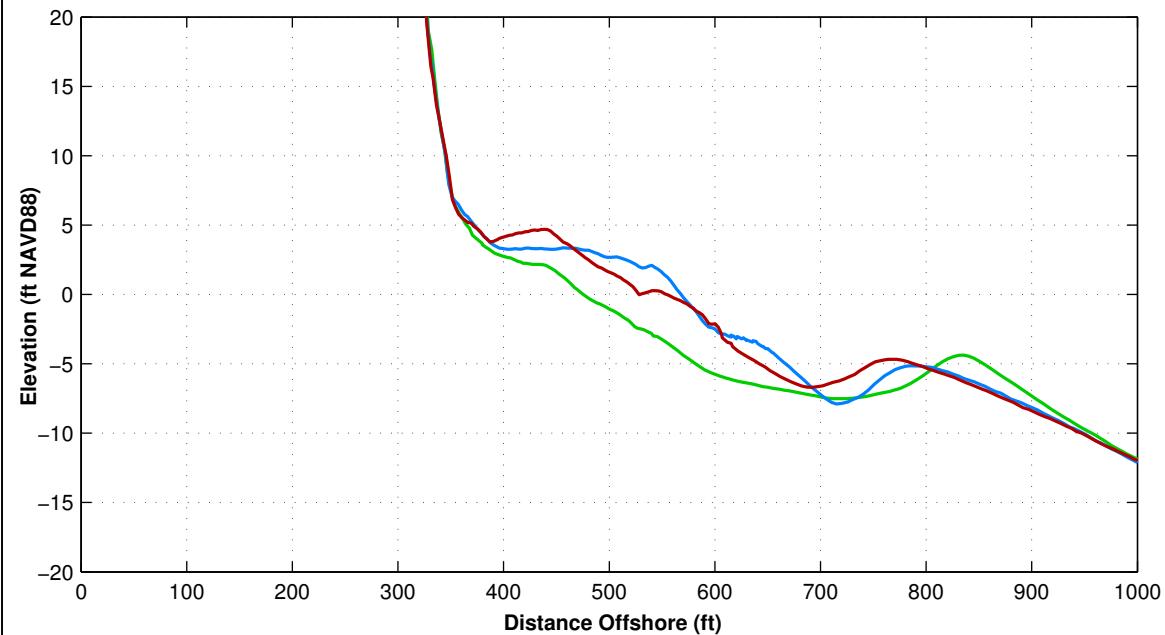
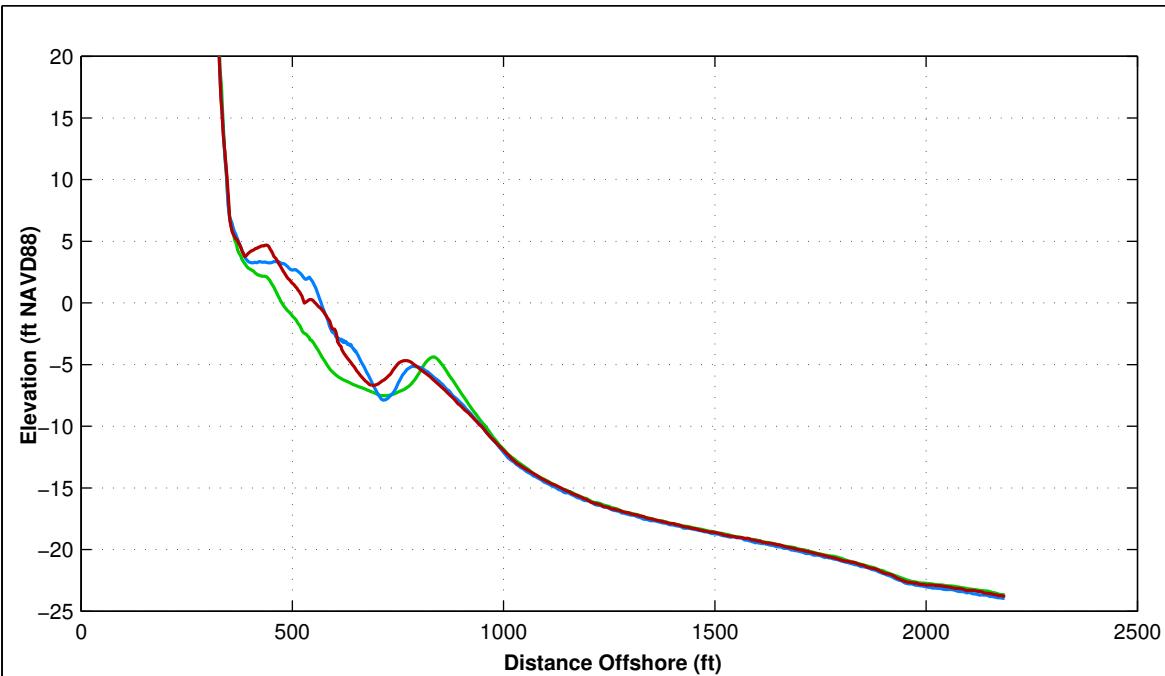
OCT 2017	—
MAY 2017	—
OCT 2016	—

Notes:

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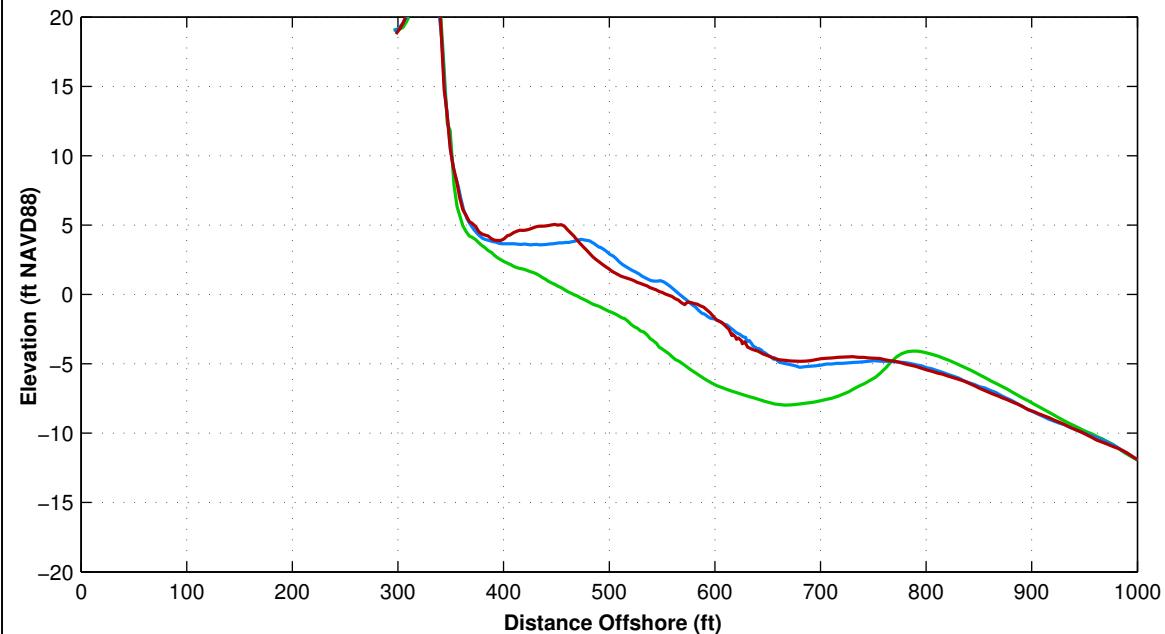
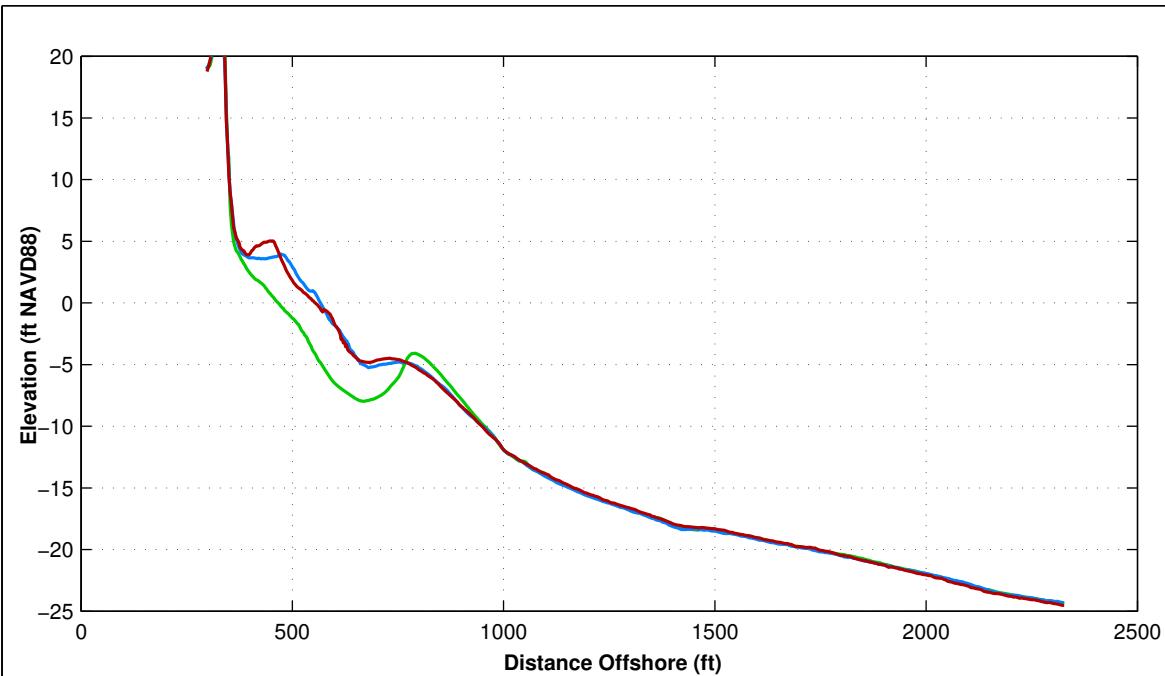
Survey Transect 315+96	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	54.47 ft/yr	-43.12 ft
Volume Change Above -15 ft NAVD88	26.25 cy/ft/yr	-1.23 cy/ft
Volume Change Above 0 ft NAVD88	10.16 cy/ft/yr	-2.09 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

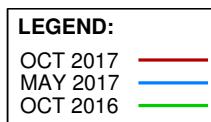
Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
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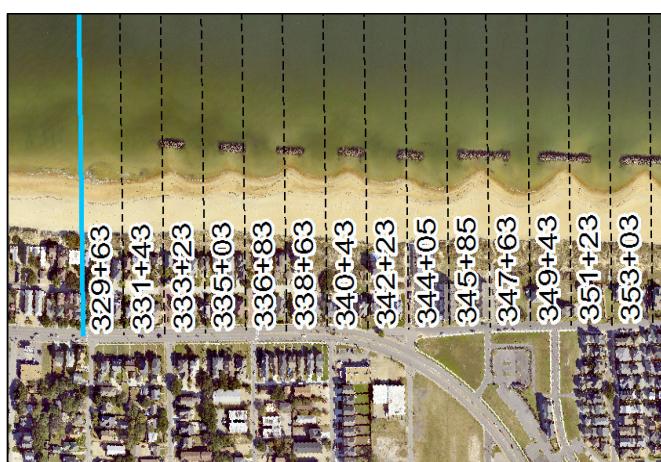
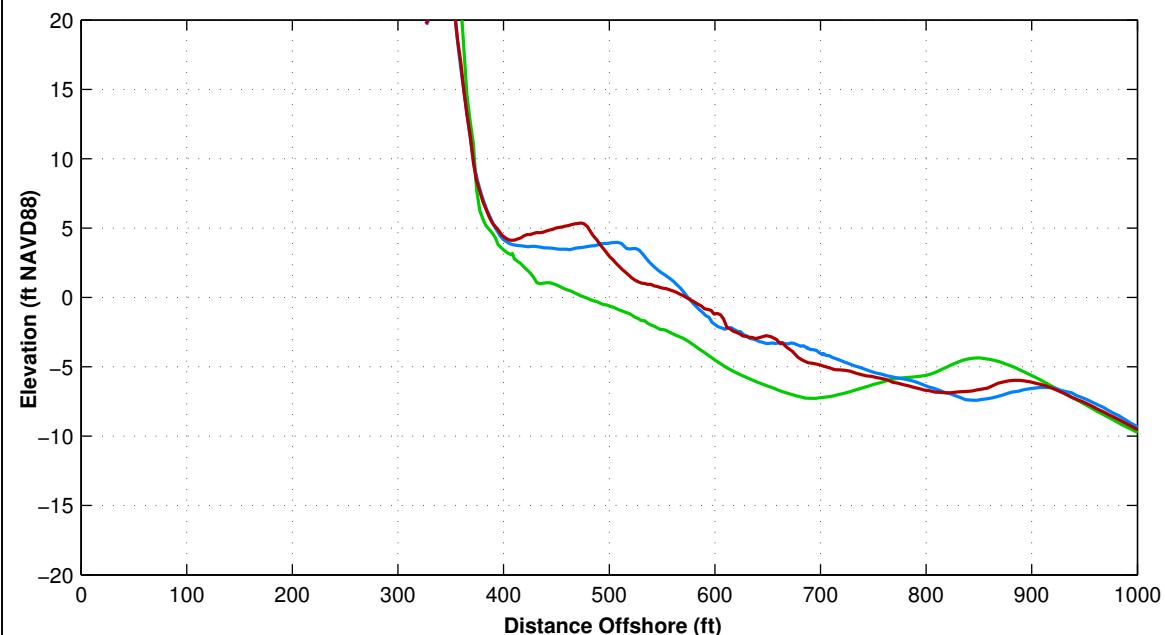
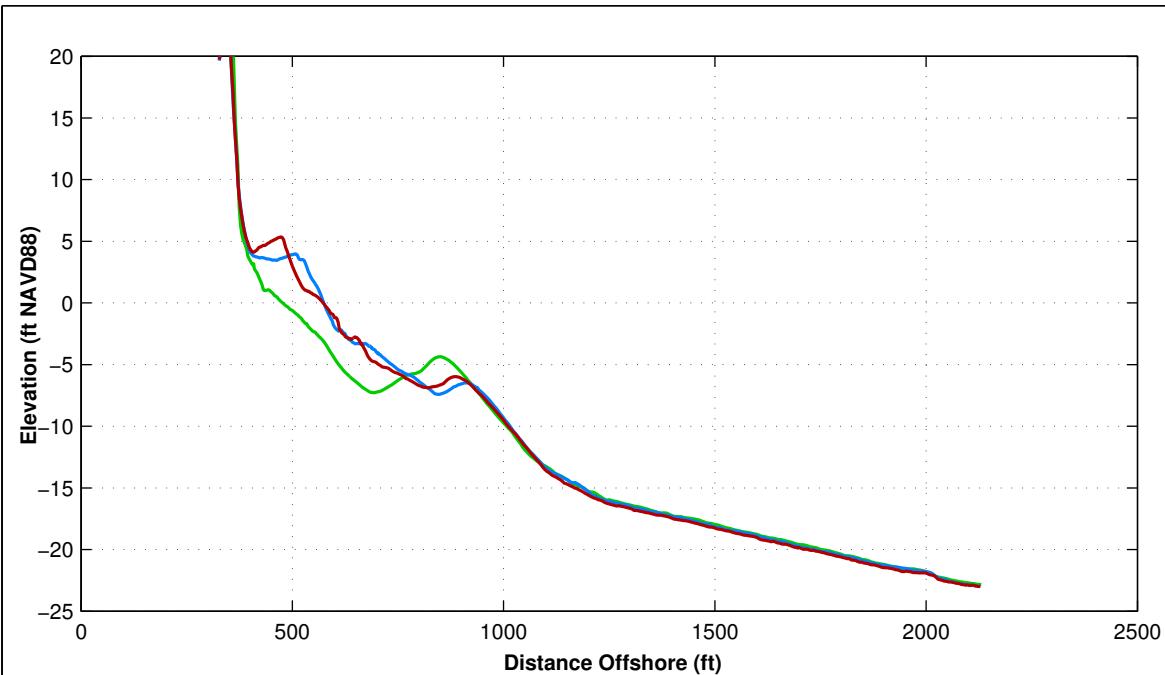
Survey Transect 323+09	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	ft/yr	ft
Volume Change Above -15 ft NAVD88	cy/ft/yr	cy/ft
Volume Change Above 0 ft NAVD88	cy/ft/yr	cy/ft



Notes:

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4. Survey Comparison Made to OCT 2016 and MAY 2017
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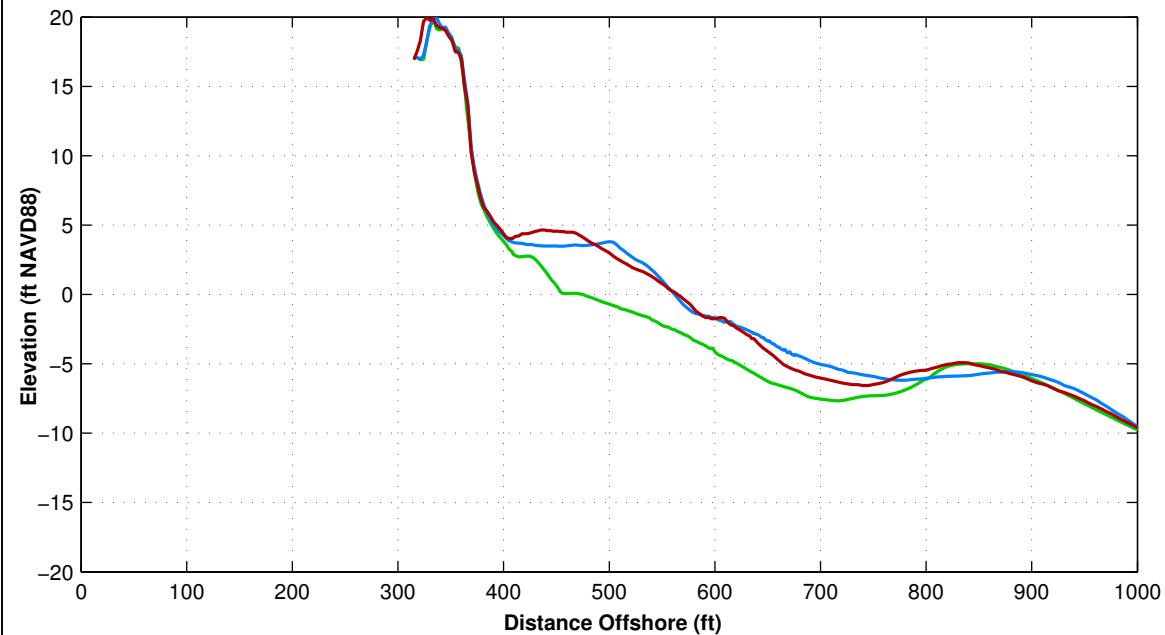
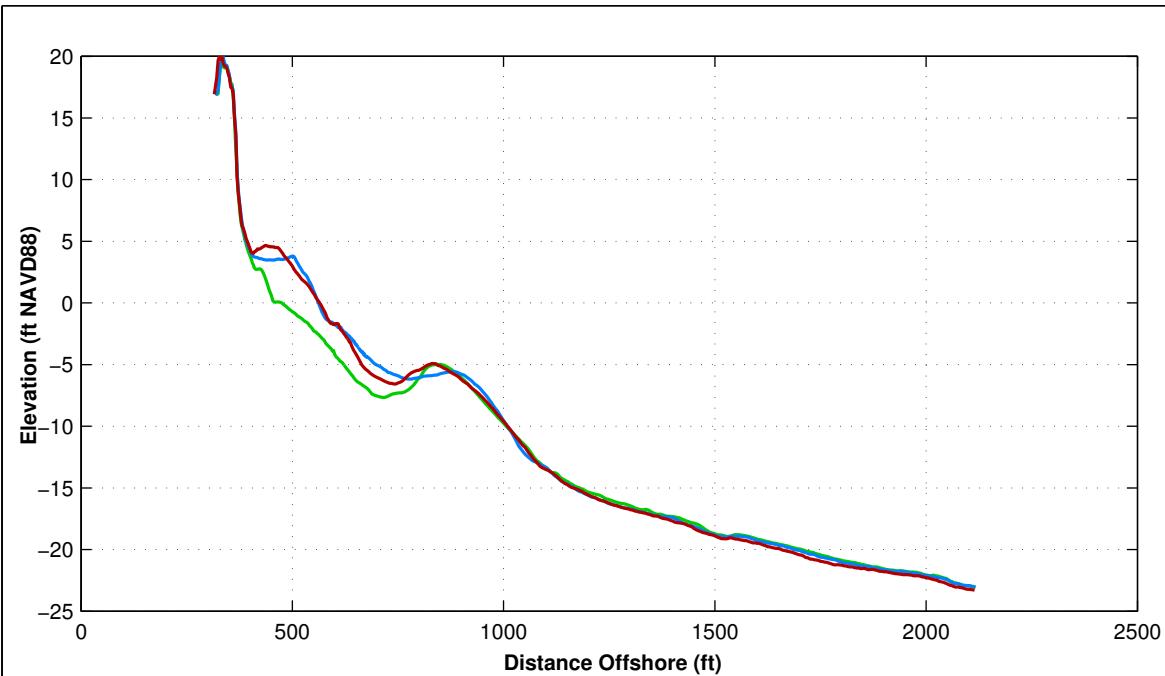
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ST 329+63

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Fall 2017



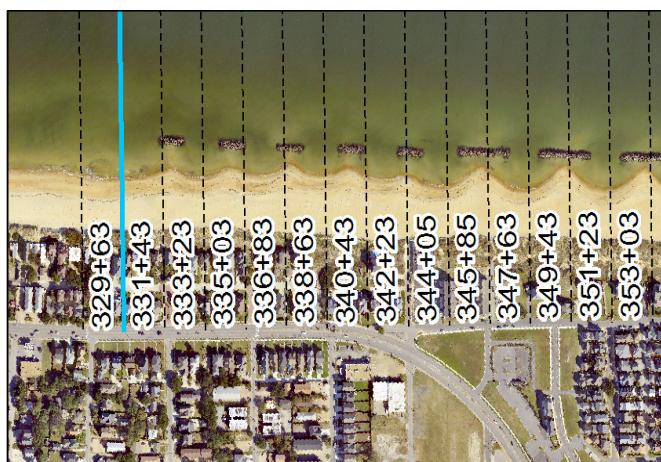
Survey Transect 331+43	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	100.52 ft/yr	-4.18 ft
Volume Change Above -15 ft NAVD88	34.38 cy/ft/yr	-1.60 cy/ft
Volume Change Above 0 ft NAVD88	15.95 cy/ft/yr	1.23 cy/ft

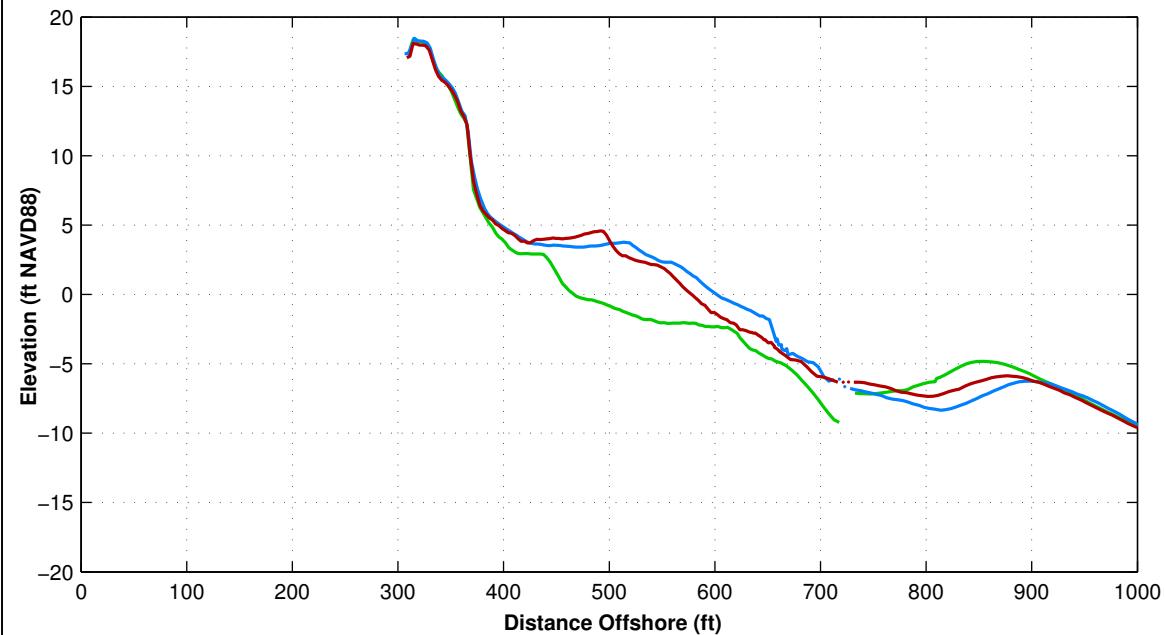
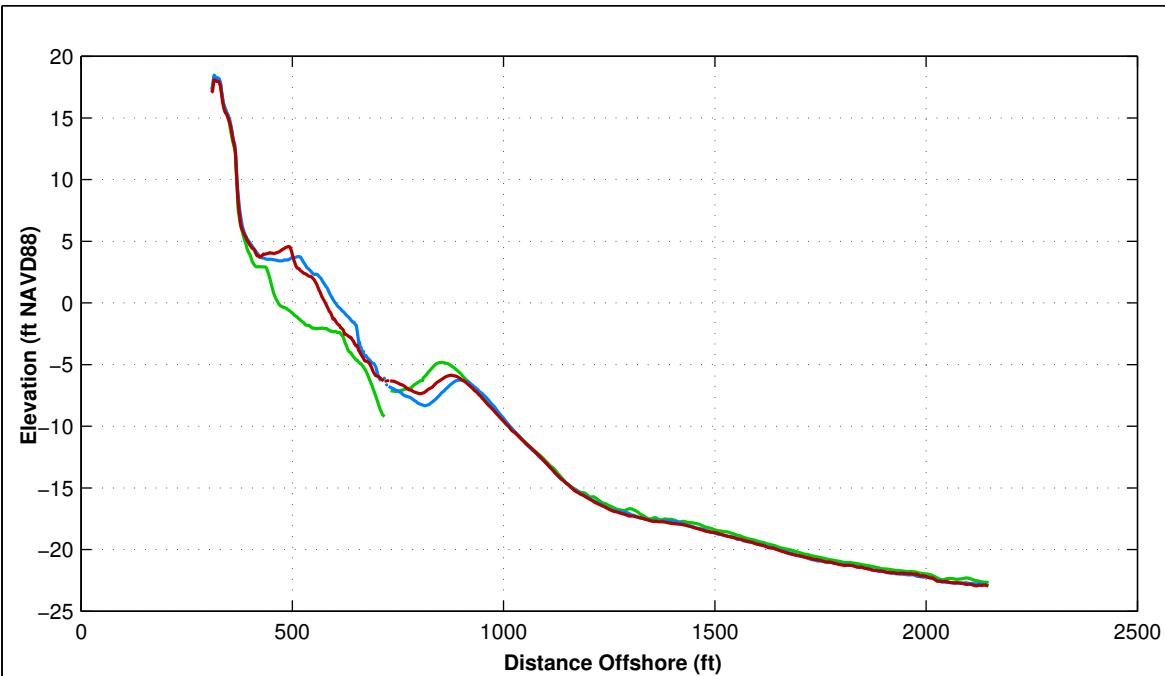
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

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3. All Survey Elevations In Feet Referenced to NAVD88.
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Survey Transect 333+23	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	110.62 ft/yr	-21.15 ft
Volume Change Above -15 ft NAVD88	23.12 cy/ft/yr	-2.71 cy/ft
Volume Change Above 0 ft NAVD88	15.96 cy/ft/yr	-2.13 cy/ft

LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

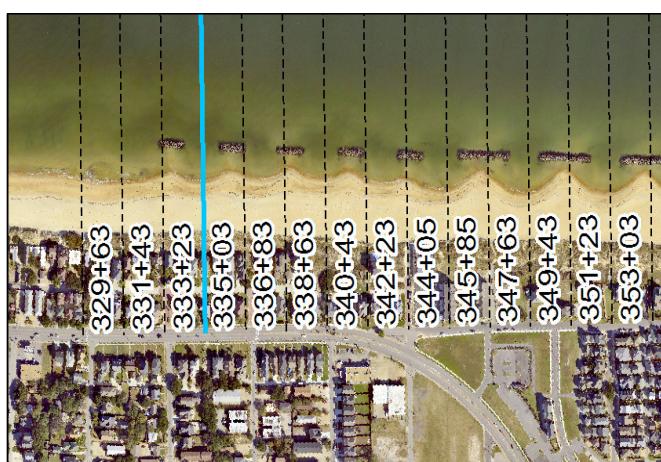
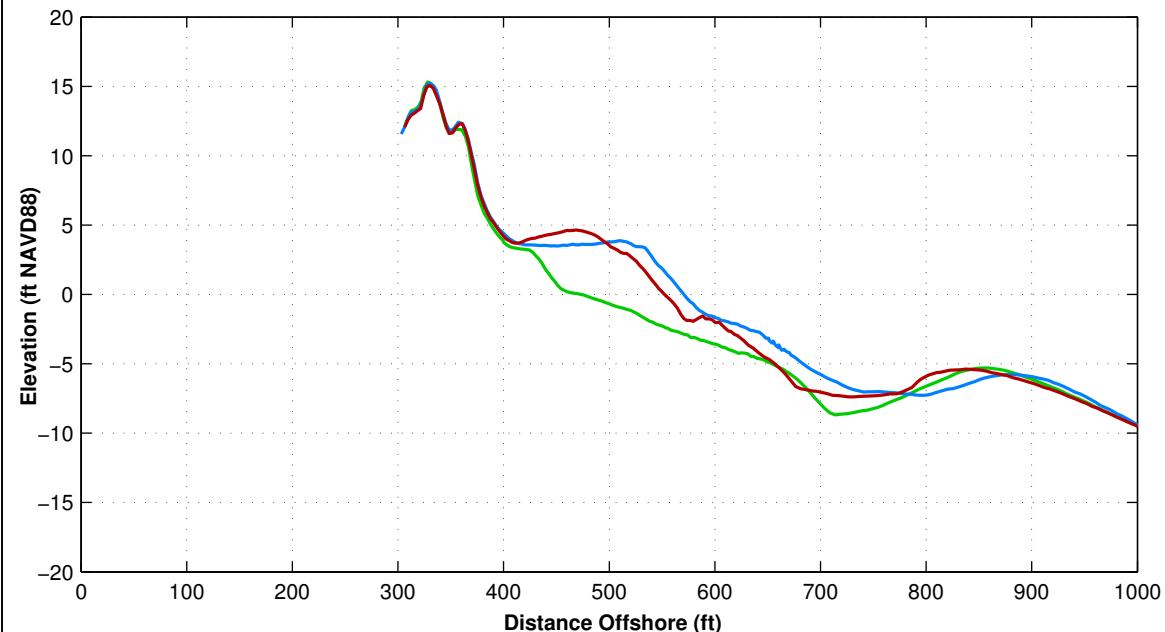
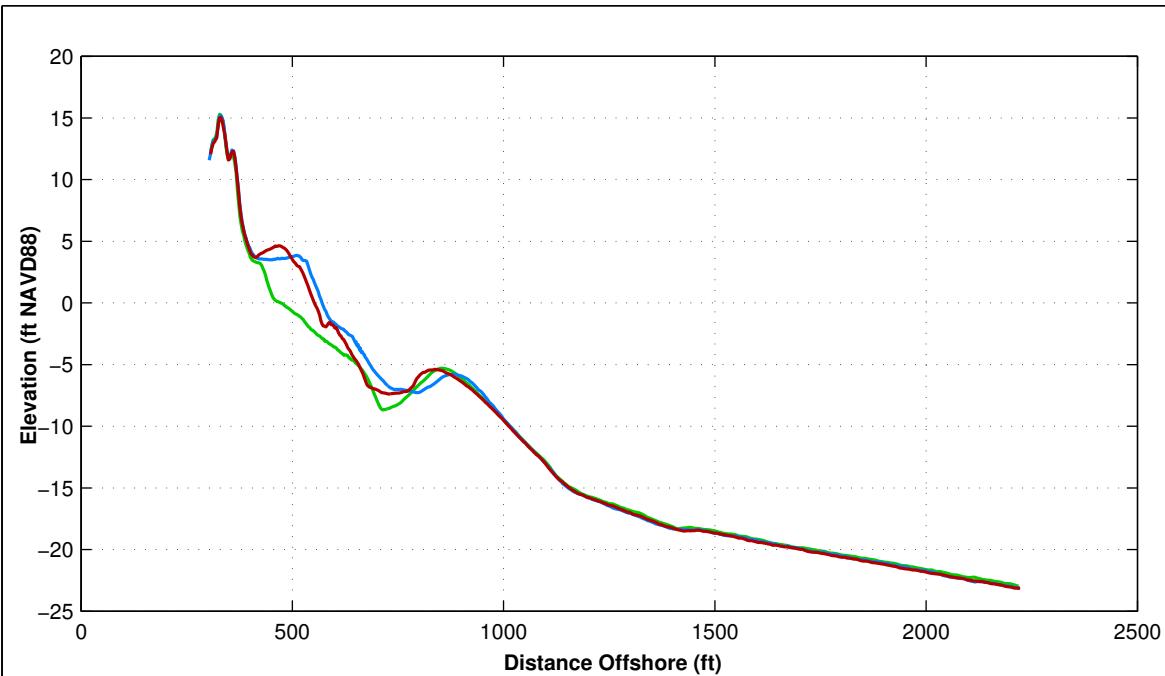
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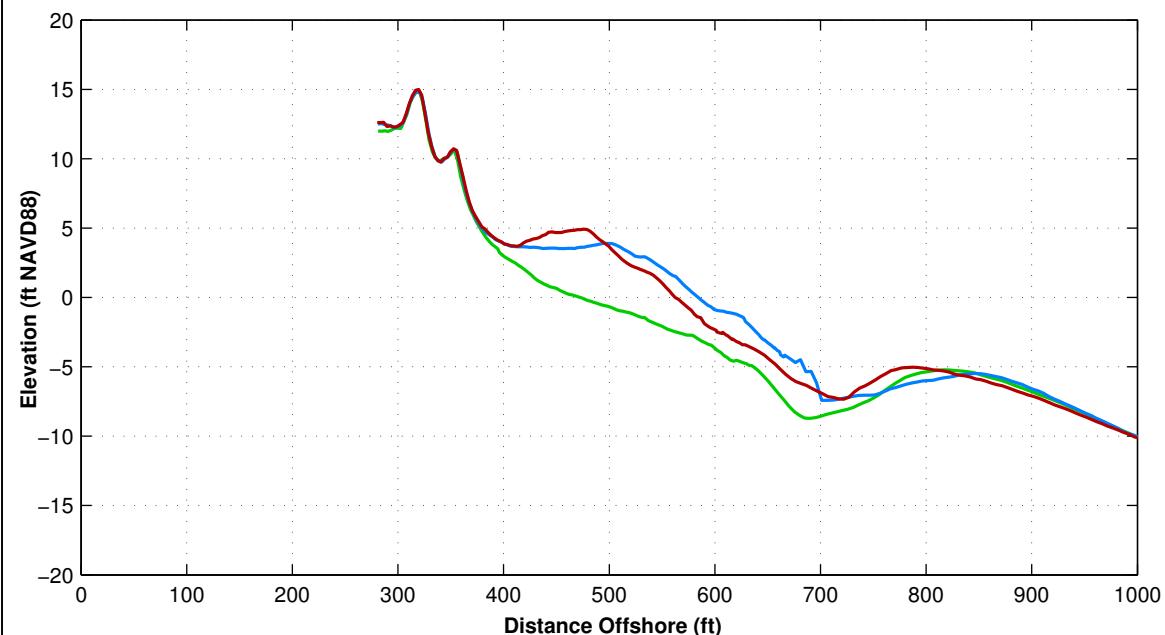
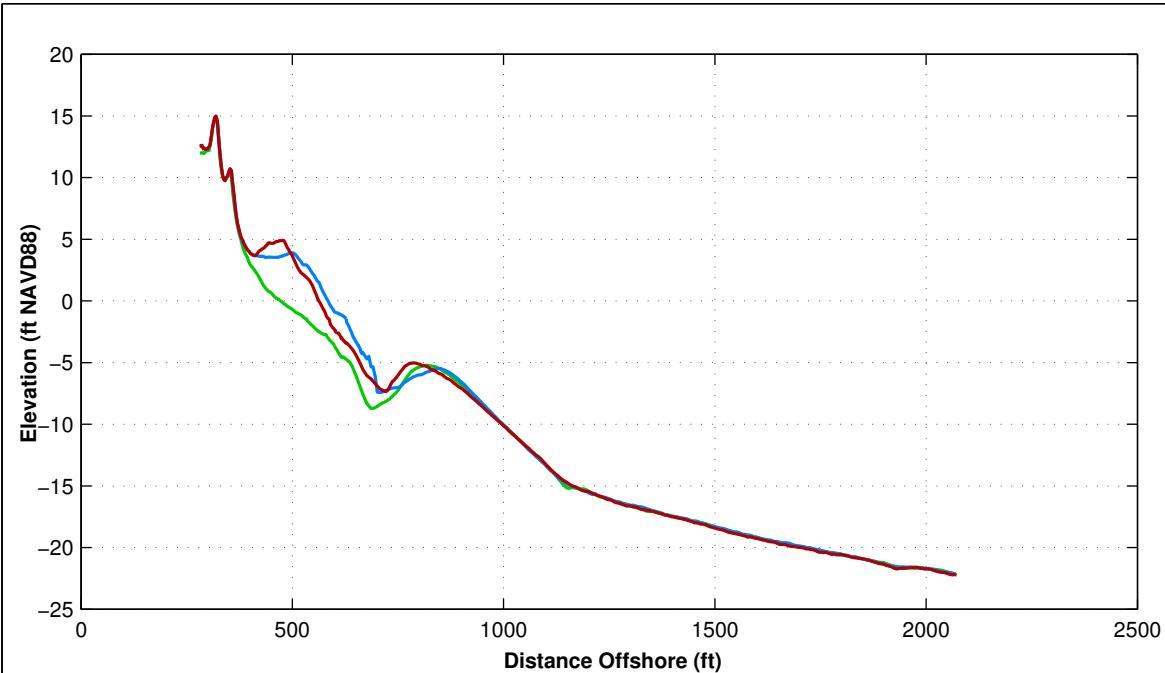
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SURVEYING DATA &
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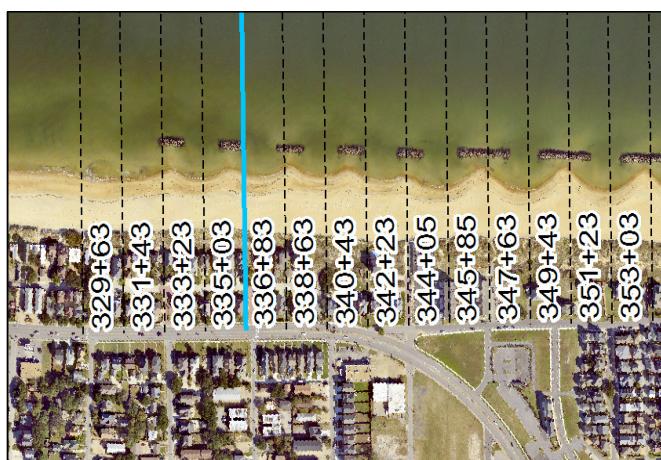


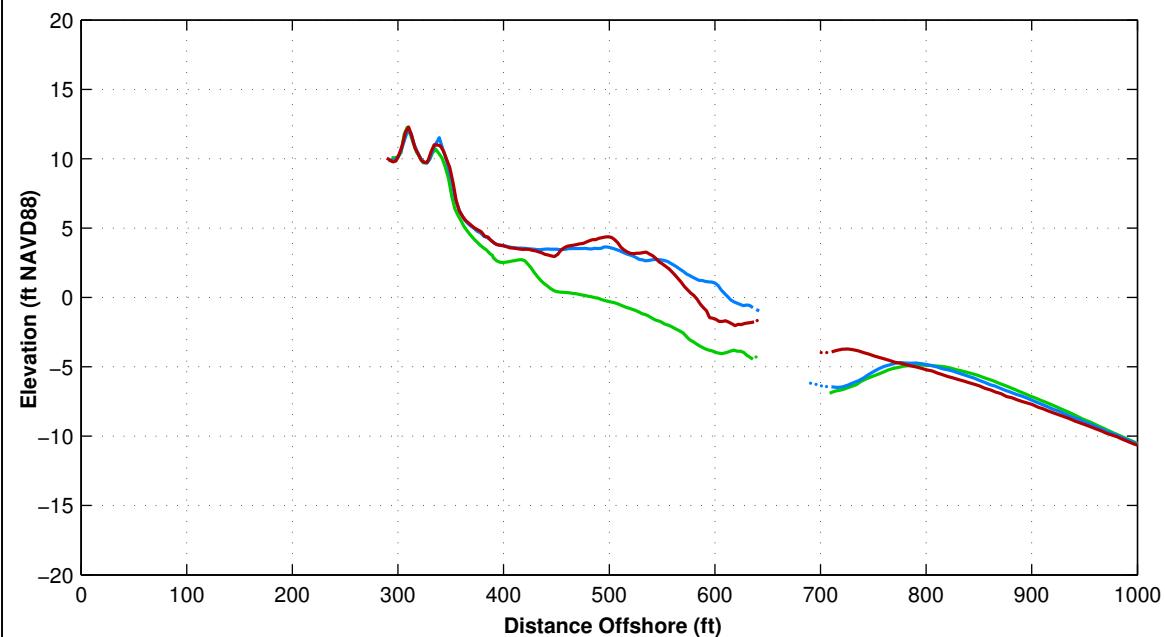
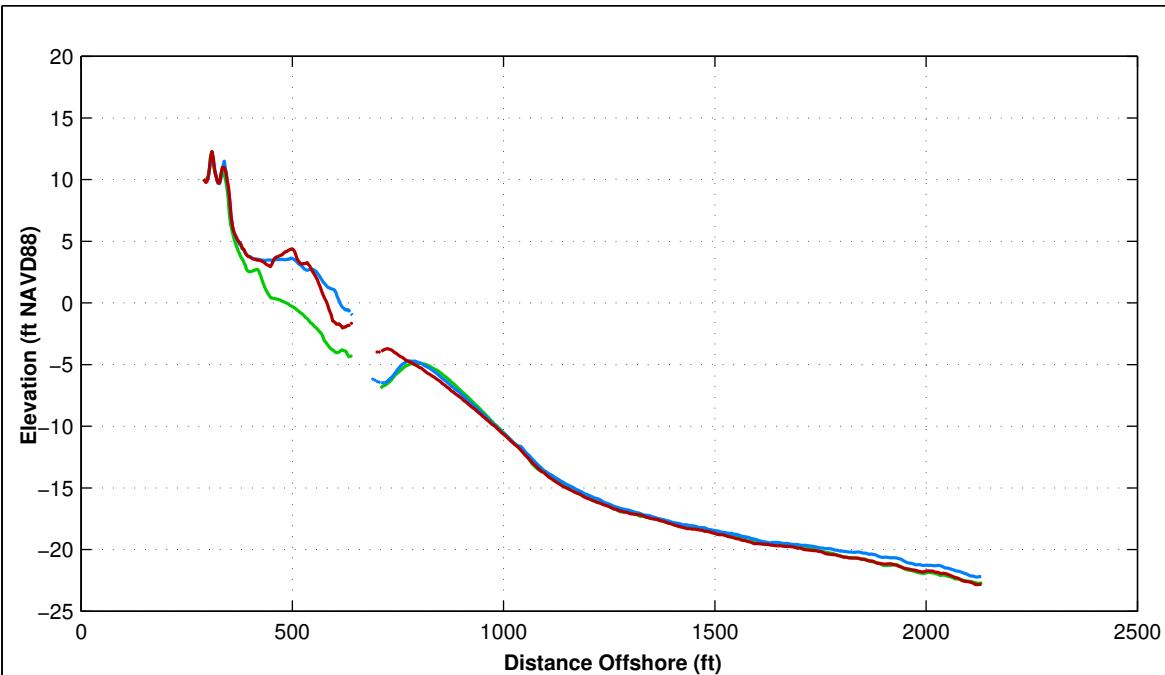


Survey Transect 336+83	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	113.63 ft/yr	-18.83 ft
Volume Change Above -15 ft NAVD88	33.59 cy/ft/yr	-4.71 cy/ft
Volume Change Above 0 ft NAVD88	18.46 cy/ft/yr	0.11 cy/ft

Notes:

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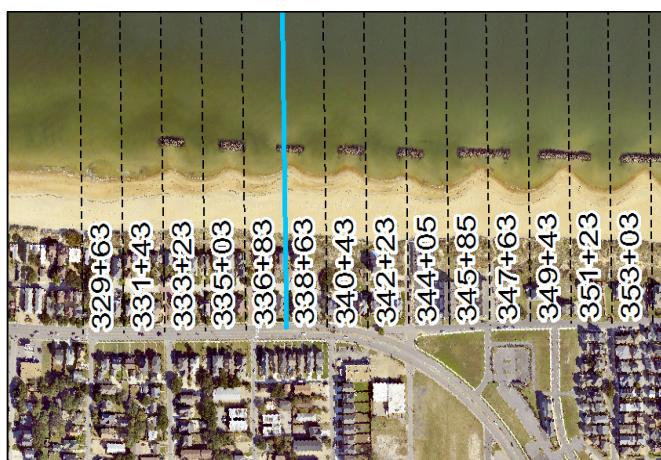
Survey Transect 338+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	131.24 ft/yr	-31.65 ft
Volume Change Above -15 ft NAVD88	30.00 cy/ft/yr	-3.45 cy/ft
Volume Change Above 0 ft NAVD88	19.64 cy/ft/yr	-0.81 cy/ft

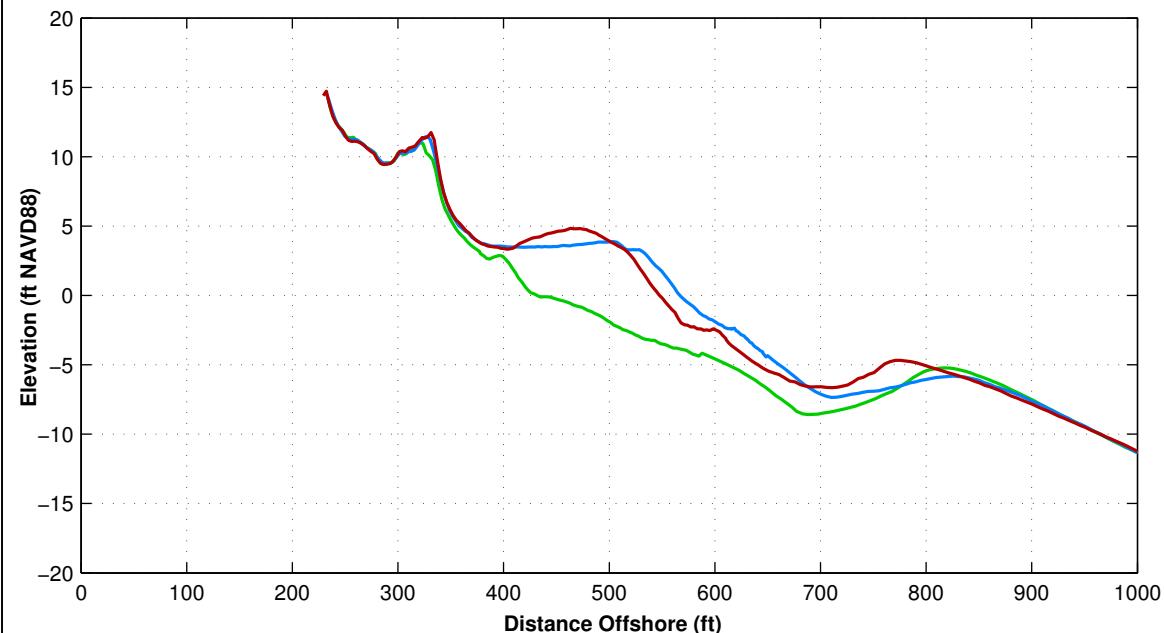
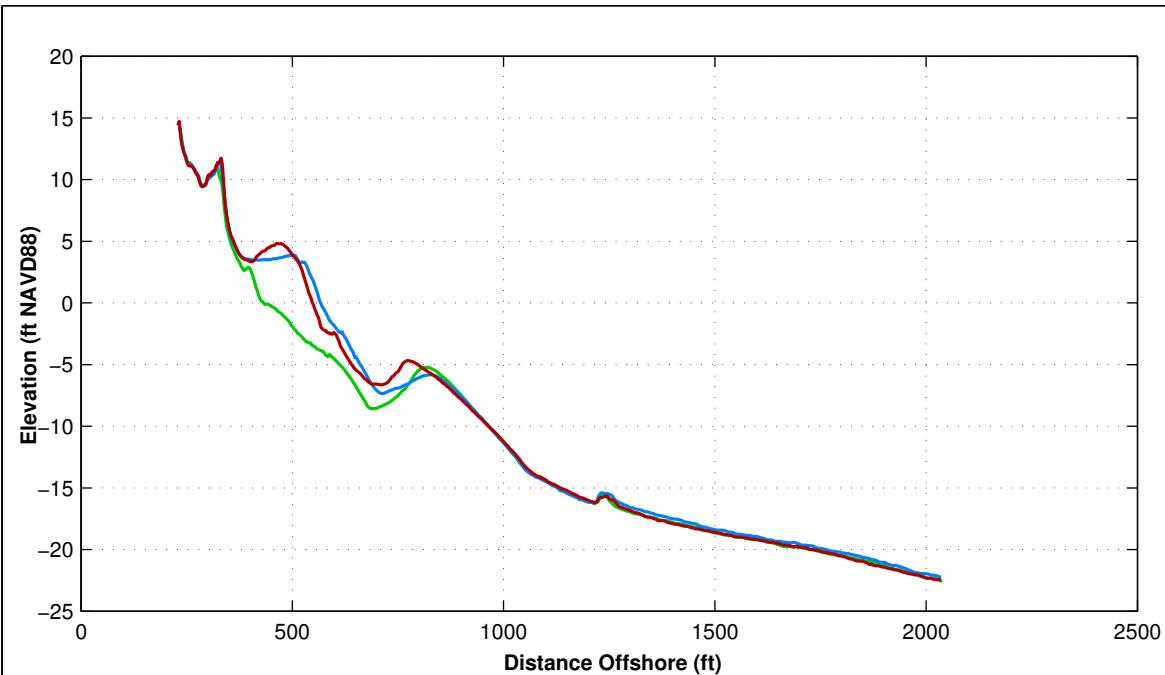
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

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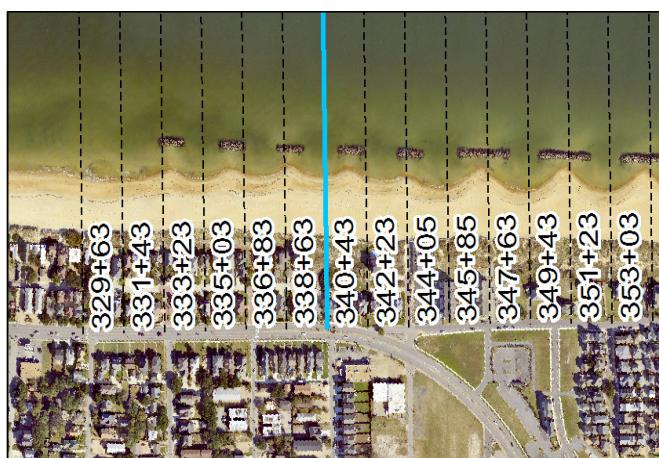


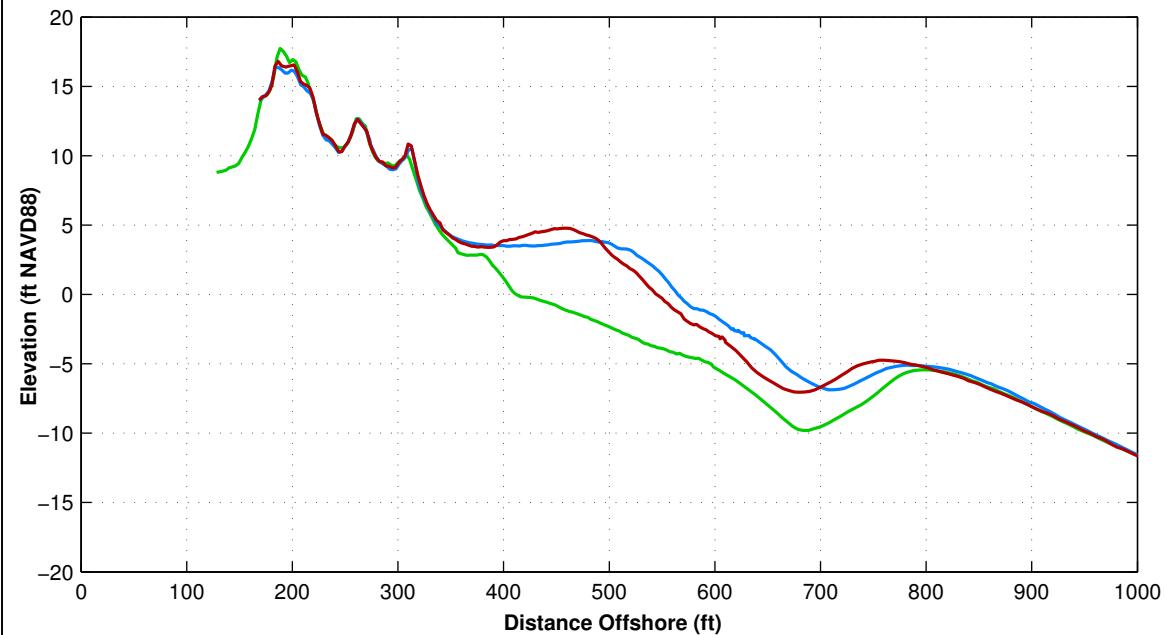
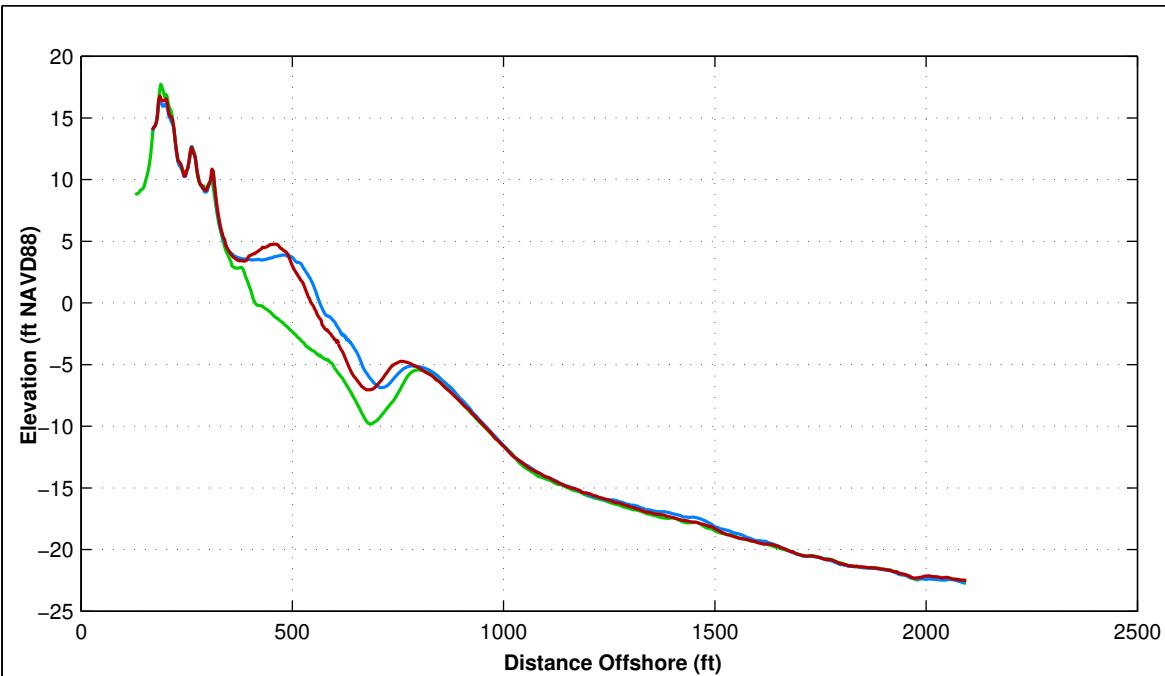
Survey Transect 340+43	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	121.18 ft/yr	-19.87 ft
Volume Change Above -15 ft NAVD88	43.57 cy/ft/yr	0.84 cy/ft
Volume Change Above 0 ft NAVD88	21.02 cy/ft/yr	0.54 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





Survey Transect 342+23	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	131.35 ft/yr	-22.23 ft
Volume Change Above -15 ft NAVD88	51.33 cy/ft/yr	-7.24 cy/ft
Volume Change Above 0 ft NAVD88	20.46 cy/ft/yr	0.19 cy/ft

LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

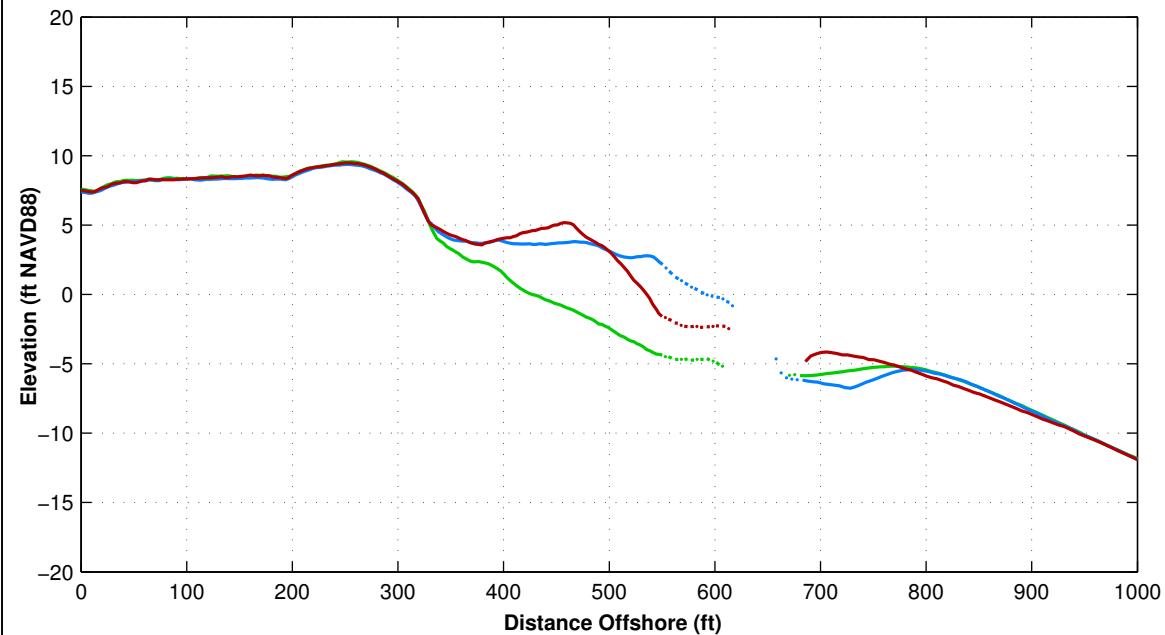
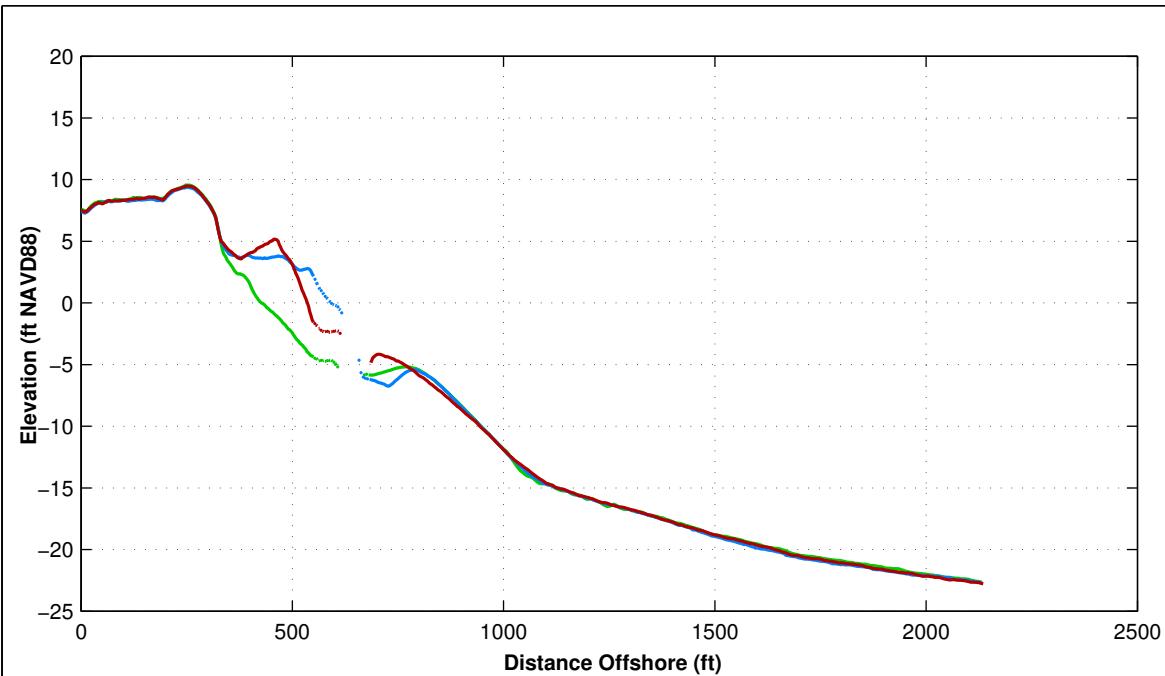
Notes:

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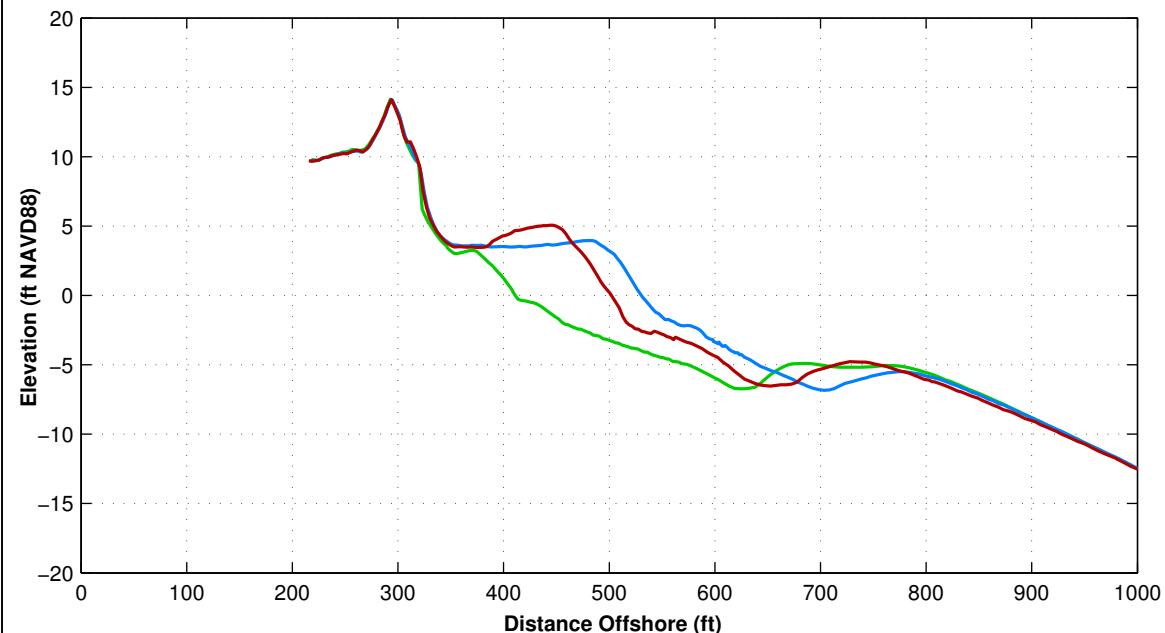
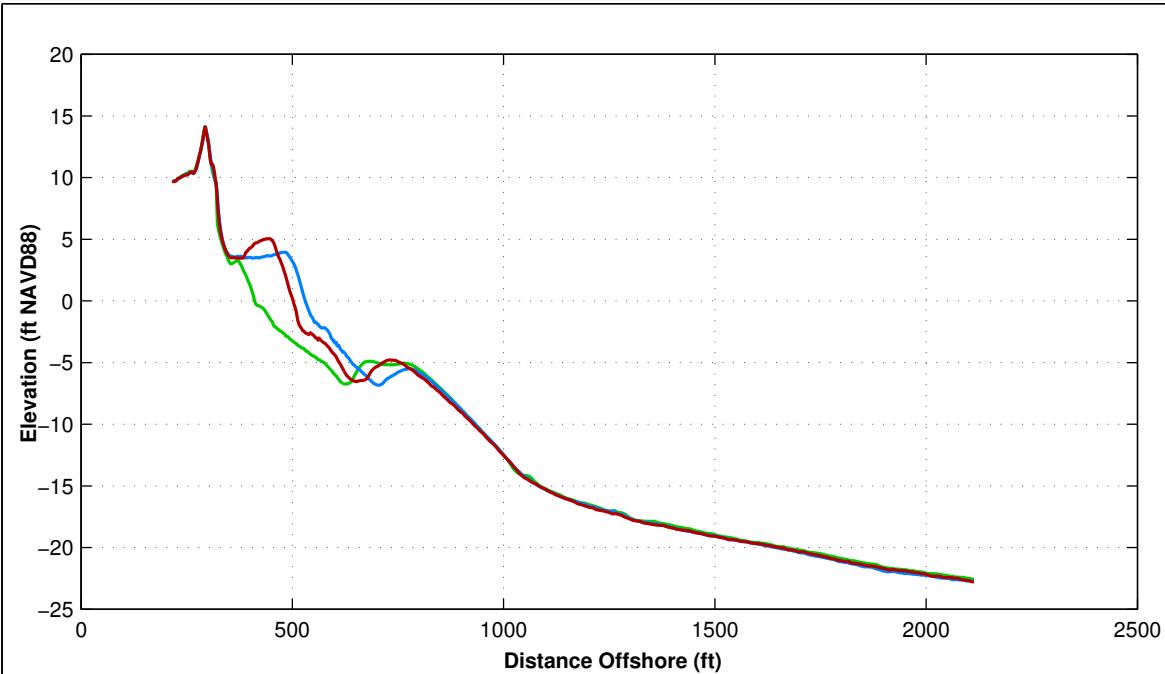


Survey Transect 344+05	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	117.84 ft/yr	-44.84 ft
Volume Change Above -15 ft NAVD88	31.72 cy/ft/yr	5.14 cy/ft
Volume Change Above 0 ft NAVD88	20.56 cy/ft/yr	-0.21 cy/ft

Notes:

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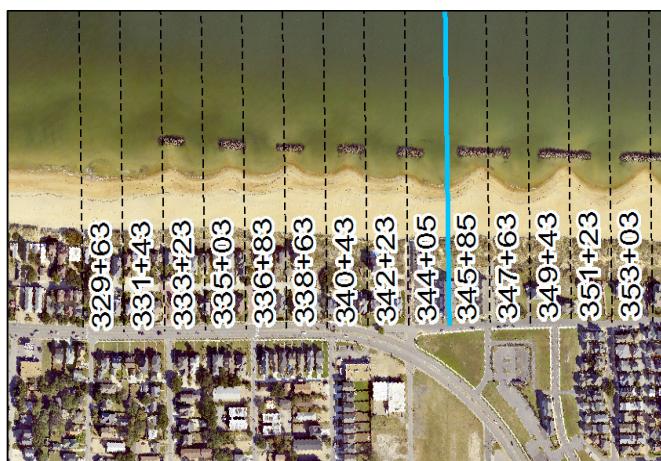
Survey Transect 345+85	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	90.27 ft/yr	-29.89 ft
Volume Change Above -15 ft NAVD88	26.06 cy/ft/yr	-7.83 cy/ft
Volume Change Above 0 ft NAVD88	16.31 cy/ft/yr	-1.40 cy/ft

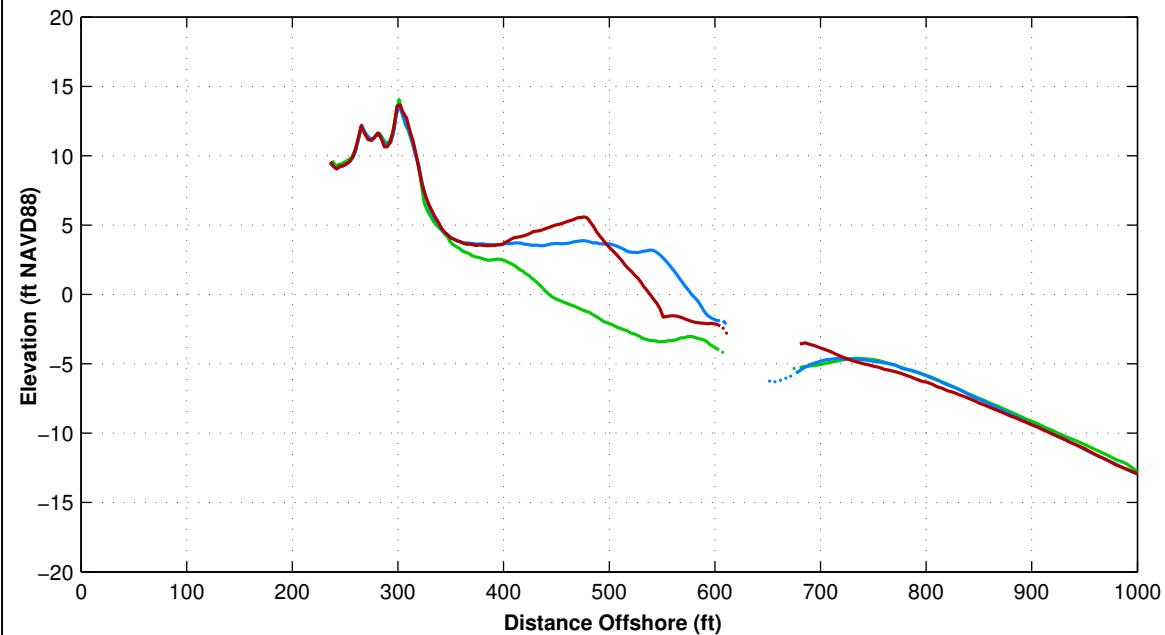
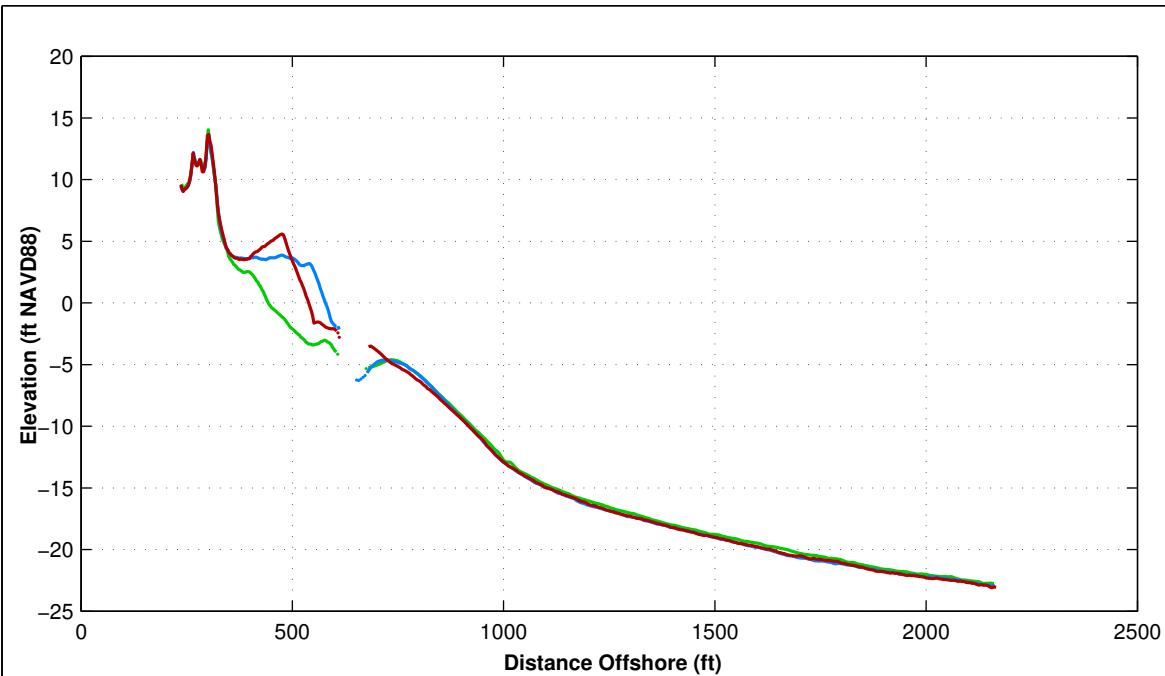
LEGEND:

- OCT 2017 — Red line
- MAY 2017 — Blue line
- OCT 2016 — Green line

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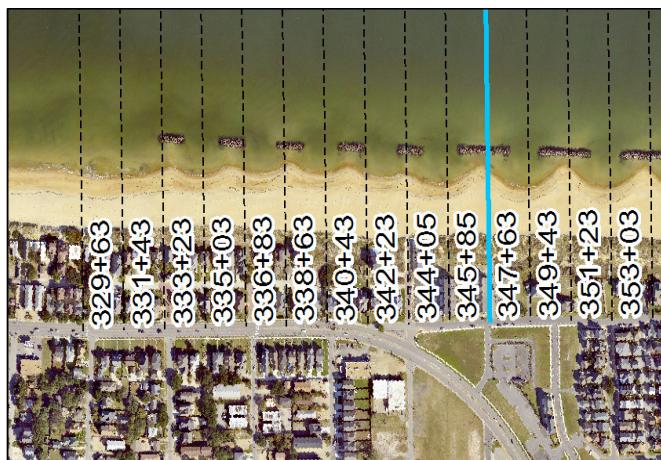


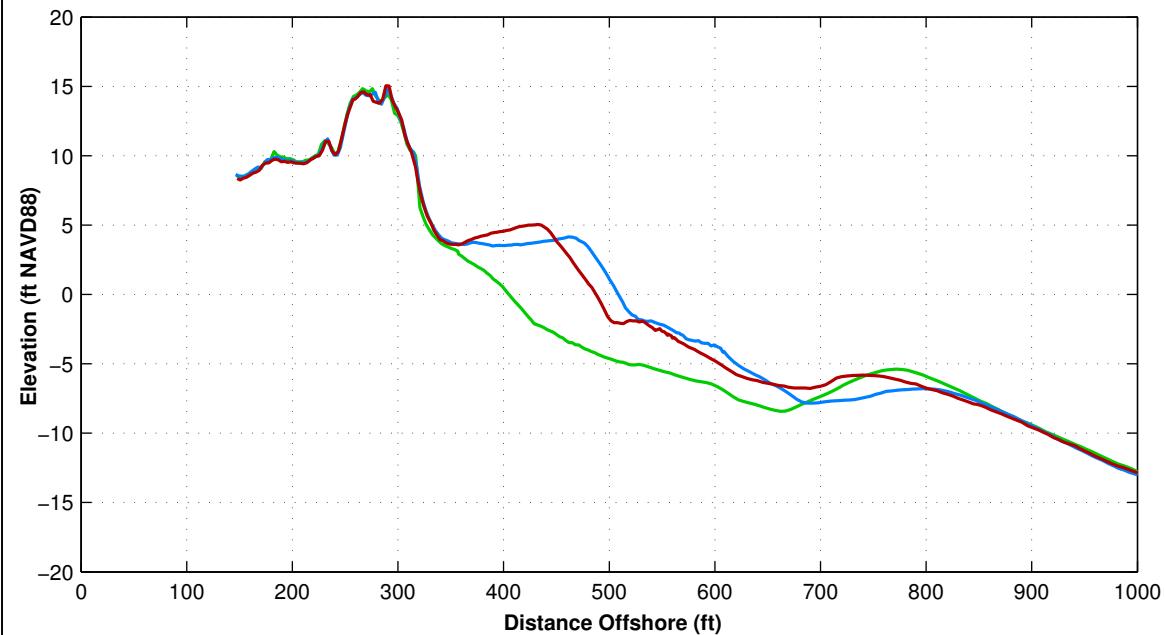
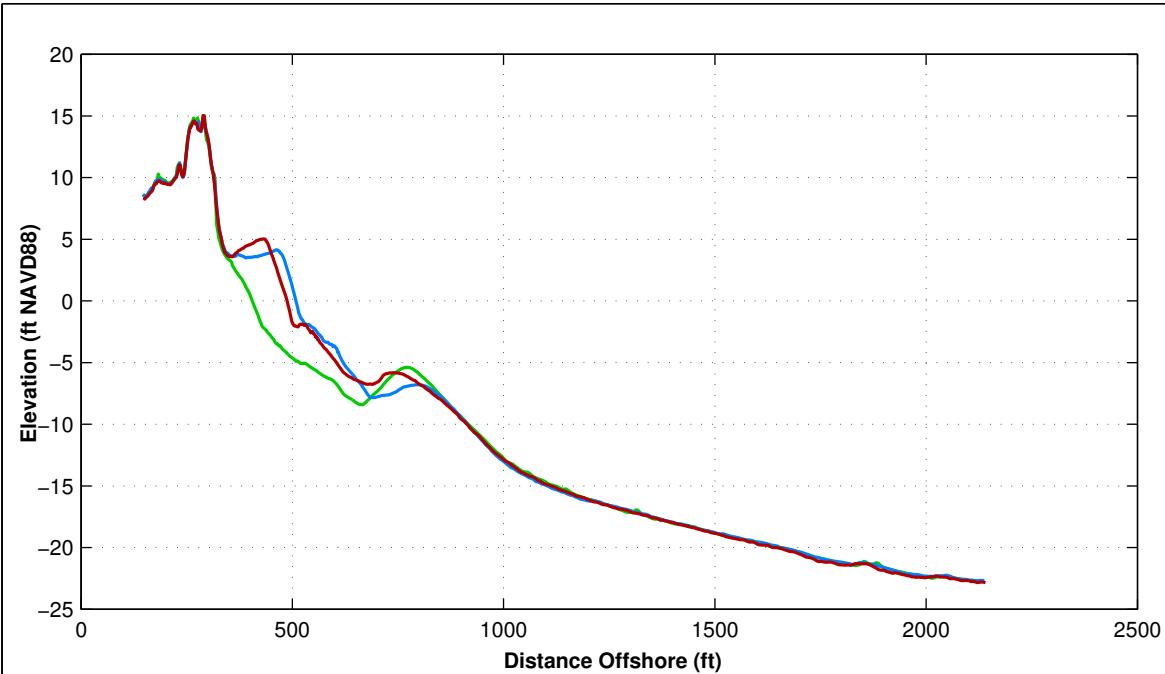


Survey Transect 347+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	99.61 ft/yr	-39.42 ft
Volume Change Above -15 ft NAVD88	27.20 cy/ft/yr	-4.17 cy/ft
Volume Change Above 0 ft NAVD88	19.60 cy/ft/yr	-0.90 cy/ft

Notes:

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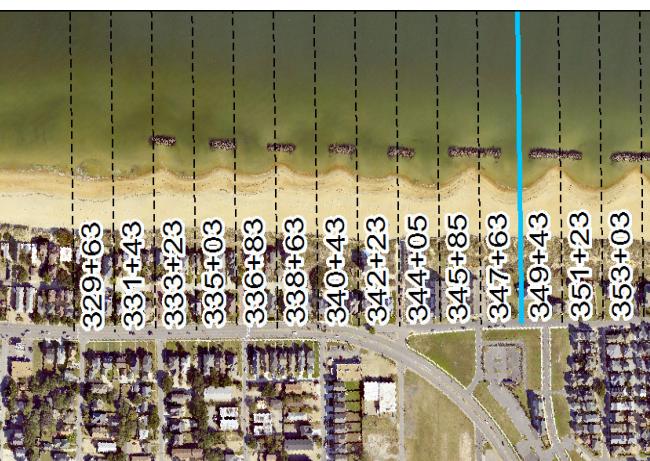


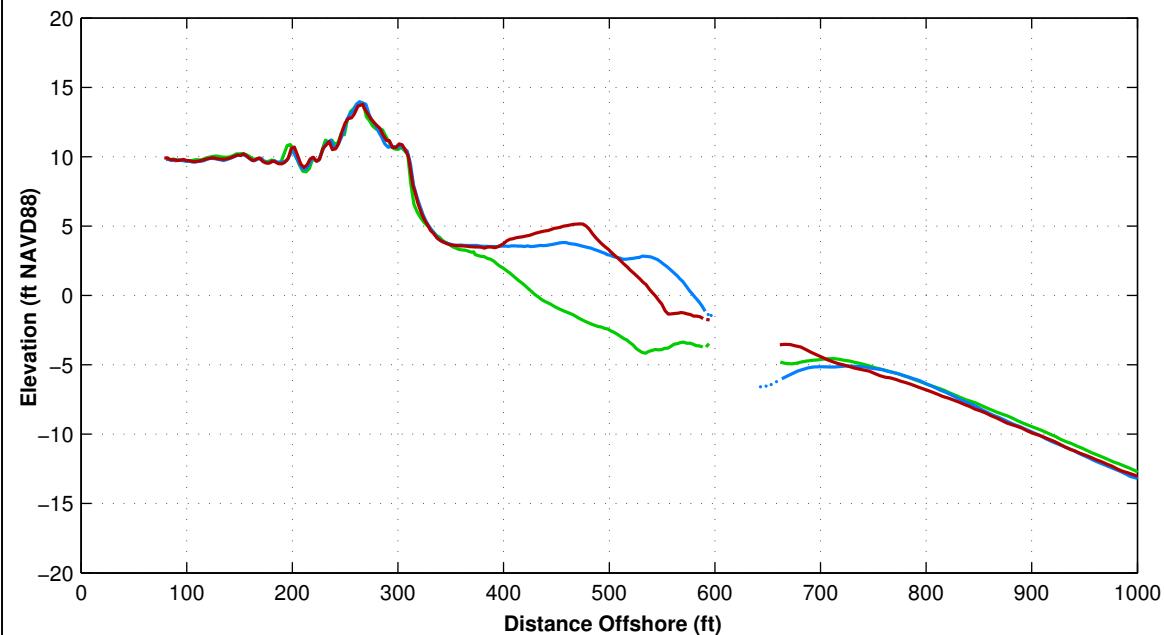
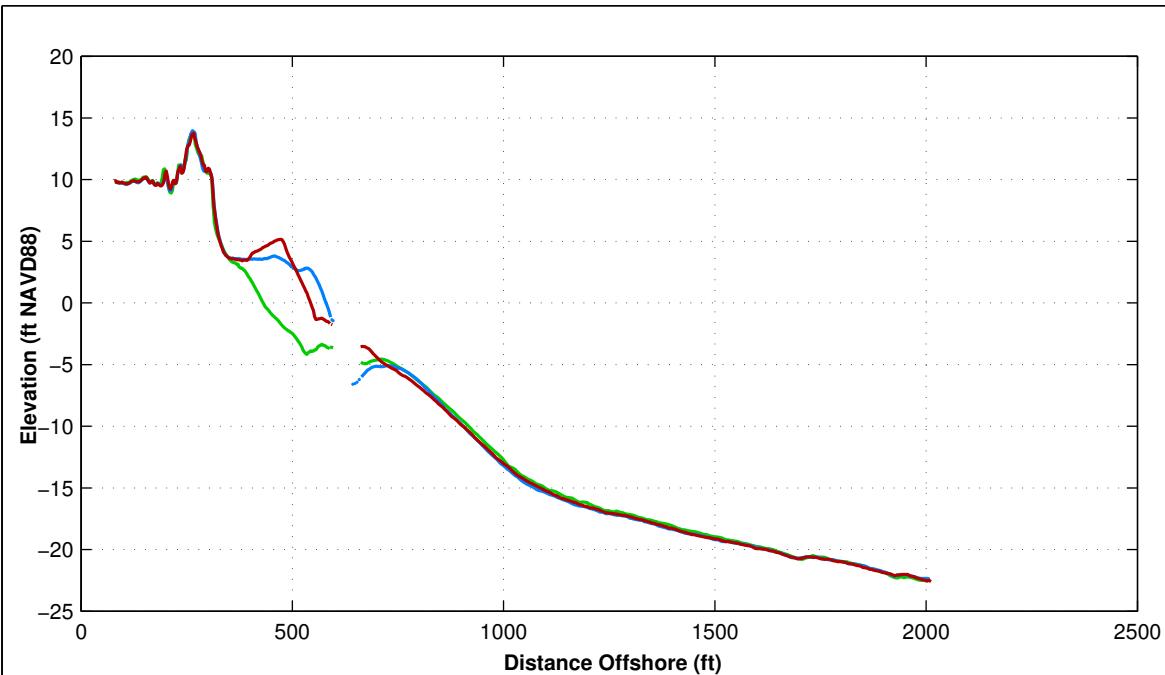
Survey Transect 349+43	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	86.44 ft/yr	-22.62 ft
Volume Change Above -15 ft NAVD88	37.56 cy/ft/yr	-0.23 cy/ft
Volume Change Above 0 ft NAVD88	15.38 cy/ft/yr	-1.38 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

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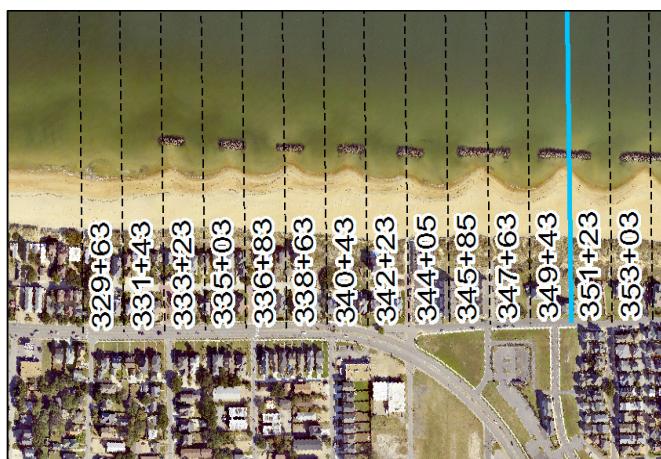
Survey Transect 351+23	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	116.45 ft/yr	-38.16 ft
Volume Change Above -15 ft NAVD88	29.19 cy/ft/yr	-0.32 cy/ft
Volume Change Above 0 ft NAVD88	19.57 cy/ft/yr	-0.20 cy/ft

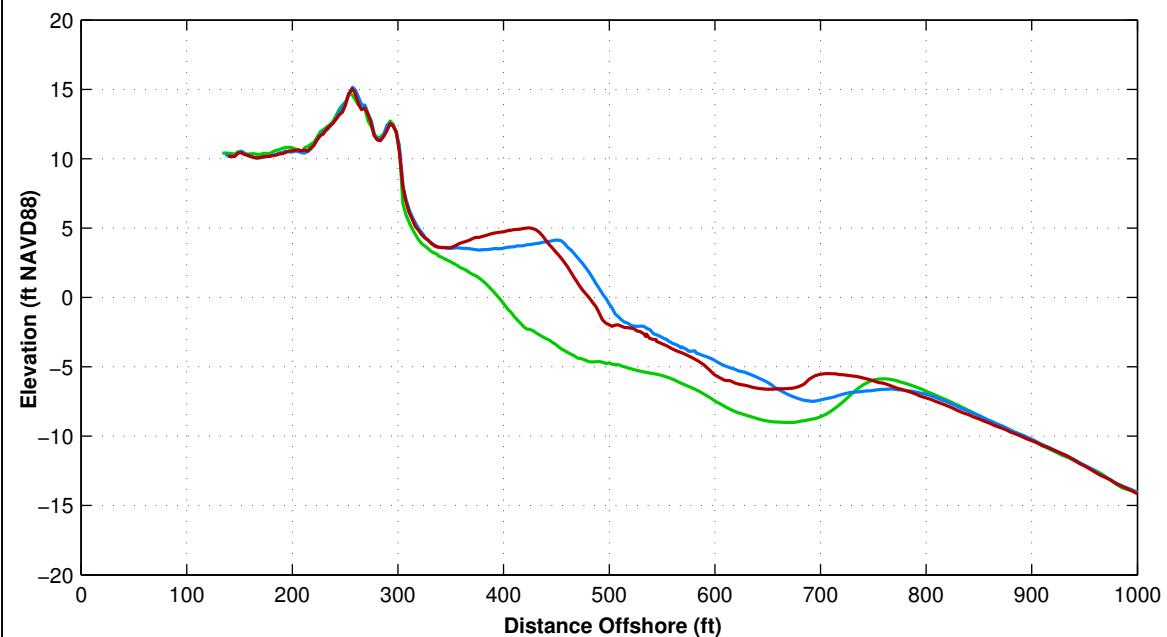
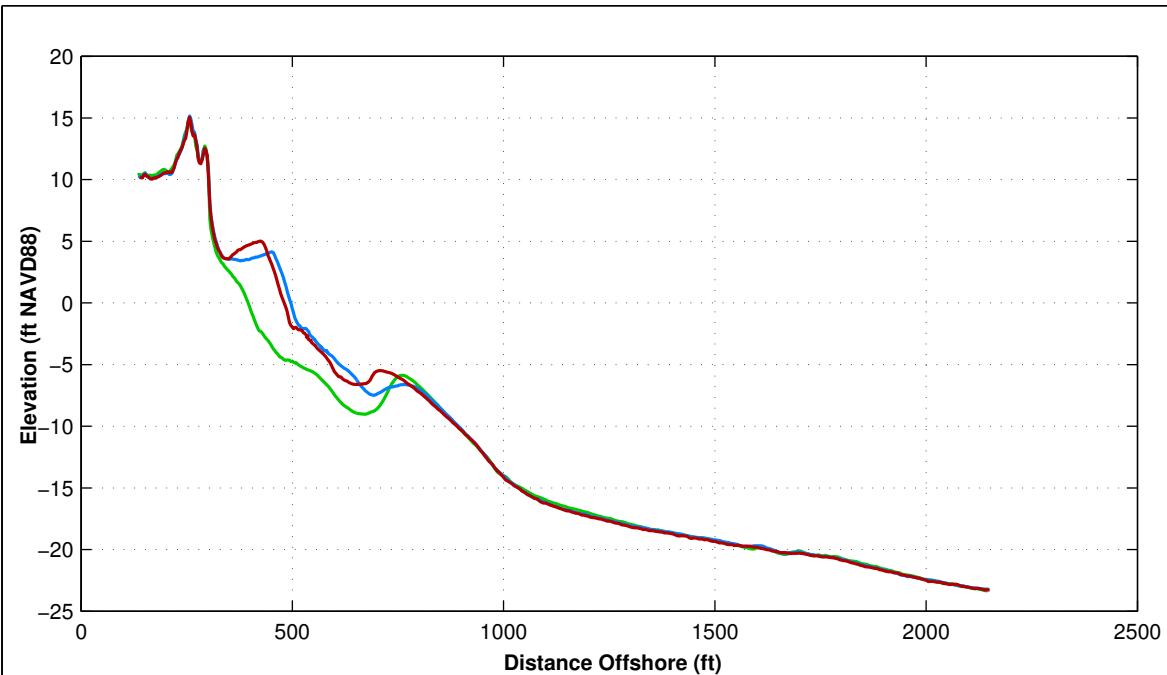
LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
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Notes:

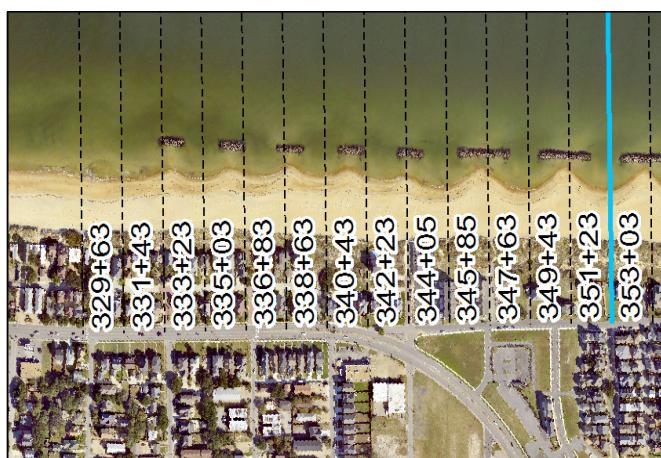
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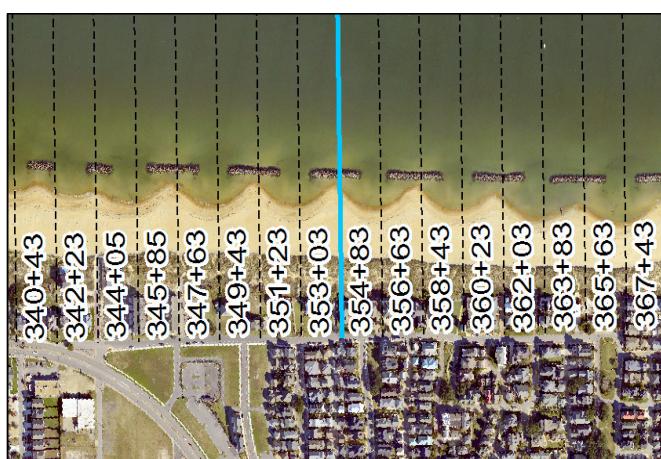
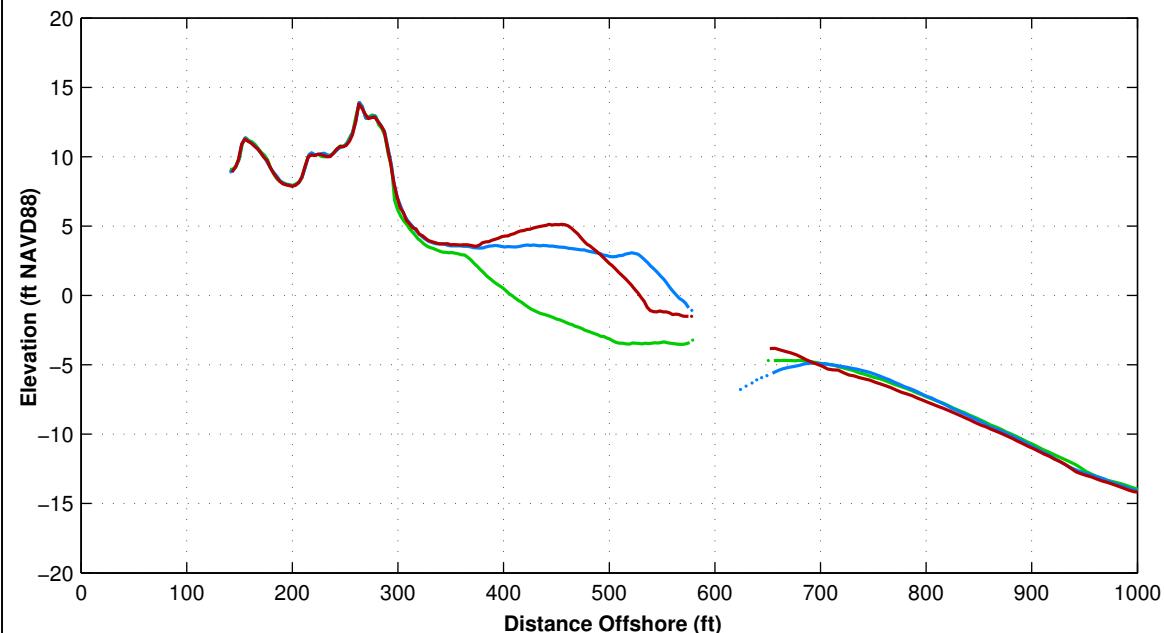
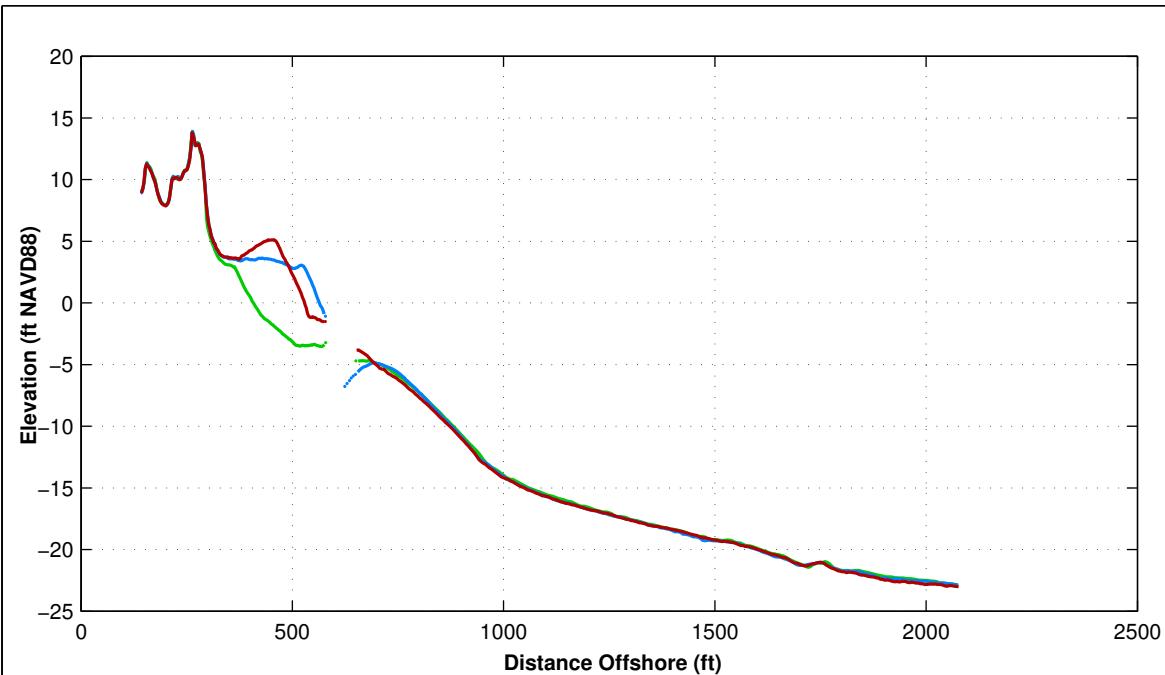
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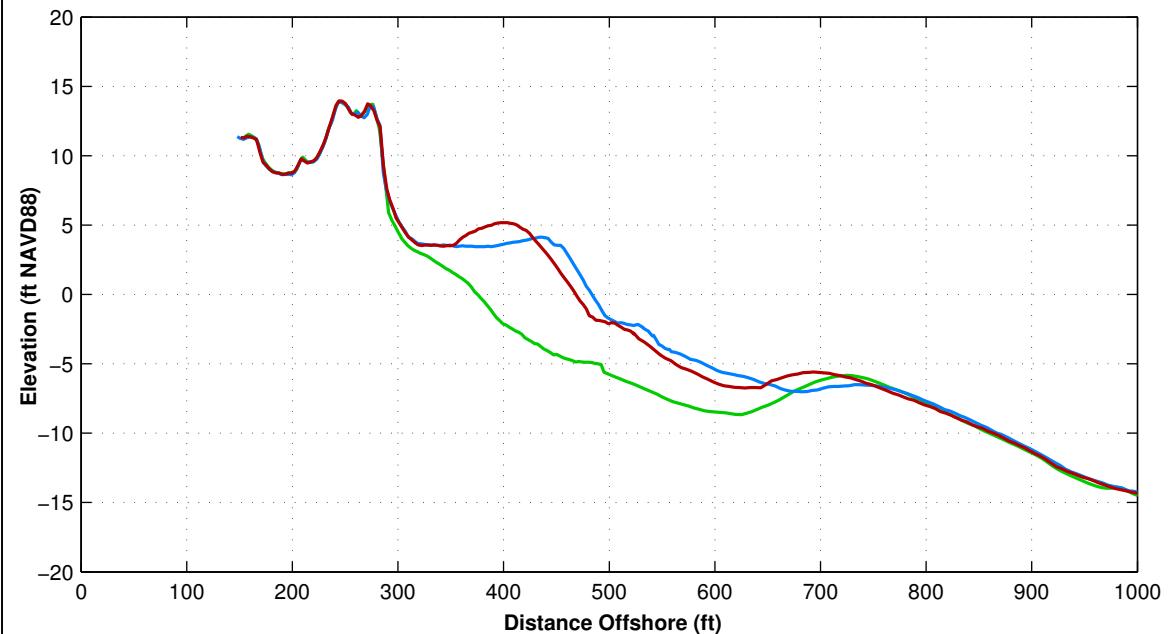
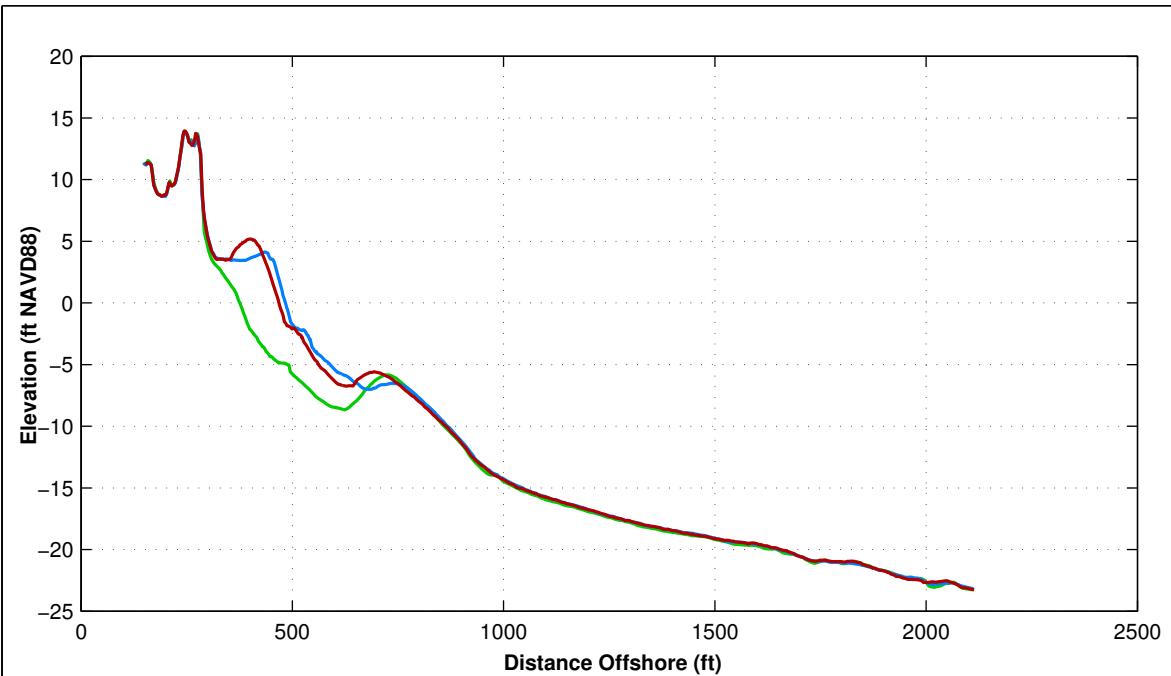
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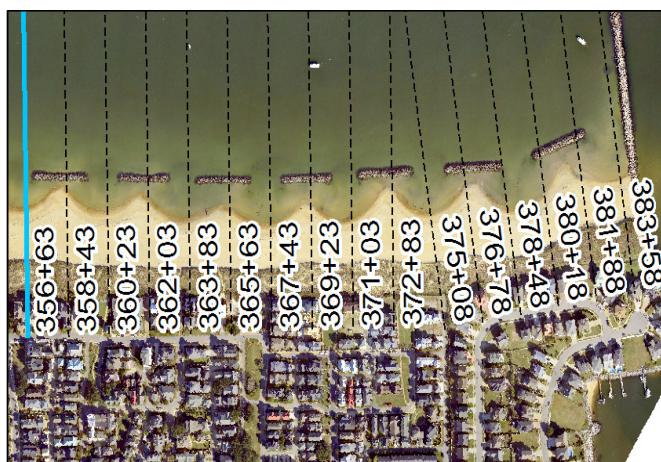
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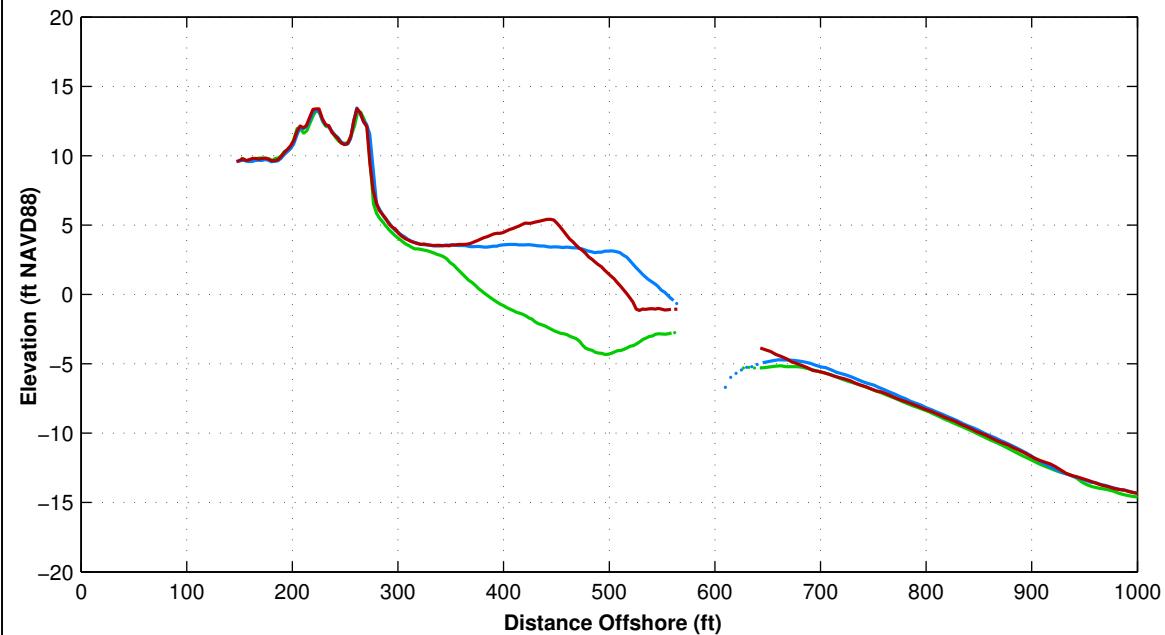
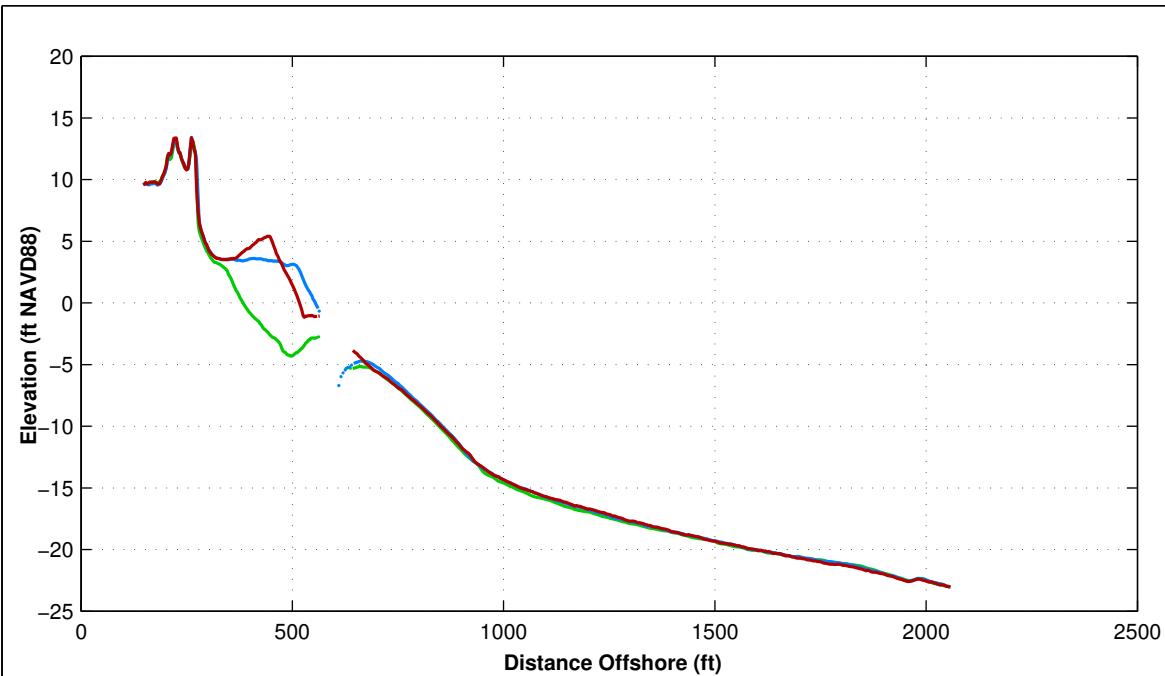
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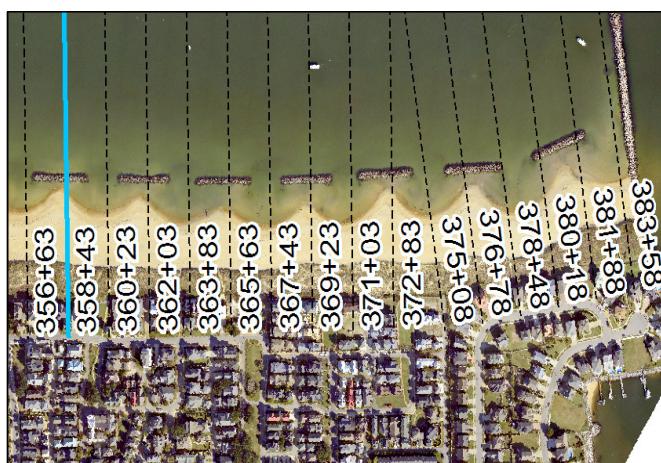
Survey Transect 358+43	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	139.29 ft/yr	-32.80 ft
Volume Change Above -15 ft NAVD88	43.11 cy/ft/yr	-2.17 cy/ft
Volume Change Above 0 ft NAVD88	23.59 cy/ft/yr	0.41 cy/ft

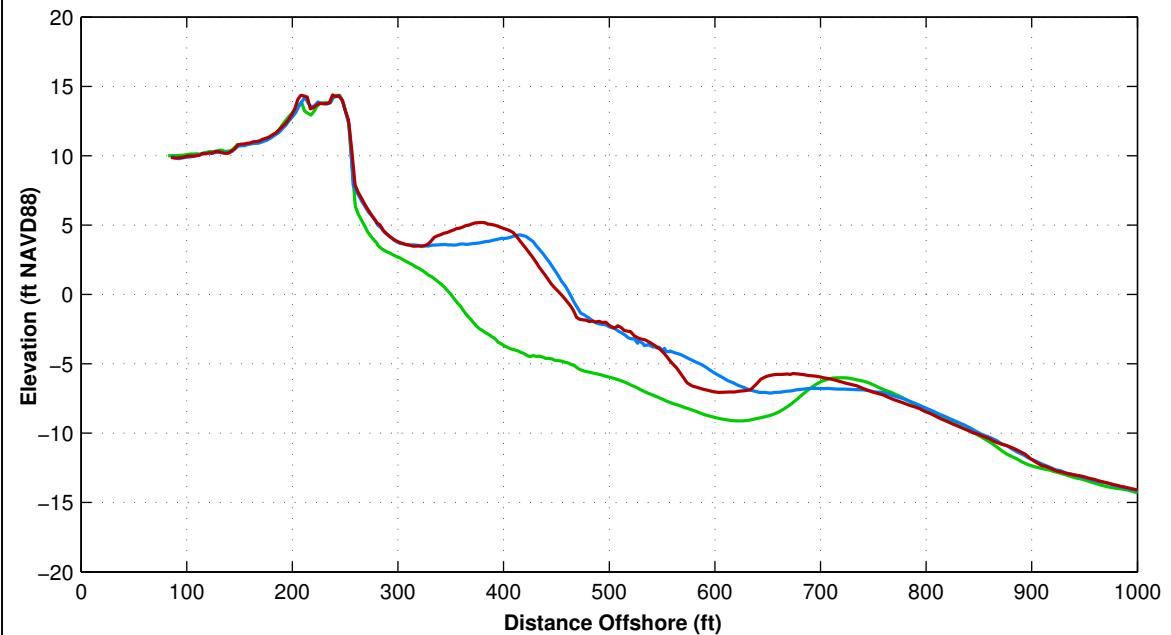
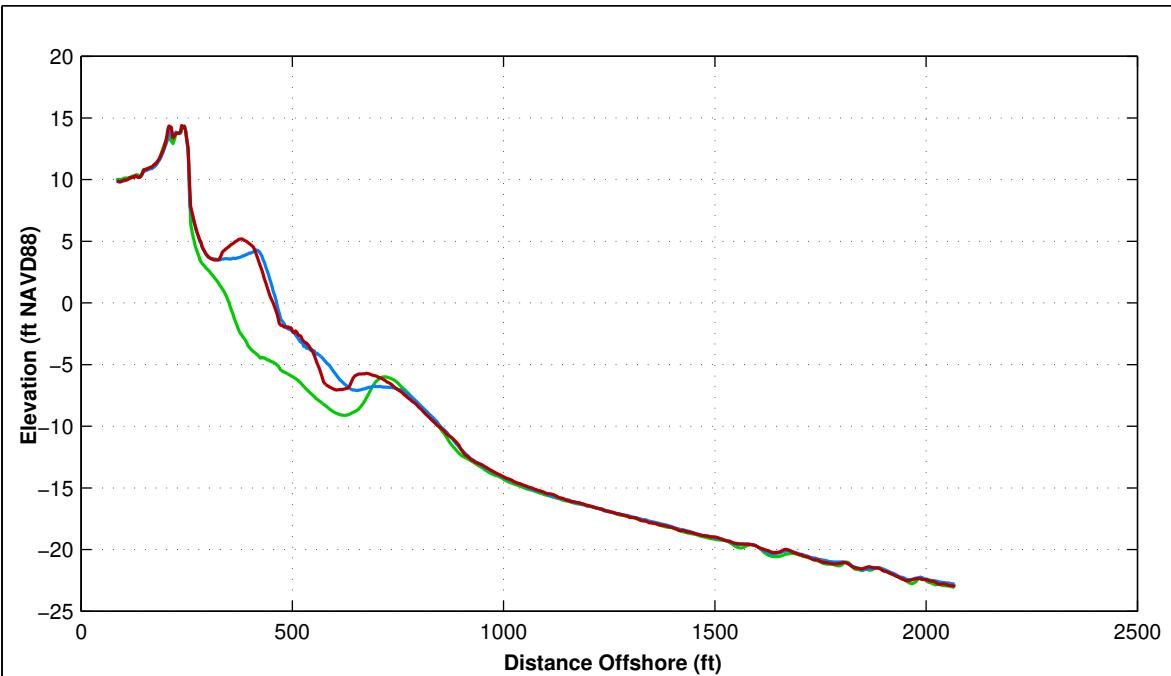
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

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5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





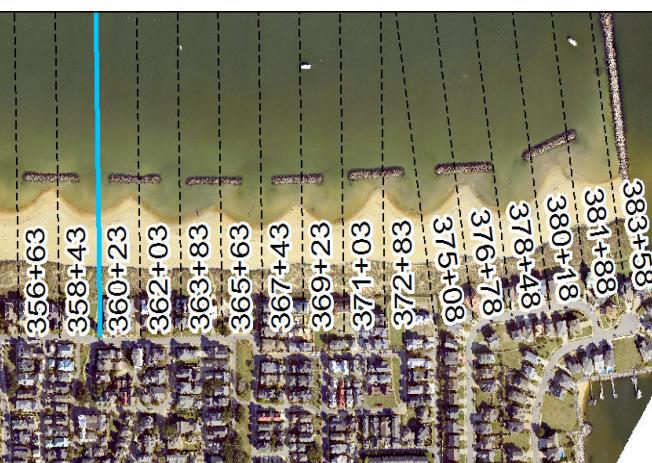
Survey Transect	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
360+23		
Shoreline Change at MHW (0.98 ft NAVD88)	106.58 ft/yr	-11.60 ft
Volume Change Above -15 ft NAVD88	60.09 cy/ft/yr	1.06 cy/ft
Volume Change Above 0 ft NAVD88	21.38 cy/ft/yr	1.91 cy/ft

LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.



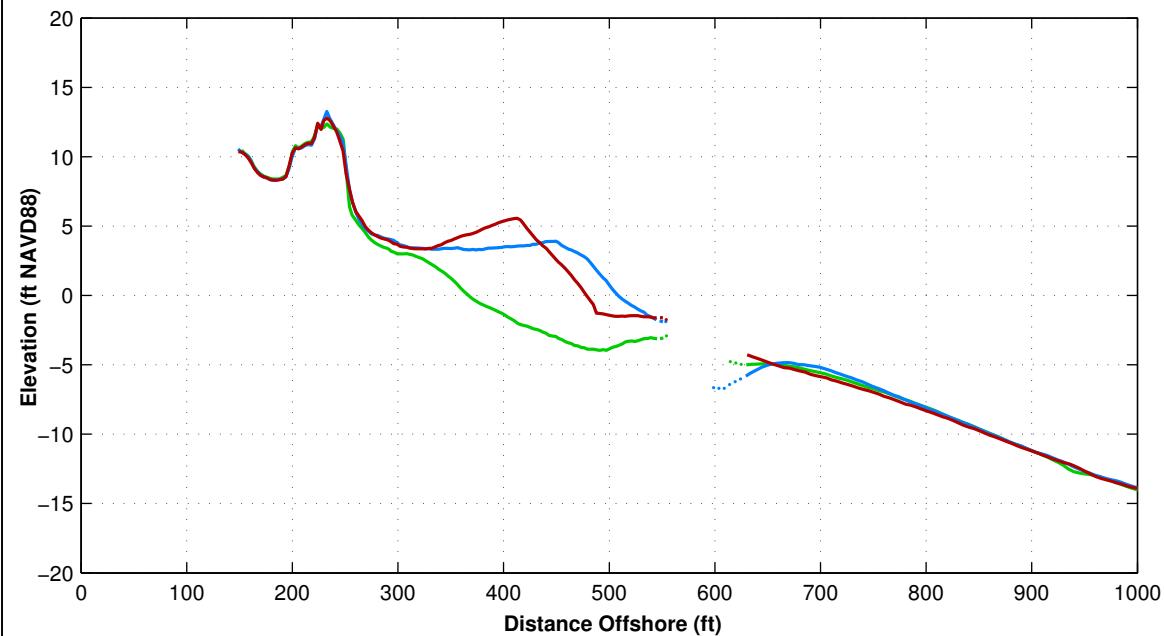
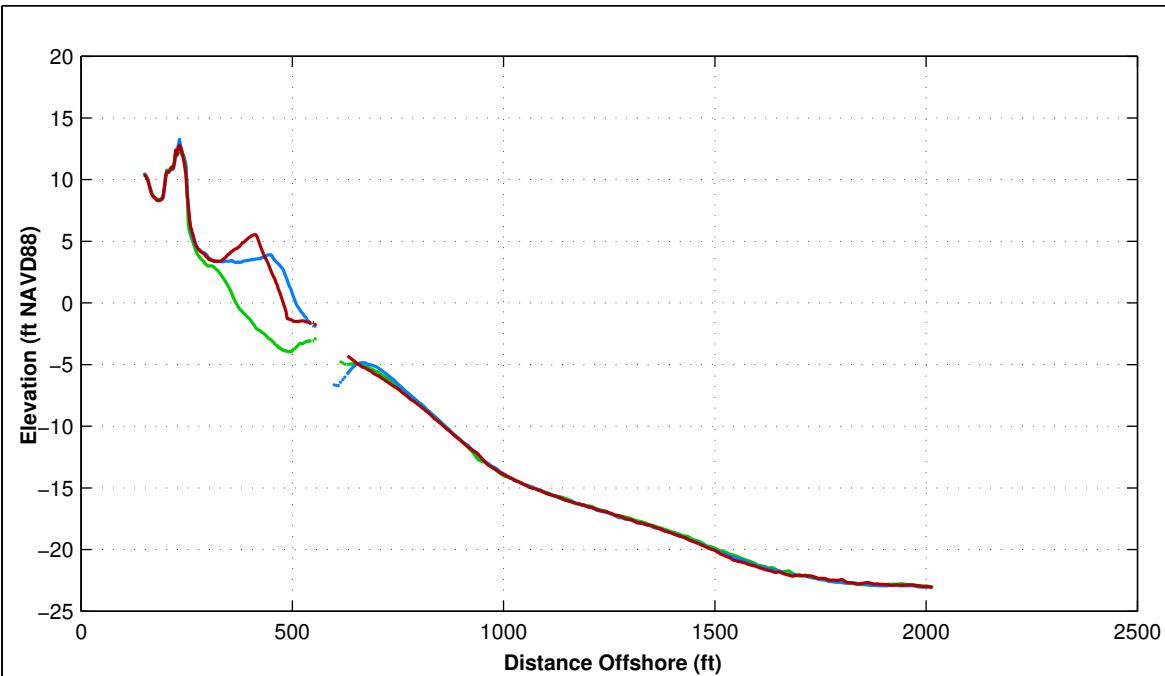
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ST 360+23

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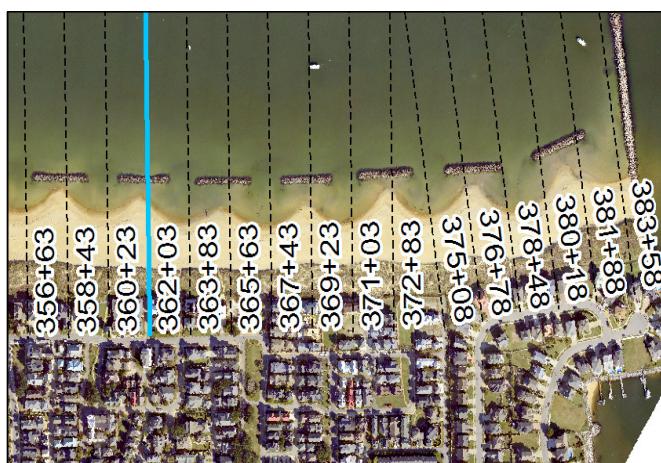
Survey Transect 362+03	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	115.59 ft/yr	-28.98 ft
Volume Change Above -15 ft NAVD88	34.10 cy/ft/yr	-4.14 cy/ft
Volume Change Above 0 ft NAVD88	20.96 cy/ft/yr	0.29 cy/ft

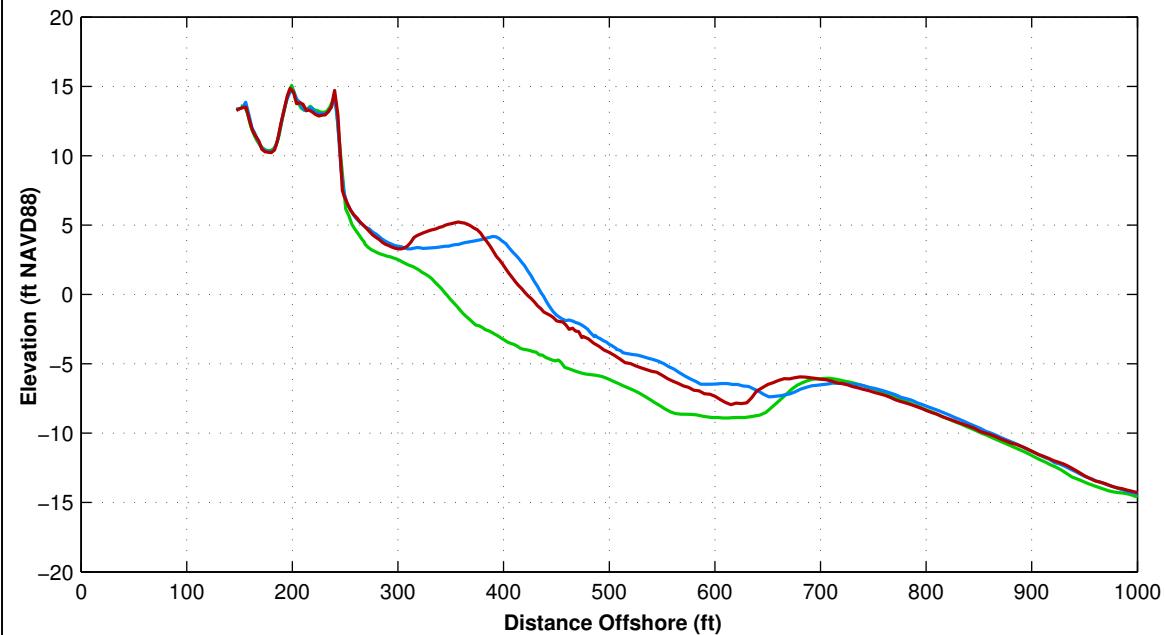
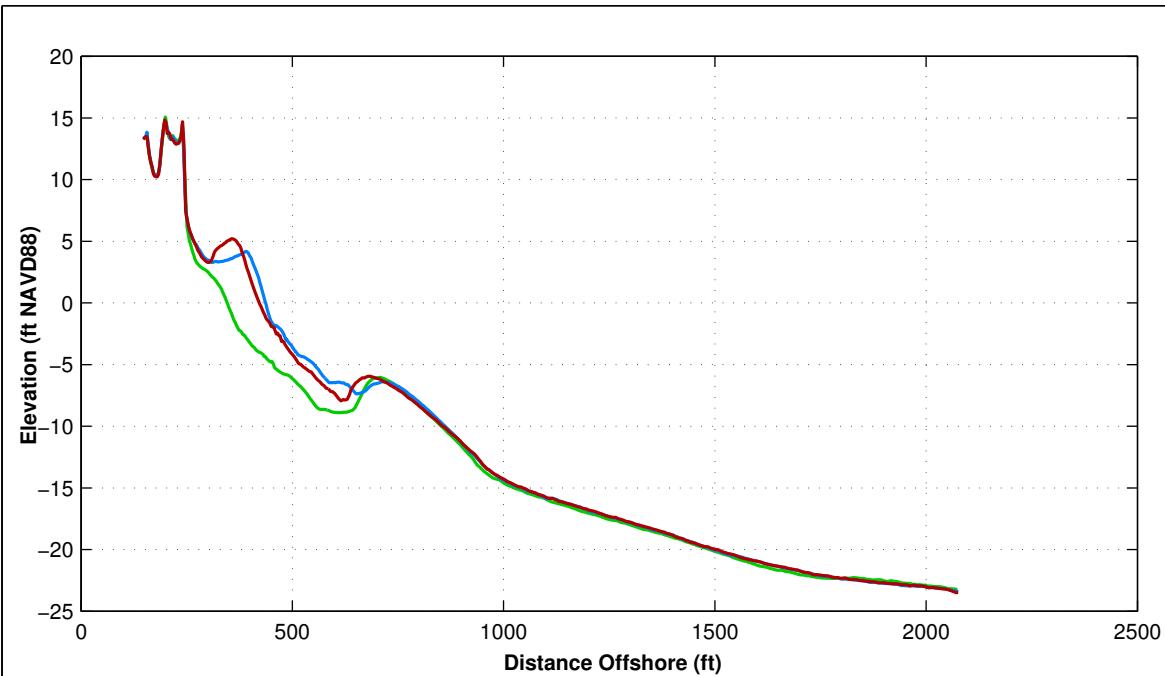
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

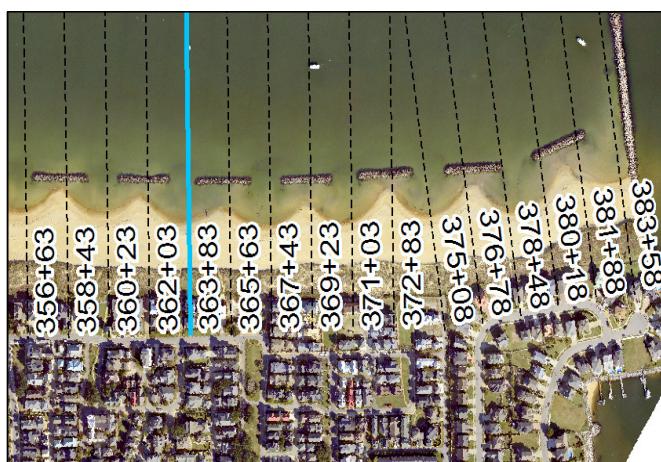
1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
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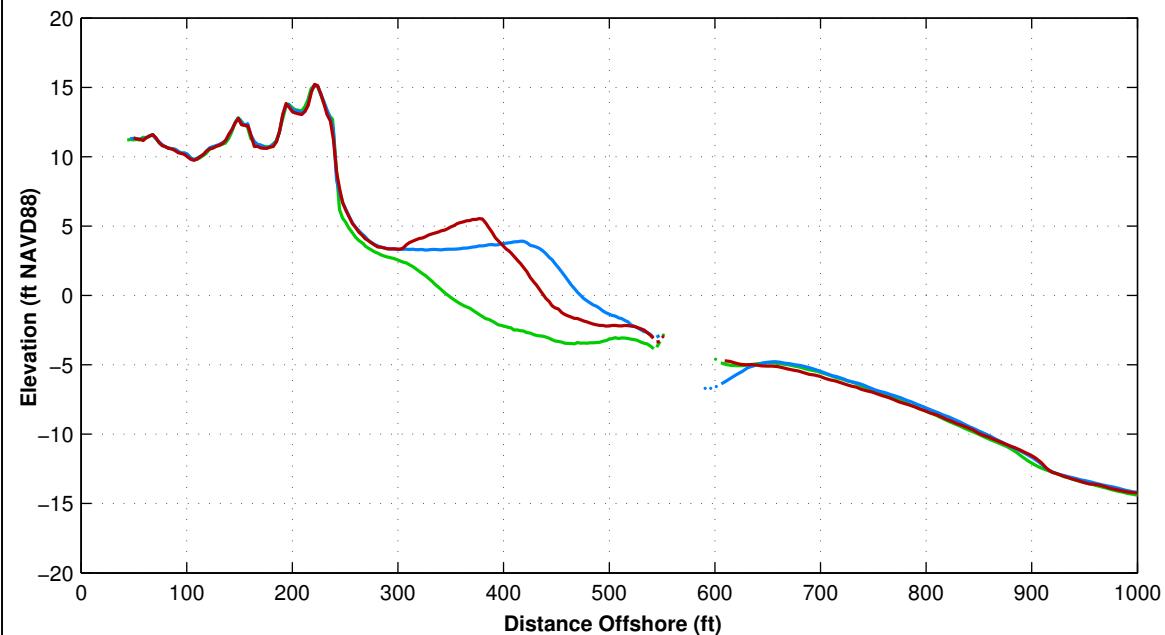
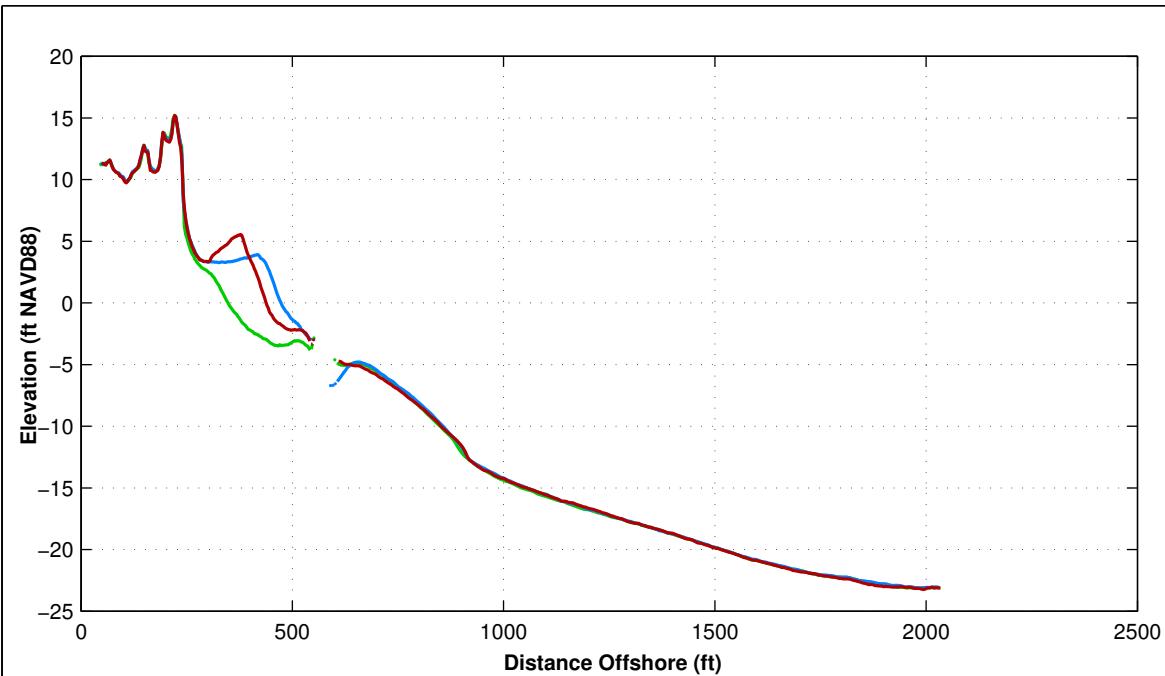
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ST 363+83

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Survey Transect 365+63	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	96.31 ft/yr	-33.57 ft
Volume Change Above -15 ft NAVD88	29.95 cy/ft/yr	-5.87 cy/ft
Volume Change Above 0 ft NAVD88	18.23 cy/ft/yr	-0.78 cy/ft

LEGEND:

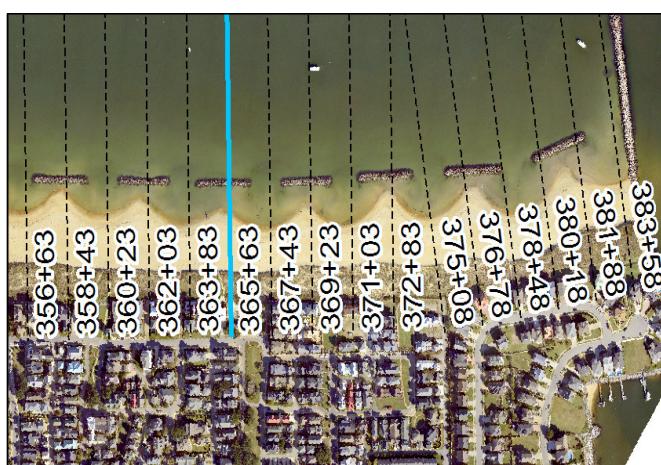
OCT 2017 — Red line

MAY 2017 — Blue line

OCT 2016 — Green line

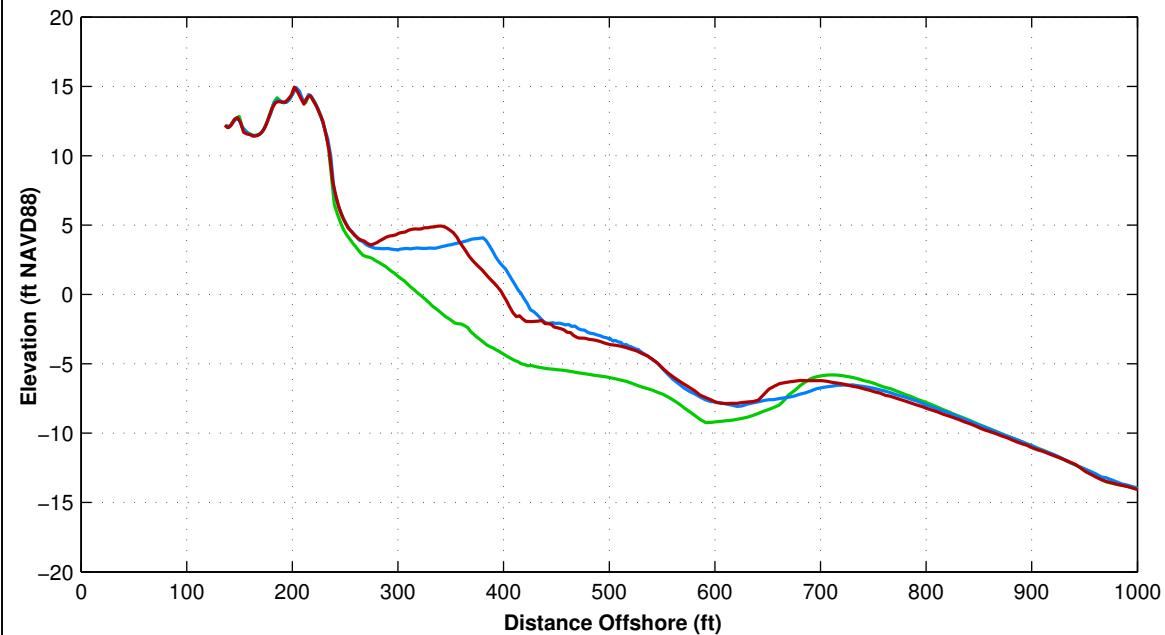
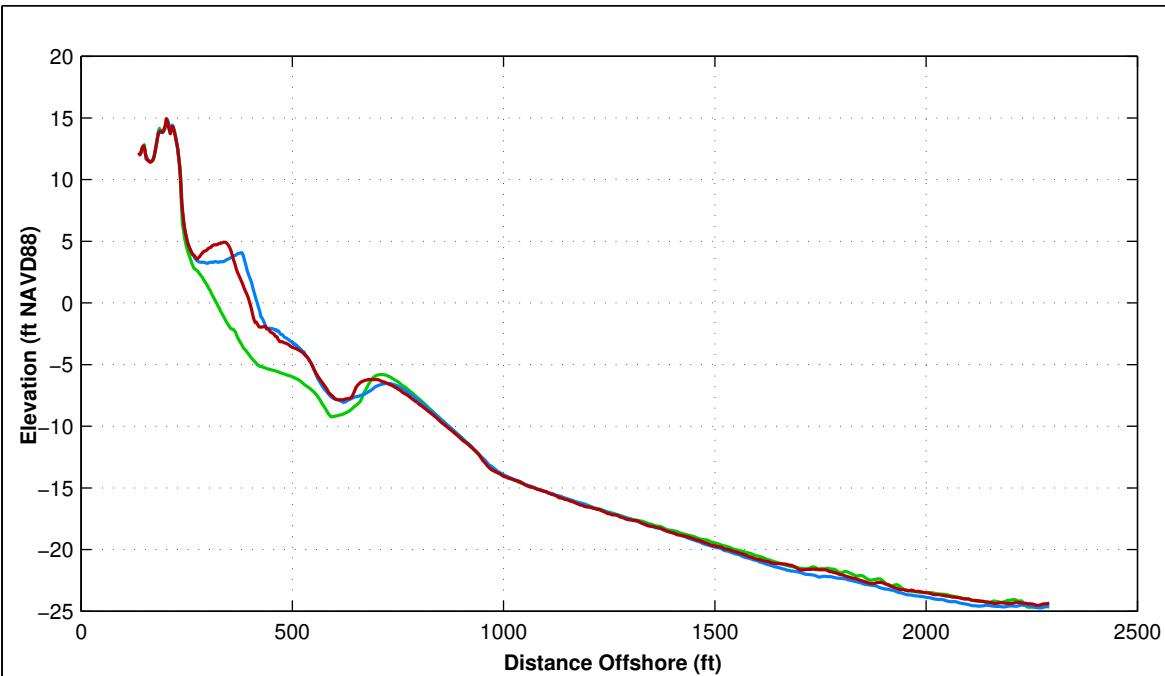
Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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4. Survey Comparison Made To OCT 2016 and MAY 2017
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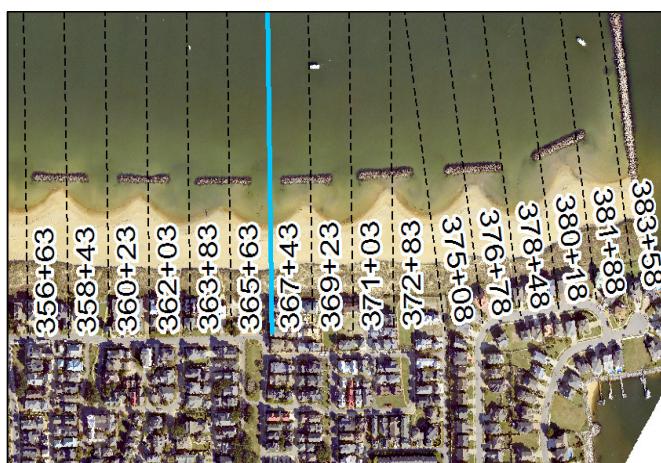
Survey Transect 367+43	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	83.40 ft/yr	-19.66 ft
Volume Change Above -15 ft NAVD88	41.18 cy/ft/yr	-1.80 cy/ft
Volume Change Above 0 ft NAVD88	15.34 cy/ft/yr	-0.02 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

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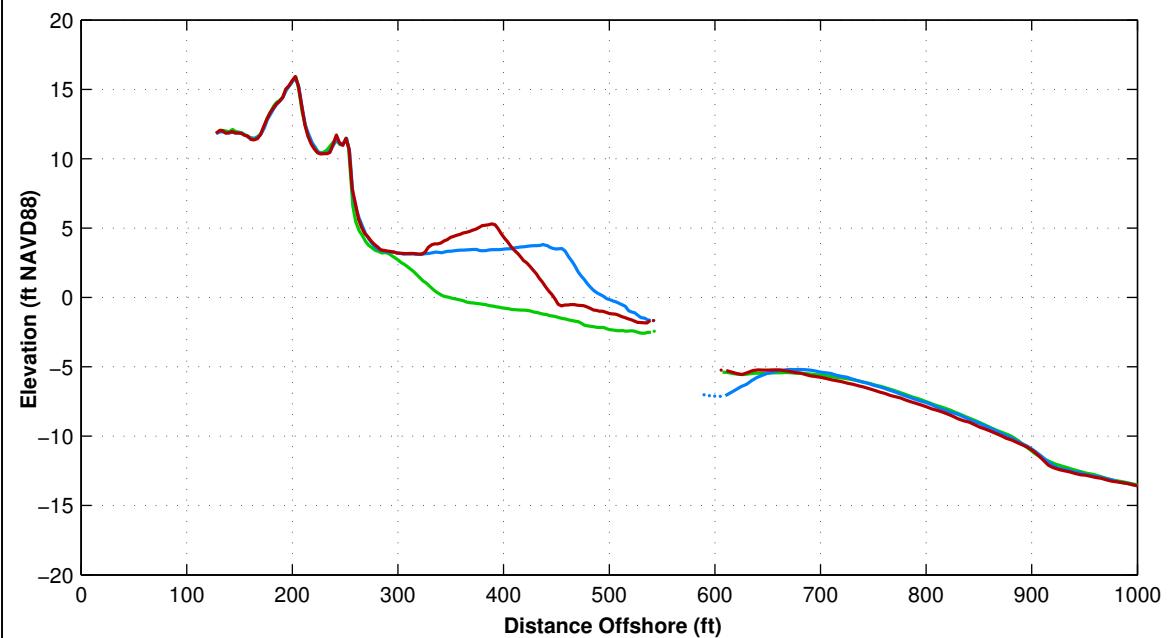
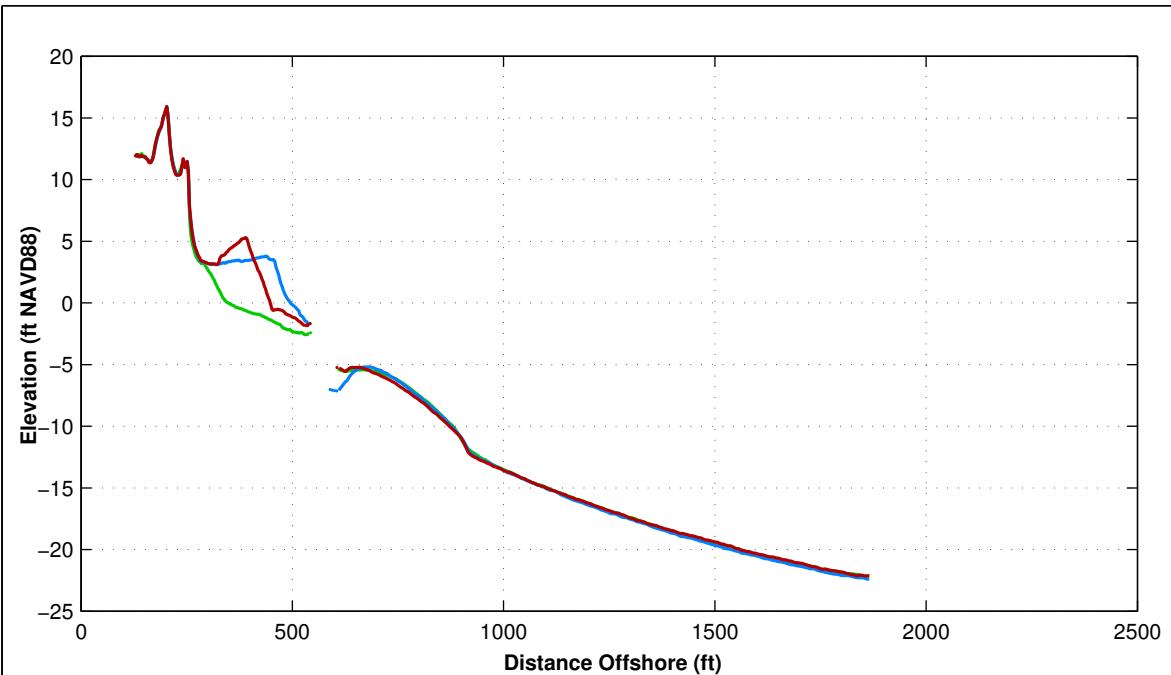
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ST 367+43

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SURVEYING DATA &
ANALYSIS

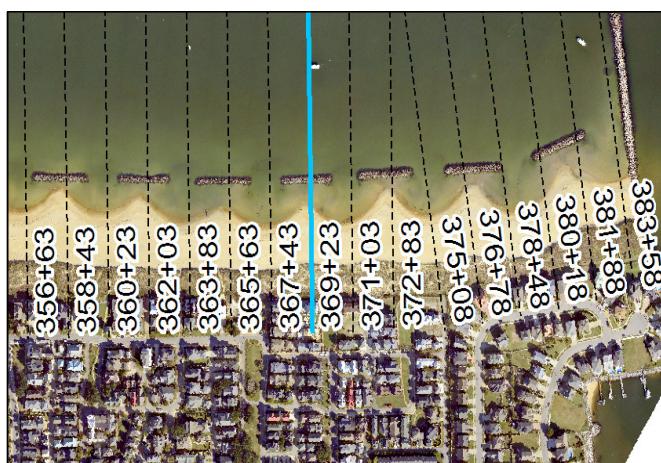
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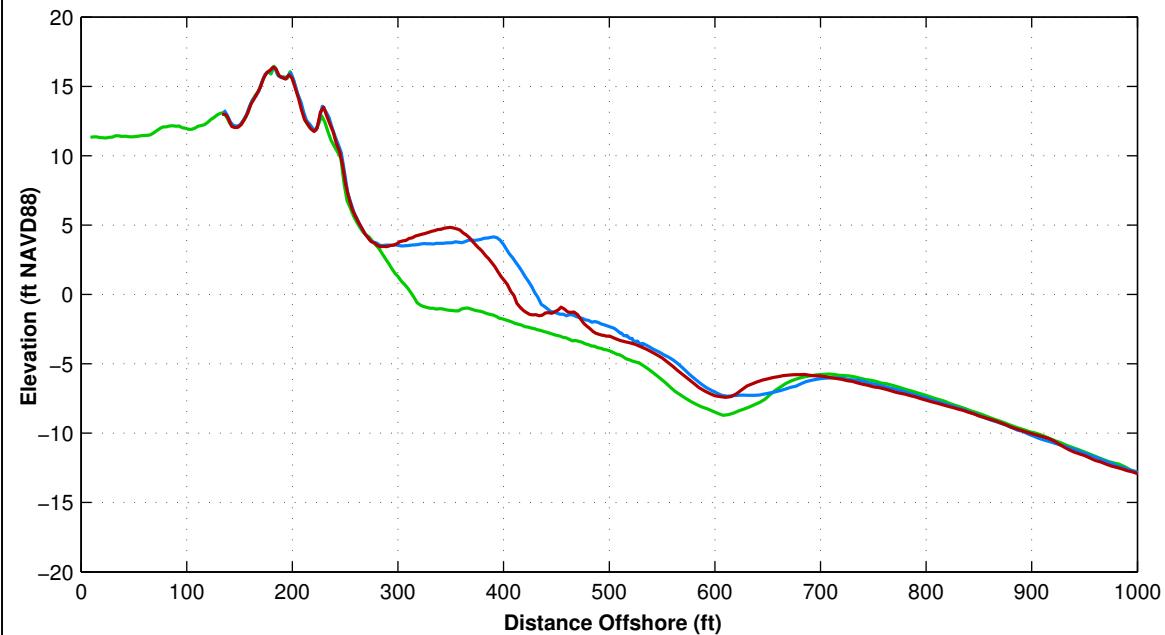
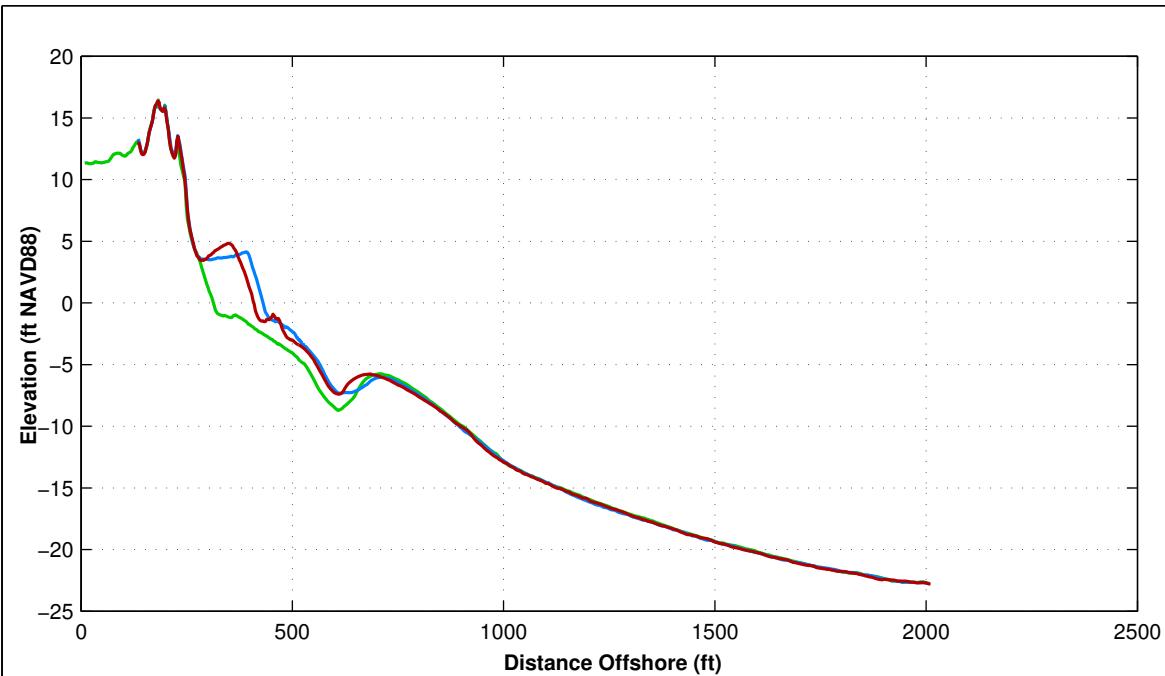
Fall 2017



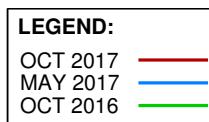
Notes:

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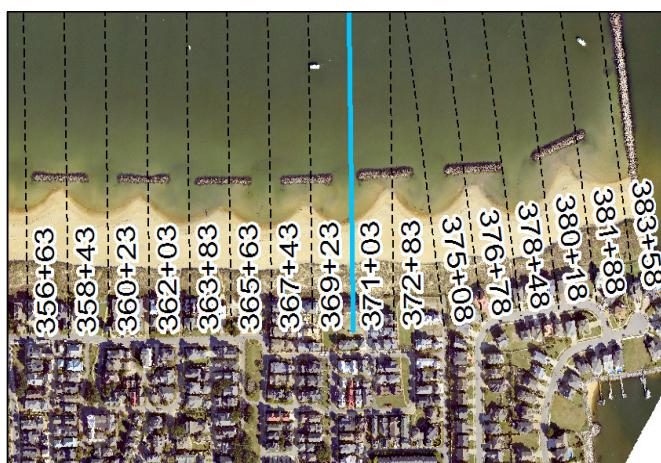


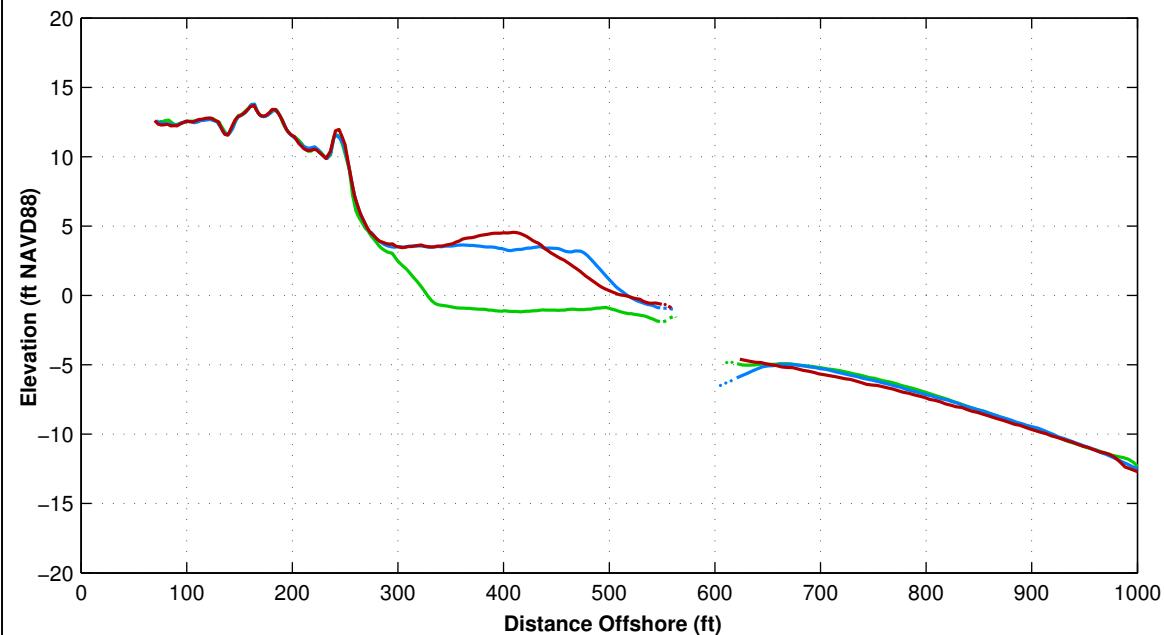
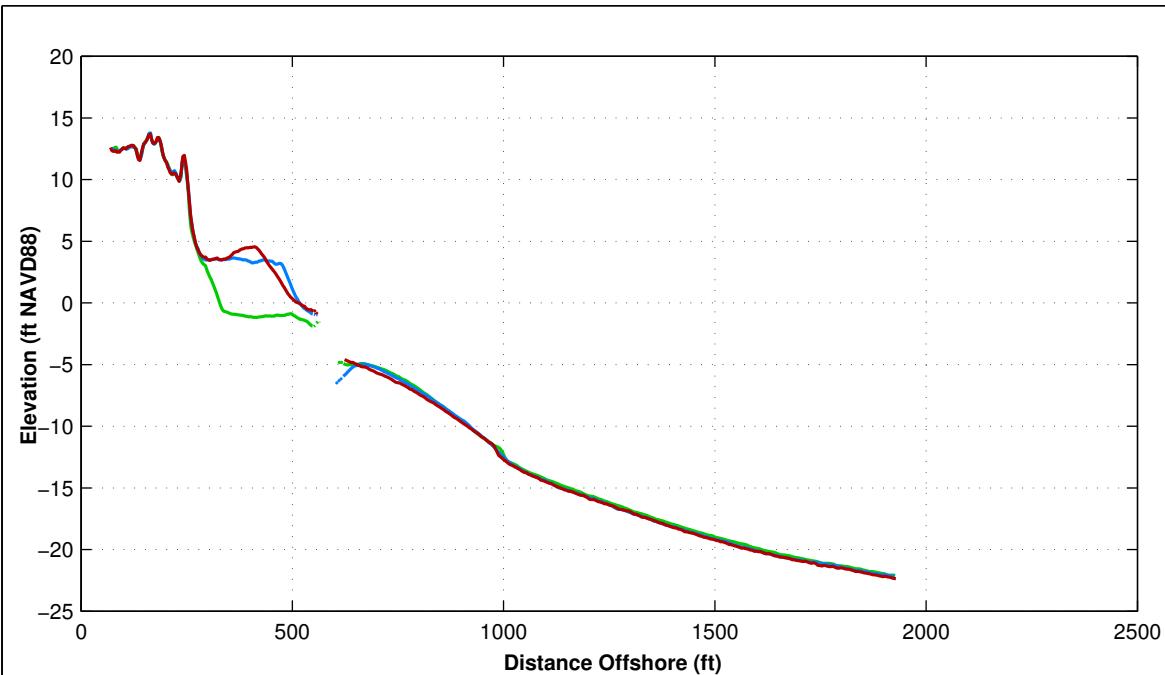
Survey Transect 371+03	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	ft/yr	ft
Volume Change Above -15 ft NAVD88	cy/ft/yr	cy/ft
Volume Change Above 0 ft NAVD88	cy/ft/yr	cy/ft



Notes:

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2. Sections Are Viewed Toward Decreasing Stationing.
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4. Survey Comparison Made to OCT 2016 and MAY 2017
5. For Transects With Offshore Breakwaters, Volume Change Calculations Were Limited To The Portions Of The Profiles Both Landward and Seaward Of The Breakwater.





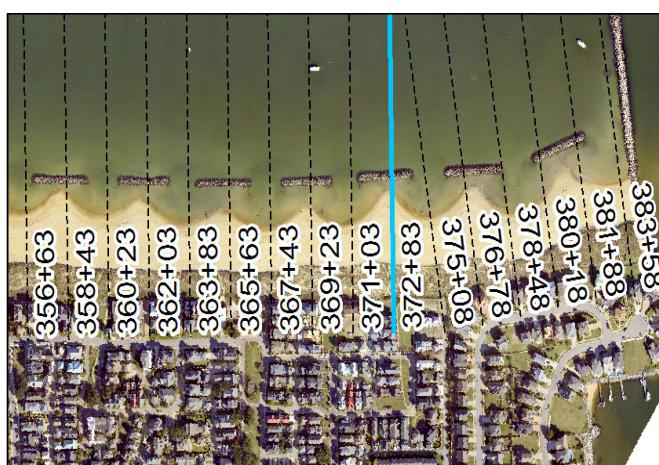
Survey Transect 372+83	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	168.00 ft/yr	-16.57 ft
Volume Change Above -15 ft NAVD88	28.30 cy/ft/yr	-1.87 cy/ft
Volume Change Above 0 ft NAVD88	24.32 cy/ft/yr	0.30 cy/ft

LEGEND:

OCT 2017 — Red line
MAY 2017 — Blue line
OCT 2016 — Green line

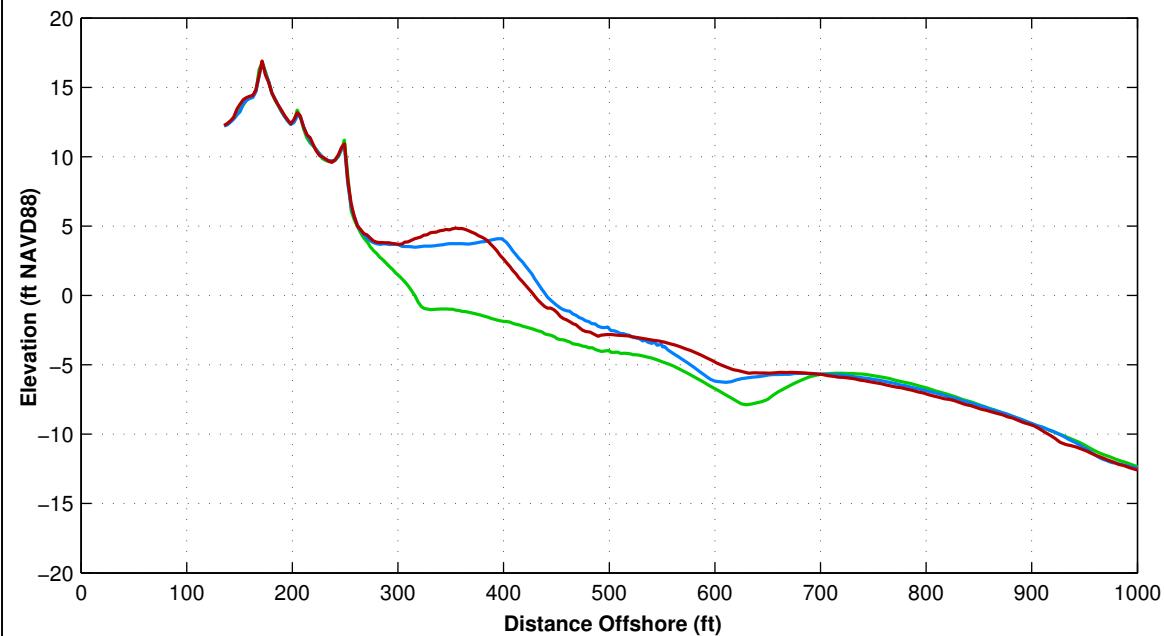
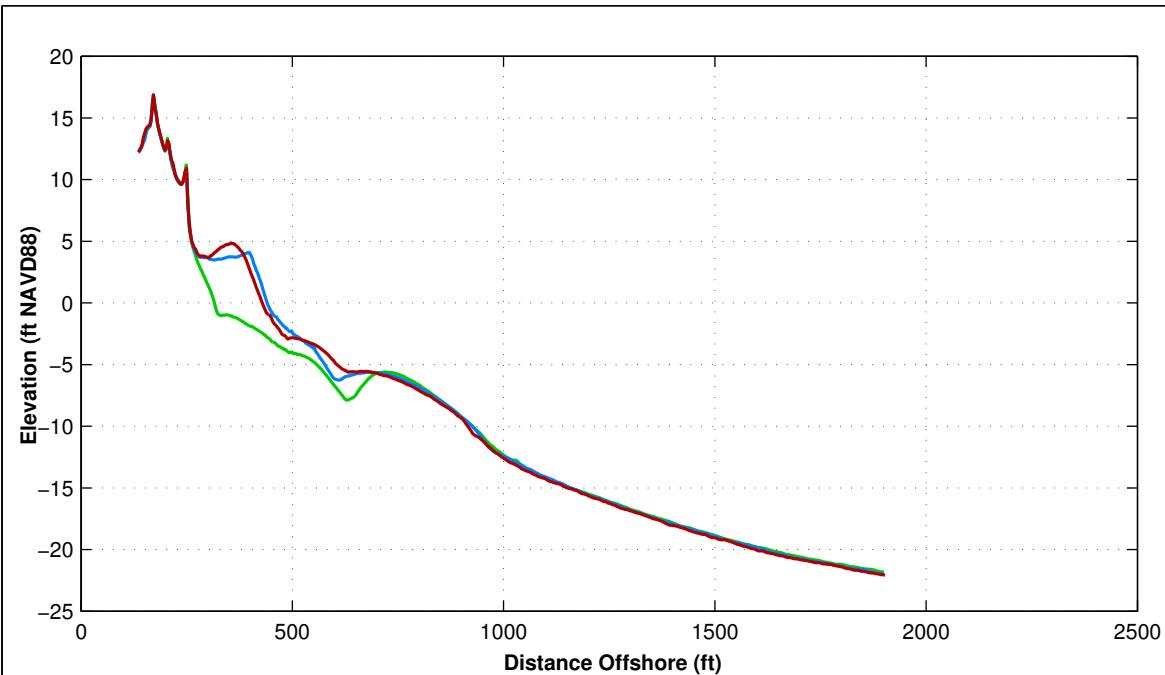
Notes:

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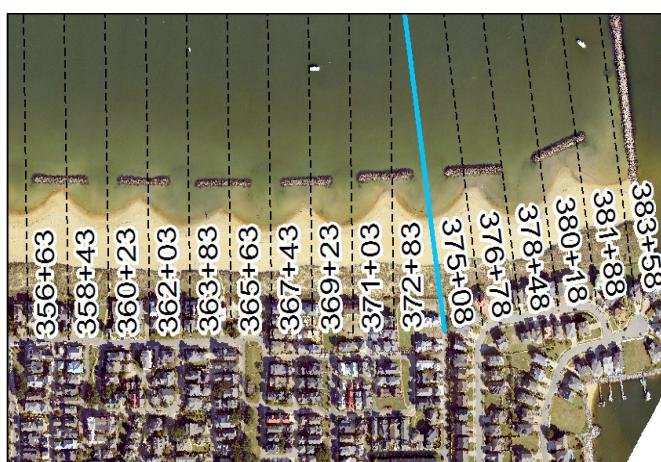
Survey Transect 375+08	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	111.97 ft/yr	-13.61 ft
Volume Change Above -15 ft NAVD88	34.95 cy/ft/yr	-1.00 cy/ft
Volume Change Above 0 ft NAVD88	18.50 cy/ft/yr	0.71 cy/ft

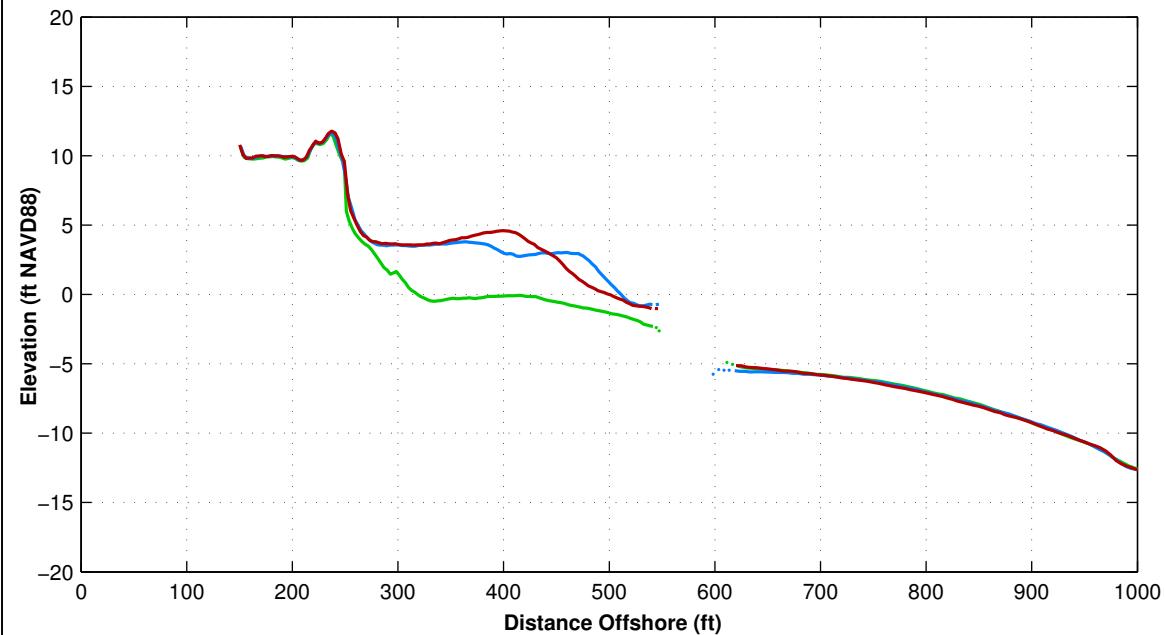
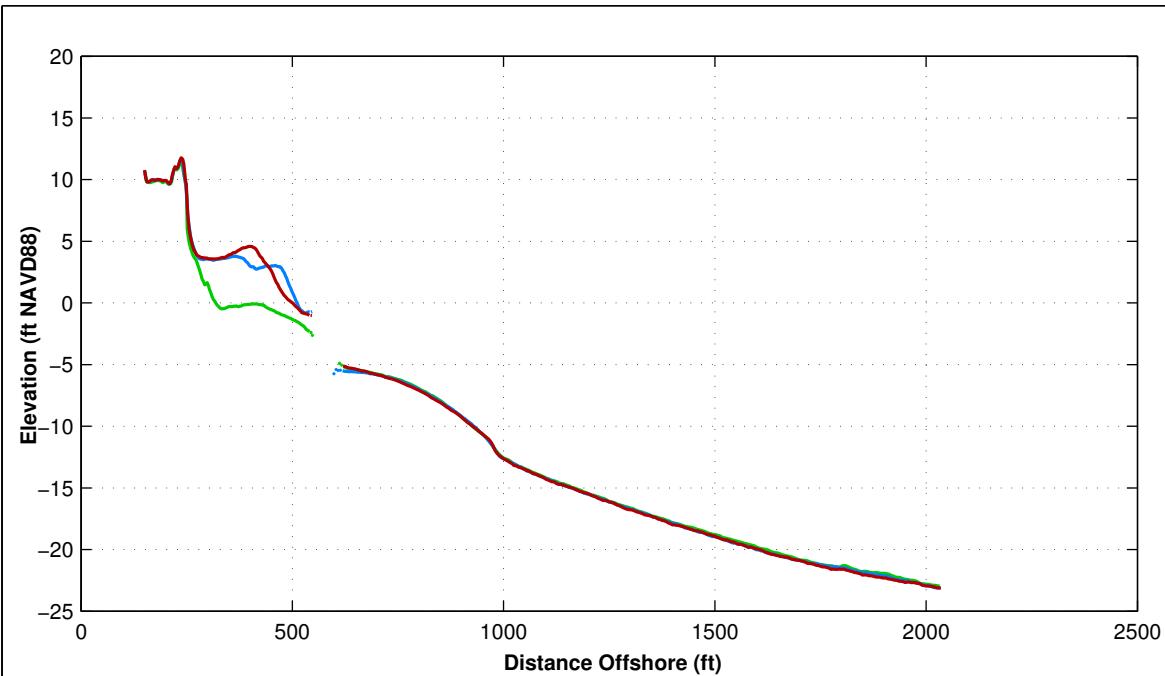
LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

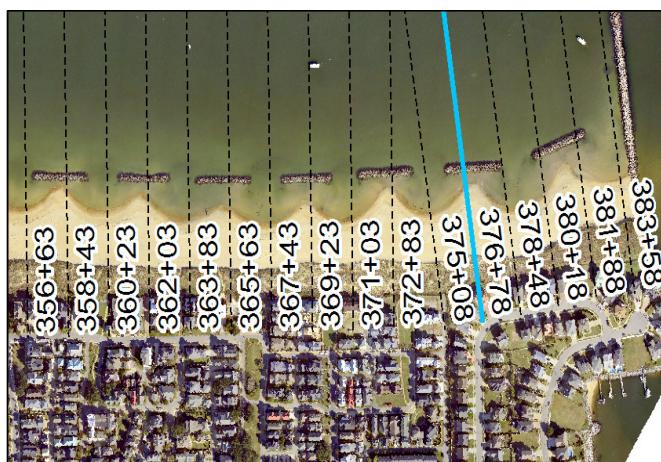
1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
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Notes:

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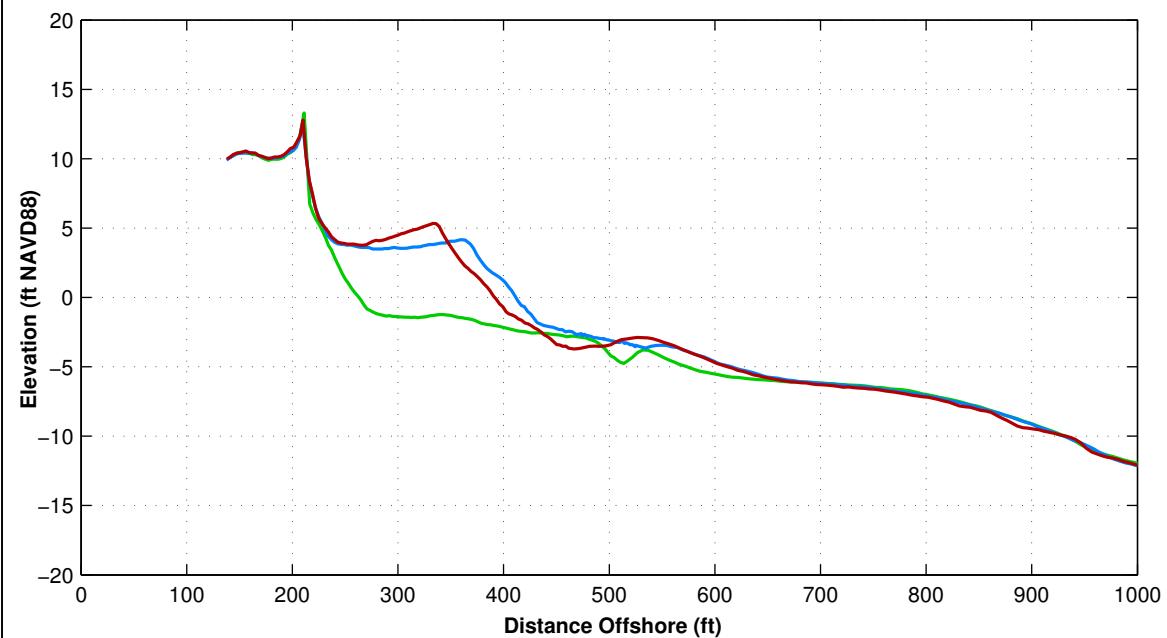
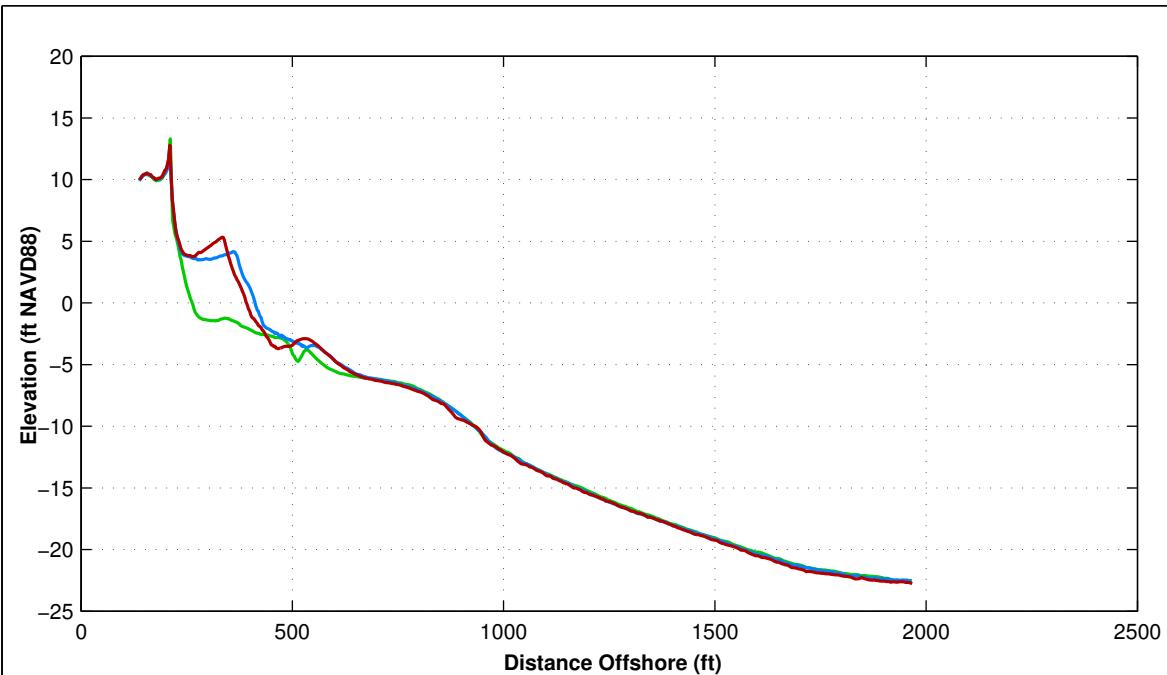
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ST 376+78

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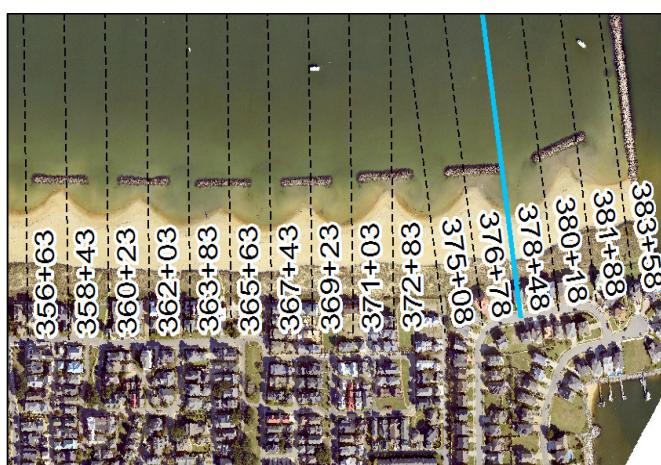
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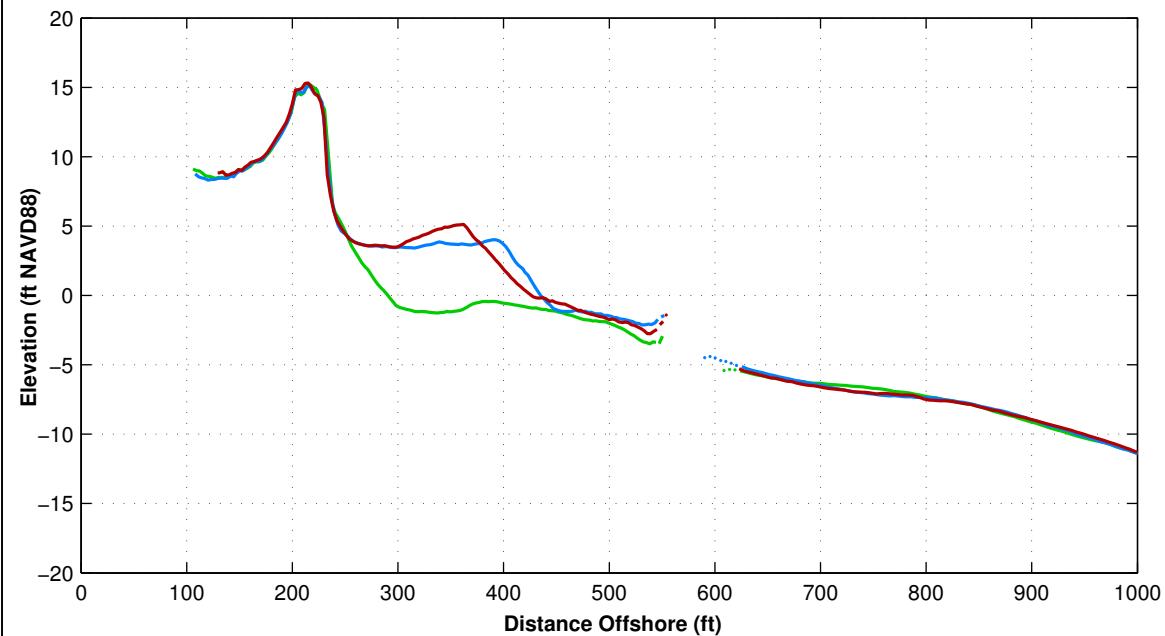
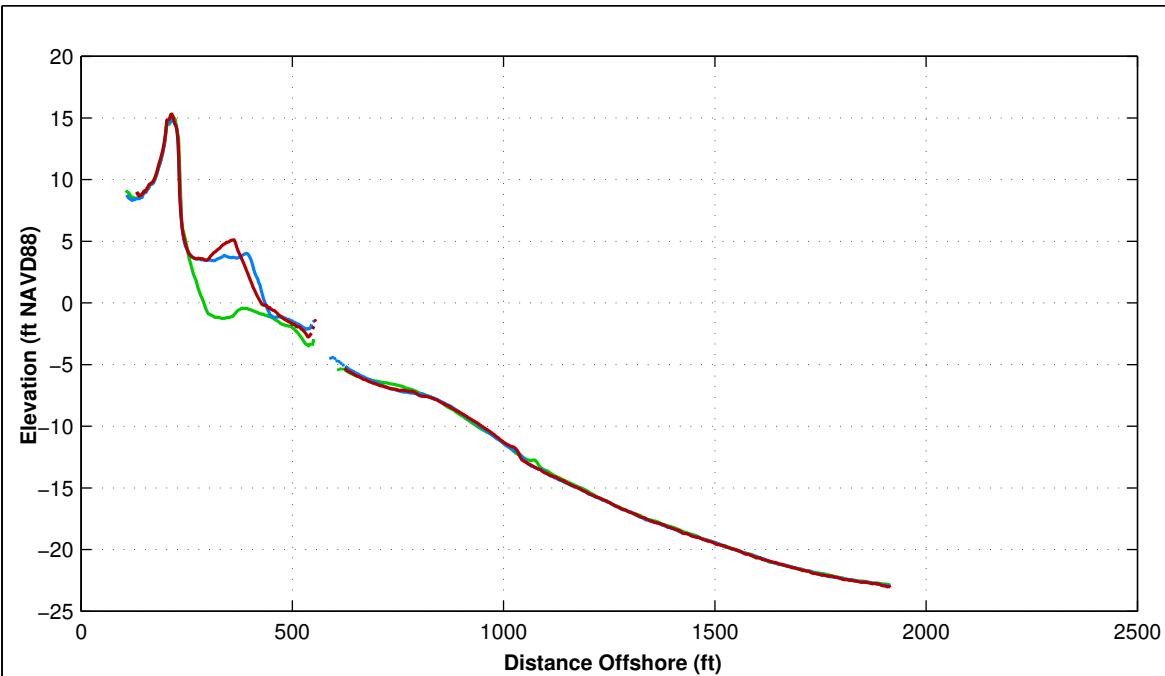
Fall 2017



Notes:

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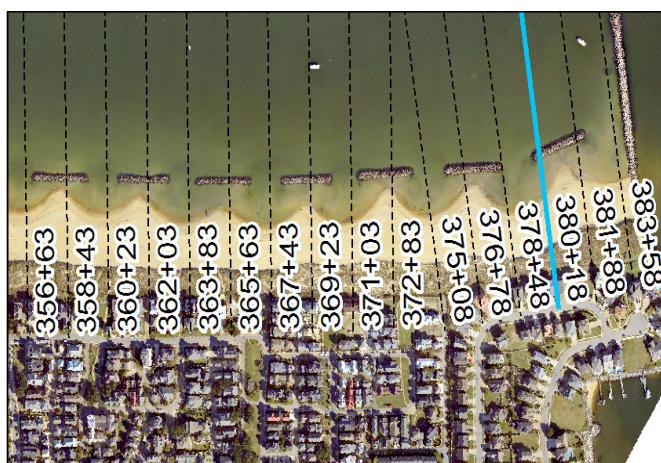
Survey Transect 380+18	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	132.73 ft/yr	-15.48 ft
Volume Change Above -15 ft NAVD88	25.68 cy/ft/yr	0.02 cy/ft
Volume Change Above 0 ft NAVD88	19.93 cy/ft/yr	0.47 cy/ft

LEGEND:

- OCT 2017
- MAY 2017
- OCT 2016

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
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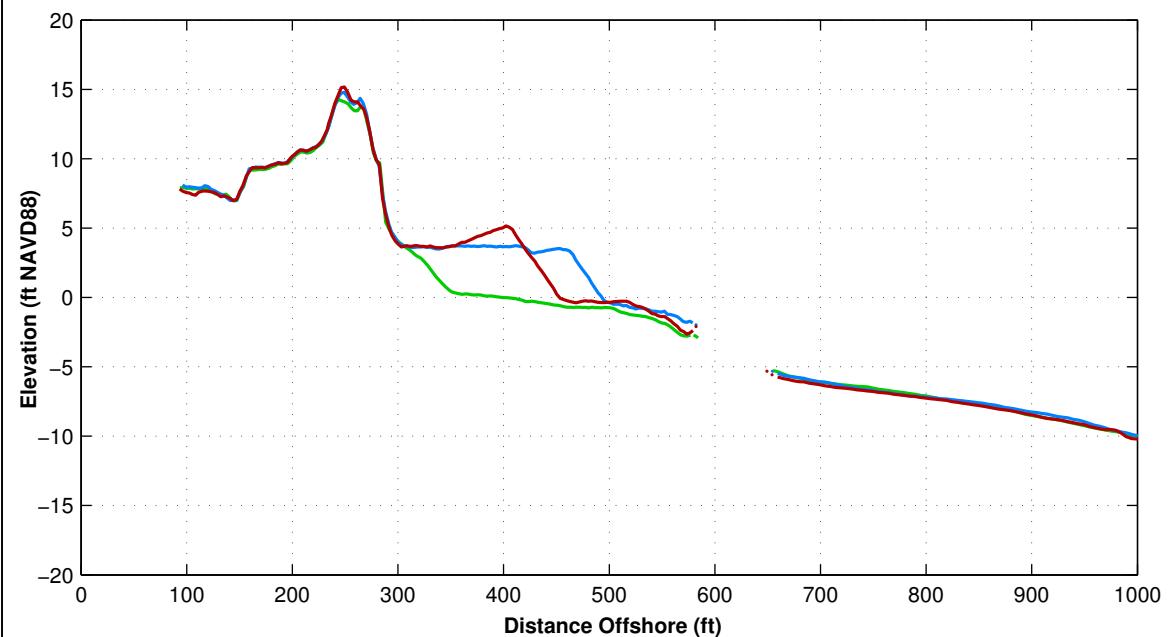
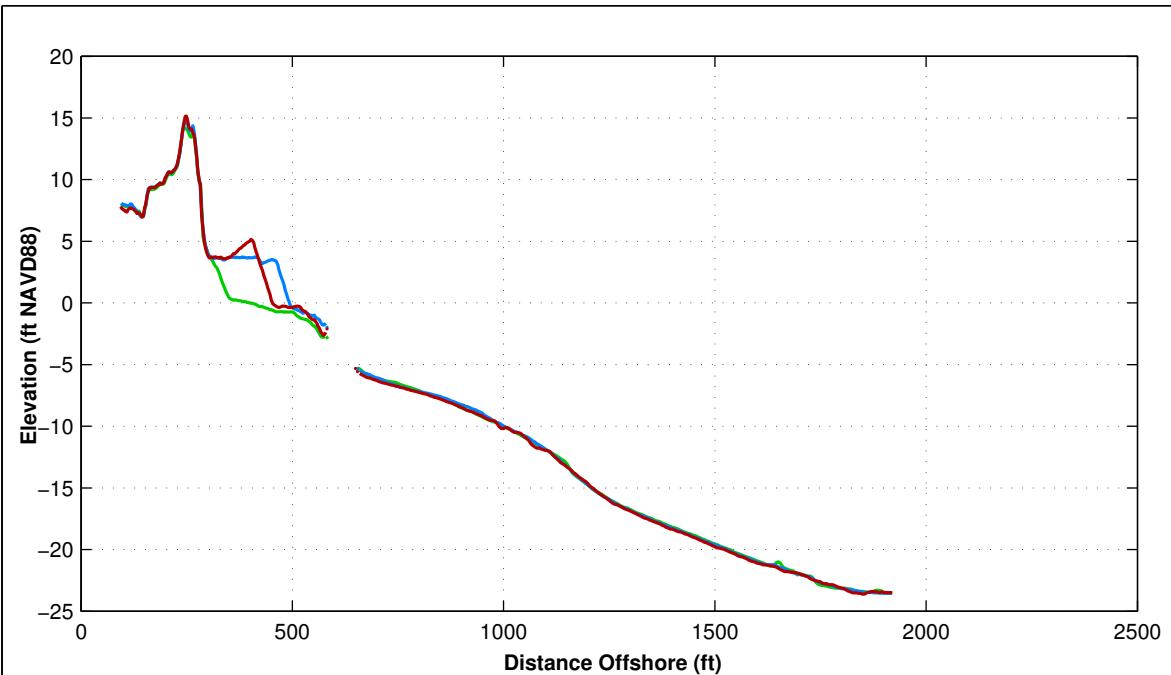
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ST 380+18

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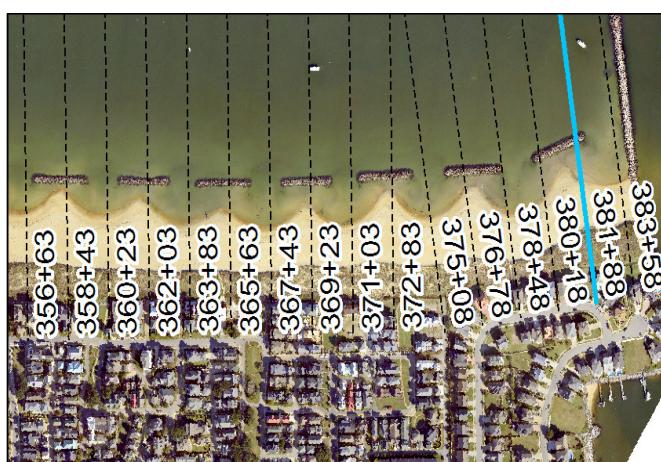
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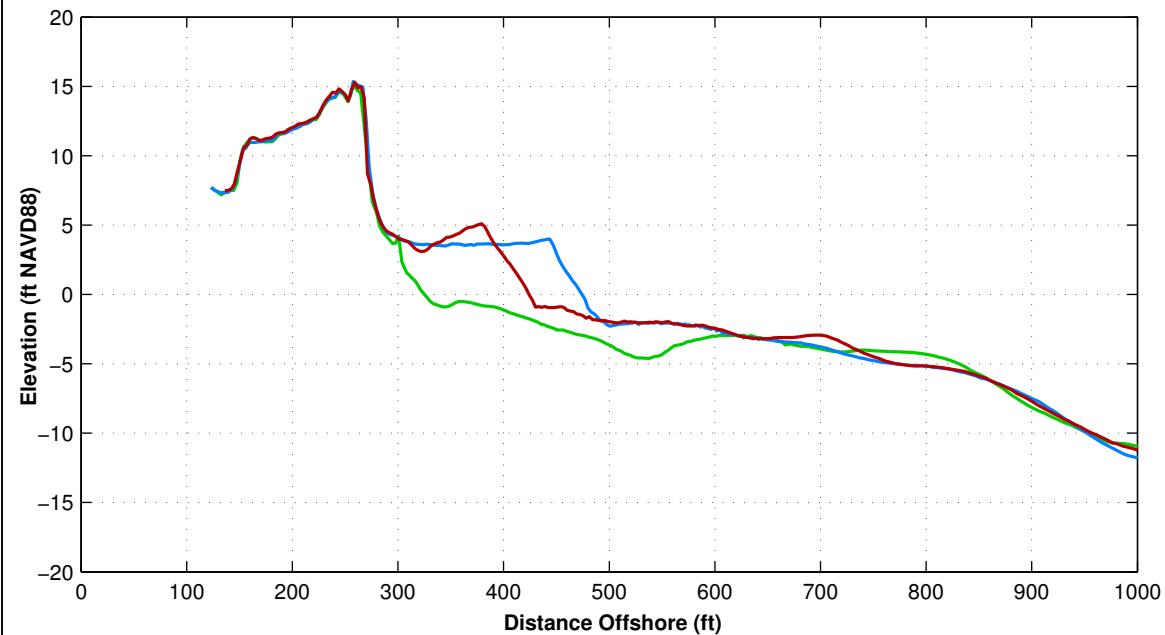
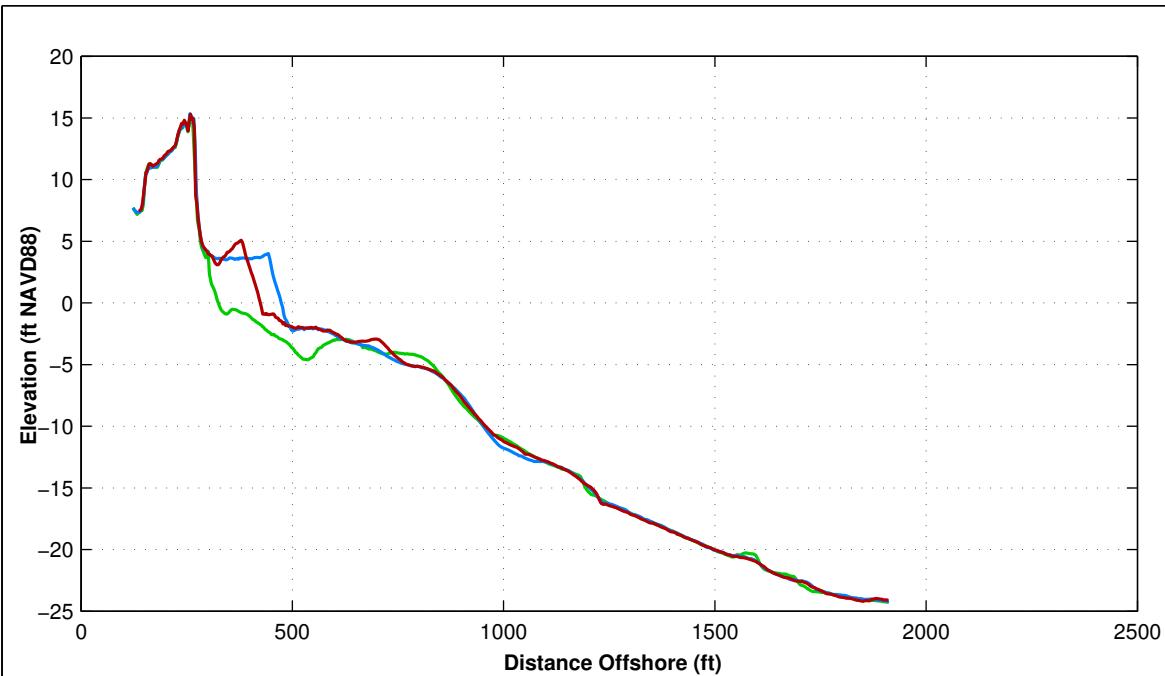
Notes:

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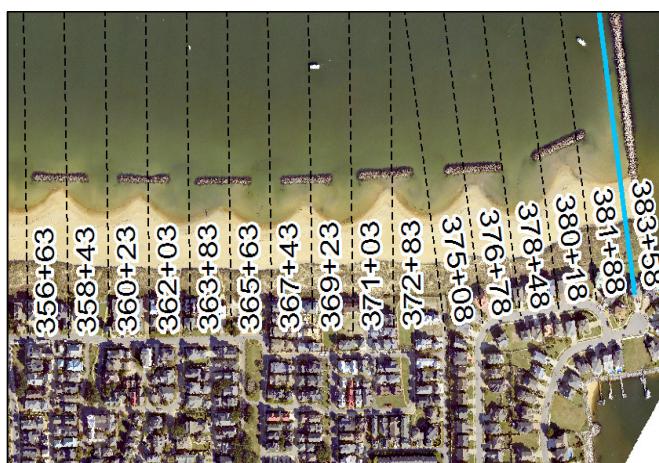


Survey Transect 383+58	OCT 2017 – OCT 2016	OCT 2017 – MAY 2017
Shoreline Change at MHW (0.98 ft NAVD88)	101.46 ft/yr	-48.39 ft
Volume Change Above -15 ft NAVD88	30.32 cy/ft/yr	-2.96 cy/ft
Volume Change Above 0 ft NAVD88	16.13 cy/ft/yr	-5.24 cy/ft

LEGEND:
 OCT 2017 — Red line
 MAY 2017 — Blue line
 OCT 2016 — Green line

Notes:

1. Station From West To East At Varying Intervals.
2. Sections Are Viewed Toward Decreasing Stationing.
3. All Survey Elevations In Feet Referenced to NAVD88.
4. Survey Comparison Made to OCT 2016 and MAY 2017
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**Table C-1. Summary of Shoreline Change and Volume Change
(October 2016 to October 2017)**

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.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from October 18, 2016 to October 16, 2017.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
0+00	10/18/2016	10/16/2017	23.07	5.05	12.36
2+50	10/18/2016	10/16/2017	9.49	2.44	-8.28
5+00	10/18/2016	10/16/2017	10.69	3.14	13.50
7+50	10/18/2016	10/16/2017	7.07	2.68	-10.66
10+00	10/18/2016	10/16/2017	-4.28	1.88	8.86
12+50	10/18/2016	10/16/2017	10.50	3.32	-3.28
15+00	10/18/2016	10/16/2017	6.22	3.51	-4.33
17+50	10/18/2016	10/16/2017	32.67	5.75	8.05
20+00	10/18/2016	10/16/2017	203.38	28.10	44.27
22+50	10/18/2016	10/16/2017	195.04	30.48	68.56
25+00	10/18/2016	10/16/2017	222.59	32.30	49.88
27+50	10/18/2016	10/16/2017	162.27	23.02	54.36
30+00	10/18/2016	10/16/2017	224.74	31.08	54.52
32+50	10/18/2016	10/16/2017	150.45	26.04	49.54
35+00	10/18/2016	10/16/2017	126.17	18.14	26.67
37+50	10/18/2016	10/16/2017	131.49	17.59	35.14
40+00	10/18/2016	10/16/2017	190.84	25.72	53.22
42+50	10/18/2016	10/16/2017	162.94	22.95	61.17
45+00	10/18/2016	10/16/2017	166.58	23.66	54.29
45+25	10/18/2016	10/16/2017	128.52	18.09	57.17
47+30	10/18/2016	10/16/2017	106.80	16.58	41.34
49+35	10/18/2016	10/16/2017	115.64	14.68	31.45
51+41	10/18/2016	10/16/2017	128.28	19.20	56.92
53+46	10/18/2016	10/16/2017	144.08	17.73	39.59
55+51	10/18/2016	10/16/2017	153.19	21.91	56.65
57+57	10/18/2016	10/16/2017	127.07	17.98	36.32
59+62	10/18/2016	10/16/2017	150.25	25.12	64.93
61+62	10/18/2016	10/16/2017	120.06	19.03	35.07
63+62	10/18/2016	10/16/2017	162.00	25.76	69.36
65+62	10/18/2016	10/16/2017	135.07	23.26	41.22
67+62	10/18/2016	10/16/2017	173.91	27.22	67.78
69+62	10/18/2016	10/16/2017	143.53	16.54	27.74
71+62	10/18/2016	10/16/2017	138.18	21.00	49.24
73+62	10/18/2016	10/16/2017	150.98	20.56	35.01
75+62	10/18/2016	10/16/2017	159.95	24.09	51.75
77+62	10/18/2016	10/16/2017	173.29	20.57	33.85
79+62	10/18/2016	10/16/2017	169.68	21.54	52.59
81+62	10/18/2016	10/16/2017	148.47	20.66	53.47
83+62	10/18/2016	10/16/2017	138.17	18.72	49.96
85+62	10/18/2016	10/16/2017	86.38	14.36	37.38
87+62	10/18/2016	10/16/2017	111.17	18.63	47.19

**Table C-1. Summary of Shoreline Change and Volume Change
(October 2016 to October 2017) Cont.**

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from October 18, 2016 to October 16, 2017.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
93+41	10/18/2016	10/16/2017	86.80	13.59	34.87
103+08	10/18/2016	10/16/2017	91.35	15.49	37.76
120+93	10/18/2016	10/16/2017	93.86	15.93	34.87
129+17	10/18/2016	10/16/2017	39.80	9.20	21.77
141+98	10/18/2016	10/16/2017	76.95	14.03	30.47
152+01	10/18/2016	10/16/2017	76.98	13.84	33.71
163+49	10/18/2016	10/16/2017	87.33	16.71	33.75
169+63	10/18/2016	10/16/2017	93.60	17.99	43.38
171+63	10/18/2016	10/16/2017	98.29	16.63	40.43
173+63	10/18/2016	10/16/2017	101.16	18.19	41.33
175+63	10/18/2016	10/16/2017	107.92	21.95	44.76
177+63	10/18/2016	10/16/2017	96.68	19.86	45.51
179+63	10/18/2016	10/16/2017	98.09	17.39	29.27
181+63	10/18/2016	10/16/2017	82.32	14.97	26.95
183+63	10/18/2016	10/16/2017	123.30	18.91	30.69
185+63	10/18/2016	10/16/2017	105.19	18.30	54.63
187+63	10/18/2016	10/16/2017	121.98	17.25	26.29
189+63	10/18/2016	10/16/2017	104.51	18.03	39.73
191+63	10/18/2016	10/16/2017	127.91	17.72	29.04
193+63	10/18/2016	10/16/2017	85.39	15.37	32.92
195+63	10/18/2016	10/16/2017	78.66	13.79	29.04
206+86	10/18/2016	10/16/2017	26.01	4.89	13.04
218+66	10/18/2016	10/16/2017	-13.92	-1.53	-9.34
229+85	10/18/2016	10/16/2017	-15.78	-0.57	-3.79
242+03	10/18/2016	10/16/2017	-4.61	-0.10	-2.40
252+62	10/18/2016	10/16/2017	-21.42	1.20	-0.71
263+22	10/18/2016	10/16/2017	-1.26	2.43	2.47
274+53	10/18/2016	10/16/2017	27.76	6.65	18.75
281+40	10/18/2016	10/16/2017	62.47	10.76	30.64
288+39	10/18/2016	10/16/2017	89.49	16.57	36.24
295+27	10/18/2016	10/16/2017	73.62	11.71	37.18
302+24	10/18/2016	10/16/2017	76.44	15.89	37.49
315+96	10/18/2016	10/16/2017	54.47	10.16	26.25
323+09	10/18/2016	10/16/2017	82.13	15.59	42.80
329+63	10/18/2016	10/16/2017	87.76	15.27	31.08
331+43	10/18/2016	10/16/2017	100.52	15.95	34.38
333+23	10/18/2016	10/16/2017	110.62	15.96	23.12
335+03	10/18/2016	10/16/2017	93.63	14.93	25.04
336+83	10/18/2016	10/16/2017	113.63	18.46	33.59
338+63	10/18/2016	10/16/2017	131.24	19.64	30.00
340+43	10/18/2016	10/16/2017	121.18	21.02	43.57
342+23	10/18/2016	10/16/2017	131.35	20.46	51.33

**Table C-1. Summary of Shoreline Change and Volume Change
(October 2016 to October 2017) Cont.**

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.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from October 18, 2016 to October 16, 2017.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change Rate at MHW (ft/yr)	Volume Change Rate Above 0 ft NAVD88 (cy/ft/yr)	Volume Change Rate Above -15 ft NAVD88 (cy/ft/yr)
344+05	10/18/2016	10/16/2017	117.84	20.56	31.72
345+85	10/18/2016	10/16/2017	90.27	16.31	26.06
347+63	10/18/2016	10/16/2017	99.61	19.60	27.20
349+43	10/18/2016	10/16/2017	86.44	15.38	37.56
351+23	10/18/2016	10/16/2017	116.45	19.57	29.19
353+03	10/18/2016	10/16/2017	87.82	16.16	46.47
354+83	10/18/2016	10/16/2017	128.19	16.20	32.37
356+63	10/18/2016	10/16/2017	96.69	17.96	49.73
358+43	10/18/2016	10/16/2017	139.29	23.59	43.11
360+23	10/18/2016	10/16/2017	106.58	21.38	60.09
362+03	10/18/2016	10/16/2017	115.59	20.96	34.10
363+83	10/18/2016	10/16/2017	76.93	15.70	43.80
365+63	10/18/2016	10/16/2017	96.31	18.23	29.95
367+43	10/18/2016	10/16/2017	83.40	15.34	41.18
369+23	10/18/2016	10/16/2017	110.89	17.92	21.55
371+03	10/18/2016	10/16/2017	98.31	15.71	30.25
372+83	10/18/2016	10/16/2017	168.00	24.32	28.30
375+08	10/18/2016	10/16/2017	111.97	18.50	34.95
376+78	10/18/2016	10/16/2017	168.89	26.11	29.46
378+48	10/18/2016	10/16/2017	128.85	20.58	29.65
380+18	10/18/2016	10/16/2017	132.73	19.93	25.68
381+88	10/18/2016	10/16/2017	102.51	16.46	17.42
383+58	10/18/2016	10/16/2017	101.46	16.13	30.32

**Table C-2. Summary of Shoreline Change and Volume Change
(May 2017 to October 2017)**

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.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from May 25, 2017 to October 16, 2017.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change at MHW (ft)	Volume Change Above 0 ft NAVD88 (cy/ft)	Volume Change Above -15 ft NAVD88 (cy/ft)
0+00	5/25/2017	10/16/2017	6.75	3.29	21.56
2+50	5/25/2017	10/16/2017	9.02	2.35	7.06
5+00	5/25/2017	10/16/2017	-4.61	0.80	2.17
7+50	5/25/2017	10/16/2017	8.63	2.36	11.86
10+00	5/25/2017	10/16/2017	-12.46	0.24	-3.22
12+50	5/25/2017	10/16/2017	3.01	2.53	1.06
15+00	5/25/2017	10/16/2017	-36.73	-2.10	-7.84
17+50	5/25/2017	10/16/2017	-0.19	2.41	3.79
20+00	5/25/2017	10/16/2017	47.66	5.20	5.47
22+50	5/25/2017	10/16/2017	-17.41	-0.23	-1.09
25+00	5/25/2017	10/16/2017	39.02	5.83	8.95
27+50	5/25/2017	10/16/2017	-24.14	-0.76	0.50
30+00	5/25/2017	10/16/2017	68.56	11.29	15.34
32+50	5/25/2017	10/16/2017	-22.06	2.18	3.21
35+00	5/25/2017	10/16/2017	6.75	2.29	9.97
37+50	5/25/2017	10/16/2017	-4.89	2.59	5.79
40+00	5/25/2017	10/16/2017	10.68	1.99	0.83
42+50	5/25/2017	10/16/2017	-25.29	-0.61	4.55
45+00	5/25/2017	10/16/2017	24.97	3.28	3.94
45+25	5/25/2017	10/16/2017	-49.05	-2.66	-8.80
47+30	5/25/2017	10/16/2017	-61.24	-6.52	-16.75
49+35	5/25/2017	10/16/2017	-38.82	-4.56	2.12
51+41	5/25/2017	10/16/2017	-30.35	-0.87	1.33
53+46	5/25/2017	10/16/2017	-6.89	1.37	8.52
55+51	5/25/2017	10/16/2017	-3.76	1.23	7.76
57+57	5/25/2017	10/16/2017	-1.60	-0.40	5.53
59+62	5/25/2017	10/16/2017	-15.95	-2.01	0.36
61+62	5/25/2017	10/16/2017	-7.54	-1.08	5.84
63+62	5/25/2017	10/16/2017	-10.78	-2.12	2.23
65+62	5/25/2017	10/16/2017	-11.02	-1.73	2.67
67+62	5/25/2017	10/16/2017	-18.59	-1.83	-4.67
69+62	5/25/2017	10/16/2017	8.85	-0.12	4.19
71+62	5/25/2017	10/16/2017	-19.32	-0.08	-3.40
73+62	5/25/2017	10/16/2017	-7.81	-0.18	7.66
75+62	5/25/2017	10/16/2017	-16.13	-2.52	-0.02
77+62	5/25/2017	10/16/2017	16.72	3.54	8.70
79+62	5/25/2017	10/16/2017	22.83	3.66	10.77
81+62	5/25/2017	10/16/2017	11.25	3.88	8.96
83+62	5/25/2017	10/16/2017	-13.17	0.11	3.13
85+62	5/25/2017	10/16/2017	-24.41	-0.56	2.57
87+62	5/25/2017	10/16/2017	-21.50	0.88	2.57

**Table C-2. Summary of Shoreline Change and Volume Change
(May 2017 to October 2017) Cont.**

1. Positive changes indicate accretion or gain in volume along the profile and negative changes indicate erosion or loss of volume along the profile.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from May 25, 2017 to October 16, 2017.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change at MHW (ft)	Volume Change Above 0 ft NAVD88 (cy/ft)	Volume Change Above -15 ft NAVD88 (cy/ft)
93+41	5/25/2017	10/16/2017	-4.42	2.24	3.72
103+08	5/25/2017	10/16/2017	-29.05	-0.63	-1.32
120+93	5/25/2017	10/16/2017	-21.54	1.16	1.36
129+17	5/25/2017	10/16/2017	-22.82	-1.82	2.50
141+98	5/25/2017	10/16/2017	-33.44	-0.43	-3.57
152+01	5/25/2017	10/16/2017	-18.66	2.43	4.62
163+49	5/25/2017	10/16/2017	-32.07	1.76	2.37
169+63	5/25/2017	10/16/2017	-41.35	-0.39	-0.98
171+63	5/25/2017	10/16/2017	-38.14	-1.72	-3.66
173+63	5/25/2017	10/16/2017	-33.69	-0.52	-1.29
175+63	5/25/2017	10/16/2017	-34.19	0.33	-5.68
177+63	5/25/2017	10/16/2017	-28.66	-0.03	2.35
179+63	5/25/2017	10/16/2017	-49.29	-2.46	-4.02
181+63	5/25/2017	10/16/2017	-28.26	-0.84	-3.61
183+63	5/25/2017	10/16/2017	-43.83	-2.20	-2.50
185+63	5/25/2017	10/16/2017	-28.83	-0.20	-1.17
187+63	5/25/2017	10/16/2017	-32.40	-1.19	-0.47
189+63	5/25/2017	10/16/2017	-11.21	2.52	2.80
191+63	5/25/2017	10/16/2017	-28.44	1.96	4.69
193+63	5/25/2017	10/16/2017	-62.57	-3.23	-10.80
195+63	5/25/2017	10/16/2017	-54.70	-4.19	-10.53
206+86	5/25/2017	10/16/2017	23.95	7.08	13.11
218+66	5/25/2017	10/16/2017	-9.90	0.69	-1.76
229+85	5/25/2017	10/16/2017	2.36	-0.12	-5.76
242+03	5/25/2017	10/16/2017	-0.98	0.25	3.07
252+62	5/25/2017	10/16/2017	-11.76	-2.74	-3.97
263+22	5/25/2017	10/16/2017	24.19	3.61	0.98
274+53	5/25/2017	10/16/2017	13.69	3.60	5.52
281+40	5/25/2017	10/16/2017	-6.79	-0.92	-6.58
288+39	5/25/2017	10/16/2017	-29.37	-1.04	-3.31
295+27	5/25/2017	10/16/2017	-42.61	-2.03	-6.09
302+24	5/25/2017	10/16/2017	-18.89	0.56	-1.21
315+96	5/25/2017	10/16/2017	-43.12	-2.09	-1.23
323+09	5/25/2017	10/16/2017	-25.07	-0.04	1.10
329+63	5/25/2017	10/16/2017	-28.72	0.17	-1.90
331+43	5/25/2017	10/16/2017	-4.18	1.23	-1.60
333+23	5/25/2017	10/16/2017	-21.15	-2.13	-2.71
335+03	5/25/2017	10/16/2017	-19.24	-1.30	-7.72
336+83	5/25/2017	10/16/2017	-18.83	0.11	-4.71
338+63	5/25/2017	10/16/2017	-31.65	-0.81	-3.45
340+43	5/25/2017	10/16/2017	-19.87	0.54	0.84

**Table C-2. Summary of Shoreline Change and Volume Change
(May 2017 to October 2017) Cont.**

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.
2. MHW assumed at +0.98 ft-NAVD88.
3. Shoreline Change and Volume Change is calculated for the period between surveys from May 25, 2017 to October 16, 2017.

Transect Number (Station)	Old Survey Date	New Survey Date	Shoreline Change at MHW (ft)	Volume Change Above 0 ft NAVD88 (cy/ft)	Volume Change Above -15 ft NAVD88 (cy/ft)
342+23	5/25/2017	10/16/2017	-22.23	0.19	-7.24
344+05	5/25/2017	10/16/2017	-44.84	-0.21	5.14
345+85	5/25/2017	10/16/2017	-29.89	-1.40	-7.83
347+63	5/25/2017	10/16/2017	-39.42	-0.90	-4.17
349+43	5/25/2017	10/16/2017	-22.62	-1.38	-0.23
351+23	5/25/2017	10/16/2017	-38.16	-0.20	-0.32
353+03	5/25/2017	10/16/2017	-16.92	-0.02	-1.41
354+83	5/25/2017	10/16/2017	-35.24	0.16	-3.27
356+63	5/25/2017	10/16/2017	-16.10	0.66	-3.31
358+43	5/25/2017	10/16/2017	-32.80	0.41	-2.17
360+23	5/25/2017	10/16/2017	-11.60	1.91	1.06
362+03	5/25/2017	10/16/2017	-28.98	0.29	-4.14
363+83	5/25/2017	10/16/2017	-18.33	0.06	-5.28
365+63	5/25/2017	10/16/2017	-33.57	-0.78	-5.87
367+43	5/25/2017	10/16/2017	-19.66	-0.02	-1.80
369+23	5/25/2017	10/16/2017	-41.51	-2.46	-5.78
371+03	5/25/2017	10/16/2017	-22.31	-2.20	-4.23
372+83	5/25/2017	10/16/2017	-16.57	0.30	-1.87
375+08	5/25/2017	10/16/2017	-13.61	0.71	-1.00
376+78	5/25/2017	10/16/2017	-25.17	0.52	0.04
378+48	5/25/2017	10/16/2017	-21.11	0.18	-4.82
380+18	5/25/2017	10/16/2017	-15.48	0.47	0.02
381+88	5/25/2017	10/16/2017	-39.47	-3.51	-7.08
383+58	5/25/2017	10/16/2017	-48.39	-5.24	-2.96

ENGINEERING ACTIVITIES LOG AND LOG OF SURVEYS FOR ENTIRE OCEAN VIEW SHORELINE

No	Date	Project Type	Location	Description	Vol (cy)	Extent (ft)	Unit Vol (cy/ft)	Sand Source
1	1920-1937	Groin Construction	Willoughby Spit Shoreline	62 groins built by private property owners				
2	Dec 1926-Jan 1928	Jetty Construction	Little Creek Inlet	East Jetty Construction				
3	Dec 1926-Nov 1928	Jetty Construction	Little Creek Inlet	West Jetty Construction				
4	1938	Groin Construction	Between Willoughby Spit and Chesapeake Blvd.	37 timber groins built by City of Norfolk				
5	1953	Beach Nourishment	18th Bay St to 27th Bay St (East Ocean View)	Beach Nourishment	1,260,000	3,000	420	
6	1953	Beach Nourishment	27th Bay St to West Jetty (East Ocean View)	Beach Nourishment	500,000	1,800	278	
7	1960	Beach Nourishment	East End Parking Lot to West Jetty (East Ocean View)	Beach Nourishment	159,000	900	177	
8	1962	Beach Nourishment	Terminal Groin to 9th View St (Willoughby Spit)	Beach Nourishment	176,000	6,900	25	
9	1981	Groin reconstruction	Willoughby Spit area	5 timber groins were reconstructed				
10	1982	Beach Nourishment	East Ocean View	Beach Nourishment	400,000			Pretty Lake
11	1983	Groin Removal	Ocean View Park area	3 groins removed				
12	1983	Groin Construction	Western end of Willoughby Spit	5 groins built by the City of Norfolk				
13	Jan-Apr 1984	Beach Nourishment	Terminal Groin to 5th View St (Willoughby Spit)	Beach Nourishment	537,500	11,000	49	Navy Piers
14	Aug-Nov 1984	Beach Nourishment	21st Bay St to East End Parking Lot (East Ocean View)	Beach Nourishment	400,000	3,000	133	Pretty Lake
15	1985	Beach Nourishment	6th View St to Sarah Constant Shrine Park	Beach Nourishment	50,000			Navy's Willoughby project site
16	1987	Beach Nourishment	5th View St to Mason Creek	Beach Nourishment	50,000	2,000	25	Truck Haul
17	1988	Beach Access Construction	Willoughby and Ocean View	19 pedestrian beach access ways constructed				
18	Spring 1988	Dune Repair	Willoughby Beach	used 10,000 cy of accretion from terminal groin				
19	June, 1989	Dune Repair	Willoughby Beach	used 25,000 cy of accretion from terminal groin				
20	1989	Beach Nourishment	21st Bay St to East End Parking Lot (East Ocean View)	Beach Nourishment	133,000	3,000	44	Cape Henry Channel
21	1990	Breakwater Construction	Western end of Willoughby Spit-Lea View Ave.	2 near shore breakwaters				
22	1990	Terminal Groin Reconstruction	Western end of Willoughby Spit-Lea View Ave.	Original wooden groin raised and extended using rock				
23	1990	Beach Nourishment	Willoughby Spit-Near Terminal Groin	Beach Nourishment	100,000			West of Terminal Groin
24	1990-1991	Dune Stabilization/repair	Various Locations	dune vegetation planting,sand fence construction, elevated public access way, cross-over structures, and timber roads for vehicles				
25	1995	Beach Nourishment	Willoughby Spit	Beach Nourishment	240,000			15th View
26	December, 1995	Beach Nourishment	13th View St to 12 View St (in 4 groin pockets)	Beach Nourishment	4,000			15th View
27	December, 1995	Beach Nourishment	Critical Area 1: 8th View St to 7th View St	Beach Nourishment	30,000	1,000	30	15th View
28	March, 1997	Terminal Groin (trunk) Elevated	Willoughby Spit	terminal groin (trunk) elevated +4 ft				
29	Jan 1997- April 1997	Breakwater Construction	Critical Area 1: Worth St to 8th View	nearshore breakwaters 1-4 constructed				
30	December 1997 - March 1998	Breakwater Construction	Critical Area 1: Worth St to 8th View	nearshore breakwaters 5-7 constructed				
31	October 1998 City Survey		Entire Ocean View Shoreline					
32	December, 1998	Beach Nourishment	Critical Area 1: East of 8th View St-near site of future groin spur	Beach Nourishment	500	175	3	
33	October 1999 City Survey		Entire Ocean View Shoreline					
34	1999	Breakwater Construction	Critical Area 2: Just east of Community Beach	4 nearshore breakwaters constructed				
35	November-December 1999	Groin Spur Construction	Critical Area 1: Worth St to 8th View	groin spur construction				
36	December, 1999	Beach Nourishment	Center of COV breakwaters	Beach Nourishment	4,000			
37	December, 1999	Beach Nourishment	Critical Area 1: East of 8th View St-leeward of newly constructed groin spur	Beach Nourishment	1,000	200	5	15th View
38	July 2000 City Survey		From Approx. 9th View St to Little Creek Inlet					
39	August, 2000	Breakwater Construction	Critical Area 3: 21st Bay to Little Creek Inlet	nearshore breakwaters 2,3,4 constructed				
40	October 2000 City Survey		From Approx. 12th View St to Little Creek Inlet					
41	July, 2001	Beach Nourishment	Critical Area 1: Worth St to 8th View	Beach Nourishment	500			Truck Haul
42	September, 2001	Beach Nourishment	Critical Area 1: East of 8th View St-between breakwater 7 and groin spur	Beach Nourishment	2,000	300	7	15th View
43	October 2001 City Survey		Entire Ocean View Shoreline					
44	November, 2001	Breakwater Construction	Critical Area 3: 21st Bay to Little Creek Inlet	nearshore breakwaters 1,5,6,7 constructed				
45	March - April, 2002	Breakwater Work	Critical Area 1: breakwater 7	work on toe extensions				
46	May, 2002	Beach Nourishment	Critical Area 1: East of 8th View St-between breakwater 7 and groin spur	Beach Nourishment	3,438	300	11	15th View
47	June, 2002	Groin Removal	Critical Area 1: Worth St to 8th View	Removal of timber groin channalward of rock spur				
48	July 2002 City Survey		Entire Ocean View Shoreline - excluding approx. Sherwood Pl. to Warwick Ave.					
49	October 2002 City Survey		Entire Ocean View Shoreline - minimal survey data (no beach or bathymetric survey points)					
50	March 2003 City Survey		East Ocean View Shoreline (19th Bay to Little Creek Inlet)					
51	April 2003 City Survey		East Ocean View Shoreline (17th Bay to Little Creek Inlet)					
52	June 2003 Waterway Survey		East Ocean View Shoreline (17th Bay to Little Creek Inlet)					
53	September, 2003	Beach Nourishment	Critical Area 1: West of 8th View St beach access	Beach Nourishment	1,100	350	3	15th View

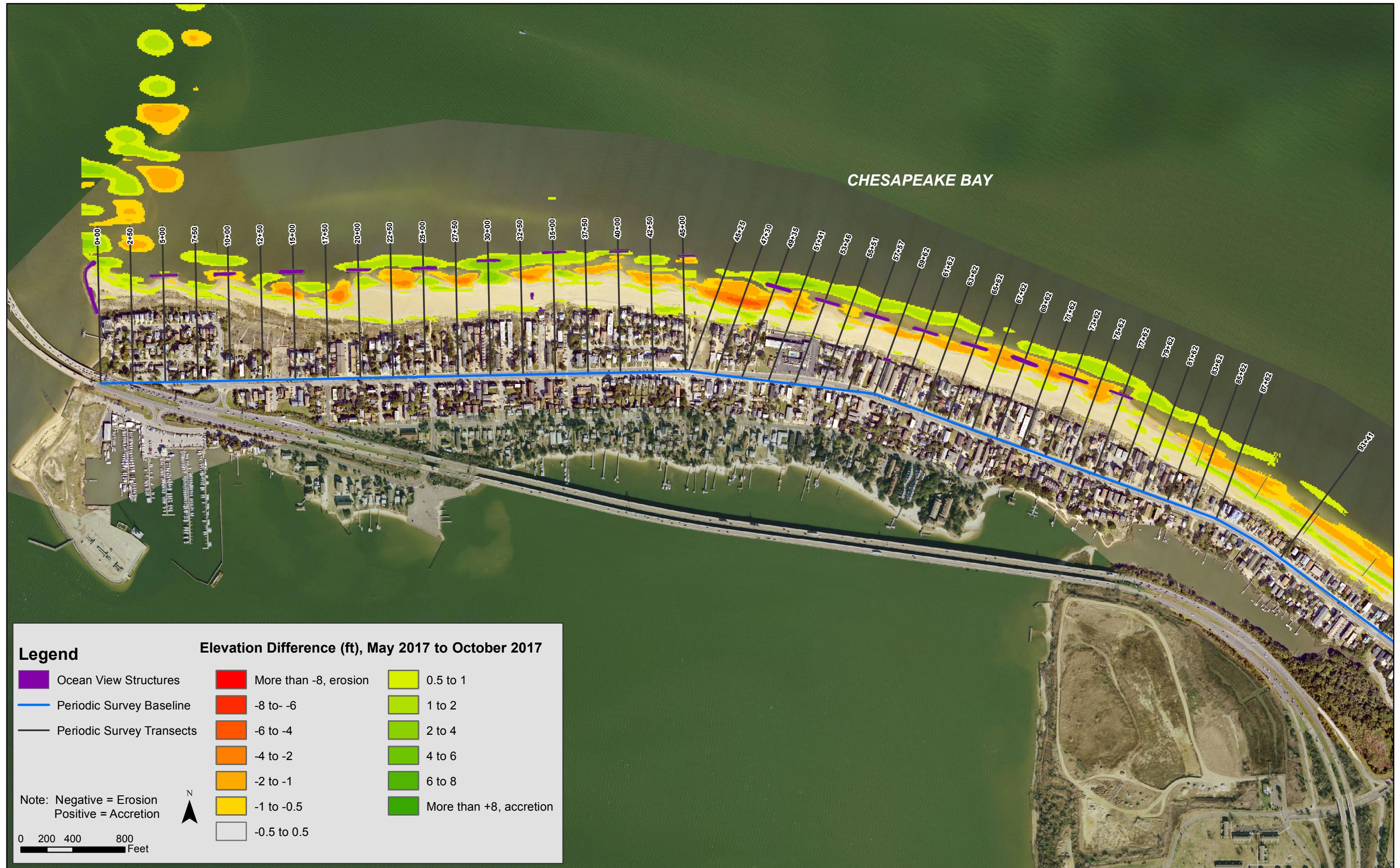
No	Date	Project Type	Location	Description	Vol (cy)	Extent (ft)	Unit Vol (cy/ft)	Sand Source
54	October 2003 Waterway Survey		Post-Isabel Survey - East Ocean View Shoreline (17th Bay to Little Creek Inlet)					
55	October, 2003	Beach Nourishment	Critical Area 3: 19th Bay St	Beach Nourishment	6,000	545	11	upland sand trucked in
56	October, 2003	Beach Nourishment	Critical Area 3: East of 30th Bay St	Beach Nourishment	1,000	150	7	upland sand trucked in
57	December, 2003	Beach Nourishment	Critical Area 3: 17th Bay St to Little Creek Inlet	Beach Nourishment	359,000	5,280	68	Thimble Shoal Channel
58	December, 2003	Beach Nourishment	Critical Area 1: 9th View St to 7th View St (+400 ft)	Beach Nourishment	39,800	1,260	32	
59	Nov-Dec 2003 Post-Fill Survey		East OceanView Shoreline (17th Bay to Little Inlet Creek)					
60	Feb-April, 2004 Waterway Survey		From Approx. Willoughby Spit to 17th Bay St					
61	August, 2004	Beach Nourishment	13th View to 11th View, Behind Western 4 Breakwaters at 800 Block, 1200' East of dogleg	Beach Nourishment	37,000	4,950	7	Truck Haul
62	January-March, 2005	Dune Restoration	Willoughby Spit to Central Ocean View (14th View St to Warwick Ave)	Willoughby Spit to Central Ocean View Dune Restoration Project	504,329	18,300	28	Thimble Shoal Channel
63	January-March 2005 Post-Fill Survey		Willoughby Spit to Warwick Ave.					
64	September 2005 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
65	January-February, 2006	Groin Spur & Toe Extension Removal	Critical Area 1: East of 8th View	groin spur removal				
66	January-February, 2006	Breakwater Construction	Critical Area 1: East of 8th View	nearshore breakwater 8 constructed				
67	January-February, 2006	Breakwater Construction	Critical Area 3: 29th Bay to Little Creek Inlet	nearshore breakwaters 8, 9, & 10 constructed				
68	March 2006 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
69	October 2006 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
70	March 2007 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
71	October 2007 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
72	March 2008 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
73	October 2008 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
74	March, 2009	Beach Nourishment	East Ocean View and Bay Oaks	Beach Nourishment	196,000			
75	April 2009 McKim & Creed Periodic Survey		Entire Ocean View Shoreline					
76	August-October, 2009	Breakwater Construction	Bay Oaks	5 Nearshore Breakwaters Constructed				
77	October 2009 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
78	November-December 2009 Post-Storm Survey		Entire Ocean View Shoreline					
79	March 2010 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
80	April, 2010	Dune Restoration	Willoughby Spit and 800 Block	Dune restoration using sediment from terminal groin and 800 block breakwaters				
81	October 2010 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
82	April 2011 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
83	October 2011 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
84	March 2012 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
85	October 2012 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
86	January-May, 2013	Breakwater Construction	Willoughby Spit	7 Nearshore Breakwaters Constructed				
87	January-May, 2013	Dune Restoration/Beach Nourishment	Willoughby Spit	Dune Restoration at Lea View Ave and Beach Nourishment from 11th View to 13th View	35,000			Willoughby Spit / Truck Haul
87	January-May, 2013	Breakwater Relocation	800 Block	Breakwater 7 moved further offshore				
88	April 2013 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
89	May-October, 2013	Timber Groin Removal	West Ocean View	7 Timber Groins removed east of the Pier				
90	October, 2013	Rock Groin Construction	West Ocean View	Rock Groin Constructed between Sarah Constant Shrine Park and the 200 Block				
91	October 2013 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
92	November 2013	Beach Nourishment	West Ocean View	Beach Nourishment	73,600			Truck Haul
93	March 2014 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
94	October 2014 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
95	April 2015 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
96	October 2015 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
97	January-February 2016	Beach Nourishment	Toler Place (between 11th View and 12th View Streets)	Emergency nourishemt placed above MHW	16,400			Willoughby Spit
98	February 2016	Beach Nourishment	Adjacent to Terminal Groin	Emergency nourishemt placed above MHW	1,500			Truck Haul Upland Source
99	May 2016 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
100	October 2016 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
101	February 2017 Federal Project Ore-Construction Survey (by GLDD)		Entire Ocean View Shoreline					
102	March-May 2017	Beach Nourishment	14th View Street to Warwick Avenue, and 1st Bay Street to Little Creek Inlet	Initial Construction of the Federal Project by USACE	1,200,358		variable	Thimble Shoal Aux. Channel
103	May 2017 Federal Project Post-Construction Survey (by GLDD)		Entire Ocean View Shoreline					
104	May 2017 Geodynamics Periodic Survey		Entire Ocean View Shoreline					
105	October 2017 Geodynamics Periodic Survey		Entire Ocean View Shoreline					

REFERENCE*

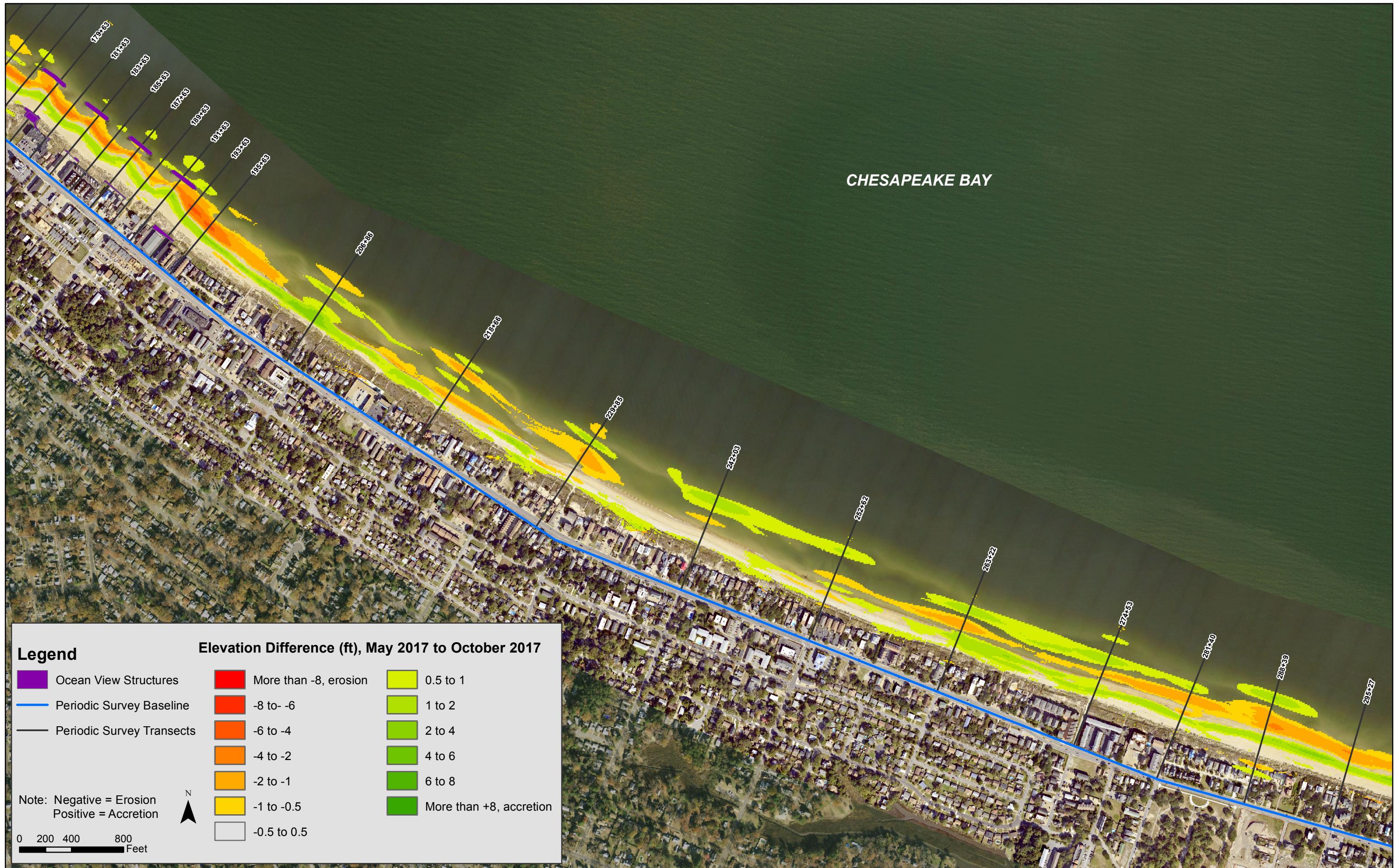
Critical area 1: Worth St to 8th View
Critical area 2: Chesapeake Blvd. to Atlans St.
Critical area 3: 21st Bay to Little Creek Inlet

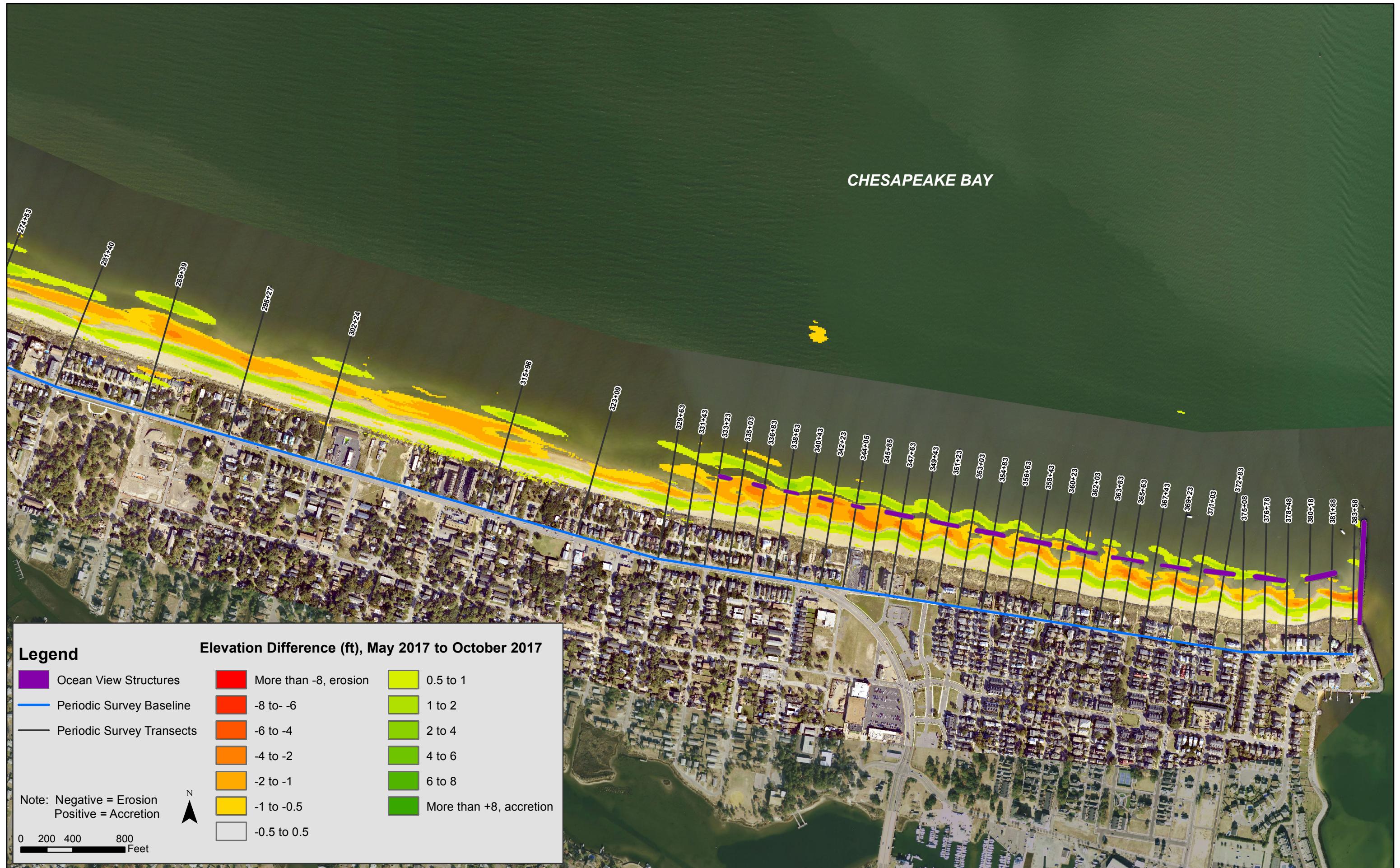
*Critical areas of concern for erosional damage defined in

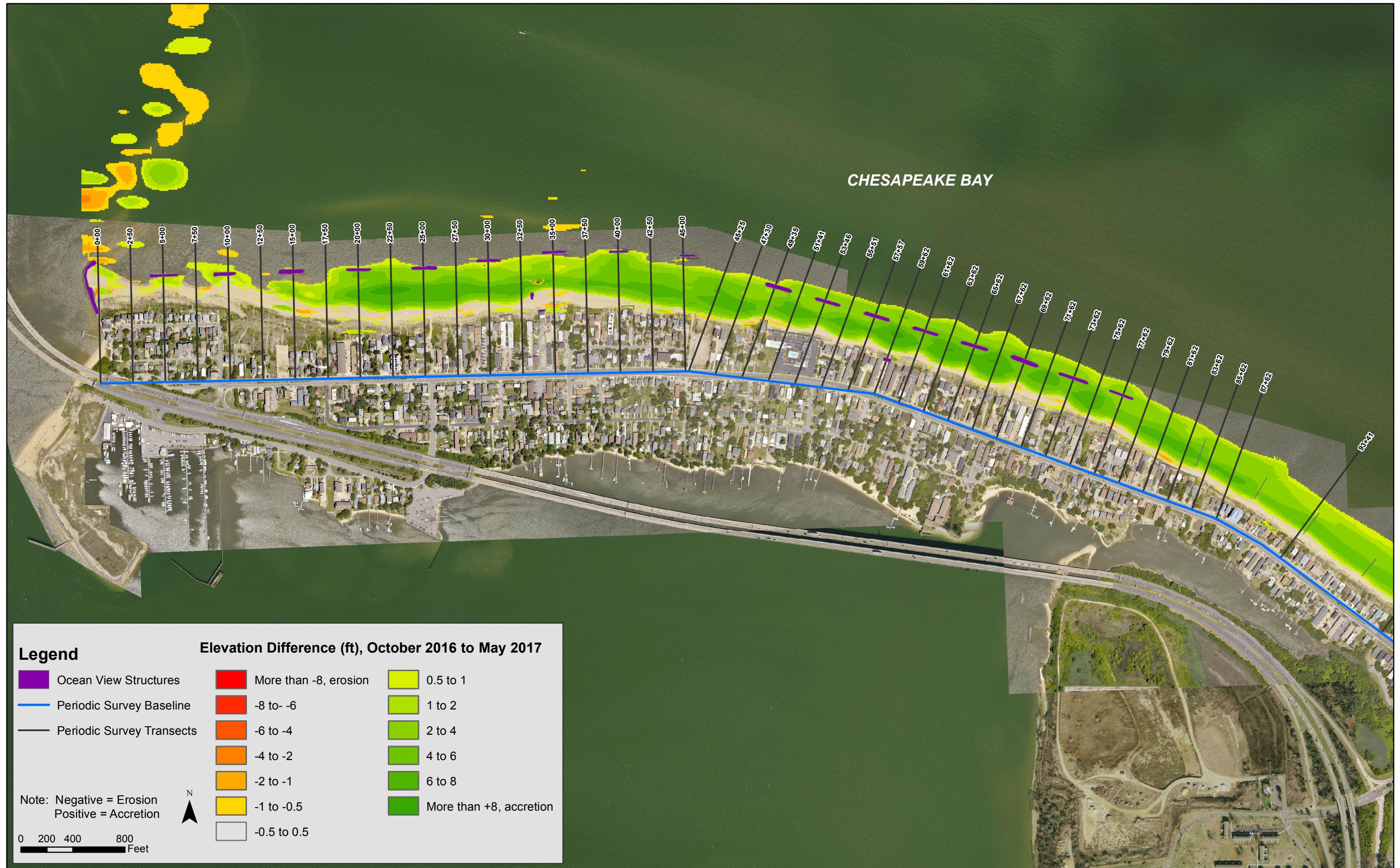
Andrews, Miller & Assoc., Inc. "Beach Management Plan, City of Norfolk Virginia", January, 1993.

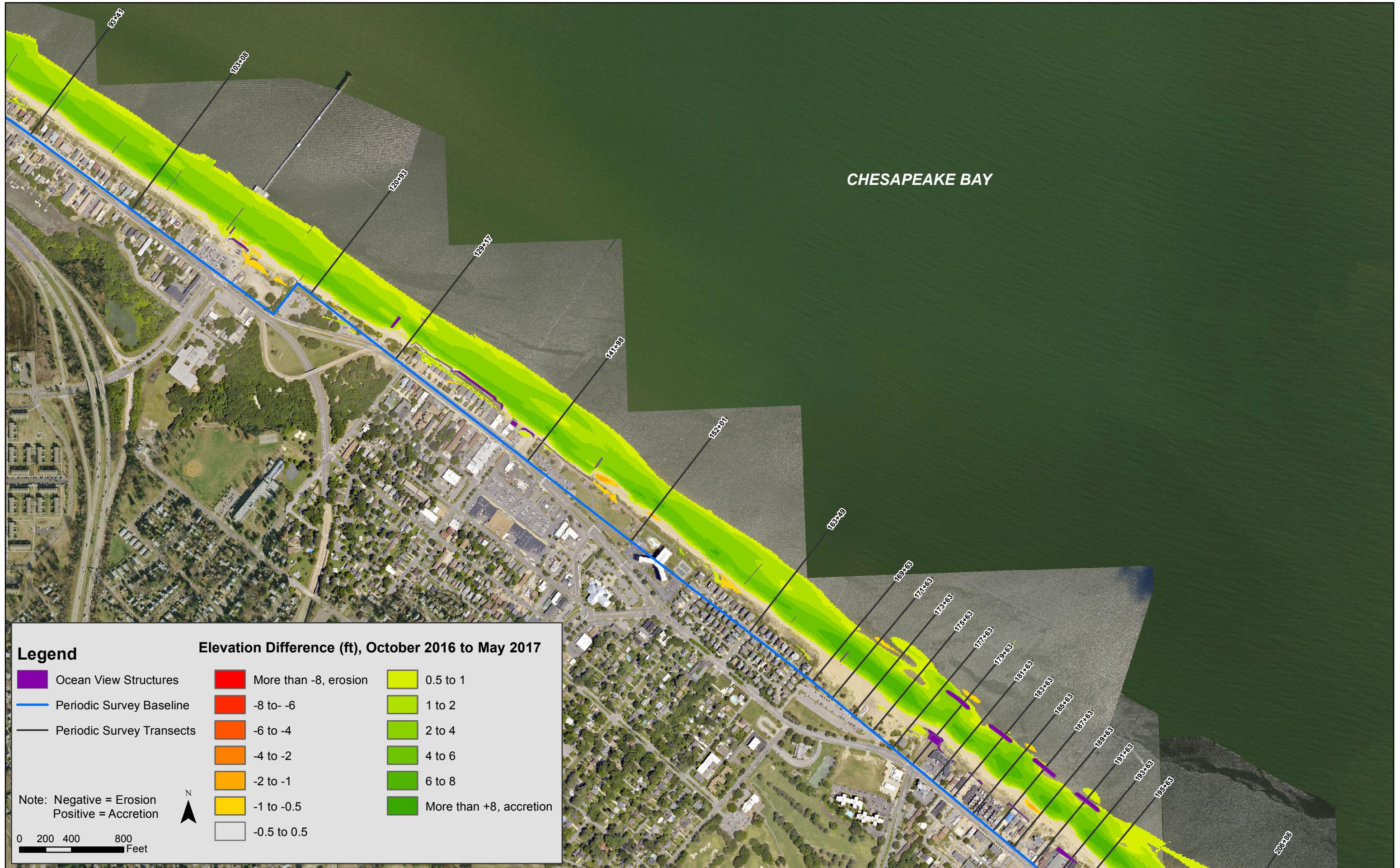


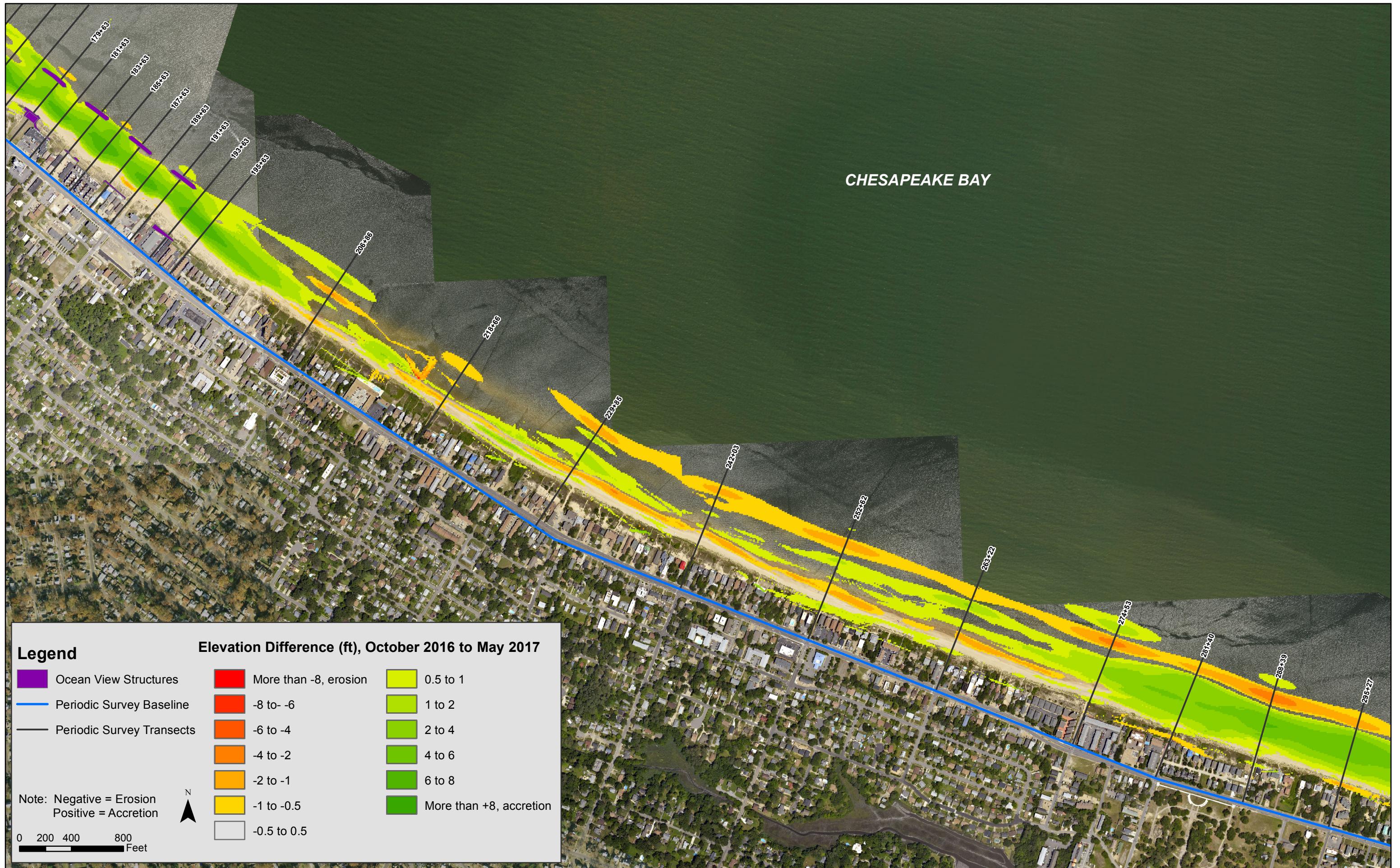


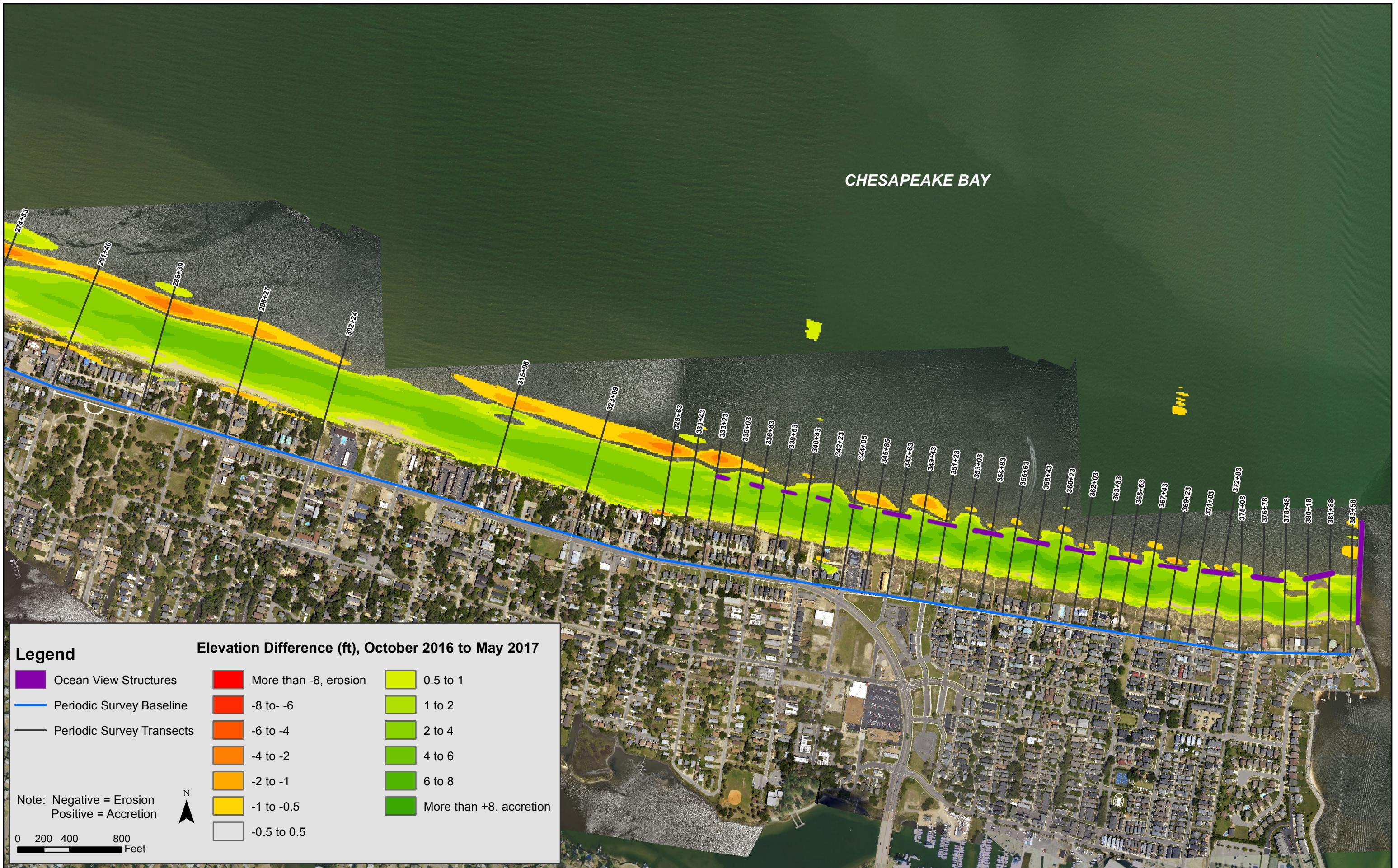














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