

**LEE COUNTY, FLORIDA
SHORE PROTECTION PROJECT
GASPARILLA ISLAND SEGMENT**

2013 BEACH RENOURISHMENT

**FOURTH ANNUAL POST CONSTRUCTION MONITORING REPORT
October 2018**



**US Army Corps
of Engineers**
Jacksonville District

**U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT**

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Introduction

The Federally-authorized Lee County, Gasparilla Island Shore Protection Project (SPP) consists of beach renourishment along 2.8 miles of Gulf coastline extending from the Lee County northern boundary to near Boca Grande Pass. The primary purpose of the project is to reduce the risk of damage to upland property from storm-induced erosion and flooding. Initial construction of the Lee County, Gasparilla Island SPP was completed in 2007 by the nonfederal sponsor with reimbursement by the federal government (under Section 206 of the Water Resources Development Act of 1992 (WRDA92)). A Project Information Report (PIR) for impacts sustained by Tropical Storm (T.S.) Debby in June 2012 determined that the project qualified for Flood Control and Coastal Emergencies (FCCE) funds. As a result, this project was fully restored with a combination of FCCE and Construction General (CG) funds from October through December 2013.

The performance of the 2013 renourishment of the Lee County, Gasparilla Island shoreline is the subject of this monitoring report. This report was prepared under the provisions of Florida Department of Environmental Protection (DEP) Permit 0174403-001-JC and Monitoring Plan dated October 2013, which requires annual beach profile monitoring of the beach renourishment project and preparation of a monitoring report to present the results of each survey. This Fourth Annual Post Construction Monitoring Report will present the results of the most recent monitoring survey completed in August 2018 along with the comparisons to previous surveys.

The surveyed beach profiles used in this monitoring study are based on the Department of Natural Resources (DNR), now renamed Florida Department of Environmental Protection (FDEP), monuments. The federal project extends from FDEP monument R-11 (north) to R-24 (south), as seen in **Figure 1**, with additional tapered extensions from 1200 ft north of R-11 and 600 ft south of R-24, shown in **Figure 2**. Note that the “FDEP-” survey monument designation is typically shortened to “R-“ for convenience. The borrow area is located approximately 1.0 mile southwest of the southern end of Gasparilla Island, as shown in **Figure 1**.

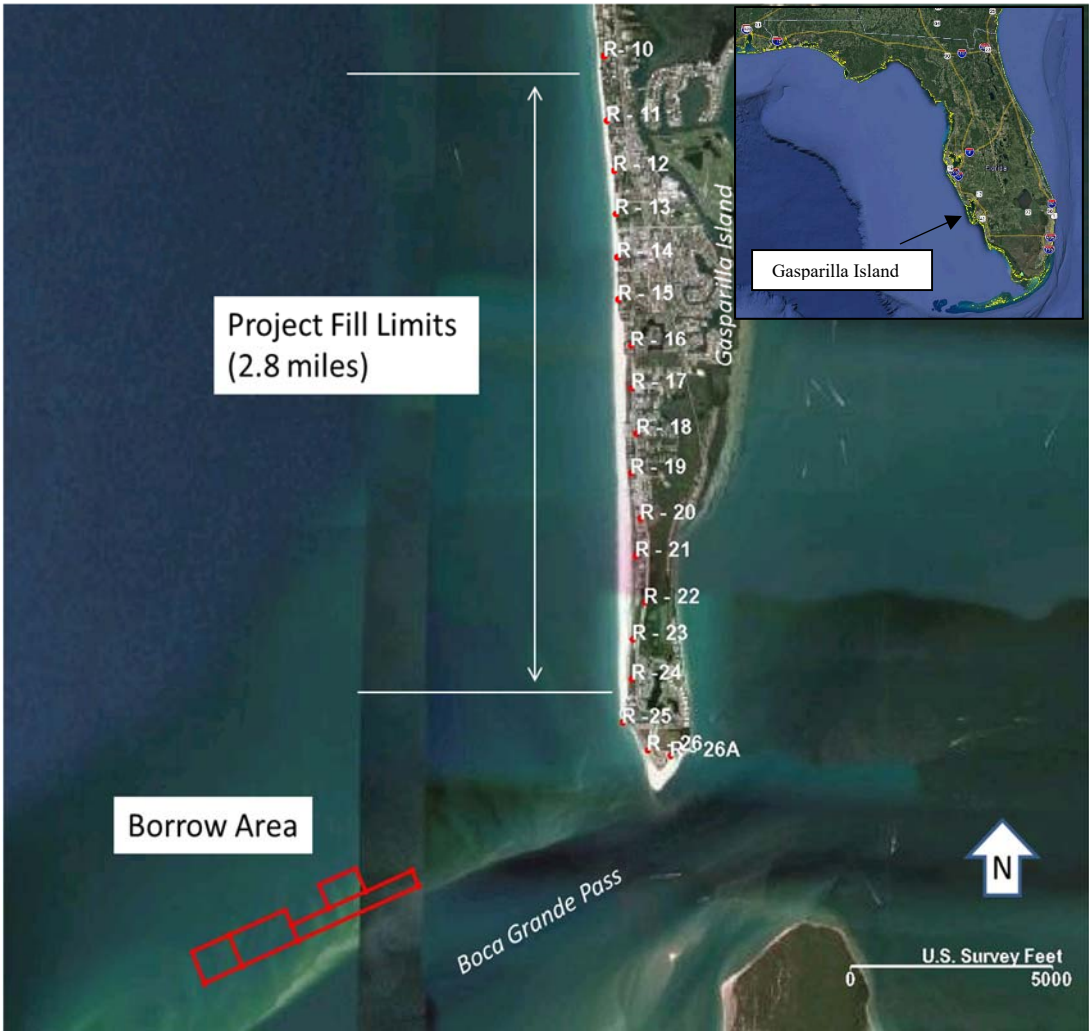


Figure 1: Lee County Gasparilla Island Shore Protection Project Map

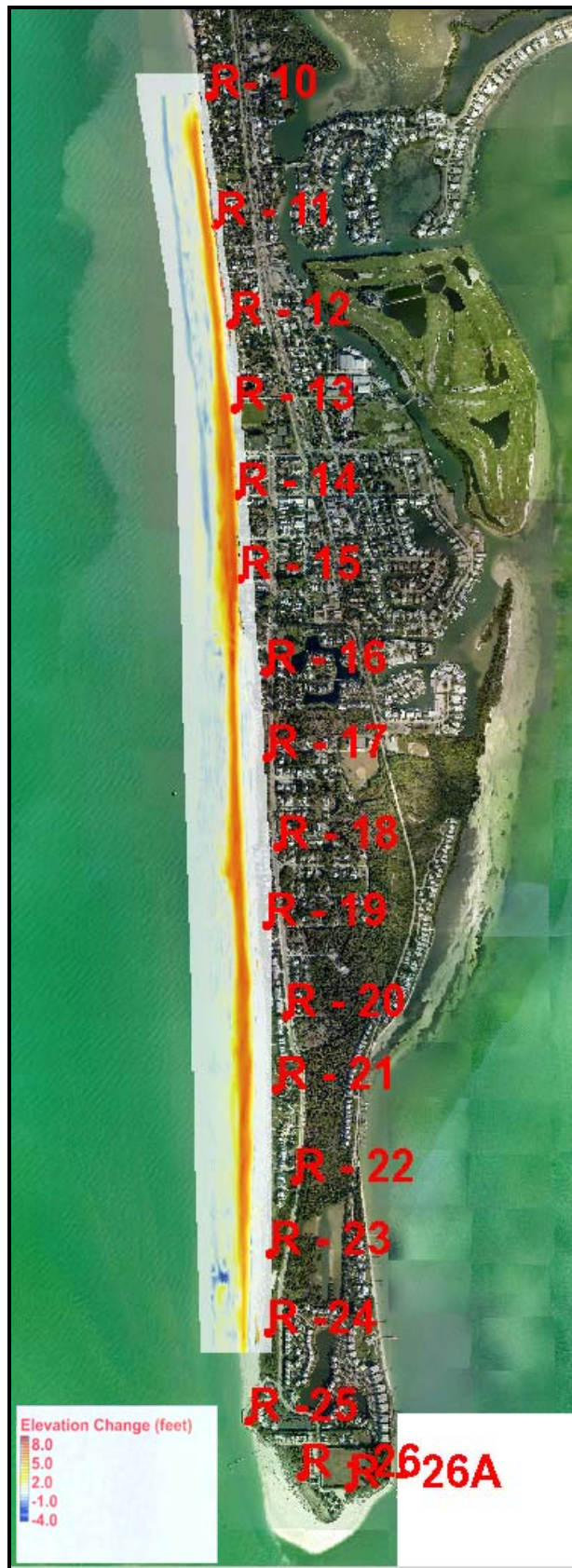


Figure 2: Limits of the 2013 renourishment construction project fill area depicted by elevation change from pre to post-construction surveys and FDEP survey monuments

Authority

The Lee County, Florida, Beach Erosion Control Project was authorized under the provisions of Section 201 of the 1965 Flood Control Act by Senate Resolution dated December 17, 1970, and House Resolution dated December 15, 1970. The authorized project provides for Federal participation in beach erosion control measures for the gulf shoreline of Gasparilla Island, Captiva Island, and Estero Island in Lee County, Florida.

Project History

The local non-federal sponsor (Lee County) completed initial construction in 2007 under authority provided in Section 206 of the Water Resources Development Act of 1992 (WRDA92). In January 2000 Lee County, under a cost-share agreement with the Florida Department of Environmental Protection (FDEP), initiated engineering design and permitting for initial construction on a reimbursement basis with the Federal government under Section 206 Authority. The final design included a segmented breakwater located approximately 325 ft offshore of R-25; two T-head groins in the vicinity of R-26, and restoration from R-11 to R-24 using approximately 920,000 cubic yards of sand from an offshore borrow area. The initial construction of the restoration project was completed in April 2007 by Lee County. The design template consists of a 20 ft berm at elevation of +5 ft MLW with a foreshore slope of 1V:15H transitioning to a nearshore slope of 1V:25H at MLW extending out to the intersection with the existing profile.

A General Reevaluation Report (GRR) was approved in 2001 with an April 2008 Addendum which updated the cost-sharing percentages from 58.7% federal and 41.3% non-federal to 54.4% federal and 45.6% non-federal. The source of material for the 2007 construction of the Lee County, Gasparilla Island Segment project was the offshore borrow area located one mile southwest of the southern end of Gasparilla Island (**Figure 1**). The structures were scheduled for construction in 2010, but have not been constructed. The project included construction of 0.9 acres of artificial reef offshore of R-11 to mitigate for adverse impacts to nearshore hardbottom which was completed before initial construction.

Completion of a Rehabilitation Effort for the Lee County Hurricane and Storm Damage Reduction Project Gasparilla Island Segment Project Information Report (PIR, February 2013) for impacts sustained by T.S. Debby (June 2012) resulted in a positive request for Flood Control and Coastal Emergencies (FCCE) and CG funds. The planned renourishment volume equaled 421,200 cubic yards (cy) every 7 years (2001 GRR).

Impacts of the 2012-2013 Hurricane Season

The 2013 Lee County, Gasparilla Island Segment renourishment was performed to repair damages caused by T.S. Debby in 2012 and also included advanced nourishment to restore the project to its full project dimensions. Following T.S. Debby in 2012, Hurricane Isaac and Hurricane Sandy were the only tropical events to occur in the region throughout the remainder of 2012 (**Figure 3**). Hurricane Sandy, while a significant event on the Atlantic coast, was not significant on the Gulf coast, with maximum sustained winds of 25 knots and water levels less than 1.0 ft above predicted tides measured at Ft. Myers. Hurricane Isaac was a tropical storm during most of its time in the Gulf of Mexico and did not become a Category 1 hurricane until just before landfall in Louisiana. Maximum sustained winds of 39 knots and a maximum storm

surge of 2.3 ft were measured at Ft. Myers. These subsequent weather events in the project area were not significant and likely caused no more than normal background erosion.

Between the May 2013 pre- and Feb 2014 post-construction monitoring surveys three tropical events of minor significance occurred in the project vicinity, T.S. Andrea, Tropical Depression Dorian, and T.S. Karen (**Figure 4**). T.S. Andrea, occurring during June 5-7 2013, had maximum sustained winds of 24 knots and water levels 1.3 ft above predicted tide measured at Ft Myers. Tropical Depression Dorian following a path along the Florida Atlantic coast occurred during July 23–Aug 3 2013 and had maximum sustained winds of 17 knots and water levels 0.5 ft above the predicted tide measured at Ft Myers. T.S. Karen, occurred during Oct 3-6 2013, and had maximum sustained winds of 25 knots of minimal duration with water levels 1.3 ft above predicted tide for a 24 hour period, as measured at Ft. Myers. No record of any significant extra-tropical events were found during the survey interval.

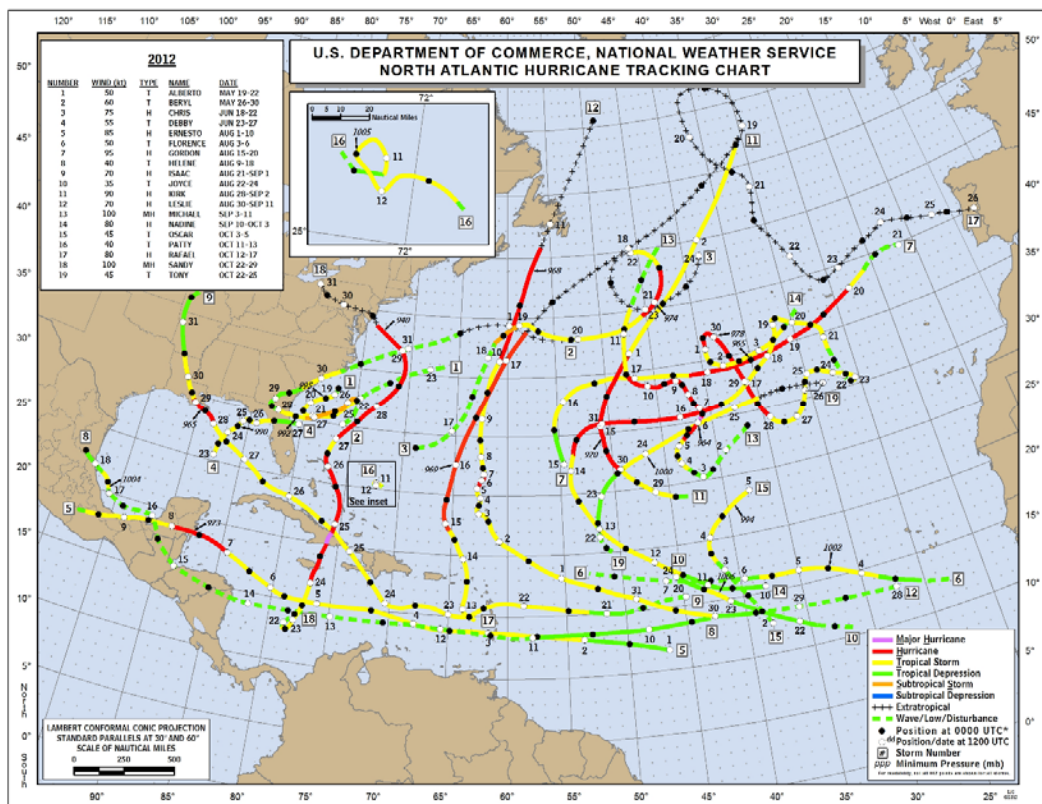


Figure 3: Hurricane and tropical storm tracks – 2012

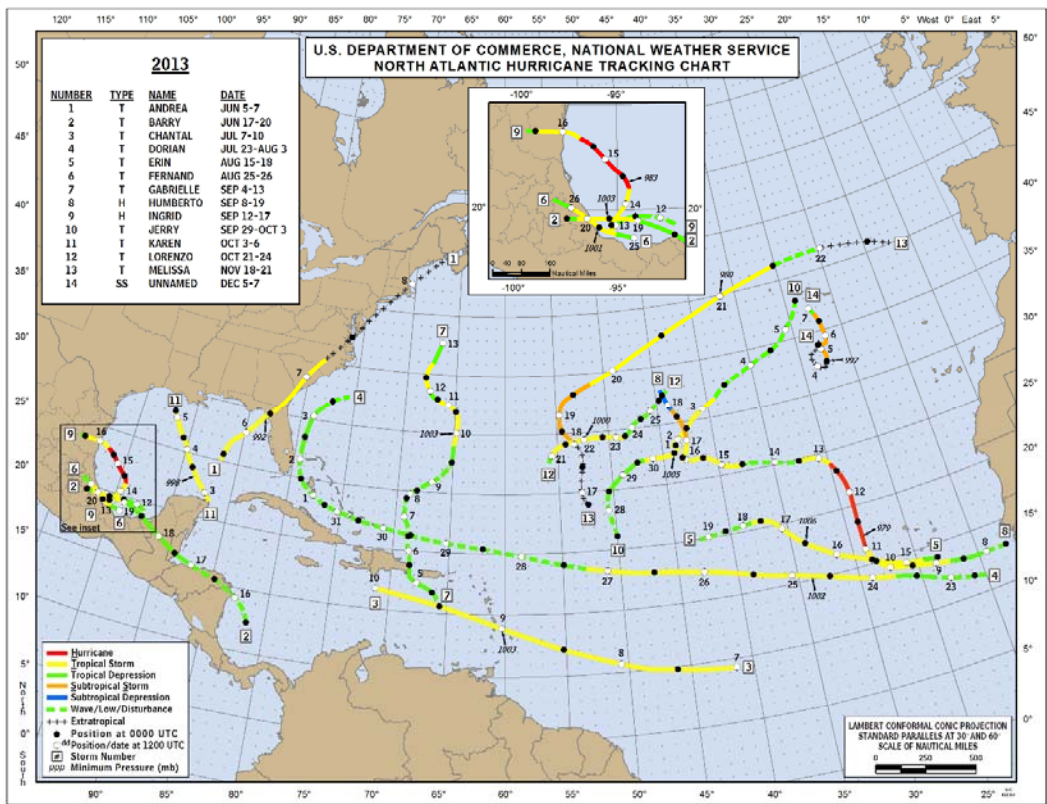


Figure 4: Hurricane and tropical storm tracks – 2013

2013 Lee County Gasparilla SPP Renourishment

The 2013 renourishment of the Lee County, Gasparilla Island Segment SPP was constructed from October 26, 2013 through December 10, 2013 and is the subject of this monitoring report. This renourishment was performed to repair damages to the Federal project resulting from T.S. Debby, which impacted Florida 23-27 June 2012. The 2013 PIR recommended placement of 467,250 cy (31.6 cy/ft) to repair damages and rebuild affected portions of the Lee County, Gasparilla SPP to its full construction template. A portion of the total volume, 79,250 cy, was paid by the Federal government at no cost to the local sponsor under FCCE funding. The remaining 388,000 cy was additional advanced nourishment volume. As shown in **Figure 1**, project construction covered 2.8 miles of the southern end of Gasparilla Island. The 2013 project was constructed from R-24.5 to R-10.5, including tapers. The total project cost was \$ 9.8 million with 17 % or \$ 1.7 million attributed to the FCCE renourishment. The source of fill for the 2013 renourishment was the offshore borrow area located one mile southwest of the southern end of Gasparilla Island as shown in **Figure 1**.

Figure 5 shows a typical construction template as used in the 2013 renourishment. This fill template is consistent with the template used in the initial project. The Lee County SPP authorization requires the construction and maintenance of a specific design template in order to reduce damages due to storm-induced erosion along the project length. The construction cross-section includes the fill required to construct the design cross-section plus additional fill placed seaward of the design section for advanced nourishment. The construction template includes a 100-ft wide berm at an elevation of +3.8 ft North American Vertical Datum of 1988

(NAVD88), sloping at 1V:125H to +3.0 ft NAVD88 and then sloping down to existing bottom at a 1V:10H slope between monuments R-10.5 to R-24.5 (including tapers).

The final volume placed according to contract payment during the 2013 Lee County, Gasparilla Segment SPP renourishment was 457,800 cy. This volume of material was calculated based on acceptance section surveys, which are performed separately from the pre- and post- fill monitoring surveys. Acceptance section surveys are taken over short reaches of shoreline as the project progresses. As such, they are taken shortly after each section of fill is completed and do not typically reflect equilibration of material due to erosion or profile adjustment. The elapsed time between the pre- and post-construction FDEP profile monitoring surveys is typically much longer, in this case approximately 8 months (May 2013 to February 2014). During this time the project equilibrates to some degree following fill placement (i.e. constructed slopes evolve to foreshore slopes that are more representative of the pre-project beach). Also, since the entire length of the project is surveyed at the same time, these FDEP monitoring surveys give a better “snapshot” of the overall project condition.

During the 2013 construction an adjustment was required for the fill template along Gasparilla Island. The contract volume was based on the May 2013 survey of Gasparilla Island Beach collected during plans and specifications phase (Spring of 2013), which yielded an estimated 480,000 cubic yards of material required for the construction template—this was the volume that was used in the construction contract solicitation and engineering plans and specifications. The preliminary pre-construction survey, survey #13-207 was conducted in October 2013, of Gasparilla Island using 500 ft intervals. This survey yielded a substantially lower volume of 341,000 cy of material resulting in a potential 29% underrun of the contract volume.

To account for a decrease in contract volume due to natural accretion and recovery of the beach, the contract plans were modified with an additional berm width of 30 ft (from 100 to 130 ft) from R-19 to R-21 and extended the berm width by 10 ft between R-10.5 and R-15.5.

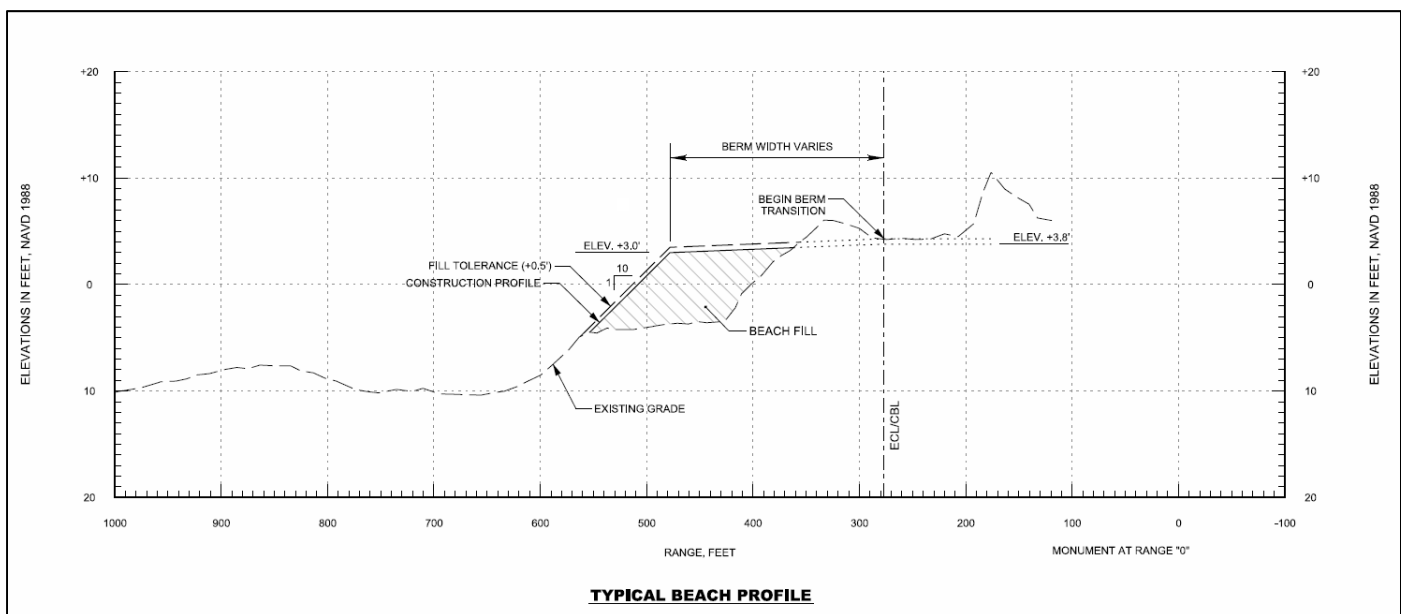


Figure 5: Typical profile and beach fill template

Approximately 55,000 cy of additional material was added to the project by increasing the berm width. This increase in berm width is considered additional advanced nourishment since it is beyond the 20-ft design berm width. The modified contract volumes were thus 128,000 cy of design berm (less required due to natural accretion), and 338,000 cy of advanced fill for a total volume of 466,000 cy. The total proposed advanced nourishment for this project with the berm width adjustment is 338,000 cy, which is less than the advanced nourishment volume requirement of 421,200 cy as predicted in the 2001 GRR.

Wave Conditions 2013 to 2016

The wave conditions between January 2013 and December 2016 are displayed in **Figure 6**. These figures are taken from the Coastal Data Information Program (CDIP) buoy station 144. This station is located approximately 130 miles north-west of the project area but it is the only station with a dataset that incorporates this time period in the vicinity. It reflects the general conditions of the waves off the west coast of Florida which give an idea of the wave climate during this time period but may not reflect the exact wave conditions at Gasparilla Island.

The threshold for elevated wave conditions was set at 3.0 meters relative to mean sea level and there were several events that crossed this threshold from 2013 to 2016. The most notable of those events included Tropical Storm Colin and Hurricane Hermine, both of which occurred in 2016. Otherwise, this period is considered to be fairly calm for tropical systems in the Gulf of Mexico.

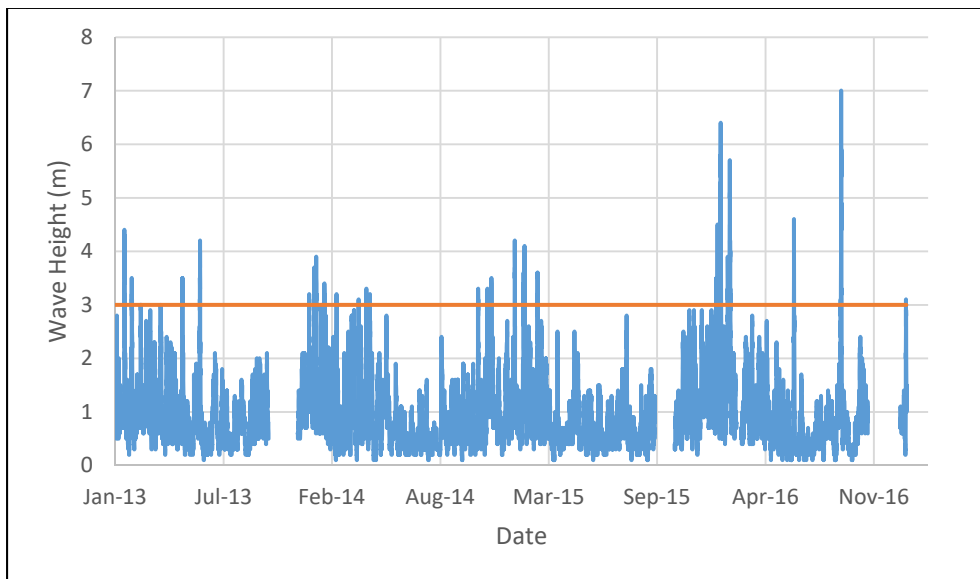


Figure 6: Wave Heights at CDIP Station 144 from 2013 to 2017

Impacts of Hurricane Irma (2017)

Hurricane Irma impacted the Lee County Shore Protection Project Gasparilla Segment during September of 2017. Hurricane Irma developed near the Cape Verde Islands and eventually strengthened into a Category 5 hurricane. The path of the hurricane can be seen in **Figure 7**.

The hurricane made landfall on Cudjoe Key in the Florida Keys and again on Marco Island, FL. The hurricane moved up the central portion of Florida and weakened to a tropical depression over the Georgia-Alabama border which then dissipated in Mississippi. Hurricane Irma had maximum sustained wind speeds in the project area of 57.7 knots measured at Venice Beach. The water level rose 4.9 ft above the predicted tide on 10 September at Naples, FL. A PIR was prepared following Hurricane Irma and determined the project qualified for FCCE funds. The impacts of the storm to the Gasparilla Island project area are discussed further in this report.



Figure 7: Hurricane Irma Track

Wave Conditions 2017 to 2018

The wave conditions between July 2017 and August 2018 were observed to have several periods of elevated wave heights. In addition to Hurricane Irma in September 2017, there were elevated wave heights during Hurricane Nate in early October and Tropical Storm Philippe in late October. There were almost continual elevated wave heights between December and February due to a series of nor'easters. The threshold to determine elevated wave heights was set at 3.0 meters relative to mean sea level. **Figure 8** shows the wave conditions at CDIP Station 144 for comparison with the wave record from 2013 to 2016. Compared to the period from 2013-2016, the study period for the 4th Annual Monitoring Report shows much more wave energy above the 3.0 m threshold. This shows that the Gulf of Mexico was very active during this timeframe. Elevated wave conditions recorded by National Data Buoy Center (NDBC) Station 42097 are presented in **Figure 9**. This station is located at Pulley Ridge, FL at a depth of 81 meters, approximately 110 miles southwest of the project area. This station is closer to the project area and has a more complete wave record and so was included to provide a complementary view of the wave conditions near Gasparilla Island.

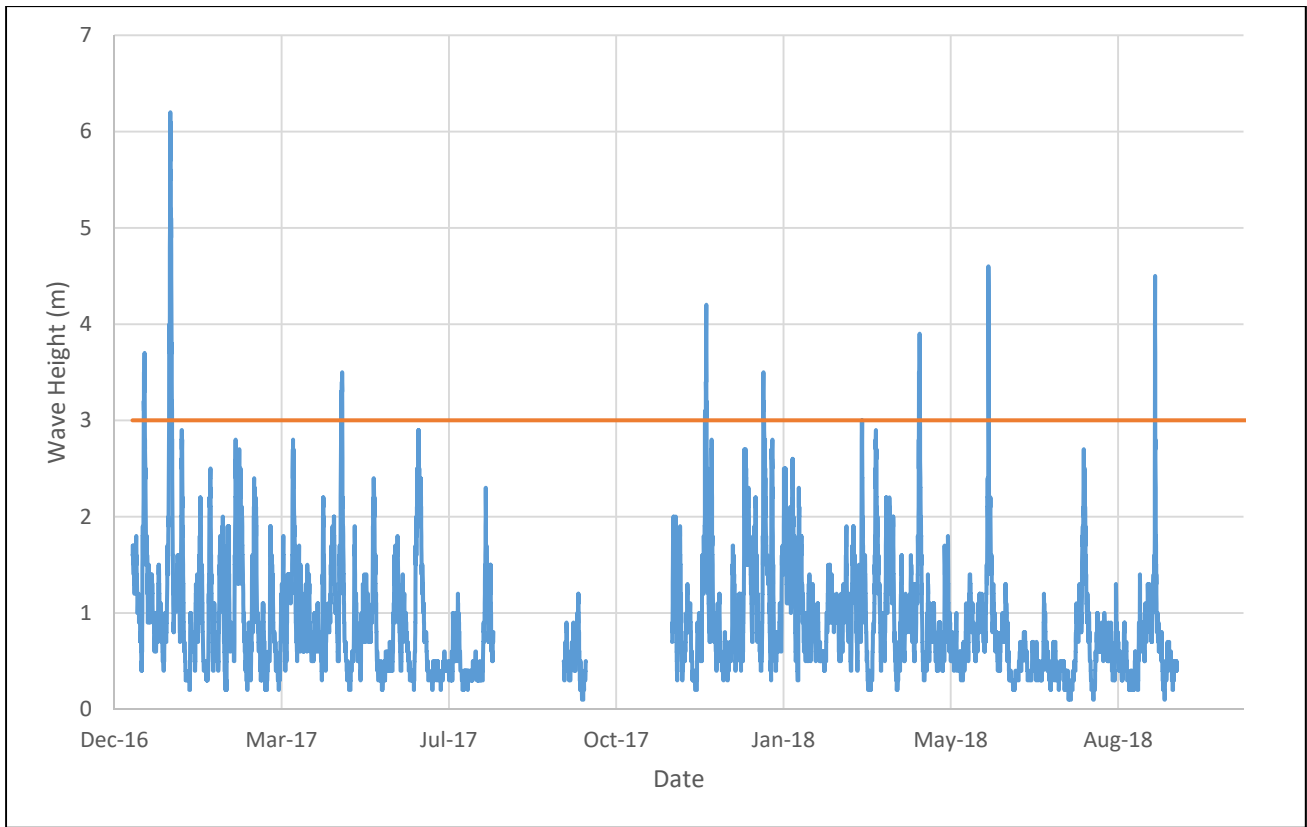


Figure 8: Wave Conditions January 2017 to October 2018 at CDIP Station 144

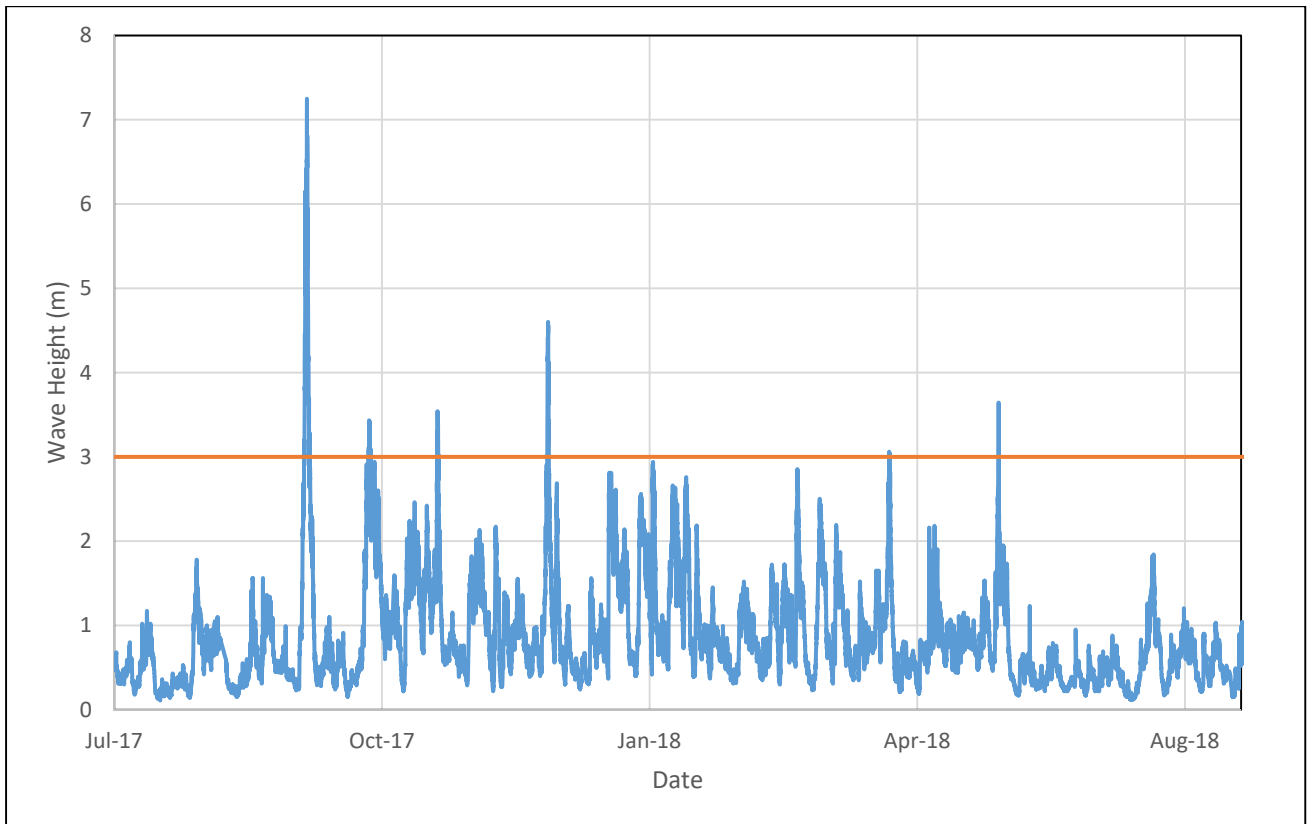


Figure 9: Wave Conditions July 2017 to August 2018 at NDBC Buoy Station 42097 (Pulley Ridge, FL)

Monitoring Surveys

A summary of the survey information is shown below in **Table 1**.

2013 and 2014 Monitoring Surveys

Both the pre-construction monitoring survey and post-construction monitoring survey consist of beach profile transects surveyed along the Lee County Gasparilla Island Segment shoreline. Degrove Surveyors Inc. performed the pre-construction monitoring survey (Post Sandy Survey 13-077) during 13 – 17 May 2013 which extends from R-10 (North) to R-26A (South) with profiles about every 500 ft at R-monuments and half monuments and profile lengths of 3000 ft. The pre-construction survey also included the borrow area. Construction of the beach fill began at the south end of the project. The pre-/post- fill construction surveys were performed during construction between 26 October and 13 December 2013. The pre-/post- fill construction pay volume survey (Survey 13-207) extends from R-10 (North) to R-24.5 (South) with profiles about every 100 ft (not specifically at R-monuments) and profile lengths of about 575 ft. A preliminary construction “before dredge” (13-207 BD) survey and an “after dredge” (13-207 AD) survey were also conducted as part of the construction contract. These profiles were about 500 ft apart (not specifically at R-monuments) with profile lengths of about 1,000 ft. Construction of the beach fill was completed on 13 December 2013. USACE performed the post-construction monitoring survey (Survey 14-039) during 11-12 February 2014 which extends from R-10 (North) to R-26A (South) with profiles at R-monuments about every 1,000 ft and profile lengths of about 4,000 ft. USACE also conducted the post-construction borrow area survey (14-041) on 11 February 2014.

2015 Monitoring Survey

Hyatt Survey Services, Inc. performed the first annual monitoring survey (15-085) between 29 June and 10 July 2015 and covered from R-10 (North) to R-26A (South). USACE surveyed the borrow area from 5 May – 6 May 2015 under survey number 15-086. The 2015 monitoring surveys reference NAVD88 for vertical positioning and the horizontal positions are referenced to NAD83.

2016 Monitoring Survey

Hyatt Survey Services, Inc. completed the second annual monitoring survey (16-088) between 1 June and 3 June 2016 which extends from R-10 (North) to R-26A (South). USACE conducted the borrow area monitoring survey (16-100) from 11-12 May 2016. Datums for all surveys used in this report are in NAD83 (horizontal) and NAVD88 (vertical). All units of measurement are in feet (ft).

2017 Monitoring Survey

Hyatt Survey Services, Inc. completed the third annual monitoring survey (17-141) between 10 July and 11 July 2017 which extends from R-10 (North) to R-26A (South). USACE conducted the borrow area monitoring survey (17-149) from 16-17 August 2017. Datums for all surveys used in this report are in NAD83 (horizontal) and NAVD88 (vertical). All units of measurement are in feet (ft).

2017 Post-Hurricane Irma Survey

Coastal Engineering Consultants, Inc. completed the post-Hurricane Irma survey (18-018) on 28 September 2017 which extends from R-10 (North) to R-26A (South).

2018 Monitoring Survey

The fourth annual monitoring survey (18-200) was completed by Seaside Engineering and Surveying, LLC. The survey was conducted from 16-17 August 2018 and extends from R-10 in the North to R-26A in the South.

Table 1: Monitoring Surveys

Survey	Date	Beach Profiles	Borrow Area
*Post Sandy Survey (Pre Construction)13-077	13-17 May 2013	R10 – R26A	X
BD, Pre/Post Fill, AD 13-207	26 Oct to 13 Dec 2013	R10 – R24.5	
*Post Construction Survey 14-039	11-12 Feb 2014	R10 – R26A	
Post Construction Borrow Area Survey 14-041	11 Feb 2014		X
*First Annual Monitoring Survey 15-085	29 June to 10 July 2015	R10 – R26A	
First Annual Monitoring Borrow Area Survey 15-086	5-6 May 2015		X
*Second Annual Monitoring Survey 16-088	1-3 Jun 2016	R10 – R26A	
Second Annual Monitoring Borrow Area Survey 16-100	11-12 May 2016		X
*Third Annual Monitoring Survey 17-141	10-11 July 2017	R10 – R26A	
Third Annual Monitoring Borrow Area Survey 17-149	16-17 August 2017		X
*Post-Hurricane Irma Beach Profile Survey 18-018	28 September 2017	R10 – R26A	
*Fourth Annual Monitoring Survey 18-200	16-17 August 2018	R10 – R26A	

***Surveys used for the MHW shoreline and volume analyses presented in this report.**

To evaluate the monitoring surveys with reference to a tidal datum such as Mean High Water (MHW), the geodetic datum North American Vertical Datum (NAVD88) must be related to the tidal datum in the project area. The nearest tidal datum in the project area is Port Boca Grande, Station No.8725577 available from NOAA. This gauge is located in Charlotte Harbor on the east side of Gasparilla Island just inside the Boca Grande Pass. Due to tidal compression,

this gauge is not representative of tide range that occurs on the Gulf side of Gasparilla Island where the project is located.

NOAA analysts (personal communication) recommended that the NOAA VDatum model should be applied to determine the relationship between NAVD88 and the tidal datums. A confirmation of the VDatum model application was run at the Venice (8725858) and Naples (8725110) gauges, the two closest gulf side gauges, and three gauges in Gasparilla Sound and Pine Island Sound, all of which have NAVD88 and NGVD29 published along with the tidal datums. This exercise was performed as a check on the VDatum model. All values checked within a tolerance of +/- 0.01 feet (ft).

The VDatum model was then applied for three locations along the project, one at the northern end (R-10), the mid-point (R-17), and the final at the southern end (R-25). The VDatum model at R-17 is shown in **Table 2**; VDatum is used for all conversions between NAVD88 and MHW for the survey analysis in this report. Mean High Water is 0.08 ft above NAVD88 and Mean Low Water (MLW) is 1.25 ft below NAVD88.

Table 2: VDatum Tidal Datums at R-17

Datum	Value(ft)
Mean High Water (MHW)	1.77
North American Vertical Datum of 1988(NAVD88)	1.69
Mean Sea Level (MSL)	1.12
National Geodetic Vertical Datum of 1929 (NGVD29)	0.54
Mean Low Water (MLW)	0.44
Mean Lower Low Water (MLLW)	0.00

Survey Analysis

The USACE Coastal Engineering Design and Analysis System (CEDAS) Regional Morphology Analysis Package (RMAP) software was used to analyze the latest monitoring survey (18-200). The present analysis, which analyzes changes between 2017 and 2018, appends the results of the 2013, 2014, 2015, 2016, and 2017 monitoring surveys for the 2013 renourishment event. Comparative profiles were plotted for each monument location and are provided in **Appendix – Beach Profiles**.

The survey analysis consists of two components: a mean high water (MHW) position change analysis and a volumetric change analysis. For the mean high water position change analysis, the distances between MHW positions were measured from each plotted cross-section in the beach fill area for each survey interval using CEDAS-RMAP software. The resulting shoreline position change values are summarized in **Table 3**. Data from **Table 3** were plotted graphically in **Figure 10**. More detailed views of shoreline responses at each profile can be seen in the plotted cross-sections in **Appendix – Beach Profiles**. These cross-sections are referenced to North American Vertical Datum 1988 (NAVD88).

In a similar manner, volumetric changes were calculated between the pre-construction, post-construction, first annual monitoring survey, and the second annual monitoring surveys. The unit volume from each plotted cross-section in the beach fill area was calculated utilizing the CEDAS-RMAP software. Changes in beach fill volumes between adjacent profile lines were

then computed using the End-Area method. Volumetric change computations include the area extending in the cross-shore direction from the dune seaward to a depth of closure of -13 ft (MHW). The 13 ft depth of closure is typically the outer limit of the zone of most active sediment transport for the project area.

MHW Position Changes

As expected, analysis of pre-construction (May 2013) and post-construction (February 2014) surveys indicated a substantial shoreline advance along the length of the Federal project, which is a direct result of the placement of beach fill during this period. From February 2014 to the first annual monitoring survey completed in July 2015, the MHW shoreline position retreated throughout most of the beach fill area. This is expected behavior for a shoreline following a nourishment event. **Figure 11** shows the mean high water position over the length of the project monitoring relative to the pre-construction position.

Between February 2014 and July 2015, individual profile MHW changes vary from a maximum shoreline retreat of -47.4 ft at R-14 to a maximum shoreline advance of +21.1 ft at R-23. As shown in **Table 3** the average MHW retreat over the length of the beach fill area during this time was -17.2 ft. The MHW position from R-11 to R-15 and R-18 to R-21 experienced the greatest shoreline retreat from February 2014 to July 2015 relative to the rest of the beach fill area. During construction of the project in 2013, the 100 ft construction template berm was extended by 10 ft from R-11 to R-15.5 and by 30 ft from R-19 to R-21. The areas of greatest MHW retreat are, in general, the same areas where the construction template was extended seaward during the 2013 nourishment. This indicates a smoothing out of the seaward berm extensions created during the 2013 nourishment, as the shoreline naturally straightens itself across the beach fill area. The advance of the MHW position at R-23 and R-24 from February 2014 to July 2015 may be a result of the armored headland at R-25 functioning to retain sand on the dry beach at the Southern end of the beach fill area.

The maximum and minimum MHW position changes from July 2015 to June 2016 were a shoreline advance of +1 ft at R-10 and a shoreline retreat of -37.5 ft at R-18 respectively. The average MHW retreat over the length of the beach fill area during this time was -17.1 ft, which is very similar to the -17.2 ft average for the 2014 to 2015 time period. The area of greatest MHW retreat is migrating towards the center of the project, which is typical for beach renourishments as they mature. Shoreline stabilization can be seen in the comparison of MHW position change for February 2014 to July 2015 and July 2015 to June 2016 within **Figure 10**. These two data sets show consistent shoreline retreat as the beach attempted to equilibrate after the beach placement.

Between June 2016 and July 2017 only two of the profiles experienced shoreline advance. The other profiles all experienced retreat. The maximum MHW position advance was +5.9 ft at R-23. The maximum MHW position retreat was -39.4 ft at R-16. The average MHW retreat over the length of the beach fill area during this time period was -9.1 ft, which is less erosion than the previous two years (-17.2 and -17.1 ft). The pattern of erosion along the project was inconsistent. The areas that had the most retreat were R-14, R-16, R-19, and R-24. These four locations had much greater MHW retreat (ranging from -17.1 to -34.9 ft) than the rest of the profiles (+5.9 to -11.3 ft). These values are much smaller than the previous two years of shoreline change where the majority of the profiles experienced -14 ft of retreat or greater.

From July 2017 to August 2018 there was retreat at all but three profiles. R-10, R-16, and R-19 were the only profiles that experienced an advancement of the MHW position. The maximum shoreline advance was 3.8 ft at R-16 and the maximum shoreline retreat was -40.7 ft at R-23. The average MHW position change during this time period was -12.3 ft. The average retreat of -12.3 ft is greater than the previous year (-9.1 ft) but less than the first two years of monitoring (-17.2 and -17.1 ft). The MHW change had a pattern of slight accretion or minor retreat from R-10 to R-20 (with the exception of R-15 which saw a retreat of -29.1 ft) and major retreat from R-21 to R-24. These profiles saw retreats between -21.5 and -40.7 ft). Hurricane Irma impacted the Gasparilla Island project in September 2017 and a majority of the losses suffered during this year are attributed to this storm. Specific details of Hurricane Irma's impact on the MHW line can be found below in the section titled: Analysis of the Impacts of Hurricane Irma on MHW Position and Volumetric Changes.

Comparison of the pre-construction survey (13-077) in May 2013 to the latest monitoring survey (18-200) in August 2018, reveals that the current average MHW position is 44.7 ft seaward of the pre-construction MHW position across the beach fill area. This is an average retreat of -12.3 ft compared to July 2017 position. This monitoring period included the effects of Hurricane Irma which resulted in almost universal shoreline retreat along the project area. The southern portion of the project (R-17 to R-24) remains the healthiest portion of the surveyed area, as seen by the percent remaining in **Table 3**. This is likely a result of the structure at the southern end of the project, the net littoral drift in the area (North to South), or a combination of both.

Table 3: Mean High Water Position Change

FDEP R-Monument	MHW Position Change (feet)						Percent Remaining Feb 2014 to Aug 2018
	May2013- Feb2014	Feb2014- Jul2015	Jul2015- Jun2016	Jun2016- Jul2017	Jul2017- Aug2018	May2013- Aug2018	
10	35.0	-7.1	1.0	0.4	1.9	31.1	89%
11	72.1	-26.3	-15.1	-1.3	-8.2	21.2	29%
12	86.5	-26.0	-25.5	-7.4	-2.8	24.9	29%
13	91.6	-35.2	-25.3	-3.7	-3.0	24.5	27%
14	105.5	-47.4	-23.0	-17.1	-0.8	17.2	16%
15	106.0	-26.8	-16.8	-3.7	-29.1	29.6	28%
16	87.8	-5.2	-30.1	-34.9	3.8	21.4	24%
17	95.3	-12.0	-30.0	-8.8	-5.0	39.5	41%
18	106.2	-20.1	-37.5	-3.1	-6.3	39.2	37%
19	141.1	-30.8	-23.7	-21.0	0.8	66.5	47%
20	147.0	-24.8	-7.5	-11.3	-9.7	93.7	64%
21	157.5	-20.0	-14.2	-2.3	-33.3	87.6	56%
22	133.0	-4.0	-3.2	-1.4	-30.6	93.9	71%
23	83.7	21.1	-5.5	5.9	-40.7	64.5	77%
24	55.9	7.4	-0.6	-26.2	-21.5	15.2	27%
AVG	100.3	-17.2	-17.1	-9.1	-12.3	44.7	44%

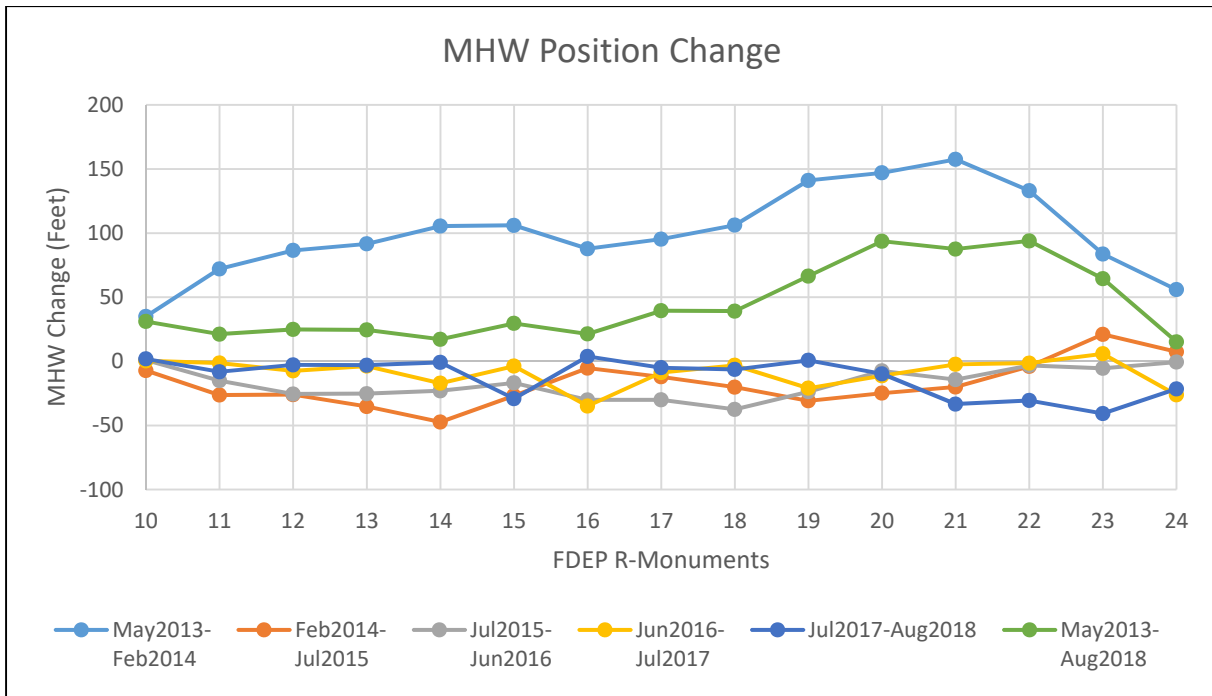


Figure 10: MHW Position Change

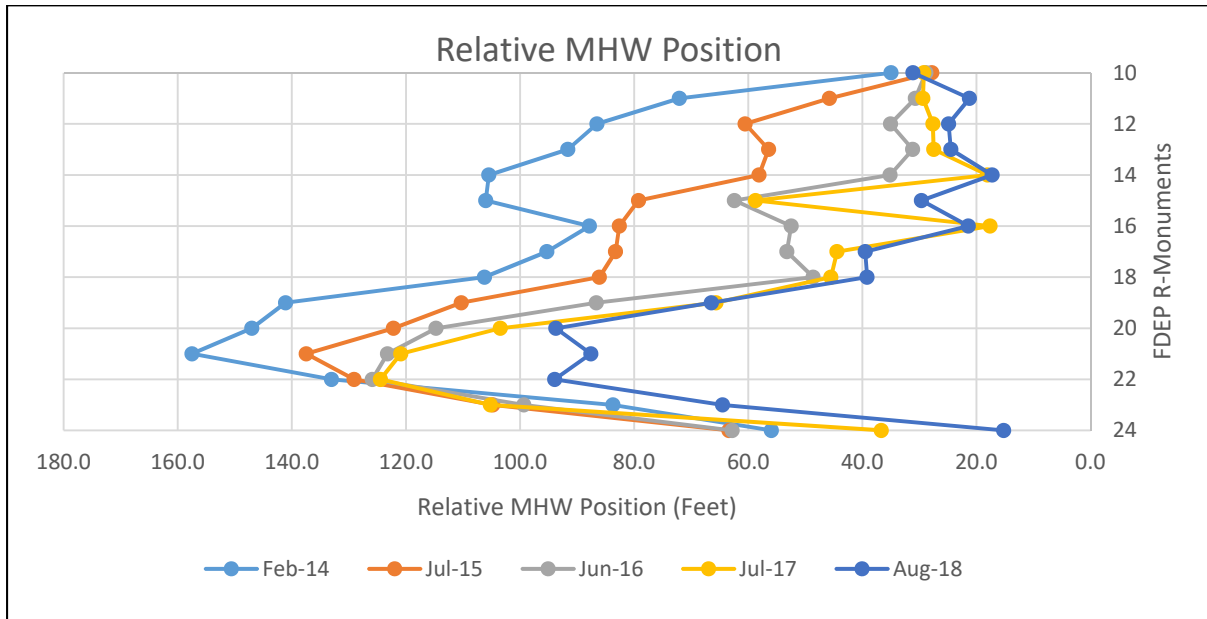


Figure 11: MHW Position Over Length of Project Monitoring Relative to Pre-Project Position

Volumetric Changes

Volumetric changes were measured directly from adjacent beach profile pairs in a manner similar to the methodology presented above for the MHW change analysis. Volumetric calculations extend from the dune to approximately -13 ft MHW, corresponding to the zone of most active sediment transport. **Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9** present the total volumetric changes between profiles in the beach fill area for the intervals from May 2013 to February 2014, February 2014 to July 2015, July 2015 to June 2016, June 2016 to July 2017, July 2017 to August 2018, and May 2013 to August 2018 respectively, with all volumetric changes measured in cubic yards (cy). The tabulated data for the volumetric change above the 13-ft MHW depth contour in **Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9** are presented graphically in **Figure 12**.

Consistent with the MHW analysis above, volumetric gains occurred during the pre-construction (May 2013) to post-construction (February 2014) monitoring period, a direct result of the 2013 beach nourishment. Individual profile unit volume changes varied from a minimum gain of 13.0 cy/ft at R-10 to a maximum gain of 50.1 cy/ft at R-15. The average unit volumetric gain across all of the profiles in the beach fill area during this time was 34.3 cy/ft. The total volume gain in the beach fill area from May 2013 to February 2014 was 510,500 cy. Of this total volume gain, 188,500 cy was gained above MHW and 322,000 cy was gained between 0 ft MHW and -13 ft MHW. This volume is 52,700 more than the payment volume (457,800 cy) perhaps due to the timing of the surveys, continued natural post-storm recovery, and/or equilibration that occurred between payment surveys and monitoring surveys.

Between February 2014 and July 2015, individual profile unit volume changes vary from a maximum loss of 22.0 cy/ft at R-14 to a maximum gain of 5.4 cy/ft at R-17. The average unit volumetric change across all of the profiles in the beach fill area during this time was -7.0 cy/ft. The total volume loss in the beach fill area from February 2014 to July 2015 was 100,900 cy. Of this total volume loss, 21,500 cy came from above MHW and 79,400 cy came from between 0 ft MHW and -13 ft MHW. The total volume loss in the beach fill area from February 2014 to July 2015 accounts for approximately 20% of the volume gain, as seen in **Table 5**. Approximately 80% of the volume gained above MHW from pre to post-construction remained in place in July 2015.

The stretch of shoreline between R-16 and R-17 was the only area that experienced a net gain in volume above -13 ft MHW between February 2014 and July 2015. This stretch of shoreline lies in between the two areas where the berm template was extended seaward during the 2013 construction. The accretion in this area is indicative of a smoothing out of the seaward berm extensions created during the 2013 nourishment, as the shoreline naturally straightens itself across the beach fill area.

The stretch of shoreline from R-21 to R-24.5 gained volume above MHW between February 2014 and July 2015. This may be a result of the armored headland at R-25 functioning to retain sand on the dry beach at the southern end of the beach fill area. Another reason for the volume gain above MHW along this stretch is that the beach in this area is backed by a very wide gently sloping vegetated fore dune. Patches of vegetation in this area appear to be extending seaward which can help to trap and retain sand. A slight increase in the elevation of this fore dune area is noticeable when comparing the February 2014 and July 2015 profiles for this area (**Appendix – Beach Profiles**).

From July 2015 to June 2016 a maximum gain of 14.9 cy/ft occurred at R-10 while a maximum loss of 7.2 cy/ft occurred at R-12. Gains outside the placement limits are indicative of continued lateral spreading of renourishment material. The average unit volumetric change across all of the profiles in the beach fill area from July 2015 to June 2016 was 3.0 cy/ft which equates to a net gain in volume of 35,600 cy. Of this total volume gain, 34,100 cy was lost above MHW while 69,700 cy was gained from 0 ft MHW to -13 ft MHW. Throughout all of the R-monuments from July 2015 to June 2016 the beach profile is generally eroding above MHW and accreting in the nearshore sand bar from 0 ft MHW to -13 ft MHW, which is typical of cross-shore equilibration for a beach following a renourishment.

From June 2016 to July 2017 a maximum gain of 7.6 cy/ft occurred at R-20 while a maximum loss of 33.4 cy/ft occurred at R-24. R-18, R-20, R-21 are the only monuments at which accretion occurred. All of the other monuments experienced erosion. This varies from the Second Annual Monitoring Report, which showed accretion at 9 out of the 15 R-Monuments. The average unit volumetric change across all of the beach fill area from June 2016 to July 2017 was -6.6 cy/ft with a total net loss of volume of 84,500 cy. Throughout all of the R-monuments from June 2016 to July 2017 the beach profile is generally eroding below MHW (0 to -13 ft MHW) and slightly accreting above MHW. The surveys show that the total volume gained above MHW is 8,000 cy (0.6 cy/ft) and the total volume loss below MHW is 92,500 cy (-7.2 cy/ft).

The period from July 2017 to August 2018 saw a total loss of 60,600 cy of volume. This magnitude of erosion is a direct result of Hurricane Irma which caused impacts in September of 2017. The direct impacts of the storm are discussed in detail further in the report. This section will just discuss the trends from the entire 4th year of monitoring. There was a net loss of material at 11 out of 15 profiles. The only profiles that saw an increase of unit volume were R-12, R-16, R-20, and R-22. The maximum gain during this monitoring period was 7.3 cy/ft which occurred at R-16. This continues a trend found in the 3rd Annual Monitoring Report which showed erosion at the majority of profiles. The maximum rate of volume loss was 21.4 cy/ft which occurred at R-24. This is the second consecutive year that R-24 experienced the highest rate of erosion. This trend is likely not a long term concern because the southern tip of the project area is the healthiest portion of the beach and the adjacent profiles (R-22 and R-23) do not show a similar pattern. This suggests that this is simply a coincidence but should be checked during the next monitoring report. The average volume change from July 2017 to August 2018 was -4.5 cy/ft. Unlike the last monitoring period which saw erosion primarily below MHW, the 4th year monitoring period saw erosion consistent both above and below MHW. This is primarily due to Hurricane Irma which caused a significant amount of material to be lost above MHW (discussed further below). The surveys show that the total volume lost above MHW is 19,800 cy (-1.5 cy/ft) in addition to the total volume lost below MHW, which is 40,800 cy (-2.9 cy/ft), for a total volume loss of 60,600 cy (-4.5 cy/ft) during the 2017 to 2018 monitoring period.

From May 2013 (pre-construction) to August 2018 it can be seen that a net volume of 300,100 cy has been gained, of which 121,200 cy is above MHW and 178,900 cy is from 0 ft MHW to -13 ft MHW. Roughly 59% of the original volume that was placed in 2013 (510,500 cy) remains with 41% eroded as of July 2017. About 64% remains above MHW and 56% remains between MHW and -13ft. Refer to **Table 10** for percent remaining at all R-monuments. The average erosion rate within the project limits following the 2013 construction is 52,600 cy/yr.

This is slightly less what was anticipated when the project was originally designed (60,000 cy/yr). This is predominately due to the lack of significant storms that have occurred within the project location since the 2013 renourishment with the exception of Hurricane Irma in October 2017 which resulted in the erosion rate from 2017-2018 nearly matching the anticipated rate (60,600 cy/yr vs 60,000 cy/yr).

Table 4: Volumetric Change – May 2013 to February 2014

May2013-Feb2014 (13-077 to 14-039)		Unit Volume Change (cy/lf)			Volume Change (cy)		
FDEP R-Mon	Dist Btw Mon (feet)	Above 0' MHW	0' to -13' MHW	Above -13' MHW	Above 0' MHW	0' to -13' MHW	Above -13' MHW
10		3.6	9.4	13.0			
	1,358				8,907	19,356	28,263
11		9.5	19.1	28.6			
	1,097				10,509	20,218	30,728
12		9.7	17.7	27.4			
	1,011				11,712	19,184	30,896
13		13.5	20.2	33.7			
	1,009				14,565	25,446	40,011
14		15.4	30.2	45.6			
	1,062				15,888	34,924	50,812
15		14.5	35.6	50.1			
	1,070				13,370	33,479	46,849
16		10.5	27.0	37.5			
	1,043				11,545	26,736	38,281
17		11.7	24.3	35.9			
	995				12,808	25,609	38,417
18		14.1	27.2	41.3			
	1,000				17,230	23,437	40,666
19		20.4	19.7	40.1			
	965				19,803	22,167	41,970
20		20.7	26.3	46.9			
	965				19,834	19,584	39,418
21		20.5	14.3	34.8			
	986				17,177	18,884	36,060
22		14.4	24.0	38.4			
	905				9,821	19,236	29,057
23		7.3	18.5	25.8			
	718				4,227	10,794	15,021
24		4.5	11.6	16.0			
	509				1,134	2,941	4,075
24.5		0.0	0.0	0.0			
Average	980	12.7	21.7	34.3	12,569	21,466	34,035
Total	14,693				188,529	321,995	510,524

Table 5: Volumetric Change – February 2014 to July 2015

Feb2014-Jul2015 (14-039 to 15-085)		Unit Volume Change (cy/lf)			Volume Change (cy)		
FDEP R-Mon	Dist Btw Mon (feet)	Above 0' MHW	0' to -13' MHW	Above -13' MHW	Above 0' MHW	0' to -13' MHW	Above -13' MHW
10		-0.7	-2.0	-2.7			
	1,358				-2,765	-2,961	-5,726
11		-3.4	-2.3	-5.7			
	1,097				-3,263	-1,824	-5,087
12		-2.6	-1.0	-3.6			
	1,011				-3,695	-4,896	-8,591
13		-4.7	-8.7	-13.4			
	1,009				-5,700	-12,157	-17,857
14		-6.6	-15.4	-22.0			
	1,062				-5,347	-14,085	-19,431
15		-3.5	-11.1	-14.6			
	1,070				-1,459	-5,849	-7,309
16		0.8	0.2	1.0			
	1,043				548	2,773	3,321
17		0.3	5.1	5.4			
	995				-1,667	77	-1,590
18		-3.6	-5.0	-8.6			
	1,000				-2,591	-2,005	-4,595
19		-1.6	1.0	-0.6			
	965				-1,708	-584	-2,292
20		-2.0	-2.2	-4.2			
	965				-577	-2,879	-3,456
21		0.8	-3.8	-3.0			
	986				1,265	-8,677	-7,413
22		1.8	-13.8	-12.0			
	905				2,226	-13,876	-11,651
23		3.1	-16.9	-13.7			
	718				2,392	-9,843	-7,451
24		3.5	-10.6	-7.0			
	509				895	-2,687	-1,792
24.5		0.0	0.0	0.0			
Average	980	-1.2	-5.8	-7.0	-1,430	-5,298	-6,728
Total	14,693				-21,447	-79,473	-100,919

Table 6: Volumetric Change – July 2015 to June 2016

Jul2015-Jun2016 (15-085 to 16-088)		Unit Volume Change (cy/lf)			Volume Change (cy)		
FDEP R-Mon	Dist Btw Mon (feet)	Above 0' MHW	0' to -13' MHW	Above -13' MHW	Above 0' MHW	0' to -13' MHW	Above -13' MHW
10		-0.5	15.4	14.9			
	1,358				-1,968	13,520	11,552
11		-2.4	4.5	2.1			
	1,097				-2,641	-148	-2,789
12		-2.4	-4.8	-7.2			
	1,011				-2,503	-3,547	-6,050
13		-2.5	-2.2	-4.8			
	1,009				-3,176	-529	-3,706
14		-3.8	1.2	-2.6			
	1,062				-2,990	7,161	4,171
15		-1.9	12.3	10.4			
	1,070				-3,053	10,270	7,218
16		-3.8	6.9	3.1			
	1,043				-4,049	5,071	1,022
17		-3.9	2.8	-1.1			
	995				-4,341	2,044	-2,296
18		-4.8	1.3	-3.5			
	1,000				-3,660	2,839	-821
19		-2.5	4.4	1.9			
	965				-1,108	4,119	3,011
20		0.2	4.2	4.4			
	965				-2,005	3,255	1,250
21		-4.4	2.6	-1.8			
	986				-2,863	7,193	4,331
22		-1.4	12.0	10.6			
	905				-292	10,031	9,739
23		0.8	10.2	10.9			
	718				406	6,460	6,866
24		0.4	7.8	8.2			
	509				92	1,991	2,083
24.5		0.0	0.0	0.0			
Average	980	-2.2	5.2	3.0	-2,277	4,649	2,372
Total	14,693				-34,151	69,731	35,579

Table 7: Volumetric Change – June 2016 to July 2017

Jun2016-July2017 (16-088 to 17-141)		Unit Volume Change (cy/lf)			Volume Change (cy)		
FDEP R-Mon	Dist Btw Mon (feet)	Above 0' MHW	0' to -13' MHW	Above -13' MHW	Above 0' MHW	0' to -13' MHW	Above -13' MHW
10		1.2	-5.3	-4.1			
	1,358				1,025	-6,012	-4,987
11		0.3	-3.6	-3.2			
	1,097				-24	-6,681	-6,705
12		-0.4	-8.6	-9.0			
	1,011				329	-6,915	-6,586
13		1.0	-5.1	-4.0			
	1,009				-121	-6,965	-7,085
14		-1.3	-8.7	-10.0			
	1,062				-467	-7,385	-7,852
15		0.4	-5.2	-4.8			
	1,070				-1,341	-9,284	-10,626
16		-2.9	-12.2	-15.1			
	1,043				-254	-8,275	-8,529
17		2.4	-3.7	-1.3			
	995				2,698	-3,060	-362
18		3.0	-2.5	0.6			
	1,000				-132	-1,256	-1,388
19		-3.3	-0.1	-3.3			
	965				-1,249	3,313	2,064
20		0.7	6.9	7.6			
	965				-47	4,763	4,716
21		-0.8	2.9	2.2			
	986				1,781	-4,551	-2,770
22		4.4	-12.2	-7.8			
	905				4,145	-13,406	-9,261
23		4.8	-17.4	-12.7			
	718				1,731	-18,291	-16,559
24		0.1	-33.5	-33.4			
	509				14	-8,526	-8,512
24.5		0.0	0.0	0.0			
Average	980	0.6	-7.2	-6.6	539	-6,169	-5,629
Total	14,693				8,089	-92,531	-84,442

Table 8: Volumetric Change – July 2017 to August 2018

Jul2017-Aug2018 (17-141 to 18-200)		Unit Volume Change (cy/lf)			Volume Change (cy)		
FDEP R-Mon	Dist Btw Mon (feet)	Above 0' MHW	0' to -13' MHW	Above -13' MHW	Above 0' MHW	0' to -13' MHW	Above -13' MHW
10		-0.8	0.6	-0.2			
	1,358				-888	-4,345	-5,233
11		-0.5	-7.0	-7.5			
	1,097				-865	-1,274	-2,139
12		-1.1	4.7	3.6			
	1,011				-2,006	1,741	-265
13		-2.9	-1.2	-4.1			
	1,009				-2,486	-1,039	-3,524
14		-2.0	-0.8	-2.9			
	1,062				-4,134	-6,931	-11,065
15		-5.7	-12.2	-18.0			
	1,070				-1,309	-4,420	-5,728
16		3.3	4.0	7.3			
	1,043				1,184	537	1,720
17		-1.0	-2.9	-4.0			
	995				-886	-5,834	-6,720
18		-0.7	-8.8	-9.5			
	1,000				1,258	-10,675	-9,417
19		3.3	-12.6	-9.3			
	965				1,874	-5,153	-3,280
20		0.6	1.9	2.5			
	965				-238	771	532
21		-1.1	-0.3	-1.4			
	986				-1,785	1,459	-325
22		-2.5	3.2	0.7			
	905				-4,015	3,024	-991
23		-6.4	3.4	-2.9			
	718				-4,165	-4,563	-8,728
24		-5.2	-16.1	-21.4			
	509				-1,333	-4,108	-5,441
24.5		0.0	0.0	0.0			
Average	980	-1.5	-2.9	-4.5	-1,320	-2,721	-4,040
Total	14,693				-19,793	-40,810	-60,604

Table 9: Volumetric Change – May 2013 to July 2018

May2013-Aug2018 (13-077 to 18-200)		Unit Volume Change (cy/lf)			Volume Change (cy)		
FDEP R-Mon	Dist Btw Mon (feet)	Above 0' MHW	0' to -13' MHW	Above -13' MHW	Above 0' MHW	0' to -13' MHW	Above -13' MHW
10		2.8	18.1	20.9			
	1,358				4,311	19,558	23,869
11		3.5	10.7	14.3			
	1,097				3,716	10,292	14,008
12		3.2	8.0	11.3			
	1,011				3,836	5,568	9,404
13		4.4	3.0	7.3			
	1,009				3,082	4,756	7,838
14		1.8	6.5	8.2			
	1,062				2,950	13,684	16,634
15		3.8	19.3	23.1			
	1,070				6,208	24,196	30,405
16		7.8	25.9	33.7			
	1,043				8,973	26,842	35,815
17		9.4	25.6	35.0			
	995				8,613	18,836	27,449
18		7.9	12.3	20.2			
	1,000				12,105	12,341	24,446
19		16.3	12.4	28.7			
	965				17,612	23,862	41,474
20		20.2	37.1	57.3			
	965				16,966	25,494	42,460
21		15.0	15.8	30.7			
	986				15,575	14,308	29,883
22		16.6	13.3	29.9			
	905				11,885	5,008	16,893
23		9.6	-2.2	7.4			
	718				4,592	-15,443	-10,851
24		3.2	-40.8	-37.7			
	509				802	-10,389	-9,587
24.5		0.0	0.0	0.0			
Average	980	8.4	11.0	19.4	8,082	11,927	20,009
Total	14,693				121,226	178,912	300,138

Table 10: Percentage of Volume Remaining

		2014 (Post Construction) - 2015		2014 (Post Construction) - 2016		2014 (Post Construction) - July 2017		2014 (Post Construction) - August 2018	
FDEP R-Mon	Dist Btw Mon (feet)	Total Volume Change (cy)	Percent Remaining	Total Volume Change (cy)	Percent Remaining	Total Volume Change (cy)	Percent Remaining	Total Volume Change (cy)	Percent Remaining
10									
	1358	22,537	80%	34,089	121%	29,102	103%	23,869	84%
11									
	1097	25,641	83%	22,852	74%	16,147	53%	14,008	46%
12									
	1011	22,305	72%	16,255	53%	9,669	31%	9,404	30%
13									
	1009	22,154	55%	18,448	46%	11,363	28%	7,838	20%
14									
	1062	31,381	62%	35,552	70%	27,699	55%	16,634	33%
15									
	1070	39,541	84%	46,758	100%	36,133	77%	30,405	65%
16									
	1043	41,602	109%	42,624	111%	34,095	89%	35,815	94%
17									
	995	36,827	96%	34,530	90%	34,169	89%	27,449	71%
18									
	1000	36,071	89%	35,250	87%	33,862	83%	24,446	60%
19									
	965	39,678	95%	42,689	102%	44,753	107%	41,474	99%
20									
	965	35,962	91%	37,212	94%	41,928	106%	42,460	108%
21									
	986	28,648	79%	32,978	91%	30,208	84%	29,883	83%
22									
	905	17,406	60%	27,145	93%	17,884	62%	16,893	58%
23									
	718	7,570	50%	14,435	96%	-2,124	0%	-10,851	0%
24									
	509	2,283	56%	4,366	107%	-4,146	0%	-9,587	0%
24.5									
Total	14,693	409,604	80%	445,184	87%	360,742	71%	300,138	59%

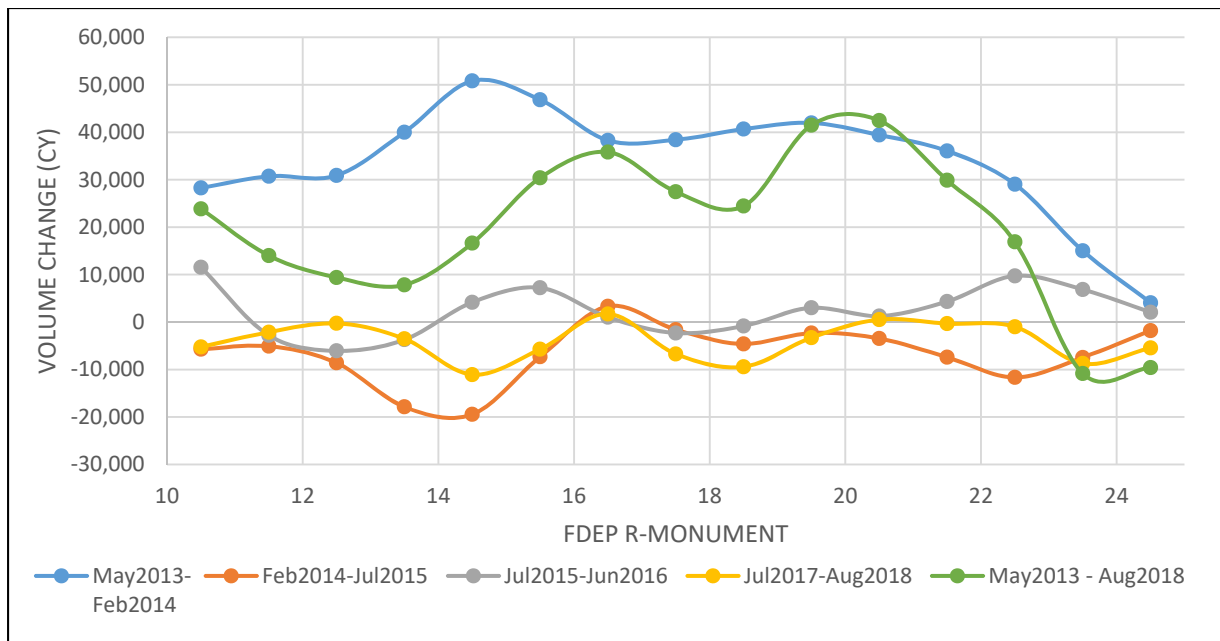


Figure 12: Volumetric Change from Dune To -13 Ft MHW in the Beach Fill Area

Analysis of the Impacts of Hurricane Irma on MHW Position and Volumetric Changes

This section assesses the impacts that Hurricane Irma had on the MHW position change and changes in volume along the Gasparilla Island shoreline. Between July 2017 and October 2017, Gasparilla Island experienced erosion at 11 out of 15 profiles due to Hurricane Irma (**Table 11**). The maximum MHW advance was +6.2 ft at R-10 and the maximum MHW retreat was -22.4 ft at R-15. The southern portion of the beach, which has historically been healthy, experienced the most recession from Hurricane Irma. All of the profiles from R-17 to R-24 experienced recession, while some of the northern profiles advanced. **Figure 13** shows the MHW position change after Hurricane Irma. The average MHW position after Irma is 49.7 ft seaward of the pre-construction MHW line.

From July 2017 to October 2017 a maximum volumetric gain of 3.4 cy/ft occurred at R-11. This was the only profile that saw a net gain in volume. This is expected from a strong hurricane such as Irma. The average unit volumetric change across the entire beach fill area was -3.9 cy/ft with a total net loss of 52,000 cy. Across all of the R-monuments, the beach profile eroded above MHW. The majority of the profiles were also erosional below MHW (0 to -13 ft MHW). The surveys show that the total volume loss above MHW is 45,000 cy (-3.0 cy/ft) and the total volume loss below MHW is 7,000 cy (0.5 cy/ft). The volumetric change at each of the R-monuments can be seen in **Table 12**, below.

As of October 2017, a net volume of 308,700 cy from the 2013 construction event has been retained (**Table 14**), of which 96,000 cy is above MHW and 212,700 cy remains from 0 ft MHW to -13 ft MHW. Roughly 60% of the original volume that was placed in 2013 remains with 40% eroded as of October 2017. About 51% remains above MHW and 66% remains between MHW and -13 ft.

The period of time after Hurricane Irma was also studied. By using the October 2017 and August 2018 surveys, it is possible to get an idea of how the beach recovered in the year following the hurricane. **Table 11** includes the MHW position change between October 2017 and August 2018. The maximum MHW position advance was 16.5 ft at R-17 and the maximum retreat was -29.5 ft at R-21. The beach roughly followed the pattern of MHW change shown during Hurricane Irma. The northern portion of the beach experienced a mixture of advance and retreat while the southern portion from R-20 to R-24 solely experienced retreat.

This pattern of retreat, however, is not mirrored by the volumetric change in the project area. Only two profiles (R-15 and R-23) experienced erosion above the MHW from October 2017 to August 2018 while all of the other profiles show accretion. Below MHW, the results are more mixed with 6 out of 15 profiles showing erosion while the other profiles show accretion. The total volume change above MHW is 31,100 cy (2.1 cy/ft) and the total volume change below MHW is -39,300 cy (2.7 cy/ft) for a total net volume change of -8,200 cy (0.6 cy/ft) during this time period. This pattern of accretion above MHW and erosion below suggests a period of post-storm recovery where material that had gathered in the offshore sand bar was transported back onto the berm. The overall pattern of retreat of the MHW position appears to be the result of material being pushed higher onto the berm and dune system. This can be seen when comparing the October 2017 profiles and the August 2018 profiles found in **Appendix – Beach Profiles**.

The total net volume retained during the time period from February 2014 to August 2018 is 300,100 cy (**Table 14**) of which 121,200 cy is above MHW and 178,900 cy is between 0 ft MHW to -13 ft MHW. This is roughly 59% of the total original volume that was placed during the 2013 construction event.

Table 11: MHW Position Change due to Hurricane Irma

MHW Position Change (feet)								
FDEP R-Monument	May2013-Feb2014	July2017-Oct2017	May2013 - Oct2017	Percent Remaining Feb2014 to Oct 2017	Oct2017-Aug2018	May2013 - Aug2018	Percent Remaining Feb2014 to Aug 2018	Percent Remaining Change Oct2017 to Aug2018
10	35.0	6.2	35.4	101.3%	-4.3	31.1	89.0%	-12.3%
11	72.1	5.7	35.1	48.7%	-13.9	21.2	29.4%	-19.2%
12	86.5	-3.0	24.6	28.5%	0.3	24.9	28.8%	0.3%
13	91.6	0.5	28.0	30.5%	-3.5	24.5	26.7%	-3.8%
14	105.5	-8.5	9.6	9.1%	7.7	17.2	16.3%	7.3%
15	106.0	-22.4	36.3	34.2%	-6.7	29.6	27.9%	-6.3%
16	87.8	2.0	19.6	22.3%	1.8	21.4	24.4%	2.0%
17	95.3	-21.4	23.0	24.2%	16.5	39.5	41.4%	17.3%
18	106.2	-7.8	37.8	35.5%	1.4	39.2	36.9%	1.3%
19	141.1	-5.7	60.0	42.5%	6.5	66.5	47.1%	4.6%
20	147.0	-7.2	96.2	65.5%	-2.5	93.7	63.7%	-1.7%
21	157.5	-3.8	117.1	74.3%	-29.5	87.6	55.6%	-18.7%
22	133.0	-9.0	115.5	86.8%	-21.6	93.9	70.6%	-16.2%
23	83.7	-19.3	85.9	102.7%	-21.5	64.5	77.0%	-25.6%
24	55.9	-15.7	21.0	37.5%	-5.8	15.2	27.2%	-10.3%
AVG	100.3	-7.3	49.7	49.6%	-5.0	44.7	44.1%	-5.4%

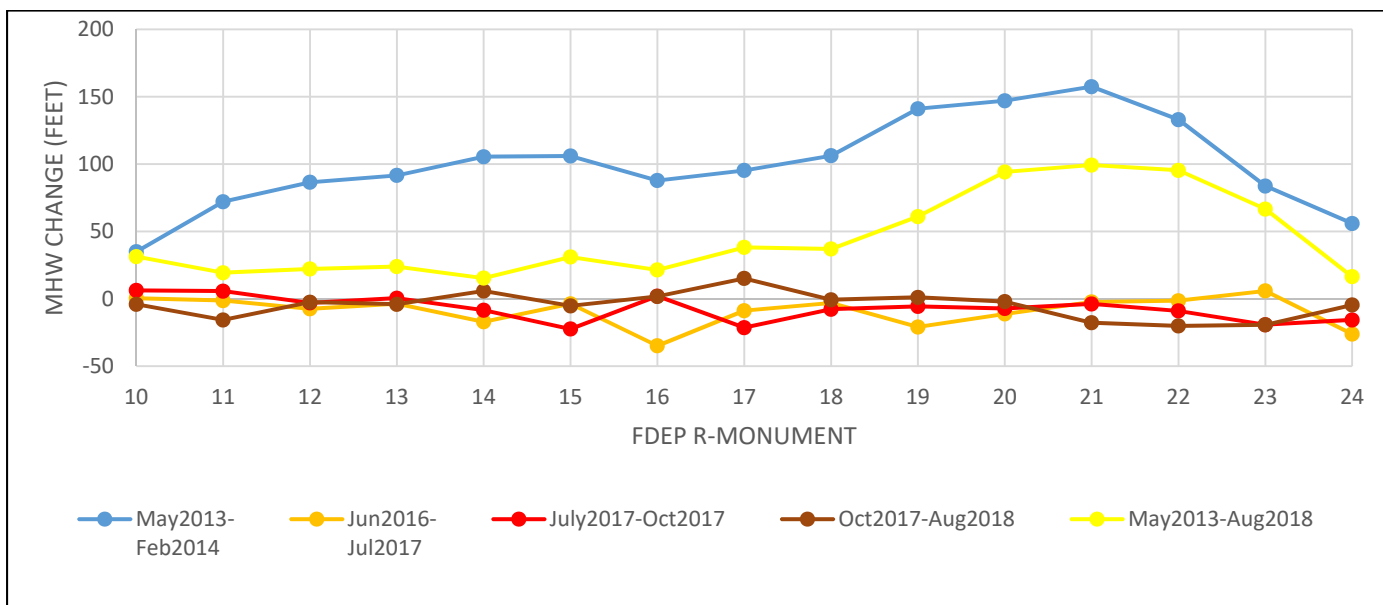


Figure 13: MHW Position Change Including Hurricane Irma

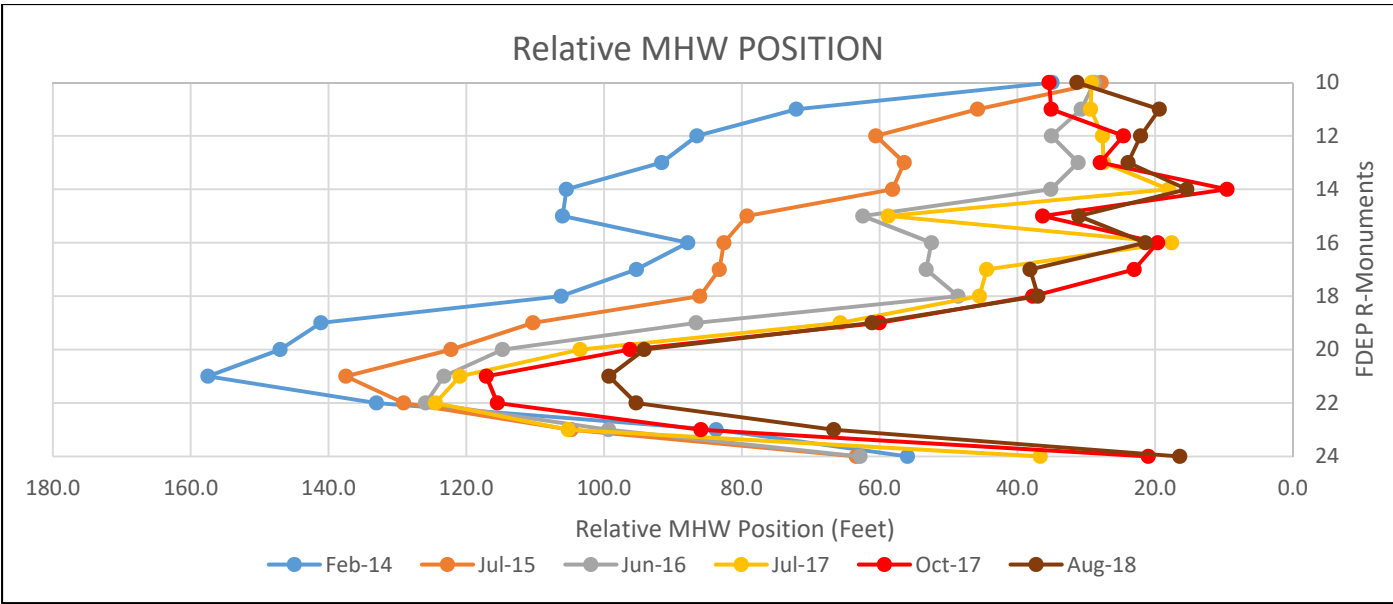


Figure 14: MHW Position Relative to Pre-Construction Position Including Hurricane Irma

Table 12: Volumetric Change – July 2017 to October 2017

July2017-Oct2017 (17-141 to Post-Irma FCCE)		Unit Volume Change (cy/lf)			Volume Change (cy)		
FDEP R-Mon	Dist Btw Mon (feet)	Above 0' MHW	0' to -13' MHW	Above -13' MHW	Above 0' MHW	0' to -13' MHW	Above -13' MHW
10		-1.8	0.6	-1.2			
	1,358				-1,993	3,522	1,529
11		-1.1	4.6	3.4			
	1,097				-2,429	3,615	1,186
12		-3.3	2.0	-1.3			
	1,011				-3,396	2,654	-742
13		-3.4	3.2	-0.2			
	1,009				-3,439	2,826	-613
14		-3.4	2.4	-1.0			
	1,062				-3,924	-175	-4,099
15		-4.0	-2.7	-6.7			
	1,070				-2,373	-1,745	-4,118
16		-0.4	-0.5	-1.0			
	1,043				-2,612	-1,814	-4,426
17		-4.6	-2.9	-7.5			
	995				-4,262	-3,287	-7,549
18		-4.0	-3.7	-7.7			
	1,000				-3,398	-2,988	-6,386
19		-2.8	-2.3	-5.1			
	965				-2,947	-2,192	-5,139
20		-3.3	-2.2	-5.6			
	965				-3,446	-499	-3,945
21		-3.8	1.2	-2.6			
	986				-3,651	-374	-4,025
22		-3.6	-2.0	-5.5			
	905				-3,301	-2,202	-5,502
23		-3.7	-2.9	-6.6			
	718				-2,772	-3,019	-5,791
24		-4.0	-5.5	-9.5			
	509				-1,018	-1,402	-2,420
24.5		0.0	0.0	0.0			
Average	980	-3.2	-0.7	-3.9	-2,997	-472	-3,469
Total	14,693				-44,958	-7,081	-52,039

Table 13: Volumetric Change – October 2017 to August 2018

Oct2017-Aug2018 (Post-Irma to 18-200)		Unit Volume Change (cy/lf)			Volume Change (cy)		
FDEP R-Mon	Dist Btw Mon (feet)	Above 0' MHW	0' to -13' MHW	Above -13' MHW	Above 0' MHW	0' to -13' MHW	Above -13' MHW
10		1.4	-0.5	1.0			
	1,358				1,358	-8,934	-7,576
11		0.6	-12.7	-12.1			
	1,097				1,505	-5,890	-4,385
12		2.2	2.0	4.1			
	1,011				1,373	-1,696	-323
13		0.5	-5.3	-4.8			
	1,009				921	-4,813	-3,893
14		1.3	-4.2	-2.9			
	1,062				89	-8,158	-8,069
15		-1.1	-11.1	-12.3			
	1,070				1,424	-3,885	-2,460
16		3.8	3.9	7.7			
	1,043				4,089	1,748	5,836
17		4.0	-0.5	3.5			
	995				3,724	-3,690	34
18		3.4	-6.9	-3.5			
	1,000				4,652	-2,366	2,287
19		5.9	2.2	8.0			
	965				4,829	2,095	6,924
20		4.1	2.2	6.3			
	965				4,150	-266	3,884
21		4.5	-2.7	1.7			
	986				2,857	802	3,659
22		1.3	4.4	5.7			
	905				324	2,307	2,631
23		-0.6	0.7	0.1			
	718				-195	-3,740	-3,936
24		0.1	-11.2	-11.1			
	509				20	-2,842	-2,822
24.5		0.0	0.0	0.0			
Average	980	2.1	-2.7	-0.6	2,075	-2,622	-547
Total	14,693				31,118	-39,327	-8,209

Table 14: Percent Remaining Before and After Hurricane Irma

		2014 (Post Construction) - 2015		2014 (Post Construction) - 2016		2014 (Post Construction) - July 2017		2014 (Post Construction) - Hurricane Irma (Oct 2017)		2014 (Post Construction) - August 2018	
FDEP R-Mon	Dist Btw Mon (feet)	Total Volume Change (cy)	Percent Remaining	Total Volume Change (cy)	Percent Remaining	Total Volume Change (cy)	Percent Remaining	Total Volume Change (cy)	Percent Remaining	Total Volume Change (cy)	Percent Remaining
10											
	1358	22,537	80%	34,089	121%	29,102	103%	30,631	108%	23,869	84%
11											
	1097	25,641	83%	22,852	74%	16,147	53%	17,333	56%	14,008	46%
12											
	1011	22,305	72%	16,255	53%	9,669	31%	8,928	29%	9,404	30%
13											
	1009	22,154	55%	18,448	46%	11,363	28%	10,750	27%	7,838	20%
14											
	1062	31,381	62%	35,552	70%	27,699	55%	23,600	46%	16,634	33%
15											
	1070	39,541	84%	46,758	100%	36,133	77%	32,015	68%	30,405	65%
16											
	1043	41,602	109%	42,624	111%	34,095	89%	29,669	78%	35,815	94%
17											
	995	36,827	96%	34,530	90%	34,169	89%	26,620	69%	27,449	71%
18											
	1000	36,071	89%	35,250	87%	33,862	83%	27,477	68%	24,446	60%
19											
	965	39,678	95%	42,689	102%	44,753	107%	39,615	94%	41,474	99%
20											
	965	35,962	91%	37,212	94%	41,928	106%	37,983	96%	42,460	108%
21											
	986	28,648	79%	32,978	91%	30,208	84%	26,183	73%	29,883	83%
22											
	905	17,406	60%	27,145	93%	17,884	62%	12,382	43%	16,893	58%
23											
	718	7,570	50%	14,435	96%	-2,124	0%	-7,915	0%	-10,851	0%
24											
	509	2,283	56%	4,366	107%	-4,146	0%	-6,566	0%	-9,587	0%
24.5											
Total	14,693	409,604	80%	445,184	87%	360,742	71%	308,703	60%	300,138	59%

Borrow Area Survey Analysis

This section assesses the current condition of the borrow area based on survey 17-149 performed on August 16-17, 2017. The surveys of the borrow area were analyzed using the compare surfaces tool of Aquaveo Surface Model System (SMS). **Figure 15, Figure 16, Figure 17, Figure 18, and Figure 19** show the borrow area depths from the pre-construction, post-construction, first annual, second annual, and third monitoring surveys respectively. **Figure 20, Figure 21, Figure 22, and Figure 23** display the bathymetric changes from the pre-construction (May 2013) to post-construction (February 2014), post-construction (February 2015) to first annual (May 2015), first annual (May 2015) to second annual (May 2016), and second annual (May 2016) to third annual (August 2017) monitoring surveys respectively. **Figure 24** shows the bathymetric change from pre-construction to May 2016 and **Figure 25** shows the bathymetric change from pre-construction to August 2017. As per the permit monitoring plan, surveys of the borrow area are only required every other year. A survey of the borrow area was not conducted in 2018.

The offshore borrow area for the 2013 Lee County, Gasparilla Island Segment SPP renourishment project is located approximately 1 mile southwest of the southern end of Gasparilla Island, in pre-dredging water depths of about -10 ft, NAVD88 (see **Figure 1**). The maximum permitted excavation limits in the borrow area used for this nourishment were -25.2 ft, NAVD88 (equivalent to -23.46 ft MLLW and -24.0 ft NGVD29). The dimensions of the permitted borrow area are approximately 1,200 ft (North-South) by 5,800 ft (East-West).

The pre-construction survey was conducted during 13-17 May 2013 (Survey 13-077 Post Sandy Survey). The post-construction borrow area survey was performed on 11 February 2014. The total net volume change measured within the limits of the permitted borrow area was -398,800 cy. This is lower than the measured contract pay volume within the fill template on the beach (457,800 cy). The difference may represent some sediment movement into the borrow area given the length of time between the end of construction and the post-construction monitoring survey of the borrow area. Also a volume difference of -86,700 cy was calculated for the borrow area access, Cut 1, which could be due to sediment movement out of Cut 1 and possibly into Cut 2. Analysis of the pre- and post-construction borrow area monitoring surveys indicates that the area was dredged relatively uniformly, and no areas were, presumably, dredged beyond the permitted limits.

The May 2015 monitoring survey indicates that the cuts dredged for the 2013 project have all gained volume since February 2014. Cut 2 has filled in with 128,100 cy and cut 3 has filled in with 31,400 cy. In **Figure 21** cool colors represent volume gains while warm colors indicate volume losses between the February 2014 and May 2015 surveys.

The May 2016 monitoring survey also showed a gain in volume since May 2015. Cut 2 accumulated 117,500 cy, while Cut 3 accreted 20,000 cy. **Figure 22** depicts from the volume changes between May 2015 and May 2016. The borrow area is still accreting sediment, but at a slower rate than the previous monitoring period.

The July 2017 monitoring survey had a gain since May 2016. Cut 2 accumulated 45,600 cy and Cut 3 accumulated 32,200 cy. **Figure 23** depicts the volume changes between the second and third monitoring surveys.

The cumulative change in borrow area volume since the pre-construction monitoring survey (May 2013) is shown in **Figure 24**. Comparing the pre-construction survey (May 2013) to the third annual survey (July 2017), the borrow area contains roughly 25,700 cy less than the 2013 survey (**Figure 25**). Of the total, a deficit of 4,400 cy and 21,300 cy remains for Cut 2 for Cut 3, respectively.

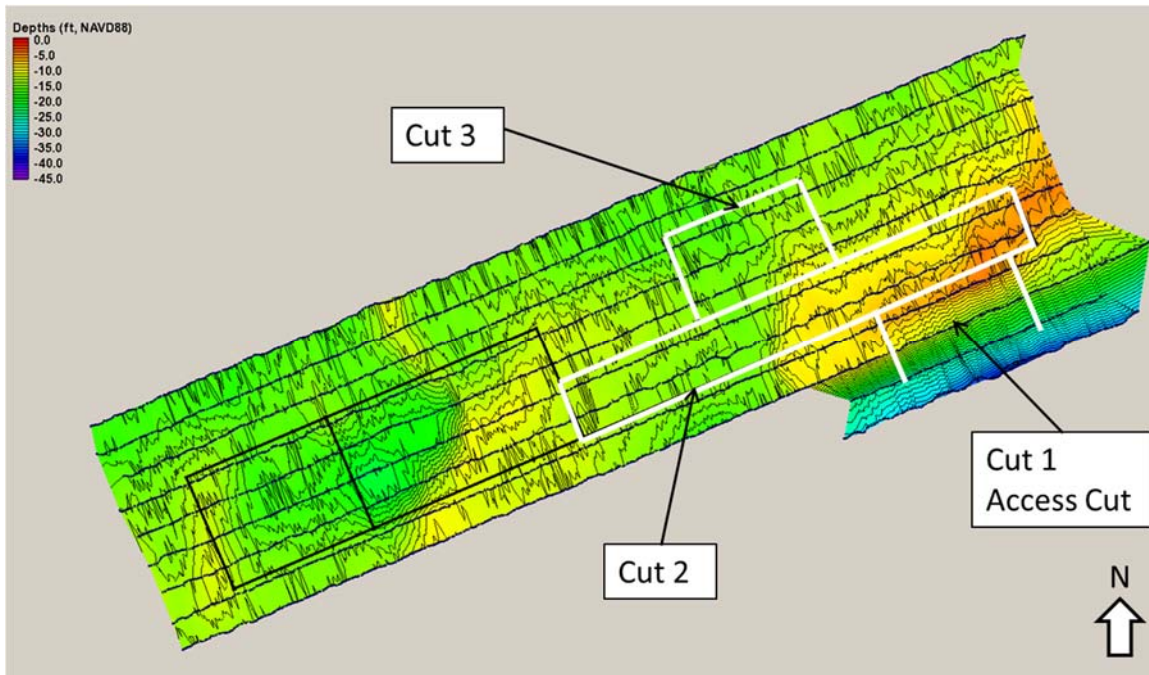


Figure 15: Pre-Construction Borrow Area Depths (Survey 13-077, May 2013)

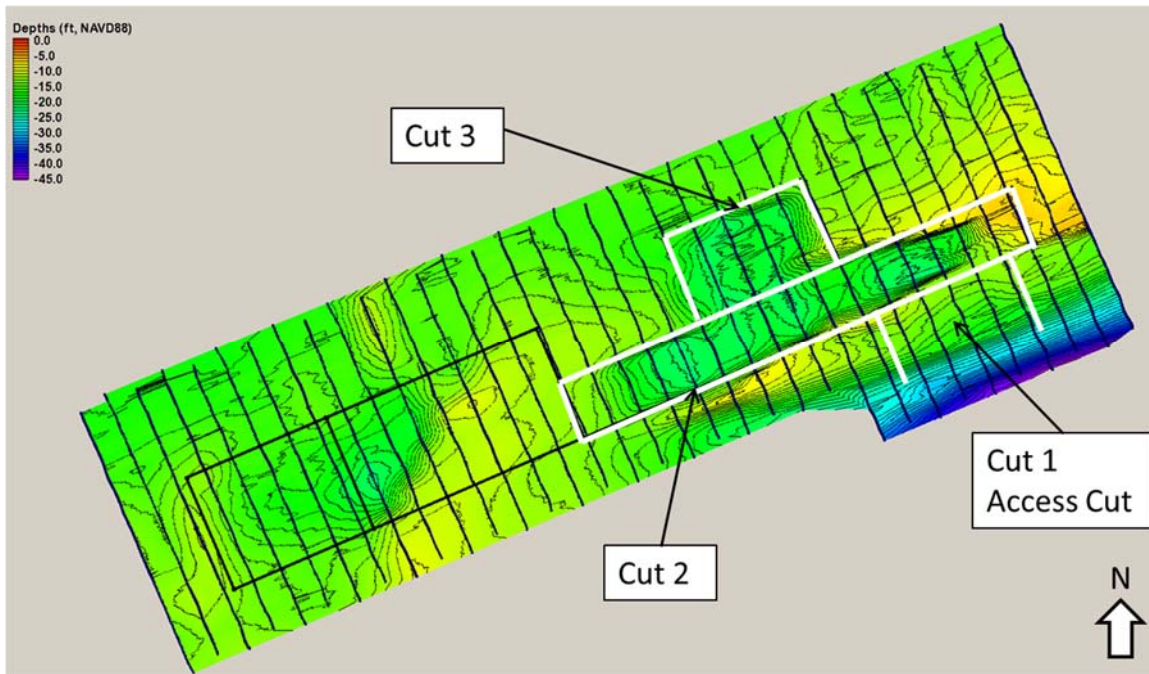


Figure 16: Post-construction Borrow Area Depths (Survey 14-041, Feb 2014)

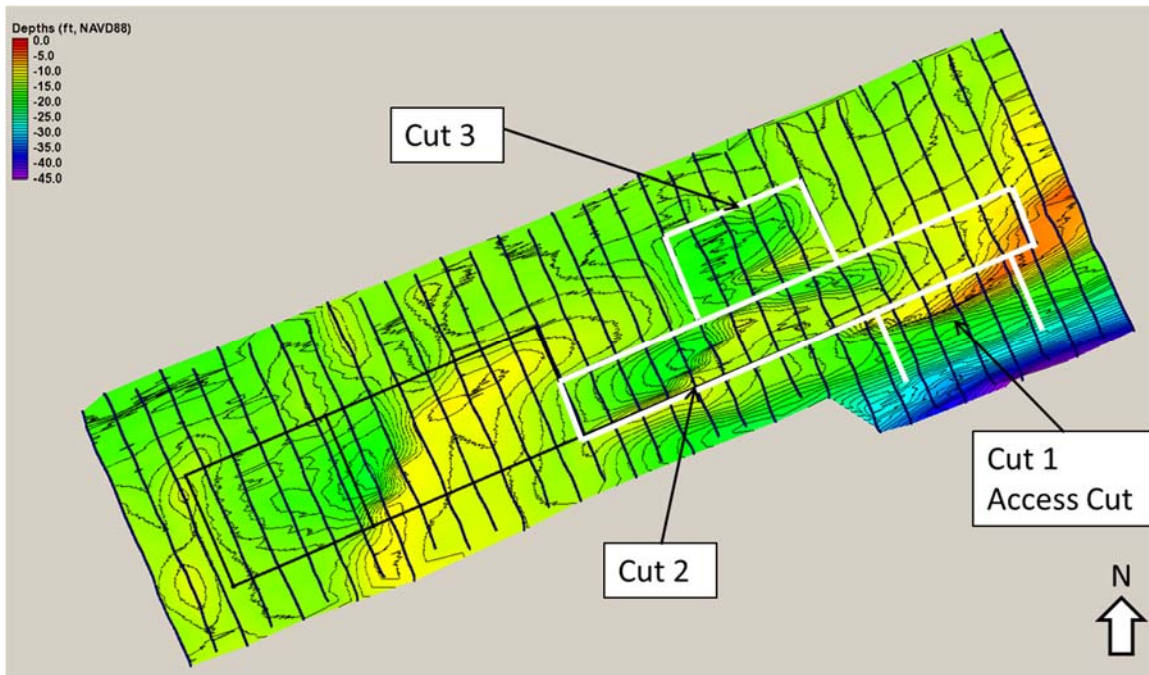


Figure 17: First Annual Monitoring Borrow Area Depths (Survey 15-086, May 2015)

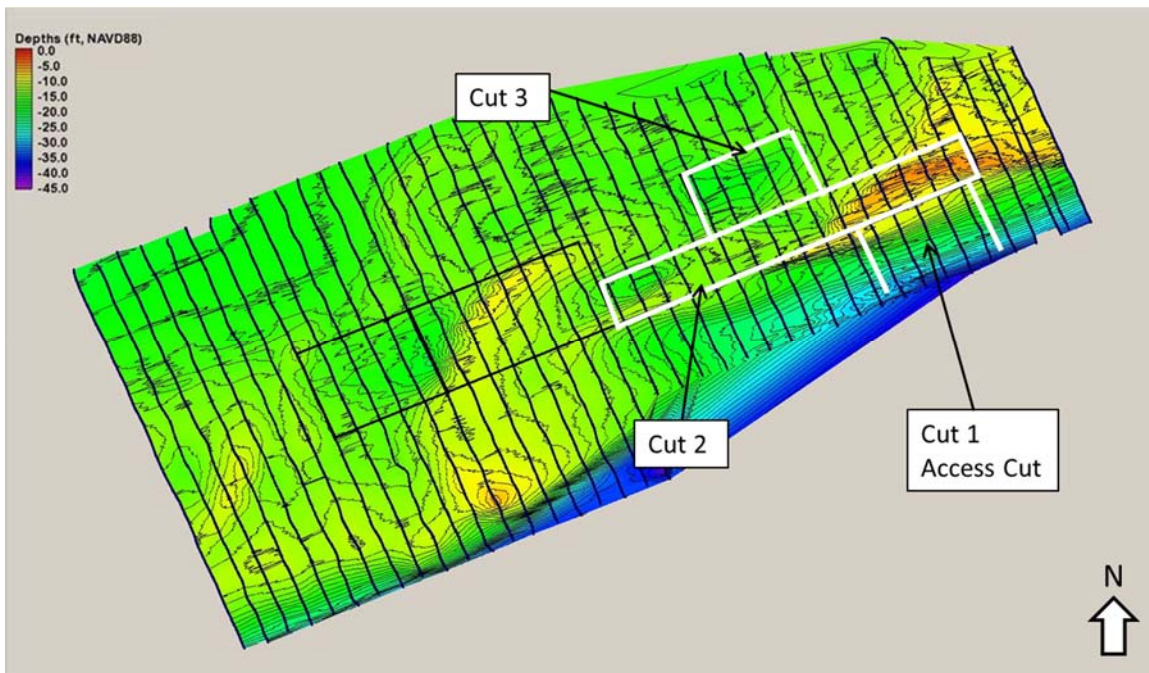


Figure 18: Second Annual Monitoring Borrow Area Depths (Survey 16-100, May 2016)

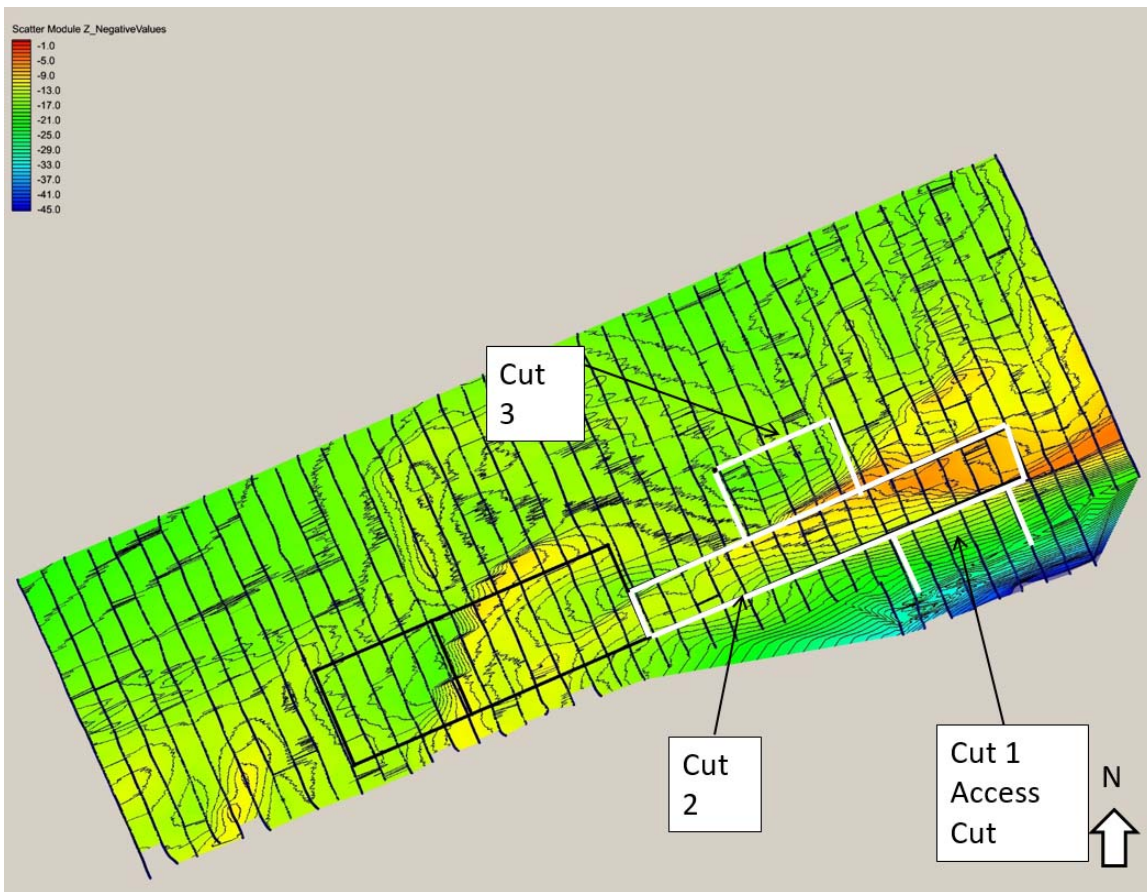


Figure 19: Third Annual Monitoring Borrow Area Depths (Survey 17-149, August 2017)

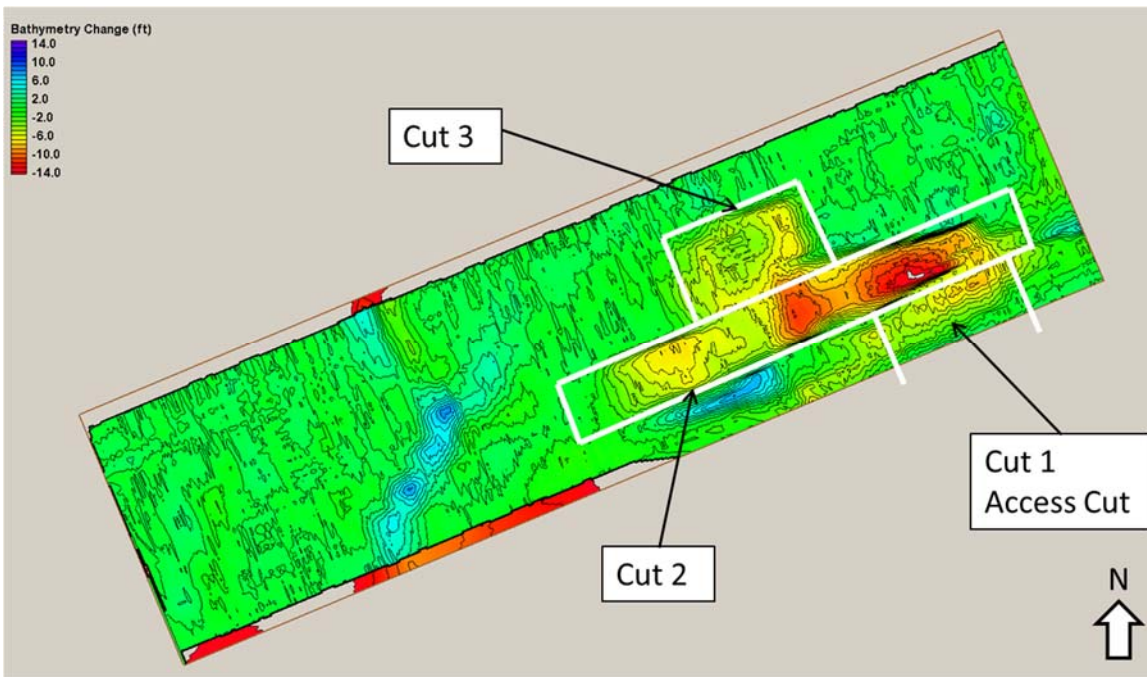


Figure 20: Borrow Area Pre To Post-Construction Bathymetry Change

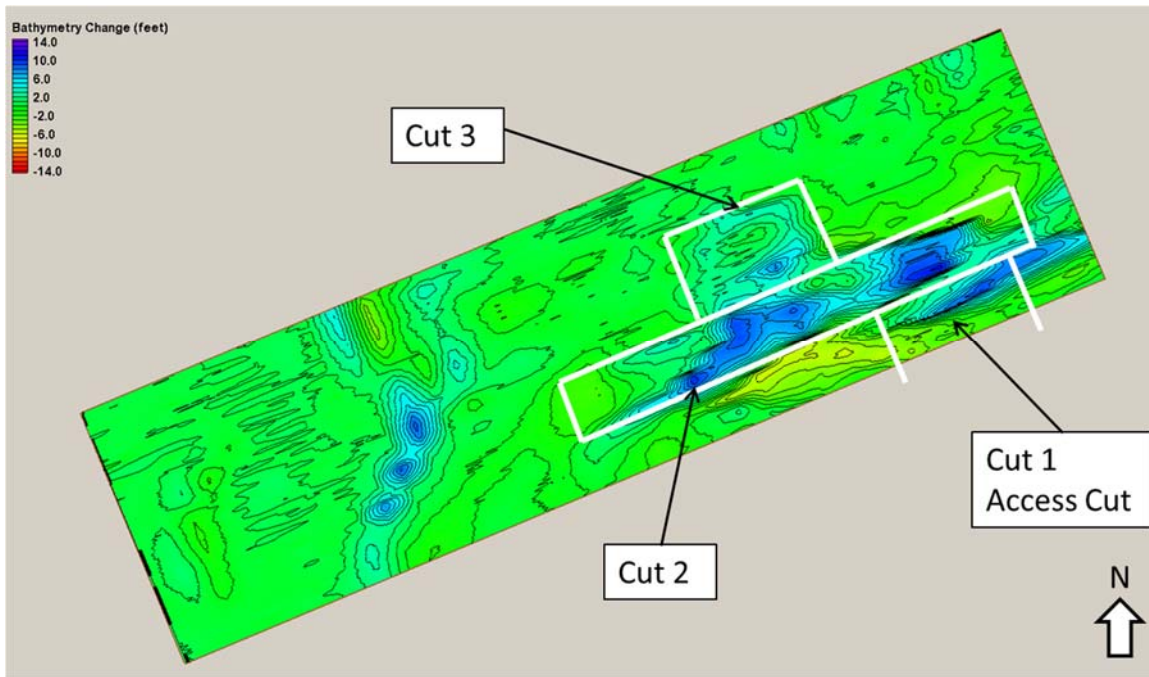


Figure 21: Borrow Area Post-Construction To First Annual Bathymetry Change

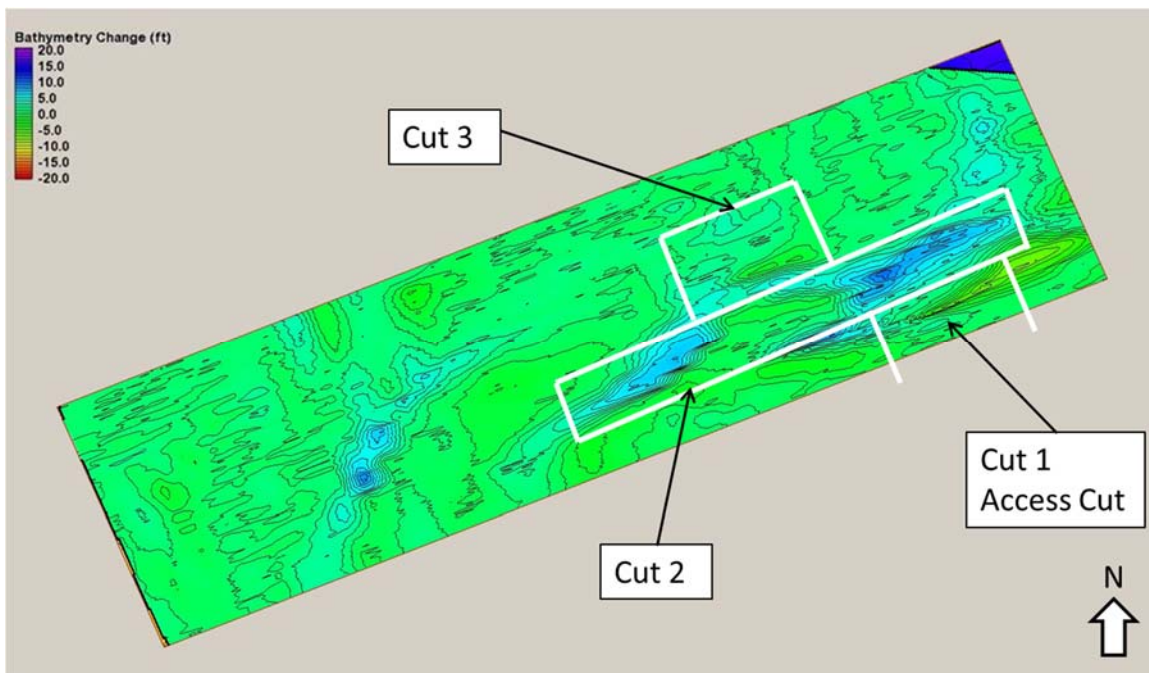


Figure 22: Borrow Area First Annual To Second Annual Bathymetry Change

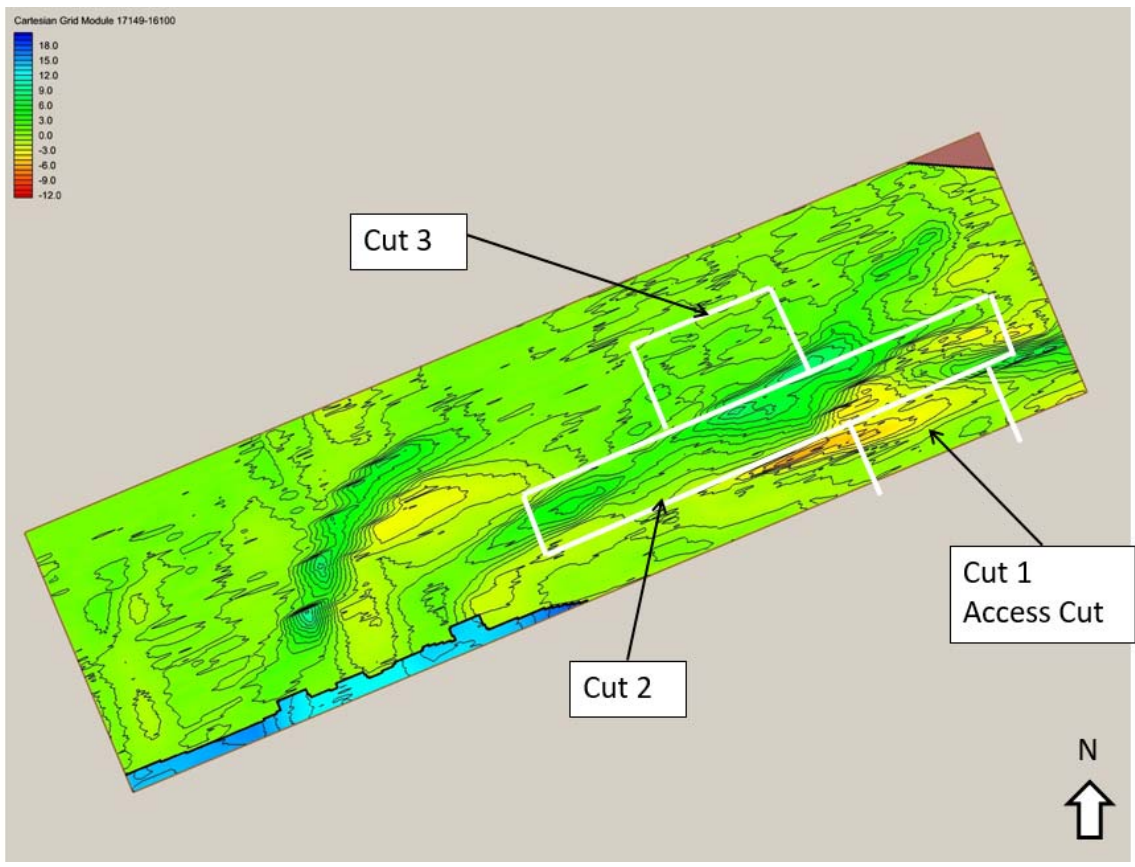


Figure 23: Borrow Area Second To Third Annual Bathymetry Change

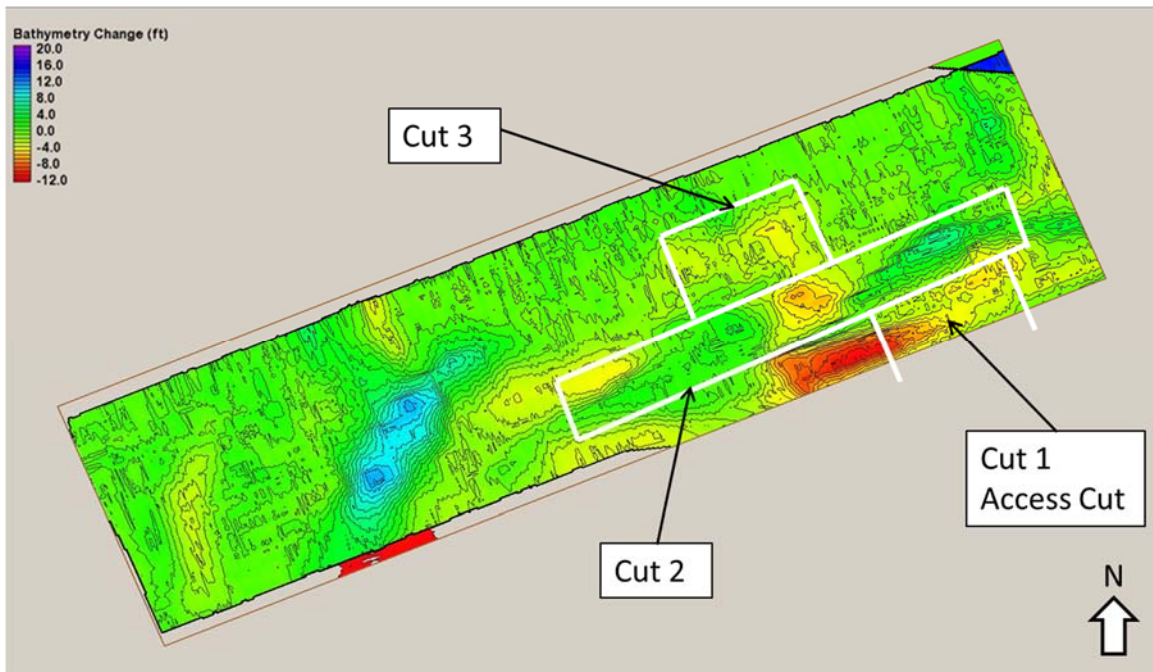


Figure 24: Borrow Area Pre-Construction To May 2016 Bathymetry Change

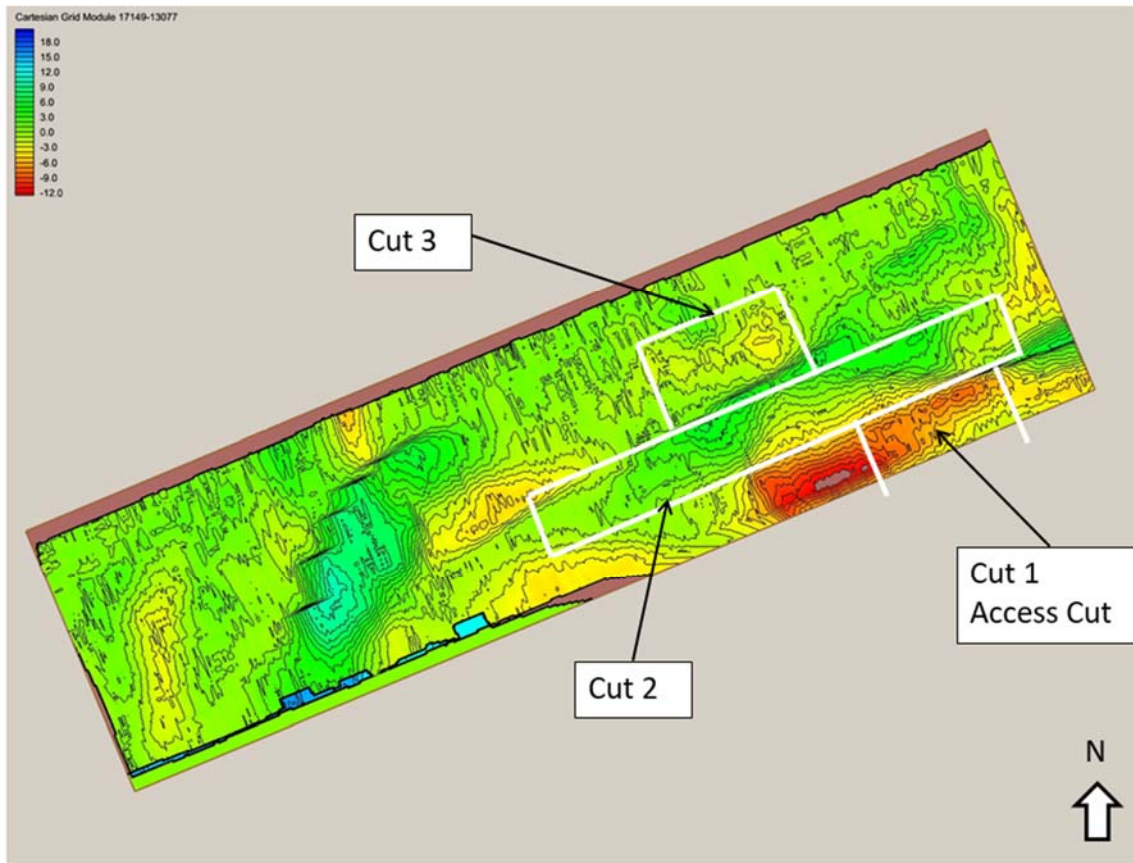


Figure 25: Borrow Area Pre-Construction To August 2017 Bathymetry Change

Summary

This report summarizes the history of the Lee County, Gasparilla Island Segment SPP and provides details of the 2013 renourishment. The changes between the pre-construction (13-077), post-construction (14-039 and 14-041), first annual (15-085 and 15-086), second annual (16-088 and 16-100), third annual monitoring (17-141 and 17-149), and fourth annual monitoring (18-200) beach profile surveys and borrow area surveys were evaluated along with the post-Hurricane Irma beach survey (18-018).

The average MHW position was at 57.0 ft seaward of the pre-construction MHW position across the beach fill area in July 2017 and after Hurricane Irma it was at 49.7 ft. After the latest survey in August 2018, the average MHW position is at 44.7 ft. The MHW position has steadily moved landward since the project's construction and some areas of the project are below 30% of their initial post-construction width. These areas are primarily located in the northern portion of the project, which has traditionally been an area plagued by erosion. The southern portion of the project remains in fairly healthy condition.

A volumetric erosion of 60,600 cy occurred between July 2017 and August 2018. This value is extremely close to the annual net loss of 60,000 cy predicted in the 2001 GRR based on historic volume changes. This period of evaluation included the impacts from Hurricane Irma. The Gasparilla Island Segment experienced another 52,000 cy of erosion between July 2017 and October 2017 due to Hurricane Irma but only lost an additional 8,200 cy from October 2017 to August 2018. 300,100 cy of the material placed in 2013 remain as of August 2018. This is 59% of the original 2013 construction volume of 510,500 cy.

The borrow area cuts dredged for the 2013 project have all experienced an in-filling of material. Cuts 2 and 3 gained 159,500 cy (32% of the 510,500 cy removed) between the post-construction and first annual monitoring surveys. Additionally, between the first and second annual monitoring surveys the borrow area accreted 137,600 cy (28%). Between May 2016 and July 2017 the borrow area accreted 77,800 cy (15%). A deficit of 125,600 cy (25%) remains in the borrow area due to the 2013 renourishment event. A borrow area survey was not conducted in 2018.

In general, the project is performing as expected. The average erosion rate within the project limits following the 2013 construction is 52,600 cy/yr. This is close to what was anticipated when the project was originally designed (60,000 cy/yr). The majority of volume placed during the 2013 renourishment event remains within the monitored area but has been redistributed in the cross-shore direction with material moving from above MHW to the nearshore sand bar as the construction template equilibrates to a more natural profile following the 2013 renourishment event.

References








- U.S. Army Corps of Engineers (USACE), 2001. Lee County, Florida, Shore Protection Project (Gasparilla and Estero Islands), General Re-evaluation Report with Environmental Impact Statement. Jacksonville District.
- U.S. Army Corps of Engineers (USACE), 2013. Project Information Report (PIR), Rehabilitation Effort for the Lee County Hurricane and Storm Damage Reduction Project, Gasparilla Island Segment, Florida. Jacksonville District.
- U.S. Army Corps of Engineers (USACE), 2017. Project Information Report (PIR), Rehabilitation Effort for the Lee County, Florida Shore Protection Project, Gasparilla Island Segment.

Appendix – Beach Profiles

The following profiles are plotted with elevations referenced to NAVD 88. The distance across shore is relative to the R-monument location.

There are two plots presented for each R-monument. The first plot is zoomed in to more clearly show the changes in the dune, berm, and nearshore features. The second plot is zoomed out to show the full extent of the profile covered by the surveys.

The seven profiles plotted at each R monument are:

-  “R-#_077_xyz” : Pre-construction monitoring survey, May 2013.
-  “R-#_039_xyz” : Post-construction monitoring survey, February 2014.
-  “R-#_085_xyz” : 2015 monitoring survey, July 2015.
-  “R-#_088_xyz” : 2016 monitoring survey, June 2016.
-  “R-#_141_xyz” : 2017 monitoring survey, July 2017.
-  “R-#_018_xyz” : Post-Hurricane Irma survey, October 2017.
-  “R-#_18-200_xyz”: 2018 monitoring survey, August 2018.

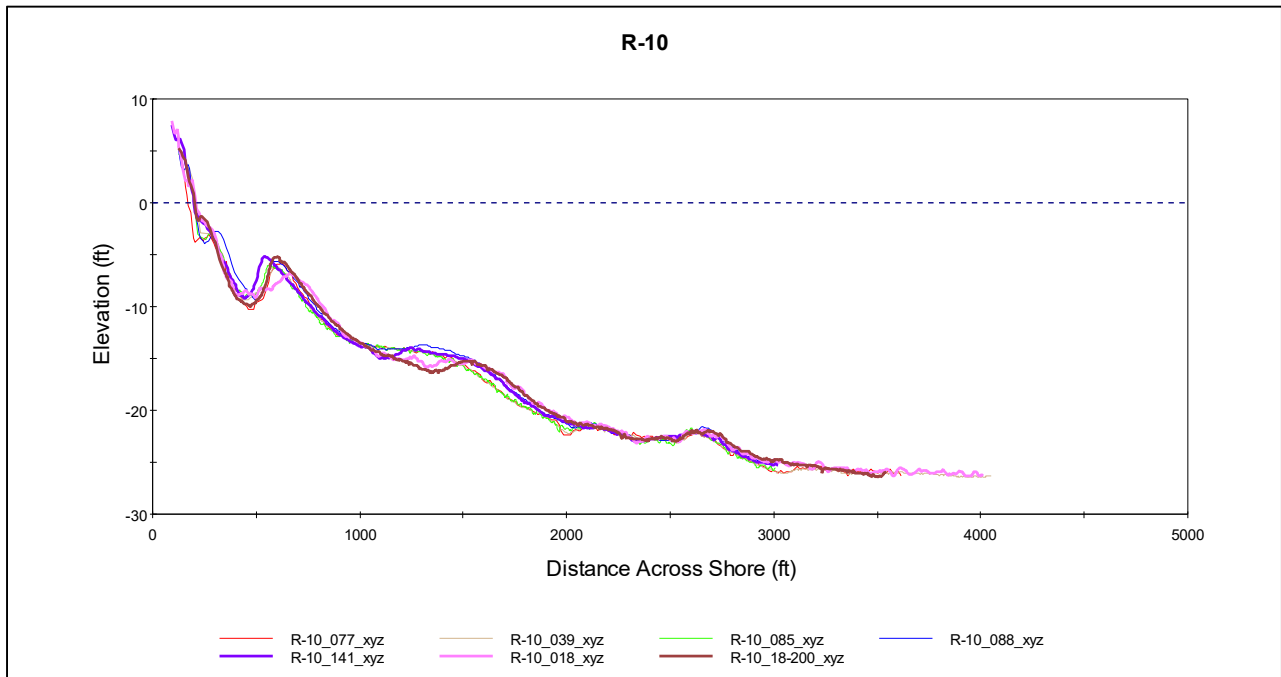
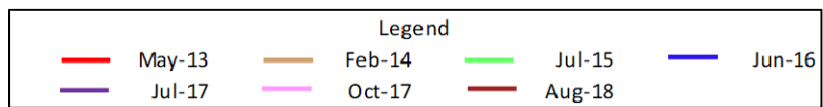
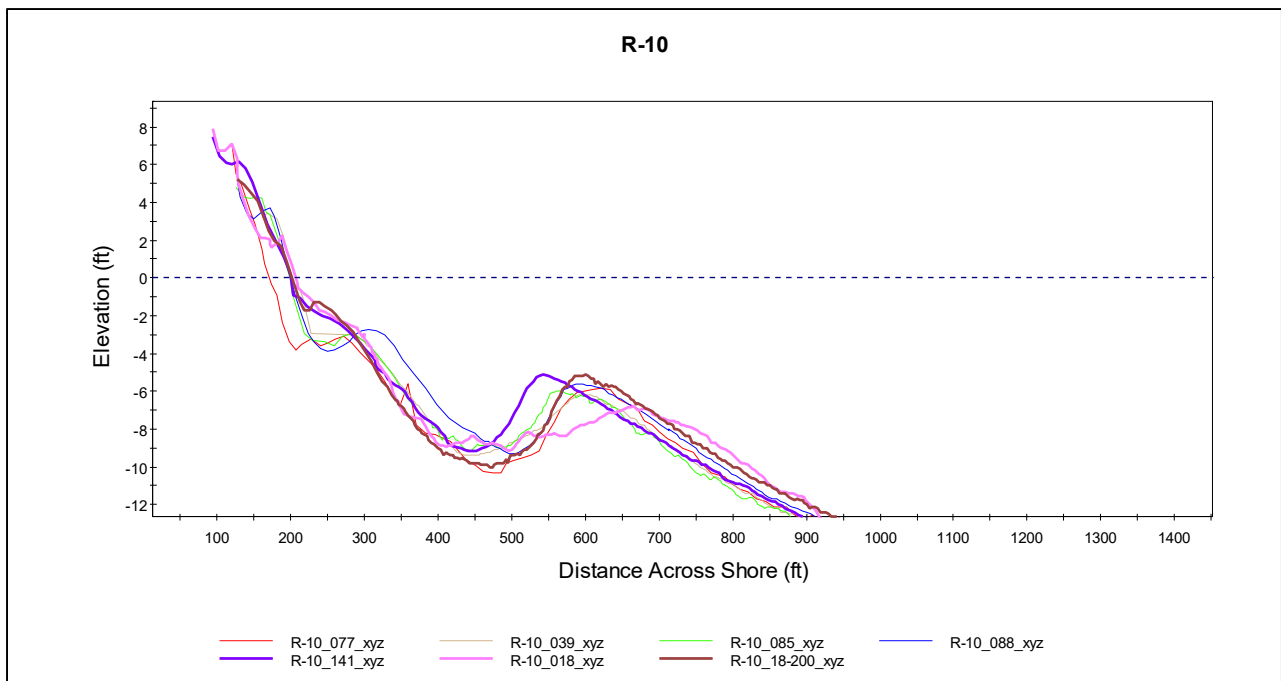


Figure 26: Survey Profiles at R-10.
Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

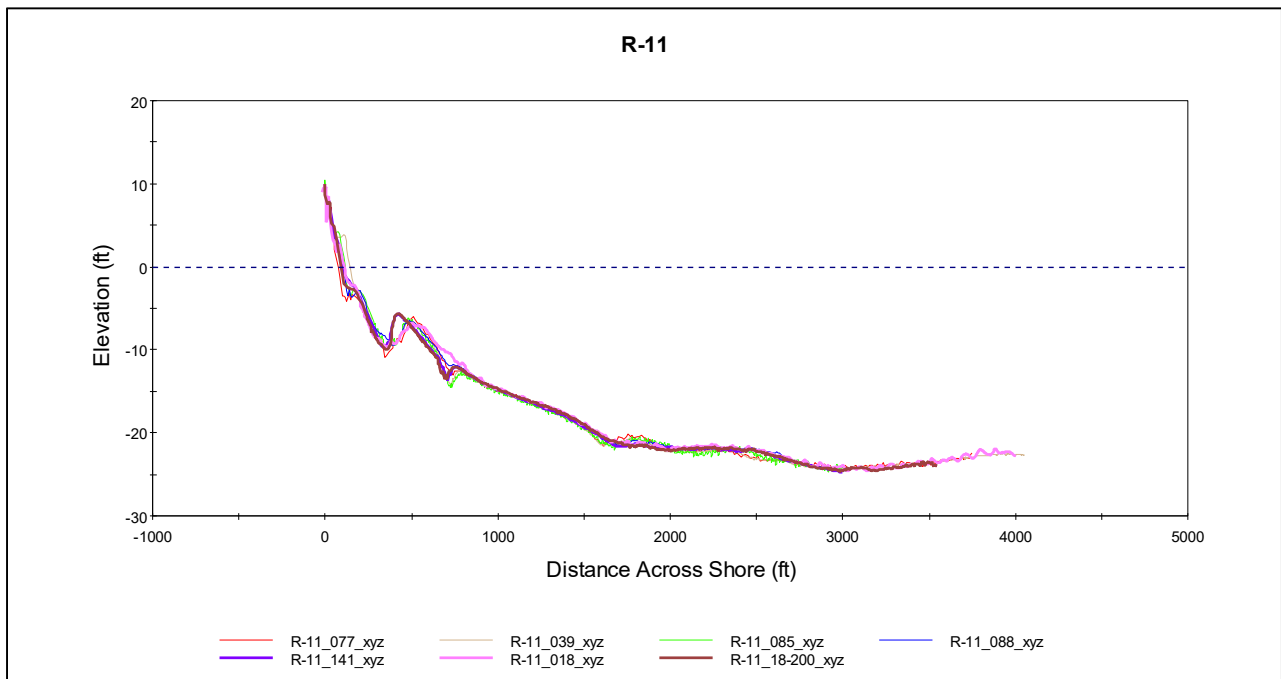
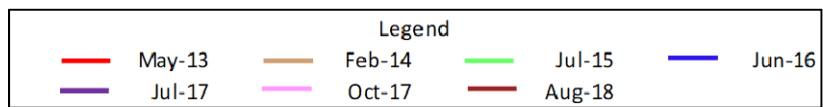
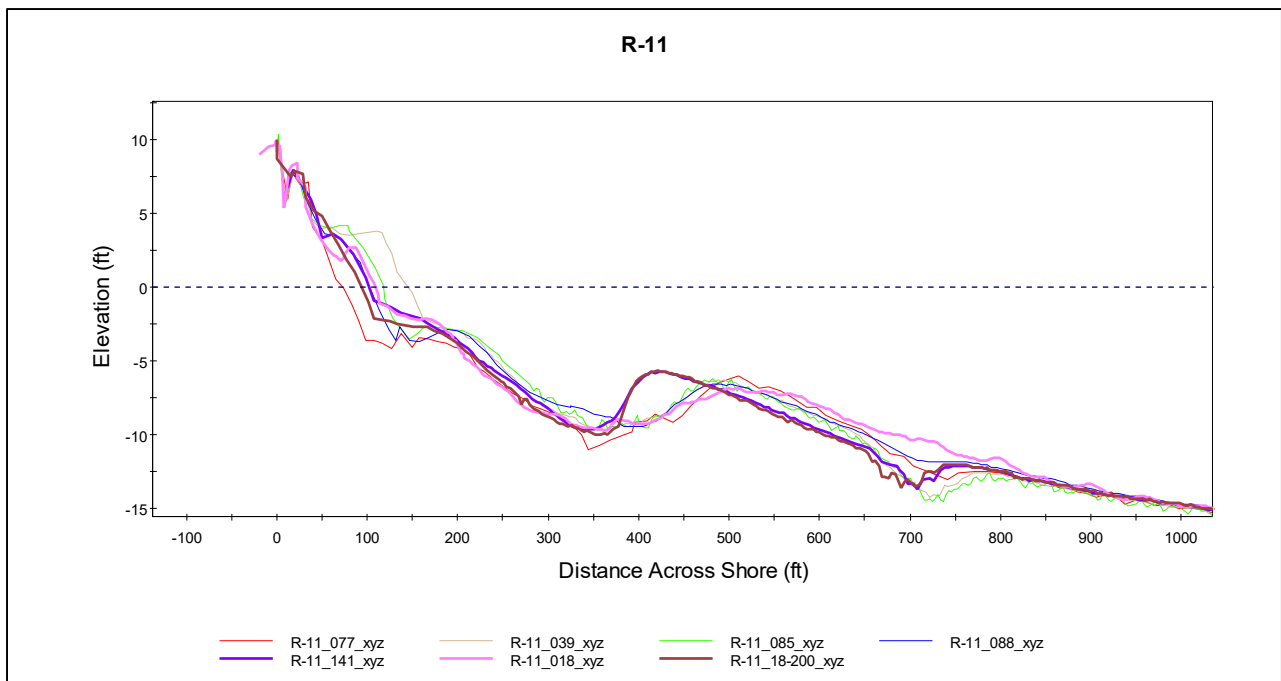


Figure 27: Survey Profiles at R-11
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

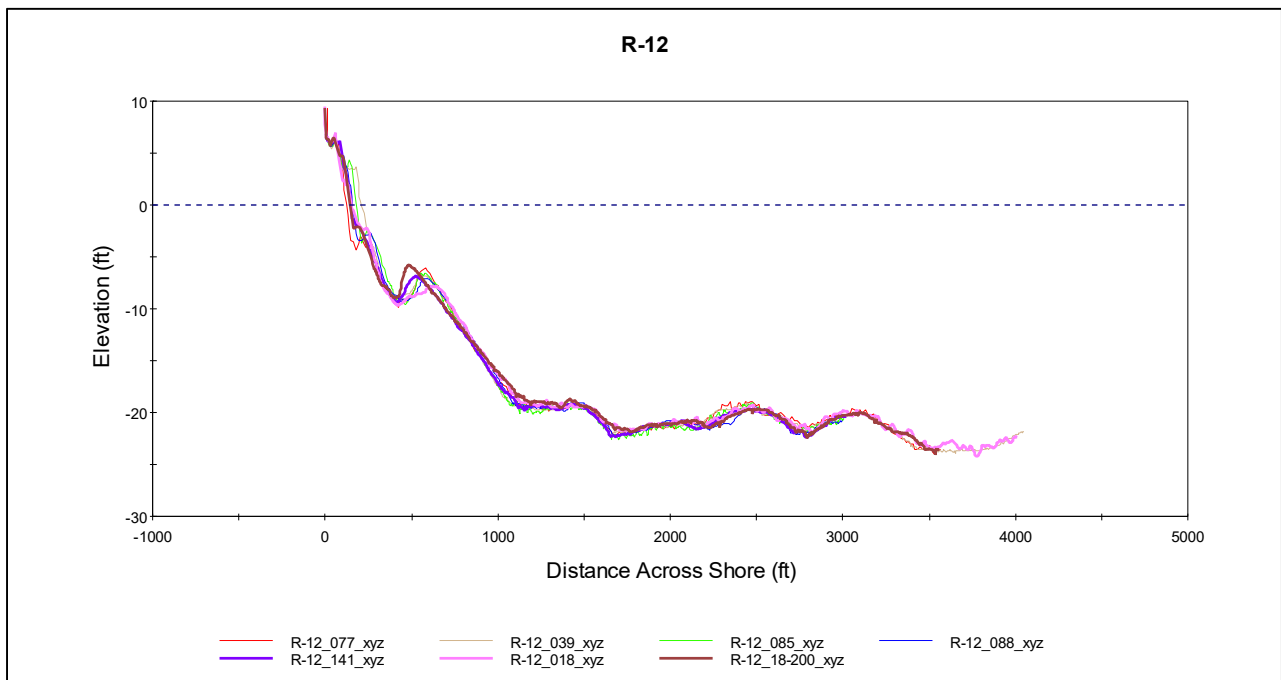
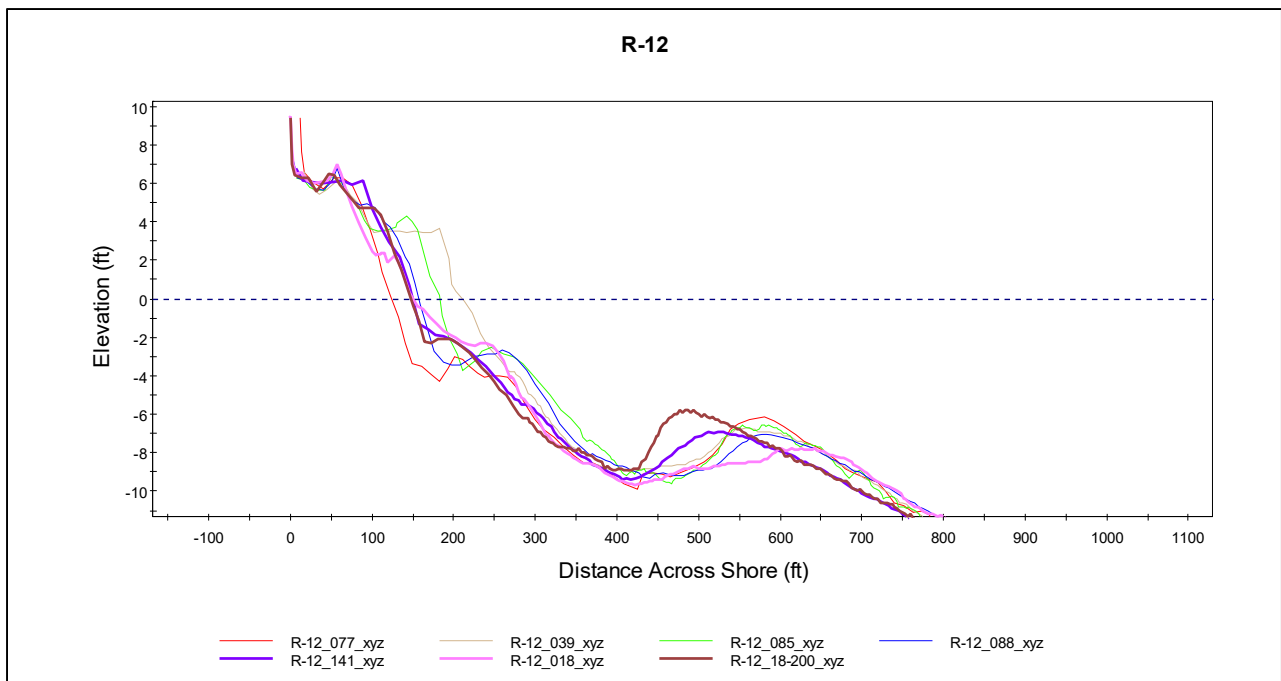
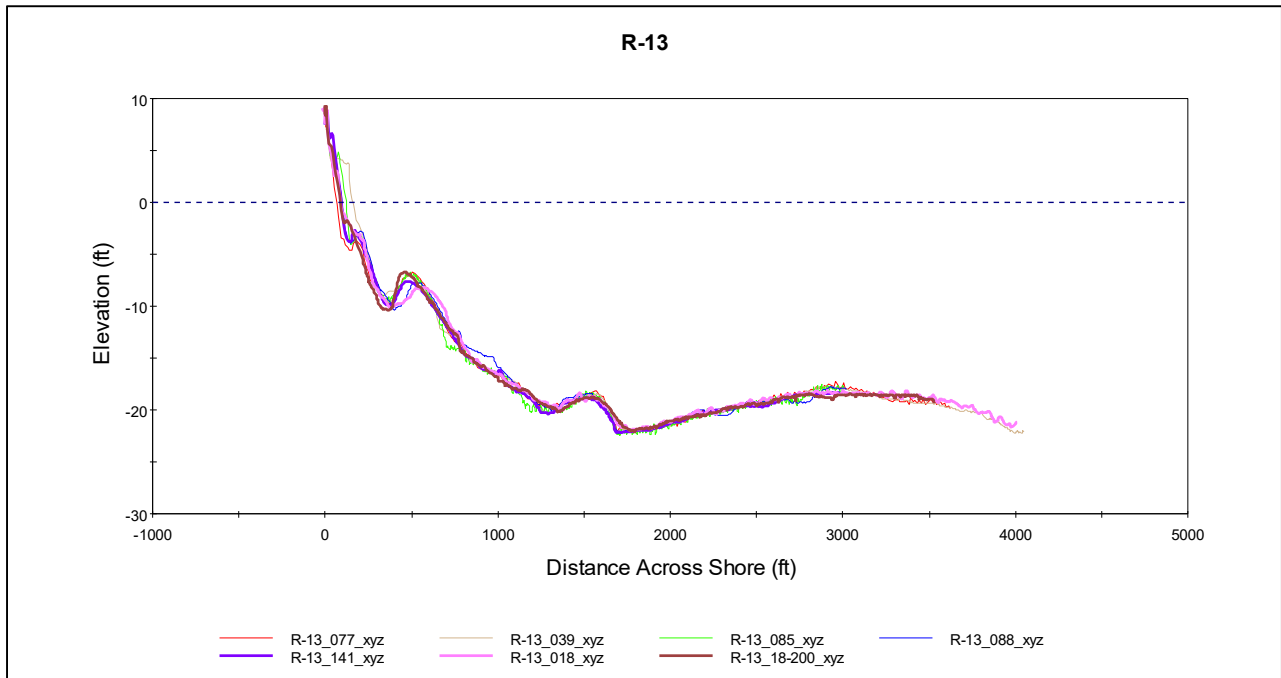
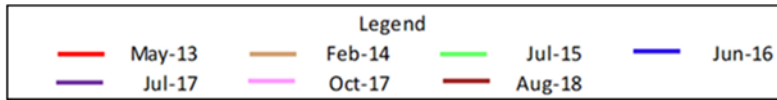
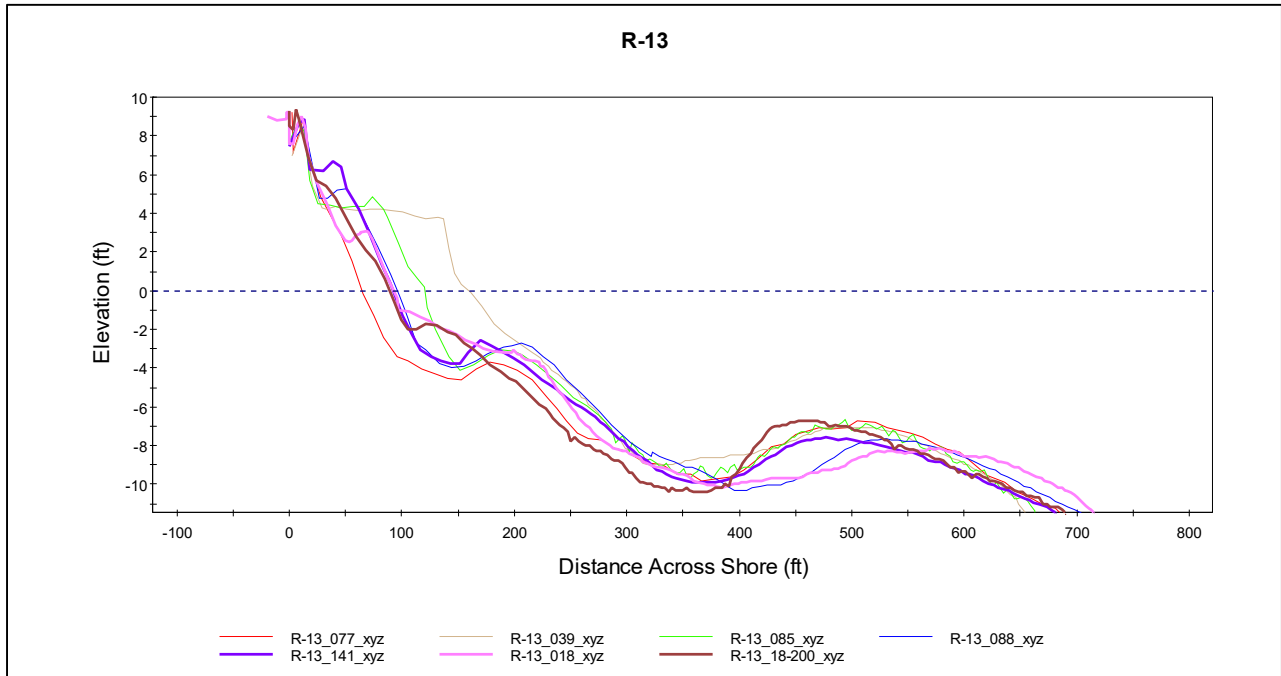


Figure 28: Survey Profiles at R-12
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument



May 2013 Feb 2014 July 2015 May 2016 July 2017 October 2017

Figure 29: Survey Profiles at R-13
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

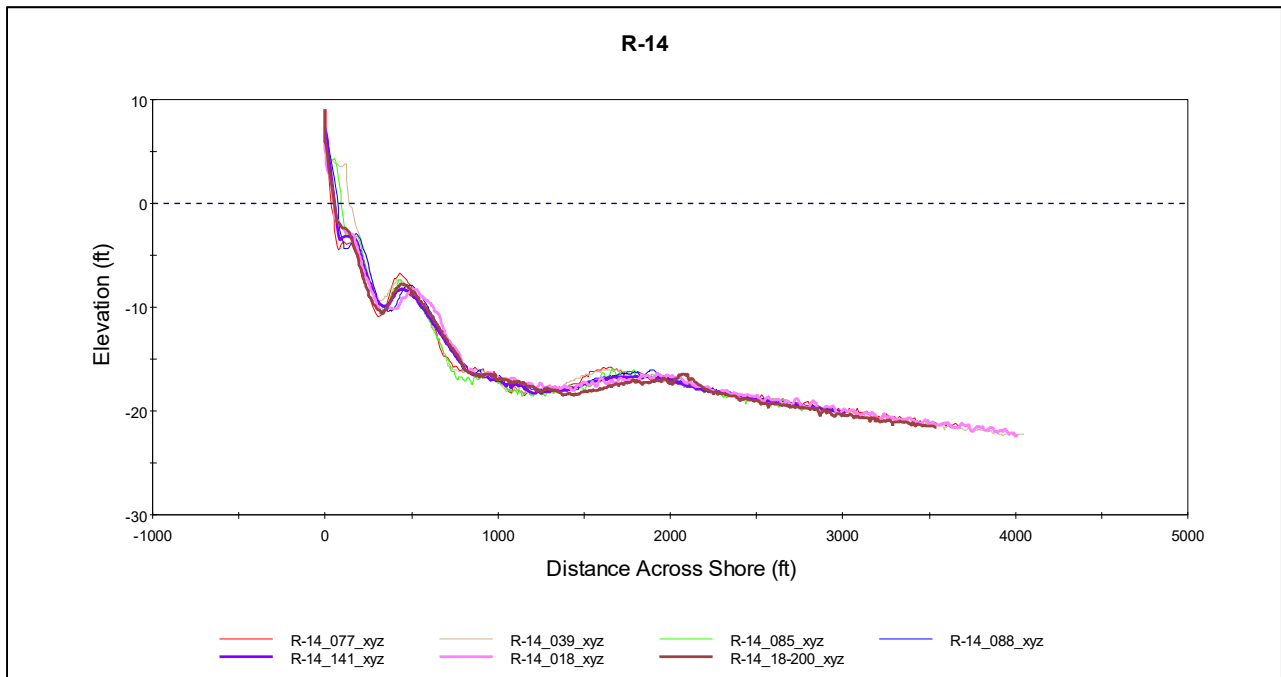
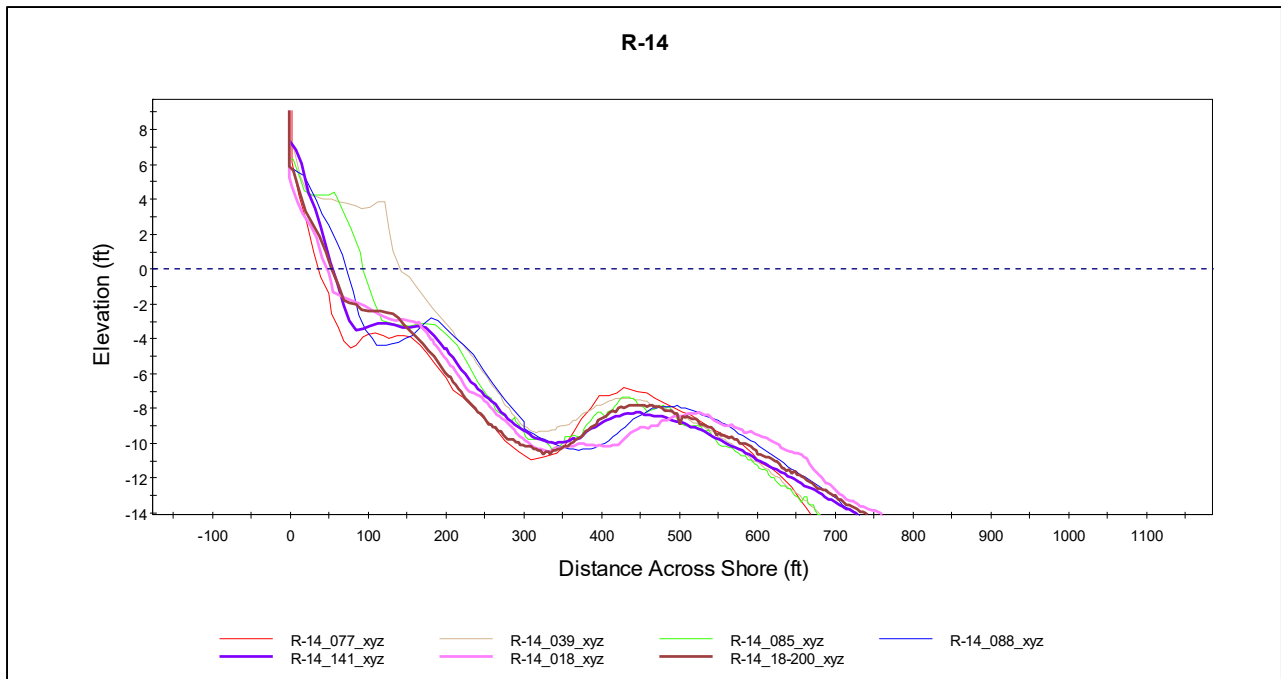


Figure 30: Survey Profiles at R-14
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

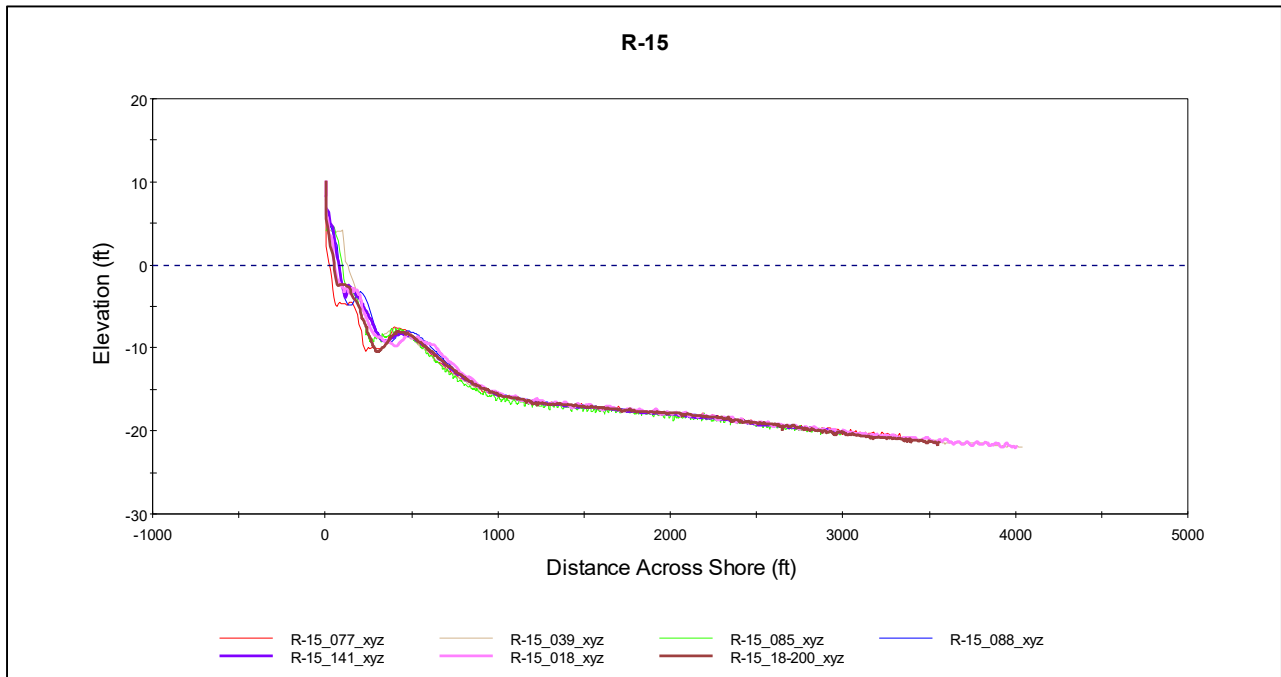
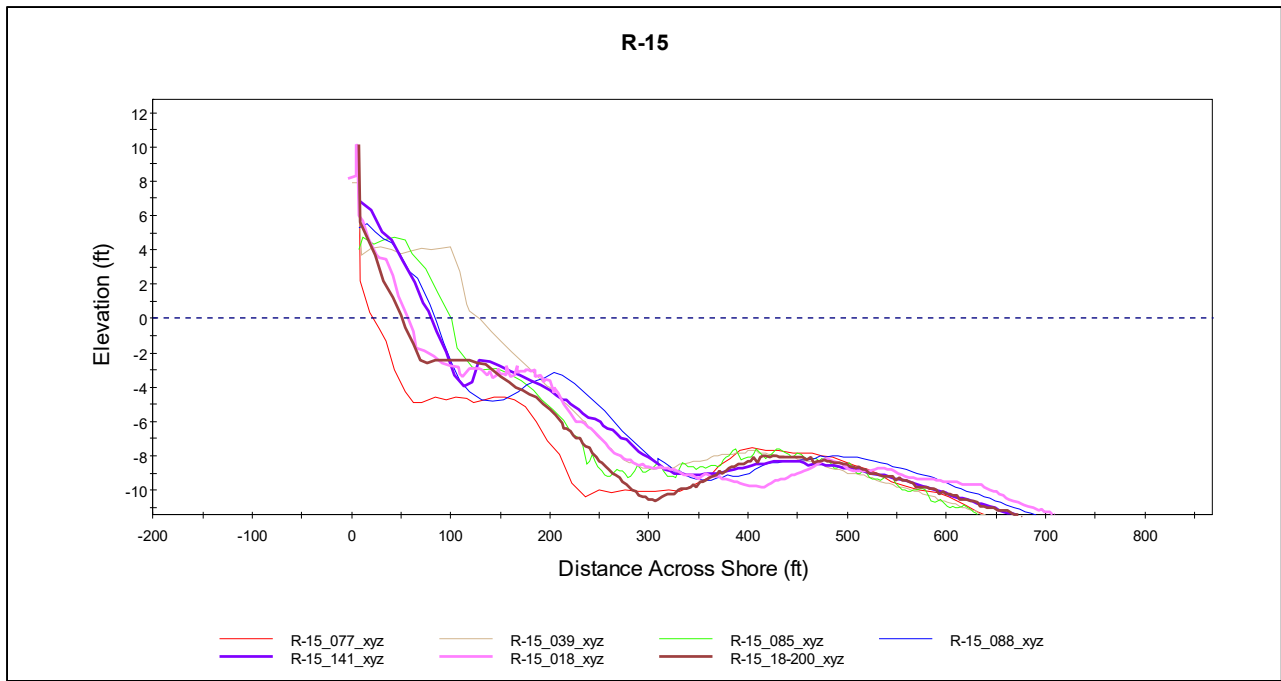


Figure 31: Survey Profiles at R-15
Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

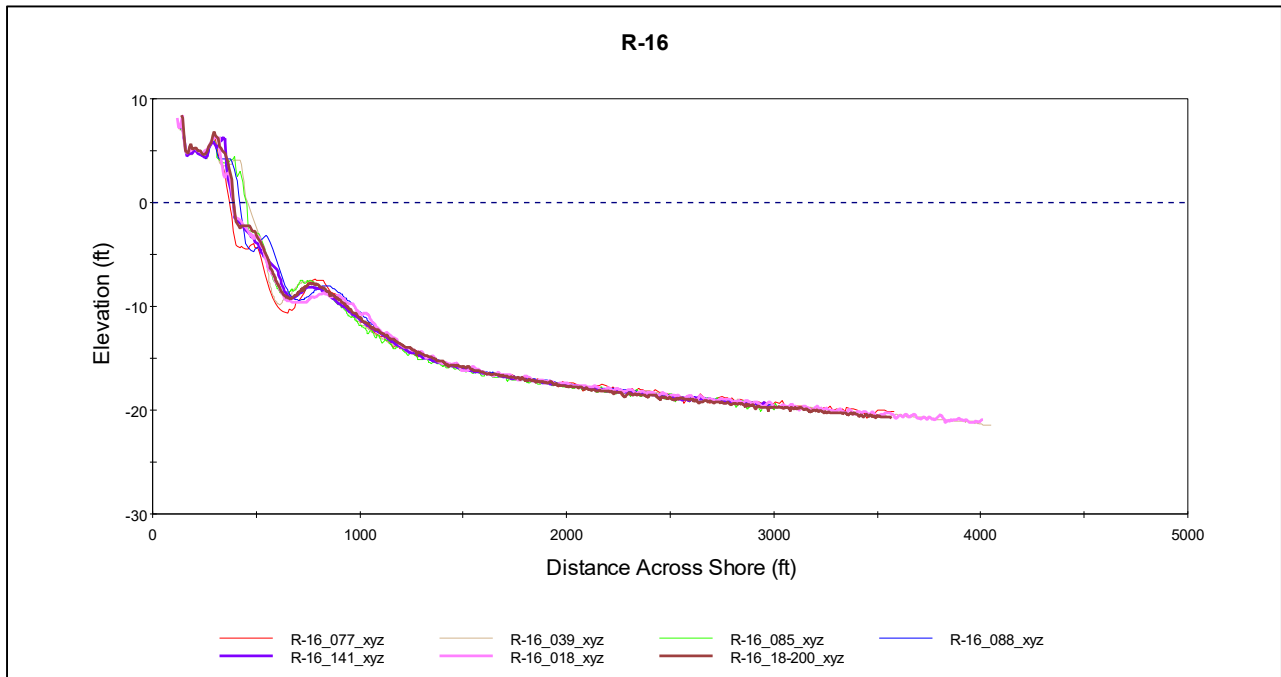
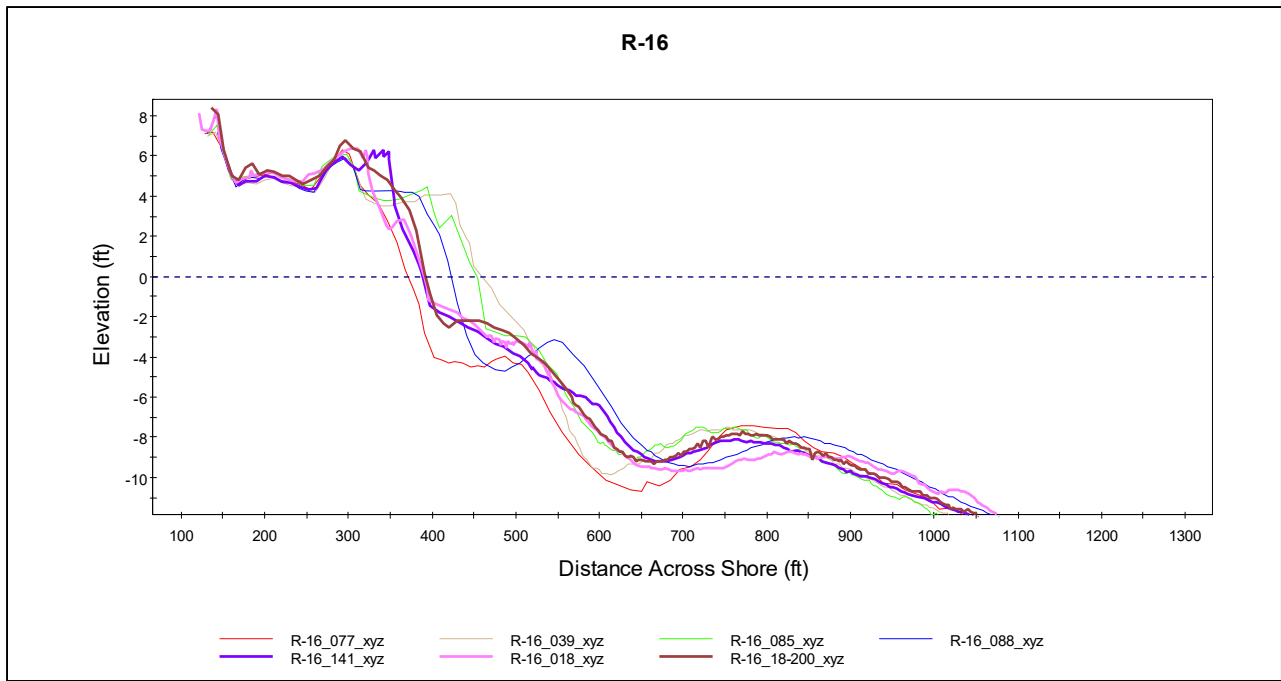


Figure 32: Survey Profiles at R-16
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

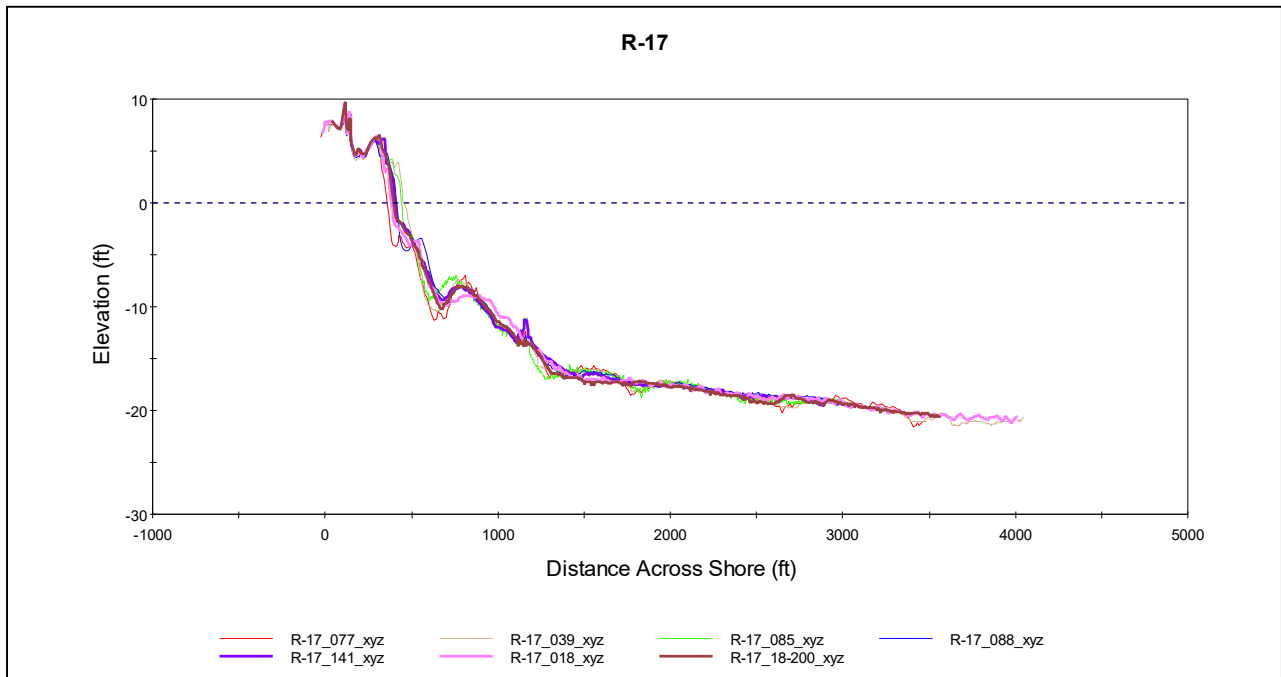
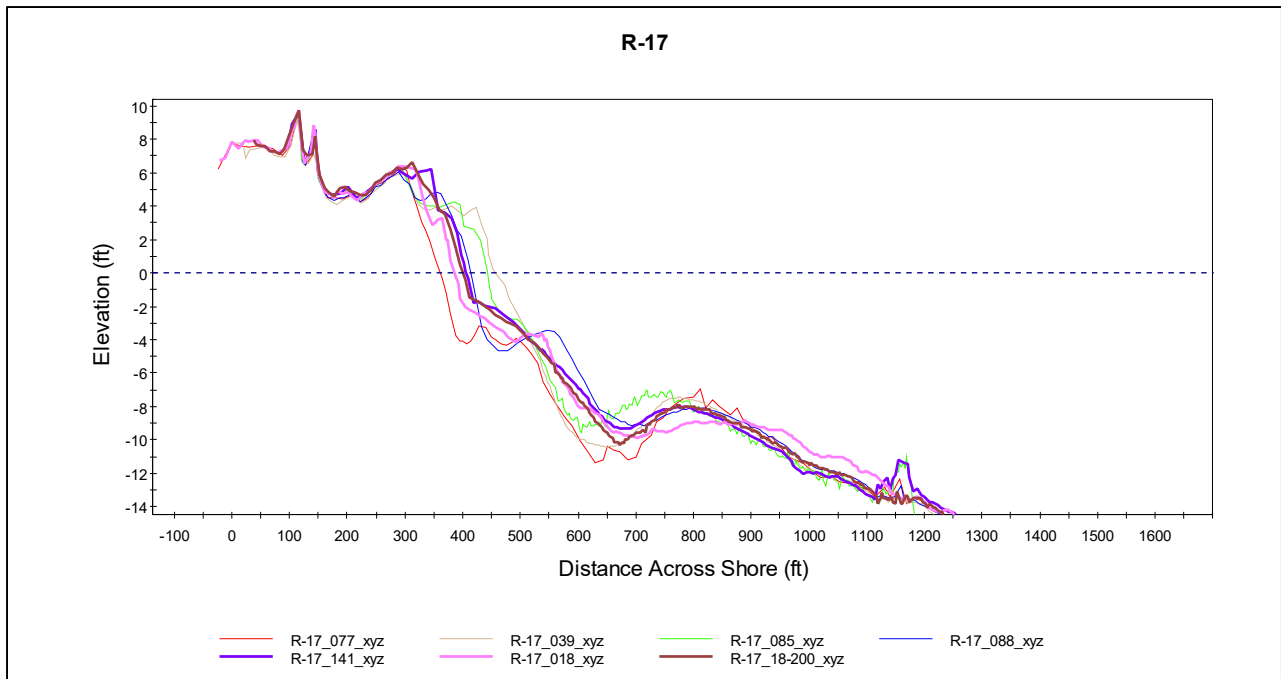


Figure 33: Survey Profiles at R-17
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

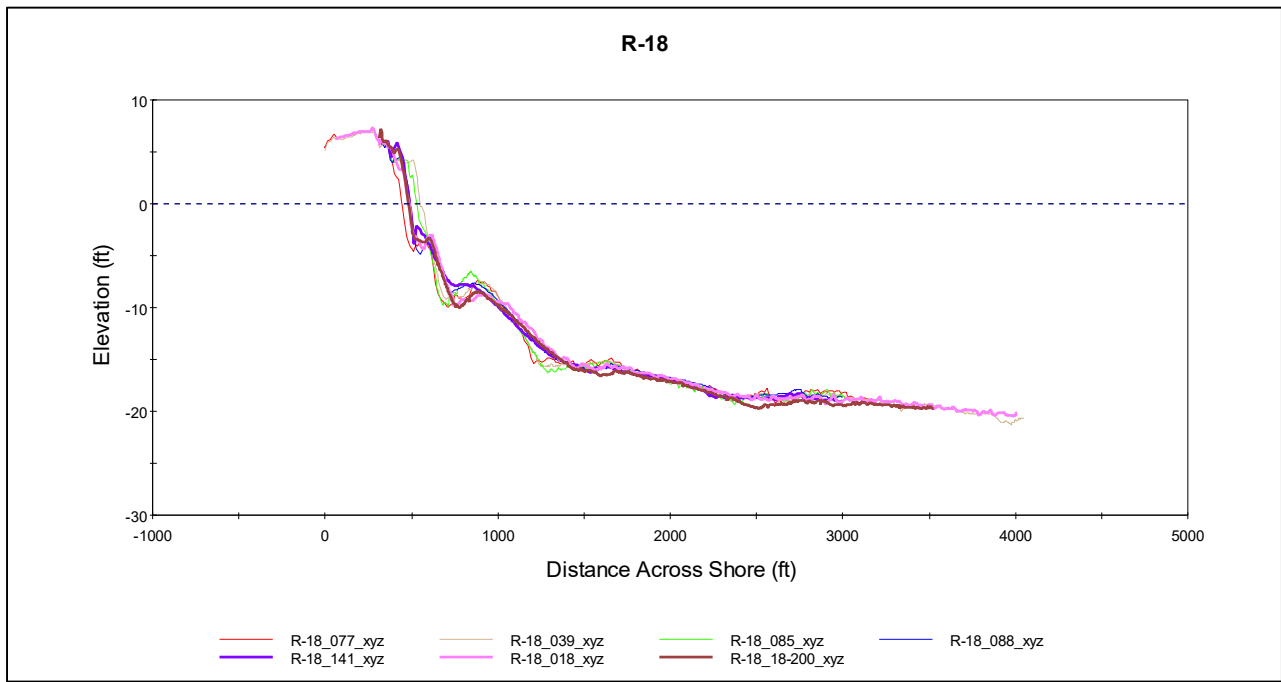
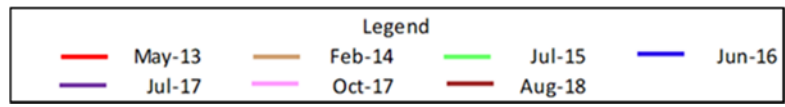
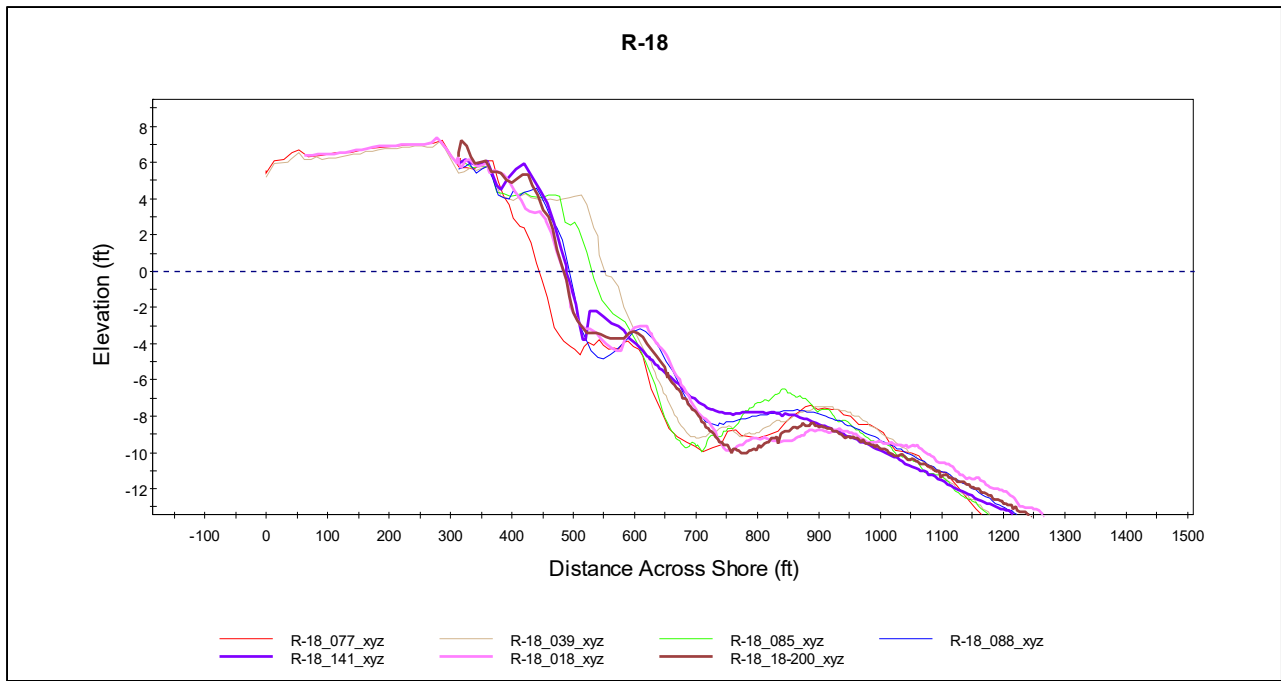


Figure 34: Survey Profiles at R-18
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

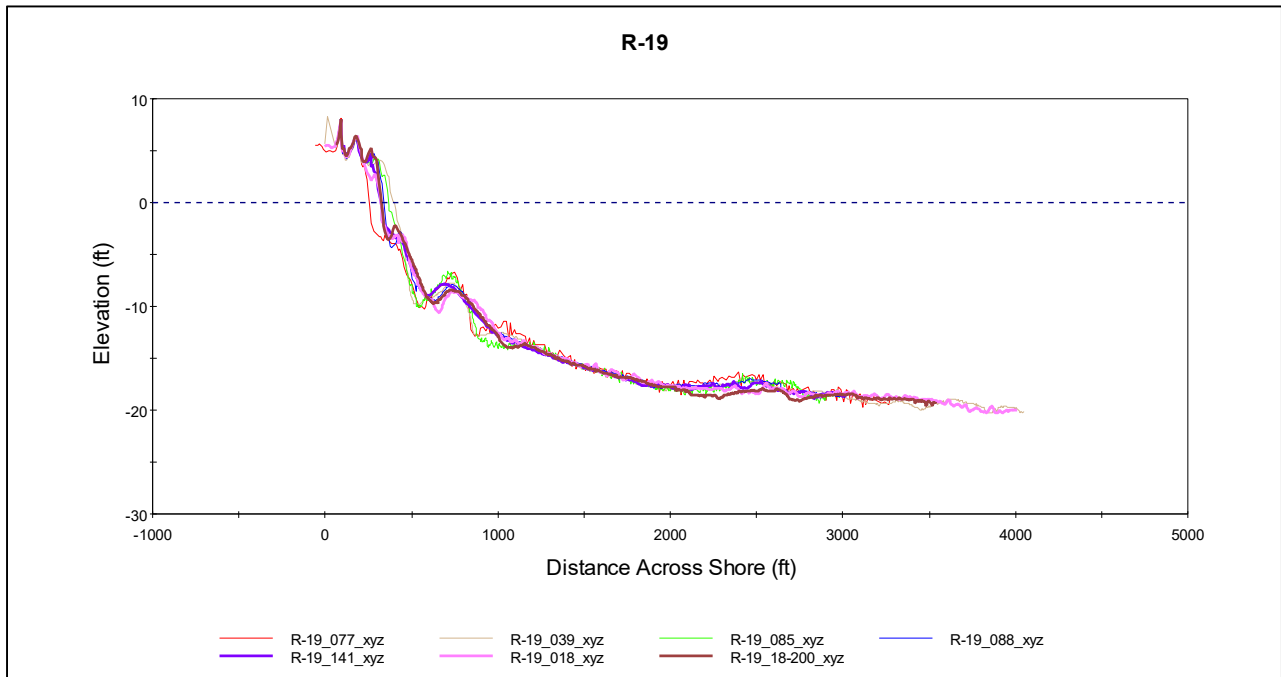
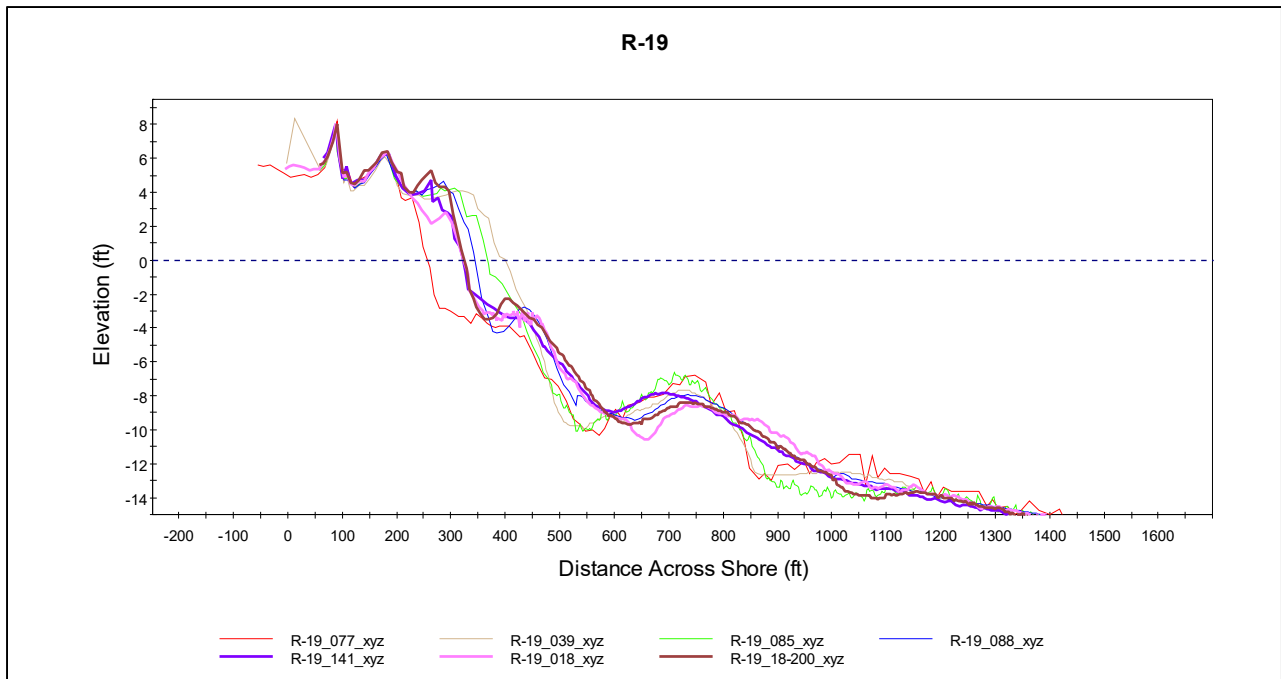


Figure 35: Survey Profiles at R-19
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

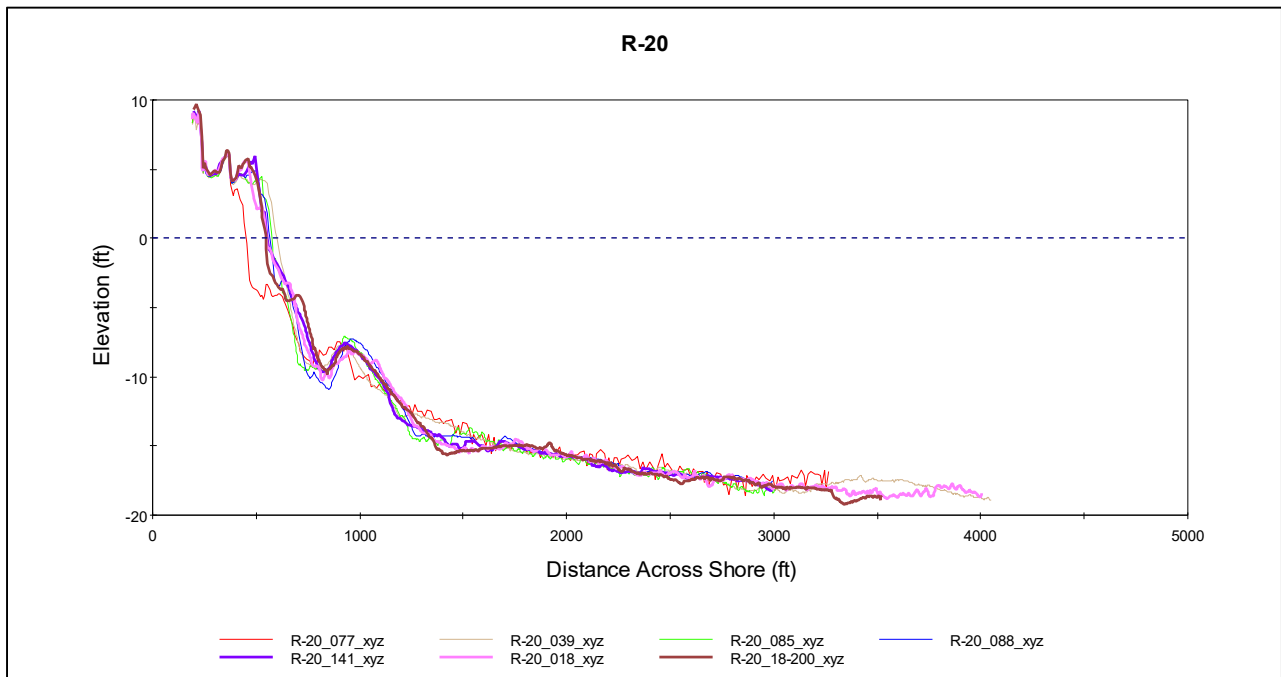
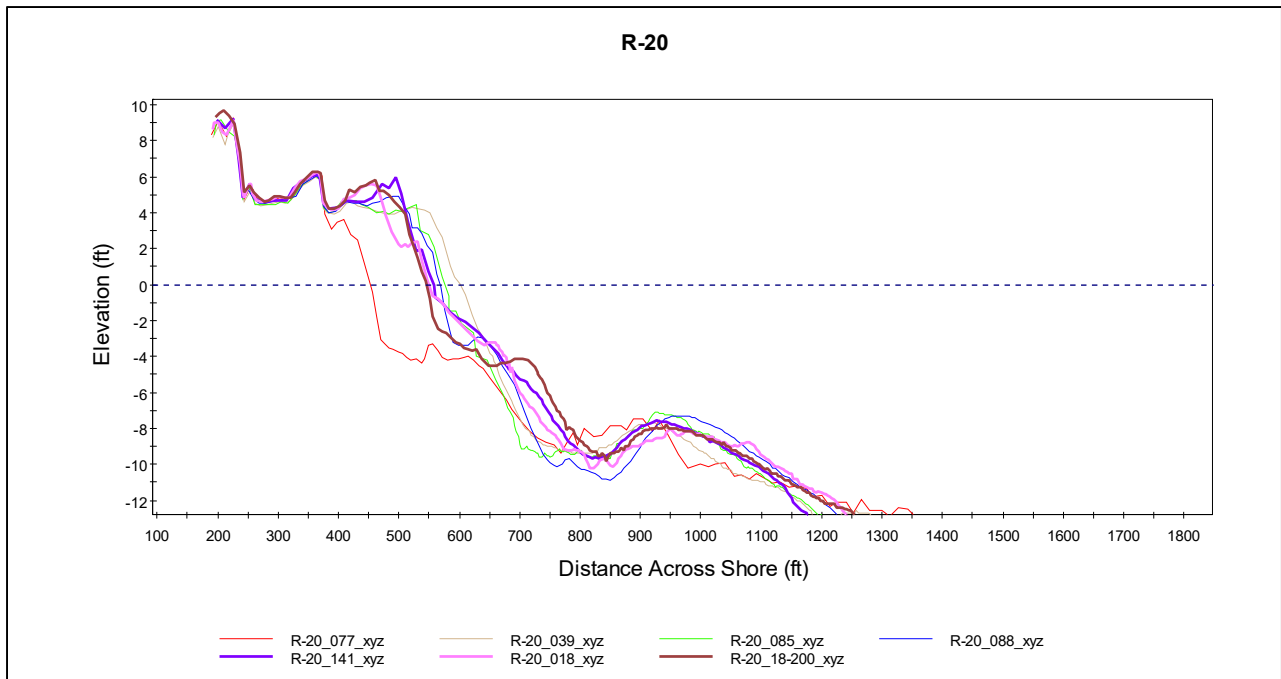


Figure 36: Survey Profiles at R-20
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

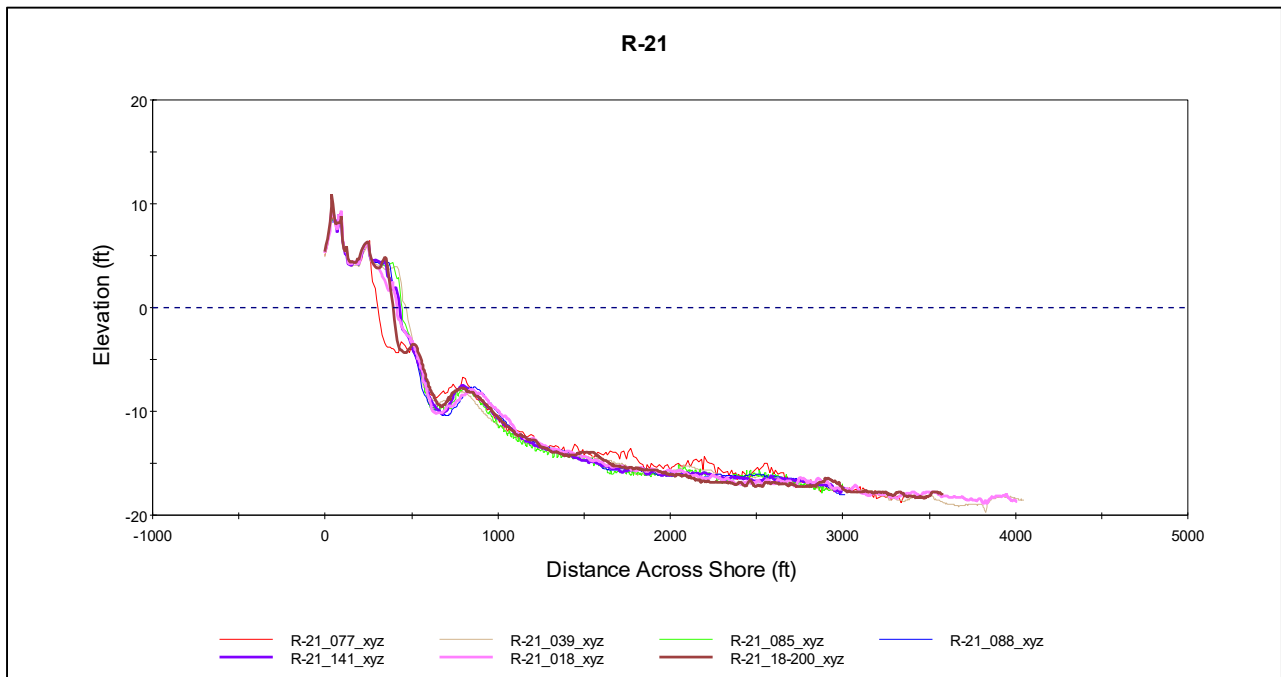
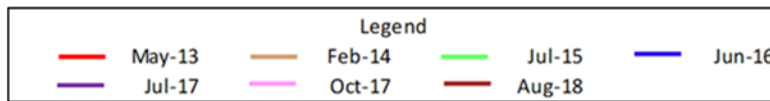
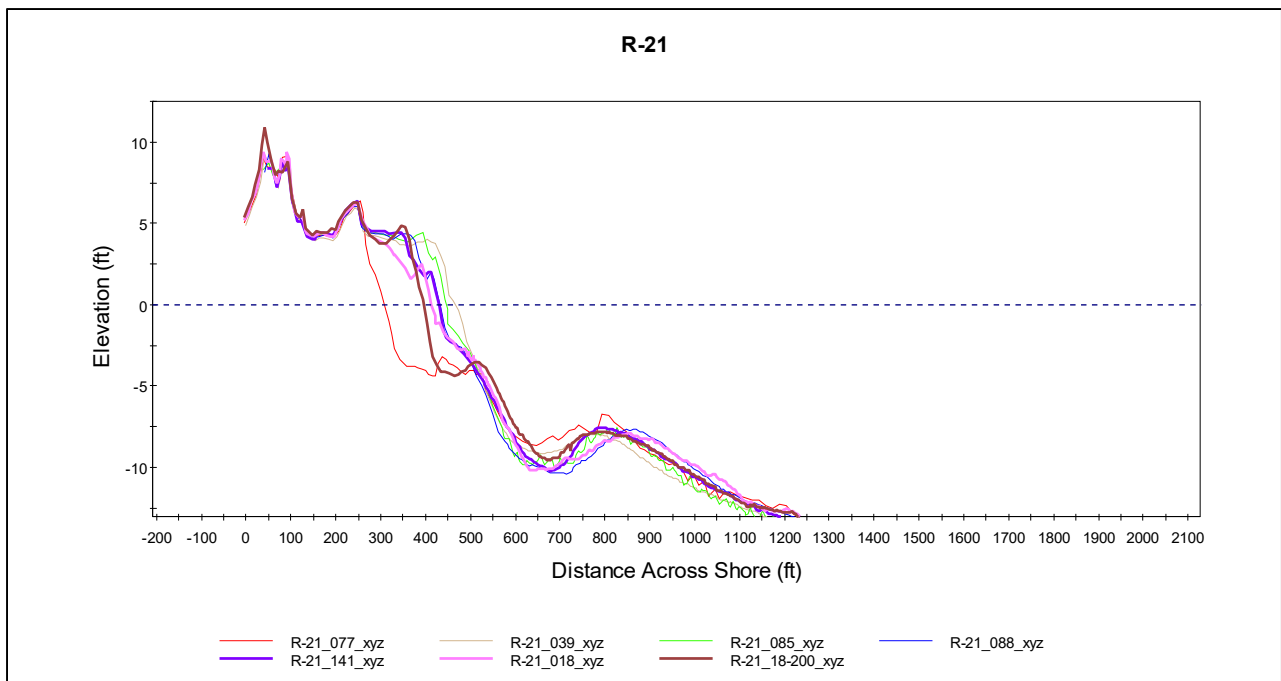


Figure 37: Survey Profiles at R-21
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

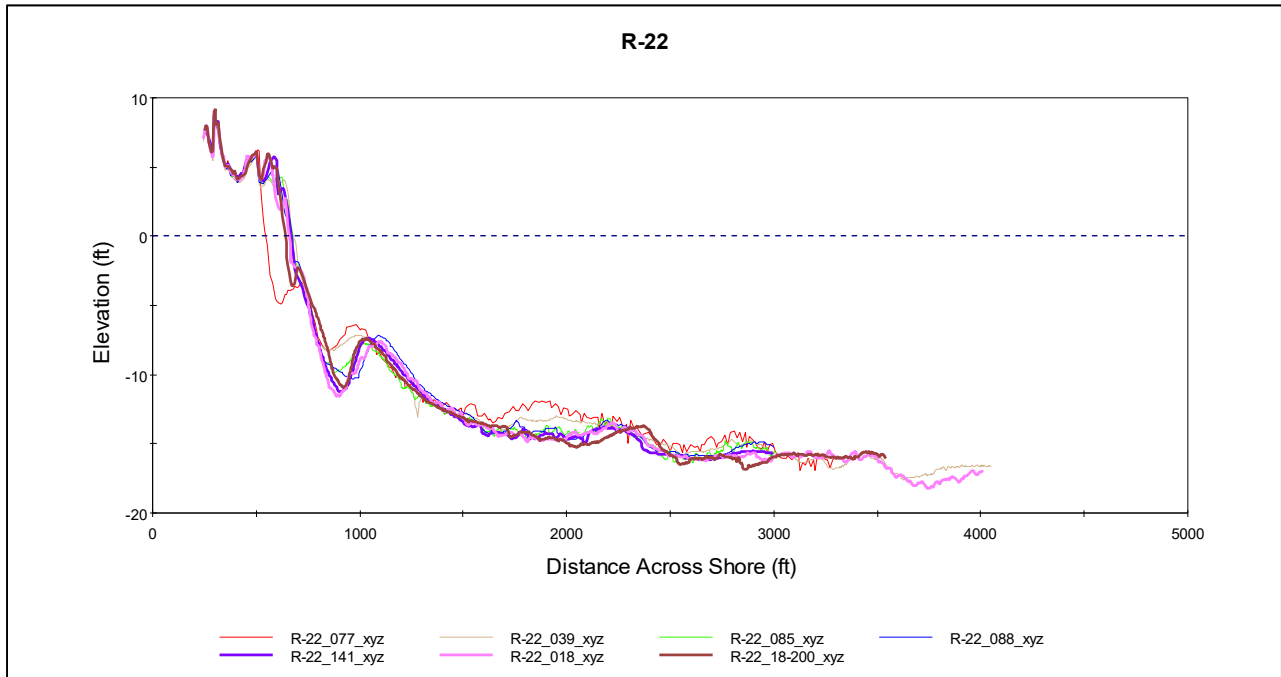
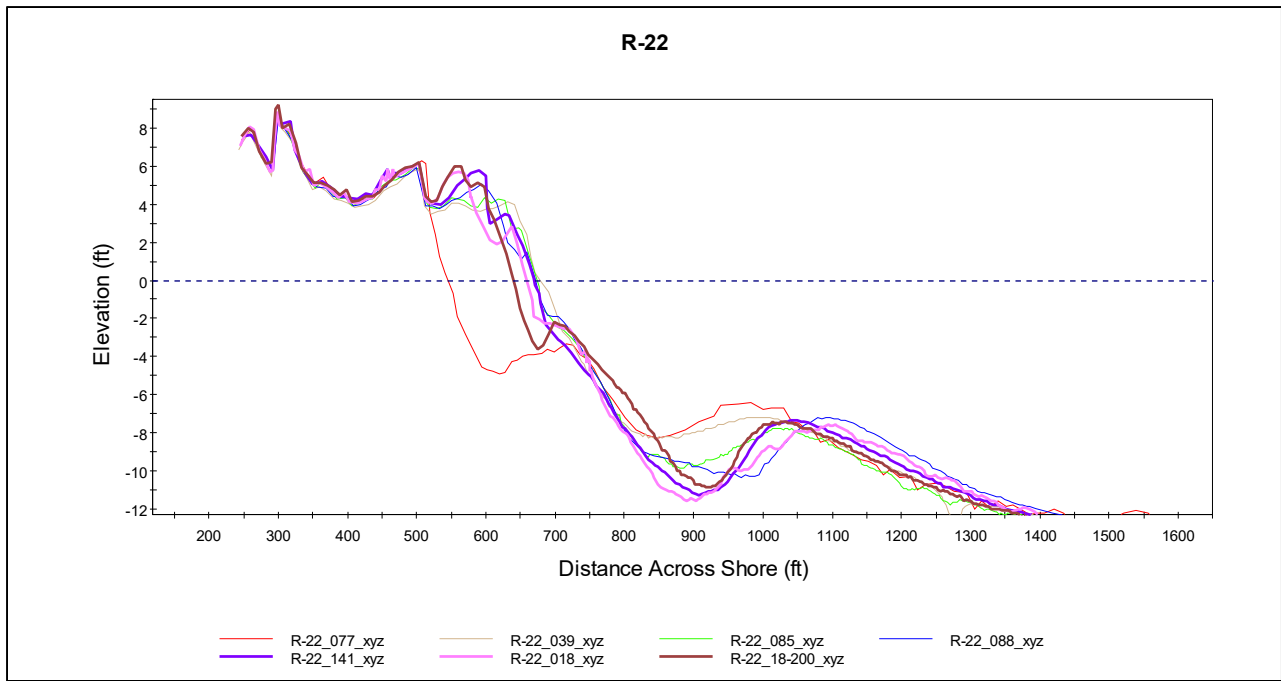


Figure 38: Survey Profiles at R-22
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

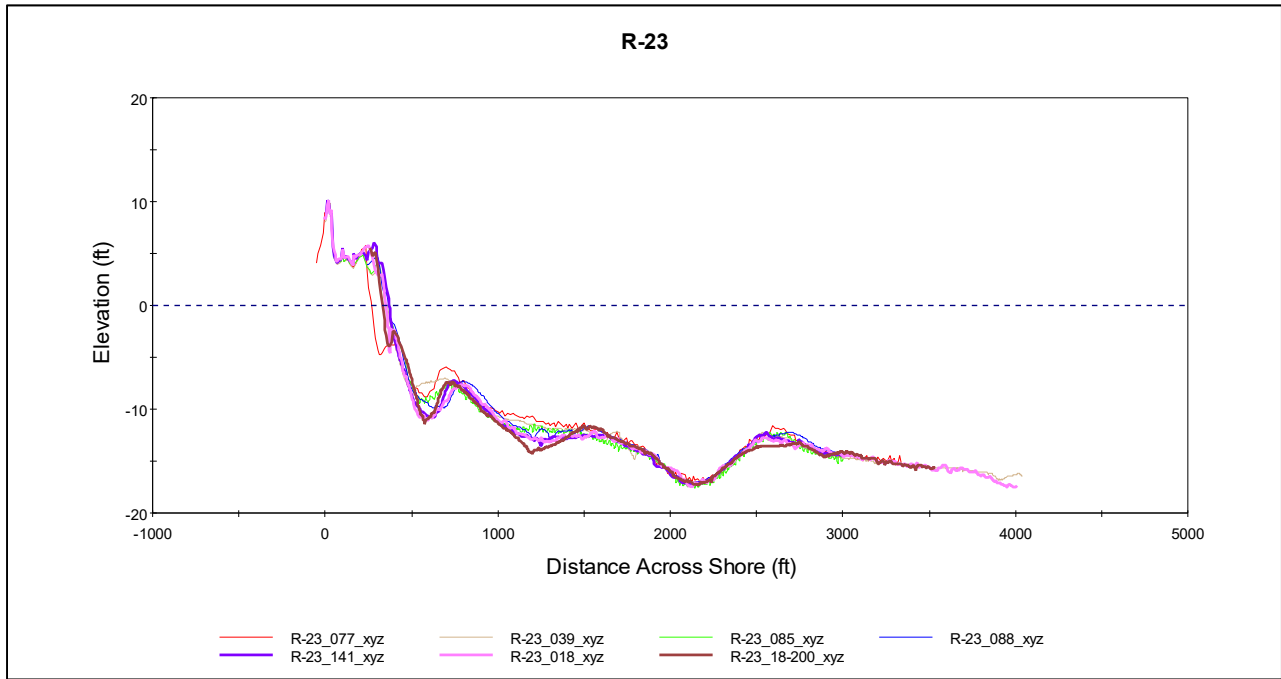
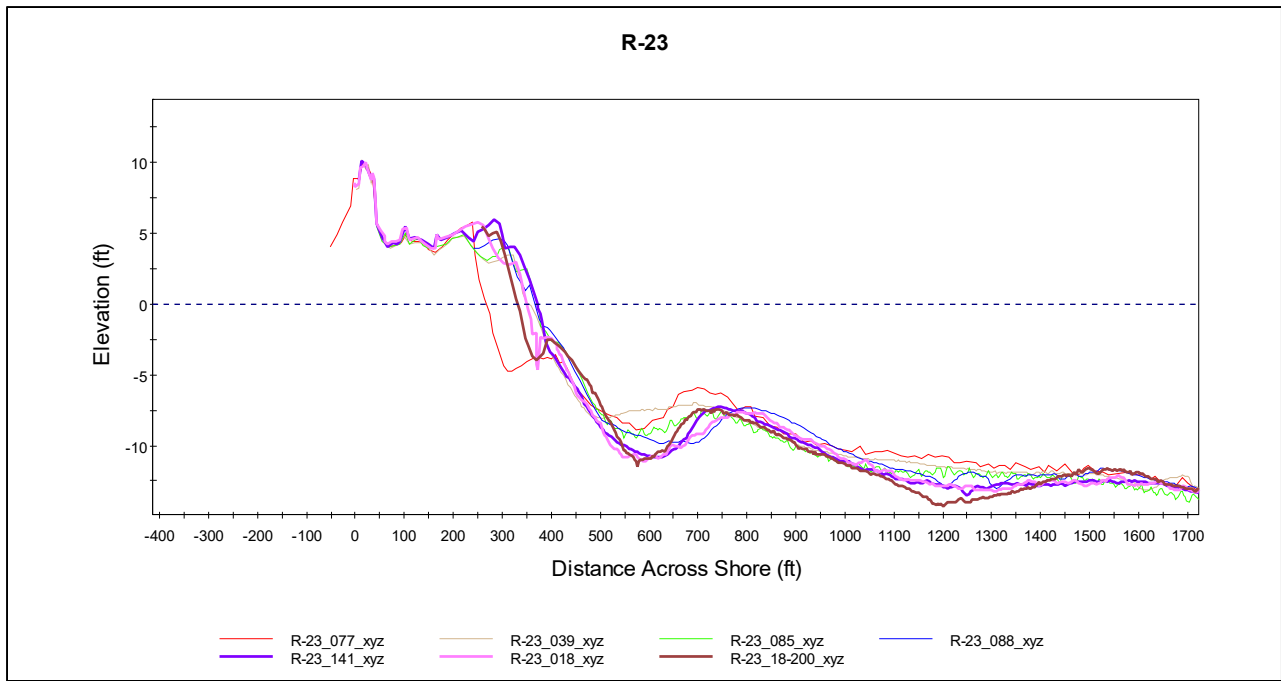


Figure 39: Survey Profiles at R-23
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

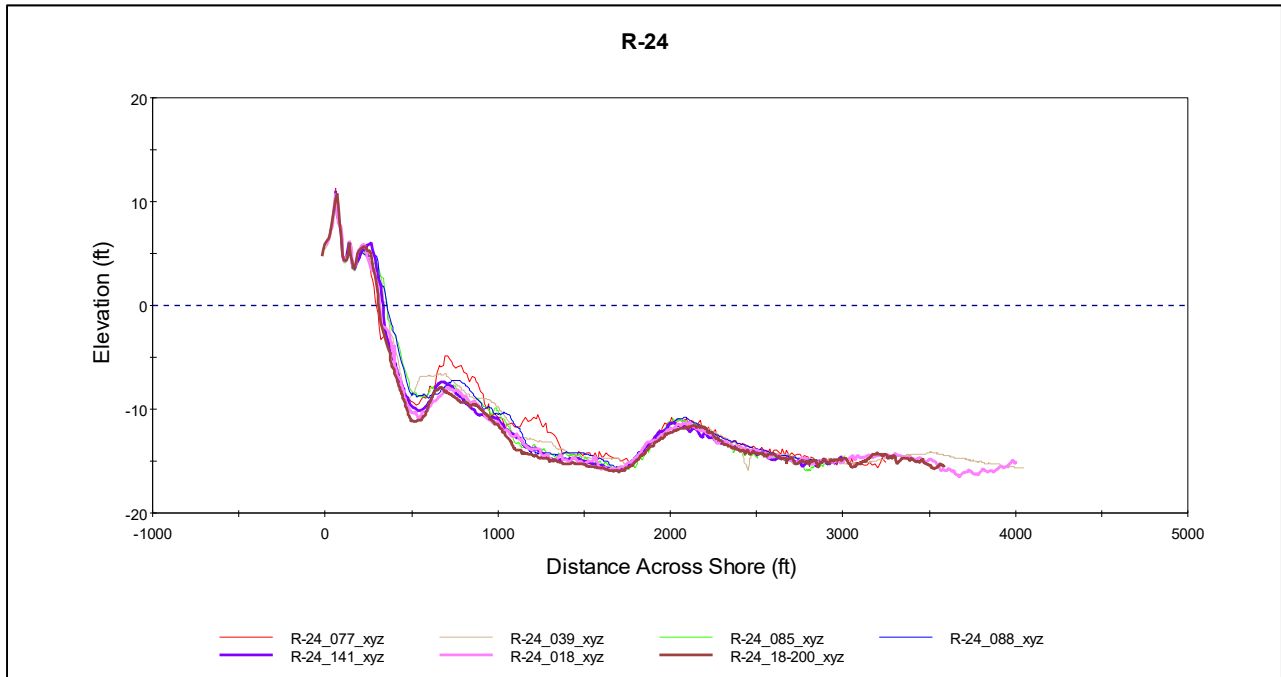
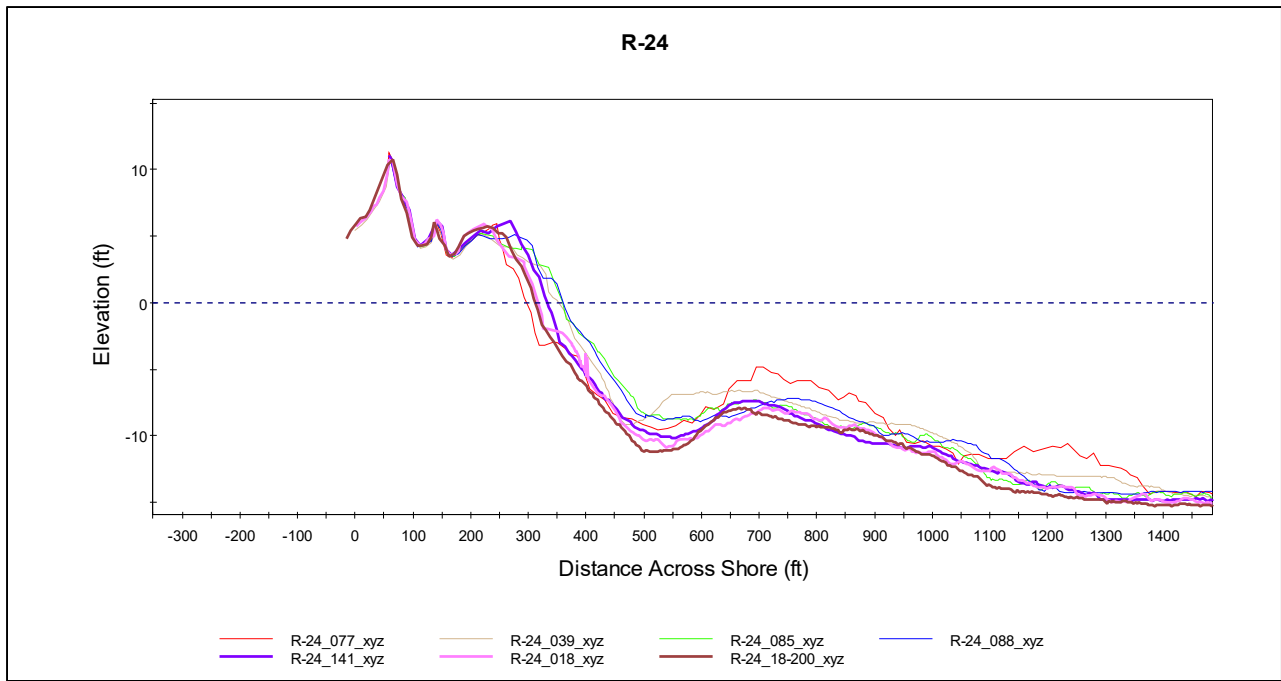


Figure 40: Survey Profiles at R-24
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

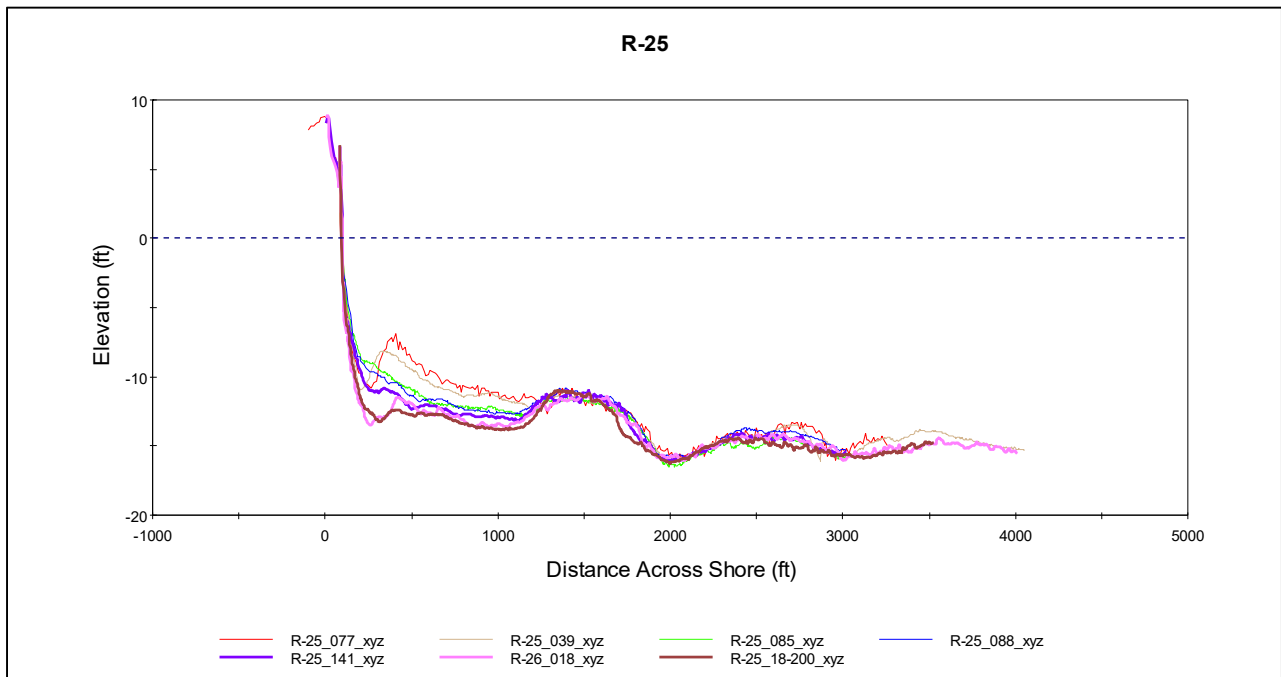
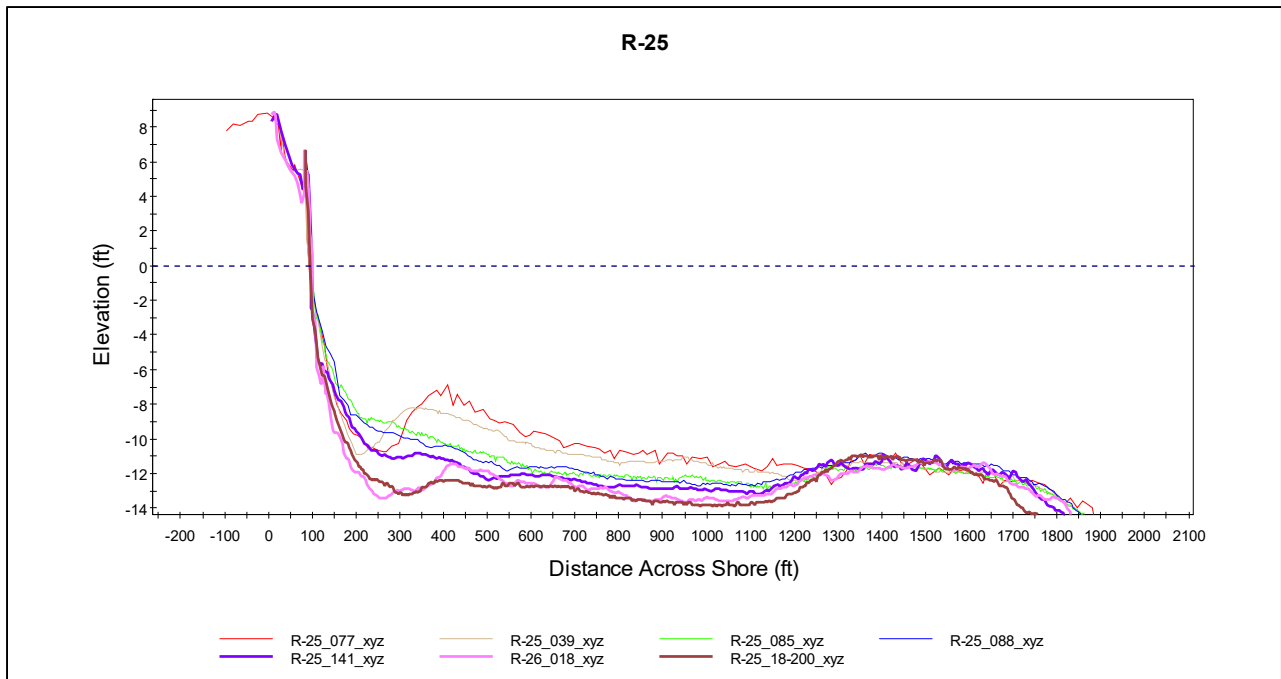


Figure 41: Survey Profiles at R-25
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

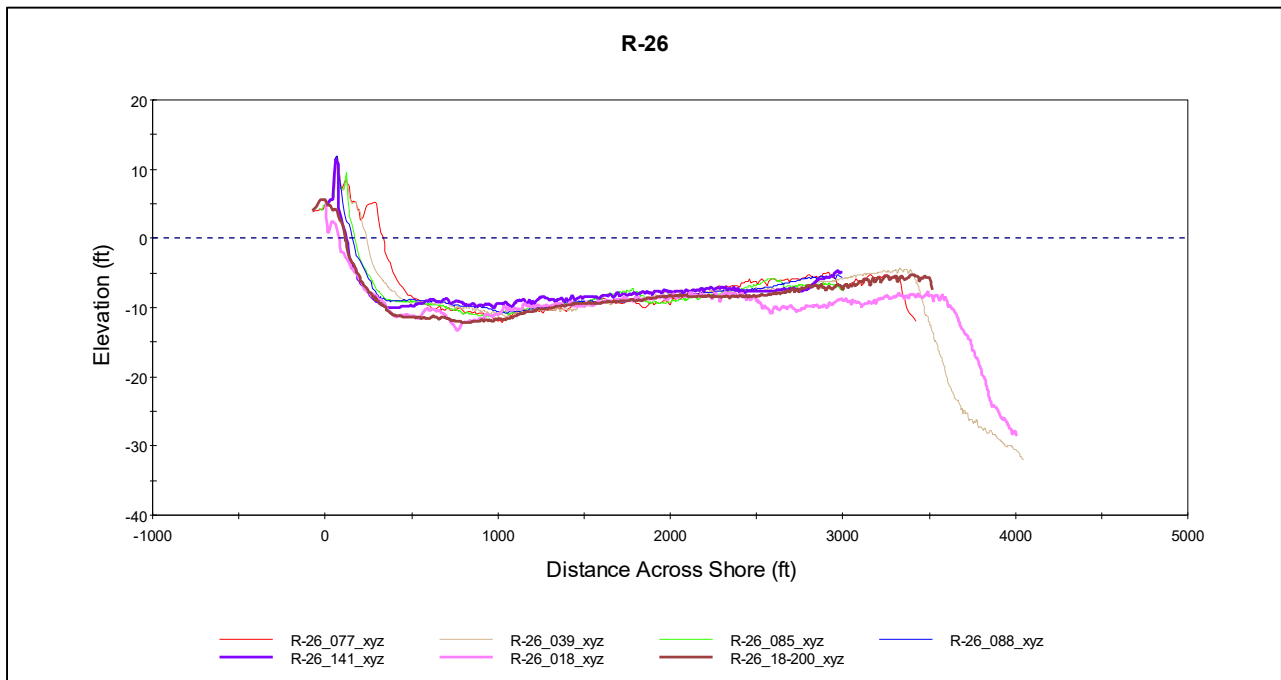
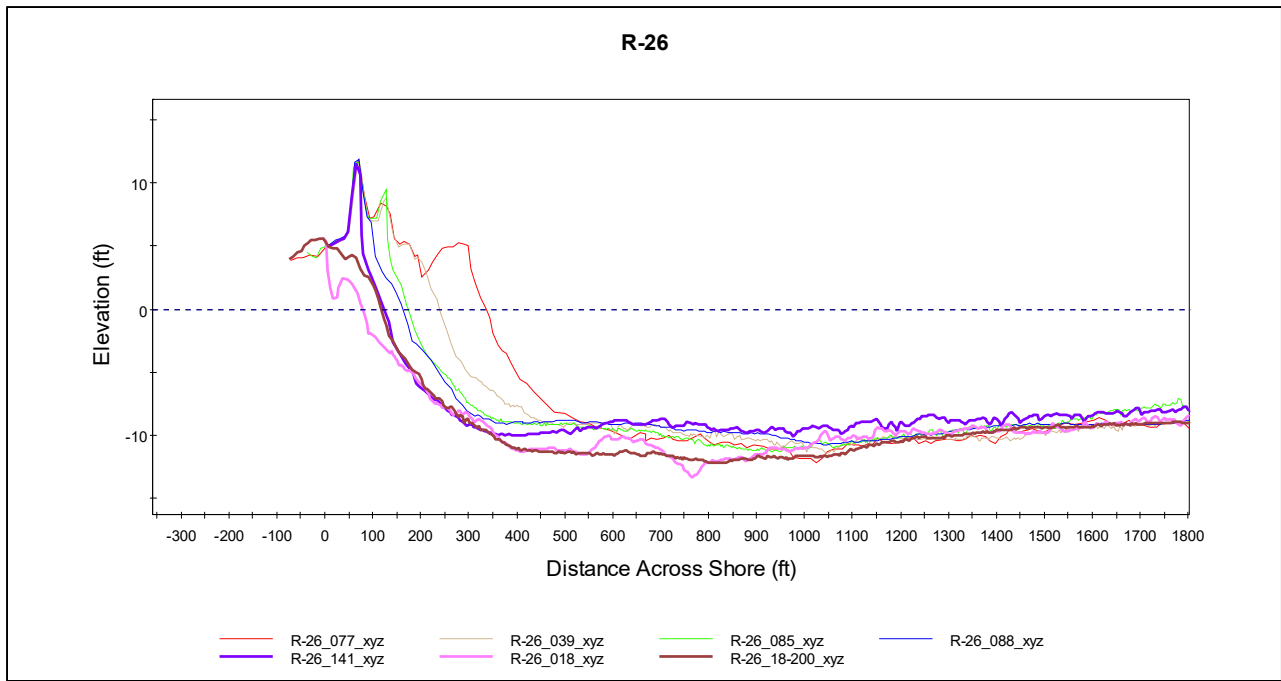


Figure 42: Survey Profiles at R-26
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument

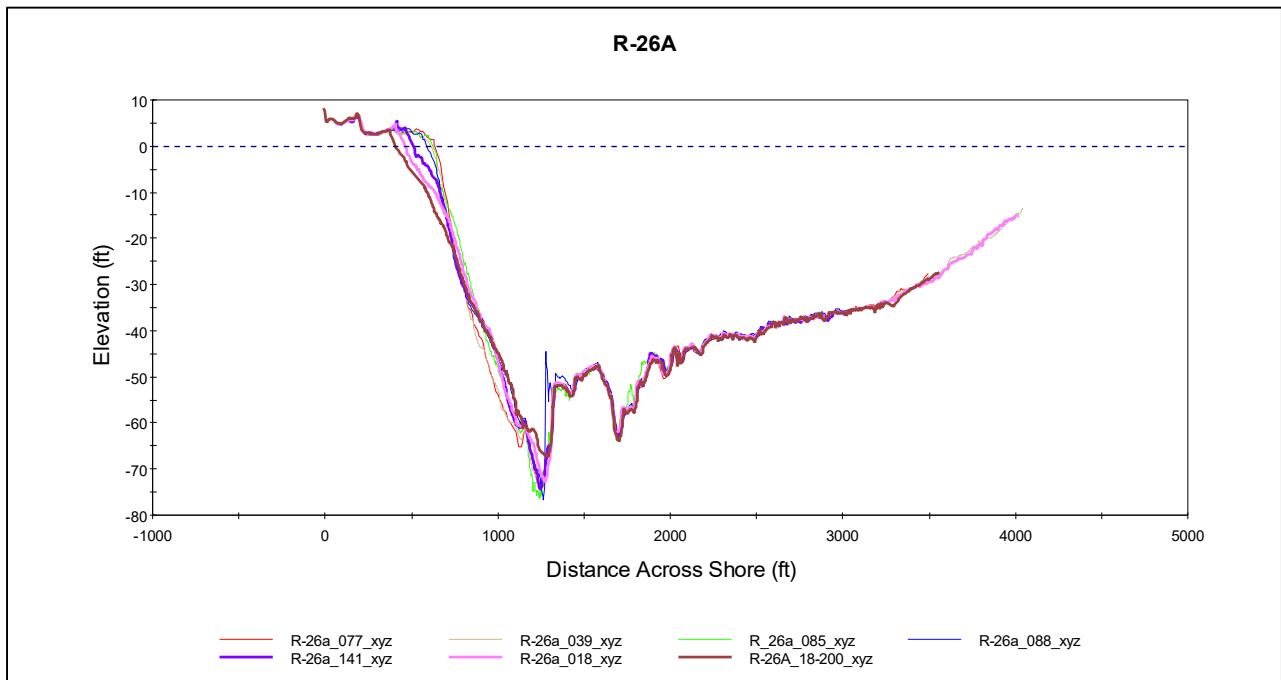
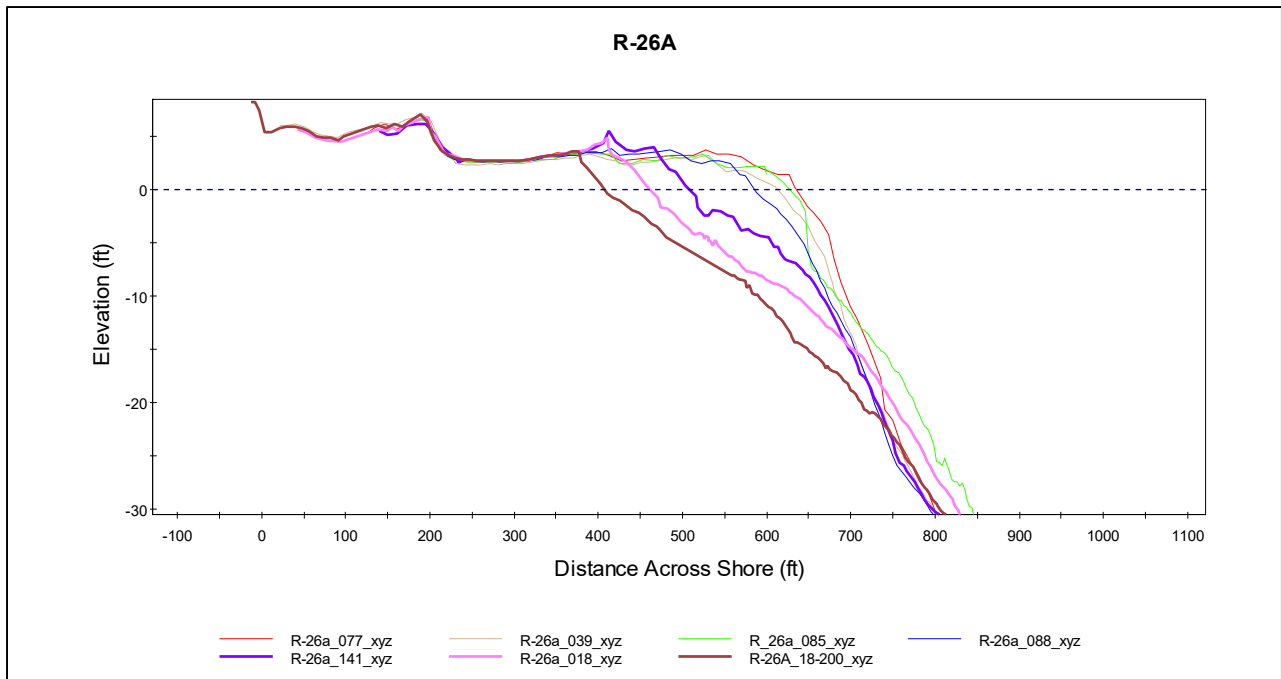


Figure 43: Survey Profiles at R-26A
 Elevation is in ft NAVD88, Distance is from the FDEP R-Monument