St. Joseph Peninsula Beach Nourishment Project
Gulf County, Florida

County Beach Nourishment and Environmental Enhancement
T.H. Stone Memorial St. Joseph Peninsula State Park
National Fish and Wildlife Foundation (NFWF)

Post-Construction Monitoring Report 2023

This information is provided in partial fulfillment of the monitoring requirements in
JCP Permit No. 0342057-001-JC, Gulf County, Florida for the
St. Joseph Peninsula Beach Nourishment and Environmental Enhancement Project and the
T.H. Stone Memorial St. Joseph Peninsula State Park Project

PREPARED FOR:

GULF COUNTY FLORIDA STATE PARKS ...the Real Florida℠ — Florida Department of Environmental Protection

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MRD Associates, Inc. (MRD) was authorized by the Gulf County Board of County Commissioners (BCC) in Contract No. RFP-1920-36, Task Order No. 009, dated May 1, 2023 and the Florida Park Service, FDEP Contract No. CN333, Task Assignment No. 3, dated August 14, 2020 to conduct physical monitoring of the St. Joseph Peninsula (SJP) Beach Nourishment and Environmental Enhancement Project (2019 Project) and the National Fish and Wildlife Foundation (NFWF) Emergency Coastal Resilience Project (NFWF Project). The following summarizes the findings of the post-construction monitoring for the period between 2019 and 2023:

1. Two beach segments on SJP were nourished between September and November 2019. A total of 721,759 yds^3 was placed within the Southern County Beach Segment (R-89.6 and R-105.5) and 154,693 yds^3 was placed within the Michael's Cut State Park Beach Segment (R-70.5 and R-73).
2. The NFWF Project was constructed between February and December 2021 which placed a total of 78,930 yds^3 within the Southern County Beach Segment (R-89.6 and R-105.5).
3. A total of 1.9M yds^3 eroded within the Southern County Beach Segment between 2009 and 2019. Due to the impacts of Hurricane Michael prior to the construction of the 2019 Project and limited available funding, only 42% of the eroded volume was replaced as part of the 2019 Project.
4. The greatest erosional losses following the 2019 Project occurred on the southern end of SJP (Stumphole Section) with a maximum volume change rate of -52.3 $yds^3/lf/yr$ at R-103.
5. The shoreline and volume changes were compared to the mean grain size (d_{50}) trends. The mean grain size of the material placed as part of the 2008 Project showed a decreasing (fining) trend from north to south. The material placed as part of the 2019 Project showed a more uniform distribution of the d_{50} over the project limits. Despite the differences in d_{50}, the shoreline and volume changes following both projects showed similar trends.
6. Since the construction of the 2019 Project, a total of -1,373,500 yds^3 (190% of volume placed during 2019 Project) has eroded within the Southern County Beach Segment.
7. The Michael's Cut State Park Beach Segment has lost -63,700 yds^3 since the project was constructed. The losses along the Michael's Cut State Park Beach Segment were largely due to erosion at R-70 and R-73.
8. Three (3) persistent "hotspots" continue along SJP, located at the Southern Sunset Condominiums (R-102.1), Aruba Dr (R-96.9), and Cape Palms (R-90.7).
9. Future nourishment efforts will likely include the construction of multiple coastal structures within the Stumphole Section of shoreline (R-100 to R-105.5). Coastal structures will decrease the erosion rate, retain placed sand, and anchor future beach fill to increase the longevity of the project tentatively scheduled for construction in November of 2024.
10. The next monitoring investigation will be performed in the summer of 2025 per DEP permit requirements..

1.0 Introduction

MRD Associates, Inc. (MRD) was authorized by Gulf County Board of County Commissioners (BCC) in Contract No. RFP-1920-36, Task Order No. 009, dated May 1, 2023, and the Florida Park Service, FDEP Contract No. CN333, Task Assignment No. 3, dated August 14, 2020, to conduct physical monitoring of the following projects:

1) 2019 St. Joseph Peninsula (SJP) Beach Nourishment and Environmental Enhancement Project (2019 Project)
    a. Southern County Beach Segment – Florida Department of Environmental Protection (DEP) Monuments R-89.6 to R-105.5
    b. Michael's Cut State Park Beach Segment – DEP Monuments R-70.5 to R-73
2) National Fish and Wildlife Foundation (NFWF) Emergency Coastal Resilience Project (NFWF Project) – DEP Monuments R-89.6 to R-105.5.

This report describes the post-construction monitoring results for the period between 2019 and 2023 as well as historical monitoring results.

1.1 Permit Requirements

Pursuant to Specific Condition 40 of the Florida Department of Environmental Protection (DEP) Permit 0342057-001-JC, Gulf County dated December 21, 2016, and Chapter 62B-41.005(16), F.A.C., physical monitoring of the 2019 Project and the NFWF Project will be conducted through the acquisition of project-specific data to include topographic and bathymetric surveys of the beach and offshore area, and an engineering analysis of such data compared to historic data. The survey data was collected at approximately 500-foot spacing along the beach between DEP Monuments R-65 through R-78 and R-85 through R-110. The R-monuments referenced in this report are spaced at approximately 1,000 feet apart and ½ virtual monuments are spaced at 500-foot spacing. These surveys extend roughly 5,000 feet north and south of the limits of each beach fill segment to document any potential impacts to the adjacent beach.

1.2 Nourishment History

2008/2009 St. Joseph Peninsula Erosion Control Project

As part of the 2008/2009 SJP Erosion Control Project (2008 Project), approximately 7.5 miles of shoreline were nourished with approximately 3.6 million cubic yards (yds^3) of sand between March 2008 and January 2009. The first restoration project on SJP consisted of two (2) reaches between DEP Monuments R-67 and R-74.8 (State Park Beach Segment) and DEP Monuments R-74.8 and R-105.5 (County Beach Segment). The sand was placed by Manson Construction Company using the hydraulic hopper dredge Bayport. The sand for the project was obtained from two (2) borrow sources which included Borrow Area "A" and Borrow Area "C".

2019 St Joseph Peninsula Beach Nourishment and Environmental Enhancement Project

The re-nourishment of SJP was originally scheduled to begin on October 8, 2018 and consisted of only the southern portion of the County Beach Segment between DEP Monuments R-89.6 and R-105.5. Hurricane Michael made landfall on October 10, 2018 and caused the re-nourishment project to be delayed and caused the Michael's Cut breach near Eagle Harbor (***Figure 1***). As a result of Hurricane Michael, the 2019 SJP Beach Nourishment and Environmental Enhancement Project (2019 Project) included the planned Southern County Beach Segment between R-89.6 and R-105.5 and added the Michael's Cut State Park Beach Segment between R-70.5 and R-73. The Michael's Cut State Park Beach Segment was added to the 2019 Project to reestablish park access to the north and restore the shoreline at the Michael's Cut breach near Eagle Harbor.

Southern County Beach Segment

The 2019 Project within the Southern County Beach Segment consisted of placing 721,759 (705,882 of pay) yds^3 of sand between DEP Monuments R-89.6 and R-105.5. The Southern County Beach Segment was constructed between September 2019 and November 2019. The sand was placed by Manson Construction Company using the hydraulic hopper dredge, Glenn Edwards using sand obtained from Borrow Area "F". The beach and dune construction template consisted of a beach berm ranging between 45- and 220-feet in width with a landward elevation of +5.5 feet, NAVD88 sloping seaward at 150 horizontal to 1 vertical (150H:1V). The constructed dune consisted of a 20-foot dune crest at an elevation of +12 feet, NAVD88 with side slopes of 3H:1V.

Michael's Cut State Park Beach Segment

Once the Southern County Beach Segment was completed in November 2019, Manson Construction mobilized 6.2-miles to the north to construct the Michael's Cut State Park Beach Segment with sand obtained from Borrow Area "F". The purpose of this project was to fill in the Michael's Cut breach near Eagle Harbor and restore park access to the north. This project placed 154,693 (145,000 of pay) yds^3 of sand along the 0.7-mile Michael's Cut State Park Beach Segment located between DEP Monuments R-70.5 and R-73. The construction template consisted of a 75-foot-wide beach berm with a landward elevation of +5.5 feet, NAVD88 sloping seaward to +4.5 feet, NAVD88. The constructed dune consisted of a 20-foot dune crest at an elevation of +12 feet, NAVD88 with side slopes of 3H:1V.

2021 NFWF Emergency Coastal Resiliency (Dune Enhancement) Project

The National Fish and Wildlife Foundation (NFWF) Emergency Coastal Resiliency (Dune Enhancement) Project, referred to in this report as the NFWF Project, was constructed between February 2021 and December 2021 within the 3.1-mile Southern County Beach Segment between DEP Monuments R-89.6 and R-105.5. North Florida Construction (NFC)

placed 78,930 yds^3 of sand as part of the dune enhancement project with sand from the Honeyville Borrow Pit, an upland sand source in Wewahitchka, Florida via a truck-haul project. In general, the typical construction template consisted of a dune crest at +12-feet, NAVD88 with a dune crest varying between 10- and 25-feet. The side slopes vary between 3H:1V and 8H:1V depending on the available dry beach width at the time of construction.

Between 2019 and 2022, a total of 955,382 yds^3 was placed within the Southern County Beach Segment and Michael's Cut State Park Beach Segment with material obtained from Borrow Area "F" and the Honeyville Borrow Pit (***Figure 1***). Of the total 955,382 yds^3 placed, approximately 800,680 yds^3 was placed within the 3.1-mile Southern County Beach Segment and 154,693 yds^3 was placed within the Michael's Cut State Park Beach Segment. A "Sediment Quality Control and Quality Assurance Plan" was implemented through-out the three projects. ***Table 1*** summarizes the sand placed during this monitoring period (2019 to 2023).

Table 1. *Project Description Summary – 2019 to 2023*

Description	2019 Project		NFWF Emergency Coastal Resilience Project	Total
	Southern County Beach Segment	Michael's Cut State Park Beach Segment		
Project Length	3.1-miles (R-89.6 to R-105.5)	0.7-miles (R-70.5 to R-73)	3.1-miles (R-89.6 to R-105.5)	3.8-miles
Sand Volume Placed	721,759 yds^3	154,693 yds^3	78,930 yds^3	955,382 yds^3
Total Construction Cost	$10.2 million	$2.0 million	$4.1 million	$16.3 million

1.3 Survey History

The monitoring data is necessary for Gulf County, DEP, the Florida Park Service, and NFWF to regularly observe and assess, with quantitative measurements, the performance of the projects constructed between 2019 and 2023. Monitoring data allows all entities to assess any adverse effects which have occurred and the need for any adjustments, modifications, or mitigation response to the projects. This also provides information necessary to plan, design, and optimize subsequent follow-up projects, and potentially reduce the need for and costs of unnecessary work. The following survey data sets acquired during this monitoring period are found in ***Table 2***.

The immediate post-construction survey data within the Southern County Beach Segment (Dewberry 2019) and Michael's Cut State Park Beach Segment (Dewberry 2020) was used as the baseline conditions (MRD 2020b and 2021) and compared to the most recent monitoring survey data (Dewberry 2023). This report will present the shoreline and volume changes since the construction of the 2019 Project for both the Southern County Beach Segment and the Michael's

Cut State Park Beach Segment. Additionally, long-term shoreline and volume changes were assessed using the immediate post-construction survey and 5-year post-construction monitoring survey from the 2008 Project, conducted in February 2009 and August 2014, respectively.

This monitoring report, and subsequent reports, will also include a comparison of the shoreline and volume changes to the mean grain size (d_{50}) presented in Section 3.0. The purpose of showing the variation of grain size within the project limits is to determine if there is a correlation between the sand grain size placed during the construction of the beach nourishment project, and the performance of the fill placement.

Table 2. *Survey History for the St. Joseph Peninsula Nourishment Projects – 2018 to 2023.*

Year	Survey Description	Beach Segment	Survey Dates	Source
2018	Pre-Construction	County	June 14-19, 2018	Dewberry
2018	Post-Michael	County and State Park	October 24-November 4, 2018	USACE
2019	Construction (BD & AD)	County and State Park	September-November 2019	Manson
+2019	Post-Construction	County	November 18-26, 2019	Dewberry
+2020	Post-Construction	State Park	February 19-24, 2020	Dewberry
*2021	Pre-Construction (NFWF)	County	February 23, 2021	Dewberry
*2021	Post-Construction (NFWF)	County	April-November 2021	Dewberry
2022	Monitoring Survey	County and State Park	August 6-26, 2022	Dewberry
2023	Monitoring Survey	County	July 11-25 2023	Dewberry
2023	Monitoring Survey	State Park	July 26-27, 2023	Dewberry

Notes: *Surveys only extend to wading depth and were taken at 100-foot increments.

+Immediate post-construction surveys used as baseline conditions.

1.4 Storms

1.4.1 Hurricane Michael (October 2018)

Hurricane Michael made landfall on October 10, 2018, 2 days before the construction of the beach nourishment project was set to begin, delaying the project to 2019. The hurricane made landfall near Mexico Beach and Tyndall Air Force Base, Florida as a Category 5 storm. The storm produced devastating winds and storm surge near the coast and caused $25 billion in damage in the United States (NHC, 2019). The storm caused significant beach and dune erosion along SJP and caused the Michael's Cut breach at Eagle Harbor (***Figure 1***).

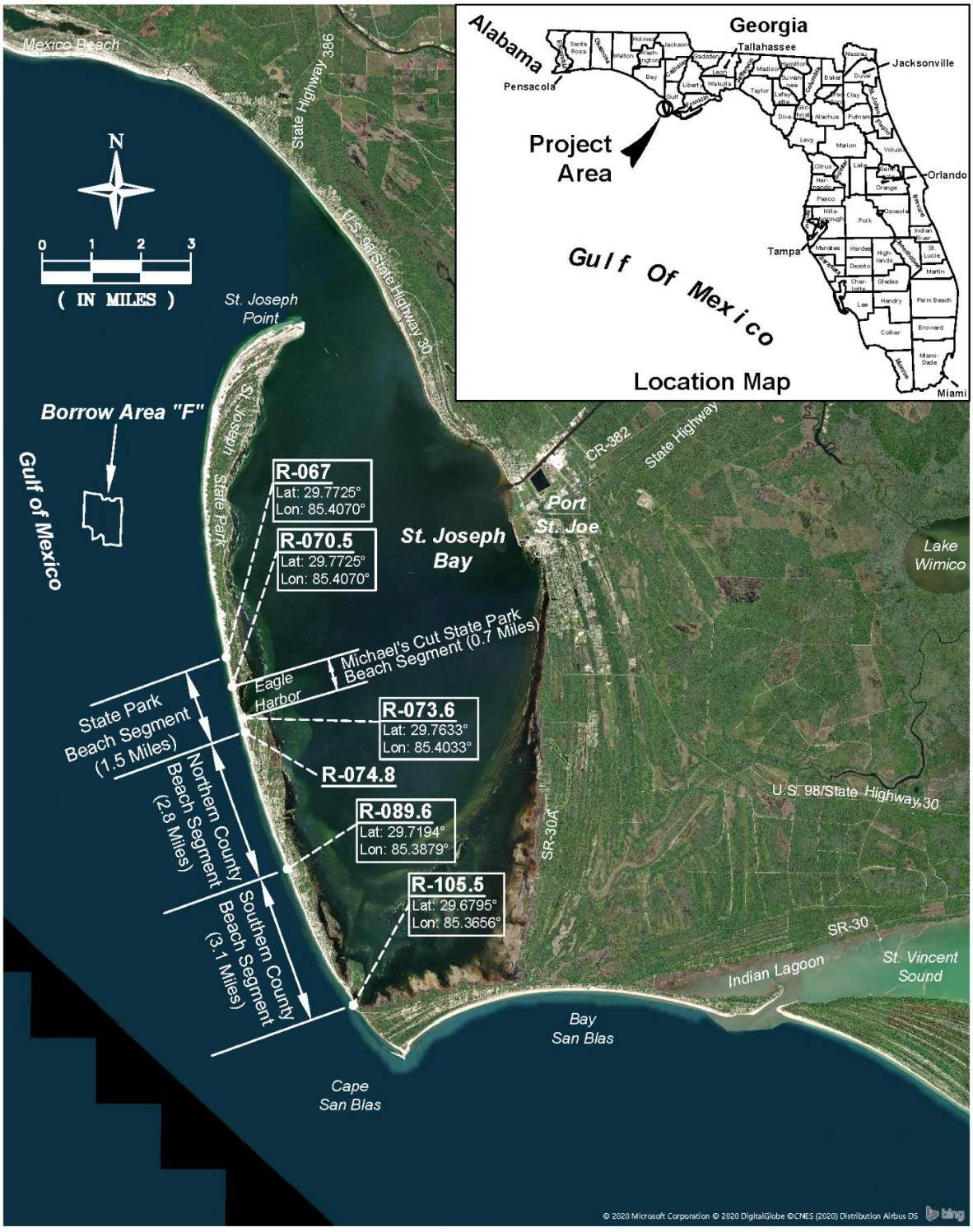

Figure 1. *Project Location Map.*

1.4.2 Hurricane Sally (September 2020)

Hurricane Sally made landfall on September 15, 2020, in Gulf Shores, Alabama with maximum sustained winds of 110 miles per hour (MPH) and minimum central pressure of 965 millibars. Impacts from Sally were observed throughout the Florida Panhandle, where there was significant shoreline erosion. It was estimated that approximately 163,000 yds^3 of sand was lost from the southern SJP shoreline as a result of Hurricane Sally (MRD 2021b).

1.4.3 Tropical Storms

Additionally, three (3) named tropical storms made landfall within 20 nautical miles of SJP between the construction of the 2019 SJP Beach Nourishment Projects and the 2022 monitoring survey including Fay (July 2020), Fred (August 2021), and Mindy (September 2021).

2.0 Survey Methodologies

The Post-Construction survey data was acquired by Dewberry Engineers, Inc. (2023) between July 11 and 25, 2023 for the Southern County Beach Segment and between July 26 and 27, 2023 for the State Park Beach Segment. The elevation data was collected at approximately 500-foot spacing along the beach between DEP Monuments R-65 through R-78 and R-85 through R-110. The 2018 pre-construction profiles (Dewberry, 2018) were only conducted for the Southern County Beach Segment and for every R-Monument between R-85 and R-110 (APPENDIX B). These surveys extend roughly 5,000 feet north and south (control sections) of the limits of each beach fill segment to document any potential impacts to the adjacent beach. Surveys were conducted in accordance with the DEP Monitoring Standards for Beach Erosion Control Projects, edited October 2014 and meets the technical specifications for "Beach Profile Topographic Surveying, and Offshore Profile Surveying." The following information is found in the Appendices:

APPENDIX A – Survey Plan Views
APPENDIX B – Monitoring Profiles
APPENDIX C - Published Control Monuments
APPENDIX D - Photos

Documentation of all published control monuments, as well as benchmarks found and used for survey purposes, data, and plots are presented in Dewberry (2023).

Vertical data was collected in the North American Vertical Datum of 1988 (NAVD 88). All horizontal data was collected and provided in the Florida State Plane Coordinate System, North Zone, North American Datum of 1983 (NAD 83). The attached profile data and the DEP format data are all referenced to NAD 83 and NAVD 88 (Dewberry 2018, 2019 and 2020) datums in feet. The field survey(s), and data collection and reduction comprised of four main process steps: 1) Monument Verification/Control Establishment, 2) Beach Profile Topographic Surveys, 3) Offshore Profile Surveys; and, 4) Data Processing.

2.1 Monument Verification/Control Establishment

Prior to the start of each survey, reconnaissance of the monuments to be used was conducted to verify the location and condition of the monument. In order to achieve the required accuracies, the beach profiles and wading surveys were controlled using 2nd order DEP "A" monuments as indicated in the Monument Information Report located in APPENDIX C. Real Time Kinematic GPS (RTK) was utilized throughout the survey in order to maintain the 2nd order control. Horizontal and vertical positioning checks were conducted at the beginning and end of every day for each survey.

2.2 Beach Profiles

Beach profiles were conducted utilizing RTK GPS throughout the survey utilizing the control established in Section 2.1. Profiles started up to 500 feet landward of the monument location and commenced seaward to a depth far enough offshore so that a minimum of 50 feet overlap was established between the wading and the nearshore/offshore vessel survey. Elevations were taken at least every 10 feet along the profile, and at all grade breaks. Data was collected utilizing Spectra Precision Epoch 80 GNSS RTK GPS systems. Profile lines were uploaded into Topcon's "Stake to Line" program to ensure horizontal tolerances were maintained along the survey line during the upland/beach portion of the survey. All data was collected directly in State Plane Florida North NAD 83 and NAVD 88 (APPENDIX B) datums in feet.

2.3 Nearshore/Offshore Profiles

Nearshore profiles extend offshore up to 3,500 feet from the monuments to approximately -30 feet NAVD 88. The landward limits of the nearshore vessel survey were conducted to a point that lay 50 feet landward of the seaward-most point collected during the beach profiles. The nearshore surveys were conducted as close to high tide as possible and during calm seas (less than 2 feet). Data was collected utilizing the 22' aluminum survey vessel "Nemo" using a Ross 825B dual frequency sounder with a through-hull mounted transducer.

A Spectra Precision Epoch 80 GNSS RTK GPS system was utilized for horizontal positioning which provided sub-meter accuracies. The data was fed into a laptop running HYPACK® navigation software with preloaded survey lines in order to maintain vessel navigation. Soundings were collected at 10 Hz and were correlated to horizontal positions in real-time via HYPACK®. The sounder was calibrated daily prior to the start of surveying, and at the end of each day, using an Odom Digibar Pro sound velocity probe. Measurements were taken at 1-foot intervals down to approximately -30 feet.

2.4 Data Processing

Data collected during these surveys was completed with two different software programs. The beach profiles were collected utilizing RTK GPS and a Topcon proprietary software program. Data was collected using HYPACK® for the offshore profiles. This data was then processed using the subroutine single beam editor in HYPACK® to remove any anomalies in the data and filter out

waves if they were present. The beach and offshore survey data were then reduced to ten (10) foot bins along each of the profile lines. A final XYZ file was outputted from HYPACK® containing the edited data which was then imported into AutoCAD for final processing and merging of upland data. The plan view and profiles of the processed survey data collected are presented in APPENDICES A and B, respectively.

3.0 Sediment Quality

Pre- and post-construction sediment samples were collected and analyzed for the 2008 Project and the 2019 Project in accordance with the 2007 and 2016 Sediment Quality Assurance/Quality Control (QA/QC) Plans, prepared by MRD, respectively. ***Figure 2*** shows the historic sediment mean grain size (d_{50}) data collected in 2005, 2009, 2015 and 2019 (***Table 3***). The purpose of plotting the variation of grain size within the project limits was to determine if there was a correlation between the sand grain size placed during the construction of the 2019 Project and the beach fill performance, which will be documented in subsequent monitoring reports.

The 2005 sediment data was collected on October 4, 2005, across the profile for every 5th DEP R-Monument (approximately 5,000-foot spacing). Sixty (60) samples were collected along eight profiles (R-70, R-75, R-80, R-85, R-90, R-95, R-100 and R-110) and analyzed for use in the design of the 2008 Project (MRD 2006). The samples collected in 2005 represent the average "native" beach sand mean grain size (d_{50}) for all the samples collected along the profile from the toe of the dune, mid-berm, MHWL, MLWL, -5, -10, -15, and -20-foot contour.

During the construction of the 2008 Project sand samples were collected from roughly mid-berm for multiple dates between April 2008 and January 2009 as the beach project progressed. The purpose was to document the sand quality and determine if the requirements of the Sediment QA/QC Plan were being met. This sand was obtained from Borrow Areas "A" and "C". Thirty-nine (39) samples were collected along the beach between R-67 and R-105 at every R-Monument approximately mid-berm (MRD 2009).

Prior to the start of the 2019 Project, sand samples were collected along SJP on August 28, 2015, to determine the beach sand characteristics within the project limits (MRD 2015). Forty (40) samples were collected along seven (7) profile lines (R-75, R-80, R-85, R-90, R-95, R-100 and R-105), taken at the toe of the present dune, mid-berm, mean high water line, mean low water line, the -5, and -10 foot contours.

The 2019 sediment samples were collected on November 19, 2019, at mid-berm and analyzed at every R-Monument (roughly 1,000-feet) to document the post-construction sediment quality (MRD, 2020b). A summary of the results is presented in ***Table 3*** and plotted in ***Figure 2***.

Table 3. *Summary of Variations in Mean grain size, d_{50} (mm) for various years along SJP.*

DEP Monument	Year			
	2005 (1)	2009(2)	2015(1)	2019(2)
R-71*	-	0.30	-	0.26
R-72*	-	0.27	-	0.26
R-73*	-	0.31	-	0.26
R-90	0.26	0.24	0.23	0.27
R-91	-	0.28	-	0.31
R-92	-	0.31	-	0.23
R-93	-	0.23	-	0.25
R-94	-	0.23	-	0.26
R-95	0.24	0.22	0.22	0.43
R-96	-	0.27	-	0.26
R-97	-	0.22	-	0.28
R-98	-	0.21	-	0.28
R-99	-	0.21	-	0.23
R-100	0.24	0.21	0.21	0.33
R-101	-	0.21	-	0.25
R-102	-	0.20	-	0.27
R-103	-	0.22	-	0.26
R-104	-	0.21	-	0.31
R-105	-	0.21	0.22	0.29

* Sample collected within the State Park Segment
(1) 5th DEP R-Monument at R-70, R-75, 85, R-90, R-95, R-100 and R-105 sampled across the profile.
(2) Every R-Monument (1,000 feet) mid-berm.

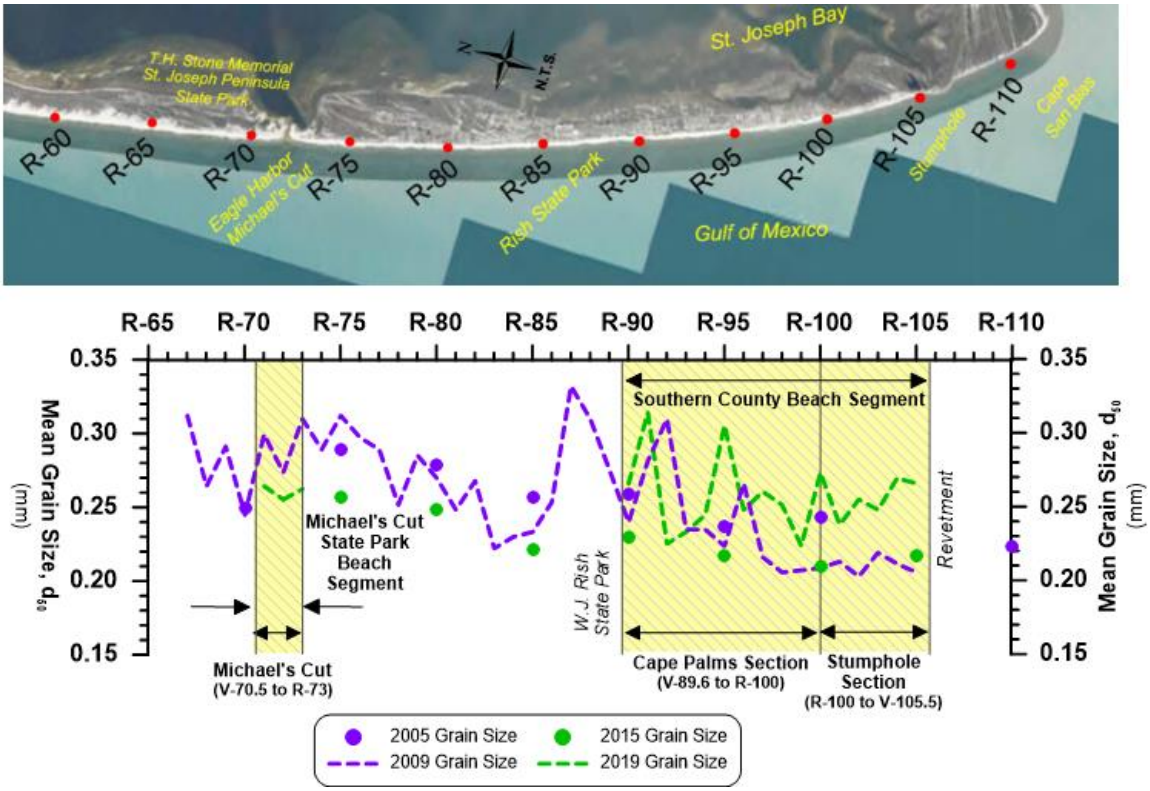

Figure 2. *Historical mean grain size (d50) data versus DEP R-Monuments.*

4.0 Shoreline and Volume Changes

Monitoring the post-construction shoreline adjustment of a beach fill project is one of the critical components to assessing the performance of a beach restoration project. The Mean High Water (MHW) elevation (+0.62' NAVD 88) is surveyed to document the short-term and long-term displacement (in feet) and annual rates (in feet per year) of the Mean High-Water Line (MHWL) to estimate shoreline change trends and identify critical shoreline segments requiring remedial action. The second method of assessing the performance of a beach fill project is documenting the volume changes across the same project limits. Volumetric changes are calculated using the average end area method, using the measured changes between profiles for each of the documented time periods in units of cubic yards per linear foot of shoreline (yds^3/lf) and annualized rates in cubic yards per linear foot of shoreline per year ($yds^3/lf/yr$). A 3-point average is applied to all these measurements to smooth out anomalies. These measured volume changes are used to obtain a reasonable estimate of the short-term and long-term volume changes along the fill limits.

4.1 Historic

Two (2) analyses are presented in this section to document the historic shoreline and volume changes for SJP. Historic volume changes were analyzed between 1997 and 2008 (pre-beach nourishment) and 2009 to 2018 (pre- 2019 Project).

4.1.1 1997 to 2008/2009 SJP Nourishment Project

Over the 11-year period between 1997 and 2008, total volume change rates ranged between +83.1 yds^3/lf (+7.7 $yds^3/lf/yr$) and -226.6 yds^3/lf (-21.0 $yds^3/lf/yr$) within the 2008 Project limits (R-67 to R-105.5). The average volume change within the project limits was -101 yds^3/lf (-9.3 $yds^3/lf/yr$). A total of 3.3M yds^3 eroded between R-67 and R-105.5. The 2008 Project placed an average of +92.8 yds^3/lf for a total of 3.6M yds^3 (***Figure 3***). The volume placed during the 2008 Project sufficiently replaced the historic losses along the project shoreline over the previous 11-year period between 1997 and 2008.

4.1.2 2009 to 2018 Post-Hurricane Michael

Over the 9-year post-construction period following the construction of the 2008 Project between 2009 and 2018 (post Hurricane Michael), volume changes ranged between +58 yds^3/lf (+6 $yds^3/lf/yr$) and -312 yds^3/lf (-32 $yds^3/lf/yr$) within the limits of the Michael's Cut State Park Beach Segment (R-70.5 to R-73) and the Southern County Beach Segment (R-89.6 to R-105.5) (***Figure 4***).

A total of 1.9M yds^3 was eroded within the Southern County Beach Segment between R-89.6 and R-105.5 between 2009 and 2018. Due to the extensive impact of Hurricane Michael immediately prior to construction of the 2019 Project and limited available funding, only 721,759 yds^3 was placed within the Southern County Beach Segment during the 2019 Project, an average of 44.1 yds^3/lf. An additional 78,930 yds^3 was placed during the NFWF Project. The total 800,689 yds^3 placed is approximately 42% of the total

measured volume lost along the Southern County Beach Segment (R-89.5 and 105.5) between 2009 and 2018.

A total of 170,168 yds^3 was lost within the Michael's Cut State Park Beach Segment between R-70.5 and R-73. 154,693 yds^3 was placed within the Michael's Cut State Park Beach Segment to replace the sand lost during Hurricane Michael and fill the Michael's Cut breach near Eagle Harbor. This shoreline segment experienced a historic total volume change rate of +0.8 yds^3/lf/yr between 1997 and 2008, and -1.8 yds^3/lf/yr between 2009 and 2014. Given the relative stable to slightly erosional shoreline along this nourished segment and the net sediment transport from south to north, it was predicted that this segment would gain sand after the nourishment project.

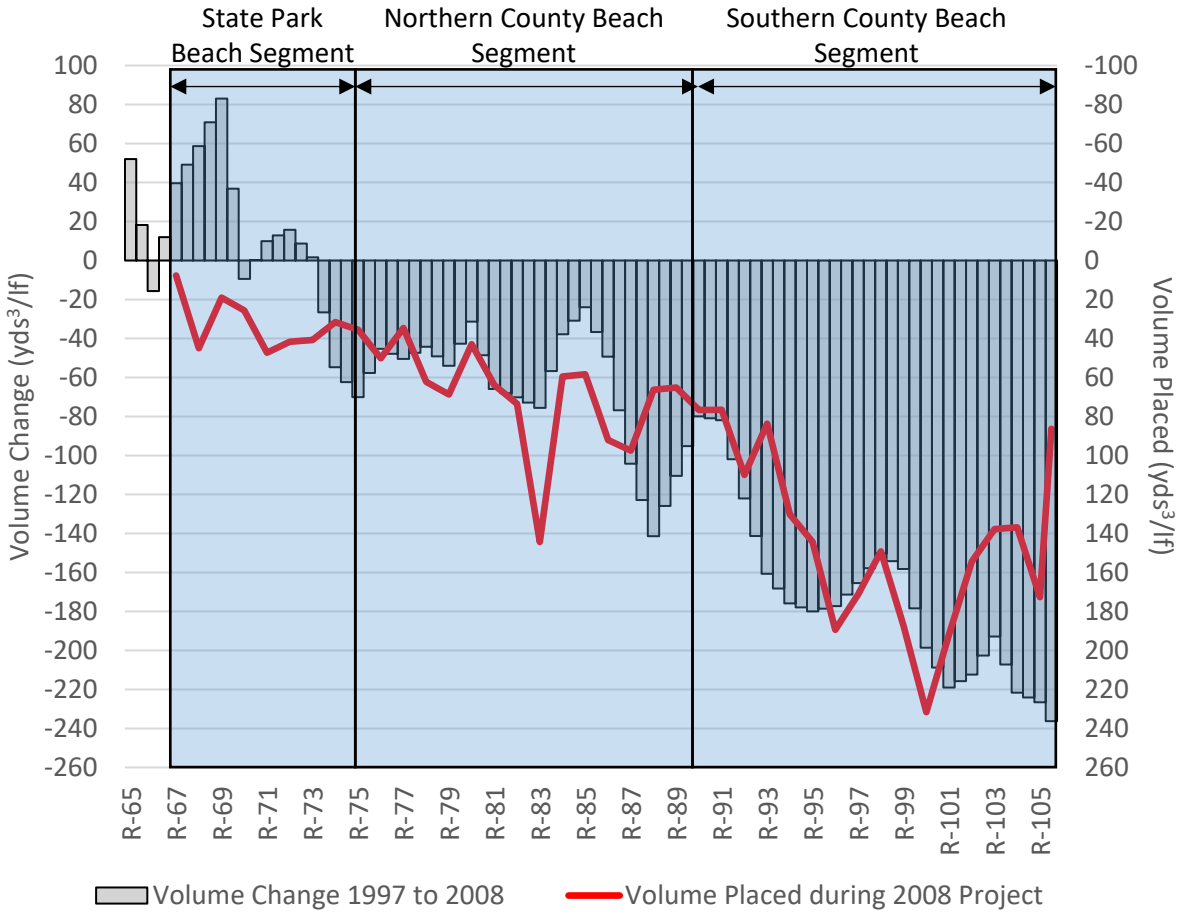

Figure 3. *Historic (pre-nourishment) volume changes between 1997 and the 2008 Project compared to the volume of fill placed as part of the 2008 Project. The blue hatch shows the limits of the 2008 Project.*

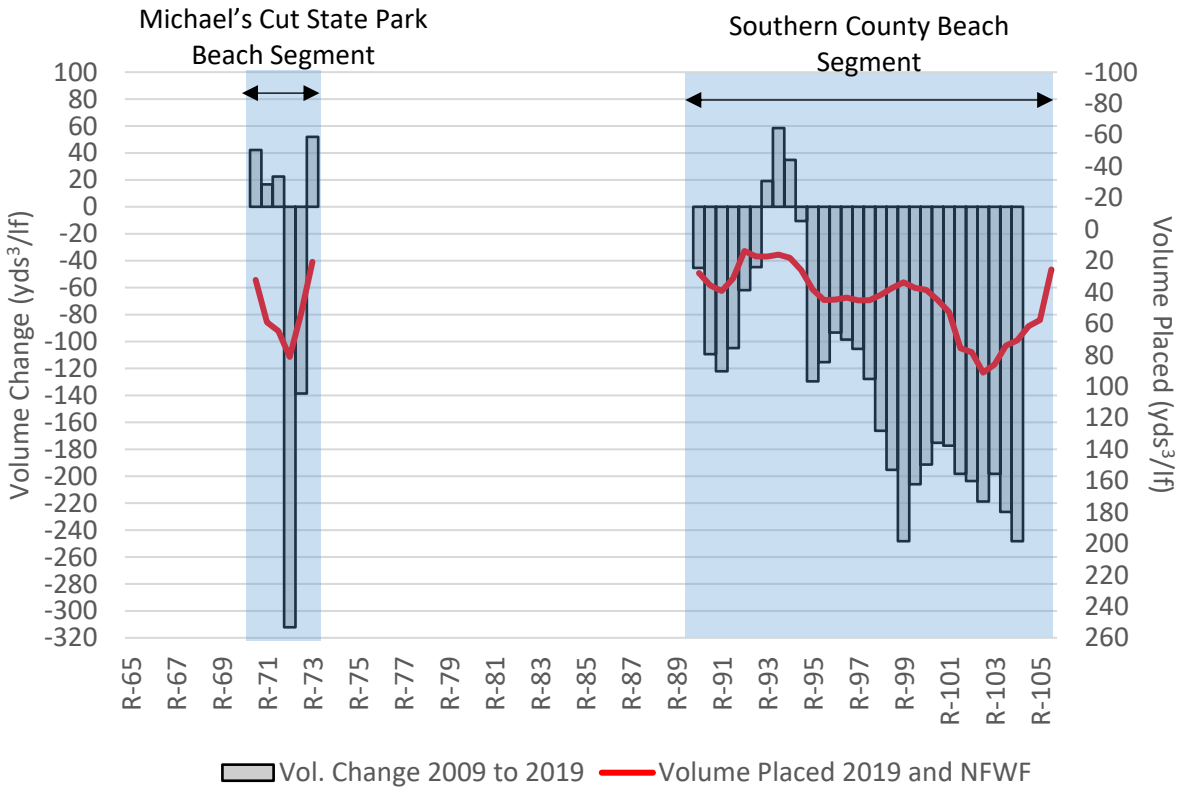

Figure 4. *Volume change between the 2008 Project and the 2019 Project compared to the volume of fill placed as part of the 2019 Project. Blue hatch shows the project limits of the 2019 Project.*

4.2 2019 SJP Beach Nourishment and Environmental Enhancement Project

The immediate post-construction (2019-2020) data is used as the baseline conditions (MRD 2020a) for post-construction monitoring and assessment of the 2019 Project performance. The post-construction shoreline and volume change rates are presented as two beach segments: 1) the Southern County Beach Segment (R-89.6 to R-105.5); and 2) the Michael's Cut State Park Beach Segment (R-70.5 to R-73). The NFWF Project was built between February and December of 2021 within the Southern County Beach Segment of the 2019 Project limits. Including this placed volume in the performance analysis does not provide a realistic representation of the performance of the beach fill and therefore was excluded from the post-construction volume changes. The performance of the NFWF Project is assessed individually in Section 4.3. ***Table 4*** and ***Table 5*** include the post-construction shoreline (MHWL) change rates (ft/yr) for the Southern County Beach Segment and the Michael's Cut State Park Beach Segment. ***Table 6*** and ***Table 7*** include the post-construction volume change rates (yds^3/lf/yr) for above and below the MHWL and the total volume change rates.

4.2.1 Southern County Beach Segment (R-89.6 to R-105.5)

Figure 5 shows the shoreline position over time relative to the R-Monuments for the Southern County Beach Segment. **Figure 6** shows the shoreline change rates and total volume change rates between the post-construction survey (November 2019) and the August 2022 survey and shows the volume change rates above and below the MHWL. The Southern County Beach Segment (R-89.6 to R-105.5) was further divided into two sections: 1) Cape Palms Section (R-89.5 to R-100), and 2) Stumphole Section (R-100 to R-105.5). These two sections mimic the same length of shoreline and nomenclature used in the 2009-2014 monitoring efforts for the 2008 Project and are used in this report for consistency. Between the immediate post-construction monitoring survey and the 2022 monitoring survey, approximately 78,930 yds^3 of sand was placed as part of the NFWF Project within the limits of the Southern County Beach Segment. Including this placed sand in the volume change calculations does not provide a realistic representation of the performance of the beach nourishment project therefore the volume changes between 2019 and 2023 were calculated by subtracting out the measured volume changes between the pre- and post-construction surveys conducted as part of the NFWF Project. The volume changes presented in this report filter out the changes reflected by the fill. No fill was placed below the MHWL during the NFWF Project, so it was not necessary to filter the shoreline change rates to account for the fill.

Shoreline Change Rates

The MHWL position change was calculated for four-time frames between the 2019 post-construction surveys and the 2023 monitoring surveys: 1) Immediate post-construction (November 2019) to NFWF pre-construction (February 2021); 2) NFWF pre-construction (February 2021) to August 2022; 3) immediate post-construction (November 2019) to July 2023; and 4) post-construction (August 2022) to post-construction July 2023. ***Figure 5*** shows the change in shoreline position relative to the R-Monuments over time for the Southern County Beach Segment. ***Figure 6*** and ***Table 4*** show the short-term and long-term shoreline change rates between 2019 and 2022, 2021 and 2022, 2019 and 2023, and 2022 and 2023.

The long-term shoreline change rates between November 2019 and July 2023 ranged between -33.3 ft/yr and -4.3 ft/yr, an average of -19.7 ft/yr for the Cape Palms Section (R-89.6 to R-100). Within the Stumphole Section, the MHWL position change ranged between -50.6 ft/yr and -18.4 ft/yr, an average of 38.7 ft/yr. Additionally, the shoreline change rates were calculated for the northern and southern control sections. Within the northern control section (R-85 to R-89.5), the MHWL position change ranged between –15.8 ft/yr and +3.4 ft/yr, an average of -1.1 ft/yr. For the southern control section (R-105.5 to R-110), the MHWL position change ranged between -29.5 ft/yr and -1.9 ft/yr, an average of -18.4 ft/yr (***Figure 6***, top).

Volume Change Rates

The total volume changes were calculated for all profiles between November 2019 and July 2023 (***Figure 6***, bottom). For the Cape Palms Section, all profiles eroded, with the greatest change measured at R-97 (-34.6 $yds^3/lf/yr$). For the Stumphole Section, all profiles showed erosion, with the greatest change measured at R-103 (-52.3 $yds^3/lf/yr$) and the smallest change measured at R-100 (-15.2 $yds^3/lf/yr$). The average total volume change rates were -21.1 and -37.2 $yds^3/lf/yr$ for the Cape Palms Section and Stumphole Section, respectively. In addition, the volume change rates were calculated above and below the MHWL. ***Figure 7*** and ***Table 6*** show the volume changes above and below the MHWL for the Southern County Beach Segment between November 2019 and July 2023.

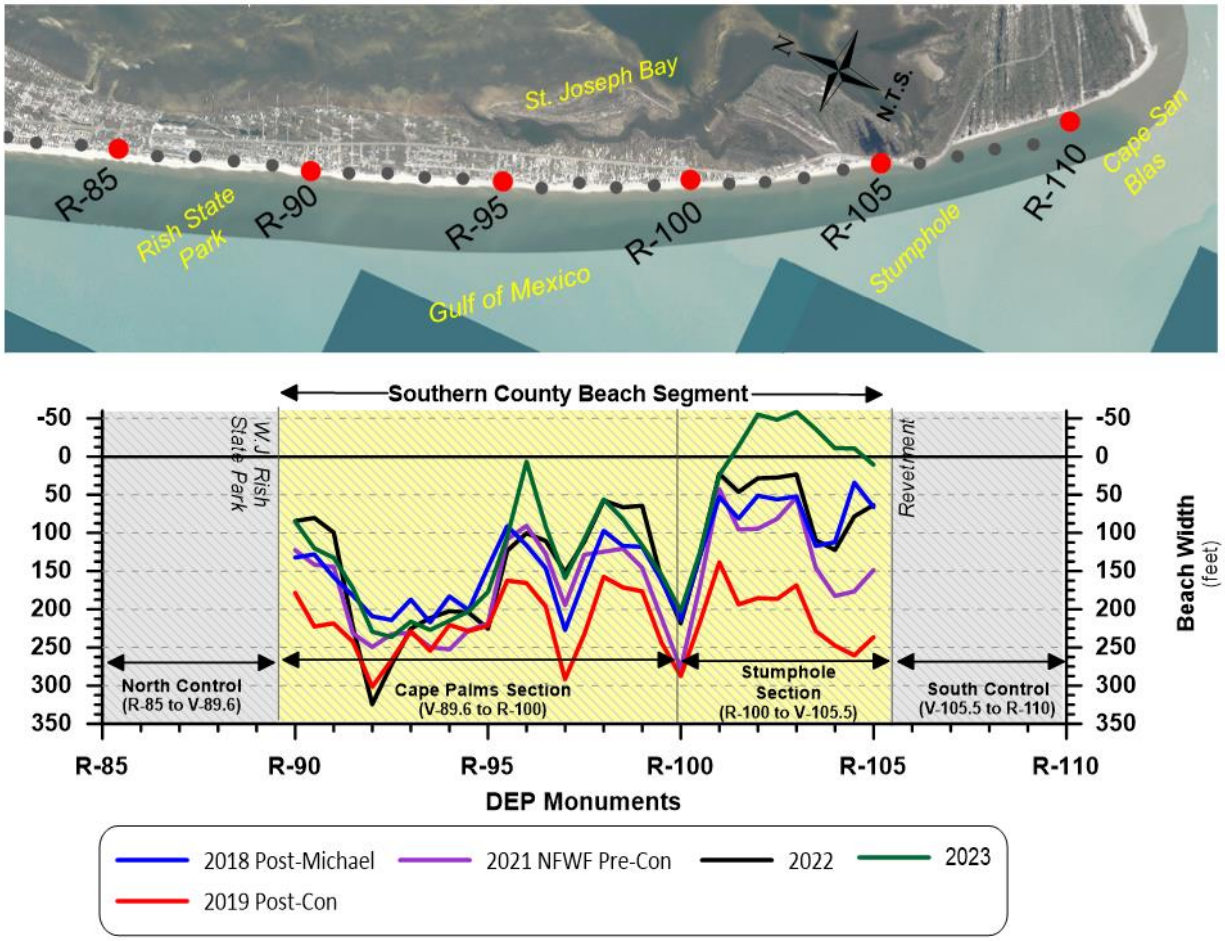

Figure 5. *Shoreline position relative to the R-Monuments for the Southern County Beach Segment in 2018 (Post-Michael), 2019, 2021, 2022, and 2023.*

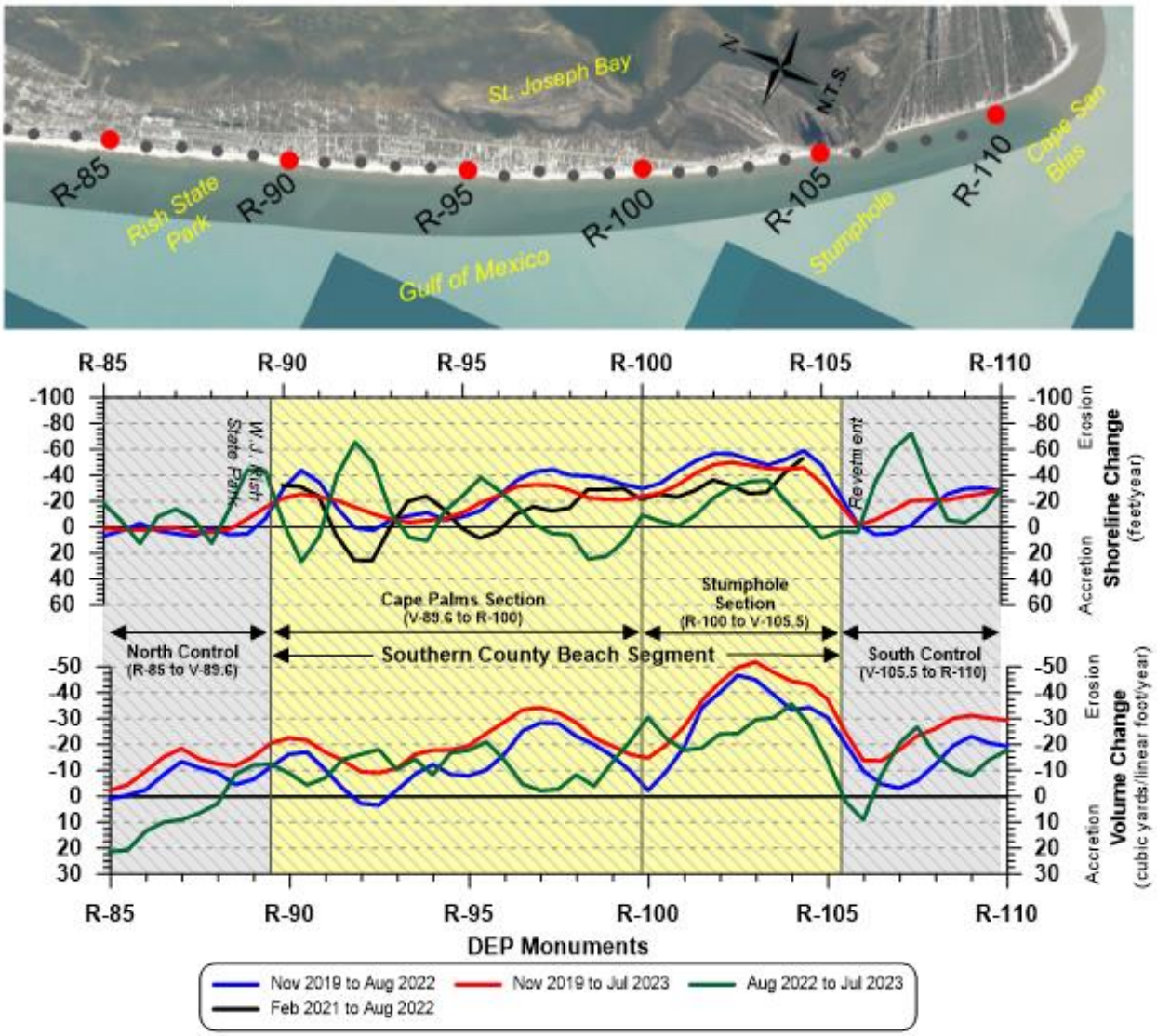

Figure 6. *Shoreline and volume changes between November 2019 (post-construction) and July 2023 for the Southern County Beach Segment.*

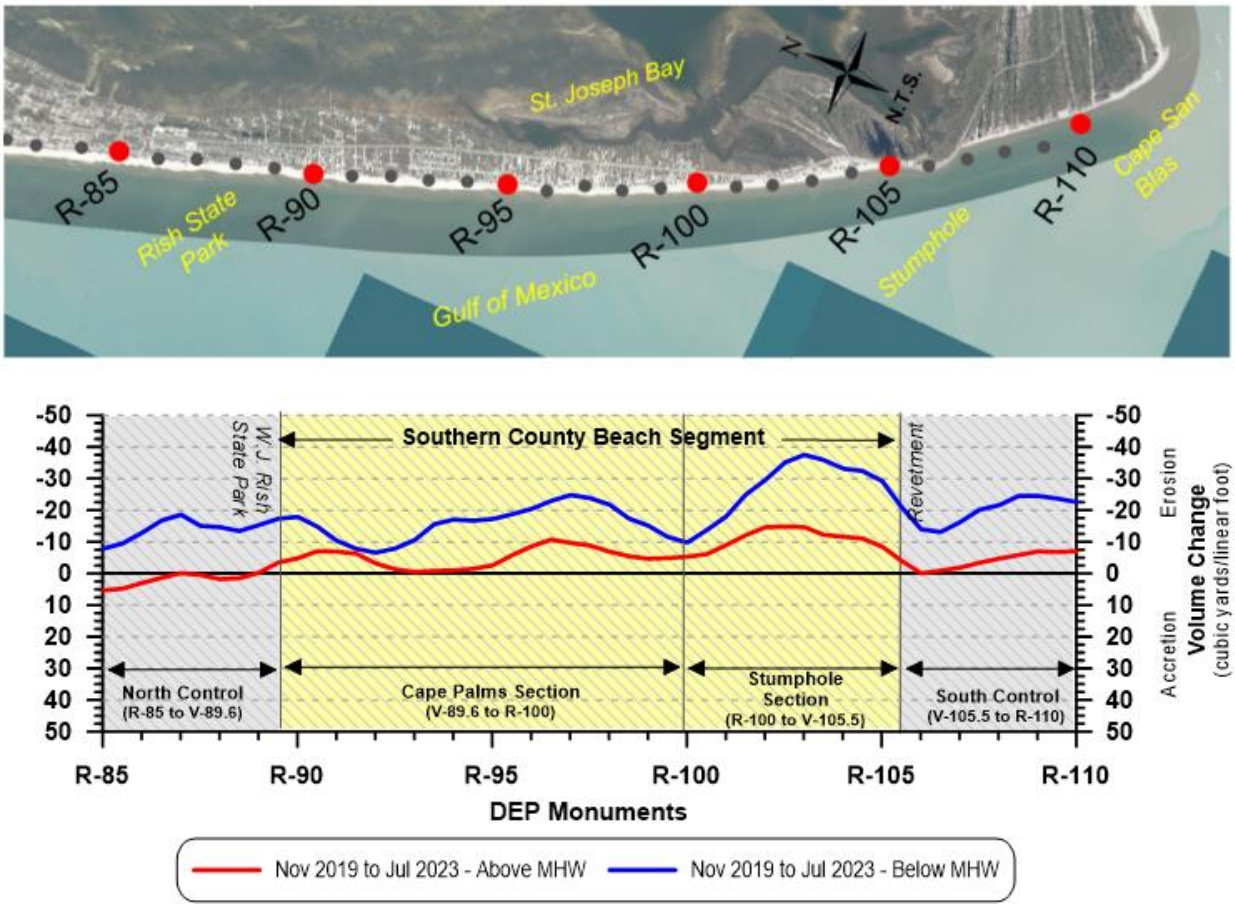

Figure 7. *Volume changes between November 2019 and August 2023, above and below the MHWL for the Southern County Beach Segment.*

4.2.2 State Park Beach Segment (R-70.5 to R-73)

Figure 8 shows the shoreline and total volume change rates between the post-construction surveys (February 2020) (MRD 2021a) and the July 2023 surveys for the Michael's Cut State Park Beach Segment. ***Figure 9*** shows the volume changes above and below the MHWL for the Michael's Cut State Park Beach Segment.

Shoreline Change Rates

The MHWL position (+0.62' NAVD 88) change varied between -11.2 ft/yr and -0.2 ft/yr, with an average change of -5.3 ft/yr within the Michael's Cut State Park Beach Segment (***Figure 8***, top). The shoreline segment remained stable between R-71 and R-72 and eroded at the edges of the fill limits. Within the northern control section (R-65.5 to R-70), the MHWL position change ranged between -17.4 ft/yr and +8.4 ft/yr, with an average change of -6.9 ft/yr. Within the southern control section (R-73.5 to R-78), the MHWL position change ranged between -15.3 ft/yr and -0.7 ft/yr, with an average change rate of -7.4 ft/yr.

Volume Change Rates

The total volume change rate for the Michael's Cut State Park Beach Segment ranged between -14.4 and +7.7 yds^3/lf/yr, with an average of -4.9 yds^3/lf/yr (***Figure 8***, bottom). The volume change rates above the MHWL ranged between +0.2 yds^3/lf/yr and +0.9 yds^3/lf/yr, with an average of +0.5 yds^3/lf/yr (***Figure 9***, red). The volume change rates below the MHWL ranged between -14.6 yds^3/ lf/yr and +7.3 yds^3/lf/yr, with an average of -5.4 yds^3/lf/yr (***Figure 9***, blue). Within the limits of the State Park Beach segment, the offshore zone (below MHWL) accreted less since the last monitoring report where the Michael's cut breach occurred in 2018 (R-72) and the offshore zone adjacent to the Michael's cut breach continued to erode. Within the northern control section, the total volume change rate ranged between -25.1 and -4.9yds^3/lf/yr, with an average of -12.7 yds^3/lf/yr. Within the southern control section, the total volume change rate ranged between -17.8 and +2.7 yds^3/lf/yr, with an average of –6.5 yds^3/lf/yr.

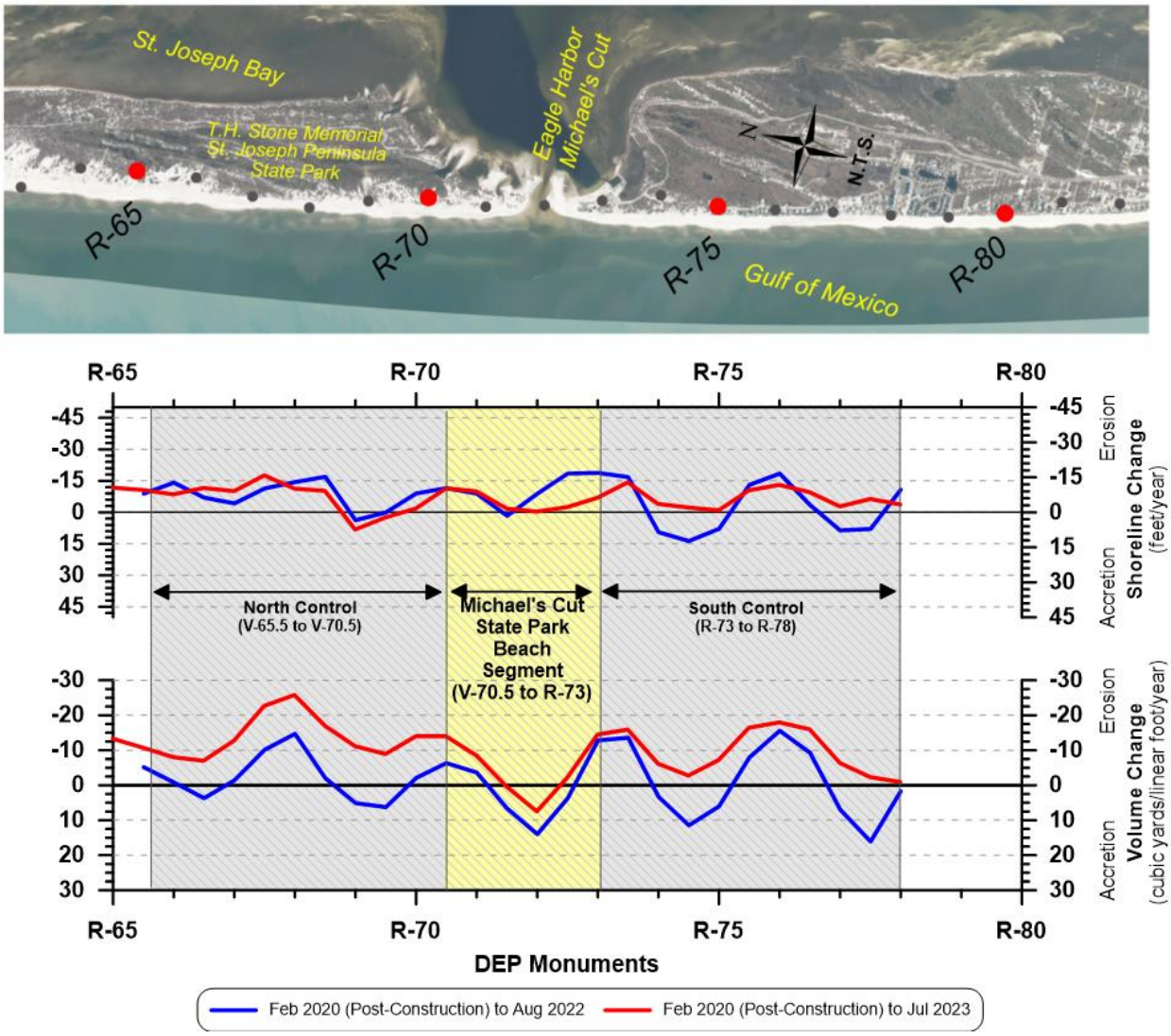

Figure 8. *Shoreline and volume changes between February 2020 (post-construction) and July 2023 for the Michael's Cut State Park Beach Segment.*

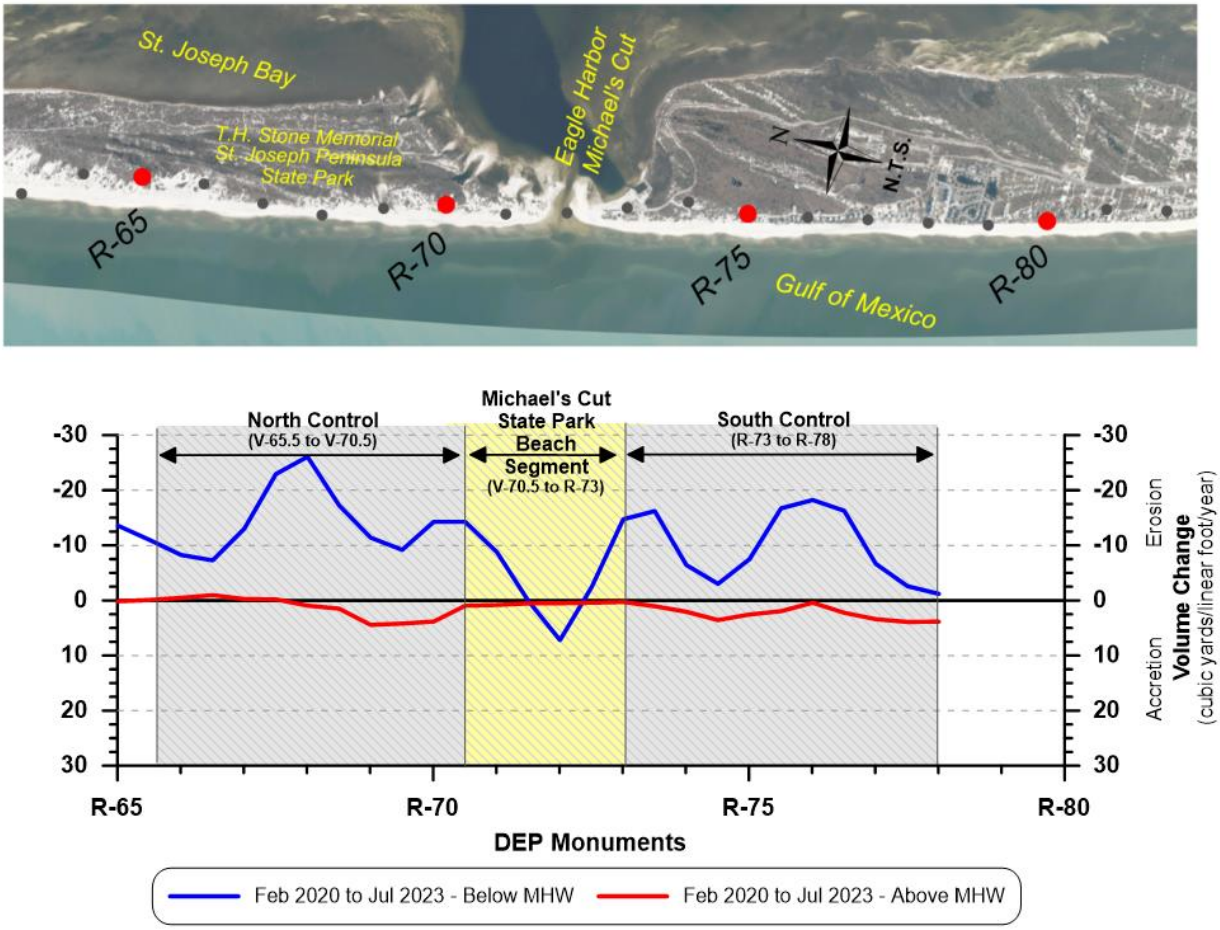

Figure 9. *Volume changes between February 2020 and July 2023, above and below the MHWL for the Michael's Cut State Park Beach Segment.*

4.3 2021 NFWF Emergency Coastal Resiliency (Dune Enhancement) Project

The pre-construction (February 2021) data from the NFWF Project is used as the baseline conditions for the post-construction monitoring and assessment of the NFWF Project performance. The immediate post-construction (April to November 2021) data was used to adjust the volume changes for the fill placement during the NFWF Project. The volume change rates were calculated above the MHWL for the County beach segment for the two (2) segments used in the analysis of the 2019 Project (Section 4.2.1) which included: 1) the Cape Palms Section (R-89.6 to R-100), and 2) the Stumphole Section (R-100 to R-105.5). Fill placement for the NFWF project was limited to above the MHWL so volume change rate calculations do not include volume changes below the MHWL.

The volume change rates above the MHWL between the pre-construction survey (February 2021) and July 2023, adjusted for fill placement, ranged between -3.8 and -1.7 yds^3/lf/yr, an average of -1.7 yds^3/lf/yr for the Cape Palms Section. For the Stumphole Section, the volume changes above

the MHWL ranged between -7.4 and -1.2 yds^3/lf/yr, an average of -4.5 yds^3/lf/yr. It should be noted that within the Stumphole Section, the NFWF project was intended to create vegetated islands, so some survey locations included no fill. The volume changes above the MHWL between the NFWF Project (2021) and the 2023 monitoring survey show slightly reduced volume change rates above the MHWL compared to rates between 2019 and 2023 (Figure 10, green).

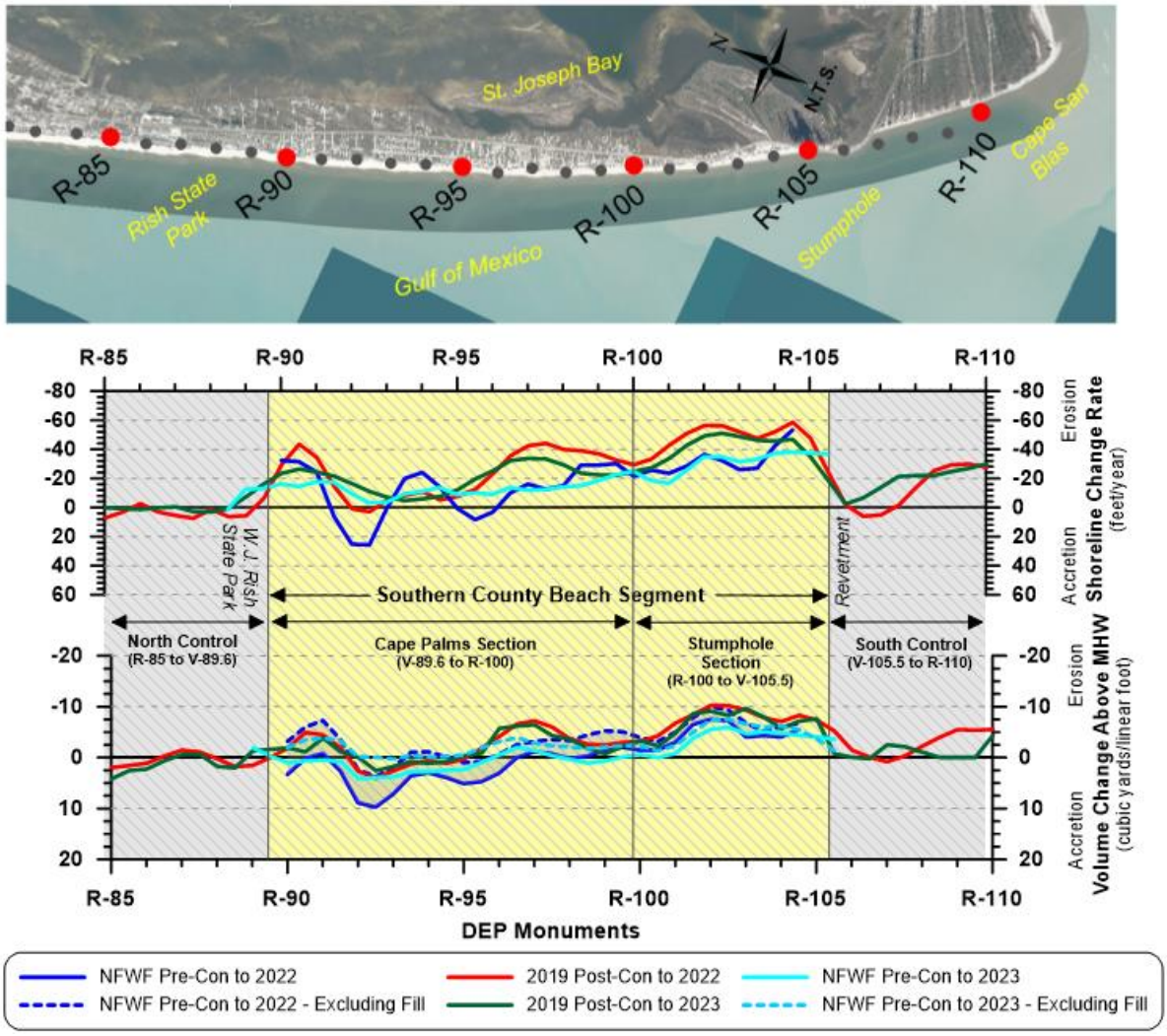

Figure 10. *Shoreline change rates and volume change rates above the MHWL between 2021 and 2023 for the NFWF Project.*

Table 4. *Southern County Beach Segment shoreline (MHWL) change rates (ft/yr 3-point average).*

	Monument		1973 to 1997	1997 to 2008	2009 to 2014	2019 to 2021	2021 to 2022	2019 to 2023	2022 to 2023
North Control (R-89.5 to R-85)	R-	85	-0.8	-0.4	-4.9	-	-	0.7	-18.2
	V-	85.5			-5.3	-	-	1.2	-4.8
	R-	86	0.8	-4.0	-4.0	-	-	1.7	12.5
	V-	86.5			-1.9	-	-	0.7	-8.3
	R-	87	-1.6	-7.9	-1.5	-	-	0.0	-14.1
	V-	87.5			-1.0	-	-	3.3	-6.3
	R-	88	-1.2	-11.1	0.6	-	-	3.4	12.2
	V-	88.5			0.1	-	-	1.1	-14.7
	R-	89	-1.0	-10.1	0.2	-	-	-7.0	-44.5
Cape Palms Section (R-100 to R-89.5)	V-	89.5			-0.5	-	-	-15.8	-43.4
	R-	90	-1.5	-8.8	-4.0	-55.2	-32.8	-23.0	-3.4
	V-	90.5			-8.0	-56.5	-31.8	-25.9	26.5
	R-	91	-2.8	-8.2	-11.9	-44.9	-24.7	-23.8	6.7
	V-	91.5			-11.7	-37.2	5.8	-21.0	-40.8
	R-	92	-1.7	-10.5	-9.0	-26.7	24.9	-15.9	-65.9
	V-	92.5			-6.6	-21.8	25.4	-10.6	-50.0
	R-	93	-1.0	-13.4	-4.0	-11.1	-0.1	-6.5	-11.2
	V-	93.5			-4.9	6.3	-20.3	-4.3	7.6
	R-	94	-0.3	-14.4	-8.0	3.2	-24.5	-5.6	10.3
	V-	94.5			-11.3	4.6	-14.4	-7.1	-12.6
	R-	95	-3.3	-16.4	-12.9	-18.4	0.4	-11.7	-24.6
	V-	95.5			-14.1	-36.8	8.0	-19.3	-38.7
	R-	96	-4.1	-16.6	-13.6	-53.7	2.8	-24.9	-28.5
	V-	96.5			-13.1	-65.0	-10.4	-31.8	-17.0
	R-	97	-0.9	-15.1	-15.3	-72.7	-16.4	-33.3	-2.0
	V-	97.5			-18.4	-69.9	-13.0	-32.8	4.8
	R-	98	-1.9	-12.5	-27.6	-57.9	-15.3	-28.9	5.8
	V-	98.5			-33.7	-39.3	-29.5	-23.1	24.3
	R-	99	-5.6	-12.6	-34.9	-30.4	-29.5	-22.0	22.3
	V-	99.5			-27.4	-19.8	-30.5	-21.6	10.6
Stumphole Section (R-105.5 to R-100)	R-	100	-6.1	-14.2	-20.8	-23.3	-21.9	-24.4	-9.4
	V-	100.5			-18.3	-42.0	-26.0	-26.8	-4.9
	R-	101	-7.6	-14.6	-17.3	-64.7	-23.9	-33.3	-1.4
	V-	101.5			-15.5	-76.6	-28.9	-42.4	-9.6
	R-	102	-7.8	-14.7	-17.3	-79.1	-36.8	-48.8	-23.2
	V-	102.5			-22.0	-83.7	-32.7	-50.6	-30.9
	R-	103	-11.4	-17.2	-28.4	-81.6	-26.5	-48.3	-35.3
	V-	103.5			-33.4	-71.0	-27.3	-45.8	-36.2
	R-	104	-6.0	-22.0	-38.3	-62.7	-42.7	-45.3	-20.1
	V-	104.5			-38.8	-60.3	-53.6	-46.4	-6.5
	R-	105	-6.9	-18.3	-27.1	-	-	-34.5	8.3
	V-	105.5			-10.7	-	-	-18.4	3.2
South Control (R-110 to R-105.5)	R-	106	-12.2	-19.8	1.6	-	-	-1.9	3.7
	V-	106.5			-1.3	-	-	-6.2	-35.4
	R-	107	-11.2	-19.6	-6.6	-	-	-13.3	-60.3
	V-	107.5			-11.3	-	-	-20.8	-72.5
	R-	108	-10.0	-28.3	-15.6	-	-	-21.5	-36.7
	V-	108.5			-20.2	-	-	-21.5	-5.9
	R-	109	-10.5	-32.7	-27.2	-	-	-24.3	-3.8
	V-	109.5			-29.1	-	-	-26.4	-13.1
	R-	110	-11.6	-35.9	-20.6	-	-	-29.5	-29.8

Table 5. *Michael's Cut State Park Beach Segment shoreline (MHWL) change rates (ft/yr 3-point average).*

	Monument		1973 to 1997	1997 to 2008	2009 to 2014	2020 to 2022	2022 to 2023	2020 to 2023
North Control (R-70.5 to R-65)	R-	65	0.3	-6.6	1.0		24.8	-11.5
	V-	65.5			5.7	-9.2	24.2	-10.4
	R-	66	-0.7	-1.3	4.6	-14.4	-21.5	-8.3
	V-	66.5			9.5	-7.3	-24.8	-11.4
	R-	67	-0.3	-1.4	13.5	-4.5	-33.3	-9.9
	V-	67.5			17.0	-11.6	1.8	-17.4
	R-	68	-0.8	-1.8	17.2	-14.7	12.2	-11.1
	V-	68.5			10.7	-17.2	24.2	-10.0
	R-	69	2.1	1.2	1.3	3.4	13.6	8.4
	V-	69.5			-5.3	-0.2	22.3	2.7
	R-	70	-4.4	-1.0	-7.5	-9.3	-5.0	-1.6
Michaels Cut (R-73 to R-70.5)	V-	70.5			-3.1	-11.8	-11.6	-11.2
	R-	71	-2.1	3.0	1.3	-9.2	-9.7	-9.8
	V-	71.5			1.8	1.4	23.5	-1.6
	R-	72	-3.1	3.3	-0.9	-9.1	43.0	-0.2
	V-	72.5			-1.3	-18.7	28.0	-2.3
	R-	73	-4.6	3.6	-0.9	-19.0	-7.3	-6.8
South Control (R-78 to R-73)	V-	73.5			1.3	-17.1	-39.2	-14.1
	R-	74	-0.3	-2.6	6.9	9.2	-43.5	-3.8
	V-	74.5			13.1	13.4	-21.4	-2.1
	R-	75	1.7	-4.6	17.1	7.6	0.1	-0.7
	V-	75.5			7.5	-13.3	4.5	-10.3
	R-	76	-3.3	-3.6	-1.6	-18.7	-21.2	-12.9
	V-	76.5			-6.1	-3.8	-30.3	-9.4
	R-	77	-3.1	-1.5	-0.4	8.3	-41.7	-2.6
	V-	77.5			7.8	7.7	-20.0	-6.1
	R-	78	-0.2	-2.5	11.2	-11.1	-14.9	-3.5

Table 6. *Southern County Beach Segment volume change rates (yds³/lf/yr 3-point average).*

	Monument		1997 to 2008			2009 to 2014			2019 to 2021 (excluding NFWF)		
			Above MHWL	Below MHWL	Total	Above MHWL	Below MHWL	Total	Above MHWL	Below MHWL	Total
North Control (R-89.5 to R-85)	R-	85	-0.5	-1.7	-2.2	0.8	-5.3	-4.5	-	-	-
	V-	85.5				0.0	-9.2	-9.2	-	-	-
	R-	86	-1.5	-3.0	-4.6	1.3	-7.6	-6.3	-	-	-
	V-	86.5				1.2	-8.3	-7.1	-	-	-
	R-	87	-3.1	-6.6	-9.7	2.6	-5.5	-2.9	-	-	-
	V-	87.5				1.0	-2.4	-1.4	-	-	-
	R-	88	-4.0	-9.1	-13.1	1.5	0.4	1.9	-	-	-
	V-	88.5				2.1	-1.3	0.8	-	-	-
	R-	89	-3.7	-6.5	-10.2	3.2	-1.9	1.3	-	-	-
South Section (R-100 to 89.5)	V-	89.5				3.4	-4.2	-0.9	-	-	-
	R-	90	-2.9	-4.5	-7.4	0.9	-8.7	-7.8	-3.2	-	-
	V-	90.5				-0.5	-12.6	-13.2	-6.0	-	-
	R-	91	-2.6	-5.0	-7.6	-1.8	-14.8	-16.7	-7.3	-	-
	V-	91.5				-1.3	-11.1	-12.4	-3.6	-	-
	R-	92	-2.6	-8.7	-11.3	-0.4	-5.7	-6.1	2.4	-	-
	V-	92.5				0.1	0.0	0.1	3.8	-	-
	R-	93	-2.6	-12.3	-14.9	-0.5	1.8	1.3	1.9	-	-
	V-	93.5				-0.7	2.7	2.0	-1.1	-	-
	R-	94	-2.7	-13.6	-16.3	-1.0	-4.5	-5.5	-1.1	-	-
	V-	94.5				-0.7	-8.1	-8.8	-0.1	-	-
	R-	95	-3.9	-12.7	-16.7	-0.9	-10.1	-10.9	1.0	-	-
	V-	95.5				-1.3	-6.6	-7.9	0.7	-	-
	R-	96	-4.3	-12.1	-16.4	-1.9	-3.2	-5.1	-0.6	-	-
	V-	96.5				-2.3	-3.8	-6.1	-2.5	-	-
	R-	97	-3.9	-11.4	-15.3	-2.5	-8.1	-10.7	-3.2	-	-
	V-	97.5				-2.4	-17.2	-19.7	-3.5	-	-
	R-	98	-2.9	-11.0	-13.9	-4.0	-25.4	-29.4	-3.3	-	-
	V-	98.5				-3.3	-30.1	-33.5	-4.4	-	-
	R-	99	-2.6	-12.0	-14.6	-3.8	-28.8	-32.6	-5.3	-	-
	V-	99.5				-2.1	-23.1	-25.2	-5.1	-	-
Stumphole Section (R-105.5 to R-100)	R-	100	-3.6	-14.8	-18.4	-2.8	-16.6	-19.3	-3.9	-	-
	V-	100.5				-2.1	-14.6	-16.7	-3.2	-	-
	R-	101	-3.4	-16.9	-20.3	-2.7	-12.0	-14.8	-5.0	-	-
	V-	101.5				-4.6	-11.4	-16.0	-7.9	-	-
	R-	102	-3.7	-16.0	-19.7	-5.7	-11.1	-16.8	-10.0	-	-
	V-	102.5				-7.0	-17.5	-24.4	-9.4	-	-
	R-	103	-3.6	-14.2	-17.9	-5.9	-25.0	-30.8	-6.8	-	-
	V-	103.5				-6.5	-31.8	-38.3	-5.3	-	-
	R-	104	-3.6	-16.9	-20.5	-6.7	-38.0	-44.7	-6.0	-	-
	V-	104.5				-6.7	-40.3	-47.0	-6.8	-	-
	R-	105	-2.6	-18.4	-21.0	-4.6	-35.5	-40.0	-	-	-
	V-	105.5				1.1	-24.5	-25.6	-	-	-
South Control (R-110 to R-105.5)	R-	106	-1.9	-20.9	-22.8	0.9	-18.4	-17.5	-	-	-
	V-	106.5				0.5	-20.8	-20.2	-	-	-
	R-	107	-2.1	-21.2	-23.3	-0.8	-27.0	-27.8	-	-	-
	V-	107.5				-1.2	-27.2	-28.4	-	-	-
	R-	108	-4.1	-23.1	-27.2	-0.5	-26.0	-26.6	-	-	-
	V-	108.5				-1.2	-25.3	-26.5	-	-	-
	R-	109	-5.1	-24.0	-29.1	-2.2	-25.7	-27.9	-	-	-
	V-	109.5				-4.9	-24.6	-29.5	-	-	-
	R-	110	-6.1	-23.9	-30.0	-3.7	-23.1	-28.7	-	-	-

	Monument		2019 to 2022 (excluding NFWF)			2022 to 2023 (excluding NFWF)			2019 to 2023 (excluding NFWF)		
			Above MHWL	Below MHWL	Total	Above MHWL	Below MHWL	Total	Above MHWL	Below MHWL	Total
North Control (R-89.5 to R-85)	R-	85	1.8	-1.2	0.6	6.6	14.6	21.3	5.2	-7.8	-2.6
	V-	85.5	1.4	-2.2	-0.8	6.9	13.9	20.8	4.6	-9.4	-4.8
	R-	86	1.0	-3.8	-2.8	3.2	10.3	13.5	2.8	-12.8	-10.0
	V-	86.5	-0.4	-8.3	-8.7	2.7	7.4	10.0	1.2	-16.7	-15.5
	R-	87	-1.3	-12.6	-13.8	1.3	7.8	9.0	-0.3	-18.5	-18.8
	V-	87.5	-0.9	-10.5	-11.4	1.9	4.6	6.4	0.3	-15.0	-14.7
	R-	88	0.4	-9.9	-9.5	2.6	0.2	2.8	1.6	-14.5	-12.9
	V-	88.5	1.6	-6.6	-4.9	-1.4	-7.1	-8.5	1.3	-13.3	-12.1
	R-	89	1.4	-8.3	-6.9	-5.7	-6.4	-12.1	-0.4	-15.2	-15.7
Cape Palms Section (R-100 to 89.5)	V-	89.5	-1.2	-10.6	-11.9	-10.6	-1.9	-12.5	-3.7	-17.2	-20.9
	R-	90	-4.4	-12.3	-16.7	-9.9	0.9	-8.9	-5.0	-17.8	-22.8
	V-	90.5	-8.4	-9.0	-17.4	-7.2	2.8	-4.4	-7.3	-14.7	-22.0
	R-	91	-8.1	-2.7	-10.8	-7.3	0.2	-7.1	-7.1	-10.3	-17.4
	V-	91.5	-5.4	2.0	-3.4	-12.2	-2.1	-14.3	-6.5	-7.7	-14.2
	R-	92	-1.0	3.4	2.4	-17.1	0.9	-16.2	-3.4	-6.5	-9.9
	V-	92.5	0.7	2.3	3.0	-15.4	-2.7	-18.1	-1.5	-7.9	-9.4
	R-	93	-0.4	-2.3	-2.7	-9.4	-1.0	-10.4	-0.7	-10.5	-11.2
	V-	93.5	-1.4	-7.4	-8.8	-5.6	-8.9	-14.5	-1.0	-15.5	-16.5
	R-	94	-1.8	-10.9	-12.7	-4.8	-3.5	-8.3	-1.2	-17.0	-18.2
	V-	94.5	-1.2	-7.6	-8.8	-7.7	-9.1	-16.8	-1.7	-16.6	-18.3
	R-	95	-2.1	-6.2	-8.3	-9.5	-8.3	-17.8	-2.8	-17.1	-19.9
	V-	95.5	-4.2	-6.4	-10.6	-12.0	-9.1	-21.1	-6.0	-18.7	-24.6
	R-	96	-6.3	-10.4	-16.7	-12.1	-1.9	-14.0	-8.8	-20.4	-29.1
	V-	96.5	-8.1	-17.4	-25.6	-9.2	4.4	-4.8	-10.9	-22.8	-33.8
	R-	97	-8.4	-20.4	-28.8	-5.6	3.5	-2.2	-9.9	-24.7	-34.6
	V-	97.5	-7.6	-20.9	-28.6	-6.7	3.9	-2.8	-9.0	-23.7	-32.8
	R-	98	-5.8	-17.8	-23.5	-8.5	0.2	-8.3	-7.1	-21.7	-28.8
	V-	98.5	-5.0	-15.4	-20.4	-7.0	3.1	-4.0	-5.7	-17.3	-23.0
	R-	99	-4.8	-11.2	-16.0	-5.6	-7.7	-13.2	-4.9	-15.0	-19.9
	V-	99.5	-4.8	-5.5	-10.3	-4.0	-17.2	-21.2	-5.1	-11.5	-16.5
Stumphole Section (R-105.5 to R-100)	R-	100	-4.6	2.0	-2.7	-5.1	-25.5	-30.6	-5.5	-9.7	-15.2
	V-	100.5	-5.3	-4.4	-9.8	-3.0	-19.5	-22.5	-6.3	-13.7	-20.0
	R-	101	-8.0	-11.2	-19.2	-3.5	-14.3	-17.8	-9.2	-18.0	-27.2
	V-	101.5	-9.3	-25.2	-34.6	-6.5	-12.2	-18.7	-12.3	-24.9	-37.2
	R-	102	-11.8	-28.7	-40.4	-9.4	-14.7	-24.1	-14.8	-29.5	-44.3
	V-	102.5	-11.5	-35.6	-47.1	-9.6	-14.7	-24.2	-15.1	-35.0	-50.0
	R-	103	-10.9	-34.5	-45.4	-10.0	-19.6	-29.6	-14.9	-37.4	-52.3
	V-	103.5	-8.5	-31.2	-39.7	-7.3	-23.1	-30.4	-12.4	-35.8	-48.2
	R-	104	-8.3	-25.6	-33.9	-9.4	-26.2	-35.6	-11.8	-33.1	-44.9
	V-	104.5	-9.2	-25.5	-34.7	-5.8	-21.9	-27.7	-11.2	-32.3	-43.5
	R-	105	-8.2	-22.6	-30.8	-1.8	-12.3	-14.0	-8.7	-29.2	-37.8
	V-	105.5	-5.4	-15.3	-20.7	2.1	-0.3	1.8	-4.3	-20.9	-25.2
South Control (R-110 to R-105.5)	R-	106	-1.6	-8.7	-10.3	2.7	6.3	9.1	-0.3	-13.9	-14.2
	V-	106.5	-0.2	-4.9	-5.1	-3.8	-4.4	-8.2	-1.1	-13.0	-14.1
	R-	107	0.7	-4.2	-3.6	-6.7	-13.8	-20.4	-2.1	-16.1	-18.2
	V-	107.5	-0.4	-5.9	-6.4	-8.4	-18.4	-26.8	-3.6	-20.1	-23.7
	R-	108	-2.4	-10.2	-12.6	-6.2	-10.3	-16.5	-4.9	-21.5	-26.4
	V-	108.5	-4.2	-15.7	-19.9	-3.4	-7.4	-10.8	-6.0	-24.4	-30.4
	R-	109	-5.6	-17.9	-23.5	-3.4	-4.5	-7.9	-7.2	-24.4	-31.6
	V-	109.5	-5.5	-15.4	-21.0	-2.7	-11.4	-14.0	-7.0	-23.6	-30.5
	R-	110	-5.7	-14.1	-19.8	-4.5	-13.2	-17.7	-7.3	-22.5	-29.8

Table 7. *Michael's Cut State Park Beach Segment volume change rates (yds³/lf/yr 3-point average).*

	Monument		1997 to 2008			2009 to 2014			2020 to 2023		
			Above MHWL	Below MHWL	Total	Above MHWL	Below MHWL	Total	Above MHWL	Below MHWL	Total
North Control (R-70.5 to R-65)	R-	65	1.9	2.9	4.8	-6.1	-4.0	-4.2	0.1	-13.5	-13.4
	V-	65.5				-5.1	-9.7	-3.6	-0.2	-10.9	-11.0
	R-	66	-0.5	-0.9	-1.5	-4.4	2.8	0.0	-0.6	-8.2	-8.7
	V-	66.5				-2.3	6.8	3.0	-1.0	-7.2	-8.2
	R-	67	0.2	3.5	3.7	0.4	-0.7	6.9	-0.3	-12.9	-13.2
	V-	67.5				2.4	14.6	7.2	-0.3	-22.8	-23.1
	R-	68	0.0	5.4	5.4	0.1	7.8	6.0	0.9	-26.0	-25.1
	V-	68.5				-4.9	-4.6	-0.3	1.4	-17.1	-15.7
	R-	69	0.3	7.4	7.7	-7.9	-4.0	-6.3	4.4	-11.3	-6.9
	V-	69.5				-8.6	-10.4	-7.7	4.1	-9.1	-4.9
	R-	70	-1.3	0.4	-0.9	-5.1	-8.6	-4.6	3.7	-14.2	-10.4
Michaels Cut (R-73 to R-70.5)	V-	70.5				-2.2	5.4	0.1	0.9	-14.2	-13.3
	R-	71	-1.1	2.0	0.9	-1.8	3.5	1.1	0.7	-8.7	-7.9
	V-	71.5				-3.3	-5.6	-1.0	0.5	0.2	0.7
	R-	72	0.0	1.5	1.5	-8.2	-0.9	-7.1	0.4	7.3	7.7
	V-	72.5				-4.0	-14.8	-3.5	0.4	-2.3	-2.0
	R-	73	-0.3	0.4	0.1	-1.8	5.3	-0.7	0.2	-14.6	-14.4
South Control (R-78 to R-73)	V-	73.5				5.0	7.4	6.9	1.0	-16.1	-15.1
	R-	74	-1.6	-3.5	-5.1	6.1	8.0	9.2	2.0	-6.3	-4.3
	V-	74.5				9.7	12.2	14.1	3.5	-2.9	0.6
	R-	75	-2.4	-4.1	-6.5	8.3	22.2	12.9	2.5	-7.4	-4.9
	V-	75.5				1.2	4.3	4.4	1.9	-16.6	-14.7
	R-	76	-0.9	-3.3	-4.2	-3.8	-13.2	-3.1	0.3	-18.1	-17.8
	V-	76.5				-3.2	-0.4	-2.8	2.2	-16.2	-14.0
	R-	77	-0.1	-4.5	-4.7	4.1	5.3	3.9	3.3	-6.5	-3.2
	V-	77.5				5.5	6.8	8.5	3.8	-2.5	1.4
	R-	78	-0.5	-3.6	-4.1	5.7	13.5	8.9	3.8	-1.1	2.7

5.0 Discussion

The following discusses the findings of the shoreline and volume change analysis (Section 4.0).

5.1 Mean Sand Grain Size

Shoreline and volume change rates were compared to the mean grain size (d_{50}) presented in Section 3.0. The purpose of showing the variation of grain size within the project limits is to determine if there is a correlation between the sand grain size placed during the construction of the 2008 and 2019 Projects, and the shoreline and volume trends documented in Sections 4.2.1 and 4.2.2. ***Figure 11*** shows the historic mean grain size (d_{50}) compared to the post-construction volume changes. The post-construction volume changes are shown for the 2008 Project (2009-2014) and the 2019 Project (2019-2023). Both pre- and post-construction sand sampling for the 2008 Project showed a decrease in d_{50} from north to south (***Figure 11***, purple dots and diamonds). The pre-construction sand sampling for the 2019 Project also reflected this trend (***Figure 11***, green dots), however the post-construction sand sampling for the 2019 Project showed a more uniform

distribution of d_{50} values along the length of the shoreline. Additionally, the 2019 post-construction sand samples showed larger d_{50} values within the Stumphole Section than the 2009 post-construction samples. The volume change rates indicate that although coarser material was placed within the Stumphole Section during the 2019 Project compared to the 2008 Project, the post-construction volume change rate trends were similar for both projects. The maximum volume change rate between 2009 and 2014 was -47.0 yds^3/lf/yr at R-104.5 and the maximum volume change rate between 2019 and 2023 was -46.1 yds^3/lf/yr, 2,500 feet to the north, at R-103 (***Figure 11***).

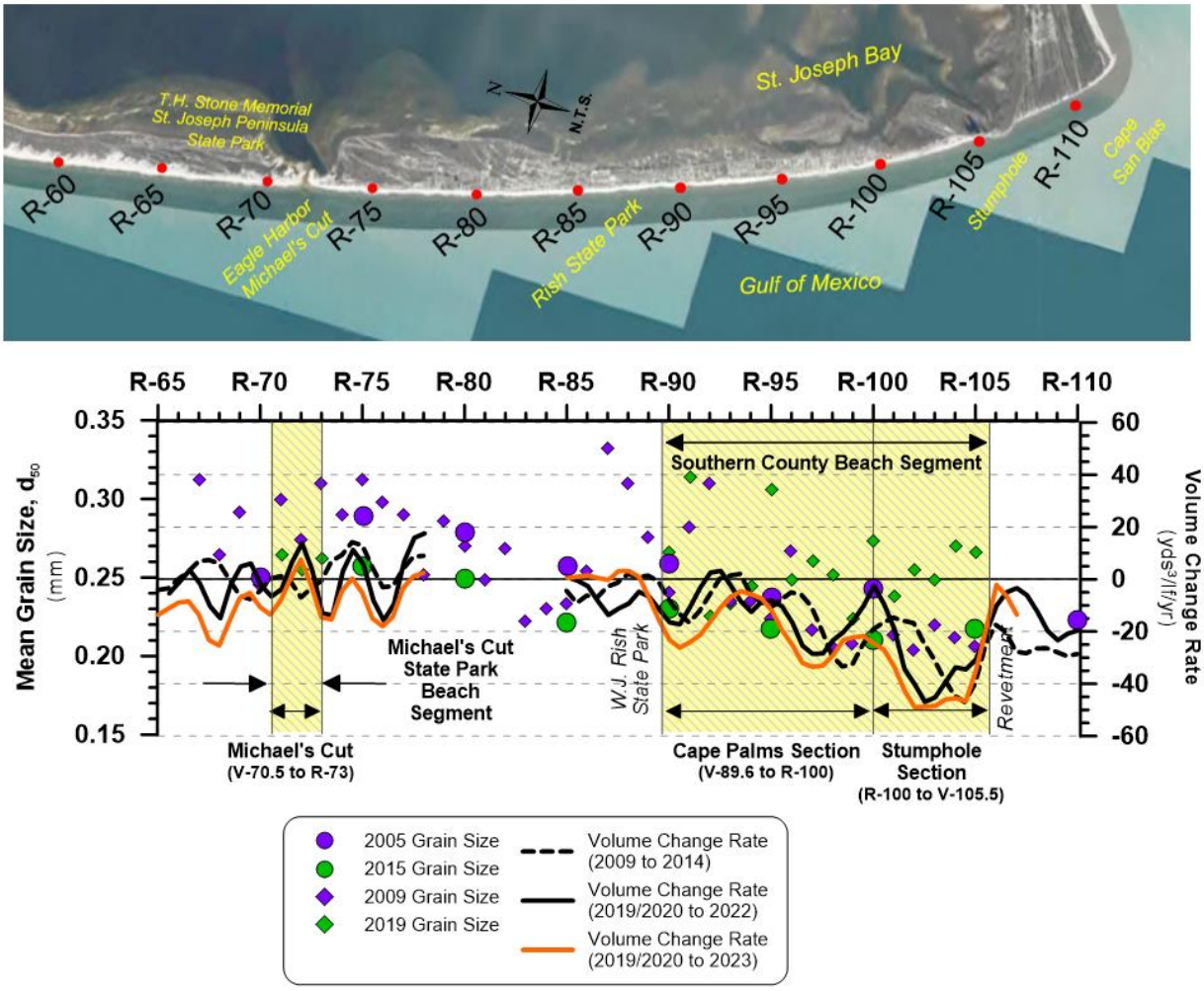

Figure 11. *Historical mean grain size (d_{50}) data vs. post-construction volume change rates.*

5.2 Total Volume Losses

A useful barometer for gauging project performance is tracking the overall volume within the beach fill limits over time. During construction of the 2019 Project, a total of 721,759 yds^3 of sand was placed within the Southern County Beach Segment (R-89.6 to R-105.5) out to the depth of closure. At the time of placement, the shoreline within the Southern County Beach Segment had

lost 1.9M yds^3 since the 2008 Project, creating a deficit of sand in the system of 1.2M yds^3 (Section 4.1.2). Since the construction of the 2019 Project, the shoreline within the Southern County Beach Segment has lost a total of -1,373,500 yds^3, increasing the deficit of sand in the system to 2.6M yds^3.

Within the Michael's Cut State Park Beach Segment, 154,693 yds^3 was placed between R-70.5 and R-73 to restore the Michael's Cut Breach at Eagle Harbor. Since the construction of the State Park Beach Segment, the shoreline between R-70.5 and R-73 has lost -63,700 yds^3, largely because of changes below the MHWL at the project boundaries.

During construction of the NFWF Project, a total of 78,930 yds^3 was placed within the Southern County Beach Segment (R-89.6 to R-105.5) above the MHWL. Since the construction of the NFWF Project, the shoreline within the Southern County Beach Segment has lost a total of 281,578 yds^3 above the MHWL between construction of the NFWF Project and the 2023 monitoring survey.

5.3 Erosional Hotspots

There are multiple "hotspots" that have occurred along the SJP shoreline. The Southern Sunset Condominiums are located within the Stumphole Section at approximately V-102.1. It is apparent from visual observation of the shoreline and structure and the analysis of the survey data that accelerated erosion has occurred in the vicinity of the Southern Sunset Condominiums. The seaward face of the condominium extends approximately 60 feet further seaward than the adjacent homes and within the active beach profile. ***Photo 1 (a-d)*** show the migration of the shoreline between post-construction and the 2023 monitoring survey. The maximum total volume change rate within the Southern County Beach Segment between 2019 and 2023 was -52.3 yds^3/lf/yr and occurred just south of the Southern Sunset Condominiums at V-103.

The second erosional hotspot is located within the Cape Palms Section and occurs between R-96 and R-97, near Aruba Drive. The home at the seaward end of Aruba Drive is sited approximately 120 feet seaward of the adjacent existing homes and is also located within the active beach profile. Immediately following construction (2019 to 2021), peak shoreline change rates were measured between R-96 and R-97 with a maximum shoreline recession of -72.7 ft/yr at R-97 (***Figure 6*** and ***Table 4***). Additionally, the greatest losses in total volume for the Cape Palms Section of shoreline occurred at R-97 (-34.6 yds^3/lf/yr). It is possible that the accelerated shoreline recession and volume losses between R-96 and R-97 were due to the interactions of waves and currents with the existing home at Aruba Drive which now extends into the Gulf of Mexico at times due to the shoreline erosion in the vicinity of the structure. It should be noted that between 2019 and 2023 the long-term shoreline changes peak at R-97 and R-102. From 2022 to 2023, the peak shoreline change rates were around a maximum shoreline recession of -33.3 ft/yr at R-97 and -50.6 ft/yr at R-102.5, just south of the Southern-Sunset Condominiums.

Additionally, following the construction of the 2008 Project, a "hotspot" was identified at Cape Palms Park between R-89 and R-90 (MRD, 2014). During Hurricane Michael, the townhomes (Cape Shoals) immediately to the north of Cape Palms were destroyed and were demolished prior to

the construction of the 2019 Project. Since the construction of the 2019 Project, there has been significant erosion observed at the Cape Palms Park between R-90 and R-90.5 (***Photo 2***).

Photo 1 (a-d.) *Shoreline evolution in the vicinity of the Southern Sunset Condominiums in (a) February 2020 (post-construction), (b) September 2021, (c) August 2022, and (d) August 2023 looking from south to north.*

Photo 2. *Observed "hotspot" erosion at Cape Palms in August 2023. Photo looking from south to north.*

6.0 Conclusions

The following conclusions and recommendations are as follows based on the findings of this investigation:

1. Two beach segments on SJP were nourished between September and November 2019. A total of 721,759 yds^3 was placed within the Southern County Beach Segment (R-89.6 and R-105.5) and 154,693 yds^3 was placed within the Michael's Cut State Park Beach Segment (R-70.5 and R-73).
2. The NFWF Project was constructed between February and December 2021 which placed a total of 78,930 yds^3 within the Southern County Beach Segment (R-89.6 and R-105.5).
3. A total of 1.9M yds^3 eroded within the Southern County Beach Segment between 2009 and 2019. Due to the impacts of Hurricane Michael prior to the construction of the 2019 Project and limited available funding, only 42% of the eroded volume was replaced as part of the 2019 Project.
4. The greatest erosional losses following the 2019 Project occurred on the southern end of SJP (Stumphole Section) with a maximum volume change rate of -52.3 yds^3/lf/yr at R-103.
5. The shoreline and volume changes were compared to the mean grain size (d_{50}) trends. The mean grain size of the material placed as part of the 2008 Project showed a decreasing (fining) trend from north to south. The material placed as part of the 2019 Project showed a more uniform distribution of the d_{50} over the project limits. Despite the differences in d_{50}, the shoreline and volume changes following both projects showed similar trends.
6. Since the construction of the 2019 Project, a total of -1,373,500 yds^3 (190% of volume placed during 2019 Project) has eroded within the Southern County Beach Segment.

7. The Michael's Cut State Park Beach Segment has lost -63,700 yds^3 since the project was constructed. The losses along the Michael's Cut State Park Beach Segment were largely due to erosion at R-70 and R-73.
8. Three (3) persistent "hotspots" continue along SJP, located at the Southern Sunset Condominiums (R-102.1), Aruba Dr (R-96.9), and Cape Palms (R-90.7).
9. Future nourishment efforts will likely include the construction of multiple coastal structures within the Stumphole Section of shoreline (R-100 to R-105.5). Coastal structures will decrease the erosion rate, retain placed sand, and anchor future beach fill to increase the longevity of the project tentatively scheduled for construction in November of 2024.
10. The next monitoring investigation will be performed in the summer of 2025 per DEP permit requirements. This five-year post-construction monitoring investigation will further refine our knowledge and background information to track the restoration project, plan future nourishment, and adjust, if necessary.

7.0 References

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APPENDIX A Survey Plan Views

APPENDIX B Monitoring Profiles

(Topographic and Offshore Profiles)

APPENDIX C Control Monuments

APPENDIX D Photos