2020 SOUTH MARCO BEACH NOURISHMENT PROJECT
TWO-YEAR POST-CONSTRUCTION
ANNUAL MONITORING SUMMARY

April 2022

DEP PERMIT 0235209-008-JC
USACOE PERMIT SAJ-2005-2726(SP/MOD-MMB)

COLLIER COUNTY

PREPARED BY
HUMISTON & MOORE ENGINEERS
HM File No. 29018

SUBMITTED TO:
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

Main Office :
5679 Strand Court
Naples, FL 34110
Phone 239 594 2021
Fax 239 594 2025
e-mail :
mail@humistonandmoore.com

2020 SOUTH MARCO ISLAND BEACH NOURISHMENT PROJECT
TWO-YEAR POST-CONSTRUCTION ANNUAL MONITORING REPORT

APRIL 2022

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INTRODUCTION

This report by Humiston & Moore Engineers (H&M) presents the analysis of a post-construction survey conducted in January of 2022. This is third monitoring survey to be conducted subsequent to the 2020 beach renourishment project completed on April 9, 2020. The survey was conducted by Sea Diversified, Inc. (SDI) between January 4th & 13th, 2022 based on the requirements of the State of Florida Department of Environmental Protection (DEP) permit 0235209-008-JM dated June 27, 2016, U.S. Army Corps of Engineers (USACOE) permit SAJ-2005-2726(SP/MOD-MMB) issued January 6, 2006, and the Physical Monitoring Plan prepared by Coastal Engineering Consultants, Inc. approved by DEP on August 2, 2012 provided in **Appendix A**. The monitoring requirements pertaining to the Central Marco Beach Regrading project, having a survey scope ranging from DEP reference monument R-130 south to R-146, is addressed in a separate report. Recent DEP permit history is summarized in **Table 1**.

Table 1. Permit History for DEP Permit Number 0235209-001

Modification Number	Date of Issuance	Description
001-JC	December 22, 2005	Beach Nourishment from R-144 to 600' south of R-148
002-EM	December 27, 2006	Regrading from R-135.5 to R-144
003-JC	October 11, 2012	15-Year Permit for Beach Nourishment from R-144 to G-4
004-BE	September 21, 2012	De-Minimis to Repair Breakwaters and Groins
005-JN	February 8, 2013	Regrading from R-134.5 to R-143
006-JP	February 21, 2013	Letter of Consent to use the Caxambas Pass Borrow Area
007-JN	February 22, 2016	Authorizes Upland Sources of Sand
008-JM	June 27, 2016	Central Marco Island Beach Regrade Project Added

South Marco Island and Caxambas Pass are located in Collier County on the southwest coast of Florida as shown in **Figure 1**. The 2020 project included the placement of approximately 79,000 cubic yards (cy) of sand on the beaches of South Marco Island from dredging the borrow area in Caxambas Pass inlet between February 15th and April 9th, 2020. This project area was included within the limits of a larger nourishment and erosion control project constructed in 1991 with the placement of over one million cubic yards of sand along three sections of Marco Island's shoreline. The 1991 project design included two short groins at the south end of the island, and an erosion control structure, a segmented breakwater (shown on the report cover). DEP required the project be monitored for five years in order to determine if the breakwater was needed. The erosion without the breakwater met projected threshold limits, and construction of the breakwater was authorized after only three years of monitoring. The breakwater was constructed in 1996, and monitoring showed the breakwater reduced beach sand losses along the south nourishment segment by approximately 75%.

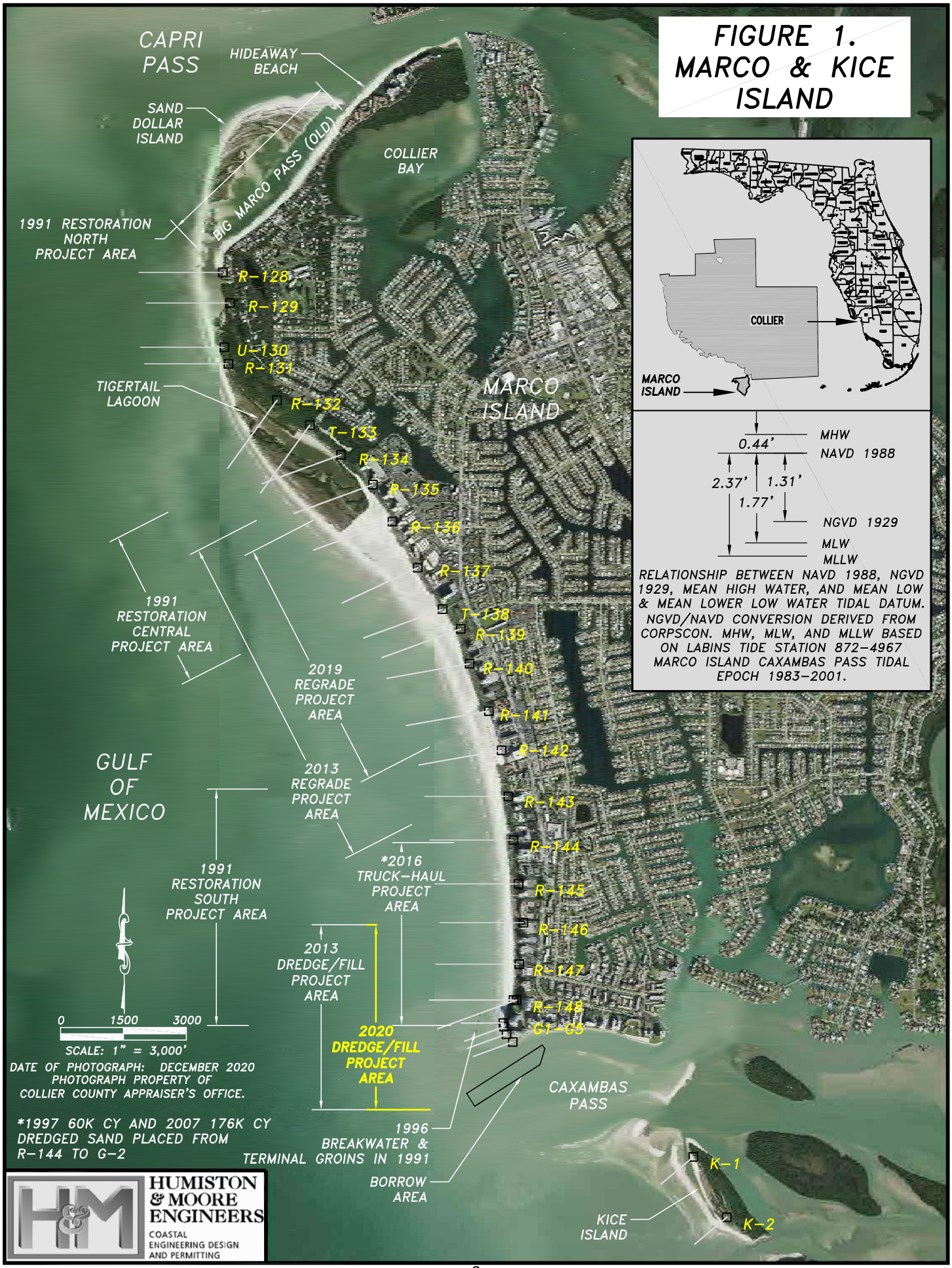
FIGURE 1.
MARCO & KICE ISLAND
CAPRI PASS
HIDEAWAY BEACH
SAND DOLLAR ISLAND
BIG MARCO PASS (OLD)
COLLIER BAY
1991 RESTORATION NORTH PROJECT AREA
R-128
R-129
U-130
R-131
TIGERTAIL LAGOON
R-132
T-133
R-134
R-135
R-136
R-137
T-138
R-139
R-140
R-141
R-142
R-143
R-144
R-145
R-146
R-147
R-148
G1-G5
MARCO ISLAND
1991 RESTORATION CENTRAL PROJECT AREA
2019 REGRADE PROJECT AREA
2013 REGRADE PROJECT AREA
GULF OF MEXICO
1991 RESTORATION SOUTH PROJECT AREA
*2016 TRUCK-HAUL PROJECT AREA
2013 DREDGE/FILL PROJECT AREA
2020 DREDGE/FILL PROJECT AREA
0 1500 3000
SCALE: 1" = 3,000'
DATE OF PHOTOGRAPH: DECEMBER 2020
PHOTOGRAPH PROPERTY OF COLLIER COUNTY APPRAISER'S OFFICE.
*1997 60K CY AND 2007 176K CY DREDGED SAND PLACED FROM R-144 TO G-2
1996 BREAKWATER & TERMINAL GROINS IN 1991
BORROW AREA
CAXAMBAS PASS
K-1
K-2
KICE ISLAND
COLLIER
MARCO ISLAND
0.44'
MHW
NAVD 1988
2.37'
1.31'
1.77'
NGVD 1929
MLW
MLLW
RELATIONSHIP BETWEEN NAVD 1988, NGVD 1929, MEAN HIGH WATER, AND MEAN LOW & MEAN LOWER LOW WATER TIDAL DATUM. NGVD/NAVD CONVERSION DERIVED FROM CORPSCON. MHW, MLW, AND MLLW BASED ON LABINS TIDE STATION 872-4967 MARCO ISLAND CAXAMBAS PASS TIDAL EPOCH 1983-2001.
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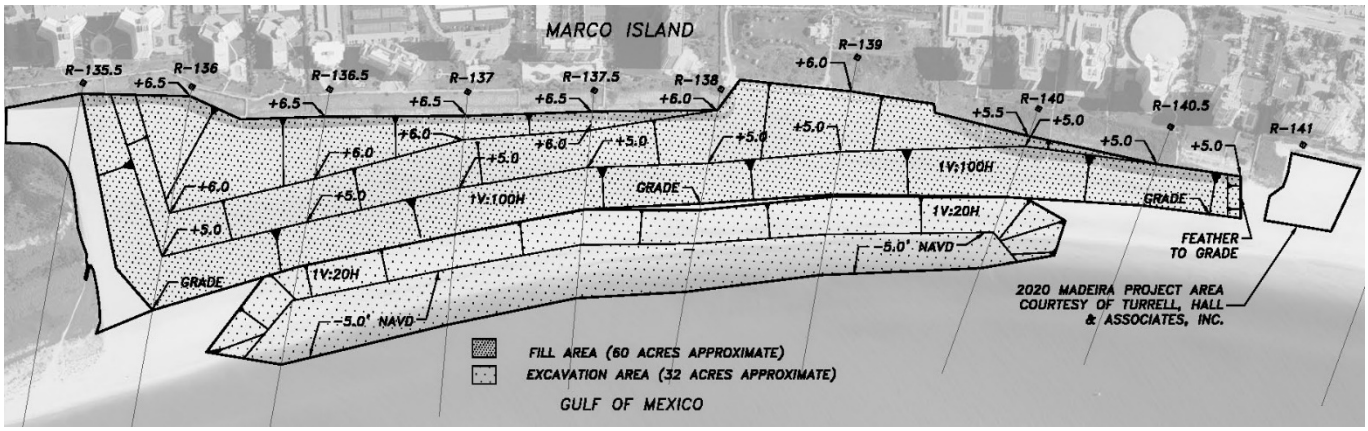
In June of 2016 permit modification 0235209-008-JM was issued authorizing the Central Marco Beach Regrading shown in **Figure 2** from DEP reference monument R-135.5 south to R-141.5, located at the northernmost end of the monitoring area addressed in this report, and includes part of the central beach project area nourished in 1991. Construction of this portion of the project was completed in April 2019; a separate annual monitoring report is conducted for the project.

Figure 2. 2019 Central Marco Island Regrade Project



On April 9, 2020 the 2020 South Marco Island Beach Nourishment Project, shown in **Figure 3a**, was completed placing approximately 79,100 cubic yards of sand dredged from Caxambas Pass on the beach from monument R-146 south to G-4. Additionally, the contractor, Florida Dredge & Dock LLC, placed approximately 4,000 cubic yards of sand dredged from Caxambas Pass near monument R-141, shown in **Figure 2**, for the Madeira Condominium in coordination with the agent for the project, Turrell, Hall & Associates, authorized under DEP Consent Order OGC Case No. 19-1445 dated December 18, 2019. An onsite screening process was employed to remove shell prior to placement of the dredged material on the beach. The process removed approximately 4,800 cubic yards of shell used to improve part of the Tigertail Beach vehicle access; the balance was barged to a local barge loading/unloading area near East Marco Bay and was hauled offsite by a contractor, Earthtech Enterprises. The severance fee for the material hauled offsite was submitted to the DEP on December 7, 2020.

BACKGROUND

- 1989: Permit 111460389 issued by FDEP authorizing the long-term renourishment of Marco Island and the construction of three offshore breakwater segments and two terminal groins at the south end of Marco Island.
- 1991: Beach restoration project placed approximately 575,000 cubic yards of sand on the south beach segment of Marco Island and included the construction of two terminal rock groins. The Notice to Proceed with breakwater construction was withheld pending 5 years of monitoring to provide additional justification for the erosion control structure. Three years of monitoring were deemed sufficient to satisfy the DEP that the breakwater was necessary.
- 1996: The construction of the segmented breakwater, authorized as part of the original design and consisting of three segments to reduce sand losses into Caxambas Pass, was given a Notice to Proceed from DEP, and the structure was built. The design was updated to stagger the structures for improved performance, out of consideration of local tidal currents.
- 1997: South Marco Beach Nourishment placed approximately 60,000 cubic yards of sand on the beach from dredging at Caxambas Pass. Minor amounts (~10,000 cy) of sand were brought by truck in ’98 & ’99.
- 2004: Hurricane Charley impacted the area on August 13, 2004 with landfall approximately 50 miles north of Caxambas Pass.
- 2005: The center of Hurricane Wilma, moving from SSE to NNW, passed south of the project area in October.

- 2007-January: South Marco Island Beach Nourishment Project placed approximately 176,000 cubic yards of sand dredged from Caxambas Pass onto the beach.
- 2008-August: Tropical Storm Fay passed within approximately 2 miles of the project area.
- 2012-June: Tropical Storm Debby passed by offshore in the Gulf of Mexico but significantly impacted Collier County beaches and the west coast of Florida.
- 2013-April: The Caxambas Pass Borrow Area was dredged and placed approximately 80,000 cubic yards of sand on the South Marco Island beach.
- 2013-April to September: Rehabilitation of the three breakwater segments and the terminal groins located on the north side of Caxambas Pass. This was done to restore the structures to the original design template, made necessary due to potential foundation settlement and possibly armor stone consolidation from numerous storms listed above. Approximately 2,700 tons of armor stone were added to the breakwater (1,375 tons) and groins (1,320 tons) to restore the structures to original design criteria. To put this in perspective the original breakwater construction used approximately 10,000 tons of armor stone.
- 2014-August: The first annual monitoring survey of the 2013 South Marco Nourishment Project was conducted by Morgan & Eklund.
- 2015-August: The second annual monitoring survey was conducted by SDI.
- 2016-January: The City of Naples, approximately 20 miles north of Marco Island, experienced a meteotsunami[2] in January 2016. A graph of the observed water levels at the Naples tide station on January 17, 2016 documenting the meteostunami is included in **Appendix B**.
- 2016-February: DEP permit modification 0235209-007-JN was issued authorizing the placement of sand within the project area from an upland source.
- 2016-March: The third annual monitoring survey was conducted by SDI.
- 2016-November: Approximately 13,200 cubic yards of truck-hauled sand from Stewart Mining located in Immokalee, Florida was placed in the project area from DEP reference monument R-144 south to Station G-2. The project was constructed to restore storm losses as a result of Tropical Storm Debby, impacting the area in June 2012, as authorized by the Federal Emergency Management Agency (PA-04-FL-4048-PW-01079).[1]
- 2017-February: The fourth annual monitoring survey was conducted by SDI.
- 2017-September: The eye of Hurricane Irma passed directly over Marco Island as a Category 3 major hurricane. The storm track is documented in **Appendix B** with brief descriptions of major storms impacting Collier County beaches since 2004, including a meteotsunami[2] impacting the County in December 2018.
- 2017-September: LIDAR survey by NOAA was conducted along the southwest coast of Florida including Kice Island and the Caxambas Pass borrow area.
- 2017-October: Post-Irma survey of the beach conducted to quantify storm impact by APTIM.
- 2018-December: Collier County was impacted by a meteotsunami[2]. A graph showing the observed water levels at the Naples Tide Station on December 20 is included in **Appendix B**.
- 2019-February: The sixth annual post-construction monitoring survey was completed by SDI.
- 2019-April: The Central Marco Regrade Project was completed.
- 2019-July: The Central Marco Regrade Project Post-Construction Monitoring Report was submitted to DEP.
- 2020-April: The South Marco Island Nourishment Project was completed, and the first post-construction monitoring survey was conducted by SDI.

[1] 2016 South Marco Tropical Storm Debby Beach Restoration Project Post-Construction Report, CB&I Coastal Planning & Engineering, Inc.

[2] Meteotsunamis have the characteristics similar to earthquake-generated tsunamis, but are caused by air pressure disturbances often associated with fast moving weather systems, such as squall lines. These disturbances can generate waves in the ocean that travel at the same speed as the overhead weather system. Development of a meteotsunami depends on several factors such as the intensity, direction, and speed of the disturbance as it travels over a water body with a depth that enhances wave magnification. NOAA 2015. (As with a tsunamis and wind generated waves, wavelength and celerity decrease as it moves into shallow water, increasing wave steepness and causing the wave to break.)

- 2021-April: The Central Marco Regrade Project One-Year Post-Construction Monitoring Report was submitted to DEP.
- 2022-January: The second annual post-construction monitoring survey was completed by SDI.

DESIGN PLAN

The 2020 project beach fill area ranges from R-146 located at the north end of the fill template, south to G-4 using the borrow area as shown in **Figure 3a**. Approximately 79,100 cubic yards of sand were placed in the fill template having a landward elevation of +4.2 NAVD, sloping seaward on a 1:100 slope to the top of the foreshore slope at +3.2 NAVD and then descending to existing grade on a 1:10 construction slope. The Caxambas Pass Borrow Area has a maximum permitted dredge depth of -18.3 NAVD. Vibracores were collected and analyzed prior to the project leading to a refined segmented borrow area design within the limits of the permitted borrow area, to lessen the shell content of the material placed on the beach. An onsite screening process was incorporated to further remove shell from the fill, proving to be very effective. As aerial photograph of the project area looking southward, taken approximately two years post-construction is shown in **Figure 3b**.

Figure 3a. 2020 Design Plan

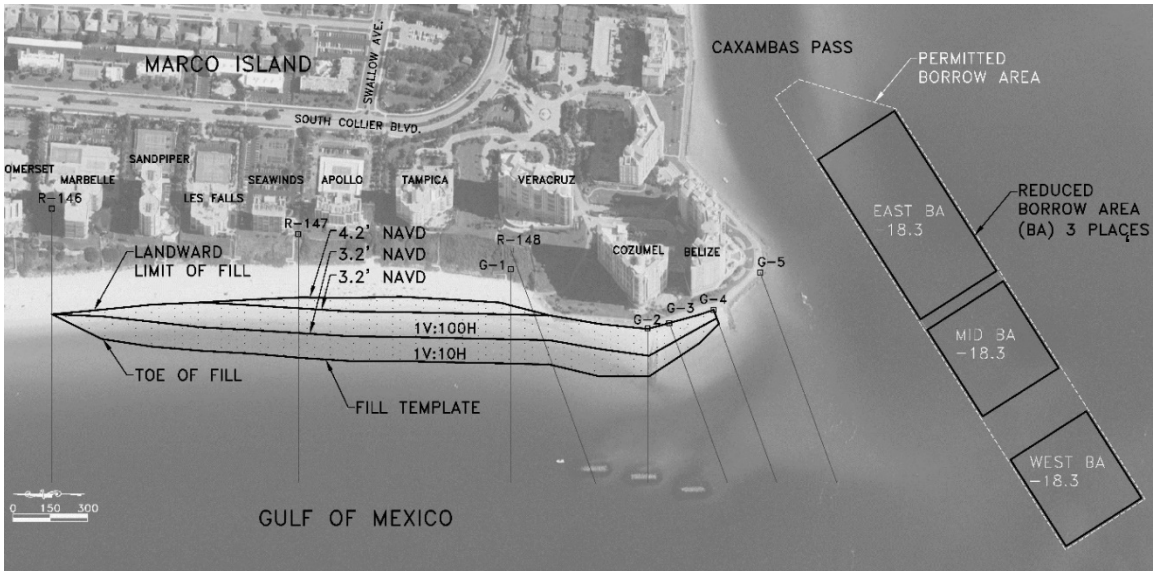
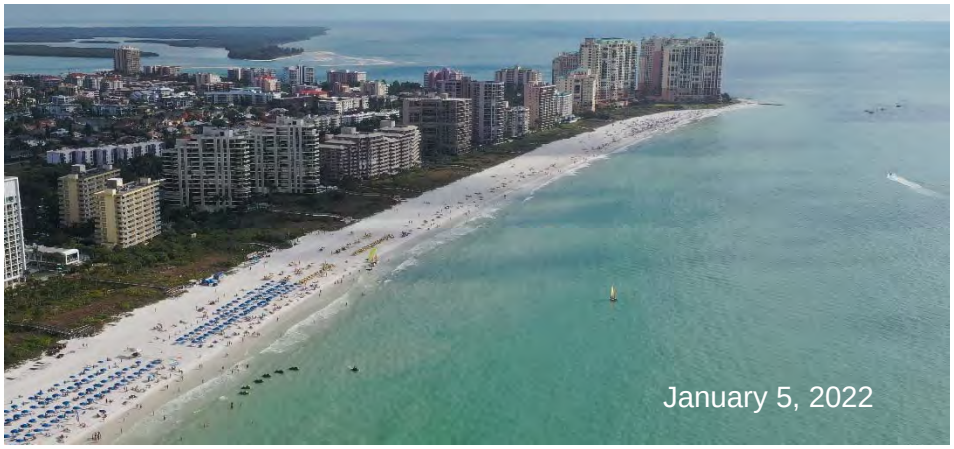


Figure 3b. January 5, 2022 Aerial Image – Two Years Post-Construction



Approximately 4,000 cubic yards of fill were placed adjacent to the Madeira Condominium near R-141 under a separate contract between the Madeira and the contractor. The work was overseen by the engineer of record in Madeira: Turrell, Hall & Associates (THA).

MONITORING SURVEY DATA

A plan view of the physical monitoring area is shown in **Figure 4** including DEP reference monuments R-139 south to G-5 on the northern side of Caxambas Pass, K-1 & K-2 south of the pass on Kice Island, the fill, and borrow areas. The survey report for the January 2022 monitoring survey by SDI is provided in **Appendix C-1**. The analysis in this monitoring report is based on data from the surveys listed below and shown graphically on the beach profiles provided in **Appendix C-2.**

- Pre-construction monitoring survey conducted in January and February 2019 by SDI on behalf of H&M.[3]
- Post-construction monitoring survey conducted in April 2020 by SDI on behalf of H&M.
- One-Year post-construction survey conducted in February 2021 by SDI on behalf of H&M.
- Two-Year post-construction survey conducted in January 2022 by SDI on behalf of H&M.

Although the January 2022 survey was conducted 20 months (1.7 years) post-construction, it serves as the two-year post-construction monitoring survey and will be referenced accordingly throughout this report. Calculations based on time such as annual infilling rates will be calculated using the actual time elapsed rounded to the nearest month. Per the approved monitoring plan provided in **Appendix A**, the borrow was surveyed as part of the most recent monitoring survey.

[3] This survey also represents the six-year post-construction survey for the 2013 project and the pre-construction survey for the Central Marco Regrade Project (monuments R-130 south to R-146).

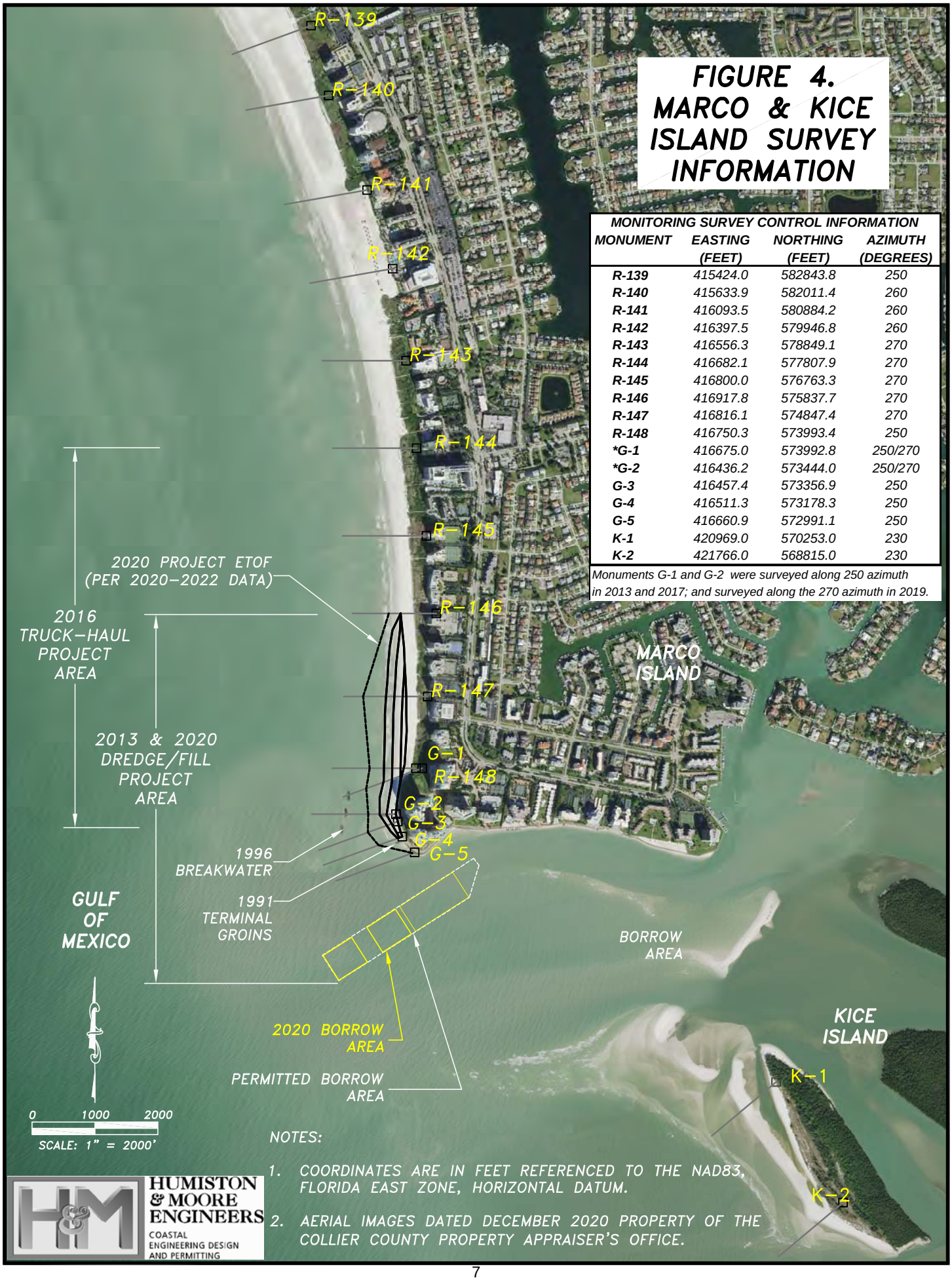


FIGURE 4. MARCO & KICE ISLAND SURVEY INFORMATION

MONITORING SURVEY CONTROL INFORMATION

MONUMENT	EASTING (FEET)	NORTHING (FEET)	AZIMUTH (DEGREES)
R-139	415424.0	582843.8	250
R-140	415633.9	582011.4	260
R-141	416093.5	580884.2	260
R-142	416397.5	579946.8	260
R-143	416556.3	578849.1	270
R-144	416682.1	577807.9	270
R-145	416800.0	576763.3	270
R-146	416917.8	575837.7	270
R-147	416816.1	574847.4	270
R-148	416750.3	573993.4	250
*G-1	416675.0	573992.8	250/270
*G-2	416436.2	573444.0	250/270
G-3	416457.4	573356.9	250
G-4	416511.3	573178.3	250
G-5	416660.9	572991.1	250
K-1	420969.0	570253.0	230
K-2	421766.0	568815.0	230

Monuments G-1 and G-2 were surveyed along 250 azimuth in 2013 and 2017; and surveyed along the 270 azimuth in 2019.

NOTES:

1. COORDINATES ARE IN FEET REFERENCED TO THE NAD83, FLORIDA EAST ZONE, HORIZONTAL DATUM.
2. AERIAL IMAGES DATED DECEMBER 2020 PROPERTY OF THE COLLIER COUNTY PROPERTY APPRAISER'S OFFICE.

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VOLUME & SHORELINE CHANGE – BEACH

Shoreline and volumetric change were determined at each monument for the February 2019 (pre-construction) , April 2020 (post-construction), February 2021 (one-year post-construction), and the January 2022 (two-year post-construction) monitoring surveys along the azimuths shown in **Table 2a** and graphically in **Figure 4**. Shoreline change is the distance between the horizontal position of the mean high water elevation on the beach face for different surveys while volumetric change compares the change in the volume of sand between surveys. By convention, positive values indicate accretion and negative values indicate erosion. **Table 2a** also designates the monitoring section limits used in this report (North of Fill, 2020 Fill Area, South of Fill and Kice Island) by grouping the DEP reference monuments.

The change in shoreline position was measured as horizontal movement of the mean high water elevation of +0.44 feet NAVD (+1.75' NGVD) where the elevation intersects the beach slope, while the offshore limits used for the volumetric analysis, also shown in **Table 2a**, are based on the intersection of the 2021 profile and the -11.8 feet NAVD (-10.5' NGVD) depth of closure contour (DOC)[4] as described and used in the previous monitoring report for consistency. Alterations in DOC were made as appropriate to account for unusual isolated volumetric changes occurring as movement of the offshore bar from storm effects. The upland limit for volumetric change analysis was determined by the landward extent of the survey data for the surveys analyzed. These limits are also shown graphically on the beach profiles in **Appendix C-2**. Additionally, the location of the equilibrated toe of fill (ETOF) is also shown along the profiles in **Appendix C-2** and **Figure 4**.

Table 2a. Profile Information for Beach Volume Change Analysis

DEP Reference Monument and Stations	2021 Azimuth Surveyed (Degrees)	Shore Perpendicular Distance from Monument to Depth of Closure (DOC) (Feet)	Section of Monitoring Area
R-139	250	1,600	North of Fill
R-140	260	1,400	
R-141	260	1,300	
R-142	260	1,200	
R-143	270	1,000	
R-144	270	1,000	
R-145	270	900	
R-146	270	1,000	2020 Fill Area
R-147	270	800	
R-148	250	850	
G-1	270	750	
G-2	270	530	
G-3	250	675	
G-4	250	700	
G-5	250	800	South of Fill
K-1	230	1,300	Kice Island
K-2	230	2,000	

[4] Depth of closure in coastal engineering terminology typically means the depth beyond which no change in bottom elevation is seen from normal coastal processes measured by monitoring surveys. The depth of -11.8 feet NAVD was established early as part of the monitoring of Collier County beaches. There are cases of sand accumulation or loss beyond -11.8 feet NAVD and in those cases the analysis is conducted further offshore to ensure analysis of data within profile closure.

The volumetric change was computed utilizing the average end area method and the distances between profiles shown in **Table 2b**. The distances represent the perpendicular segment between parallel monument azimuths, or in the case of non-parallel azimuths simply the distance between monuments.

Table 2b. Beach Volume Change – Distance between Monuments

DEP Reference Monument and Station Range			Shore Parallel Distance Between Monuments (Ft)	Section of Monitoring Area
R-139	**to**	**R-140**	859	North of Project
R-140	**to**	**R-141**	1,190	
R-141	**to**	**R-142**	976	
R-142	**to**	**R-143**	1,109	
R-143	**to**	**R-144**	1,041	
R-144	**to**	**R-145**	1,045	
R-145	**to**	**R-146**	926	
R-146	**to**	**R-147**	990	2020 Fill Area
R-147	**to**	**G-1**	855	
G-1	**to**	**G-2**	549	
G-2	**to**	**G-3**	90	
G-3	**to**	**G-4**	186	
G-4	**to**	**G-5**	227	South of Project
Caxambas Pass				
K-1	**to**	**K-2**	1,614	Kice Island

Monument G-1 was used in lieu of R-148 for the volumetric computation due to the proximity of the monuments, and the consistency of the azimuth for the survey data collection adjacent monuments.

Figure 5 is a schematic depiction of the elements involved in the analysis of shoreline and volume change in this report. Two adjacent DEP reference monuments and associated monitoring azimuths are shown along with the mean high water line (MHWL) and approximate DOC. Also shown are comparative beach profiles at the adjacent monuments and the associated area change between the monitoring survey profiles to be compared. Shoreline change is the difference in the beach width for different monitoring surveys measured at the MHWL. Volumetric change, determined by the formula shown (at the bottom of the figure) for the average *end area method*, utilizes the cross-sectional area change for different monitoring surveys at adjacent monuments and the length of beach between those monument profiles. The comparative profiles are analyzed from the landward extent of the survey data to the approximate depth of closure as shown in the figure and **Table 2a**.

In the following sections of this report, corresponding values between those shown in the tables and report text are highlighted in blue for ease of reference. The volumes in cubic yards (CY) shown in the tables were rounded to the nearest value of 10, and distances are shown in feet rounded to the nearest whole number.

Figure 5. Schematic Diagram for Typical Shoreline and Volumetric Change Analysis

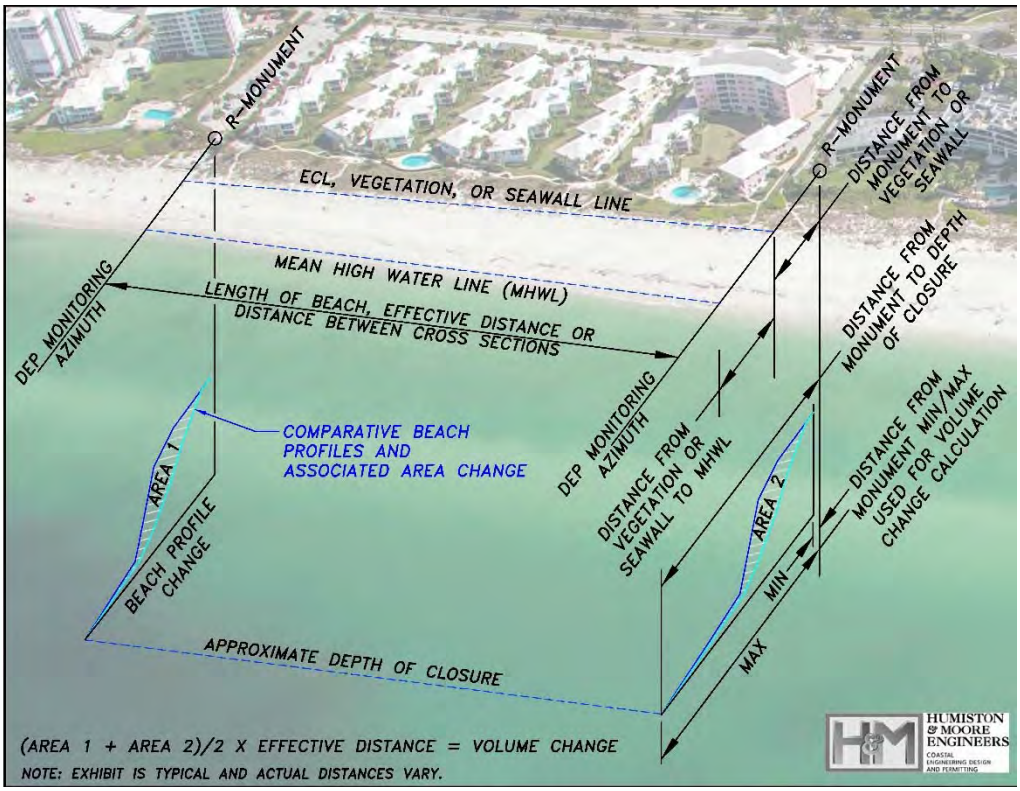


Table 3a shows the shoreline (or beach width) change for DEP reference monuments R-139 to G-5 on Marco Island and monuments K-1 and K-2 on Kice Island south of Caxambas Pass. Column 2 thru 4 (C2-C4) show shoreline change from the February 2019 pre-construction monitoring survey to the January 2022 post-construction monitoring survey for successive monitoring periods. Column 5 and 6 (C5-C6) show the cumulative change from the 2019 pre and 2020 post-construction monitoring surveys to the most recent monitoring survey conducted in January 2022. Column C5 represents the amount of additional beach width remaining since the 2020 project was constructed, or in the case of a negative value the amount of beach width lost beyond the pre-construction condition. Similarly, **Table 3b** shows the corresponding volumetric change. The 2020 project area shown with gray shading in **Tables 3a and 3b** received approximately 79,000 cy of sand during the 2020 nourishment and approximately 4,000 cubic yards of sand was placed near monument R-141 for the Madeira Condominium.[5]

The February 2019 monitoring survey was conducted prior to the *2019 Central Marco Island Regrade Project*, constructed from February to April 2019. This 2019 project included the regrading of the beach from monument R-135 south to R-141. This involved excavation of the shoreline swash zone region to provide sufficient sand to regrade the beach. The dredge template included monuments R-139 and R-140 as shown in **Figure 2**, monument R-140 was located within the taper to the existing beach at the south end of the dredge template. The relatively large change in beach width at R-140 since the pre (-44) and post-construction (58) surveys is due to the regrade project shoreline recovery. Much of the volumetric change, or swash zone region borrow area recovery, for monuments R-139 south to R-141 is located in the nearshore as shown on the beach profiles provided in **Appendix C-2**.

[5] This was managed under a separate arrangement between the Madeira Condominium and the contractor.

Table 3a. Beach - Shoreline Change

Column 1	C2	C3	C4	C5	C6
Monument	**Shorline Change (Feet)**				
	Feb. 2019 to Apr. 2020 (Pre-Post)	**Apr. 2020 to Feb. 2021 (Post-1-Yr)**	**Feb. 2021 to Jan. 2022 (1 Yr-2 Yr)**	**Feb. 2019 to Jan. 2022 (Pre-2-Yr)**	**Apr. 2020 to Jan. 2022 (Post-2-Yr)**
R-139	-101	51	7	**-44**	**58**
R-140	-3	20	-14	3	6
R-141	75	-24	-1	50	-25
R-142	10	17	-3	24	14
R-143	-11	28	7	25	36
R-144	-21	28	6	13	34
R-145	-1	-13	4	-10	-9
R-146	22	-9	8	21	-2
R-147	74	-22	-19	33	-42
R-148	117	-38	-32	47	-70
G-1	111	-36	-34	42	-70
G-2	52	-27	9	34	-18
G-3	25	17	-36	6	-19
G-4	-13	51	-32	6	19
G-5	-2	2	-1	-1	0
K-1	-31	4	5	-22	9
K-2	147	-22	69	194	47
Range	**Average Shoreline Change (Feet)**				
North of Fill (R-139 to R-145)	-7	15	**1**	**9**	**16**
2020 Project (R-146 to G-4)	56	-9	**-20**	**27**	**-29**
Kice Island (K-1 to K-2)	58	-9	**37**	86	28
Marco Island (R-139 to G-5)	22	3	-9	**17**	**-6**

Gray shading indicates 2020 project fill template location.
The 2/2029 survey also represents the pre-construction survey, monuments R-130 south to R-146, for the Central Marco Regrade Project.

The reach north of the project area shows negligible change in average width (1) and a gain of 27,000 cubic yards (27,240) of sand in the most recent monitoring period; volumetric gains in the nearshore continue south as sand feeds the reach from the north. The beach north of the project area has historically gained volume as sand from the old Big Marco Pass ebb shoal continues to migrate along the shoreline of Sand Dollar Island to the north and south. This background condition is also evident given the larger gains to the north of the monitoring area. The reach has gained 16 feet in average width and 80,000 cubic yards (82,270) of sand since the construction of the South Marco Beach nourishment project. This post-construction gain represents an average gain of 9 feet in width and almost 100,000 cubic yards (96,500) of sand more than the pre-construction condition.

Table 3b. Beach - Volume Change

Column 1	C2	C3	C4	C5	C6
Monument Range	**Volume Change (Cubic Yards)**				
	Feb. 2019 to Apr. 2020 (Pre-Post)	**Apr. 2020 to Feb. 2021 (Post-1-Yr)**	**Feb. 2021 to Jan. 2022 (1 Yr-2 Yr)**	**Feb. 2019 to Jan. 2022 (Pre-2-Yr)**	**Apr. 2020 to Jan. 2022 (Post-2-Yr)**
R-139 to R-140	-290	15,550	11,640	15,260	27,190
R-140 to R-141	17,620	7,790	7,360	25,410	15,160
R-141 to R-142	12,380	4,650	2,920	17,020	7,570
R-142 to R-143	5,660	8,080	1,930	13,730	10,000
R-143 to R-144	2,780	7,970	1,390	10,750	9,360
R-144 to R-145	440	5,750	1,940	6,180	7,690
R-145 to R-146	2,910	5,240	60	8,150	5,300
R-146 to R-147	15,560	3,490	-4,390	19,050	-900
R-147 to G-1	26,660	-2,190	-11,600	24,470	-13,790
G-1 to G-2	13,070	-3,280	-5,420	9,790	-8,700
G-2 to G-3	740	-540	-890	200	-1,420
G-3 to G-4	-770	1,820	-1,500	1,040	320
G-4 to G-5	-2,100	3,990	-3,410	1,890	580
Caxambas Pass					
K-1 to K-2	-38,720	19,350	-3,280	-19,370	16,060
Range	**Total Volume Change (CY)**				
North of Fill (R-139 to R-146)	41,500	55,030	**27,240**	**96,500**	**82,270**
2020 Project Area (R-146 to G-4)	55,260	-700	**-23,800**	**54,550**	**-24,490**
Kice Island (K-1 to K-2)	-38,720	19,350	**-3,280**	-19,370	16,060
Marco Island (R-139 to G-5)	94,660	58,320	30	**152,940**	**58,360**

Gray shading indicates 2020 project fill template location.
The 2/2019 survey also represents the pre-construction survey, monuments R-130 south to R-146, for the Central Marco Regrade Project (R-135 to R-141).

The project area from R-146 south to G-4 continues to equilibrate losing an average of 20 feet (-20) and 24,000 cubic yards of sand (-23,800) in the most recent monitoring period. Although the project area has lost 30 feet (-29) in average width and 25,000 cubic yards (-24,490) of sand since construction, the reach has an average of 27 feet (27) and 55,000 cubic yards (54,550) of sand remaining from the nourishment project. In spite of the shoreline and volumetric losses throughout the project area, the reach benefits from the predominate southward sand transport from the north.

Despite of losing 6 feet (-6) on average (R-139 to G-5) since construction, the portion of the monitoring area on Marco Island shows a gain of 17 feet (17) on average and 150,000 cubic yards (152,940) of sand remaining since the pre-construction survey in January 2019. This is due to a background accretion rate for the region on the order of 35,000 cubic yards per year (58,360/1.7).

Changes along the beach of Kice Island can be misleading due to the formation of a spit. Significant average shoreline gain (37) with associated losses in volume (-3,280) for the most recent monitoring period are mainly due to the migration of the spit.

A segmented Erosion Control Line (ECL) established in 1990 and the 2021 vegetation line were used to create a baseline to determine relative beach width. The beach width is the distance from the MHWL to either the ECL or 2021 vegetation line in reaches not containing an ECL. **Table 3c** compares beach widths for the pre-construction in February 2019, the post-construction in April 2020, the one-year post-construction in February 2021, and the two-year post-construction survey in January 2022. The average width of the project area dry beach in January 2022 is approximately 140 feet (142), roughly 20 feet greater than the pre-construction condition (118), and 20 feet less than the immediate post-construction condition (164). The beach width at R-148 was omitted from the average due to the orientation of the beach in comparison to the survey azimuth of 250°.

Table 3c. Beach Widths Pre and Post-Construction

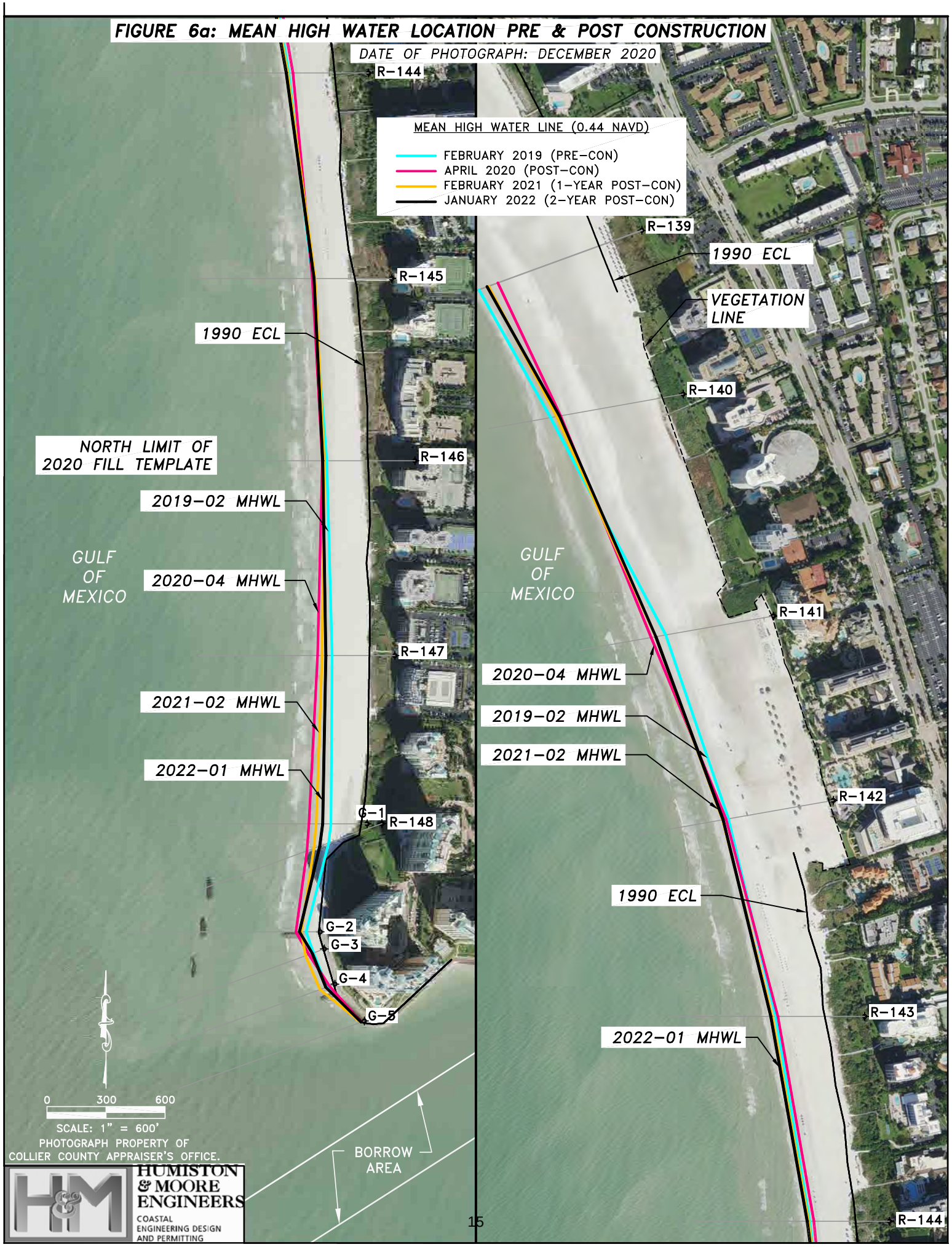
Column 1	C2	C3	C4	C5
Monument	**Beach Width (Feet)**			
	Feb. 2019 Pre-Con	**Apr. 2020 Post-Con**	**Feb. 2021 1-Year**	**Jan. 2022 2-Year**
R-139	649	547	598	605
R-140	528	525	545	531
R-141	549	624	600	599
R-142	521	530	548	545
R-143	249	238	267	274
R-144	233	212	239	246
R-145	217	217	203	208
R-146	209	232	222	230
R-147	190	264	241	222
R-148	170	287	249	217
G-1	154	266	229	196
G-2	64	116	89	98
G-3	54	79	96	60
G-4	37	24	75	43
G-5	8	6	8	6
K-1	104	73	78	82
K-2	92	239	217	285
Range	**Average Width (Feet)**			
North of Fill (R-139 to R-145)	421	413	429	430
***2020 Project (R146-R147 and G1-G4)**	**118**	**164**	159	**142**
Kice Island (K-1 to K-2)	98	156	148	184

*The beach width at R-148 was omitted from the average due to the orientation of the beach in comparison to the survey azimuth of 250°.
Gray shading indicates 2020 project fill template location.

Figures 6a shows the February 2019, April 2020, February 2021, and January 2022 MHWL overlaid on a December 2020 rectified aerial image for the portion of the monitoring area on Marco Island along with the ECL and part of the vegetation line, while **Figure 6b** shows the approximate shoreline locations south of Marco Island based on rectified aerial images[6]. **Figures 6a and 6b** map the shoreline providing a graphical presentation of the surveys and aerials, while **Table 3a** shows the shoreline change in a numerical format. The recovery of the regrade project dredge template is evident at the north end of the monitoring area, as is the shoreline recession within the project area. The Erosion Control Line (1990 ECL), provided for reference, and shown in **Figure 6a**, represents the location of the MHWL prior to the 1991 nourishment project. **Figure 6b** illustrates change in the vicinity of Kice Island, in particular the spit formation. Despite the fluctuating shoreline location, the beach remained relatively stable as evidenced in the cross sections shown in **Appendix C-2**.

[6] 2022 shoreline not shown. 2022 rectified images normally provided by the County in Spring were not available at the time this report was issued. Oblique images of Kice Island and Caxambas Pass acquired in January 2022 are provided in the report.

FIGURE 6a: MEAN HIGH WATER LOCATION PRE & POST CONSTRUCTION



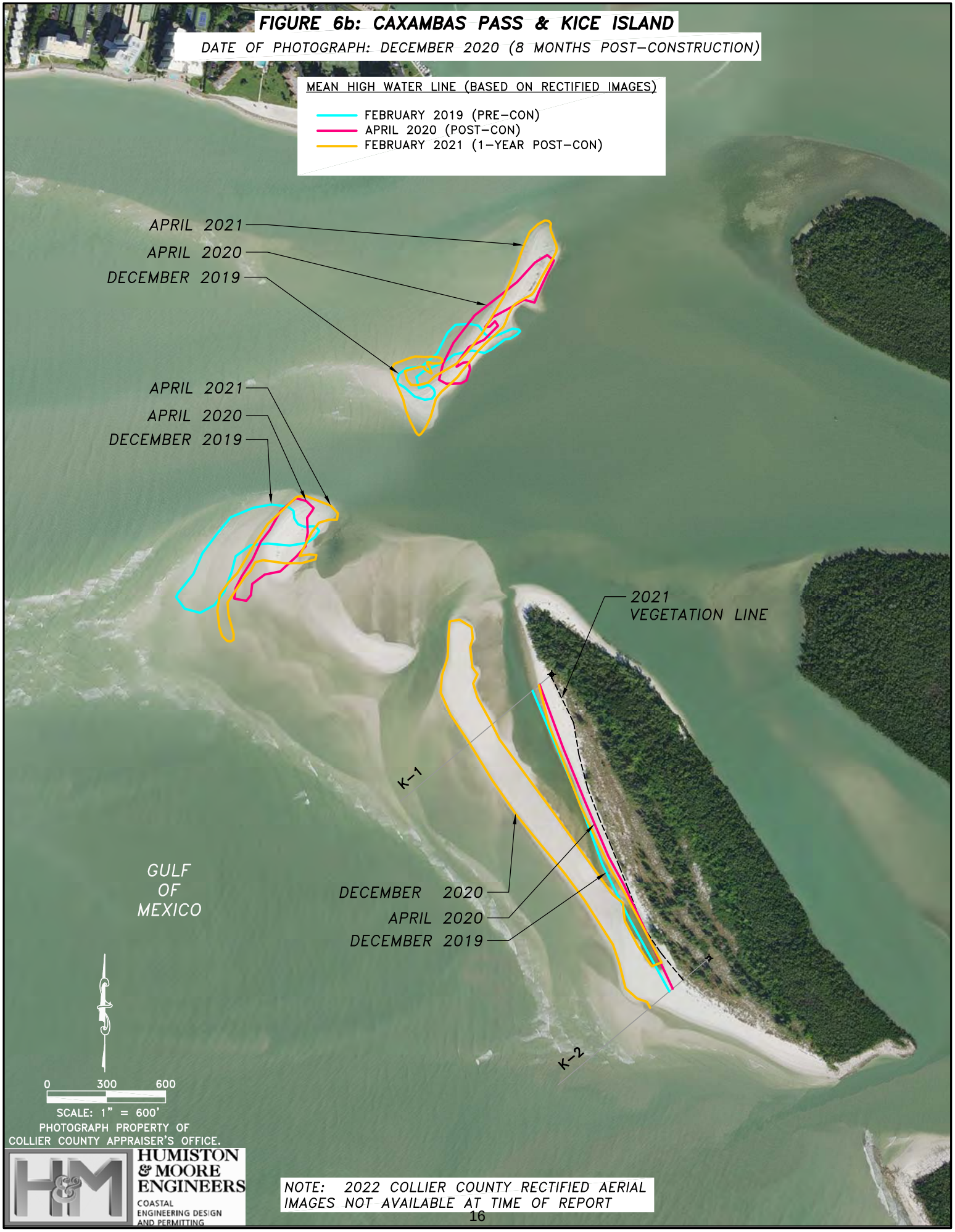
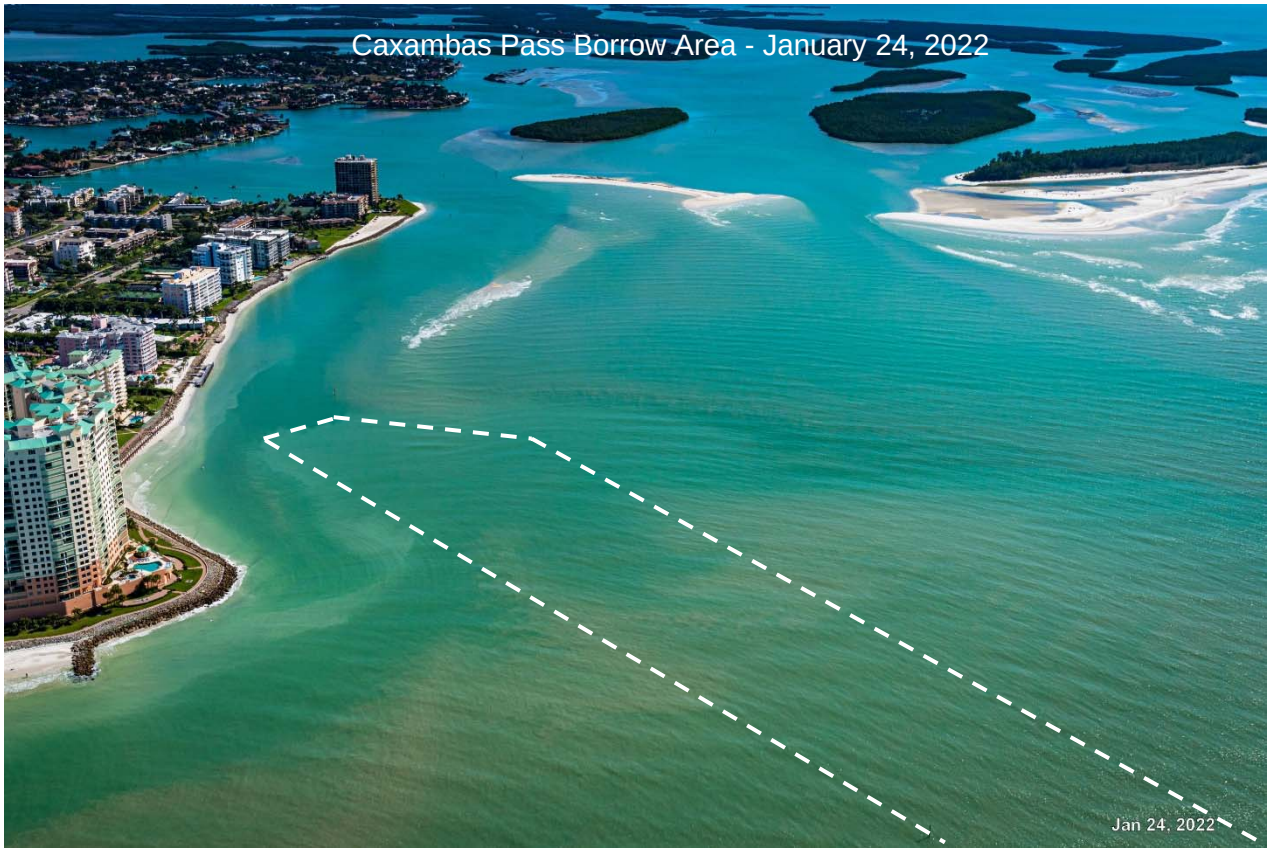


FIGURE 6b: CAXAMBAS PASS & KICE ISLAND
DATE OF PHOTOGRAPH: DECEMBER 2020 (8 MONTHS POST-CONSTRUCTION)
MEAN HIGH WATER LINE (BASED ON RECTIFIED IMAGES)
FEBRUARY 2019 (PRE-CON)
APRIL 2020 (POST-CON)
FEBRUARY 2021 (1-YEAR POST-CON)
APRIL 2021
APRIL 2020
DECEMBER 2019
APRIL 2021
APRIL 2020
DECEMBER 2019
2021 VEGETATION LINE
K-1
K-2
GULF OF MEXICO
DECEMBER 2020
APRIL 2020
DECEMBER 2019
0
300
600
SCALE: 1" = 600'
PHOTOGRAPH PROPERTY OF COLLIER COUNTY APPRAISER'S OFFICE.
HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING
NOTE: 2022 COLLIER COUNTY RECTIFIED AERIAL IMAGES NOT AVAILABLE AT TIME OF REPORT

The volumetric changes discussed in this report (and shown in **Table 3b**) are not representative of design quantities for future beach renourishment projects but rather an indication of erosion or accretion within the monitoring area. Design quantities for fill projects consider other factors as well as erosion or accretion including the existing beach width, advance nourishment requirements, predicted erosion prior to construction, storm losses, tapers, gaps, berm height, design life and beach fill end losses.

BORROW AREA

The borrow area was surveyed immediately pre and post-construction in February and April 2020 respectively, and most recently in January 2022. Approximately 90,000 cubic yards of sand were dredged from the reduced borrow area (as described in the Design Plan section of this report) during the 2020 nourishment project. There is approximately 109,000 cubic yards of sand available within the permitted template based on the January 2022 survey, representing an approximate 17,000 cubic yard gain since the April 2020 post-construction survey, and an associated infilling rate of approximately 10,000 cubic yards (17,000cy/1.7yrs) per year. **Figure 7a** shows the borrow area contours immediately post-construction in April 2020, **Figure 7b** shows the contours almost two years later in January 2022, and **Figure 7c** shows the contour change from 2020 to 2022. In **Figure 7c**, darker shades of brown represent greater material accumulation while blue shades indicate loss. Much of the material remaining in the borrow area limits after project completion had a relatively higher shell content than the material placed on the beach during the 2020 project.



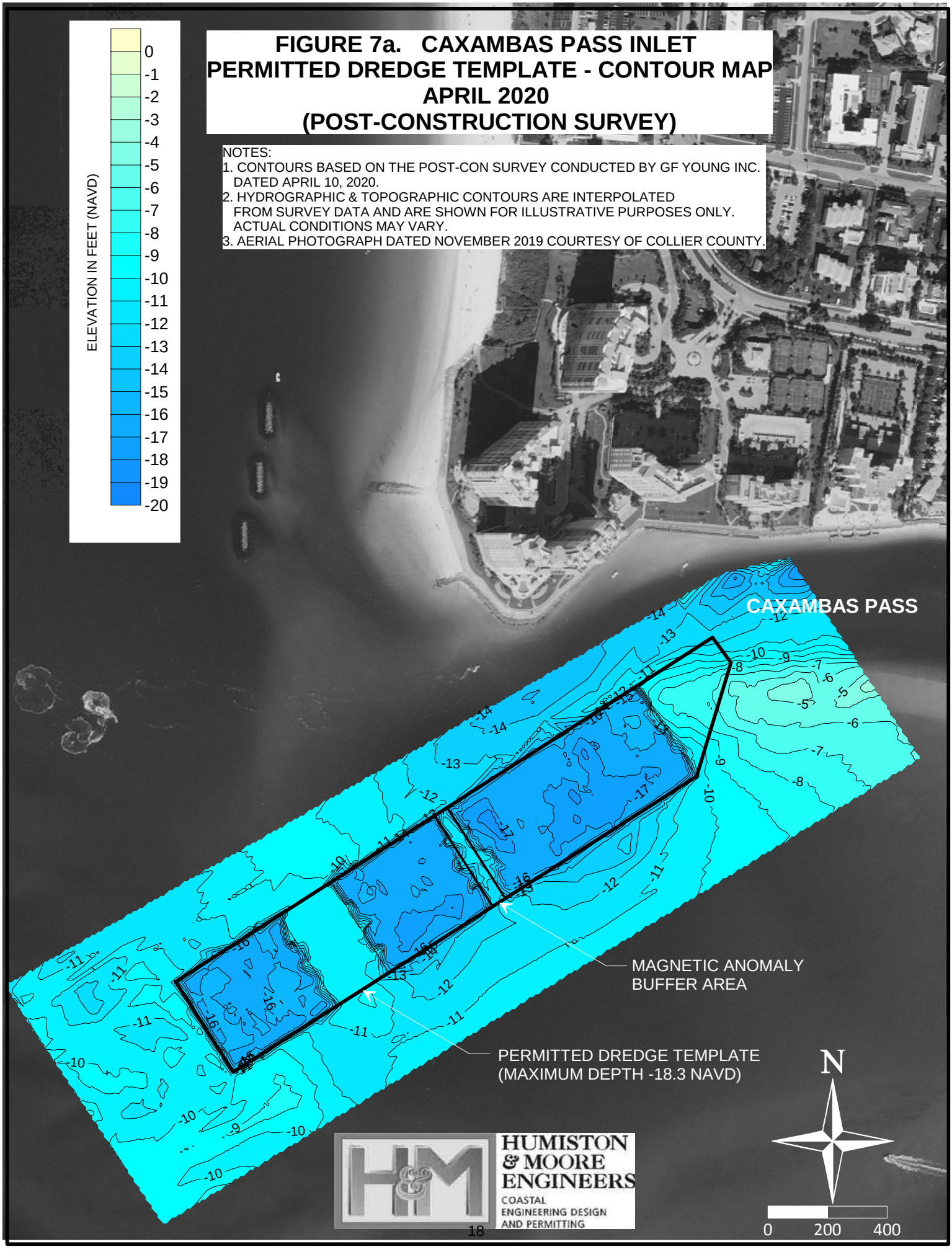
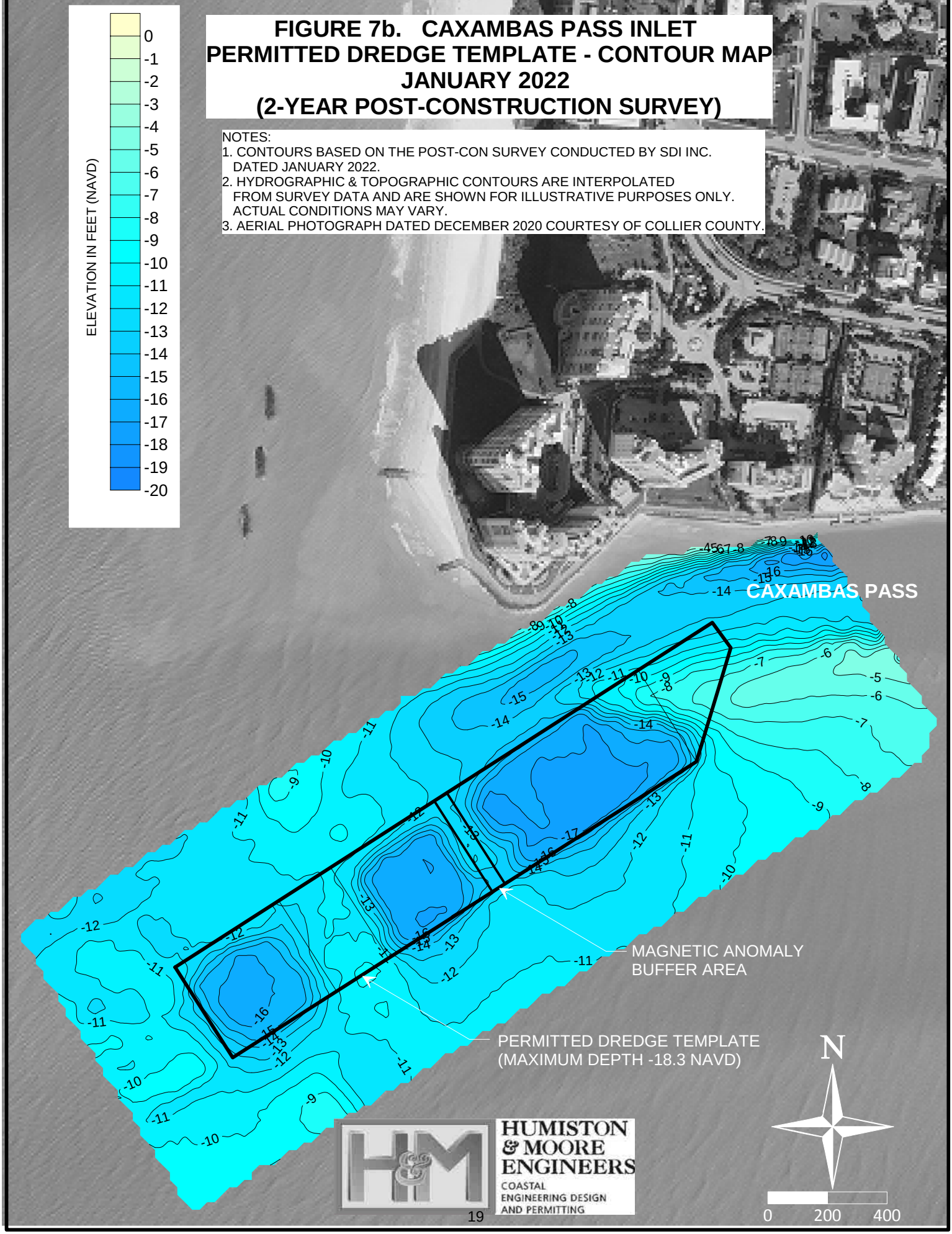

ELEVATION IN FEET (NAVD)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
-15
-16
-17
-18
-19
-20
FIGURE 7a. CAXAMBAS PASS INLET
PERMITTED DREDGE TEMPLATE - CONTOUR MAP
APRIL 2020
(POST-CONSTRUCTION SURVEY)
NOTES:
1. CONTOURS BASED ON THE POST-CON SURVEY CONDUCTED BY GF YOUNG INC. DATED APRIL 10, 2020.
2. HYDROGRAPHIC & TOPOGRAPHIC CONTOURS ARE INTERPOLATED FROM SURVEY DATA AND ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL CONDITIONS MAY VARY.
3. AERIAL PHOTOGRAPH DATED NOVEMBER 2019 COURTESY OF COLLIER COUNTY.
CAXAMBAS PASS
MAGNETIC ANOMALY BUFFER AREA
PERMITTED DREDGE TEMPLATE (MAXIMUM DEPTH -18.3 NAVD)
N
0
200
400
HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

FIGURE 7b. CAXAMBAS PASS INLET PERMITTED DREDGE TEMPLATE - CONTOUR MAP JANUARY 2022 (2-YEAR POST-CONSTRUCTION SURVEY)

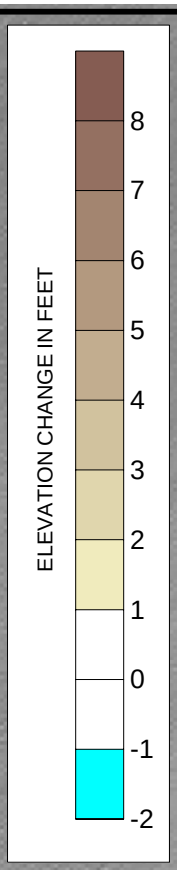
NOTES:
1. CONTOURS BASED ON THE POST-CON SURVEY CONDUCTED BY SDI INC. DATED JANUARY 2022.
2. HYDROGRAPHIC & TOPOGRAPHIC CONTOURS ARE INTERPOLATED FROM SURVEY DATA AND ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL CONDITIONS MAY VARY.
3. AERIAL PHOTOGRAPH DATED DECEMBER 2020 COURTESY OF COLLIER COUNTY.



HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

FIGURE 7c. CAXAMBAS PASS INLET
PERMITTED DREDGE TEMPLATE - CONTOUR CHANGE MAP
APRIL 2020 TO JANUARY 2022
(POST-CONSTRUCTION TO 2-YEAR POST-CONSTRUCTION SURVEY)

NOTES:
1. CONTOURS BASED ON THE G.F. YOUNG, INC. POST-CONSTRUCITON SURVEY DATED APRIL 2020 AND POST-CONSTRUCTION SURVEY DATED JAN. 2022 BY SDI.
2. HYDROGRAPHIC & TOPOGRAPHIC CONTOURS ARE INTERPOLATED FROM SURVEY DATA AND ARE SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. ACTUAL CONDITIONS MAY VARY.
3. AERIAL PHOTOGRAPH DATED DECEMBER 2020 COURTESY OF COLLIER COUNTY.



CAXAMBAS PASS

MAGNETIC ANOMALY BUFFER AREA (MAXIMUM DEPTH -13.3 NAVD)

PERMITTED DREDGE TEMPLATE (MAXIMUM DEPTH -18.3 NAVD)

CONTOURS REPRESENT A GAIN OF APPROXIMATELY 17,000 CY WITHIN THE LIMITS OF THE PERMITTED BORROW AREA FROM APRIL 2020 TO JANUARY 2022. (POST TO 2-YEAR POST-CONSTRUCTION)

N

0 200 400

HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

AERIAL IMAGES

The 2022 rectified aerial image files required under the monitoring plan and provided by the Collier County Property Appraiser's Office, in Mr. Sid format referenced to the NAD83 datum in feet Florida East Zone, will be submitted to the Department upon availability usually in spring. Additionally, aerial photographs taken in January 2022 are shown on the cover and throughout the report.

ENVIRONMENTAL

The permittee has reviewed the specific Reasonable and Prudent Measures (RPMs) and Terms and Conditions in the Revised Statewide Programmatic Biological Opinion (SPBO) dated 13 March 2015 and the Piping Plover Programmatic Biological Opinion (P3BO) dated 22 May 2013, and agreed to follow the measures included to minimize impacts to nesting sea turtles and the piping plover. Collier County (permittee) is currently conducting the sea turtle nesting monitoring program headed by Maura Kraus (MauraKraus@colliergov.net) and the shorebird monitoring program headed by Christopher D'Arco (ChristopherDarco@colliergov.net). The programs include the following:

- Sea turtle nesting monitoring is an ongoing program with the County including escarpment surveys.
- Shorebird monitoring will be conducted by the County including breeding and non-breeding birds, piping plovers and red knots. Annual shorebird data reports for the County are anticipated to be submitted by fall of 2022.
- Compaction testing and subsequent tilling is conducted by the County.
- Results of the surveys are submitted to the appropriate agencies.
- Educational material including signage, flyers, kiosks, etc. are continually reviewed and improved in part by County staff.
- Pre-construction meetings are held prior to the start of any project. Shorebird and sea turtle monitoring procedures during construction are discussed and implemented accordingly.
- The County continues to make every effort to maintain compliance with the conditions of the SPBO and the P3BO, and the conditions of the associated Corps and DEP permits.

Sea turtle monitoring reports, lighting guidelines, and Fish and Wildlife Conservation Commission Codes and Technical Reports are posted on the County website:

http://www.colliergov.net/your-government/divisions-f-r/parks-and-recreation/sea-turtle-protection/publications-reports

The Collier County Coastal Zone Management provides information to the public on a wide variety of coastal programs and projects:

http://www.colliergov.net/your-government/divisions-a-e/coastal-zone-management

And information on protected species:

http://www.colliergov.net/your-government/divisions-a-e/environmental-services/protected-species

The 2020 project was constructed from February to April 2020 with sand dredged from Caxambas Pass. There were no impacts to seagrass, hardbottom reef habitat, historical/archeological/cultural materials, shorebirds or manatees.

CONCLUSIONS & RECOMMENDATIONS

The *2020 South Marco Island Beach Nourishment Project* placed approximately 79,000 cubic yards of sand dredged from the Caxambas Pass Borrow Area on Marco Island Beach from DEP reference monument R-146 south to monitoring monument G-4 in addition to supplying approximately 4,000 cubic yards of sand to the beach near the Madeira Condominium located in the vicinity of R-141. Reference monument R-141 is located at the south end of the *2019 Marco Island Beach Regrade Project* authorized by the same permit as the *2020 South Marco Island Nourishment Project*. This annual monitoring survey was conducted in January 2022; shoreline and volume change were analyzed for beach profiles R-139 on Marco Island south to K-2 on Kice Island.

Shoreline change is compared in **Figure 8a** showing the change in beach width from the February 2019 pre-construction monitoring survey to the April 2020 and January 2022 post-construction monitoring surveys. The increase in beach width due to the 2020 project construction and the work near the Madeira Condominium at the south end of the 2019 beach regrade project is evident in the 2019 to 2020 plot. The same trend is shown in the 2019 to 2022 plot with a decrease in width near R-141 and R-148 and an associated increase in beach width to the south from R-142 to R-144 and from G-3 to G-4 as sand migrates southward. A similar trend is shown in **Figure 8b** depicting the volume change for the same time period and monitoring area. Note, there is an increase in volume north of the project area from R-139 south to R-146 as the regrade project area equilibrates.[7] **Figure 8c** plots the dry beach width for the pre, post, one-year and two-year post-construction surveys. The figure shows the average beach widths for the reach: north of the project area, the project area, and Kice Island. As shown in **Figure 8a** the project area lost width. The spit off of Kice Island continues to migrate east toward the island; volume and shoreline change can be misleading but in general the island remains stable.

[7] The 2019 regrade project reconfigured sand within the active beach profile and did not add sand to the system from an outside source.

Figure 8a. Shoreline Change - DEP Monument R-139 through K-2

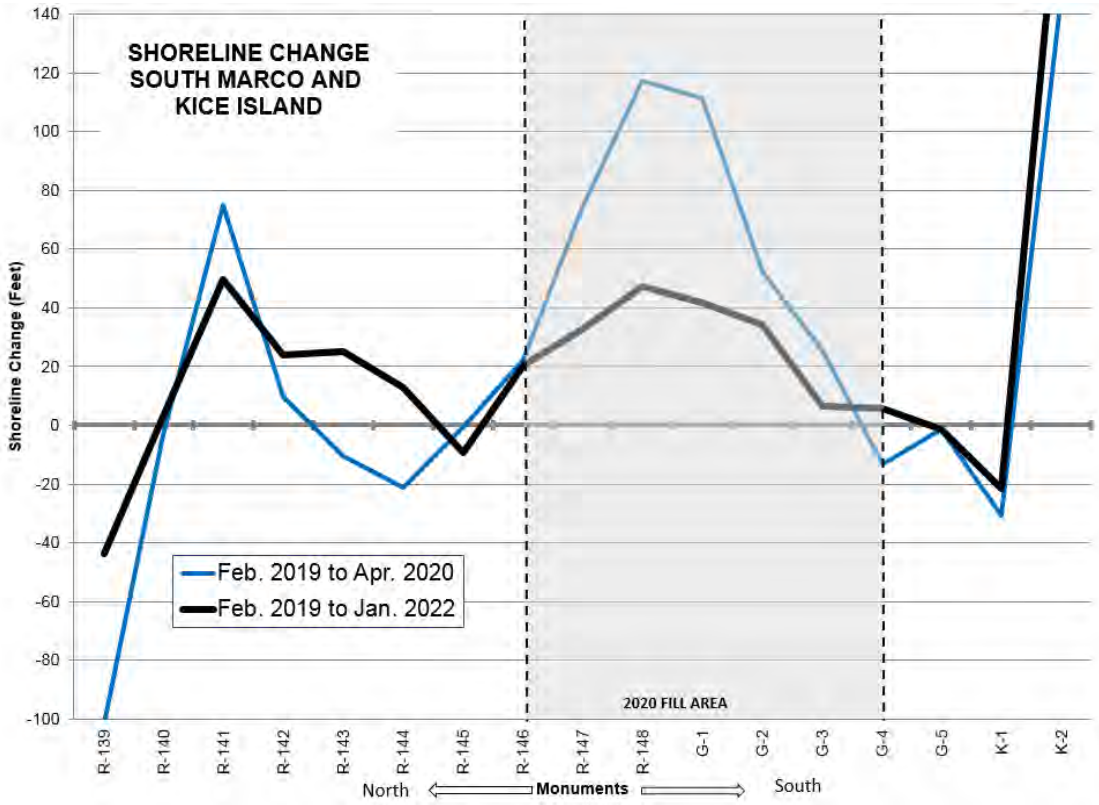
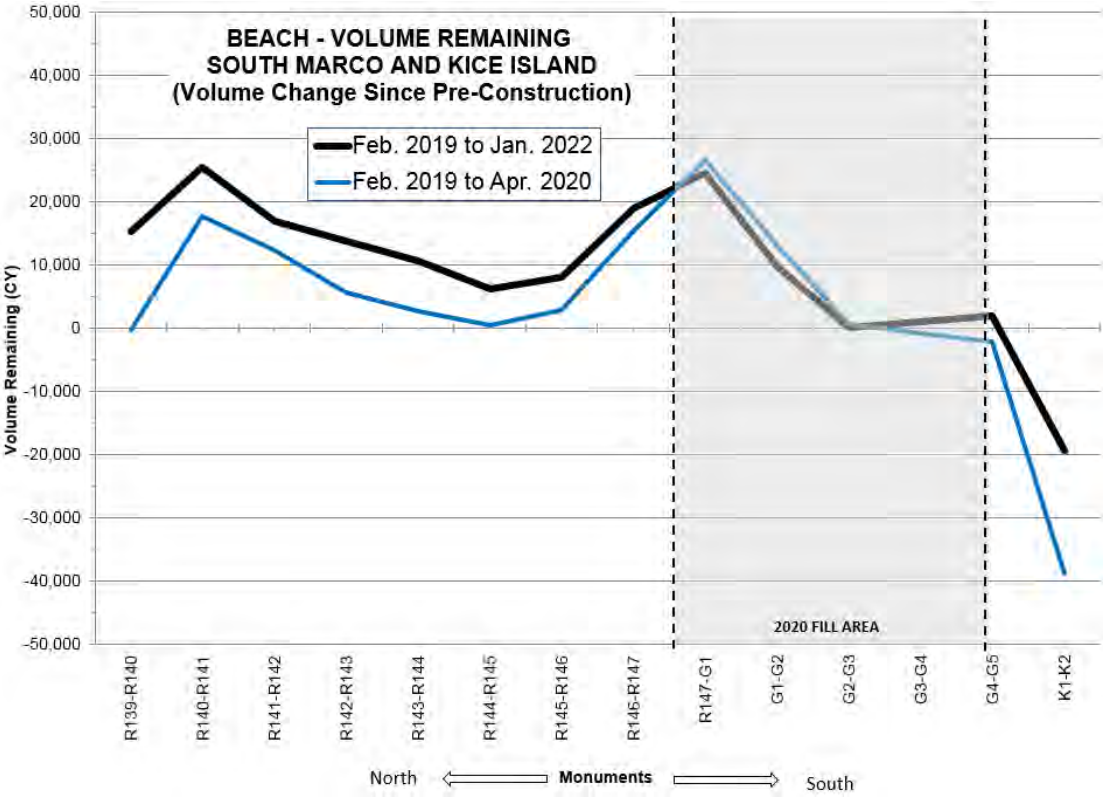


Figure 8b. Volumetric Change DEP - Monument R-139 through K-2



shaded in gray for the pre, post, and monitoring surveys. Generally, the beach width narrows from north to south ranging from 600 feet (600; Table 3c) wide at monument R-141 to approximately 10 feet (8; Table 3c) at monument G-5. Monuments G-2 through G-5 are located along the existing seawall within the groin field at the south end of Marco Island. Monument G-5, having no dry beach, is located at the south terminal groin adjacent to the north side of Caxambas Pass. The average width of the project area beach increased from 118 feet pre-construction to 142 feet two-years post-construction.

Figure 8c. Dry Beach Width

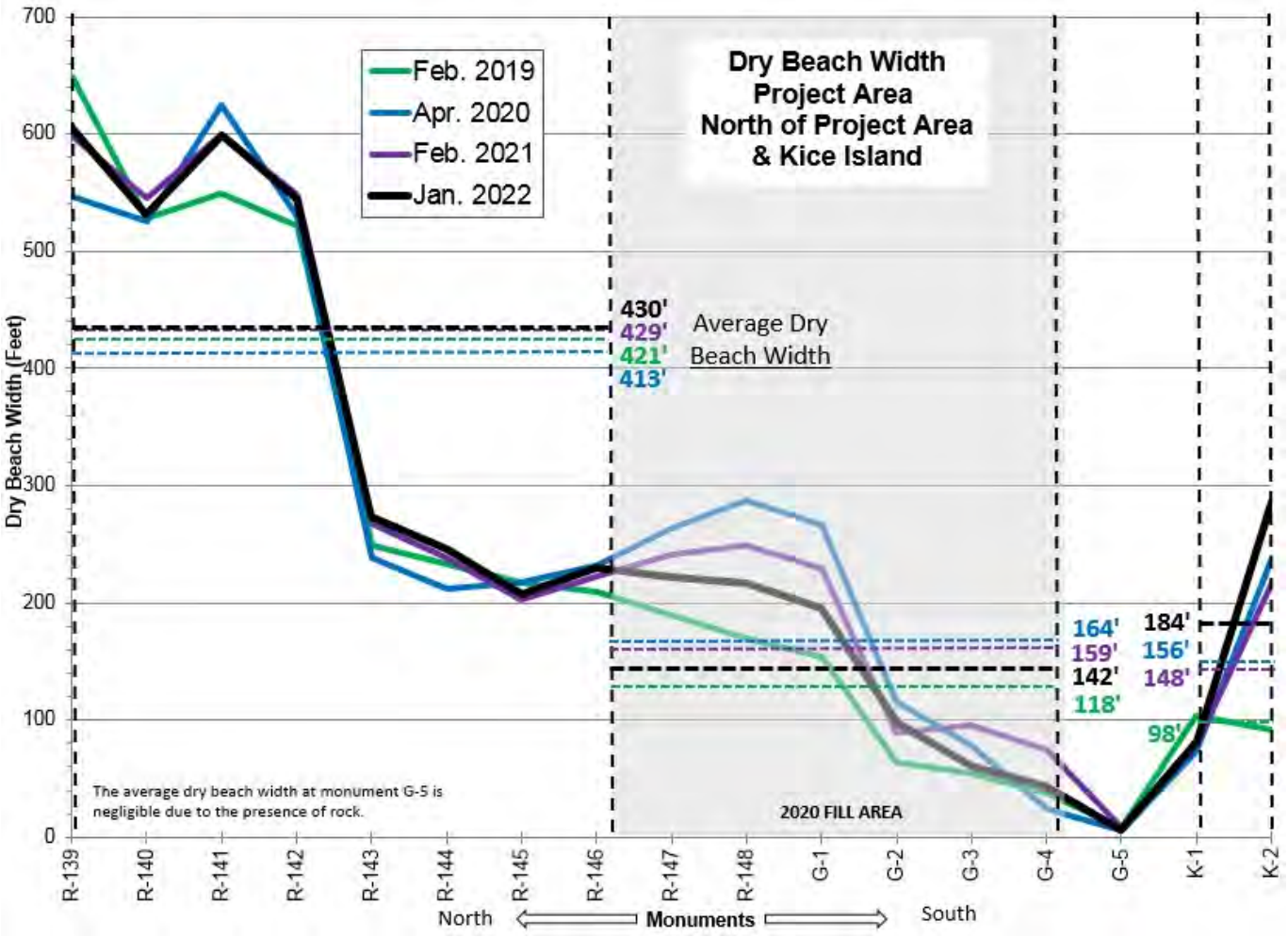
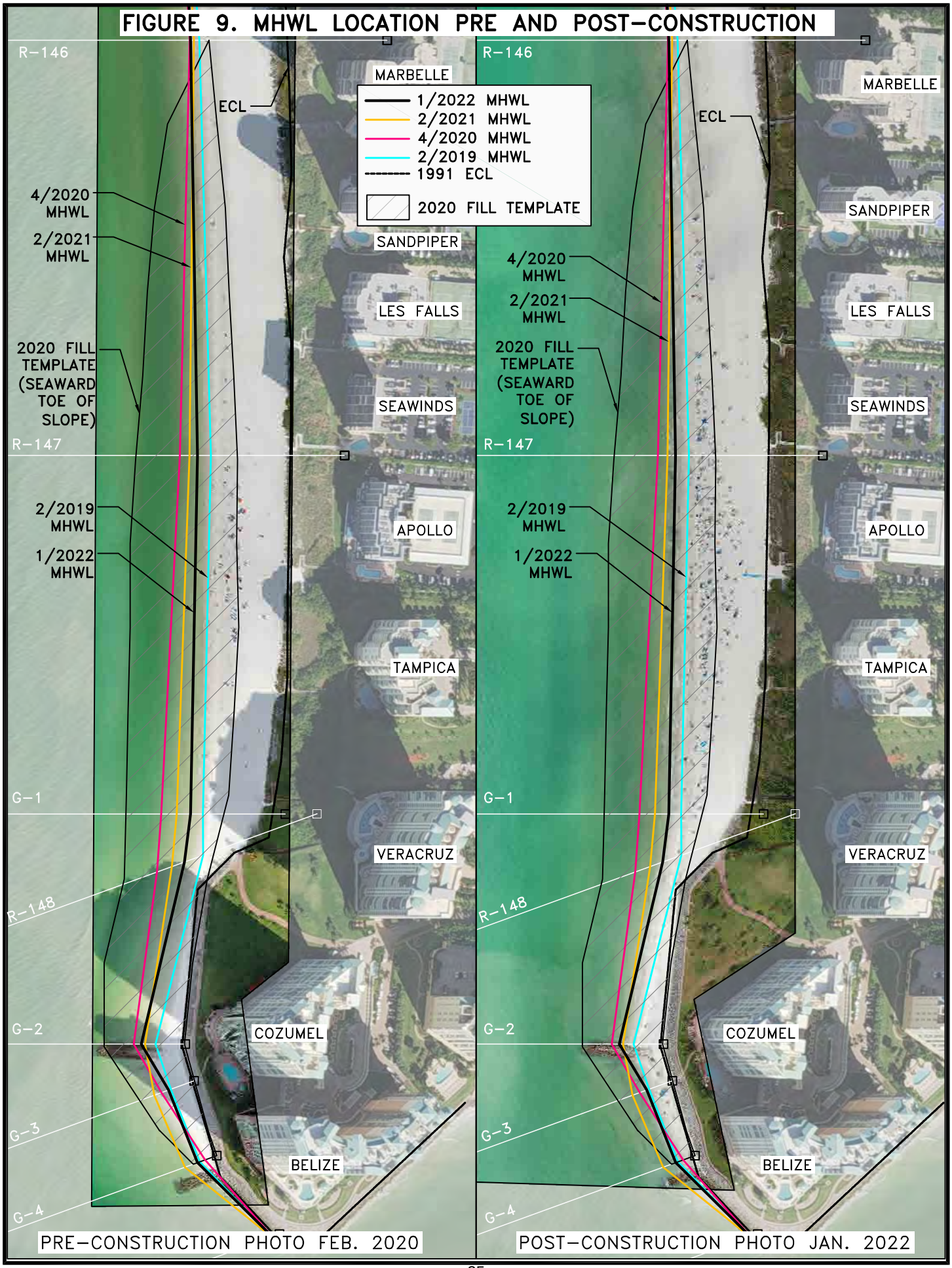


Figure 9 shows the pre and post-construction locations for the MHWL, the fill template, ECL, and names of the condominiums adjacent to the project area fill template overlaid on rectified aerial images acquired immediately pre-construction and two years post-construction. Generally, beach widths remain between the immediate pre and post-construction conditions from R-146 south to the terminal groin at G-2.

The borrow area was surveyed in January 2022. There is approximately 109,000 cubic yards of sand available within the permitted limits, although much of this material has a relatively higher shell content than was placed on the beach in 2020. Based on the post-construction and two-year monitoring surveys the infilling rate is approximately 10,000 cubic yards per year. The next and final survey of the borrow area is scheduled for 2025.

FIGURE 9. MHWL LOCATION PRE AND POST-CONSTRUCTION



The monitoring requirements pertaining to the Central Marco Beach Regrading project, having a scope of survey ranging from DEP reference monument R-130 south to R-146, will be addressed in a separate report to be submitted in 2022 in conjunction with the US Fish and Wildlife Service Biological Opinion dated January 4, 2018, Terms and Conditions 1.

The monitoring reports and nourishment discussed in this report are, in the longer term, maintenance of the comprehensive beach nourishment and erosion control project begun with 575,000 cubic yards of nourishment in 1991 and culminating with the segmented breakwater built in 1996. The relatively small amounts of nourishment at the south end of Marco Island are minor maintenance in comparison to the magnitude of the original 1991 project, and the stability of the south end of Marco Island may to a significant degree be the result of the segmented breakwater. This is evident in **Figure 9 and Figures 6a and 6b** showing the location of the 1990 Erosion Control Line (ECL)**,** established along the MHWL prior to the 1991 nourishment project, in comparison to the MHWL established during the 2022 monitoring survey.

The various aspects of the South Marco Beach Nourishment Project appear to be achieving a successful comprehensive approach, addressing this portion of Marco Island's beaches. **No additional action, other than regular maintenance of the beach is recommended at this time; monitoring shall continue per the plan provided in Appendix A. Since 2007, this project has been nourished on approximate 7-year intervals. The USACE permit will need to be re-issued. Sediment data from the borrow area will need to be evaluated as part of this process due to the relatively high shell content experienced in the past.**

REFERENCES

APTIM, Storm Damage Report: Hurricane Irma Collier County, FL, November 2017

Atkins, South Marco Island Beach Renourishment Project 2014 One-Year Post Construction Monitoring Report, February 2015

Coastal Planning & Engineering, Inc., South Marco Island Beach Renourishment 2013 Post-Construction and Beach Monitoring Report, August 7, 2013

CB&I Coastal Planning & Engineering, Inc., 2016 South Marco Tropical Storm Debby Beach Restoration Project Post-Construction Report

Florida Department of Environmental Protection, JCP South Marco Island Beach Renourishment Project, Permit 0235209-003-JC, December 22, 2005

Humiston & Moore Engineers, Marco Island Central Beach Regrading Numerical Modeling and Analysis, August 2015

Humiston & Moore Engineers, South Marco Island Beach Nourishment Project 2021 Annual Monitoring Summary Report, April 2021

APPENDIX A

PHYSICAL MONITORING PLAN
APPROVED AUGUST 2, 2012

Collier County, Florida
South Marco Island Beach Renourishment Project
Physical Monitoring Plan –REVISED
April 13, 2012

Project Description

The **South Marco Island Beach Renourishment Project** area extends for a total of slightly less than one mile from FDEP survey monument R-144 to profile line G-4, at the southernmost terminal groin. Additional survey lines are proposed as "control areas" north of the fill area on Marco Island and south of Caxambas Pass on Kice Island. The proposed sand source for the Project is the historically-used borrow area within Caxambas Pass.

Introduction

Physical monitoring of the South Marco Island Beach Renourishment Project is required pursuant to 62-B-41.005(16) F.A.C in order to allow the Department and the County to regularly observe and assess, with qualitative measurements, the performance of the Project and whether any project-related adverse impacts have occurred. Collection and analyses of the information outlined in this Monitoring Plan will accomplish the following specific objectives:

1) Identify erosion and accretion patterns (shoreline and volumetric changes) along the project and adjacent shorelines;
2) Provide data to facilitate an engineering evaluation of the beach renourishment performance;
3) Identify beach segments that have been eroded in quantities that may require corrective actions and the need for any adjustment, modifications, or mitigation of unexpected adverse effects;
4) Estimate location of the equilibrated toe of fill (ETOF); and,
5) Determine if the borrow area is experiencing infilling under post-construction conditions.

The primary components of the Physical Monitoring Plan include:

1) Beach profile and hydrographic surveys of the Project Area and adjacent beaches (per referenced FDEP monuments;
2) Hydrographic surveys of the borrow area; and,
3) Analyses and Reporting.

These activities will be carried out within the Project Area and along the adjacent shorelines as described in this Plan. Table 1 summarizes the proposed schedule for physical monitoring of the Project.

Table 1 - Monitoring Schedule for the South Marco Island Renourishment Project

Monitoring Requirement	Pre-Construction	Post-Construction				
		Immediate (60 days)	12-Month	24-Month	36-Month	5 Years
Beach and Offshore Profiles	X	X	X	X	X	X
Bathymetric Surveys of Borrow Area	X	X		X		X

Monitoring Reports		X	X	X	X	X

Each of the above monitoring requirements is described in further detail below:

Beach and Offshore Profile Surveys

All beach and offshore profile survey work performed shall be consistent with the FDEP *Monitoring Standards for Beach Erosion Control Projects* (see Sections *01000 – Beach Profile Topographic Surveying* and *01100 – Offshore Profile Surveying*). Beach and offshore profile surveys will be conducted to establish pre- and post-Project conditions within the Project Area and along the adjacent shorelines. Beach profiles will be conducted within 90 days prior to the commencement of construction (pre-construction), and within 60 days following the completion of the construction of the Project (postconstruction). Thereafter, monitoring surveys shall be conducted annually for a period of three years and then one additional time five years after completion of construction.

The monitoring area includes FDEP monuments within the bounds of the beach fill area (R-144 to R-148, G-1 to G-4); within one control area to the north (R-139 to R-143) and one control area to the south (G- 5 noting this is the end of the littoral cell on Marco Island and K-1 and K-2 on Kice Island). Traditional beach and hydrographic survey methods will be used to collect beach profile data per FDEP monitoring standards. Wading beach profile portions will be conducted using standard techniques from the dune across the beach and seaward to a depth of approximately -4 feet NAVD. The offshore, hydrographic portions of the profiles will be conducted utilizing a survey vessel typically outfitted with a digital fathometer, a Differential Global Positioning System (DGPS), and navigational software. Offshore portions will extend from the nearshore to -14.5 feet NAVD (= -13.0 feet NGVD) or 2,000 feet whichever is greater. Overlap will occur between the seaward terminus of the beach profiles and the landward origination of the hydrographic profiles in order to verify correct equipment operations. Fathometer calibrations via 'bar checks' will be performed periodically during surveys. Tidal corrections for vessel surveys will be performed using a digital recording tide gage or tide staff, which will be referenced to known vertical benchmarks. Tidal data will be recorded for the duration of the vessel surveys and applied during data reduction to achieve elevations referenced to NAVD.

Elevations of the beach profiles will be obtained at appropriate intervals and at all noticeable breaks in grade (greater than 1 foot vertically). Soundings from offshore portions of beach profiles will be obtained at appropriate intervals. Survey transects will originate at stations in the upland area of the beach corresponding to the established FDEP range monuments and extend offshore along the appropriate azimuth (degrees clockwise from magnetic north).

Bathymetric Surveys of Offshore Borrow Area

Bathymetric surveys of the borrow area cut(s) and surrounding portions of the Pass shall be conducted within 90 days prior to commencement of construction, and within 60 days following completion of construction of the Project, concurrently with the beach and offshore surveys required above. These data will be used to assess the infilling rate of the offshore borrow area. The bathymetric survey of the borrow area is to be consistent with the FDEP *Monitoring Standards for Beach Erosion Control Projects* (see Section *01200 –Borrow Site, Shoal and Other Bathymetric Surveying*).

Soundings for the bathymetric survey will be taken at no greater than 25-foot intervals along sounding lines spaced no more than 200 feet apart. The survey shall be bounded in the east-west direction by the inlet throat and the offshore 18-foot water depth contour. The survey shall extend a minimum of 400 feet outside the limits of dredging to the north or the Marco Island south end seawall, whichever is further, and a minimum of 400 feet outside the limits of dredging to the south.

Monitoring Reports
The permittee shall submit an engineering report and the monitoring data to FDEP's BBCS within 90 days following completion of the post-construction survey and each annual or biennial monitoring survey. The report shall include a comparative review of project performance versus performance expectations and identification of any adverse impacts attributable to the project.
Monitoring reports will be written following each survey, commencing with the 12month post-construction survey. The report shall summarize and discuss the data and analyses conducted each year for the 12, 24, 36-month, and 5-year post-construction time period. In general, each monitoring report will include:

- **Beach and Offshore Profile Surveys:** Each monitoring report shall include:
  - signed and sealed survey,
  - analysis for patterns, trends, or changes between annual surveys and for cumulative changes over time,
  - an evaluation of the erosion and accretion rates occurring between the initial post-construction survey and the annual monitoring surveys, and an assessment of the volume of fill remaining within the Project area, and an evaluation of the adjustment of the beach fill and volume accumulations outside of the Project area, and
  - an assessment of alongshore and cross-shore fill movement.

- **Bathymetric Surveys of the Borrow Area:** The Caxambas Pass borrow area surveys (signed and sealed) shall be analyzed and compared to the post-construction conditions to determine the infilling rate, if any, of the borrow area.

- **Appendices:** The report appendices shall include:
  - cross sections of the beach and offshore profiles and a graphical representation of volumetric and shoreline position changes throughout the monitoring area, and
  - reduced data (in digital format) from the survey of the borrow area, along with a contour plot of the borrow area survey results.

Monitoring reports and data shall be submitted including a transmittal cover letter clearly labeled with the following at the top of each page: **"This monitoring information is submitted in accordance with the approved Monitoring Plan for the Collier County South Marco Island Beach Renourishment Project, Permit No. 0235209-003-JC, for the monitoring period [XX].**

APPENDIX B

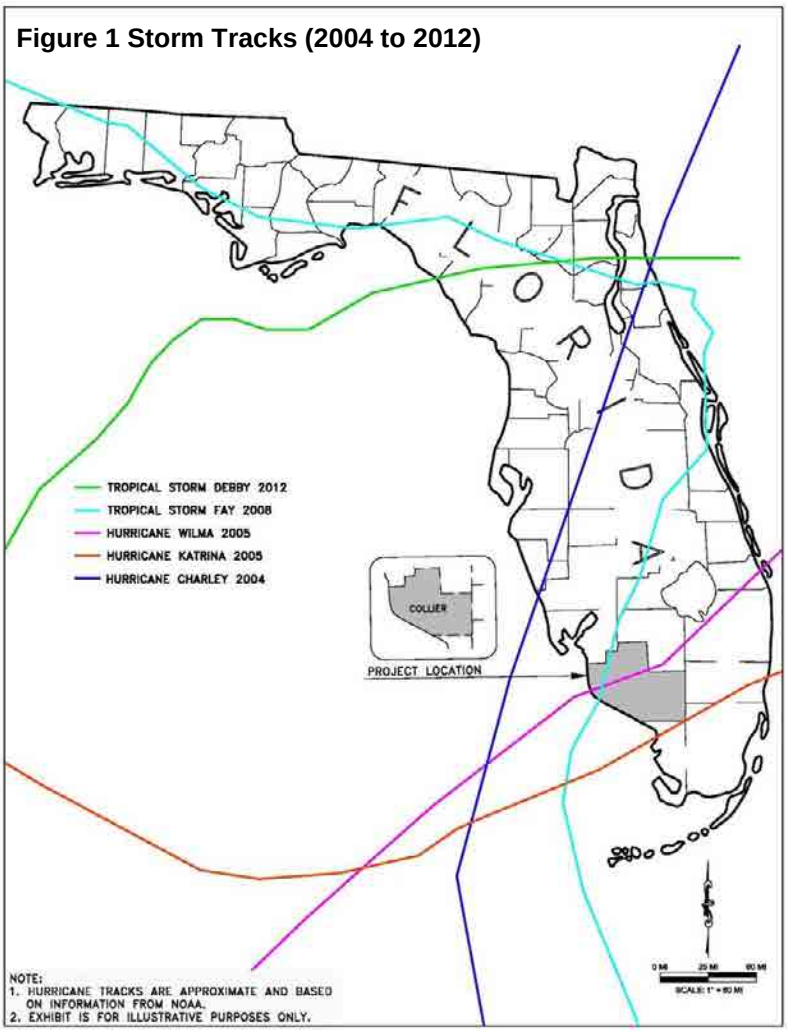
MAJOR STORM INFORMATION

Major Storm Events near Collier County

From 2004 to 2015, five major storms have made landfall near Collier County having the potential to disrupt coastal processes and change the beach topography in the project vicinity. Each storm's track can be seen in **Figure 1**.

[1]**Hurricane Charlie** (9-15 August 2004) Charley was the strongest hurricane to hit Florida since Hurricane Andrew in 1992. Before Charley made landfall on August 13 near Cayo Costa, which is just north of Captiva, it had made landfall in Cuba as a category 2. The storm decreased to a category 1 while making landfall in Cuba but then increased steadily as it made its way to Florida's southwest coast. Charley hit Florida as a category 4 hurricane with maximum sustainable winds of 150 mph. Hurricane Charley was a small storm in size but caused great damage to Florida's southwest coast.

Figure 1 Storm Tracks (2004 to 2012)



[2]**Hurricane Katrina** (23-30 August 2005) Hurricane Katrina is one of the most devastating hurricanes making landfall in the United States. Katrina was the making of three storms in the Atlantic Ocean and made landfall over the Bahamas as a Tropical Strom. While heading to Florida's east coast the storm strengthened to a category 1 hurricane just before making landfall near Miami-Dade County. The storm weakened to a tropical storm while passing over the peninsula. After spending six hours on land with winds estimated up to 70 mph, the storm entered the Gulf of Mexico just north of Cape Sable on August 26. Not soon after entering the Gulf, Hurricane Katrina grew in size and ultimately hitting the United States again in Louisiana as a category 5.

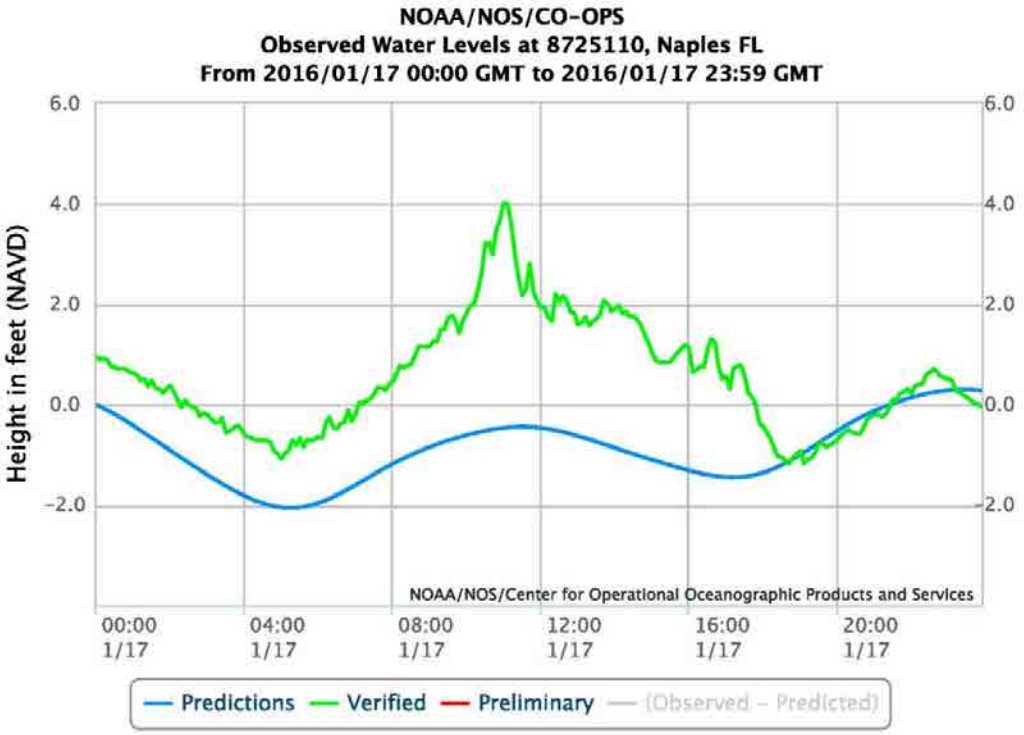
[3]**Hurricane Wilma** (15-25 October 2005) Hurricane Wilma was the strongest hurricane recorded for 2005 with winds up to 185 mph. Forming in the Caribbean Sea, Hurricane Wilma reached a category 5 hurricane over open waters. Wilma then decreased to a category 4 just before hitting the Yucatan Peninsula of Mexico. After passing over land, the winds decreased to 100 mph. After a brief increase over the Gulf of Mexico, Wilma entered the U.S. near Cape Romano (just south of the project area) as a category 3 hurricane on October 24. Wilma caused ten tornadoes while making landfall in the U.S. and caused damage to the surrounding coastline.

[4]**Tropical Storm Fay** (15-26 August 2008) Tropical storm Fay made landfall in Florida a record setting four times. After passing over the Florida Keys with winds up to 50 mph the storm slightly increased to 65 mph winds before making landfall just south of Marco Island on August 19. Rainfall estimates in Florida reached over 27 inches causing severe flooding. Storm surge and prevailing winds by the slow moving storm caused moderate coastline erosion along southwest Florida.

[5]**Tropical Storm Debby** (23-27 June 2012) Tropical Storm Debby reached a peak wind speed of 65 mph while in the Gulf of Mexico. After forming in the middle of the Gulf of Mexico, the storm headed north. After influence from a low pressure, the storm then turned west and eventually made landfall in Florida near Steinhatchee on August 26. Winds were recorded at 40 mph when making landfall on Florida's west coast. Although the storm hit northern end of the peninsula, it is recorded that Pinellas and Charlotte Counties' beaches lost 10 to 15 feet of shoreline.

The City of Naples experienced a meteotsunami[1] in January 2016. A graph of the observed water levels at the Naples Tide Station on January 17, 2016 documenting the meteotsunami is shown in **Figure 2**.

Figure 2. Observed Water Level in Naples Florida on January 17, 2016.



[5] **Hurricane Irma** (August 30-Septmeber 11, 2017) Tropical Storm Irma formed in the far eastern Atlantic Ocean, just west of the Cape Verde Islands, on the morning of August 30th. Over the

[1] Meteotsunamis have the characteristics similar to earthquake-generated tsunamis, but are caused by air pressure disturbances often associated with fast moving weather systems, such as squall lines. These disturbances can generate waves in the ocean that travel at the same speed as the overhead weather system. Development of a meteotsunami depends on several factors such as the intensity, direction, and speed of the disturbance as it travels over a water body with a depth that enhances wave magnification. NOAA 2015

following 30 hours Irma intensified into a major hurricane with highest sustained winds of 115 MPH, a category-3 storm on the Saffir-Simpson Hurricane Wind Scale.

As Irma began to approach the northern Leeward Islands on September 4th and 5th, the hurricane rapidly intensified while moving over warmer water and into a more moist atmosphere. The storm became a rare category-5 hurricane on September 5th, with maximum sustained winds of 185 MPH. This made Irma the strongest hurricane ever observed in the open Atlantic Ocean, and one of only 5 hurricanes with measured winds of 185 MPH or higher in the entire Atlantic basin. Over the next few days Irma continued moving west, passing through the northeast Leeward Islands, Virgin Islands, and just north of the islands of Puerto Rico and Hispaniola, while maintaining its category-5 winds.

The storm finally "weakened" to a category-4 hurricane on September 8th, but still had devastating winds of 155 MPH while moving through the southern Bahamas. Irma intensified to a category-5 level once again that evening, with top winds of 160 MPH, as it approached the northern coast of Cuba. Irma moved west along or just inland from the northern coast of Cuba on September 9th. This interaction with land disrupted Irma's structure a bit, as a hurricane requires plenty of deep warm water beneath the storm's center to maintain the extremely low pressure and strong winds. Thus Irma weakened slightly to a category-3 hurricane with winds of 125 MPH.
Resilient Irma made a final attempt to re-intensify while crossing the open waters of the Florida Straits. The storm quickly reached category-4 intensity with 130 MPH winds early in the morning of September 10th, while approaching the vulnerable Florida Keys.

The major hurricane made landfall near Marco Island in southwest Florida around 3 pm EDT on September 10th, as a category-3 storm with 115 MPH. Naples, Florida reported a peak wind gust of 142 MPH. Irma moved quickly northward, just inland from the west coast of Florida on September 10th and 11th. When Irma first developed in the far eastern Atlantic, despite its strength, its wind field was quite small. As the storm approached Florida, however, its wind field expanded dramatically. As Irma hit Florida, tropical storm force winds extended outward up to 400 miles from the center, and hurricane force winds extended up to 80 miles. Hurricane force wind gusts (i.e. 74 MPH or more) were reported along much of the east coast of Florida, from Jacksonville to Miami. In addition to the long periods of heavy rain and strong winds, storm surge flooding also occurred well away from the storm center, including the Jacksonville area, where strong and persistent onshore winds had been occurring for days before Irma's center made its closest approach.

By the time the minimal hurricane reached northwest Florida (on the morning of September 11th), the wind gusts across south Georgia and northwest Florida were generally in the 45 to 60 MPH range (Fig. 8). Conditions improved rapidly once the storm center passed by as strong, dry southwest winds aloft made the system asymmetric, with nearly all of the rain and most of the strongest winds being along and north of the poorly-defined center. Irma weakened to a tropical storm in south Georgia in the afternoon, and further into a tropical depression while moving north across central Georgia in the evening. See the **Figure 3** in this section showing the 2017 storm tracks.

According to the National Weather Service, wind gusts over 50 mph and heavy rain impacted the Naples area on Thursday December 20, 2018. At approximately 1:30 pm another meteotsumami hit the Naples area with wave heights momentarily increasing by 3 feet over the projected level and decreasing rapidly over the next hour. **Figure 4** shows the predicted and actual water levels on December 20, 2018.

Figure 3. Hurricane Tracking Chart for 2017.

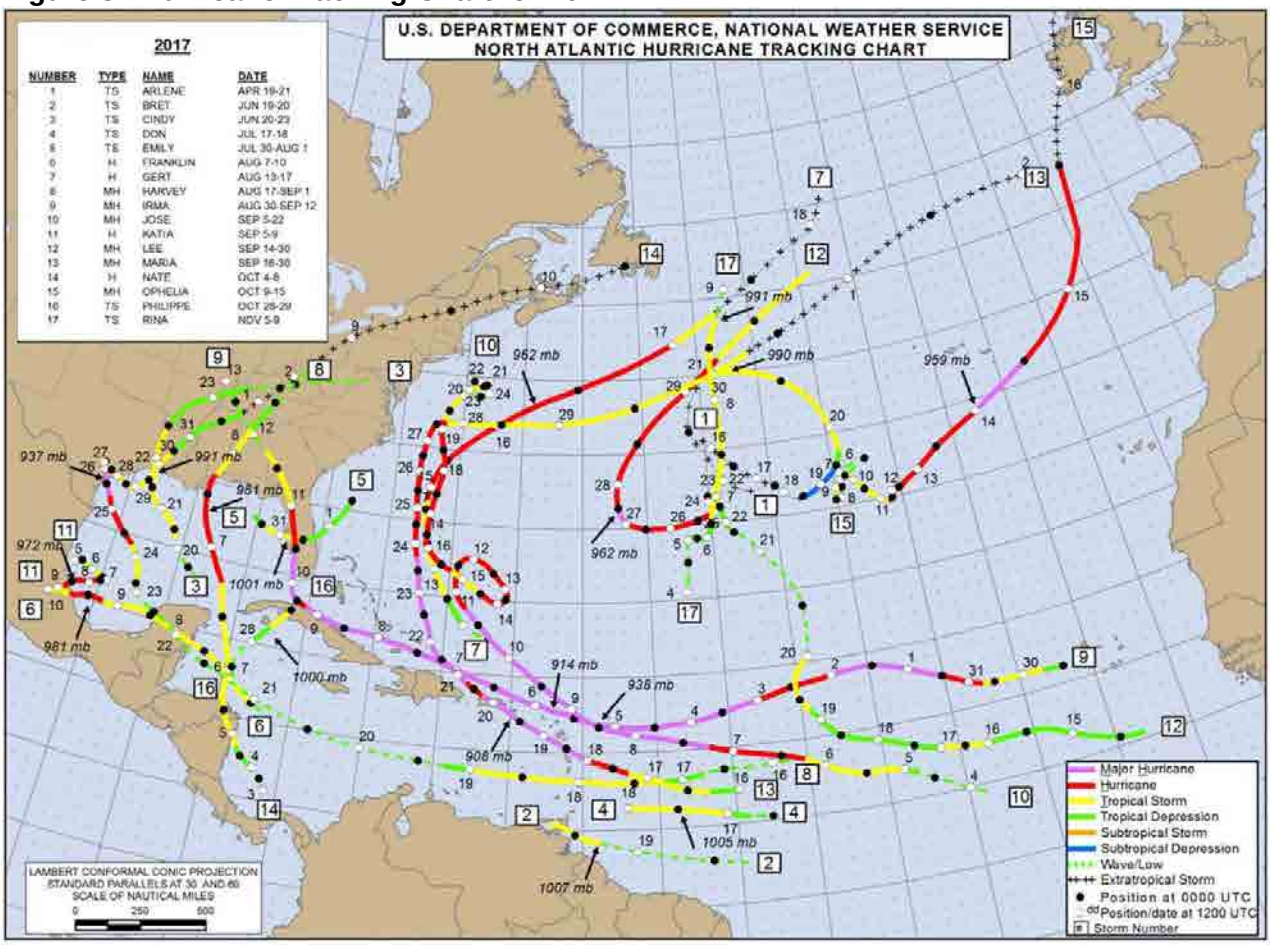
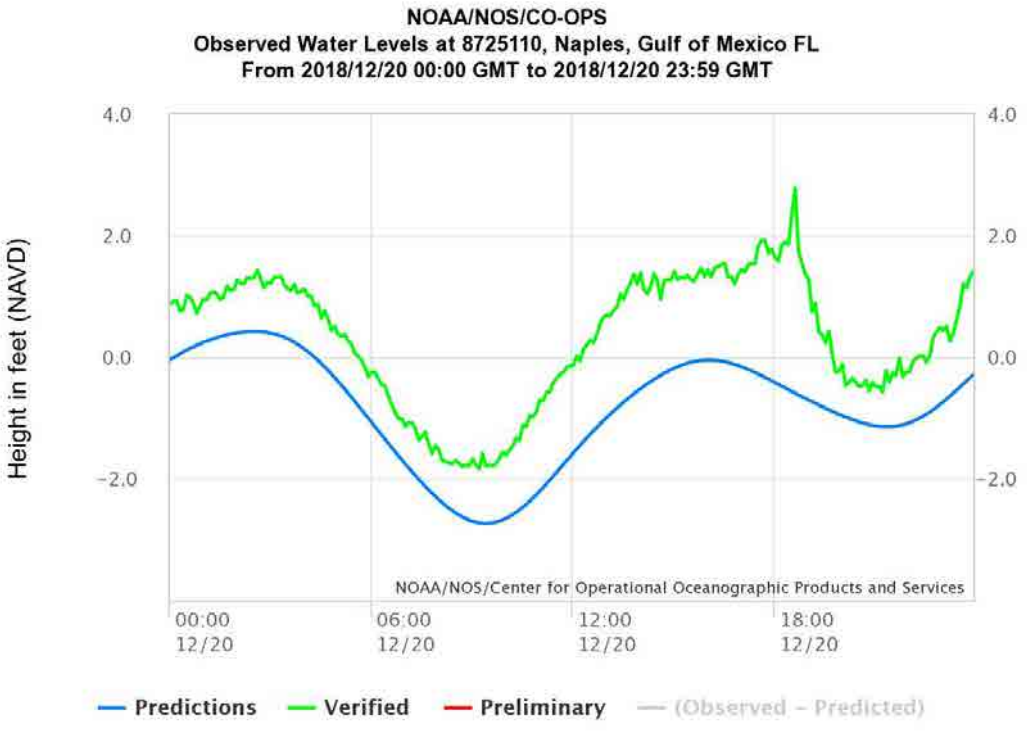


Figure 4. Observed Water Level in Naples Florida on December 20, 2018.



References

[1] Blake E.R., D.P. Brown, R.J. Pasch, "Tropical Cyclone Report Hurricane Charley," National Hurricane Center, September 2011, http://www.nhc.noaa.gov/.

[2] Brown D.P., R.D. Knabb, and J.R. Rhome, "Tropical Cyclone Report Hurricane Katrina," National Hurricane Center, December 2005, http://www.nhc.noaa.gov/.

[3] Blake E.R. and H.D Cobb III et. al, "Tropical Cyclone Report Hurricane Wilma," National Hurricane Center, January 2006, http://www.nhc.noaa.gov/.

[4]Beven, J.L. and S.R Stewart, "Tropical Cyclone Report Tropical Storm Fay," National Hurricane Center, February 2009, http://www.nhc.noaa.gov/.

[5]Kimberlain T.B., "Tropical Cyclone Report Tropical Storm Debby," National Hurricane Center, January 2013, http://www.nhc.noaa.gov/.

[6]National Oceanic and Atmospheric Administration, "Detailed Meteorological Summary on Hurricane Irma, Hurricane Irma Synopsis" National Weather Service, January 2018, https://www.weather.gov

Naples Daily News, Scientists: Waves that surprised SWFL beachgoers last week caused by rare meteotsunami, December 27, 2018

APPENDIX C-1

SURVEY REPORT

SEA Diversified, Inc.
160 Congress Park Drive, Suite 114
Delray Beach, Florida 33444
Phone: 561-243-4920

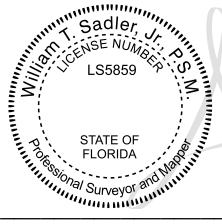
SURVEYOR'S CERTIFICATION & NOTES

Survey Title: **Collier County South & Central Marco Island 2022 Physical Monitoring Topographic & Hydrographic Survey**
Date of Report: **February 18, 2022**
Prepared for: **Humiston & Moore Engineers**
Prepared by: **Sea Diversified, Inc. (SDI Project Number 21-2954)**
Date of Survey: **January 4, 2022 – January 13, 2022**
Survey Location: **FDEP Range Monuments R-130 to R-148 including R-135.5, R-136.5, R-137.5 and G-1 to G-5, K-1, K-2 and Borrow Area, totaling 29 beach profiles**

Notes:

1. This survey report was prepared to accompany the digital data files (ASCII X, Y, Z) submitted to Humiston and Moore Engineers pertaining to the Collier County 2022 Physical Monitoring Survey "South & Central Marco" Topographic & Hydrographic Survey. The purpose of the survey was to collect topographic and bathymetric data at Florida Department of Environmental Protection (FDEP) profile control points R-130 to R-148 including R-135.5, R-136.5, R-137.5 and G-1 to G-5, K-1, K-2 and Borrow Area, totaling 29 beach profiles.
2. This survey report is not valid without the signature and the original raised seal of a Florida Licensed Surveyor and Mapper.
3. The information depicted herein represents the results of the survey on the dates indicated and can only be considered as indicating the general conditions existing at the time.
4. Horizontal data are in feet and relative to the Florida State Plane Coordinate System based on the Transverse Mercator Projection for Florida, East Zone (0901), North American Datum (NAD) of 1983, 1990 Adjustment. Vertical data are in feet and relative to the North American Vertical Datum of 1988 (NAVD 88).
5. Bathymetric data was collected using a Trimble Real-Time Kinematic (RTK) Global Positioning System (GPS) and an Odom Echotrac CV100 sounder with integrated TSS Model DMS-05 motion sensor. Horizontal position accuracy was verified using published profile control points. The sounder was calibrated prior to the start of the survey following manufacturer recommended procedures.
6. RTK tides were applied in real-time during bathymetric data collection. For redundancy tides were observed at a tide staff set to 0.0 feet relative to NAVD 88. The tide staff was attached to a wood pile and relative to FDEP Range Monument R-144 with the following published elevation of 8.86 feet NAVD 88.
7. Topographic data was collected using a combination of Real-Time Kinematic (RTK) GPS and level, rod and chain methodologies.
8. Onshore / offshore profile surveys were collected in accordance with the Monitoring Standards for Beach Erosion Control Projects prepared by the Florida Department of Environmental Protection (FDEP), Bureau of Beaches and Coastal Systems (BBCS), dated October 2014.

I hereby certify that the Topographic / Hydrographic survey is based on a recent field survey conducted under my personal direction and is true and accurate to the best of my knowledge and belief and meets the Standards of Practice set forth by the Florida Board of Professional Surveyors and Mappers in Chapter 5J-17, Florida Administrative Code, pursuant to Section 472.027, Florida Statutes.



Digitally signed by William T. Sadler
DN: cn=William T. Sadler, o=Sea Diversified, Inc., email=wts@seadiv.com, c=US
Date: 2022.02.19 09:38:05 -05'00'

William T. Sadler Jr., P.E., P.S.M. **Date**
Florida Registration Number 5859
Sea Diversified Inc. LB Number 7342

APPENDIX C-2

BEACH PROFILES

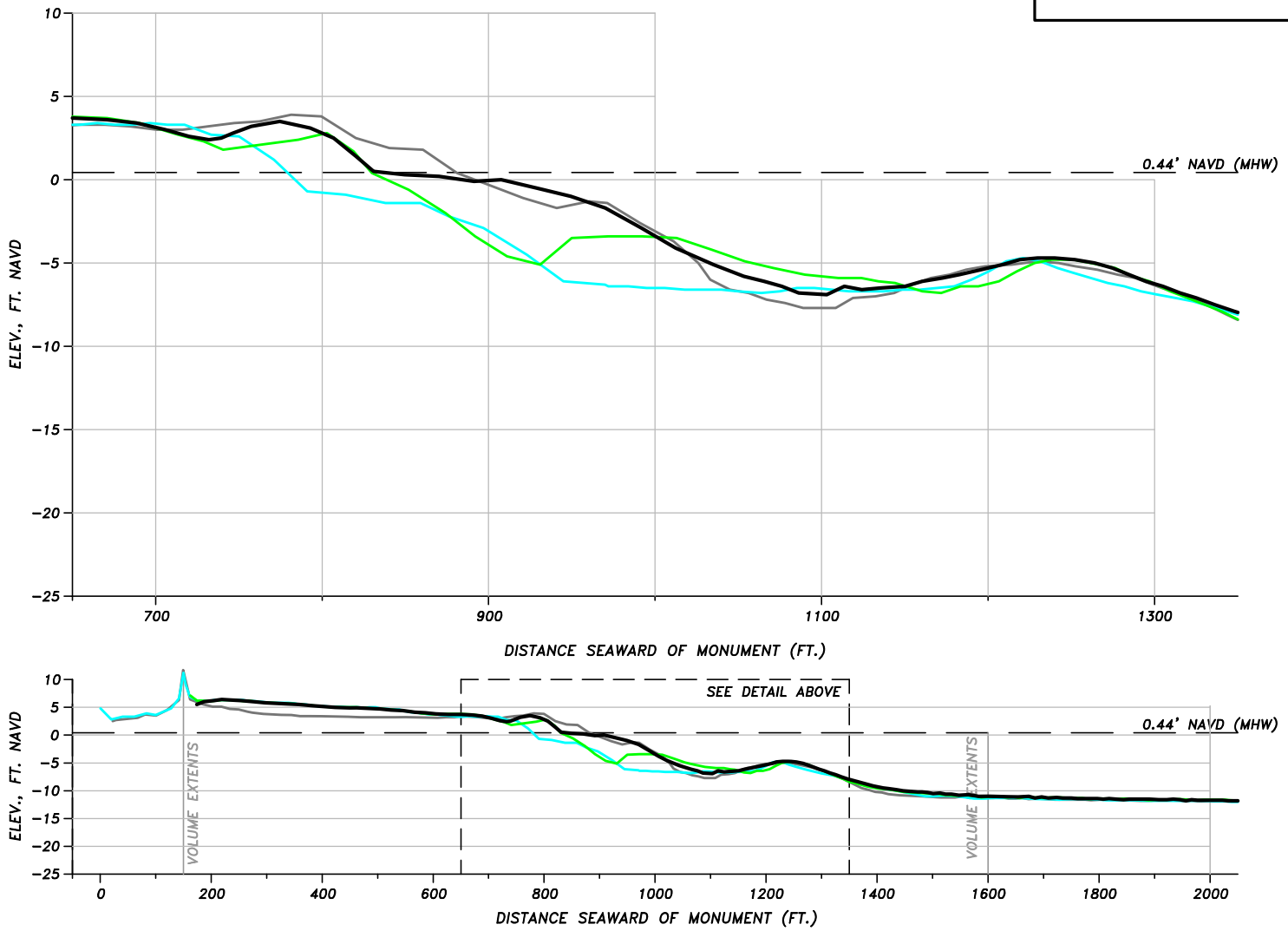
(SEE FIGURE 4 FOR BEACH PROFILE LOCATIONS)

BEACH PROFILE: R-139

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI



HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

BEACH PROFILE: R-140

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
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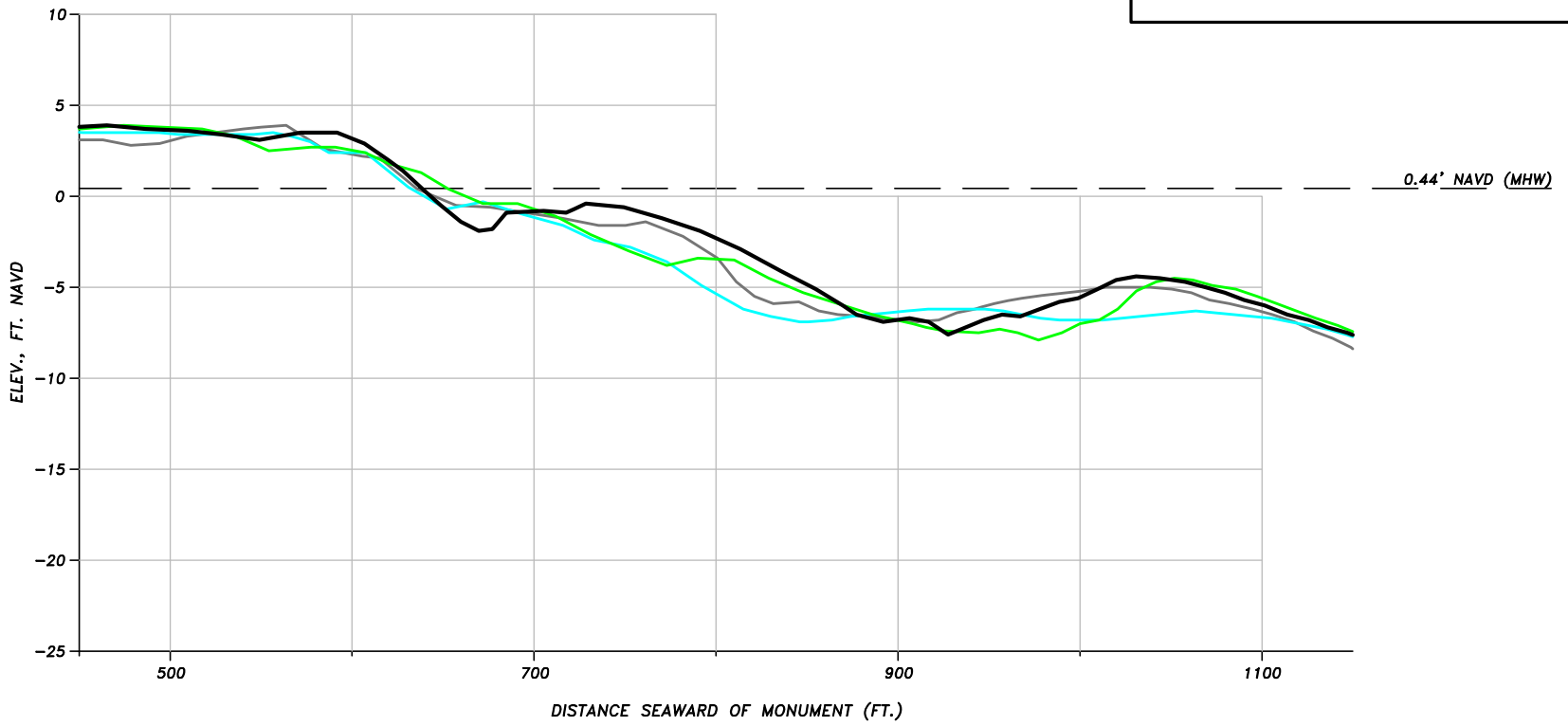
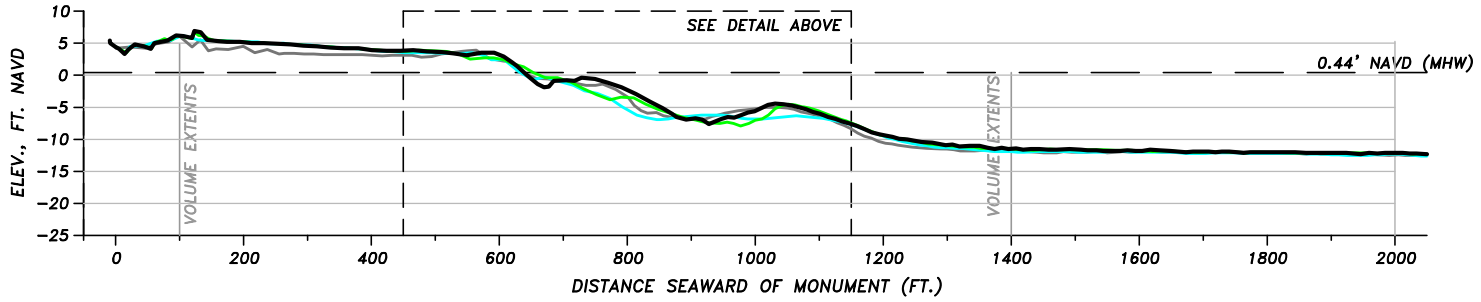
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

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JOB FILE:23065	DATUM:NAVD	FIGURE:

5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

BEACH PROFILE: R-141

NEARSHORE DETAIL

SURVEY LEGEND

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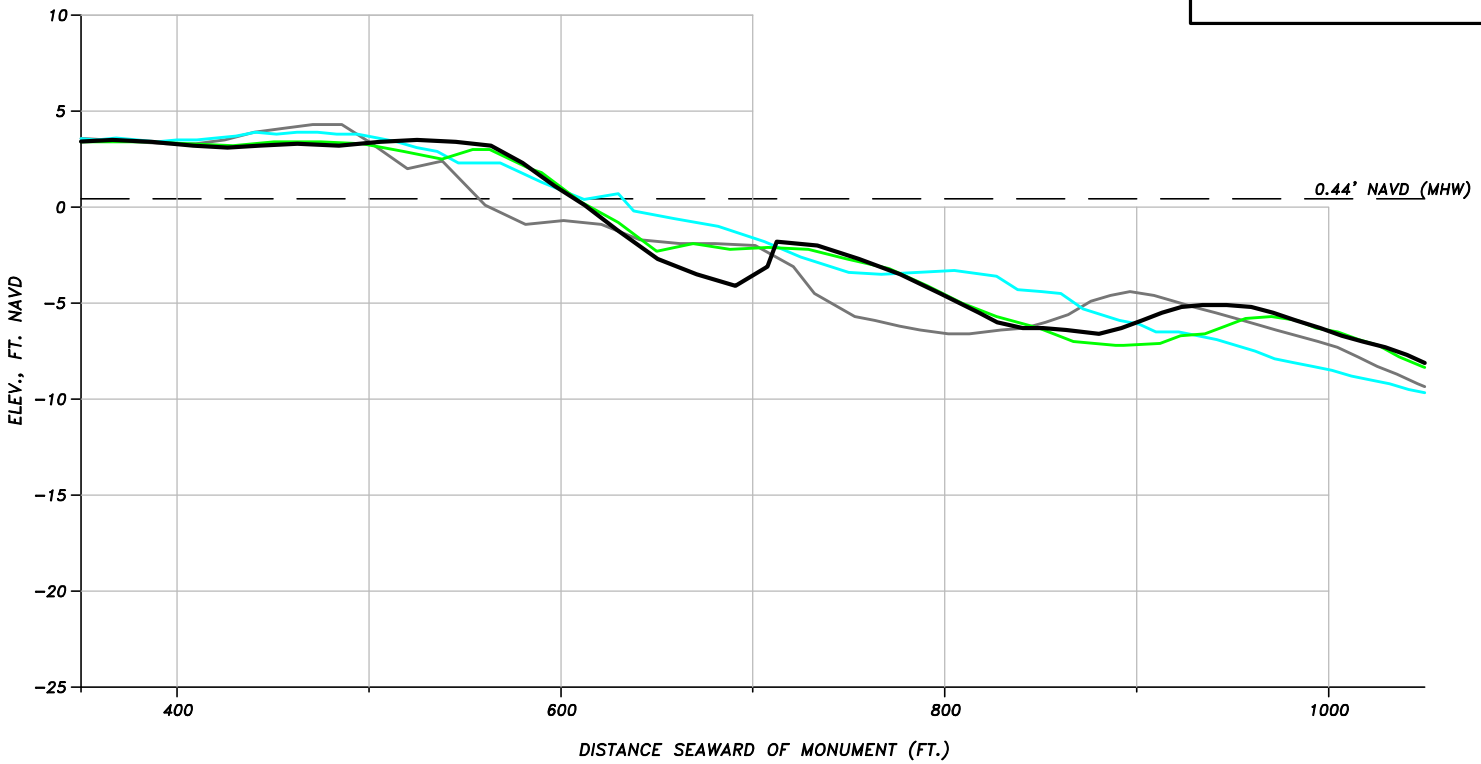
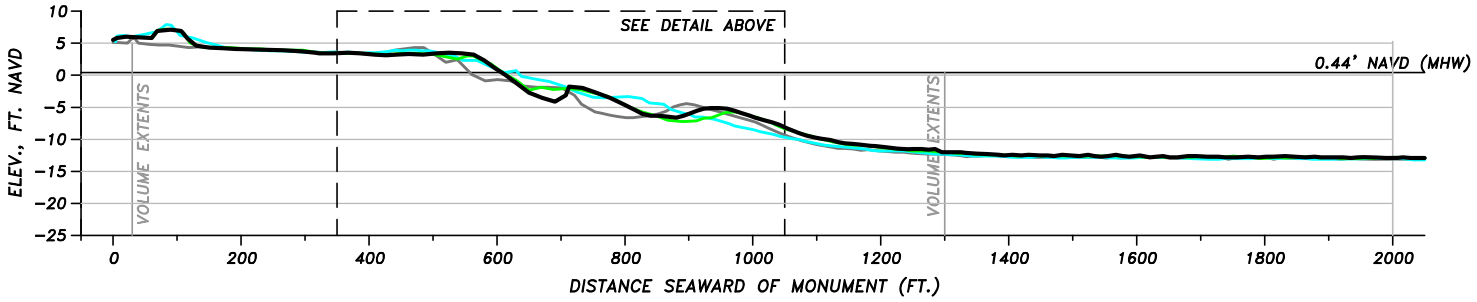
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

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5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

BEACH PROFILE: R-142

NEARSHORE DETAIL

SURVEY LEGEND

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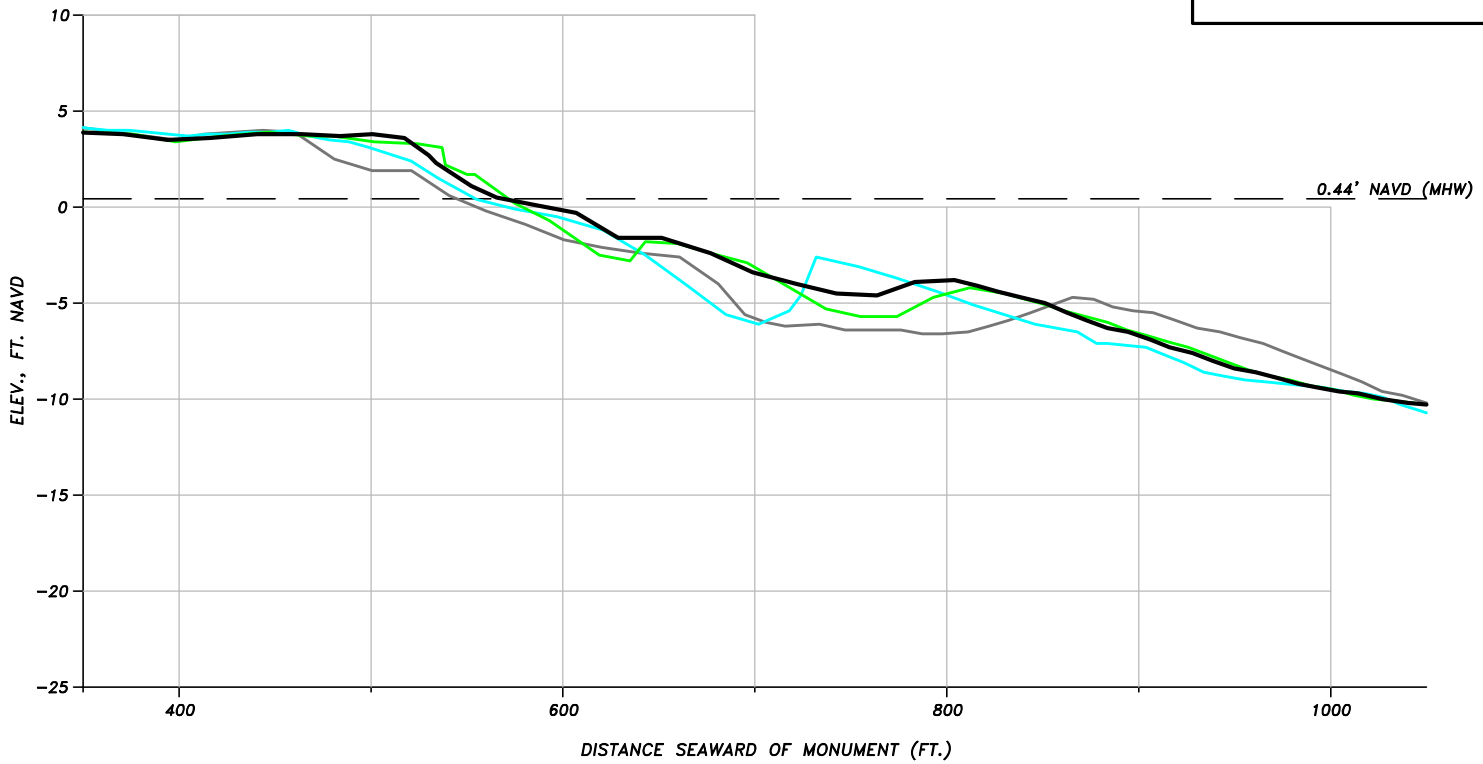

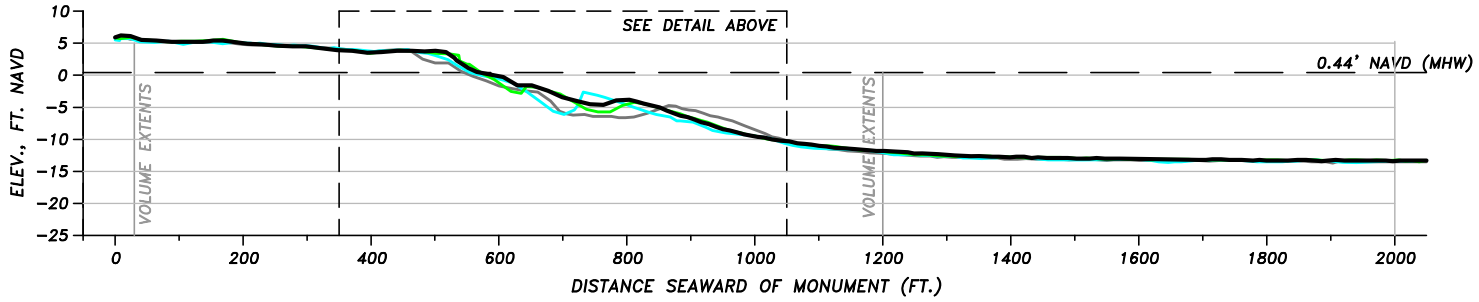

HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

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JOB FILE:23065	DATUM:NAVD	FIGURE:

5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

BEACH PROFILE: R-143

NEARSHORE DETAIL

SURVEY LEGEND

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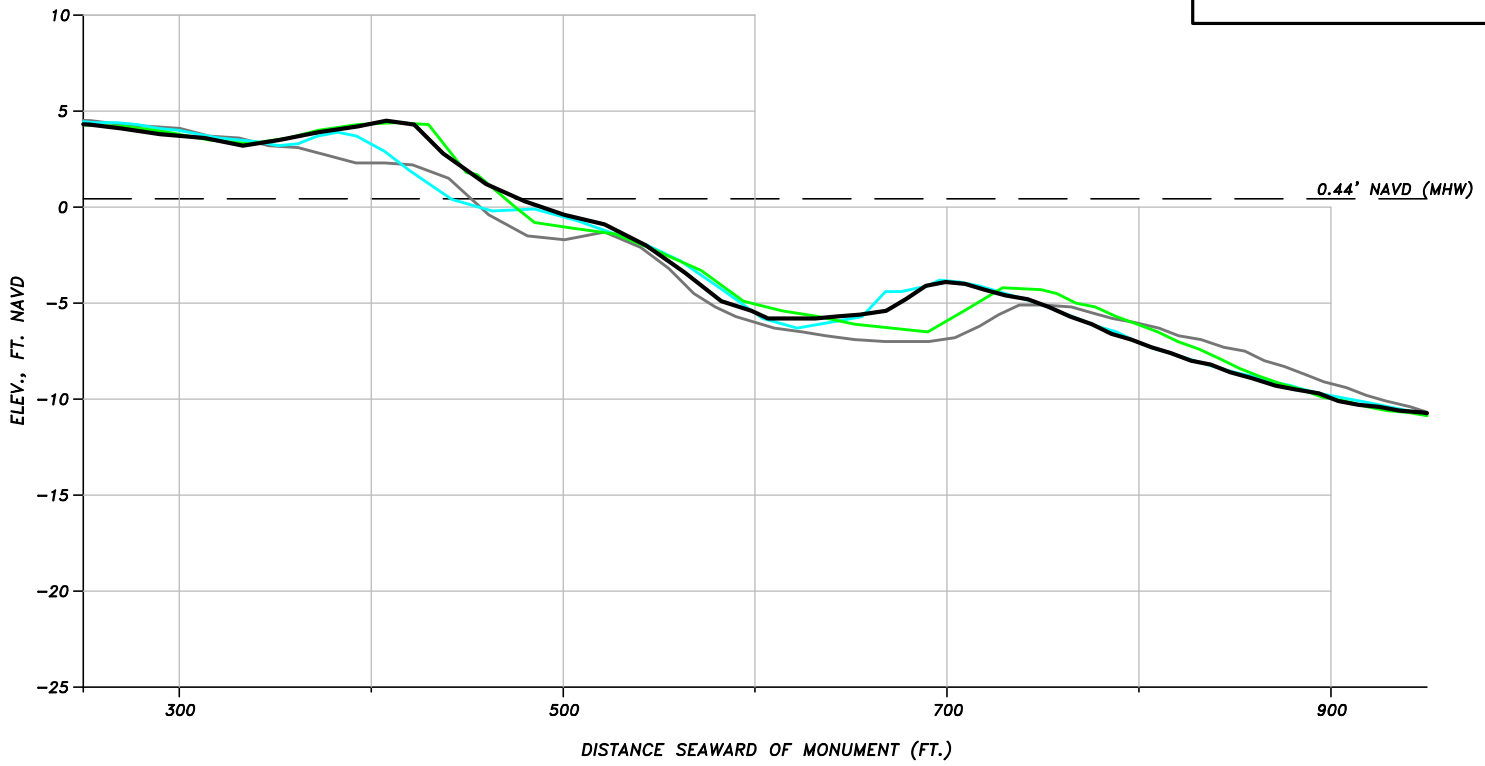

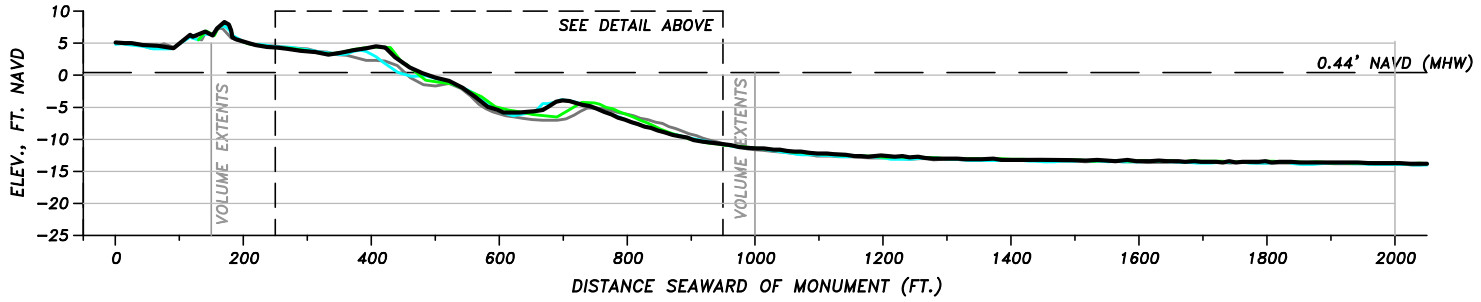

HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

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JOB FILE:23065	DATUM:NAVD	FIGURE:

5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

BEACH PROFILE: R-144

NEARSHORE DETAIL

SURVEY LEGEND

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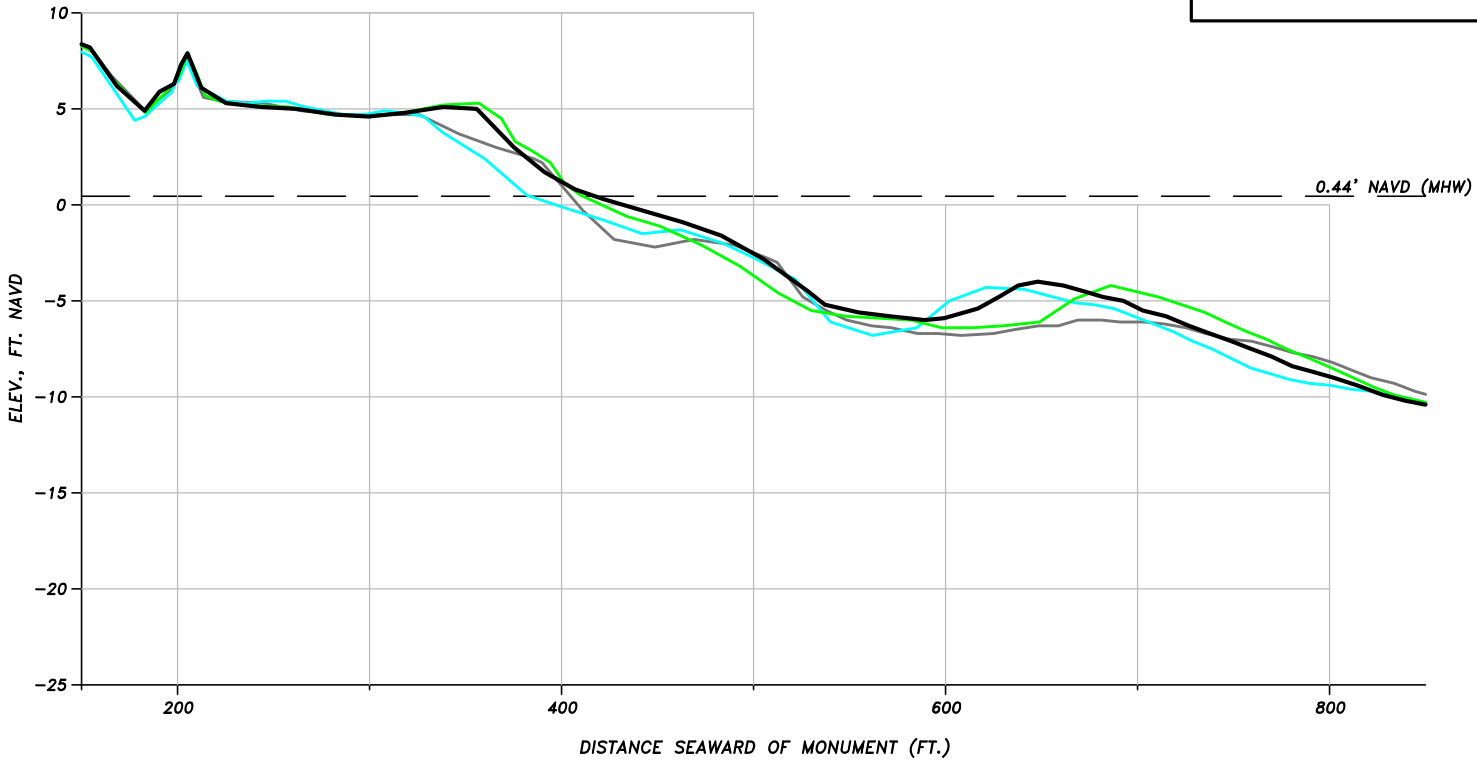

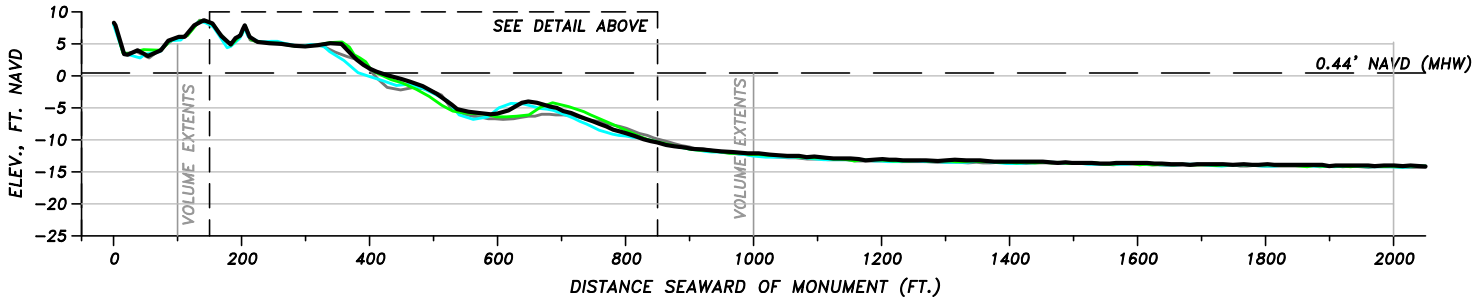

HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

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JOB FILE:23065	DATUM:NAVD	FIGURE:

5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

NEARSHORE DETAIL

BEACH PROFILE: R-145

SURVEY LEGEND

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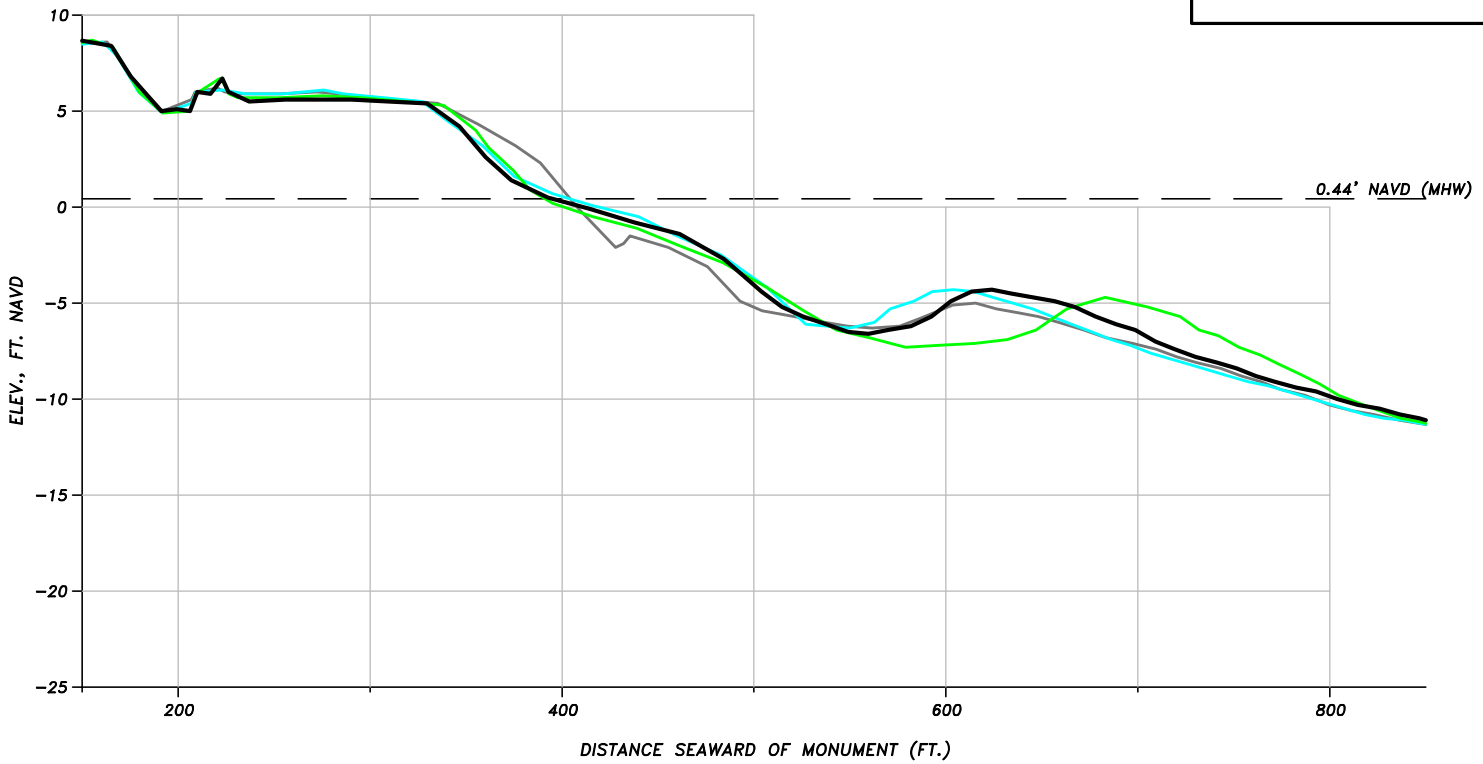

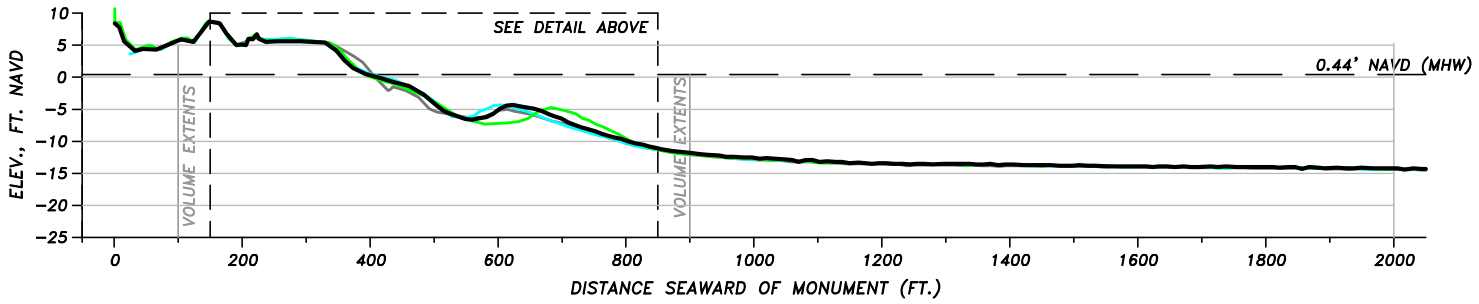

HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

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5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

NEARSHORE DETAIL

BEACH PROFILE: R-146

SURVEY LEGEND

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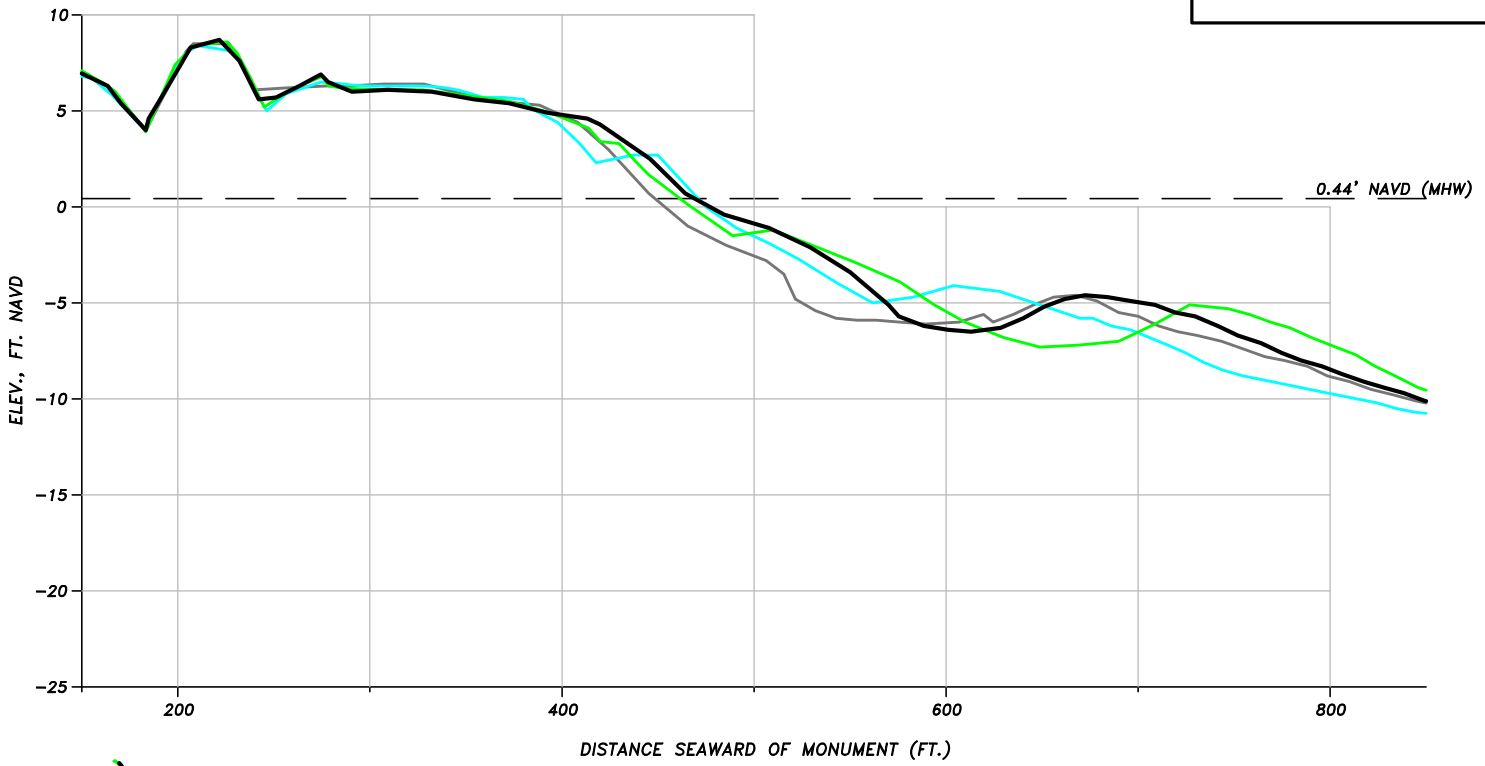
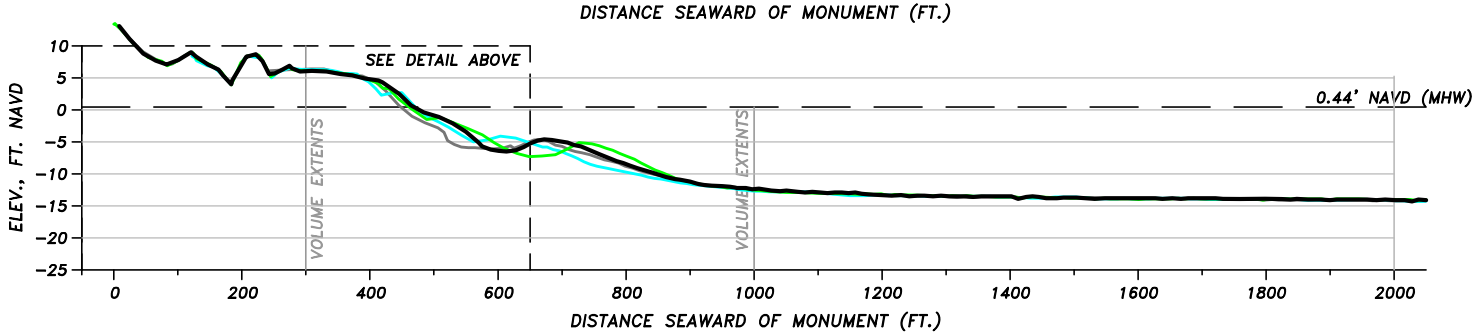
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

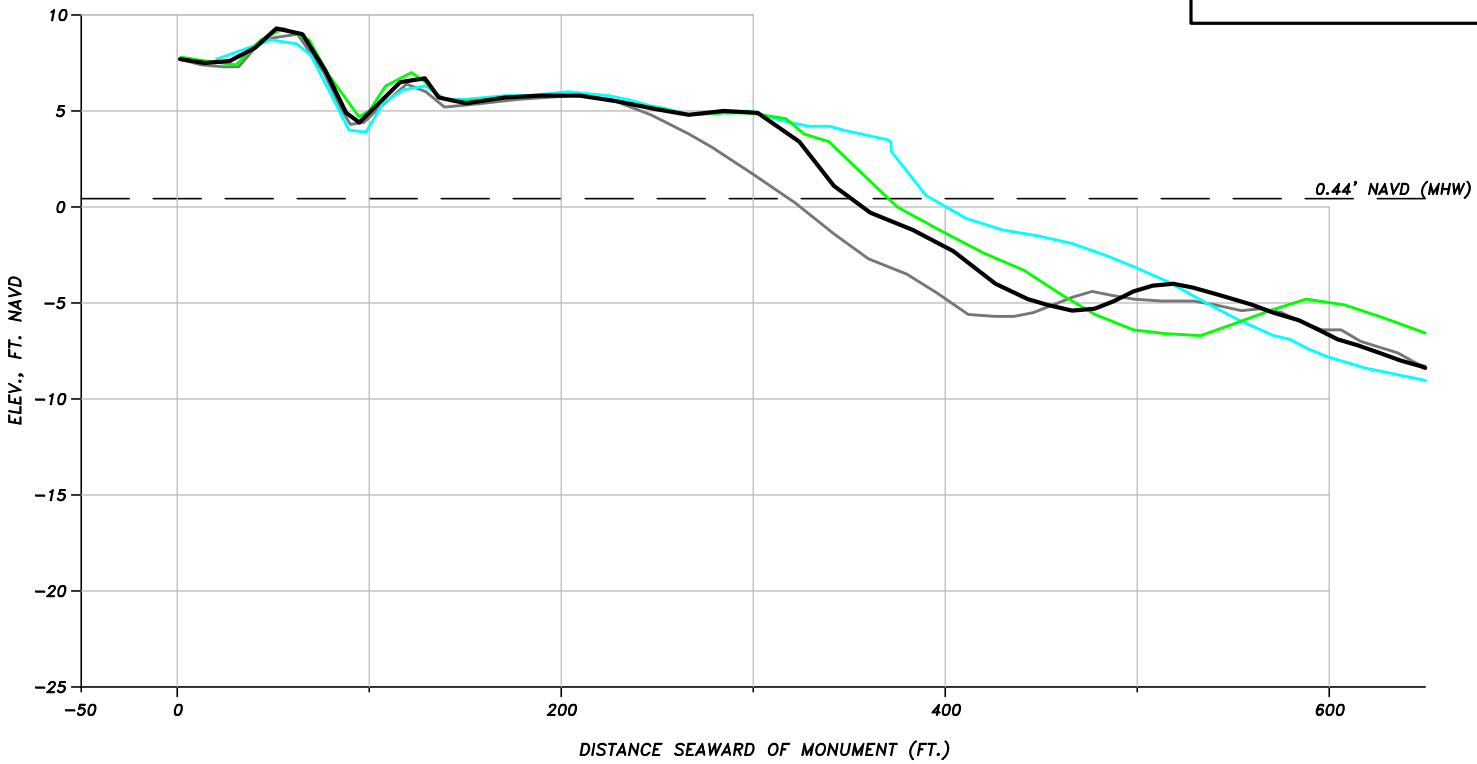
5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

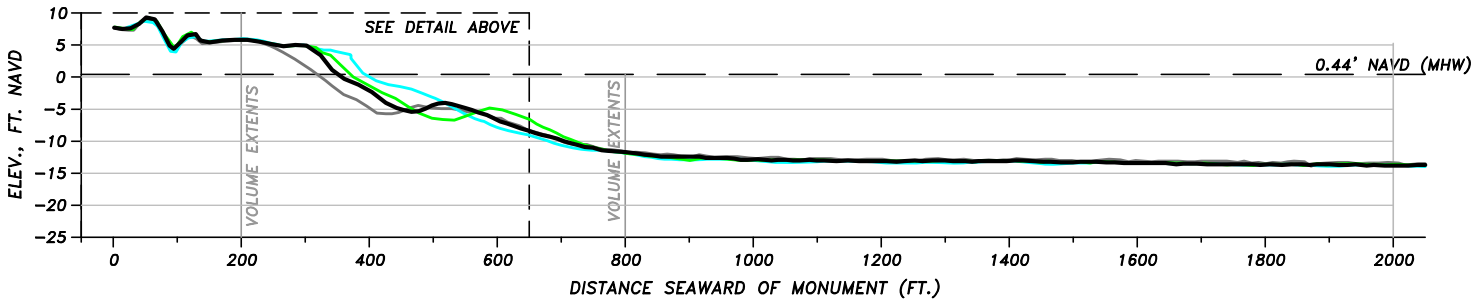
BEACH PROFILE: R-147

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

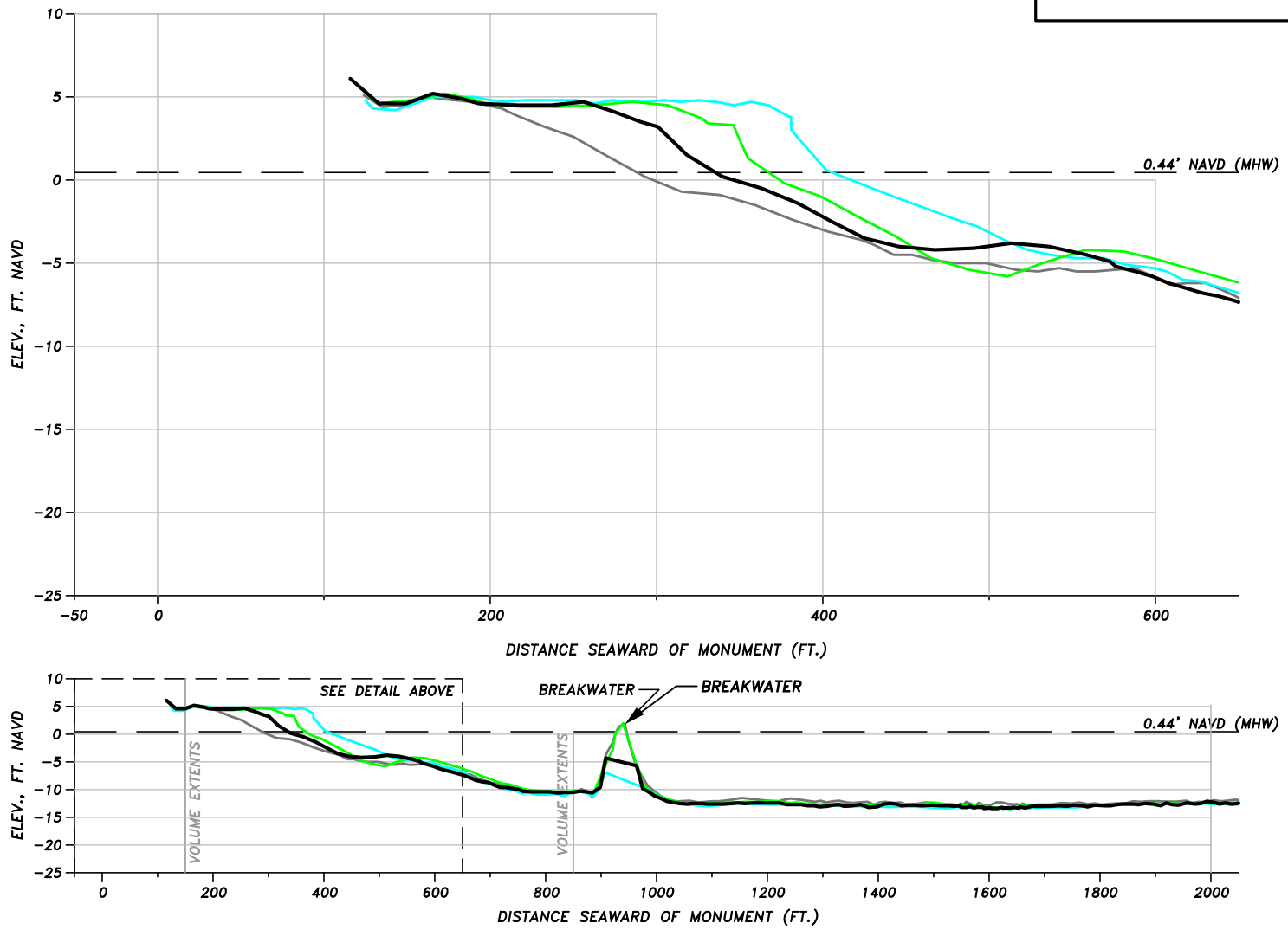
5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

BEACH PROFILE: R-148

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI



HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

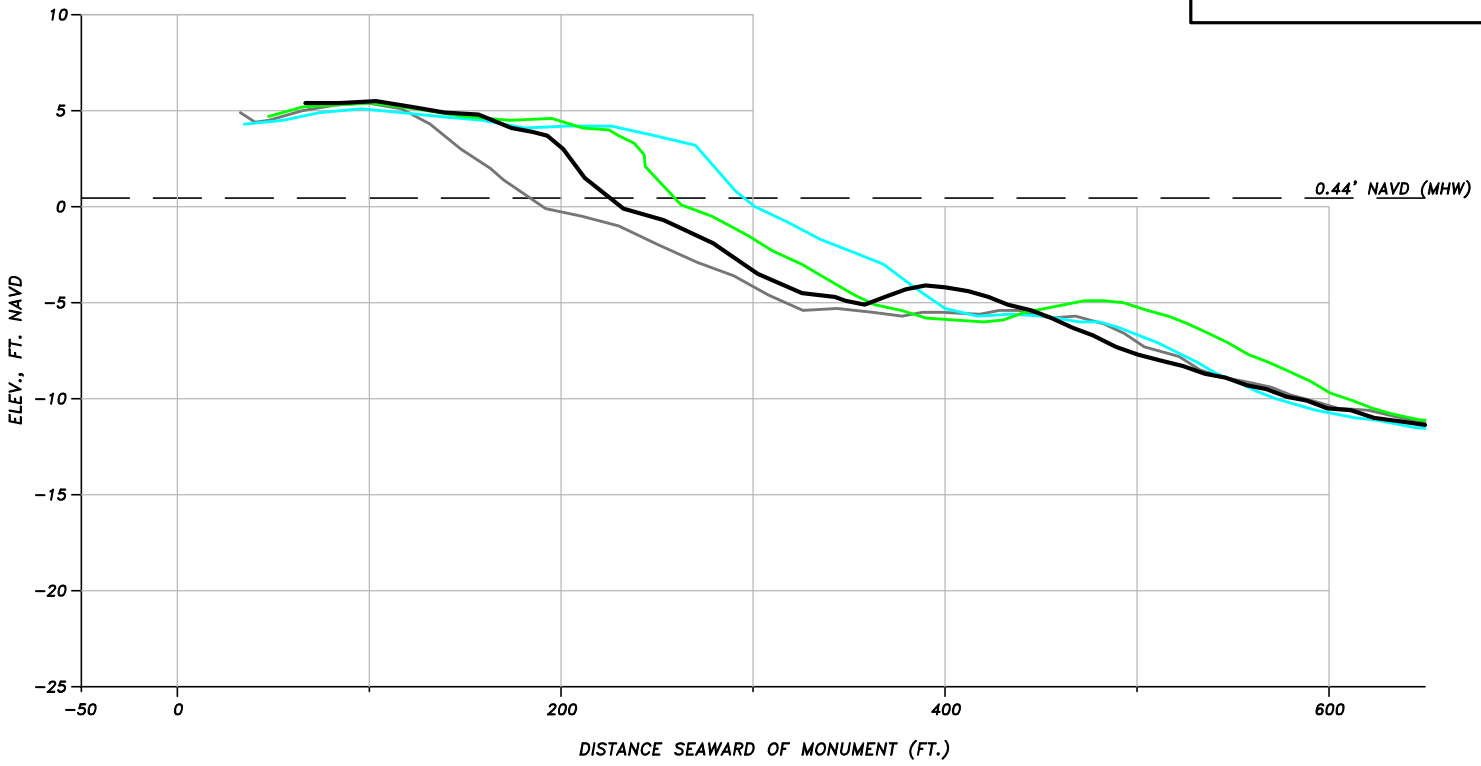
5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

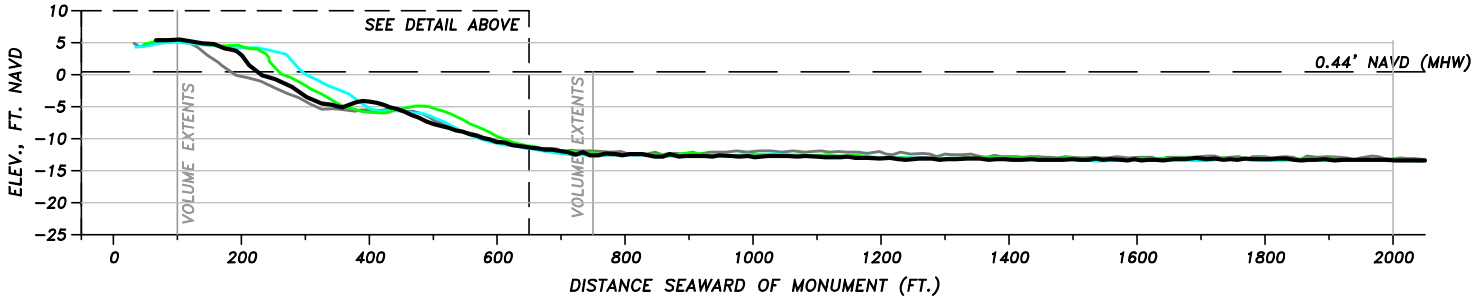
BEACH PROFILE: G-1

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

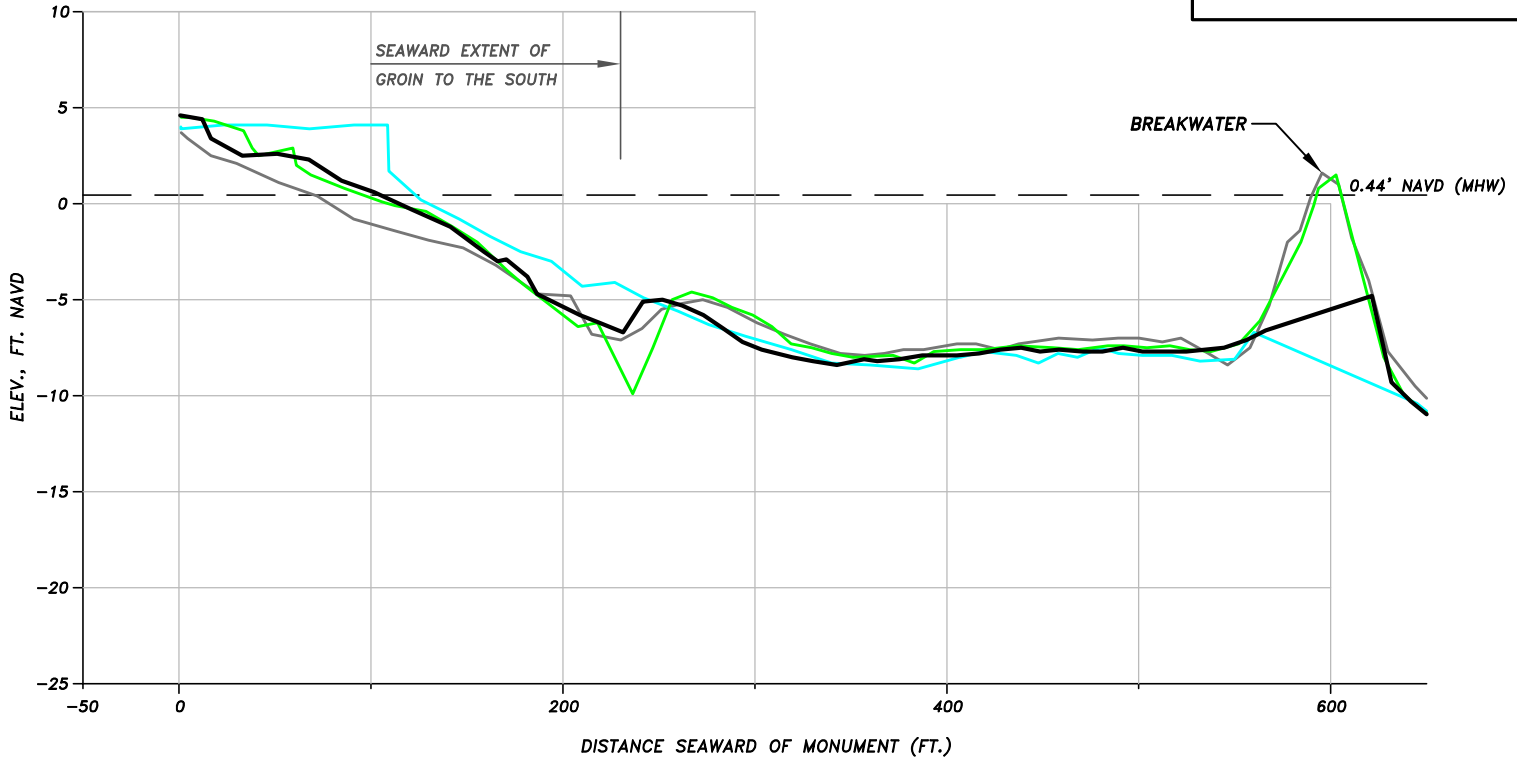
5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

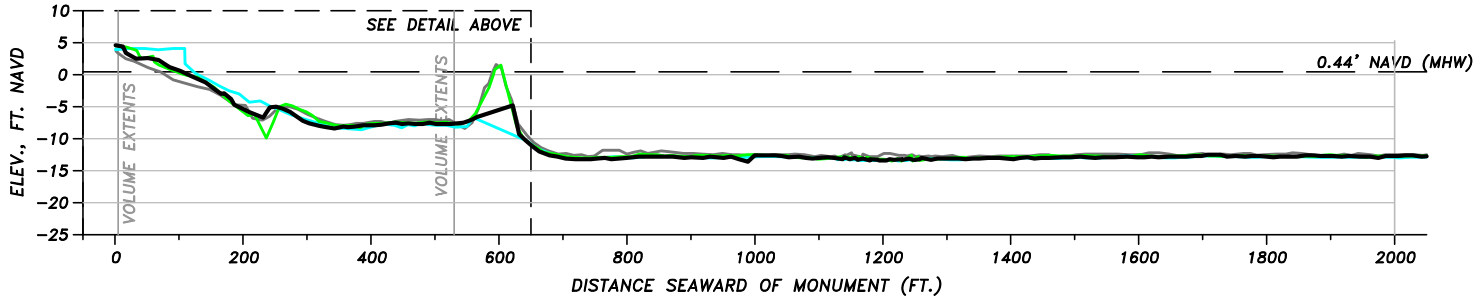
BEACH PROFILE: G-2

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

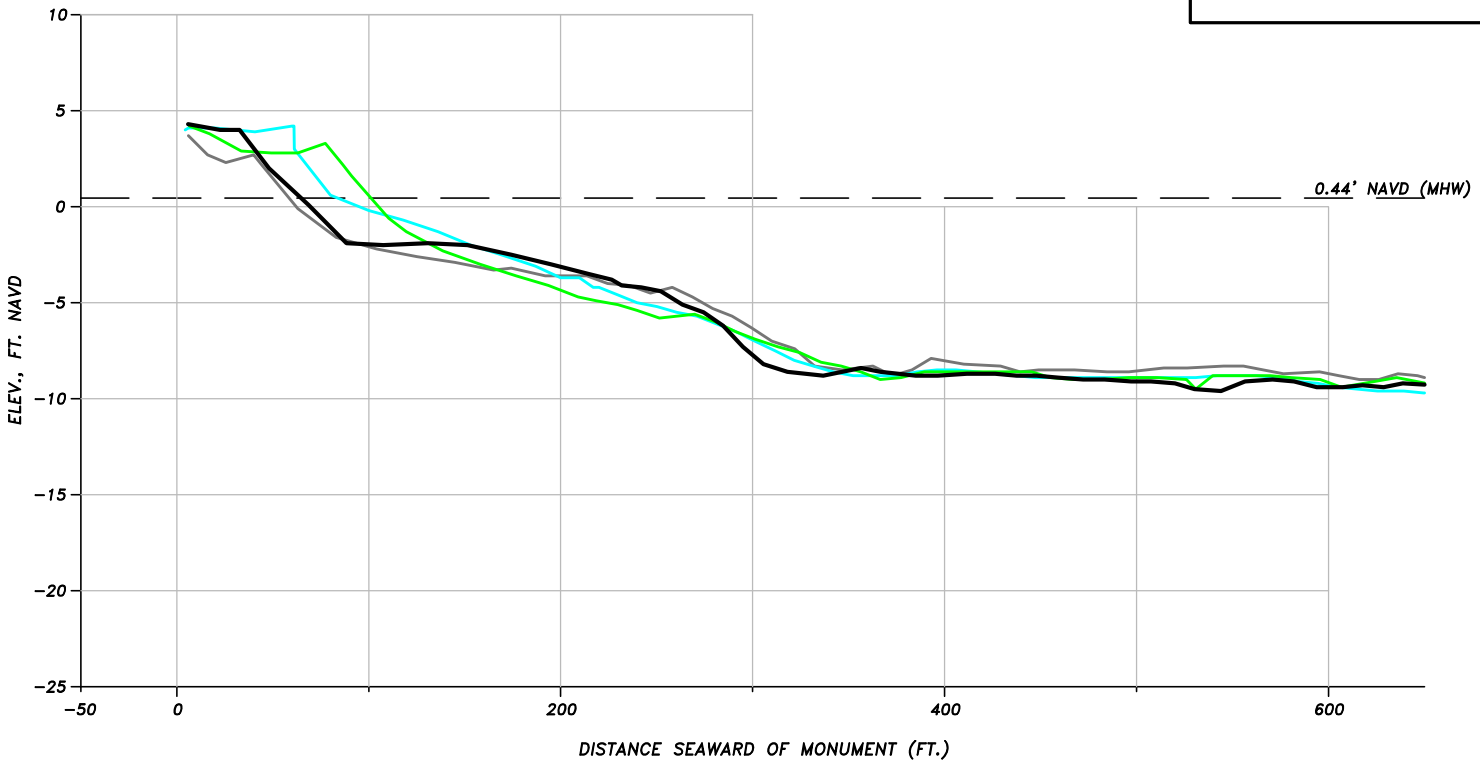
5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

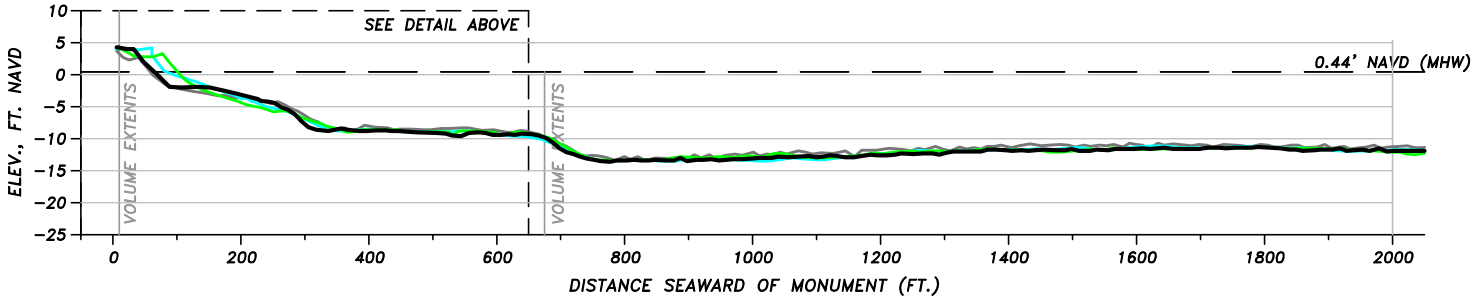
BEACH PROFILE: G-3

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

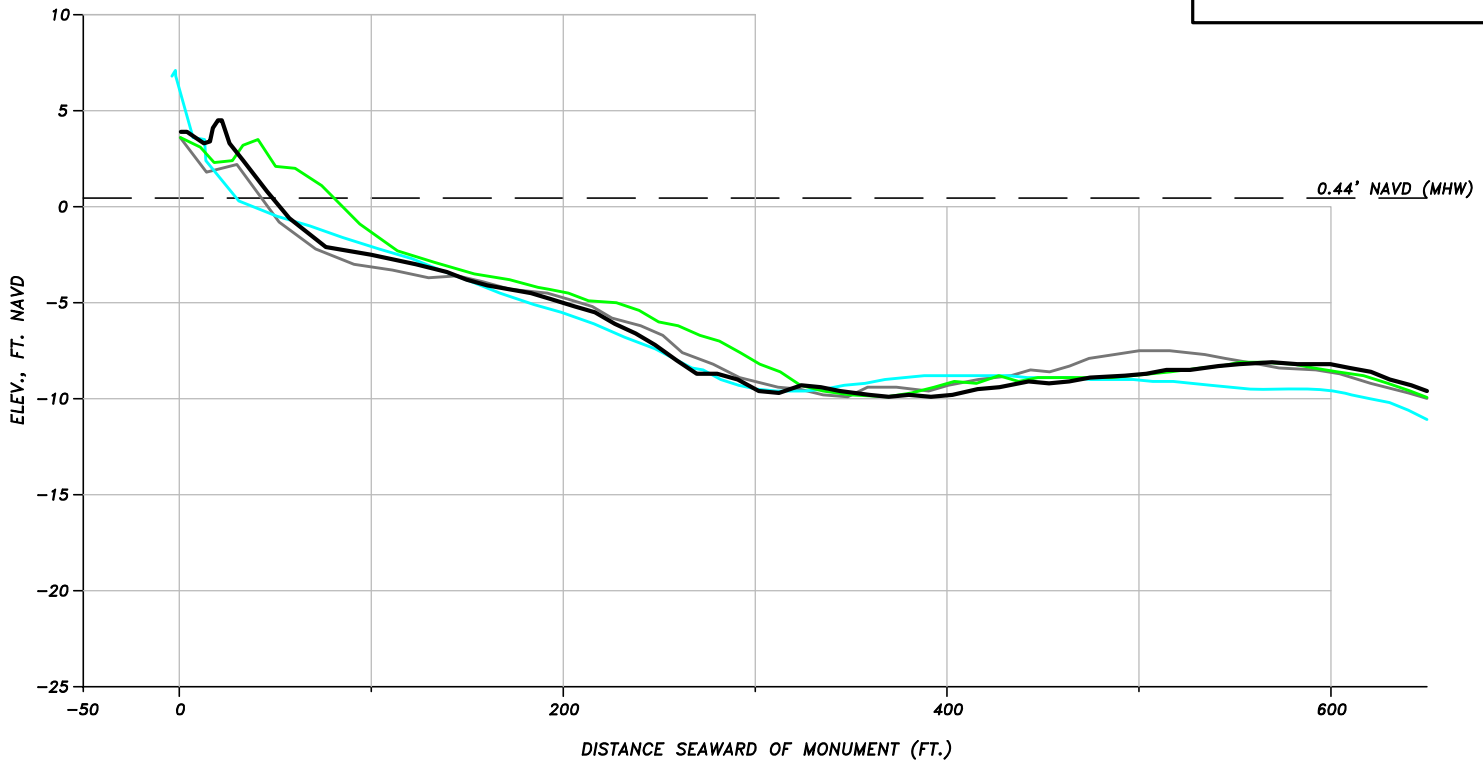
5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

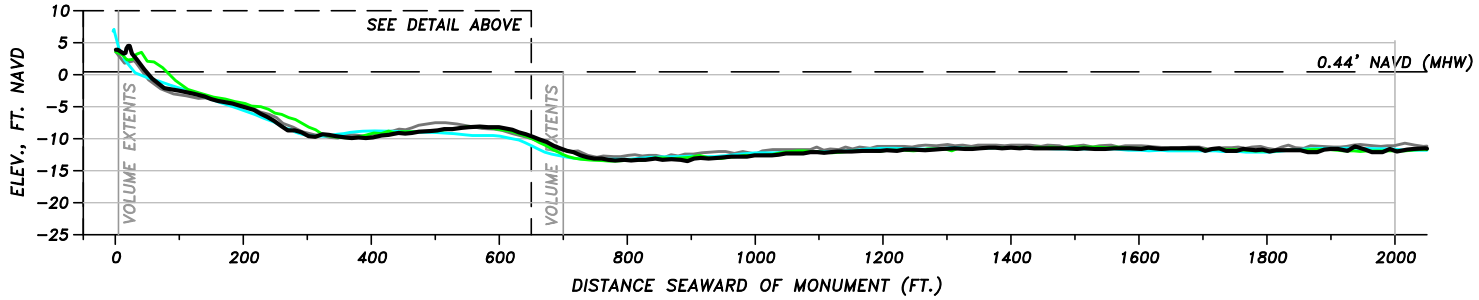
BEACH PROFILE: G-4

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI





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COASTAL ENGINEERING DESIGN AND PERMITTING

5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
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MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

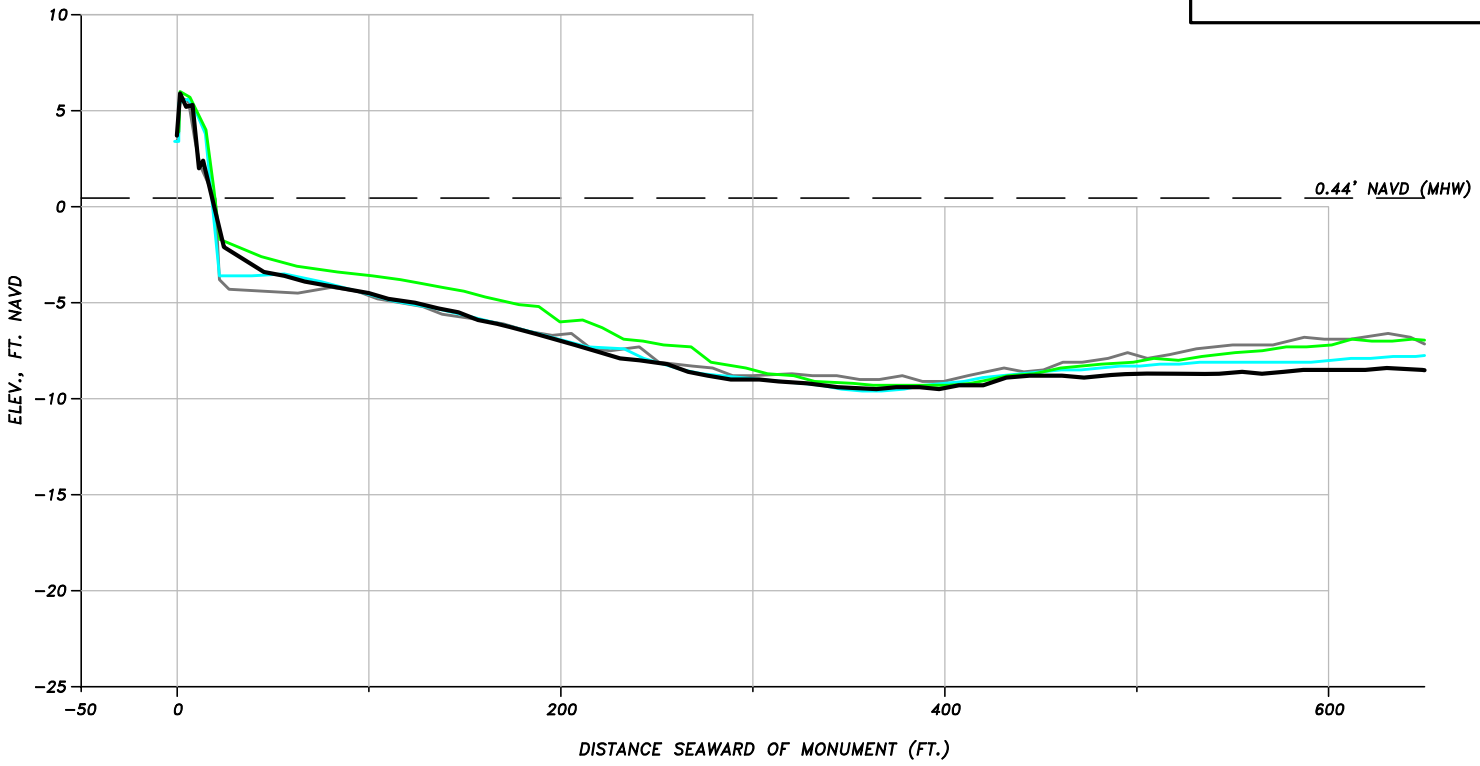
DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

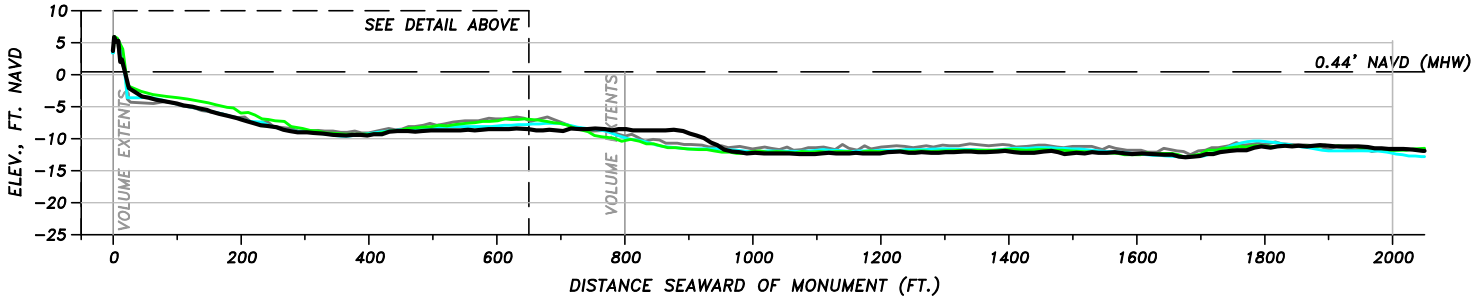
BEACH PROFILE: G-5

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

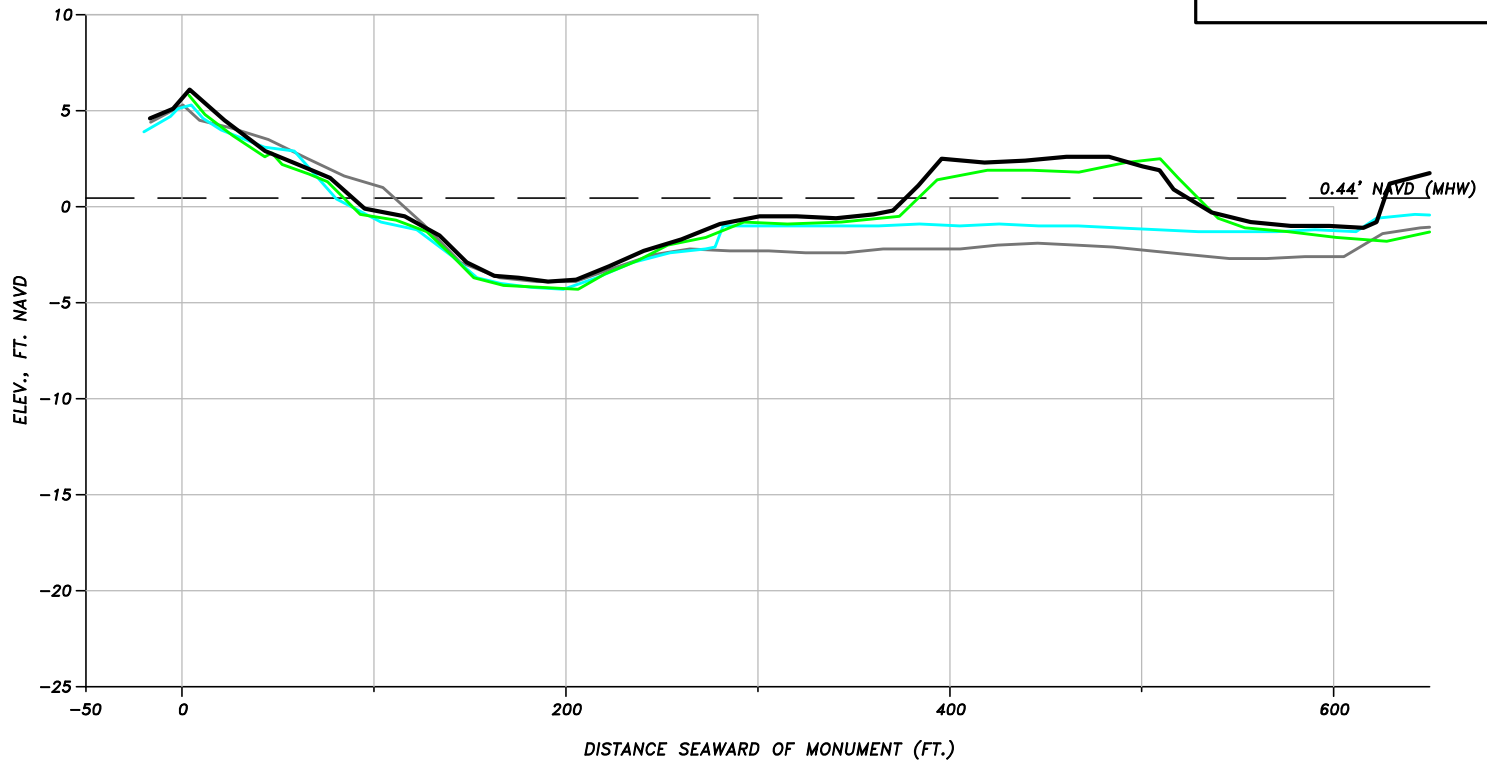
5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
PHONE: (239) 594 2021

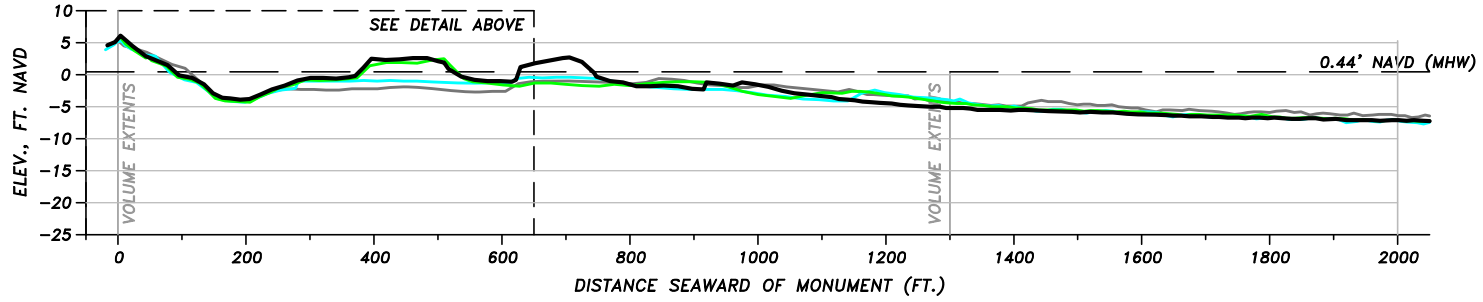
BEACH PROFILE: K-1

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

DATE: 2/1/22	FILE:23065-XS	SCALE:1"=300'
JOB FILE:23065	DATUM:NAVD	FIGURE:

5679 STRAND COURT
NAPLES, FL 34110
FAX: (239) 594 2025
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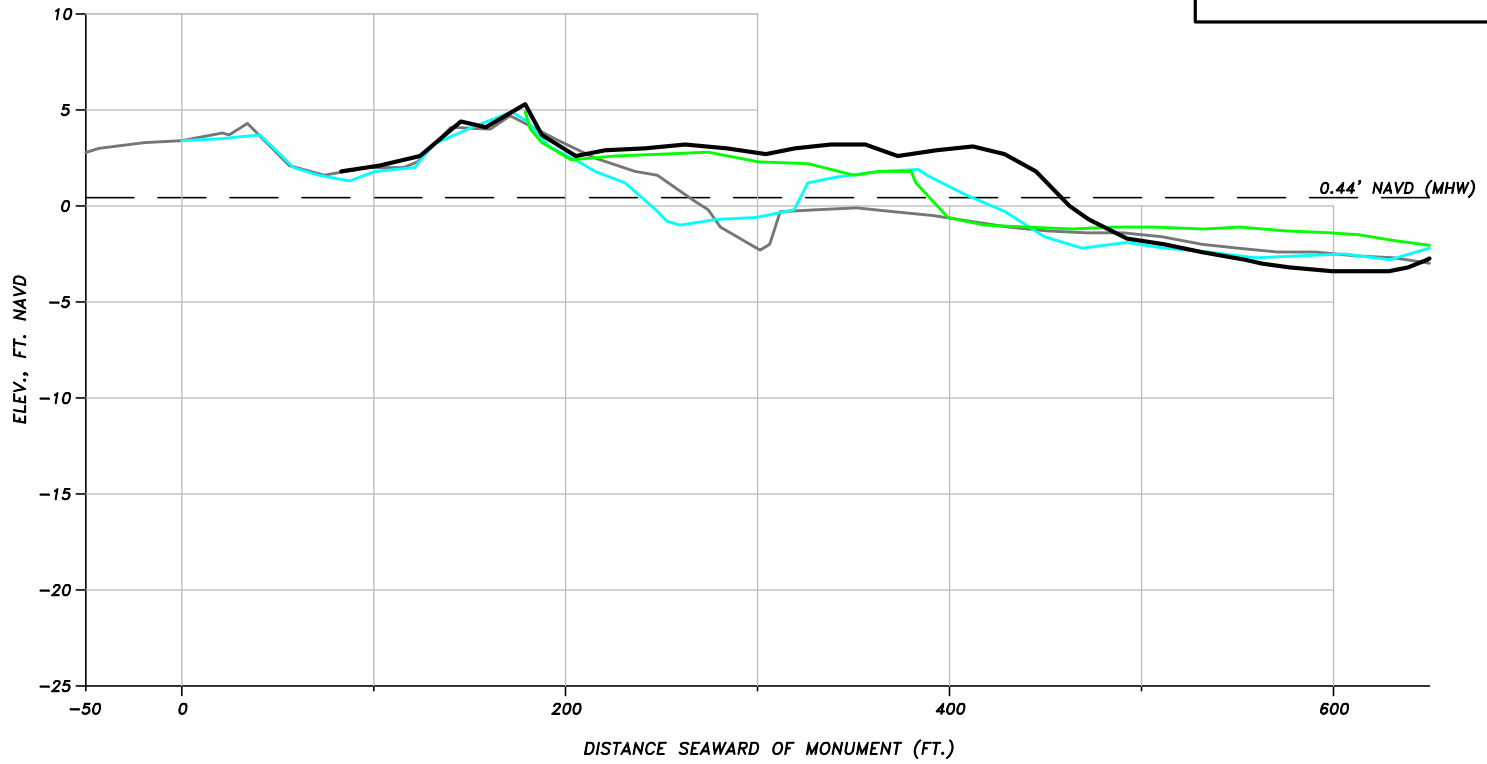
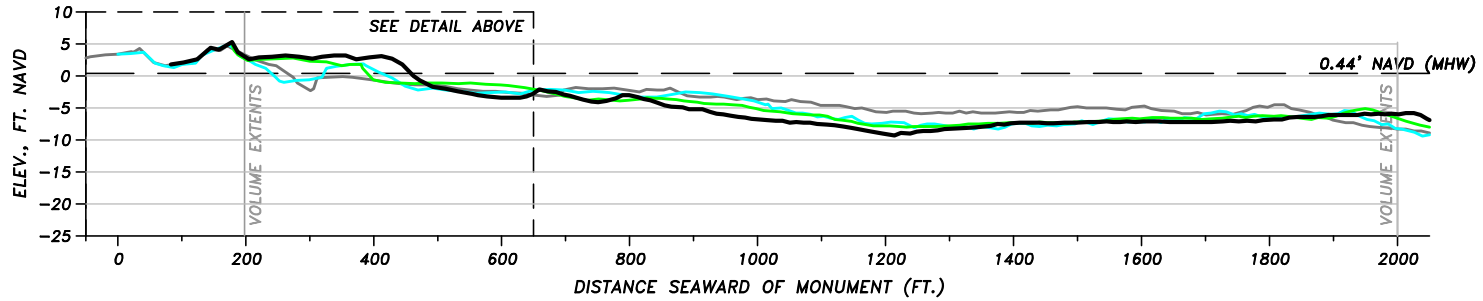
BEACH PROFILE: K-2

NEARSHORE DETAIL

SURVEY LEGEND

2019-02	(PRE-CON) MONITORING SDI
2020-04	POST-CON. MONITORING SDI
2021-02	1-YEAR POST MONITORING SDI
2022-01	2-YEAR POST MONITORING SDI





HUMISTON & MOORE ENGINEERS
COASTAL ENGINEERING DESIGN AND PERMITTING

MARCO & KICE ISLAND
BEACH PROFILE CROSS SECTIONS

FOR: COLLIER COUNTY

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