FINAL REPORT

Study of Summerhouse and Surrounding Areas

St. Johns County, Florida

Prepared for: St. Johns County Board of County Commissioners

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EXECUTIVE SUMMARY

Summerhouse Beach & Racquet Club (Summerhouse), established in 1982, encompasses nearly 26 acres and includes 256 condos within 20 separate buildings. Eight of these buildings (from north to south, buildings 1, 5, 6, 10, 11, 15, 16, and 20) front its 1,400-foot-long Atlantic Ocean shoreline. Hurricane Matthew caused significant erosion of the beach and dune system when it moved along Florida's east coast in October 2016. While the beach was still recovering from the effects of Hurricane Matthew, Hurricane Irma struck the area in 2017. With the remaining beach and dune system in an eroded state, the system became vulnerable to more frequent, less intense storms including numerous northeasters and other named tropical systems like Dorian (2019), Ian (2022), and Nicole (2022). The Summerhouse Homeowners Association started examining the vulnerabilities of its oceanfront buildings after Hurricane Irma. The southernmost oceanfront buildings (15,16, and 20) met the Florida Department of Environmental Protection's standard of eligibility for coastal armoring. In response to Hurricane Matthew, the County utilized Federal Emergency Management Agency Category B funds to place small quantities of fill to provide protection from a high frequency storm event. The fill alleviated the need for coastal armoring at that time. Post-Nicole observations show that some of this FEMA sand remained after the storm. Absent any natural recovery, future storms may cause building 20 (and possibly others) to become susceptible to erosion. St. Johns County (County) requested INTERA-GEC conduct a study to develop (1) an environmentally and financially sustainable long-term solution to maintain the flow of the Summer Haven River (SHR) and (2) a list of potential projects, which consider the potential effects of Matanzas Inlet on the adjacent beaches, to address beach erosion threatening the Summerhouse complex north of Fort Matanzas. This report focuses on solutions for Summerhouse. A separate report (INTERA-GEC, 2023) addresses the SHR.

Summerhouse lies within Matanzas Inlet's area of influence, which, in general, experiences beach erosion due to the inlet's sand-tapping effect. Over the long-term, stronger flood tidal flows deposit more sediments inside the inlet than the ebb tidal flows remove. This net imbalance allows the flood shoals inside the inlet to grow with sand that otherwise, without the presence of the inlet, would reach the Summerhouse and Summer Haven beaches. With lesser amounts of sand reaching these beaches, they become more susceptible to storm-induced erosion as the beach is generally narrower and lower over time in the presence of storms.

For completeness, this study identified two alternatives that do not require Board of County Commissioners (BOCC) action and two alternatives that the BOCC could support to address the ongoing erosion issues along Summerhouse's beaches. A seawall protecting the southernmost building (building 20) in the Summerhouse complex and a small-scale beach nourishment project fronting Summerhouse's 1,400-foot-long shoreline represent the two actions that do not require BOCC action. A steel sheet pile seawall protecting building 20 could cost $1.24 million for initial construction and $0.28 million for maintenance over 50 years, for a total of $1.52 million over 50 years in 2023 present worth equivalents. A small-scale beach nourishment project would consist of placing 75,600 cubic yards of beach - compatible sand (likely from a commercial mine) along the Summerhouse property. Conceptual initial and 50-yr maintenance costs, in 2023 present worth equivalents, equal approximately $5.79 million and $47.1 million, for a total of $52.89 million.

The other two alternatives consist of the BOCC (1) requesting the U.S. Army Corps of Engineers (USACE) perform a study on the shorelines north of the inlet to determine whether a federal interest exists in

protecting these properties from coastal storms and (2) supporting development of an inlet management plan for Matanzas Inlet. The County has already begun the first by requesting USACE study Butler and Crescent beaches from R-151 south to the Matanzas Inlet, including Summerhouse. This study could lead to future projects on the Summerhouse and adjacent northern beaches. As documented in this report, Summerhouse could indirectly benefit from beach fill projects placed near its beach even if its beachfront does not receive direct sand placement. The County can expect to contribute up to $1.5 million in financial or in-kind services to the study efforts. The County can help reduce some of its local sponsor cost by applying for state funding through the Florida Department of Environmental Protection's (FDEP's) Beach Management Funding Assistance (BMFA) program.

The County could concurrently explore serving as a potential local sponsor for developing and implementing an inlet management plan at Matanzas Inlet with the help of state funds through the FDEP's BMFA and the Florida Inland Navigation District's (FIND's) waterway assistance programs. While not necessarily alleviating their full issues, Summerhouse and Summer Haven beaches could both benefit from the bypassing of material intended for these shorelines but intercepted by inlet. The flood shoal could serve as source for bypassing. The current practice of placing Intracoastal Waterway (ICWW) material on the Summer Haven beaches could also help meet any bypassing objectives. However, that finer material may prove better suited for the beaches north of the inlet given its material is relatively fine. The direct placement of beach fill on the Summerhouse beaches via inlet management activities could provide a long-term, sustainable solution to addressing erosion there. Any dredging and bypassing of the materials could also lessen the shoaling rate within the ICWW, potentially benefiting FIND. As such, FDEP, FIND, and the County could potentially cost share in a solution that addresses numerous sediment management issues within the Matanzas Inlet area. An inlet management study would likely cost approximately $500,000 to conduct. Cost-sharing could reduce the County's share of this study cost.

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Acronyms and Abbreviations

BMFA	Beach Management Funding Assistance
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CCCL	Coastal Construction Control Line
County	St. Johns County
CSRM	Coastal Storm Risk Management
cy	cubic yards
cy/ft	cubic yards per linear foot
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FEMA	Federal Emergency Management Agency
FIND	Florida Inland Navigation District
FNAI	Florida Natural Areas Inventory
FS	Florida Statutes
ft	feet
ft/s	feet per second
GTMNERR	Guana Tolomato Matanzas National Estuarine Research Reserve
INTERA	INTERA Incorporated
INTERA-GEC	INTERA-GEC, LLC
ICWW	Intracoastal Waterway
JCP	Joint Coastal Permit
m	meters
m/s	meters per second
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
SAPWBD	St. Augustine Port, Waterway, and Beach District
SHR	Summer Haven River
SHRRP	Summer Haven River Restoration Project
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WAP	Waterway Assistance Program
WIS	Wave Information Study

1.0 Introduction

As part of a task order issued under RFQ No: 22-01; Continuing Contracts for As Needed Professional Services, Master Contract No: 22-PSA-INT-16053, St. Johns County (County) requested INTERA-GEC conduct studies to develop (1) an environmentally and financially sustainable long-term solution to maintain the flow of the Summer Haven River (SHR) and (2) a list of potential projects, which consider the potential effects of Matanzas Inlet on the adjacent beaches, to address beach erosion threatening the Summerhouse complex north of Fort Matanzas. This report focuses on solutions for Summerhouse. A separate report (INTERA-GEC, 2023) addresses the SHR.

1.1 Study Purpose and Scope

Summerhouse Beach & Racquet Club, established in 1982, encompasses nearly 26 acres and includes 256 condos within 20 separate buildings. Eight of these buildings (from north to south, buildings 1, 5, 6, 10, 11, 15, 16, and 20) front its 1,400-foot-long Atlantic Ocean shoreline. Recent problems along the Summerhouse shoreline appear to originate in 2016. Hurricane Matthew caused significant erosion of the beach and dune system when it moved along Florida's east coast in October of that year. While the beach was still recovering from the effects of Hurricane Matthew, Hurricane Irma struck the area in 2017. With the remaining beach and dune system in an eroded state, the system became vulnerable to more frequent, less intense storms including numerous northeasters and other named tropical systems like Dorian (2019), Ian (2022), and Nicole (2022). The Summerhouse Homeowners Association started examining the vulnerabilities of its oceanfront buildings after Hurricane Irma. Through analyses performed by INTERA (2020), the southernmost oceanfront buildings (15,16, and 20) met the Florida Department of Environmental Protection's standard of eligibility for coastal armoring. In response to Hurricane Matthew, the County utilized Federal Emergency Management Agency (FEMA) Category B funds to place small quantities of fill to provide protection from a high frequency storm event. Because of this project, the Summerhouse area received approximately seven cubic yards per linear foot of shoreline of dune fill in 2021. The fill alleviated the need for coastal armoring at that time. Post-Nicole observations show that some of this FEMA sand remained after the storm; however, anecdotal evidence suggests that the interaction of waves with the Fort Matanzas beach access ramp during high tide exacerbated the dune erosion between the ramp and building 20. Absent any natural recovery, future storms may cause building 20 (and possibly others) to become susceptible to erosion.

Developing environmentally and financially sustainable long-term solutions that will provide adequate protection to the Summerhouse property requires a thorough understanding of the area's existing conditions, coastal processes, and the dominant processes that continuously lead to the ongoing erosion. To achieve the understanding required to effectively identify and evaluate potential solutions, this study conducted a comprehensive topographic and bathymetric survey analysis, developed a sediment budget of the Matanzas Inlet system (Summerhouse lies within the inlet's area of influence), and analyzed the waves and hydrodynamics throughout the study area. Results of this costal processes analysis led to development of an array of potential solutions, and further evaluation identified the solutions that could potentially achieve the study goals and qualify for state and federal authorization. Finally, this study also identifies potential funding sources and partners to possibly implement feasible solutions.

1.2 Study Area

The study area's Atlantic shoreline extends from approximately two miles north of Matanzas Inlet to the St. Johns County/Flagler County line approximately 2.5 miles south of the inlet — between Florida Department of Environmental Protection (FDEP) reference monuments R-187 and R-209. The study area waterways include Matanzas Inlet, SHR, and the Intracoastal Waterway (ICWW). **Figure 1.1** provides a study area map. Monument R-193, the only reference monument along the Summerhouse shoreline, lies at the center of the Summerhouse property.

1.3 Report Participants and Coordination

The information presented herein derives from a collaborative data collection effort. To outline the scope of the study and solicit input from residents, INTERA-GEC and the County met with Summerhouse representatives on October 12, 202. Appendix A provides a brief summary of the town hall meeting.

In addition to the public outreach, INTERA-GEC contacted or met with various government entities and organizations to directly solicit available literature and data, including:

- Florida Department of Environmental Protection (FDEP)
- U.S. Army Corps of Engineers (USACE)
- Florida Inland Navigation District (FIND)
- National Park Service (NPS)
- National Oceanic and Atmospheric Administration (NOAA)
- Federal Emergency Management Agency (FEMA)
- Florida Department of Transportation (FDOT)
- St. Augustine Port, Waterway, and Beach District (SAPWBD)
- University of Florida
- Friends of the Summer Haven River
- Summerhouse Beach & Racquet Club
- St. Johns County

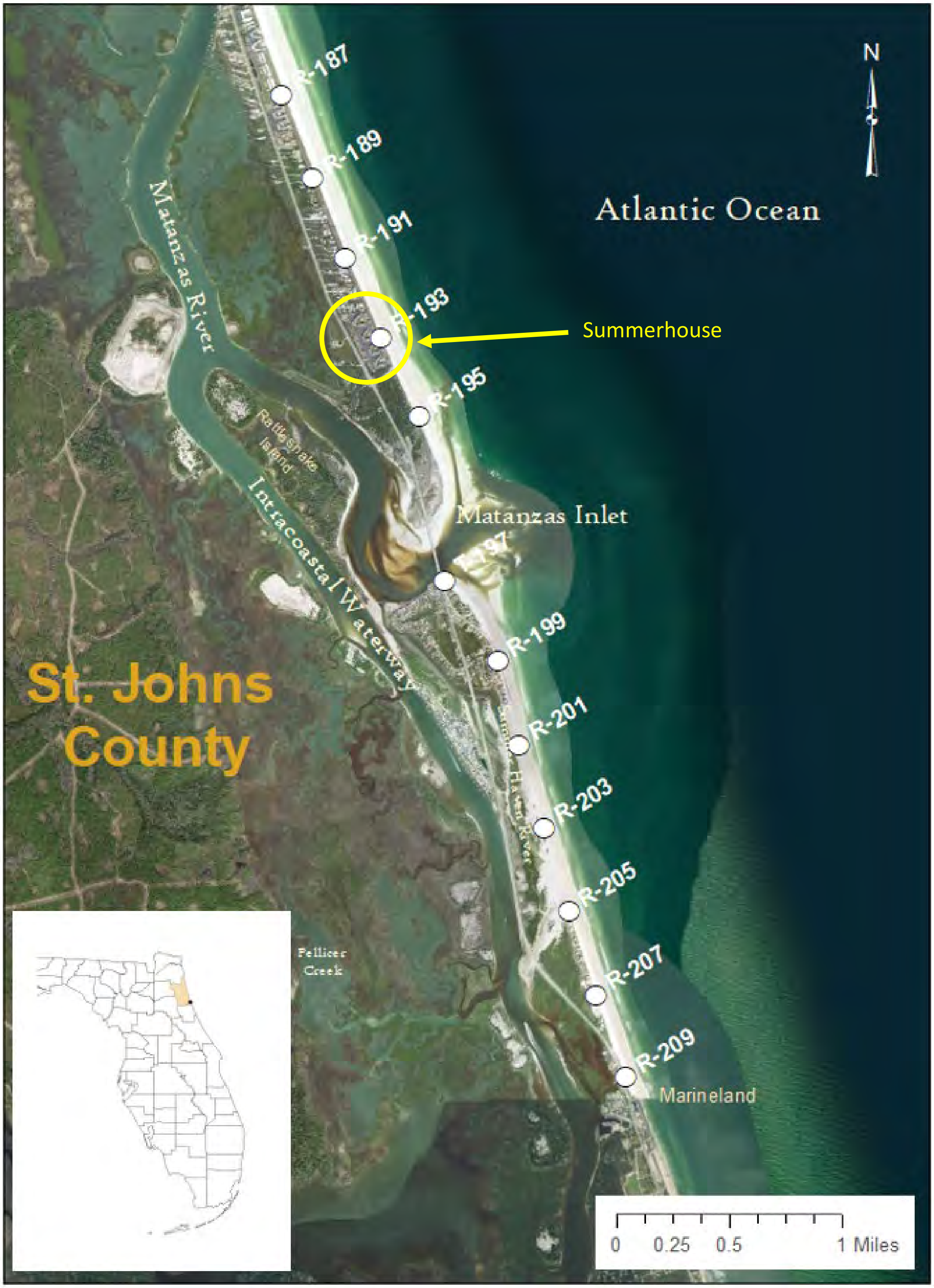


Figure 1.1 Study Area Map

2.0 Beach Management History

INTERA-GEC (2023) provides a summary of the historical beach and inlet management actions pertaining to Matanzas Inlet, Summer Haven beaches, and the SHR. This chapter focuses on beach management pertaining to only the dune and beach fronting Summerhouse.

2.1 Summerhouse Dune and Beach System History

The following narrative briefly summarizes some of the observed changes to the dune and beach system fronting the Summerhouse shoreline. **Figures 2.1-2.12** support the narrative with photos and a plot before and after select storms.

Historically, the dune system fronting Summerhouse consisted of a wide series of three dunes with varying crest elevations. **Figure 2.1** shows the dune system near the north end and **Figure 2.2** shows the dune system at the south end of the Summerhouse property circa 2000. From a 1993 aerial, the distance from buildings to the seaward edge of the dune vegetation measured nominally 150 feet (ft) (**Figure 2.3**). Before Hurricane Matthew eroded the beaches and dunes in October 2016, this distance was very similar (**Figure 2.4**). Given the shoreline orientation relative to the line of construction, the oceanfront buildings lie closer to the shoreline as you move north to south. Hurricanes and other storms in 2004 and 2005 caused some erosion of the most seaward dune as evidenced by the dune scarp (**Figure 2.5**). The 2016 aerial suggests the dune subsequently naturally recovered.

Figure 2.1 Looking North near North End of Summerhouse Property Circa 2000 (Source: Summerhouse)

Figure 2.2 Looking North near South End of Summerhouse Property Circa 2000 (Source: Summerhouse)

Figure 2.3 Aerial Acquired Feb 1993 (https://fdotewp1.dot.state.fl.us/aerialphotolookupsystem)

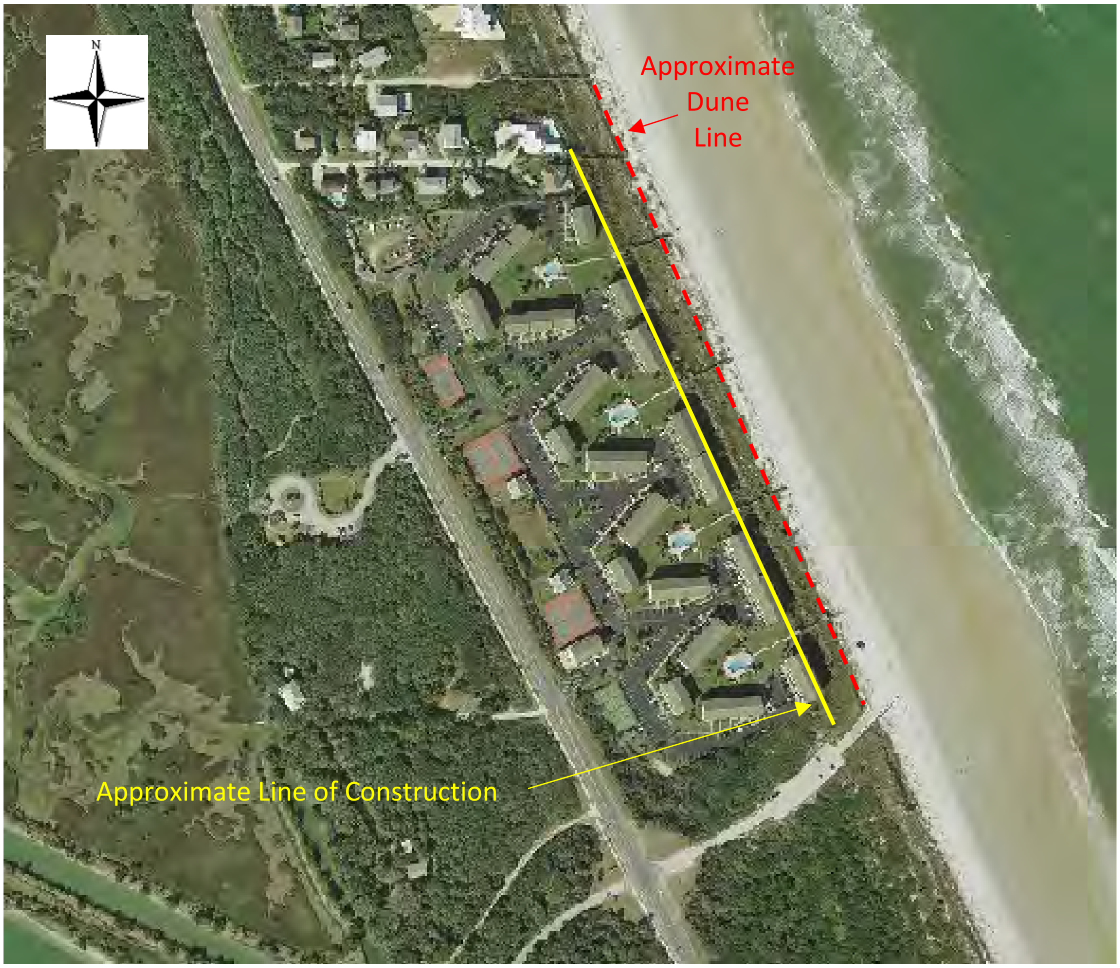


Figure 2.4 Aerial Acquired Jan/Feb 2016 (https://fdotewp1.dot.state.fl.us/aerialphotolookupsystem)

Figure 2.5 Aerial Acquired Mar 2005 (https://fdotewp1.dot.state.fl.us/aerialphotolookupsystem)

Hurricane Matthew eroded the frontal dune and generally lowered the beach elevations in October 2016. The FDEP (2017) characterized the erosion in the area as Condition IV, meaning major dune erosion occurred. **Figure 2.6** shows a comparison of United States Geological Survey (USGS) aerials (https://geodesy.noaa.gov/storm_archive/storms/matthew/index.html) taken in September 2014 and October 2016 (post-Matthew). Note that the dune lost approximately 30-40 ft of width.

Anecdotal evidence suggests that the tertiary, frontal dune was rebuilding during the late summer months the year following Hurricane Matthew. However, Hurricane Irma subsequently eroded the dune again in September 2017. Without this tertiary dune feature, the remaining beach and dune system became vulnerable to more frequent, less intense storms such as Hurricane Dorian (2019) and a northeaster in fall 2020. These lesser storms began eroding the secondary dune feature. **Figure 2.7** shows the dune damage after the northeaster.

In response to Hurricane Matthew, the County's FEMA Category B Emergency Berm Restoration Project, authorized by FDEP Permit No 0402841-001-JC, restored part of the lost dune sand. The project area (**Figure 2.8**) included, in part, R-189.85–R-193.65, extending 3,821 ft northward from Summerhouse's southern property line. Constructed in late 2021, the project placed approximately 26,405 cubic yards (cy) (6.9 cy/ft) of dune fill in this area from upland sand sources according to the County's reported values (Stephen Hammond, St. Johns County Coastal Environment Project Manager, personal communication, March 28, 2023). This sand only partially restored the secondary dune and raised the beach elevation because of funding and permitting constraints (**Figure 2.9**). **Figure 2.10** shows select historical and current beach profiles taken along R-193, the only long-term reference monument along the Summerhouse shoreline. The profiles show the healthy dune and beach system represented by May 2011 conditions, the effects of hurricanes Matthew and Irma, the conditions before (December 2020) and immediately after the FEMA dune project, and December 2022 (current) conditions. The May 2011 profile shows the primary dune near elevation +22 ft NAVD88, the secondary, middle dune near elevation +16 ft NAVD88, and the tertiary dune near elevation +10 ft NAVD88.

Figure 2.6 Comparison of Pre- and Post-Matthew Conditions near South End of Summerhouse

Figure 2.7 Post-Fall 2020 Northeaster Damage near Building 20 (source: Summerhouse)

Figure 2.8 Overview of 2021 FEMA Beach Fill Placement Area

Figure 2.9 FEMA Emergency Dune Berm near the South End of Summerhouse (Looking South)

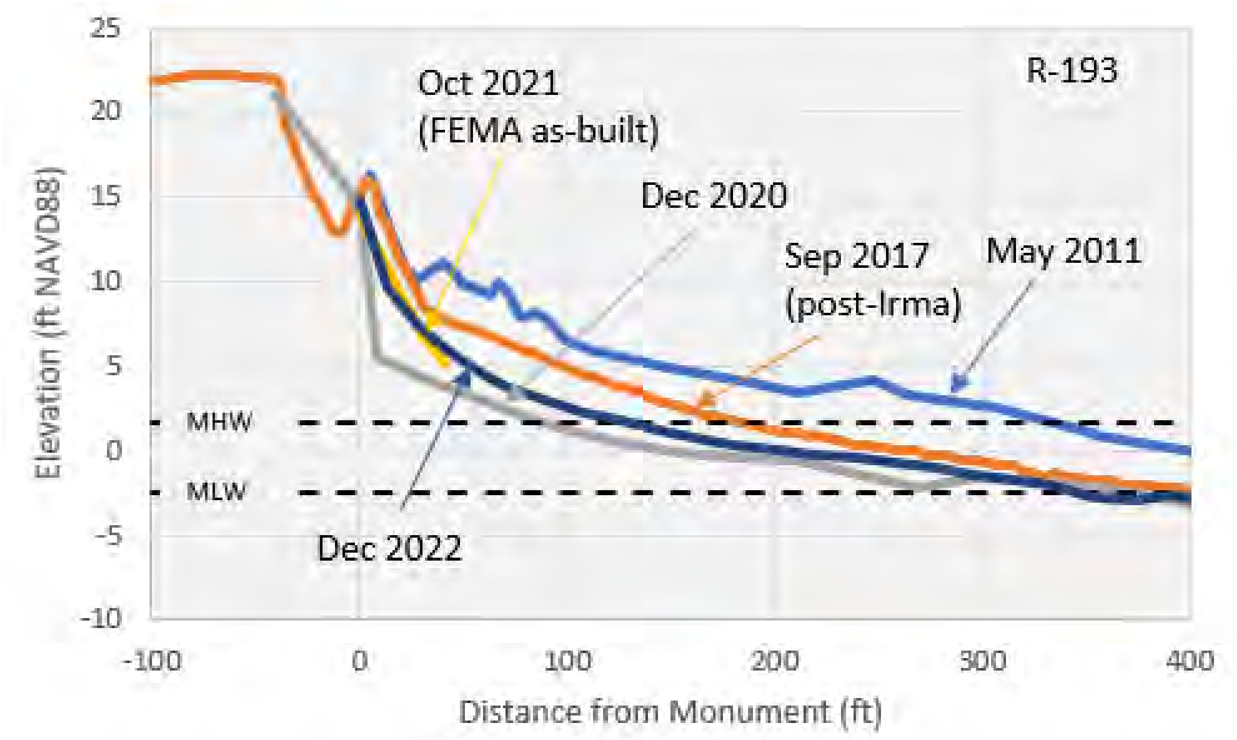


Figure 2.10 Select Historical and Current Beach Profiles along Reference Monument R-193

Hurricanes Ian and Nicole affected the study area in September (**Figure 2.11**) and November of 2022 (**Figure 2.12**). The storms eroded some of the FEMA dune sand. Interestingly, **Figure 2.10** shows that the beach had recovered some of the lost material and improved conditions over those in December 2020. However, it is still deflated relative to the May 2011 condition and even the post-Irma condition.

In light of the persistent erosion, the FDEP (2023a) recently designated 4,000 ft of beaches north of the inlet, including Summerhouse's beaches, as critically eroding. Practically, this designation by the state makes the Summerhouse shoreline eligible for up to 50% cost-sharing from the state for all costs related to beach management activities. In addition, this designation makes a federal beach project more attractive given the state has already determined a need for some action to occur. See the Chapter 5 for additional information.

The following sections summarize related state and federal permits to the prior restoration effort and available survey data to support the coastal analyses presented herein.

Figure 2.11 Post-Hurricane Ian Conditions near Buildings 5 and 6 (Looking North)

Figure 2.12 Post-Hurricane Nicole Conditions near Building 20 (Looking North) (source: Summerhouse)

2.2 Active State and Federal Permits

2.2.1 FDEP Joint Coastal Permit

2.2.1.1 Permit No. 0402841-001-JC, St. Johns County FEMA Berm Restoration – Expires August 4, 2036

On August 4, 2021, the FDEP issued Permit No. 0402841-001-JC to St. Johns County for dune restoration within seven distinct reaches totaling approximately 20.2 miles in length, including the Crescent Beach segment (R-173 to R-196) that includes Summerhouse. The dune placement template in this segment includes a maximum dune crest elevation of +15 ft NAVD88 tying into the existing dune, a varying dune crest width with a 1V:50H slope, and a seaward dune face slope of 1V:4H extending from the crest to the existing beach grade.

2.2.2 Department of the Army Dredge and Fill Permits

No known beach projects near Summerhouse, including the FEMA dune restoration project that placed fill above MHW only, have required a Department of the Army permit.

2.3 Topographic and Bathymetric Survey Data

Arc Surveying and Mapping, Inc (Arc) performed a bathymetric and topographic survey and aerial LiDAR mapping for this study (LiDAR survey date: October 20, 2022, Topographic survey date: October 17 to December 16, 2022, Hydrographic survey date: October 11 to November 29, 2022). The survey utilized a combination of data acquisition procedures including conventional survey collection, hydrographic single beam, drone-based LiDAR and photogrammetry, and Real Time Kinematic (RTK) GPS. The procedures utilized result in high-resolution spatial data, which provide accurate control and feature data acquisition. **Figure 2.13** provides a contour map of the survey.

Historic beach profile surveys spanning 1972 – 2020 along the St. Johns County coastline are available on the FDEP website: http://publicfiles.dep.state.fl.us/DWRM/Beaches/HSSD/ProfileData/prof839088/. The surveyed profiles coincide with FDEP reference monuments spaced approximately 1,000 ft apart along the shoreline. **Table 2.1** summarizes the data available for the study area. As noted in the table, not every survey included all profiles from R-187 to R-209, and not every survey extended far enough seaward to allow an accurate and realistic measurement of offshore contour changes, and hence volume changes, to the estimated depth of closure (-30 ft NAVD88).

The National Oceanic and Atmospheric Administration's (NOAA) digital coast database provides historical hydrographic surveys. The database mostly comprises surveys performed by the USACE (2004, 2009, 2010, 2016, and 2017) and the County through its Countywide Digital Contour Mapping Project (2004, 2008, 2013). Three full inlet surveys — 2016 pre- and post-Hurricane Matthew and 2017 post-Hurricane Irma — including the flood and ebb shoals are available from NOAA; the surveys prior to 2016 did not capture the full inlet. **Table 2.2** shows the date and extent of the available surveys near the study area, including the 2022 survey performed for this study.

Chapter 4 further discusses data used in this study to determine the historical trend of beach and shoreline erosion and the inlet's effects on adjacent beaches.

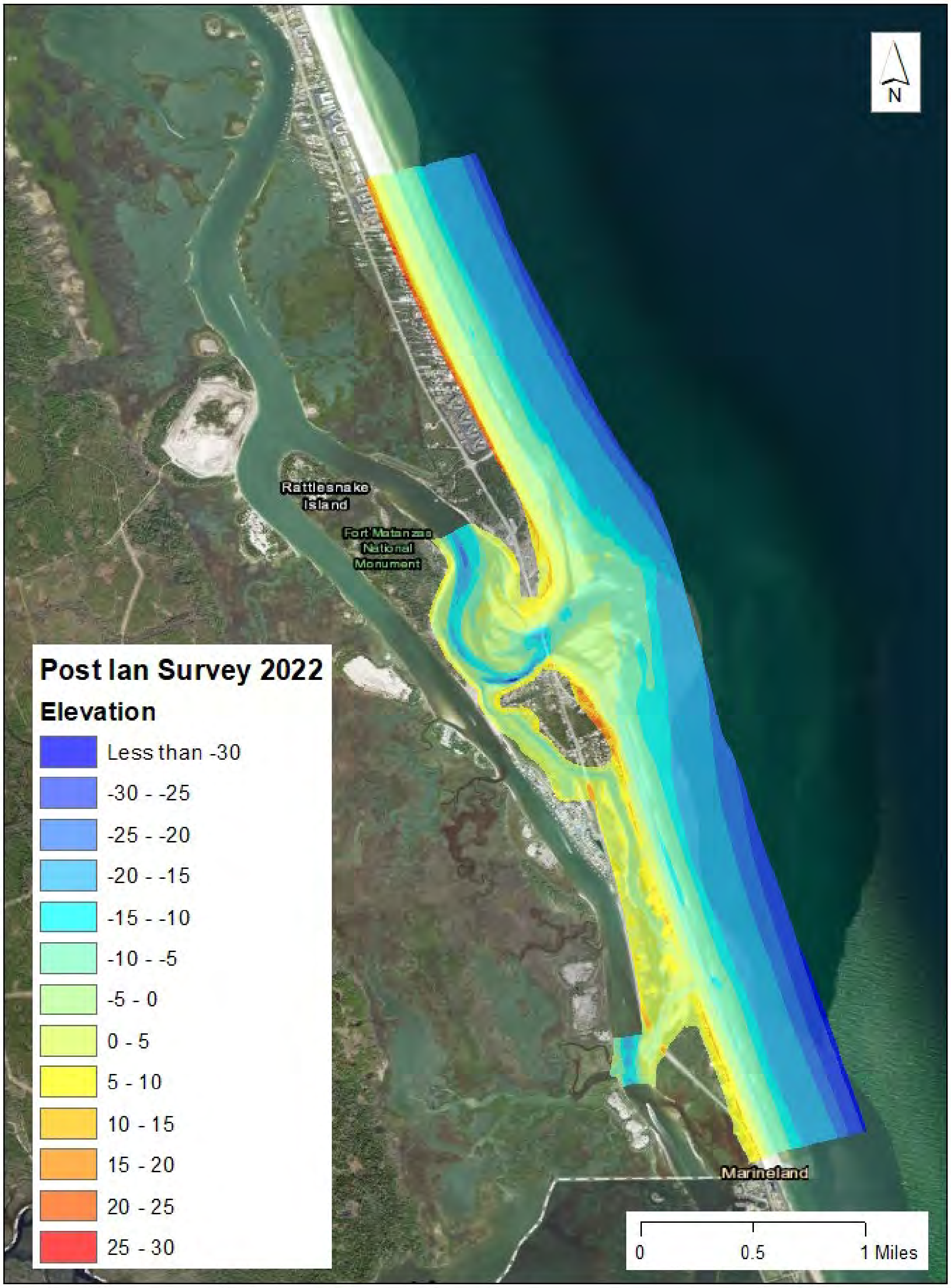


Figure 2.13 Survey Contour Map

Table 2.1 Available Beach Profile Survey Data

Filename	Source[1]	Survey Date		Survey Extents	Includes R-187 to 209
		Month	Year		
SJ7209_CCC_1.PRF	FDEP	09	1972	Entire Profile/ Wading Depth[2]	Yes
SJ8405_CON_1.PRF	FDEP	05	1984	Entire Profile/ Wading Depth[2]	Yes (except R-198)
SJ8409_PST_1.PRF	FDEP	09	1984	No data	No
SJ8412_PST_1.PRF	FDEP	12	1984	Wading Depth	Yes (except R-196, R-198)
SJ8607_CCC_1.PRF	FDEP	07	1986	Entire Profile/ Wading Depth[2]	Yes
SJ9210_CON_1.PRF	FDEP	10	1992	No data	No
SJ9307_CON_1.PRF	FDEP	07	1993	Wading Depth	Yes (except R-208, R-209)
SJ9509_CON_1.PRF	FDEP	09	1995	No data	No
SJ9604_CON_1.PRF	FDEP	04	1996	Wading Depth	No (R-200 - R-209 only)
SJ9702_CON_1.PRF	FDEP	02	1997	Wading Depth	No (R-200 - R-209 only)
SJ9902_CON_1.PRF	FDEP	02	1999	Entire Profile	Yes (except R-208, R-209)
SJ0306_CON_1.PRF	FDEP	06	2003	Entire Profile	Yes
SJ0306_OFF_1.PRF	FDEP	06	2003	Entire Profile	Yes
SJ0703_SPE_1.PRF	FDEP	03	2007	No data	No
SJ0709_CON_1.PRF	FDEP	09	2007	Entire Profile	Yes
SJ1105_CON_1.PRF	FDEP	05	2011	Entire Profile	Yes
SJ1405_COE_1.PRF	USACE	05	2014	No data	No
SJ1407_CON_1.PRF	FDEP	07	2014	Wading Depth	Yes
SJ1606_COE_1.LID	USACE	06	2016	Entire Profile[3]	Yes
SJ1611_COE_1.LID	USACE	11	2016	Entire Profile[3]	Yes
SJ1706_CON_1.PRF	FDEP	06	2017	Wading Depth	Yes
SJ1709_COE_1.LID	USACE	0	2017	Wading Depth	Yes (except R-200 - R-204)
SJ1803_OLS_1.PRF	OLS	03	2018	No data	No
SJ1911_CON_1.PRF	FDEP	11	2019	Wading Depth	Yes
SJ1912_ARC_1.PRF	ARC	12	2019	No data	No
SJ2011_DRM_1.PRF	ATL	11	2020	Wading Depth	Yes (except R-187 - R-193)

[1]FDEP=Florida Department of Environmental Protection; USACE=U.S. Army Corps of Engineers; OLS=Olsen and Associates; ARC=ARC Surveying and Mapping, Inc.; ATL=Atlantic Surveying.
[2] Survey every third profile extends offshore (-35 to -40 ft) and the others are wading depth (-2 to-8 ft)
[3] Profile extends offshore (-12 to -18 ft)

Table 2.2 Available Beach Hydrographic Data

Survey Start	Survey End	Source[1]	Description[2]	Survey Coverage
2004-11-01	2004-12-31	USACE	Post-Hurricane Ivan	Beach, Partial Channel
2004-01-17	2004-02-07	SJC	CDCM	Beach (Topo only)
2005-12-11	2006-02-05	USACE	NCMP	Beach, Fort Matanzas (Topo only)
2008-02-14	2008-02-25	SJC	CDCM	Beach (Topo only)
2009-09-27	---	USACE	NCMP	Beach, Partial Channel, Rattlesnake Island
2010-05-04	2010-06-16	USACE	NCMP	Beach
2013-01-11	2013-01-25	SJC	CDCM	Beach (Topo only)
2016-05-19	2016-07-20	USACE	NCMP	Beach, Ebb Shoal, Flood Shoal, Summer Haven River
2016-10	2016-12	USACE	Post-Hurricane Matthew	Beach, Ebb Shoal, Flood Shoal, Summer Haven River
2017-09-18	2017-10-25	USACE	Post-Hurricane Irma	Beach, Ebb Shoal, Flood Shoal, Summer Haven River
2022-10-11	2022-11-29	ARC	Post-Hurricane Ian	Beach, Ebb Shoal, Flood Shoal, Summer Haven River

[1]SJC=St. Johns County; ARC= Arc Surveying and Mapping, Inc.

[2]CDCM=Countywide Digital Contour Mapping; NCMP=National Coastal Mapping Program

3.0 Site Characteristics

Any efforts undertaken to mitigate coastal erosion at Summerhouse must consider the effects of or on the natural and physical environments of the study area. This section discusses these environments as they pertain to Summerhouse beach management.

3.1 Natural Environment

The following sections briefly discuss the natural resources, threatened and endangered species, Essential Fish Habitat (EFH), and coastal barrier resources of the study area.

3.2 Natural Resources

Florida Natural Areas Inventory (FNAI) presents a standardized classification of Florida's natural communities (FNAI, 2010). In accordance with this classification, the Summerhouse property historically contains the following natural communities, as described in FNAI (2010):

- Beach dune — A predominantly herbaceous community of wide-ranging coastal specialist plants on the vegetated upper beach and first dune above the beach (foredune).
- Coastal grassland — A predominantly herbaceous community occupying the drier portions of the transition zone between beach dunes on the immediate coast and communities dominated by woody species, such as coastal strand or maritime hammock, further inland.
- Coastal strand — An evergreen shrub community growing on stabilized coastal dunes in the peninsula of Florida, often with a smooth canopy due to pruning by salt spray.

The following sections address permitting and funding considerations related to natural resources.

3.2.1 Threatened and Endangered Species

Table 3.1, prepared by USACE in 2020 in review of a modification request to Department of the Army Permit No. SAJ-2012-02400 for the Summer Haven River Restoration Project, helps identify effects that large-scale projects at Summerhouse (i.e., fill placed above and below MHW) may have on endangered and threatened species or their critical habitats. Issuance of any future Department of the Army permits will require USACE to update this list and request U.S. Fish and Wildlife (USFWS)/National Marine Fisheries Service (NMFS) concurrence with the determinations pursuant to Section 7 of the Endangered Species Act (ESA).

Table 3.1 Endangered Species Designations in the Study Area

Species/Critical Habitat	Status*	Agency	Biological Opinion (BO)*	Covered under BO	USACE Initial Determination*
Manatee (*Trichechus manatus*)	T	USFWS	SPBO	Yes	MANLAA
Eastern Indigo Snake (*Drymarchon couperi*)	T	USFWS	Eastern Indigo Snake Key	Yes	NLAA

Species/Critical Habitat	Status*	Agency	Biological Opinion (BO)*	Covered under BO	USACE Initial Determination*
Florida Scrub Jay (*Aphelocoma coerulescens*)	T	USFWS	N/A	N/A	NE
Piping Plover (*Charadrius melodus*)	T	USFWS	P3BO	Yes	MANLAA
Rufa Red knot (*Calidris canutus rufa*)	T	USFWS	P3BO	Yes	MANLAA
North Atlantic Right Whale	E	NMFS	SARBO	Yes	NE
North Atlantic Right Whale Critical Habitat Unit 2	-	-	-	-	NLAM
Atlantic sturgeon (*Acipenser oxyrinchus oyrinchus*)	E	NMFS	SARBO/JAXBO	No	MANLAA
Shortnose sturgeon (*Acipenser brevirostrum*)	E	NMFS	SARBO/JAXBO	Yes	MANLAA
Smalltooth Sawfish (*Pristis pectinata*)	E	NMFS	SARBO/JAXBO	No	MANLAA
Sea Turtles Nesting					
Loggerhead (*Caretta caretta*)	T	USFWS	SPBO	Yes	MANLAA
Green (*Chelonia mydas*)	T	USFWS	SPBO	Yes	MANLAA
Kemp's Ridley (*Lepidochelys kempii*)	E	USFWS	SPBO	Yes	MANLAA
Leatherback (*Dermochelys coriacea*)	E	USFWS	SPBO	Yes	MANLAA
Hawksbill (*Eretmochelys imbricata*)	E	USFWS	SPBO	Yes	MANLAA
Loggerhead Sea Turtle Critical Terrestrial Habitat Unit LOGG-T-FL-03	-	USFWS	SPBO	Yes	NLAM
Sea Turtles Swimming					
Green (*Chelonia mydas*);	T	NMFS	SARBO/JAXBO	Yes	MANLAA
Kemp's Ridley (*Lepidochelys kempii*);	E	NMFS	SARBO/JAXBO	Yes	MANLAA

Species/Critical Habitat	Status*	Agency	Biological Opinion (BO)*	Covered under BO	USACE Initial Determination*
Leatherback (*Dermochelys coriacea*);	E	NMFS	SARBO/JAXBO	Yes	MANLAA
Loggerhead (*Caretta caretta*);	T	NMFS	SARBO/JAXBO	Yes	MANLAA
Hawksbill (*Eretmochelys imbricata*)	E	NMFS	SARBO/JAXBO	Yes	MANLAA
Loggerhead Sea Turtle Neritic Habitat Unit LOGG-N-15	-	NMFS	SARBO/JAXBO	Yes	NLAM
*Key: NMFS: National Marine Fisheries Service USFWS: United States Fish and Wildlife Service T: Federal Listing Status Threatened E: Federal Listing Status Endangered SPBO: Statewide Programmatic Biological Opinion 2015 SARBO: South Atlantic Region Biological Opinion 1997 P³BO: Piping Plover Programmatic Biological Opinion MANLAA: May Affect, Not Likely to Adversely Affect MALAA: May Affect, Likely to Adversely Affect NLAM: Not Likely to Adversely Modify NE: No Effect Source: https://www.saj.usace.army.mil/Missions/Regulatory/Public-Notices/Article/2118800/saj-2012-02400-mod-2-tmm/					

3.2.2 Essential Fish Habitat (EFH)

During processing of Department of the Army permit applications, USACE must consult with NMFS regarding potential effects on EFH as required by the Magnuson-Stevens Fishery Conservation and Management Act 1996. During prior consultations for Summer Haven dredging and beach fill projects, USACE has identified impacts to specific acreage of estuarine habitats utilized by various life stages of shrimp (*Farfantepenaeus* spp., *Penaeus* spp., and/or *Litopenaeus* spp.), snapper (*Lutjanus* spp.), and grouper (*Mycteroperca* spp. and/or *Epinephelus* spp.) as well as specified miles of nearshore habitat within the Atlantic Ocean. USACE has previously determined, with NMFS concurrence, that proposed projects would not have a substantial adverse impact on EFH or federally managed fisheries. For future permit applications, USACE must update their determination relative to proposed project impacts and the need for mitigation measures and coordinate with NMFS.

3.2.3 Coastal Barrier Resources

The Coastal Barrier Resources Act of 1982 (Public Law 97-348; CBRA) established the John H. Chafee Coastal Barrier Resources System (CBRS) to promote conservation of certain coastal barrier resources along the Atlantic, Gulf of Mexico, Great Lakes, U.S. Virgin Islands, and Puerto Rico coasts by restricting federal expenditures that encourage development of the resources. The CBRS includes System Units consisting of relatively undeveloped coastal areas at the time of their designation and Otherwise Protected Areas (OPAs) held primarily for wildlife refuge, sanctuary, recreational, or conservation purposes. Currently, 588 System Units encompass nearly 1.4 million acres of land and aquatic habitat, and 282 OPAs encompass 2.1 million acres (https://www.fws.gov/program/coastal-barrier-resources-act/maps-and-data). CBRA prohibits most new federal expenditures and financial assistance, including flood insurance, within System Units. However, it only prohibits federal spending on flood insurance within OPAs. CBRA does not prohibit or impose restrictions on development using non-federal funds.

Summerhouse lies along the northern boundary of OPA P05AP (Fort Matanzas National Monument) as shown in **Figure 3.1**. The CBRA does not appear to prohibit federal funding of any projects at or north of Summerhouse that USACE may consider eligible for federal authorization.

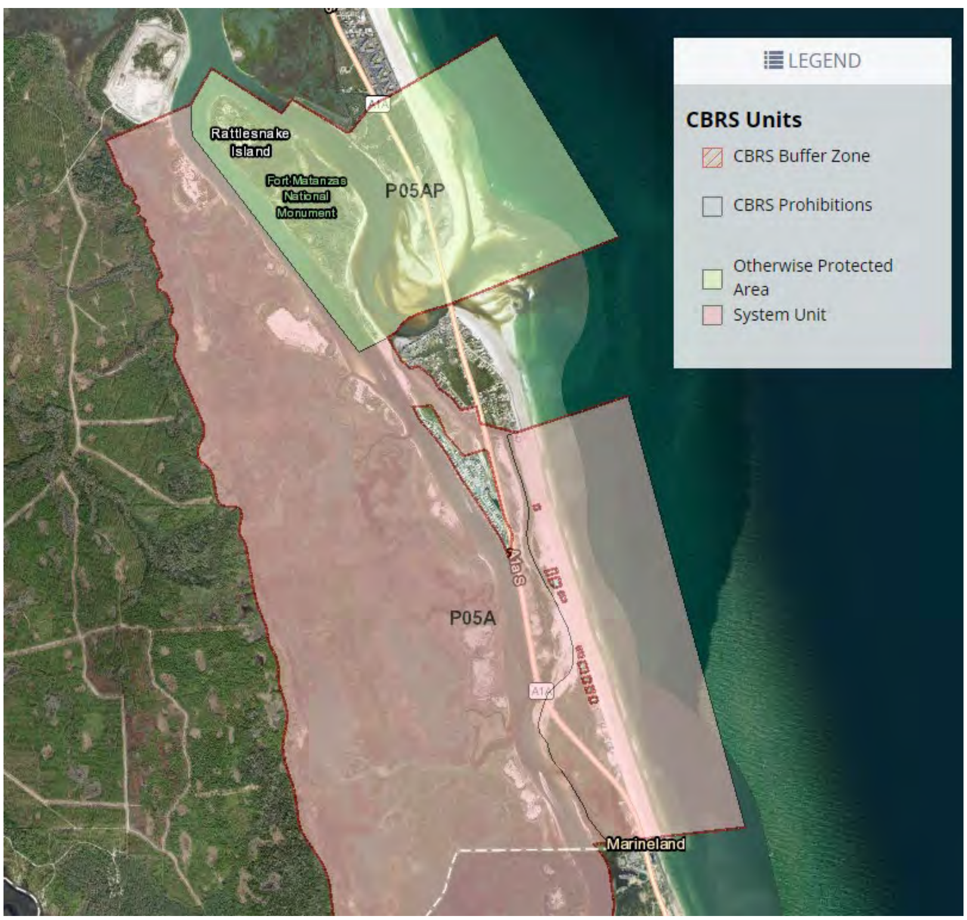


Figure 3.1 Coastal Barrier Resources (https://fwsprimary.wim.usgs.gov/CBRSMapper-v2/)

3.2.4 Guana Tolomato Matanzas National Estuarine Research Reserve

The Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), a collaboration between the FDEP and NOAA for the purposes of research, education, and stewardship), covers Matanzas Inlet and adjacent waterways (**Figure 3.2**; green shading). Note that the boundaries include some of the dune north of the inlet at the Ft. Matanzas National Monument Park and falls landward of the line of construction on the south side of the inlet. Summerhouse lies along the edge and outside of the GTMNERR at Ft. Matanzas National Monument Park.

Figure 3.2 GTMNERR Boundaries near the Study Area

3.3 Physical Environment

Many natural factors influence the coastal processes in and around Matanzas Inlet and adjacent beaches, including winds, waves, tides, currents, storm effects, and sea level rise. Anthropogenic factors include shoreline stabilization structures, beach management projects, dredging projects, and development. Florida statutes requiring preservation of native beach sand characteristics placed restrictions on beach fill and borrow areas. INTERA-GEC (2023) describes the natural factors that pertain to Summer Haven and Summerhouse alike. The following sections briefly discuss the native beach sediment data and potential sand borrow areas relevant to Summerhouse.

3.3.1 Native Beach Sediment

In 2020 and 2021, Meskel and Associates Engineering (M&AE) and GHD collected dune sand samples in Crescent Beach north of Summerhouse. M&AE's data from the dune at R-188.3, the closest sampling location to Summerhouse (approximately 4,200 ft north) indicates a median grain size of 0.16 mm, Munsell color of 5Y 8/1, and 1.6% carbonate content. GHD's data from the dune toe (R-188) indicated a median grain size of 0.17 mm, Munsell color of 2.5Y 7/1, and 5.7% carbonate content.

The Florida Geological Survey (FGS) (2009) also describes countywide native beach characteristics, including the beaches near Summerhouse, from data collected in December 2002 and 2003. The FGS collected 2-4 samples along 44 transects, approximately located along every fifth FDEP reference monument. Sample locations included the back beach, mid beach, beach berm, and swash zone. Samples SJ-39 and SJ-40, which lie at reference monuments R-190 and R-195, show mean sediment sizes of 0.15 and 0.16 mm with less than 2% carbonate content.

Based on results of the above data and additional data for other segments of the FEMA project (Ponte Vedra Beach, South Ponte Vedra Beach, Vilano Beach, Butler Beach/Crescent Beach, and Summer Haven), FDEP incorporated the sediment compliance parameters presented in **Table 3.2** into the Sediment Quality Control/Quality Assurance Plan for the County's FEMA Berm Restoration Project (Permit No. 0402841-001-JC) to ensure that borrow material complies with Florida Statutes and remains compatibility with the existing beach sand.

Table 3.2 Sediment Parameter Guidelines for County's FEMA Berm Restoration Project

Sediment Parameter	Parameter Definition	Compliance Value
Max Silt Content	Passing #230 Sieve	5%
Max Carbonate Content	Percent by Weight	35%
Max. Shell Content*	Retained on #4 Sieve	5%
Munsell Color Value	Moist Value (chroma=1 or 2; Hue 7.5 YR or 10 YR)	6 or lighter
Mean Grain Size	Moments Method	0.2 mm – 0.5 mm

*Shell Content is used as the indicator of fine gravel content for the implementation of quality control/quality assurance procedures.

3.3.2 Sand Sources

As mentioned, prior beach management efforts at Summerhouse sourced sand from upland mines, whereas efforts at Summer Haven have involved beneficial use of dredge materials from the ICWW, excavated overwash deposits from the SHR, stored dredge materials from FIND’s DMMA SJ-1, and other upland sites (see INTERA-GEC, 2023). The following paragraphs summarize the borrow sources available to support the potential alternatives discussed in Chapter 5.

3.3.2.1 Inland Commercial Mines

Private, commercial inland mines have proven a reliable source of beach compatible sand for County beaches. These commercial sources, many of which the FDEP has pre-approved, can produce more desirable coarse fill material (generally ranging up to 0.45 mm mean grain size); however, the costs to purchase the material and haul it long distances — the closest, largest-producing mines locate in Grandin, Interlachen, and Keystone Heights between Gainesville and Palatka (**Figure 3.3**) — are often relatively high. Many entities prefer importing sand from offshore, with typically higher production rates and avoidance of traffic and road use impacts, and less expensive unit costs for large-scale beach nourishment projects. However, with dredging costs continuously increasing and close offshore sources becoming scarcer in Florida, several large-scale beach restoration projects in Florida have sourced the beach fill from upland mines. For ongoing dune restoration work in north Flagler County, the winning bidder is providing 71,343 tons (approximately 49,544 cy) of sand from mines near Interlachen and Keystone Heights for a cost of $44.39/ton ($30.83/cy) (inclusive of material, transportation, and placement costs) for an 8,300-ft-long project area. The previously mentioned FEMA dune restoration project that placed sand at Summerhouse sourced sand from Vulcan Materials’ Goldhead plant in Keystone Heights and the Keuka plant in Interlachen. The mean grain size from these sources ranged from 0.36–0.37 mm, color ranged from 7.5YR 8/1 to 7.5YR 8/2, and carbonate content ranged from 0.06–0.1%.

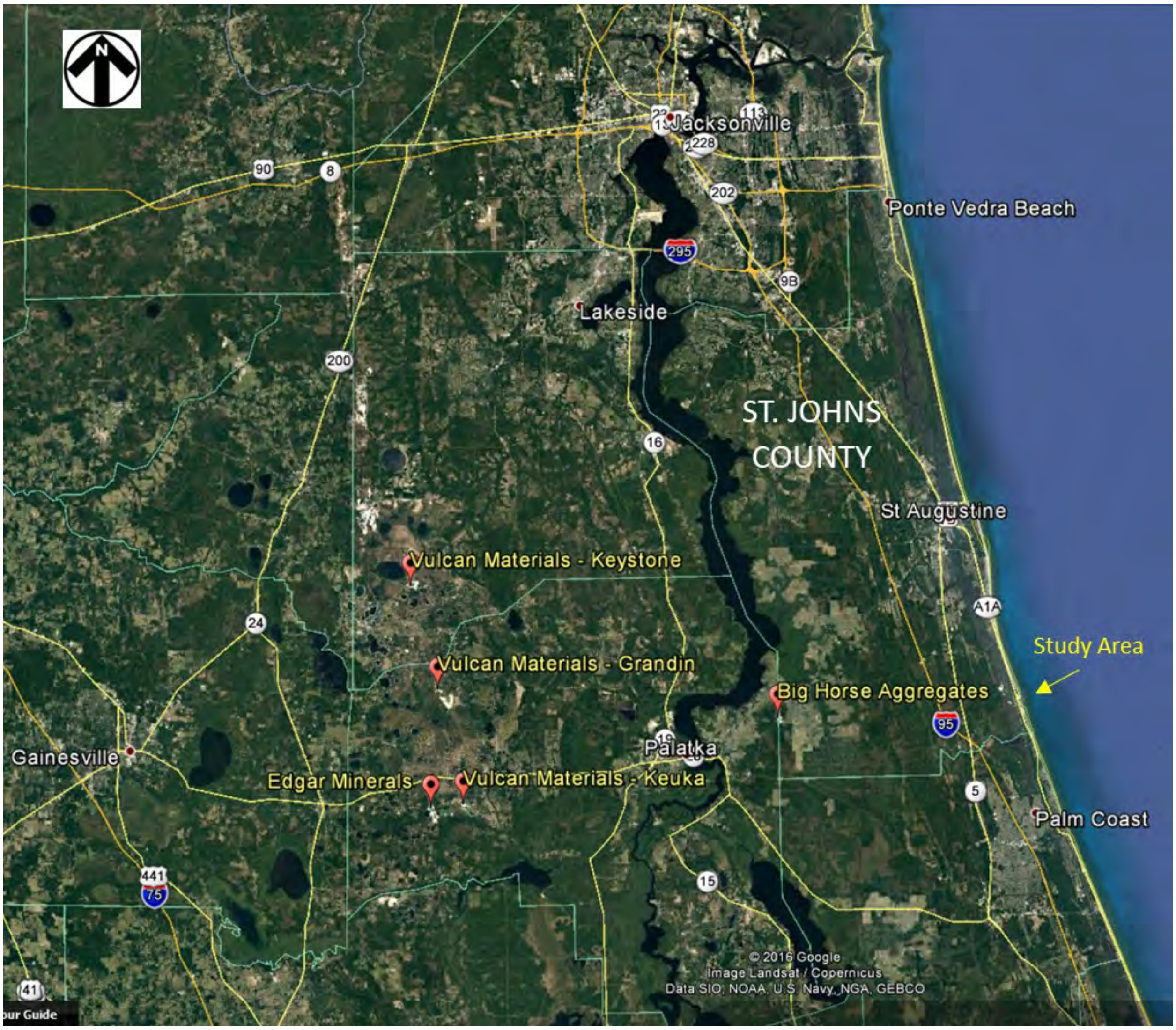


Figure 3.3 Location Map of Nearby Commercial Sand Mines (INTERA, 2017)

3.3.2.2 Intracoastal Waterway

Since 1992, FIND/USACE has predominantly placed the beach compatible dredged materials from the nearby ICWW reaches on the Summer Haven shoreline. This sediment, composed of fine sand that strong inlet and river currents can transport to the ICWW, is similar in size to native beach dune sand but finer than the native beach berm. Based on samples collected in late 2008, the USACE (2010) reports the ICWW material consists of mean grain sizes ranging from 0.13 to 0.24 mm (with a composite mean of 0.16 mm), silt content of 3.2%. The smaller sand size proves unstable when subject to the ocean waves and typically erodes quickly, providing short-lived storm protection benefits. This beneficial use of dredge material practice, however, is valuable due to its high frequency, typically substantial fill volume, and costs borne by the federal government. Federal spending restrictions typically prevent USACE from shaping a dune with the fill material or significantly altering its fill placement template. However, dune construction or template modifications to improve project benefits may remain an option should a non-federal partner cover the incremental cost (as St. Johns County has done previously). Beach placement of dredged materials represents a valuable supplement to Summer Haven, and potentially Summerhouse, beach management efforts but is not alone suitable for long-term storm protection.

3.3.2.3 Florida Inland Navigation District Dredge Material Management Areas

The County's existing state and federal permits — 0289228-001-JC and SAJ-2012-02400(SP-SCW) — for Summer Haven Dune and Beach Placement authorize DMMAs SJ-1 and FL-3 as borrow sites containing beach quality sand (**Figure 3.4**). Taylor Engineering (2010) and Taylor Engineering (2020) report composite statistics for each of the DMMAs (**Table 3.3**). The County has placed SJ-1 material on the Summer Haven beach for two significant projects: (1) the County's 2011 FEMA emergency berm project and (2) FIND's 1999 large-scale offloading of SJ-1. Recently authorized by FDEP in 2020, no entity has yet utilized FL-3 material for County projects. Both sites contain sand derived from ICWW maintenance dredging — SJ-1 for reaches near Matanzas Inlet and SHR and FL-3 for ICWW reaches in Palm Coast — which are not ideal for beach nourishment as mentioned above. Recent estimates suggest approximately 86,000 cy remain in SJ-1 and 280,000 cy in FL-3 (ATM, 2021). To access sand in the DMMAs, FIND requires execution of a Use Agreement, approval from its Executive Director for any removal less than 50,000 cy, and approval from its Board of Commissioners for any removal that exceeds 50,000 cy. The DMMAs are suitable for smaller-scale dune restoration or emergency berm efforts; however, the available volume and small grain size of the material is not suitable for any large-scale beach restoration efforts designed for long-term storm protection. FIND typically does not charge for sand from DMMAs. Finally, note that Flagler County is currently utilizing an unknown portion of the FL-3 material to restore some of its dunes north of Flagler Beach. As of this writing, Flagler County has utilized approximately 71,000 tons of FL-3 sand.

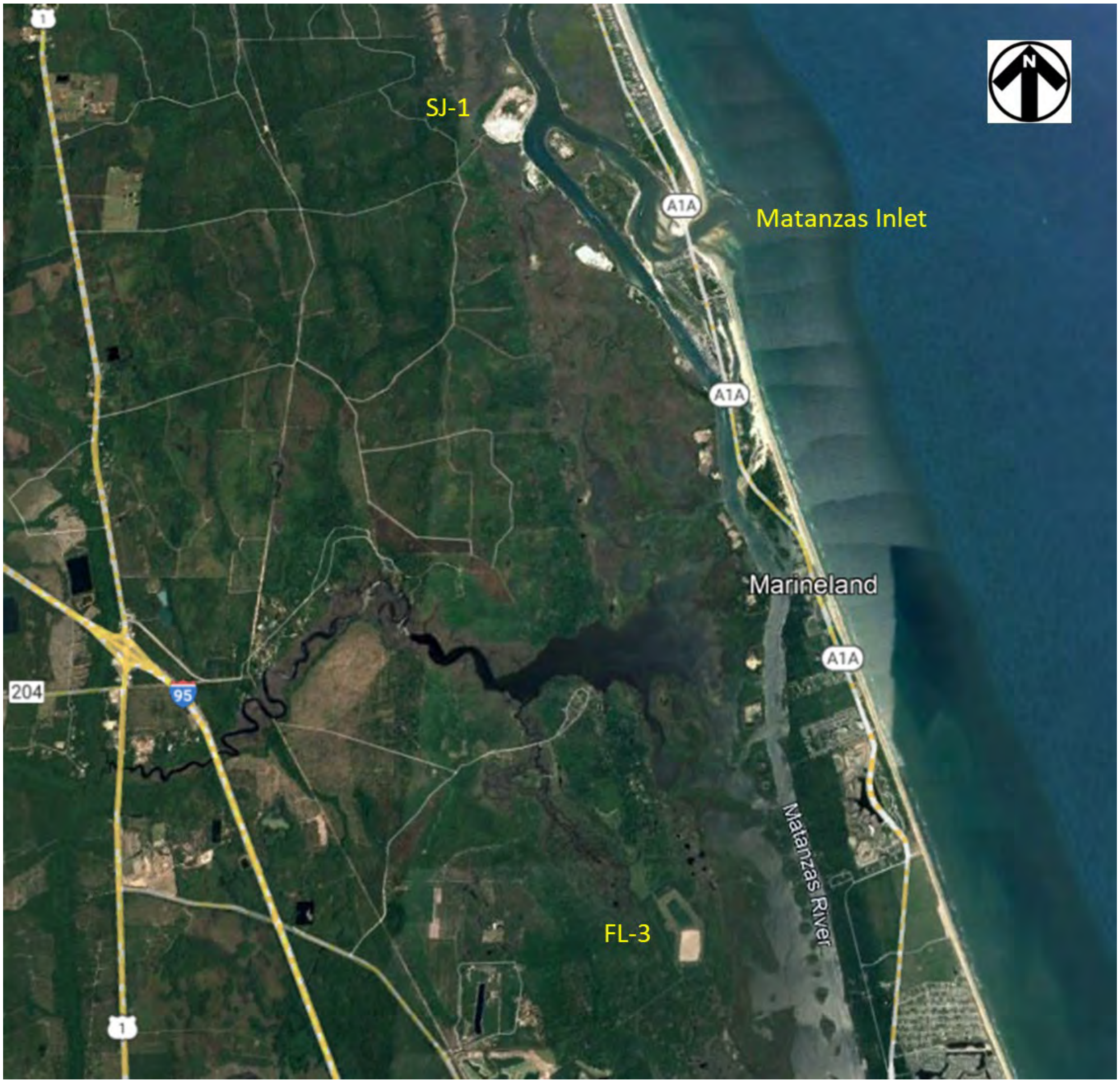


Figure 3.4 Location Map of Nearby FIND DMMAs

Table 3.3 SJ-1 and FL-3 Composite Sediment Characteristics

Parameter	SJ-1	FL-3
Mean Grain Size (mm)	0.18	0.28
Sorting (phi)	0.85	1.13
Silt (%)	0.4	0.68
Carbonate Content (%)	6.2	6.7 – 33.5
Munsell Color	2.5YR 7/2 – 5Y 7/2	5Y 6/1 – 5Y 8/1

3.3.2.4 Summer Haven River

The SHR is not a feasible source for Summerhouse because construction logistics (e.g., moving sediments across the inlet) but is included herein for a comprehensive regional sand source overview. Since 2017, FDEP has authorized excavation of overwash in the southern portion of the river to allow stakeholders to return the material to the beach to manage closure of the recurring breaches and rebuild the dunes. FDEP has only authorized each event as a one-time occurrence, requiring permit modifications for each subsequent or any future event. The river deposits represent an inexpensive source of beach compatible material for placement on the adjacent beaches. However, the available volume is insufficient for any large-scale beach restoration efforts designed for long-term storm protection.

3.3.2.5 Matanzas Inlet Flood Shoal

Figure 3.5 shows the location of the flood shoal complex. No known dredging of the inlet's flood shoal complex has occurred. INTERA-GEC collected six grab samples from 0-1 ft below top of ground at different areas of the shoal to characterize the material. The median grain sizes of the samples vary from 0.19 to 1.36 mm (composite mean of 0.60 mm) depending on shell content, which varies from 0 to 20%. Of note, the Florida Department of State Bureau of Historic Preservation has confirmed the presence of cultural resources nearby but not within the flood shoal complex; however, future findings of any significant cultural resources within the shoal (e.g., shipwrecks) may affect use of the shoal as a borrow source.

Figure 3.5 Matanzas Inlet Flood Shoal Complex and Location of Sediment Grab Samples

3.3.2.6 Offshore Sources

Figure 3.6 shows known sand sources spanning southern St. Johns County – northern Volusia County as identified in USACE's Sand Availability and Needs Determination (SAND) study — part of the South Atlantic Coastal Study (SACS) authorized by Section 1204 of the Water Resources Development Act of 2016 — which quantified 50-year sand needs and available sand resources for all current (at the time of the study) federal and non-federal beach nourishment projects in the USACE South Atlantic Division (SAD). USACE organized sand sources into the following categories.

- Proven — Resource areas with beach-quality sand whose thickness and lateral extent have been fully determined through design-level geotechnical data and in most cases are permitted.
- Potential — Resource areas with beach-quality sand whose existence has been verified through preliminary geotechnical and geophysical data (with vibracores approximately one mile apart). Thickness and/or lateral extent has been preliminarily determined.

- Unverified Plus — Resource areas hypothesized to exist on the basis of geophysical evidence (seismic profiles, bathymetry, or side scan sonar) and at least one geotechnical core or surficial samples verifying beach-quality sand.
- Unverified — Resource areas hypothesized to exist based on indirect evidence for the presence of beach-quality sand.
- Unusable — Unusable because (1) all beach-compatible material has been removed from the area prior to the SAND Study, (2) the sand source is inaccessible due to current conditions, or (3) the area was investigated and the presence of non-beach quality material throughout the area was verified.

The closest proven and potential sources offshore Butler Beach (approximately 10 miles northeast) and Flagler Beach (approximately 15 miles southeast) correspond to those investigated for the federal St. Johns County Shore Protection Project and Flagler County Coastal Storm Risk Management Project. **Figure 3.7**, which zooms into the Matanzas Inlet vicinity, shows only unverified sources closer to the study area.

Currently, no proven offshore borrow area exists to solely provide beach fill for Summerhouse/Summer Haven projects. Given the long-term sand needs for the currently authorized federal projects, coordination with USACE is necessary to identify the most suitable areas for further exploration should the County pursue identification of an offshore sand source. State and federal agencies do not charge for sand dredged from offshore.

Figure 3.6 Classification of Sand Sources Offshore Southern St. Johns County – Northern Volusia County (https://sacs.maps.arcgis.com/apps/dashboards/46d59434896a464a89d1f3b54d43d0d5)

Figure 3.7 Classification of Sand Sources Offshore Summerhouse (https://sacs.maps.arcgis.com/apps/dashboards/46d59434896a464a89d1f3b54d43d0d5)

4.0 Beach and Dune Conditions

INTERA-GEC (2023) examined Matanzas Inlet and its surrounding areas to determine the historical trend of beach and shoreline erosion. It includes details of a longshore sediment transport analysis, presents a sediment budget, summarizes the evolution of Matanzas Inlet shorelines and channel banks, and evaluates the complex flow conditions of Matanzas Inlet and the surrounding waterways and the effects of the SHR on inlet and waterways hydrodynamics. The following sections present the MHW shoreline and beach volume changes in the study area and discuss the results pertinent to Summerhouse.

4.1 MHW Shoreline Changes

This analysis assessed shoreline movement using historic MHW shoreline positions. MHW data along the County coastline originated from the FDEP's Public Files website (https://floridadep.gov/rcp/beaches-inlets-ports/content/historic-shoreline-database). MHW data, spanning 1867–2020, represent the distance between each FDEP reference monument to the MHW elevation contour for each year. **Table 4.1** shows a summary of the MHW data available within the project area. A comparison of the historic shoreline positions can suggest erosive or accretive trends. Undergoing both advancement and recession of the MHW position, shoreline changes fluctuate over time along the study area. The shoreline is dynamic and changing due to waves, winds, sea level change, storm events and erosion control measures.

Table 4.1 Available MHW Shoreline Data in the Study Area

Survey Year	Includes R-187 to 209	Survey Year	Includes R-187 to 209
1867-1872	Yes	1996	No (only R-200 to R-209)
1923	Yes	1997	Yes (except R-187 to R-189)
1952-1956	Yes	1999	Yes (except R-208, R-209)
1956-1957	Yes	2003	Yes
1970	No (only R-197 to R-200)	2007	Yes
1972	Yes	2011	Yes
1973-1975	Yes	2014	Yes
1979-1980	Yes	2016	Yes
1984	Yes	2017	Yes
1986	Yes	2019	Yes (except R-206)
1993	No (only R-192, R-195,R- 198, R-201, R-205, R-207)	2020	Yes (except R-195 to R-209)

Table 4.2 summarizes shoreline change rates in feet per year (ft/yr) for the periods 1984–2022, 2007–2022, and 2016–2022 determined via three different methods:

- End Point Method – determined simply by difference in the shoreline position at the beginning and end years of the period;
- Least Squares Method – based on the slope of a trend line fit by least square methods to all the data points within the period; and
- Average - a simple average of the End Point and Least Squares Methods.

Figure 4.1–**Figure 4.3** and **Table 4.2** show the shoreline change rates calculated via the end point method along the Atlantic beaches for the periods 1984–2022, 2007–2022, and 2016–2022. INTERA-GEC (2023) contains historical (1867–2022) shoreline trend plots at each reference monument.

The shoreline change data indicate the following:

- The beach at R-197 to R-198 appears to be within the shadow and direct influence of the ebb shoal; for all time periods analyzed, the beach in this region experienced shoreline advance (except for minor recession at R-197 from 1984 – 2022), likely associated with episodic transport of ebb shoal sediments onto the downdrift beach during storm events.
- The shoreline at R-199 remained stable due to the existing revetment fixing the shoreline position.
- From 1984 – 2022, the shoreline predominantly receded both north and south of the inlet, with shoreline advance occurring only at the far north end and at R-197 and R-198. North of the inlet, the recession magnitudes generally increased towards the inlet, with a notable increase beginning at R-194 at the south end of Summerhouse.
- From 2007 – 2022, a mix of shoreline recession and advance occurred both north and south of the inlet. The Summerhouse shoreline experienced minimal net change (R-193).
- From 2016– 2022, shoreline recession occurred north and south of the inlet primarily due to Hurricane Matthew and subsequent storms. The greatest shoreline recession magnitudes occurred just north of Summerhouse and within the breach area of Summer Haven (R-204 to R-205). The post-storm recovery activities in Summer Haven (i.e., beach placement of ICWW maintenance dredging material and overwash sediments excavated from SHR) likely partially offset the storm-induced shoreline recession.

Overall, the 1984–2022 and 2007–2022 shoreline changes reveal a general trend of decreasing shoreline recession magnitudes northwards away from the inlet, suggesting the inlet contributes to the documented erosion along the Fort Matanzas National Park and Summerhouse shorelines.

Table 4.2 Historic MHW Shoreline Changes

FDEP Reference Monument	End Point Method			Least Squares Method			Average		
	1984 – 2022	2007 – 2022	2016 – 2022	1984 – 2022	2007 – 2022	2016 – 2022	1984 – 2022	2007 – 2022	2016 – 2022
R-187	1.4	3.8	-5.1	1.0	-2.6	-10.1	1.2	0.6	-7.6
R-188	0.7	1.4	-10.6	0.3	-4.2	-15.2	0.5	-1.4	-12.9
R-189	0.2	1.2	-11.2	-0.2	-4.2	-17.8	0.0	-1.5	-14.5
R-190	-0.6	-0.4	-15.1	-0.2	-4.1	-20.9	-0.4	-2.2	-18.0
R-191	-0.6	-2.0	-13.2	-1.1	-8.3	-18.8	-0.9	-5.1	-16.0
R-192	-1.0	0.4	-9.0	-2.0	-5.2	-13.0	-1.5	-2.4	-11.0
R-193	-0.8	0.1	-5.2	-2.2	-8.8	-11.4	-1.5	-4.4	-8.3
R-194	-3.2	-0.2	-10.1	-3.4	-9.3	-19.5	-3.3	-4.8	-14.8
R-195	-4.3	-6.3	-3.9	-4.8	-11.2	-6.1	-4.6	-8.7	-5.0
R-196	-4.7	2.1	1.0	-3.8	-1.8	3.7	-4.3	0.2	2.4
Inlet									
R-197	-1.3	4.1	6.6	-2.0	2.2	7.6	-1.7	3.2	7.1
R-198	5.3	6.2	19.3	1.7	4.7	5.9	3.5	5.5	12.6
R-199	-0.2	0.0	0.4	-0.3	-0.3	-2.1	-0.3	-0.1	-0.8
R-200	-2.2	-2.3	-0.9	-1.6	-1.7	-7.0	-1.9	-2.0	-3.9
R-201	-2.8	-6.1	-2.7	-2.1	-3.4	-1.5	-2.5	-4.7	-2.1
R-202	-2.3	-5.9	-5.2	-2.2	-7.1	-2.5	-2.2	-6.5	-3.9
R-203	-2.3	-4.1	-8.3	-2.1	-5.0	-4.6	-2.2	-4.5	-6.5
R-204	-2.0	-5.6	-9.1	-1.7	-6.8	-7.7	-1.8	-6.2	-8.4
R-205	-3.1	-7.6	-13.9	-0.9	-7.1	-24.9	-2.0	-7.4	-19.4
R-206	-0.8	-0.3	-1.2	0.4	0.2	-8.9	-0.2	0.0	-5.1
R-207	0.2	2.1	0.5	0.2	1.5	-4.3	0.2	1.8	-1.9
R-208	-1.3	-1.0	-3.5	-0.4	-2.1	-6.6	-0.9	-1.5	-5.0
R-209	-0.8	0.6	-1.6	-0.4	-1.4	-3.0	-0.6	-0.4	-2.3

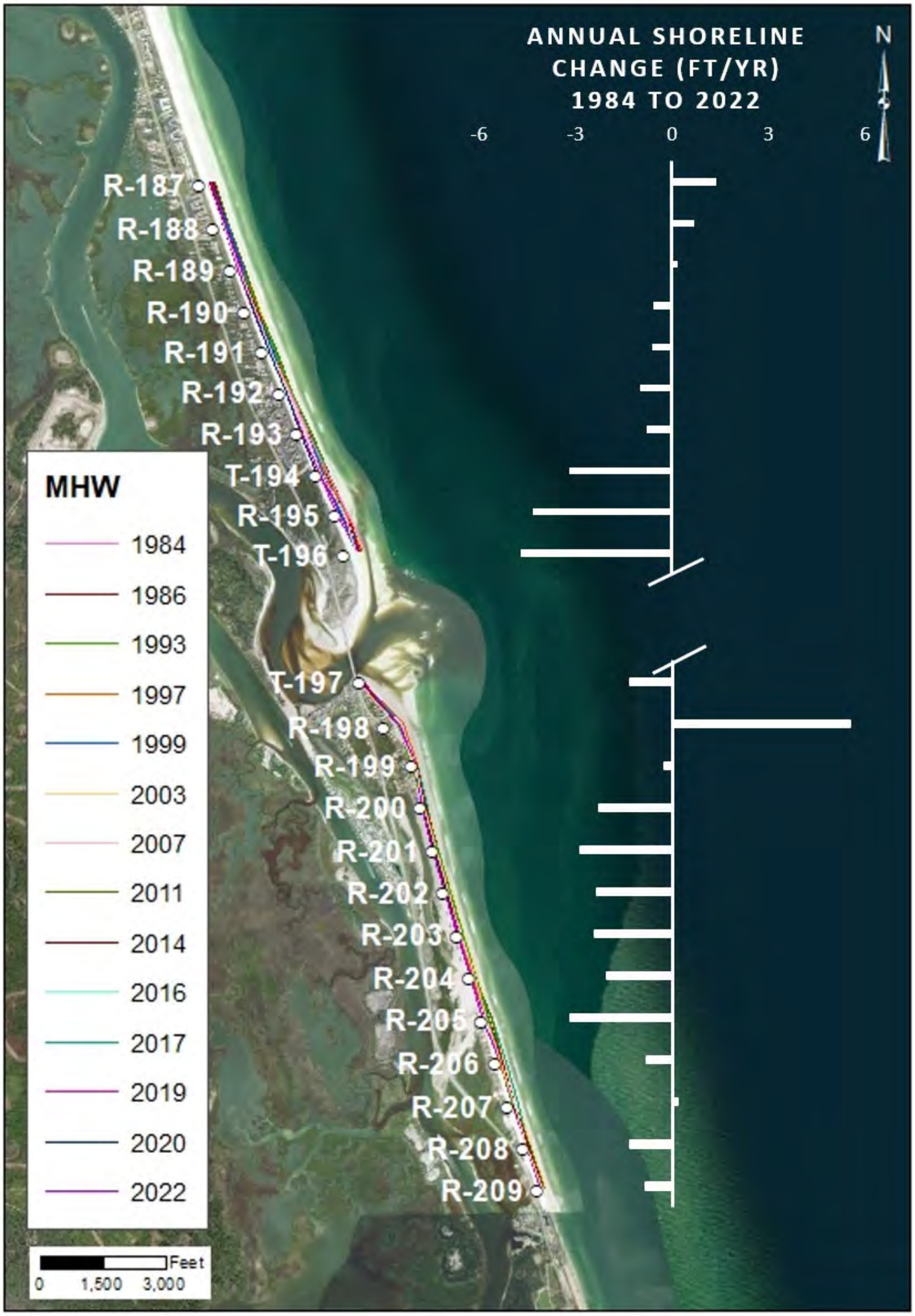


Figure 4.1 Shoreline Change Rates 1984 – 2022

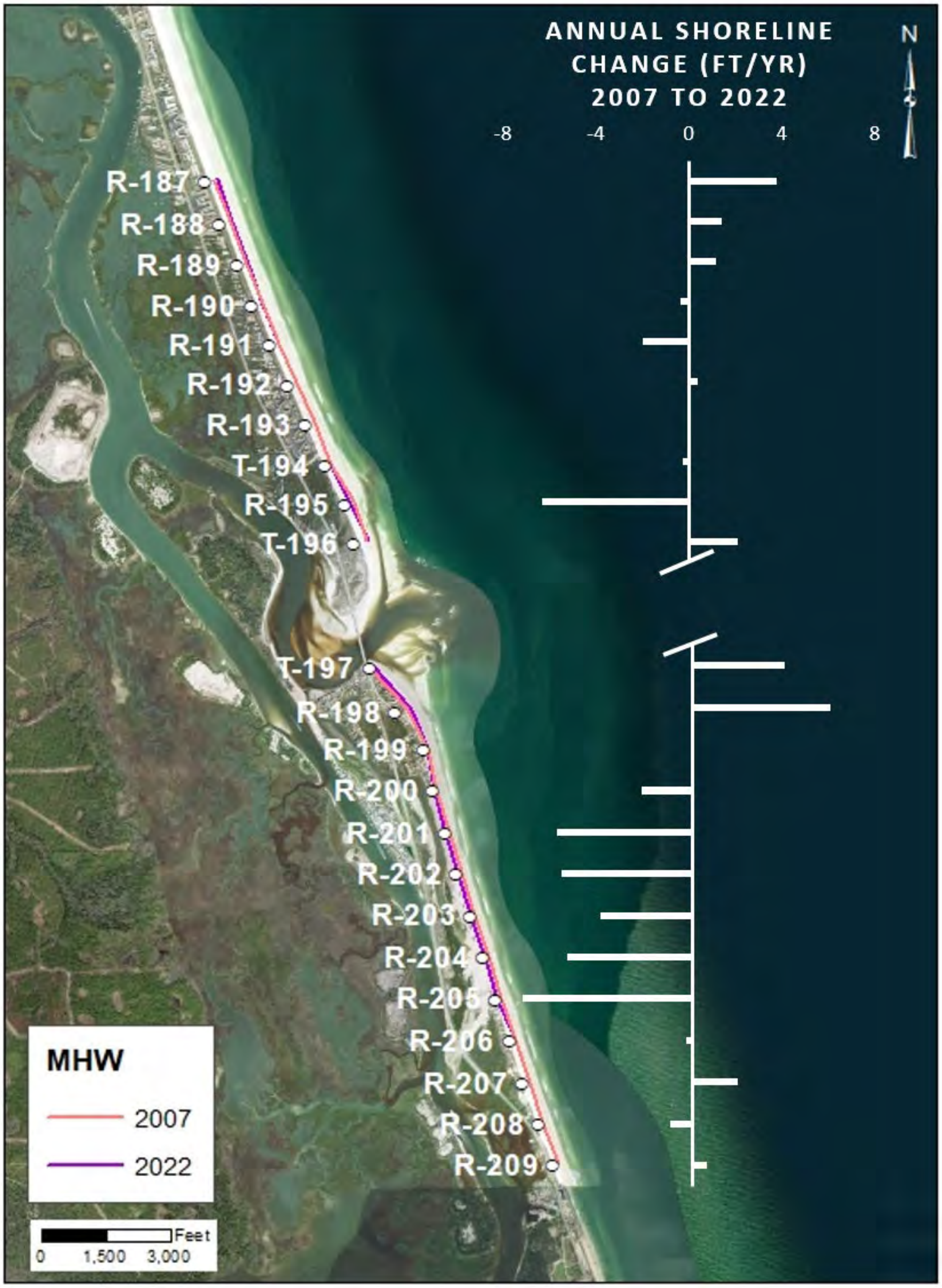


Figure 4.2 Shoreline Change Rates 2007 – 2022

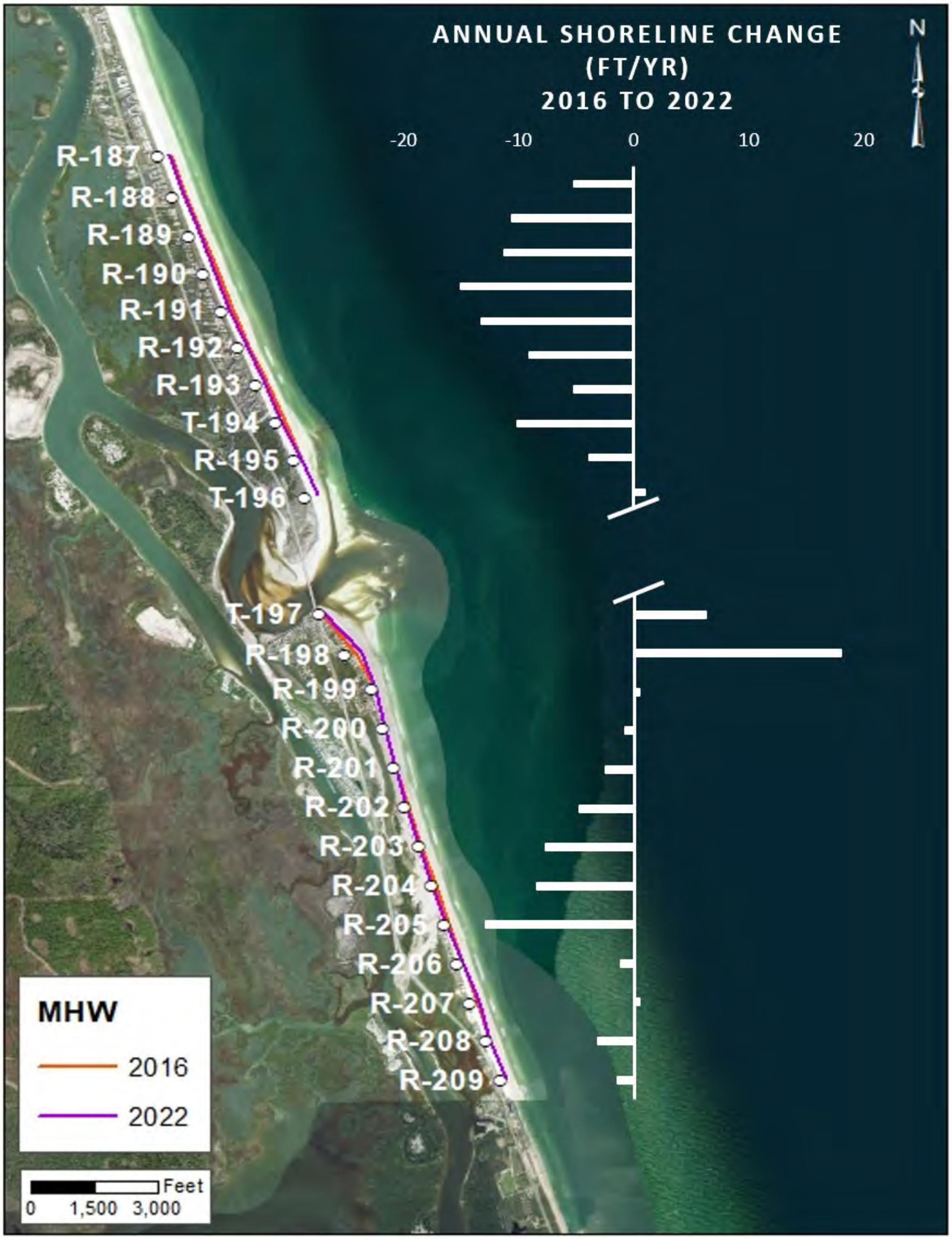


Figure 4.3 Shoreline Change Rates 2016 – 2022

4.2 Beach Volume Changes

Beach profile surveys along the St. Johns County coastline — available on FDEP's website (http://publicfiles.dep.state.fl.us/DWRM/Beaches/HSSD/ProfileData/prof839088/) — span the years 1972–2020 (**Table 2.3**). In concert with formulation of the sediment budget (presented in INTERA-GEC [2023]), data for years 2007, 2016 (pre-Hurricane Matthew), and 2022 were selected for quantitative analysis based on the completeness of the data. INTERA-GEC (2023) presents representative beach profiles for these years.

Volume change analysis was performed within a GIS framework using ArcMap 10.8.1. **Figure 4.4** shows the volume changes above and below MHW as well as the total change at each monument for the period 2007–2022. **Figure 4.5** shows these volume changes for the period 2016–2022. The data indicate:

- Between 2007 and 2022, a mix of erosion and accretion occurred.
  - North of the inlet, erosion predominantly occurred above MHW, while accretion below MHW and accretion overall occurred everywhere except immediately adjacent to the inlet. Mild accretion occurred at Summerhouse (R-193) and just south of the property (T-194).
  - The beach at R-197 to R-198 appears to lie within the shadow and direct influence of the ebb shoal; the significant accretion may have resulted from episodic transport of ebb shoal sediments onto the beach during storm events.
  - Significant erosion occurred within the SHR stretch (R-201 to R-205).
  - Volume changes at the south end of the study area resembled those at the north end of the study area, with minor erosion above MHW and significant accretion below MHW.
- Between 2016 and 2022, erosion predominantly occurred, reflecting the severe storm activity.
  - North of the inlet, erosion occurred above MHW, while accretion below MHW predominantly occurred. At the north end, nearly equal erosion and accretion magnitudes above and below MHW resulted in little net change overall. Just north and south of Summerhouse (R-192 and T-194), erosion occurred above and below MHW; the center of the Summerhouse property (R-193) experienced minor accretion overall, with erosion above MHW and slightly greater accretion below MHW.
  - Erosion predominantly occurred above and below MHW south of the inlet.
  - Volume changes at the south end of the study area again resembled those at the north end of the study area.

Overall, erosion of the dry beach (i.e., above MHW) occurred at Summerhouse over both the short and long terms. While the short-term volume changes at R-193 (i.e., center of Summerhouse property) were minimal, significant erosion occurred along the profiles immediately north and south of Summerhouse.

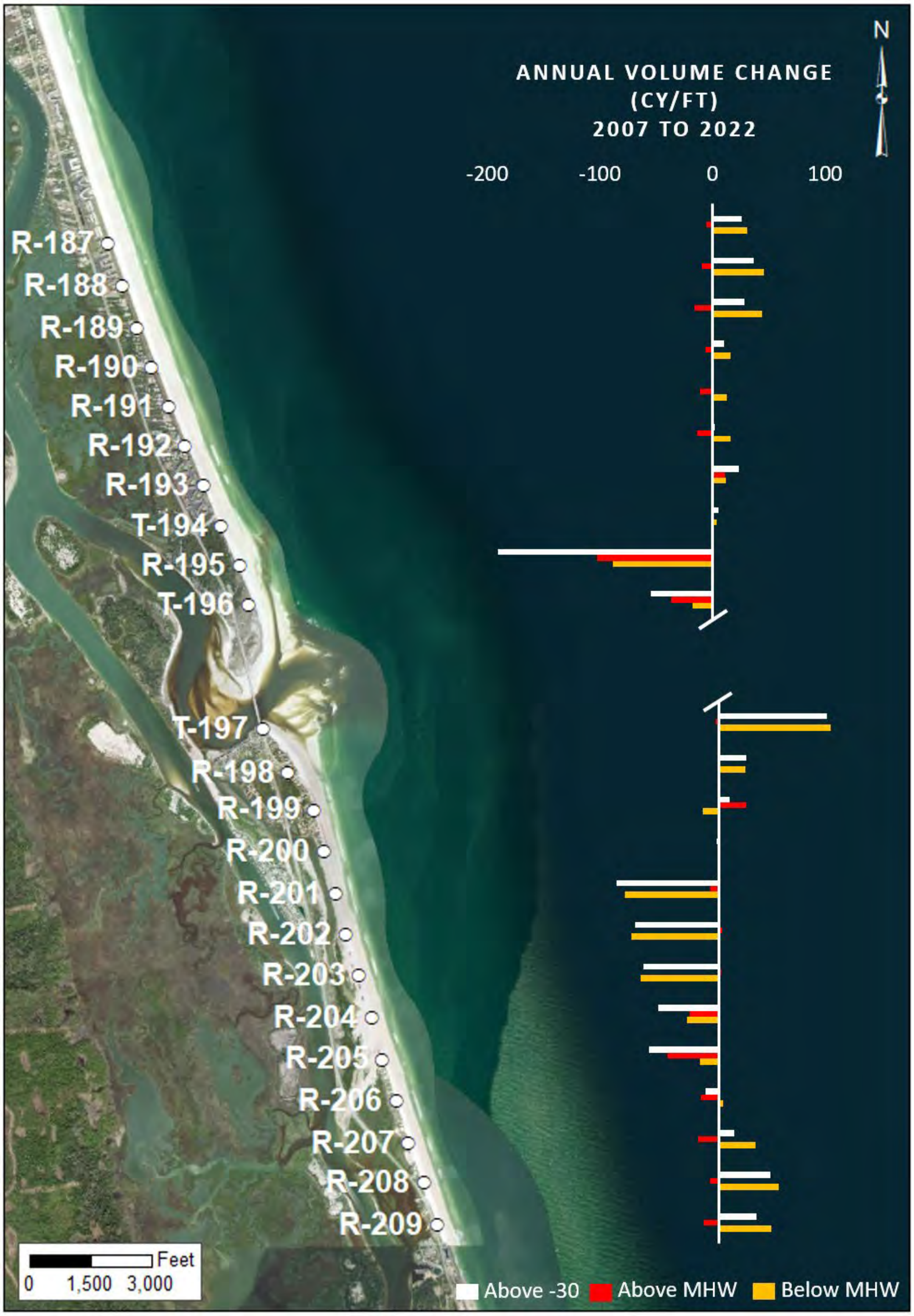


Figure 4.4 2007–2022 Volume Changes by Monument

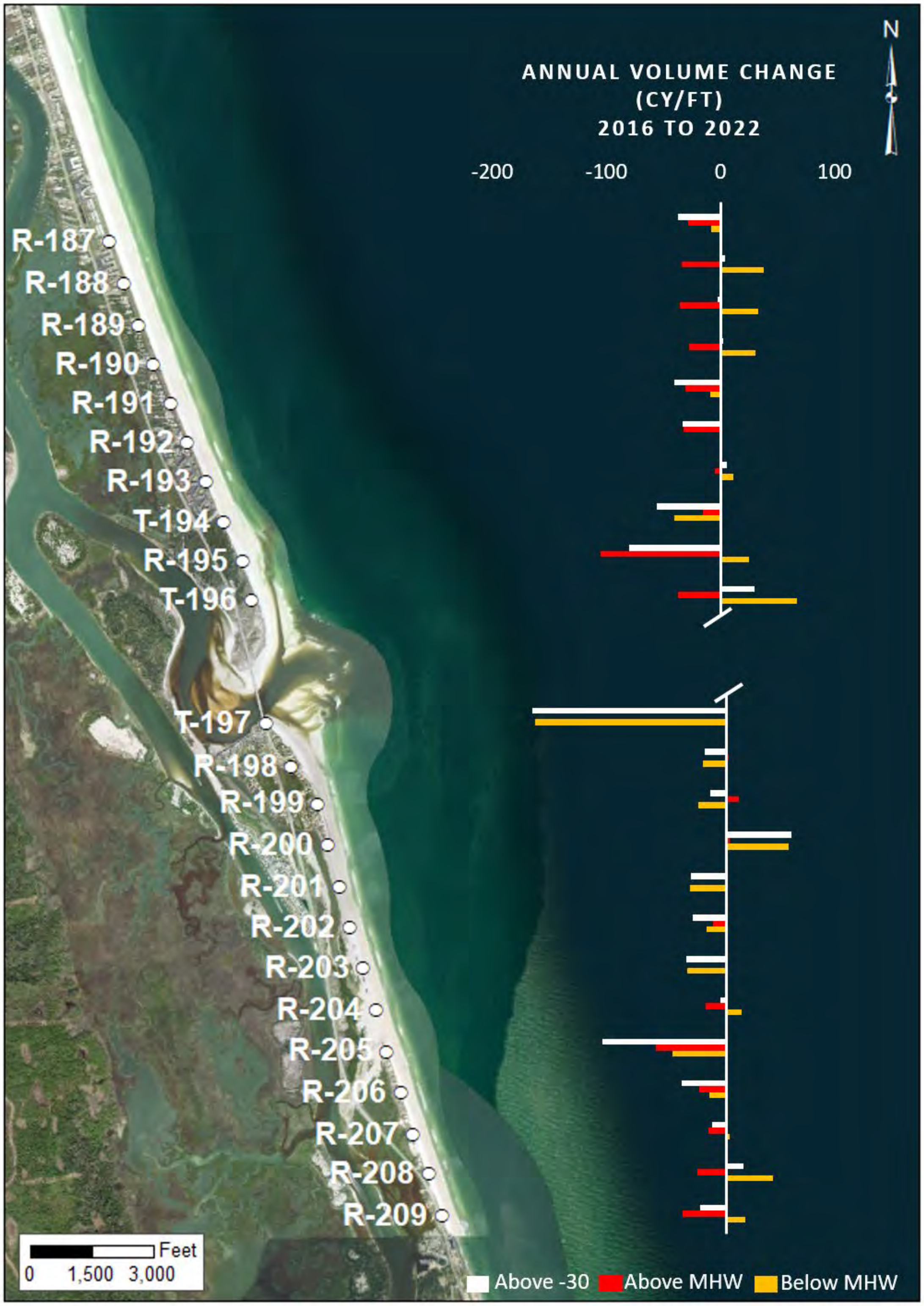


Figure 4.5 2016–2022 Volume Changes by Monument

4.3 Alongshore Area of Inlet Influence

This section assesses whether the presence of inlet has any effect on the shoreline and volume changes noted above. More specifically, it attempts to answer whether Matanzas Inlet contributes to the erosion noted on the north side of inlet.

The USACE's *Coastal Engineering Manual* (CEM) (Bodge and Rosati, 2003) introduces five methods — assessment of historical shoreline changes (or beach volume changes), even-odd analysis, alongshore variations in beach morphology, wave refraction analysis, and examination of an inlet's net sink effect — to estimate the alongshore extent of an inlet's influence on adjacent beaches. The CEM indicates that the first and last methods potentially yield estimates of both direct (near field) and indirect (far field) inlet effects.

Figure 4.6 presents an even-odd analysis published by Work and Dean (1990) for Matanzas Inlet for the period 1923-1986. They decomposed measured shoreline changes into even and odd components. Interruption of longshore sediment transport by the inlet contributes to the odd component whereas storms and sea level rise tend to affect both shorelines adjacent to an inlet similarly, contributing to the even component of shoreline change. Other wave effects, such as refraction and diffraction, could vary across both shorelines. As such, these effects could manifest as both even and odd components. Work and Dean note that for their analysis period, the even component of the shoreline change shows mild accretion on both sides of the inlet. The odd and net shoreline changes show that the inlet helps impound sand north of the inlet to the detriment of the shorelines south of the inlet. Their analysis demonstrates that the inlet's area of influence extends more than two miles north of the inlet.

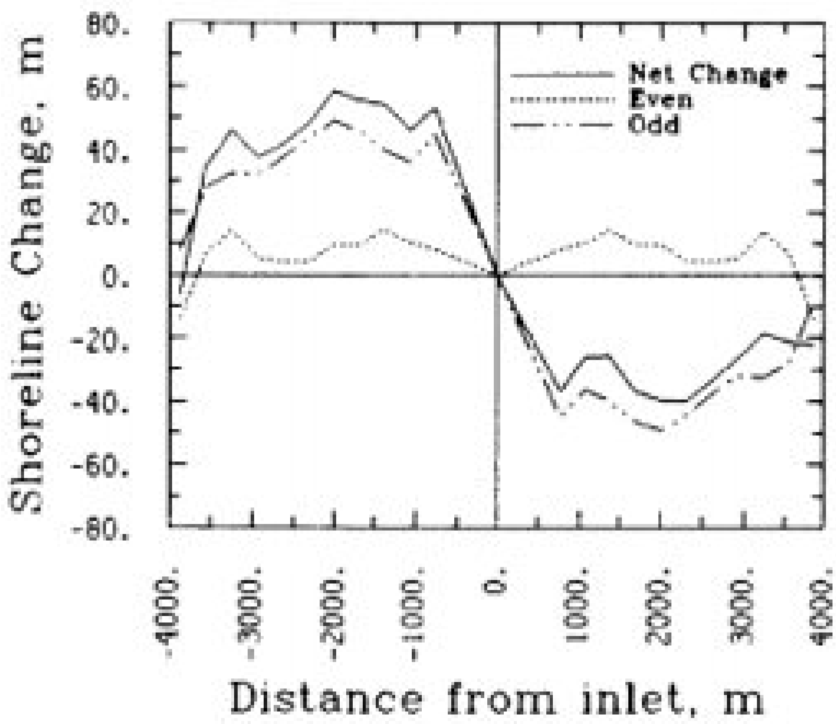


Figure 4.6 1923–1986 Even-Odd Analysis (Work and Dean, 1990)

To verify the above result, INTERA-GEC embarked on its own independent analysis. Because of data limitations, this study focused on estimating Matanzas Inlet's influence via the first method by incorporating volume changes above -30 ft NAVD88. From the CEM, determining the alongshore extent of the inlet's influence on the adjacent shorelines required identifying:

- The cessation of abrupt changes in the rates of change alongshore, and/or the reduction in variability of these rates alongshore;
- The location where the slope of a regression line drawn through a subset of along-the-shore values (neglecting transects nearest the inlet) most closely equals zero;
- Changes in the sign of the rate value from erosion to accretion (or vice versa); a change from less erosional to more erosional (or vice versa); or, from less accretionary to more accretionary (or vice versa);
- A change in slope of the cumulative shoreline change or volume change computed along the shoreline.

Following the first method, this study identified the alongshore location where a change in slope of the cumulative beach volume change exists. This study selected the period 1972-2011 as it begins the period of reliable beach survey data and excludes the significant storm activity since 2016. Computation of cumulative beach profile change computed north and south of the inlet allowed for discerning a change in slope (neglecting transects nearest the inlet). **Figure 4.7** shows the cumulative beach volume changes for 1972-2011. The changes in slope occur near R-184 and R-208.

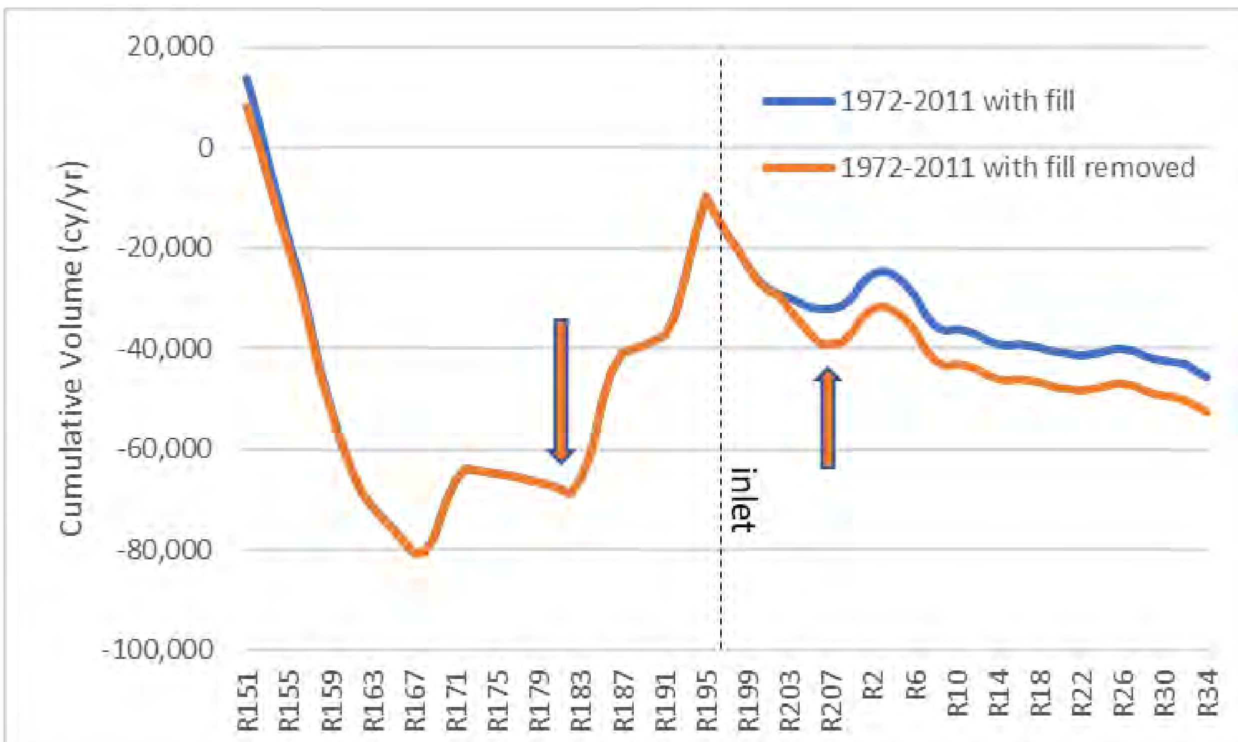


Figure 4.7 1972–2011 Cumulative Beach Volume Changes

Calculations of cumulative volume change for the north and south shorelines started at zero at the inlet and summed cumulatively at each reference monument both north and south of the inlet. The volume changes included and removed beach fill volumes for comparison purposes. Beach fill volumes removed from each profile originated from measured post-nourishment surveys' trends (Taylor Engineering, 2008) and summarized total placed volume and placement area. Excluding beach fill placements, the data suggest that cumulatively -68,817 cy/yr is lost north of inlet and -39,228 cy/yr south of the inlet because of the inlet during this period. In total, these values imply that the total sink effect of the inlet is approximately -108,000 cy/yr.

Following a similar methodology, an examination of the more recent 2007-2022 period discussed in the previous section shows a smaller northern area of inlet influence (**Figure 4.8**). The changes in slope occur near R-194 and R-207 — suggesting that the inlet influences beaches near Summerhouse. Beach fill volumes removed from each profile originated from those presented in INTERA-GEC (2023). Excluding beach fill placements, the data suggest that cumulatively nearly -20,000 cy/yr is lost north of inlet and over -126,000 cy/yr south of the inlet because of the inlet during this period. In total, these values imply that the total sink effect of the inlet is approximately -146,000 cy/yr.

Figure 4.8 2007–2022 Cumulative Beach Volume Changes

Note that the total inlet sink volumes are similar between the two examined periods — -108,000 cy/yr based on the period 1972-2011 and -146,000 cy/yr based on the period 2007-2022. Especially north of inlet, the alongshore extent of this effect also varies — between approximately 0.5 (an unusually short distance relative to other east coast inlets) and 2 miles north of the inlet. The degree of the sediment lost on the beaches because of the inlet and the alongshore extents of the inlet's influence depend on the wave climatology. While the inlet's effects north of the inlet may vary spatially and temporally, the analysis shows that the inlet may impound sediment intended for the beaches north of the inlet (including Summerhouse beaches) as well as south of the inlet.

4.4 Discussion

INTERA-GEC (2023) presents sediments budgets for the periods 2007–2022 and 2016–2022 based on the volume changes discussed above, longshore sediment transport rate calculations, and available dredge and fill placement records. Most authors think sediment moves along both the Anastasia Island and Summer Haven shorelines from north to south, and the sediment budgets presented in INTERA-GEC (2023) indicate a net longshore transport gradient of north to south. As such, Matanzas Inlet generally wants to migrate to the south. Historical aerials bear this out. This southward migration of the inlet threatened the south shoreline of the SR A1A Bridge over Matanzas Inlet, first constructed in the early 1920's and last replaced in 1993. Hurricane Dora (1964) prompted additional armoring of this shoreline. Over the long-term, stronger flood tidal flows, because of the inlet's location relative to St. Augustine and Ponce de Leon inlets, likely deposit more sediments inside the inlet than the ebb tidal flows remove. This net imbalance (evident in the sediment budgets) allows the flood shoals inside the inlet to grow with sand that otherwise, without the inlet's sand-trapping effect, would reach both Summer Haven beaches as well as those to the north during seasonal reversals (typically in late spring and summer) of the longshore transport direction.

Given the net southerly directed longshore sediment transport and minimal beach fill projects north of the inlet, the sediment budgets do not provide much insight regarding the behavior of the beach near Summerhouse other than to indicate that longshore sediment transport erosion could also occur in concert with storm-induced cross-shore erosion. The 2016–2022 sediment budget indicates the storm-induced erosion above MHW exceeds the accretion below MHW, resulting in a net loss of sand (directed towards the inlet) from the region north of the inlet. The 2007–2022 sediment budget indicates the area north of Summerhouse experienced a slight net gain of sand, while the area south of Summerhouse close to the inlet experienced net erosion. These results indicate the degree of erosion caused by the inlet may fluctuate depending on meteorological conditions, but inlet-induced erosion of the beach at or abutting Summerhouse appears to have occurred during all periods analyzed in this study.

Based on an assessment of the inlet's possible influence on beaches north and south of the inlet, as well as analysis of short- and long-term shoreline and beach volume changes, the extent of the inlet's influence alongshore appears to include the Summerhouse beaches. Furthermore, the inlet intercepts sand intended for the Summerhouse beaches for the period 1972-2011 examined. This result indicates that some of the dredged inlet sediments (from such sources such as the ICWW) historically placed at Summer Haven should perhaps be placed north of the inlet as well.

5.0 Identification and Evaluation of Potential Actions

This study followed a two-phase approach to evaluating potential alternatives — an initial screening followed by conceptual-level design assessment. The first phase identifies and summarizes possible solutions — including seawall, revetment, dune restoration, beach and dune restoration, T-head groins, breakwaters, artificial reefs, and structural dune core alternatives — and evaluates their potential for achieving the study goals and receiving regulatory approvals. The second phase further evaluates only those approaches that both may achieve the study goals and receive regulatory approval. Additionally, this study considered the costs of taking no action and continuing a policy of managed retreat.

5.1 Initial Screening of Potential Engineering Alternatives

The following sections describe the considered alternatives and their potential for meeting the project objectives.

5.1.1 Seawall

Construction of a sheet pile seawall for shoreline stabilization intents could fix the shoreline position and protect the oceanfront buildings of Summerhouse. However, once exposed to wave forces, seawalls tend to reflect wave energy seaward, which leads to exacerbated erosion and lowering of the beach profile, allowing larger waves to break closer to shore. Without replenishment of sand fronting a seawall, a significant reduction or elimination of the recreational beach, turtle nesting habitat, and shorebird habitat would likely occur. Given such adverse environmental impacts, the FDEP permits seawall construction only for protection of private property and public infrastructure under certain conditions.

One condition includes when seawalls (or other coastal armoring) locate seaward of the state's Coastal Construction Control Line (CCCL). The CCCL lies within the footprints of Summerhouse's oceanfront buildings (**Figure 5.1**; red line). Regulatory approval for a seawall seaward of the CCCL at Summerhouse would fall under the jurisdiction of the FDEP Beaches, Inlets and Ports Program as a CCCL permit. Obtaining authorization for such a wall pivots on demonstrating that the buildings are statutorily vulnerable.

Pursuant to Section 161.085(2)(a), FS, Florida may issue permits for rigid coastal armoring structures only for protection of private structures or public infrastructure (i.e., public evacuation routes, public emergency facilities, bridges, power facilities, water or wastewater facilities, other utilities, hospitals, or structures of local governmental, state, or national significance) proven vulnerable to damage from frequent coastal storms (i.e., a 15-yr storm). Per Section 161.085(2)(c), FS, absent such private structures or public infrastructure, Florida may only permit rigid costal armoring to protect private and public property if the proposed installation is between and adjoins at both ends existing rigid coastal armoring structures, follows a continuous and uniform armoring structure construction line with existing coastal armoring structures, and is no more than 250 ft in length.

If storm-induced erosion alone does not show that a structure is vulnerable, Chapter 62B-33, FAC also allows for a "geotechnical analysis by a qualified professional engineer specialized in geotechnical or foundation engineering which demonstrates that the structure would be in danger of imminent collapse following the occurrence of erosion from a 15-year return interval storm." In January 2021, the FDEP confirmed an analysis performed by INTERA that buildings 15, 16, and 20 were vulnerable based on cross-shore erosion and geotechnical slope stability modeling and June 2020 survey data. While the entire 1,400-ft-long Summerhouse beachfront may not prove eligible for a seawall, it could prove viable for a portion of the shoreline — most likely, the southernmost shoreline.

The seawall alternative, while feasible, does not require BOCC actions to implement. With the seawall confined to private property, Summerhouse would bear the responsibility of implementing this alternative. However, this study carries this alternative forward for completeness.

Figure 5.1 Location of the Coastal Construction Control Line

5.1.2 Revetment

Revetments currently exist at the northern and southern boundaries of the Summer Haven shoreline, protecting Old A1A north of R-200 and Marineland south of R-209. These structures have successfully fixed the shoreline position, but no dry beach exists seaward of these structures. Construction of a revetment along the Summerhouse shoreline could fix the shoreline position and, if constructed high enough, prevent overtopping. However, like seawalls, revetments typically lead to depletion of the beach fronting the structure and are difficult to permit.

Revetments fall under the restrictions of Section 161.085(2)(a), FS and Section 161.085(2)(c), FS discussed above for seawalls. When considering the side slopes of a revetment, its footprint can far exceed the footprint of a seawall. Given the small space available to place a revetment between the Summerhouse buildings and the beach and the need for minimizing the footprint to lessen potential environmental impacts, this alternative will not likely prove viable.

5.1.3 Dune Restoration

This alternative consists of placing a small dune seaward of the existing dune, similar to the 2021 FEMA emergency berm restoration project that constructed a dune with a maximum crest elevation of +15 ft NAVD88 tying into the existing dune, a varying dune crest width (approximately 0–30 ft at Summerhouse) with a 1V:50H slope, and a seaward dune face slope of 1V:4H extending from the crest to the existing beach grade. As borne out by experience in the area, this small dune intends to provide limited protection and may disappear rapidly. While some material remained, Hurricane Ian, a 13-yr event based on one estimate, eroded most of the placed dune in September 2022, one year after placement. Therefore, dune only restoration like the 2021 FEMA dune would not provide robust storm protection to the upland properties.

5.1.4 Beach and Dune Nourishment

This alternative would construct a large-scale beach and dune project to provide natural storm damage reduction benefits while enhancing the recreational and environmental beach functions. In theory, the initial project would include construction of a minimum design template — engineered to provide protection against selected storm conditions (e.g., 25-yr storm surge levels) — plus placement of advance fill at the seaward edge of the berm. When natural coastal processes erode the advance fill and the shoreline recedes back to the design template shoreline position, a nourishment project will occur to rebuild the advance fill template. Periodic nourishments will occur as necessary to maintain the design template and its intended level of storm protection. A fully funded long-term beach nourishment program can maintain sufficient dune characteristics and protective berm width to minimize the risk of damage to the Summerhouse property.

In general, FDEP supports beach nourishment pursuant to Section 161.161, FS and 161.091, FS, which require FDEP to develop and maintain a comprehensive long-term beach management plan for the restoration and maintenance of the state’s critically eroded beaches, which includes Summerhouse FDEP (2023a), that:

(a) Encourages regional approaches to ensure the geographic coordination and sequencing of prioritized projects;

(b) Reduces equipment mobilization and demobilization costs;
(c) Maximizes the infusion of beach-quality sand into the system;
(d) Extends the life of beach nourishment projects and reduces the frequency of nourishment; and
(e) Promotes inlet sand bypassing to replicate the natural flow of sand interrupted by improved, modified, or altered inlets and ports.

The FDEP's Strategic Beach Management Plan for the northeast Atlantic coast region (FDEP, 2020) identifies beach nourishment as the approved beach management strategy and, therefore, necessitates further evaluation.

5.1.5 T-head Groins

Traditional shore-perpendicular groins can help stabilize the shoreline by trapping longshore-directed sand along their updrift side; however, such groins have little effect on cross-shore-directed sand transport and are prone to forming rip currents. T-head groins consist of a traditional shore-perpendicular groin section ("stem") combined with a shore-parallel "head" section designed to diffract waves and form a crenulate beach between groins. Structures with heads at their seaward ends appear less susceptible to offshore losses and tend to create a more stable beach between groins, even in storms with high cross-shore transport potential (Bodge, 1998). Use of the head also allows for a shorter stem than a traditional groin, keeping the groin footprint in shallower water closer to shore, which typically reduces materials (typically rock) quantities and lowers construction costs. The heads can be angled (deviating from a strict "T" shape), oriented to align the gap between adjacent heads with the design wave angle to improve the performance of the T-head groin field. A combination of traditional groins, T-head groins, and detached breakwaters (i.e., the T-head without the stem) may also provide an improved solution.

Both traditional and T-head groins diminish the longshore sand transport and, thus, have the potential to cause downdrift beach erosion. The erosion potential can be avoided or minimized by locating the terminal groin at the end of a littoral cell (i.e., where no downdrift beach exists), in a region of decelerating longshore transport gradients (i.e., an area that tends to naturally accrete), or pre-filling the groin field with sand so, theoretically, the groins will not trap sand but rather allow longshore sand transport to bypass the groin field. At Summerhouse, any groin field must consider the potential deleterious effects on the adjacent shorelines, including the downdrift Ft. Matanzas National Park shoreline.

T-head groin maintenance requirements may consist of periodic replacement of rock following extreme storms. T-head groins, like other rock structures, are designed to withstand certain design water level and wave conditions (e.g., a 50-year storm surge). If an extreme event that exceeds the design conditions occurs, the excess wave forces may displace some of the rock to varying degrees depending on the severity of the storm. Maintenance would entail reconstructing the structure to design parameters.

T-head groins could help stabilize the Summerhouse shoreline. However, extreme water levels during powerful storms could overtop the structures and subject the dunes to wave-induced erosion, further increasing the vulnerability of Summerhouse's structures. Thus, this alternative, as a stand-alone solution, does not meet the goals of the study yet could help achieve the goals if implemented in combination with beach and dune nourishment.

Furthermore, per discussions with FDEP staff, FDEP could potentially permit construction of T-head groins only after construction and three years of performance monitoring of a beach nourishment project. The structures would have to prove necessary to extend the life of the beach nourishment project and reduce the frequency of nourishment per Section 161.091(2)(d), FS.

The T-head groin alternative is potentially viable, if needed, in combination with a beach nourishment project.

5.1.6 Breakwaters

Breakwaters consist of detached shore-parallel structures that protect a shoreline by dissipating wave energy, reduce the littoral transport landward of the structure, and promote sediment deposition if sited correctly. Breakwaters often lead to formation of a salient (i.e., a shoreline bulge) along the sheltered area landward of the breakwater. With no shore-perpendicular stem attached to the shoreline, longshore sediment transport may continue to some degree along the coast behind the breakwater. However, certain design parameters may lead to formation of a tombolo, a spit of sand that connects the beach to the breakwater, and elimination of any bypassing of sand behind the breakwater.

Protection of long sections of shoreline require multiple breakwaters constructed in a row, referred to as segmented breakwaters. One must carefully consider breakwater lengths, gap lengths, and distances from shore for optimal project performance and avoiding dangerous currents or poor water circulation. Crest elevation (emergent, submergent or low-crested) is also vital to breakwater design. Emergent breakwaters provide the most shoreline protection by preventing transmission of wave energy under design conditions. However, emergent breakwaters are more expensive and may have more pronounced adverse effects on aesthetics, water quality, and downdrift erosion. Submerged or low crested breakwaters allow some degree of overtopping, depending on design conditions, and only partially attenuate the wave energy, thus lessening the degree of shoreline protection.

Like T-head groins, per discussions with FDEP staff, FDEP could potentially permit construction of breakwaters only after construction and a minimum of three years of performance monitoring of a beach nourishment project. The structures would have to prove necessary to extend the life of the beach nourishment project and reduce the frequency of nourishment per Section 161.091(2)(d), FS.

The breakwater alternative is potentially viable, if needed, in combination with a beach nourishment project.

5.1.7 Artificial Reefs

Artificial reefs, or living breakwaters, are a type of breakwater designed to incorporate natural habitat by providing a hard substrate for colonization by oysters or hard corals or by creating shelter and habitat for marine species. Artificial reefs may consist of various materials, such as limestone boulders or re-purposed bridge and highway materials, as well as manufactured concrete reef modules offered in numerous shapes and sizes by a variety of manufacturers. One well-known example of a manufactured concrete reef module is a Reef Ball, a hemispherical shape characterized by a rough surface that promotes quick colonization by marine species and plants and many holes specifically designed to dissipate wave energy. The artificial reef alternative falls under the broader category of breakwaters. Therefore, it is potentially viable, if needed, in combination with a beach nourishment project.

5.1.8 Structural Dune Core

Construction of a dune with a structural core maintains the natural beach environment during normal conditions but can minimize erosion under severe conditions and prevent undermining of the oceanfront buildings when significant dune erosion occurs. Many have applied sand-filled geotextile products (typically tubes or bags) with mixed results. To maintain sufficient turtle nesting habitat, a three-foot deep layer of sand must remain above the geotextile forms in perpetuity. This can lead to expensive beach fill maintenance projects should chronic dune erosion occur. When exposed, geotextile tubes are also subject to vandalism, as they are easily susceptible to knife punctures. A buried seawall offers an alternative with a smaller footprint and, hence, less maintenance requirements.

Like the seawall and revetment alternatives discussed above, a structural dune core (whether composed of sand-filled geotextile products, seawall, or revetment) falls under the restrictions of Section 161.085(2)(a), FS and Section 161.085(2)(c), FS. Given the small space available to maintain a covered dune structure (if anything other than a seawall), this alternative will not likely prove viable.

5.1.9 Screening Results

Table 5.1 summarizes the initial screening results. Overall, a seawall, revetment, beach and dune nourishment, and dune restoration with a structural core meet the principal objective of protecting Summerhouse's oceanfront buildings. From a regulatory perspective, beach and dune nourishment is the most viable alternative in protecting the entire 1,400-ft-long Summerhouse shoreline with some allowance for groins and breakwaters should they prove necessary to improve beach performance. A seawall (and a seawall as a dune core) may receive regulatory approval only if the structures slated for protection are vulnerable to a high frequency storm event and the proposed wall sits as far upland as possible to minimize its effect on the natural dune system. Therefore, the seawall and beach and dune nourishment alternatives move to the next phase of study. As discussed below, dune restoration with a structural core and the seawall alternative are very similar such that this study merges the two concepts into a single alternative for further analysis.

Table 5.1 Initial Screening of Alternatives

Alternative	Protects Upland Buildings	Potentially Meets Regulatory Approval
Seawall	✓	X / ✓
Revetment	✓	X / ✓
Dune Restoration	X	✓
Beach and Dune Nourishment	✓	✓ [1]
T-head Groins	X	✓ [2]
Breakwaters (incl. Artificial Reefs)	X	✓ [2]
Dune Restoration with Core	✓	X / ✓

[1]Beach nourishment is Florida's state-wide preferred solution for shoreline stabilization.

[2]Construction and performance monitoring of a beach and dune nourishment project is a pre-requisite (per Florida rules) for shoreline stabilization structures, which Florida will only authorize to improve the longevity of beach nourishment projects.

5.2 Conceptual Design of Viable Alternatives

The following sections discuss conceptual designs of the two alternatives initially screened as meeting the project objectives and potentially meeting regulatory approval — seawall and beach and dune nourishment.

5.2.1 Seawall

An engineering analysis performed with USACE's SBEACH cross-shore erosion model helped estimate the current vulnerability of the eight oceanfront buildings (1, 5, 6, 10, 11, 15, 16, and 20) and in turn, the lateral extent of a potential seawall. Appendix B presents more details regarding model setup, calibration, and future storm simulations. Briefly, model setup included specifying a pre-storm profile, storm parameters, and sediment transport parameters. This study calibrated the model to Hurricane Matthew (2016) conditions given the availability of pre- and post-storm profiles and storm information.

Figure 5.2 shows the locations of the input pre-storm profiles, which originated from the December 2022 survey collected by Arc Surveying. Three of the five profiles represent the conditions at two buildings given their proximity. **Figures 5.3-5.7** show the predicted erosion from a 15-yr storm at the five locations. Because the storm-induced erosion falls landward of the existing dune escarpment and seaward of the buildings, the figures also show 1V:2H and 1V:3H slopes to approximate stable slopes from the dune toes of the 15-yr storm eroded profile. This exercise indicates that building 20 may become vulnerable as the 1V:3H slope extends into the footprint of the building. As such, this study proposes a conceptual design for a seawall to protect only building 20.

This analysis presented herein does not imply any of the buildings are currently vulnerable. Furthermore, it does not intend to replace the more rigorous analysis required to determine vulnerability but only serves to help form a reasonable conceptual lateral extent of wall placement for this study.

Figure 5.2 Pre-Storm Input Profile Locations

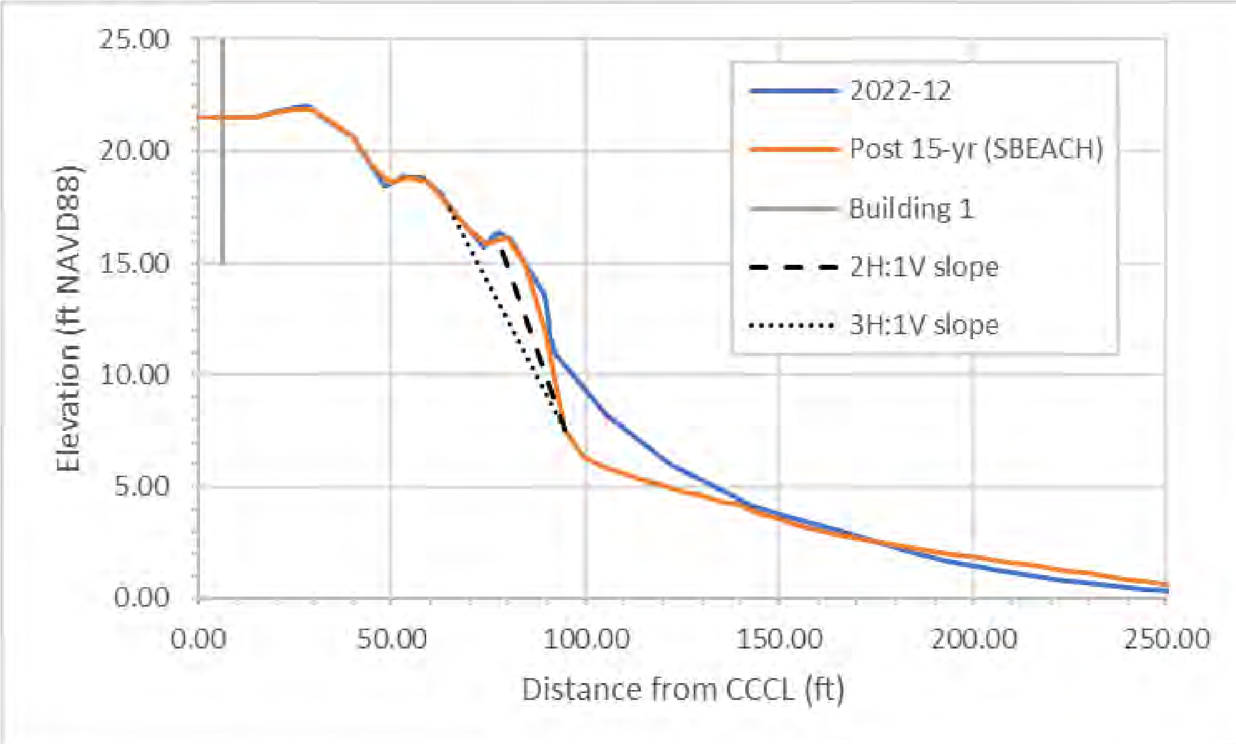


Figure 5.3 Conceptual Vulnerability of Building 1

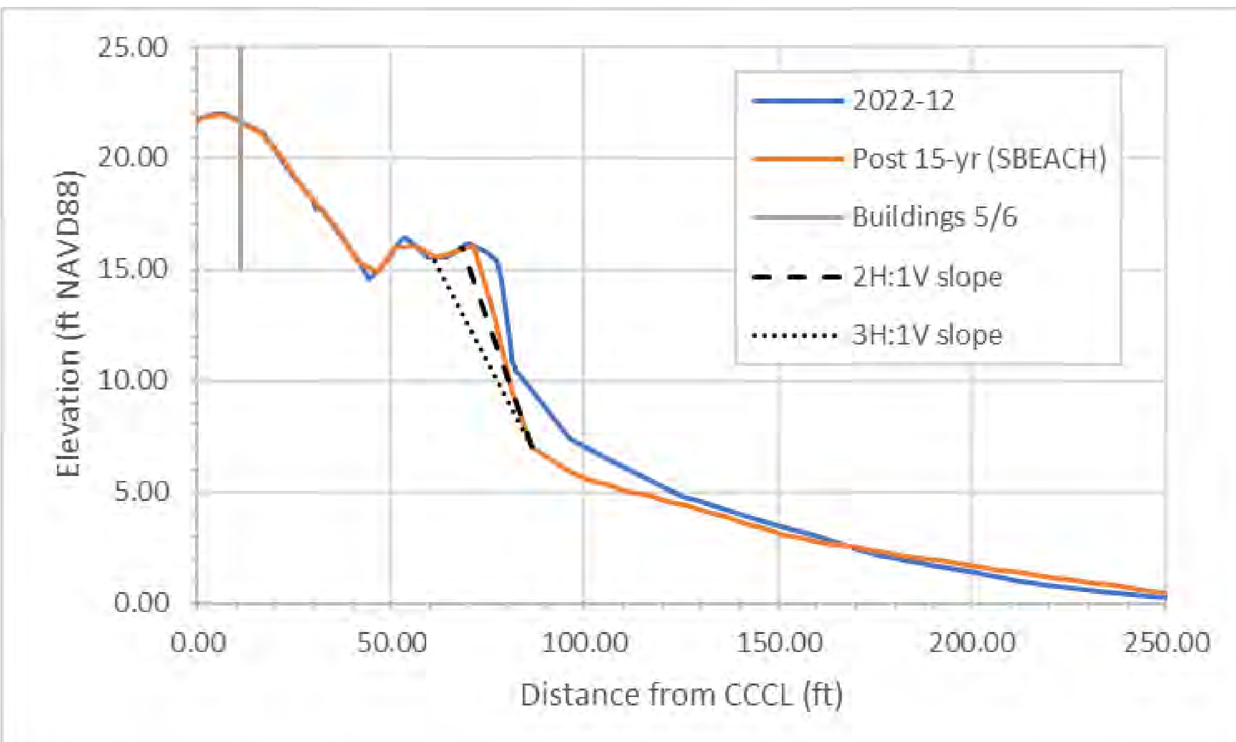


Figure 5.4 Conceptual Vulnerability of Buildings 5 and 6

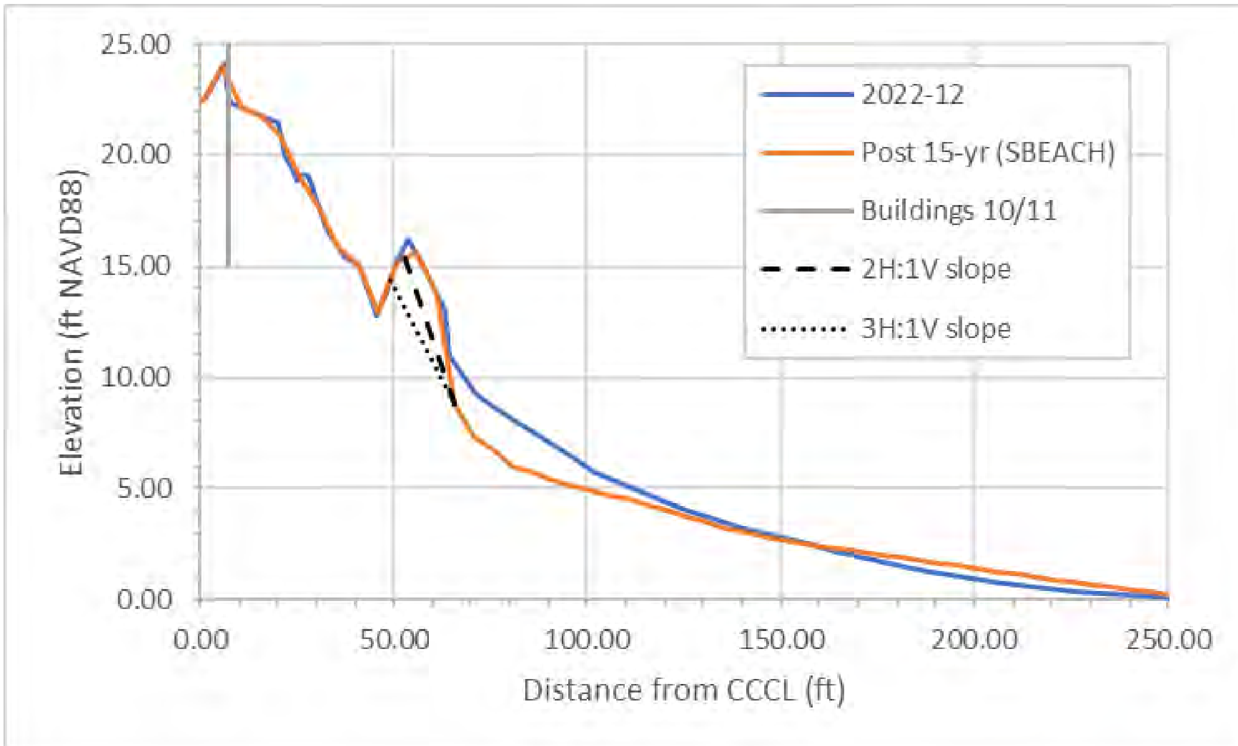


Figure 5.5 Conceptual Vulnerability of Buildings 10 and 11

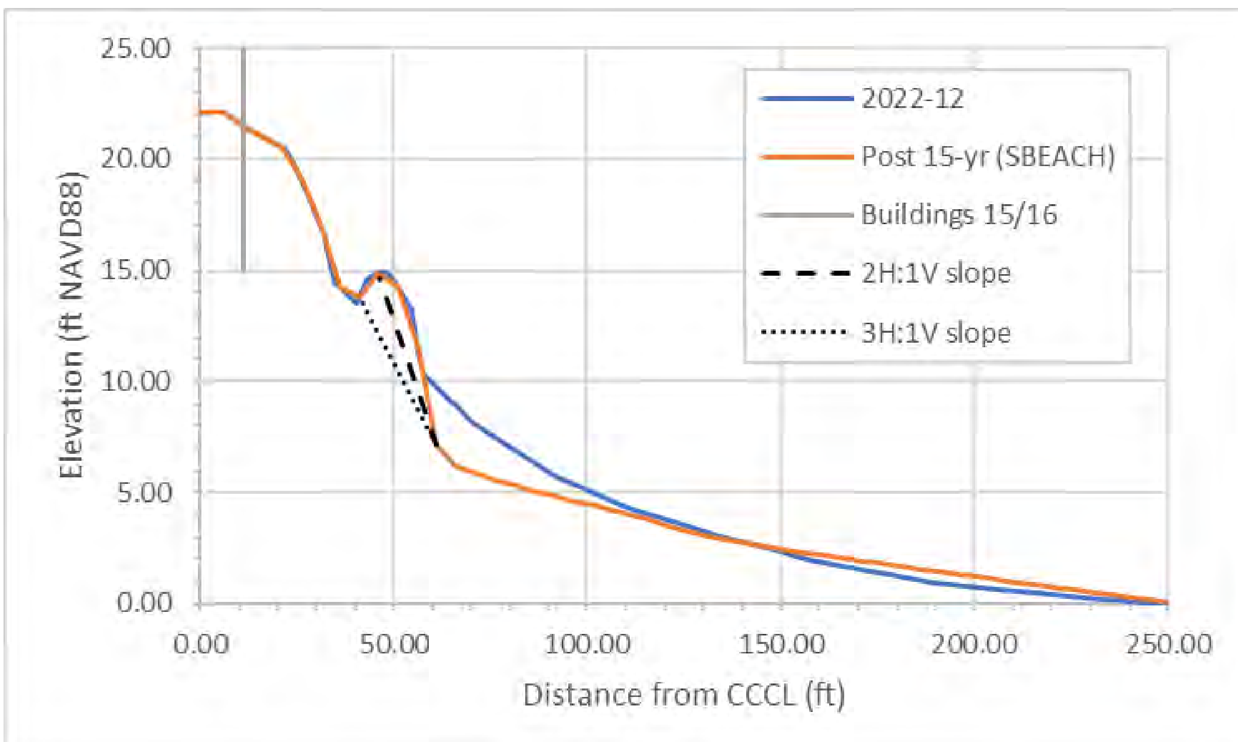


Figure 5.6 Conceptual Vulnerability of Buildings 15 and 16

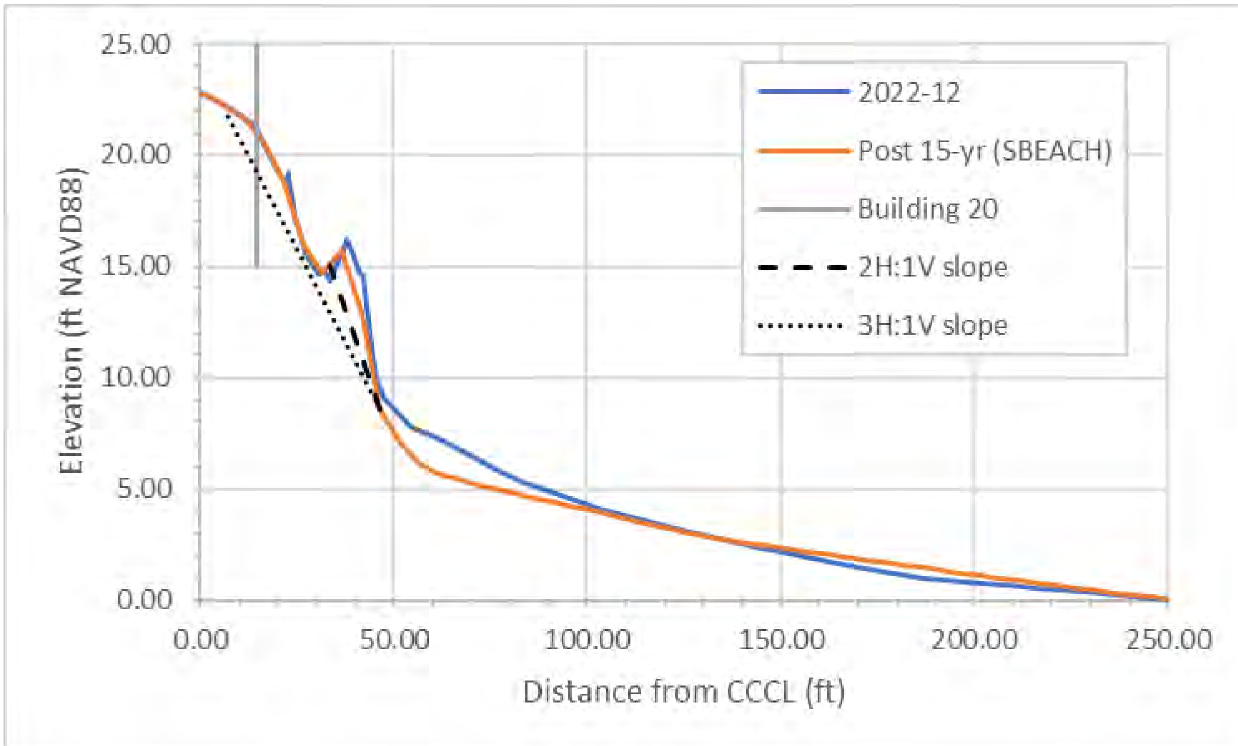


Figure 5.7 Conceptual Vulnerability of Building 20

Figure 5.8 shows a conceptual cross section and plan view for a seawall to protect building 20. This alternative consists of locating the seawall reasonably close to the building to minimize any detrimental effects on the existing dune system and setting its crest elevation below the existing grade.

Unless the wall is exposed, little to no maintenance is needed. If exposed, sheeting from the splash zone and up could prove vulnerable to corrosion and may require additional maintenance such as recoating, inspections, and repairs. Should the exposed wall become subject to a storm larger than design event, repairs may include replacing portions of wall, anchors, and backfill.

A privately funded seawall project only fronting the Summerhouse property does not require BOCC actions to implement.

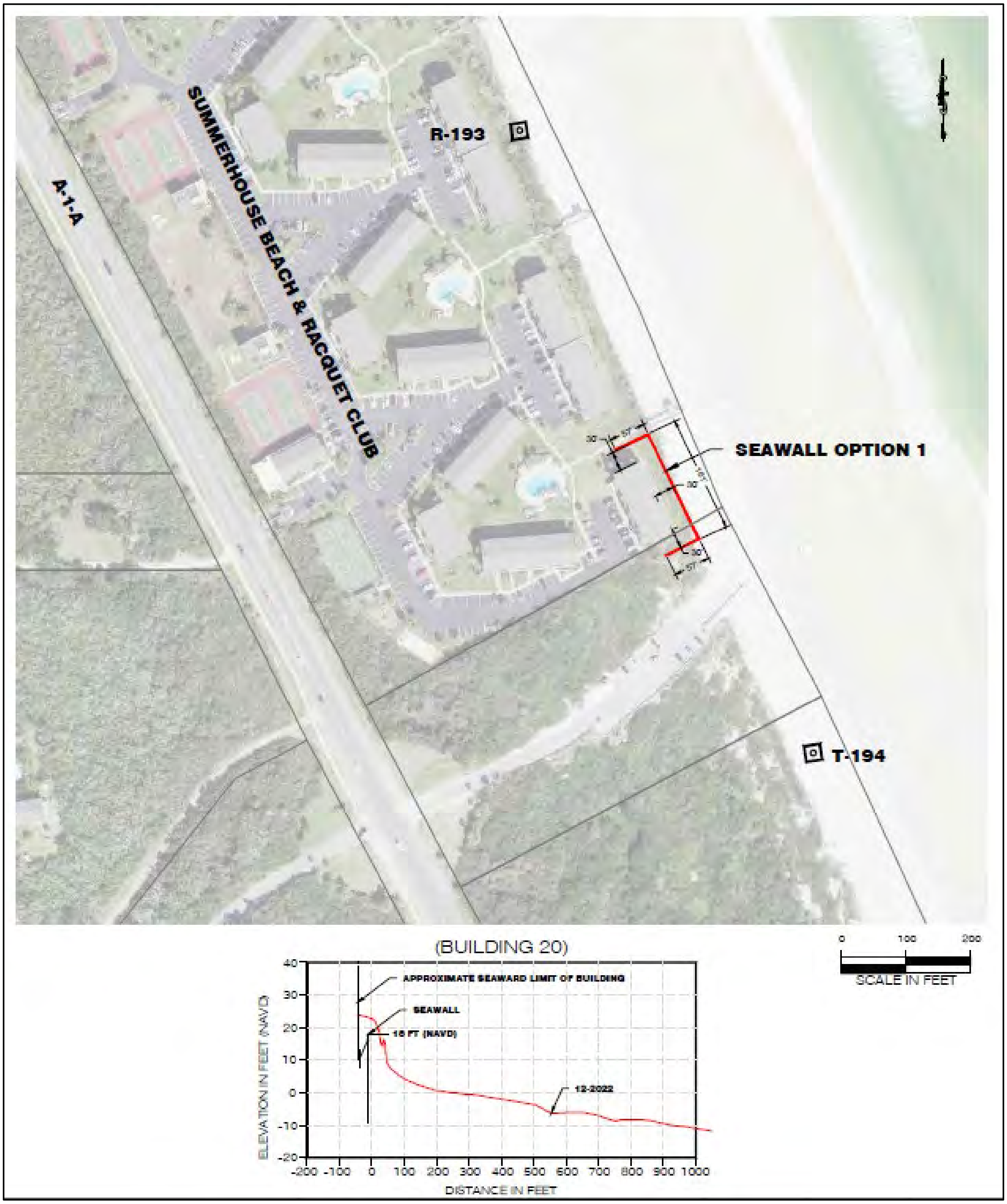


Figure 5.8 Concept Sketch – Seawall

5.2.2 Beach and Dune Nourishment

Figure 5.9 shows a conceptual cross section and plan view for a beach and dune nourishment project along the 1,400-ft-long Summerhouse beachfront. This alternative consists of restoring a portion of the secondary dune and completely restoring the seaward tertiary dune that eroded during Hurricane Matthew. The secondary dune crest reaches an elevation of +18 ft NAVD88 and the tertiary dune crest reaches +10 ft NAVD88 to match the peak historical dune conditions. The beach consists of a 118-ft wide beach crest at elevation +10 ft NAVD88 with a 10H:1V seaward slope until intersecting existing grade. Overall, the beach and dune nourishment project has an approximate fill density of 54 cy/ft for a total initial nourishment volume of approximately 87,500 cy including tapers.

An engineering analysis performed with USACE's SBEACH cross-shore erosion model helped assess the adequacy of the beach and dune template to future, synthetic storms. Appendix B presents more details regarding model setup, calibration, and future storm simulations. Briefly, model setup included specifying a pre-storm profile, storm parameters, and sediment transport parameters. This study calibrated the model to Hurricane Matthew (2016) conditions given the availability of pre- and post-storm profiles and storm information.

For the with-project simulations, storm data derived from Dean et al. (1987) and FDEP (2009) and USACE Wave Information Study (WIS). The former provides total storm tide elevations and corresponding 36-hr hydrographs while the latter provides historical offshore wave data for the period 1980-2020. The SWAN wave model (described previously) transformed the waves from deepwater to an approximate 40-ft water depth, the most seaward extent of the beach profiles. The modeled storms included the 25-, 50-, and 100-yr events. Note that the simulations applied a mean sediment size of 0.23 mm. **Figure 5.10** shows the SBEACH results for the beach and dune template. Erosion caused from the 25- and 50-yr events confines itself to the historical tertiary dune. Although difficult to see in the figure, the 100-yr event's erosion minimally extends into the secondary dune. Limiting erosion to the historical tertiary dune should keep the buildings from undermining during the storm event.

From a longevity perspective, many coastal engineers apply a diffusion analysis based on the theory of Pelnard-Considere (e.g., see Dean and Dalrymple, 2002). Following this theory, a beach fill represents a perturbation or a planform anomaly to the local uninterrupted shoreline, which over time, longshore sediment transport smooths. This smoothing or diffusion of the beach fill by longshore sediment transport acts in conjunction with any background erosion present without the beach fill. Appendix C presents the details of the diffusion analysis.

Based on site-specific parameters, including a representative background shoreline erosion rate of -1.5 ft/yr, **Figure 5.11** presents the predicted amount of the beach fill remaining over time for the concept project. The figure shows that no fill remains after approximately three years. This short fill life primarily relates to the very short length of the project.

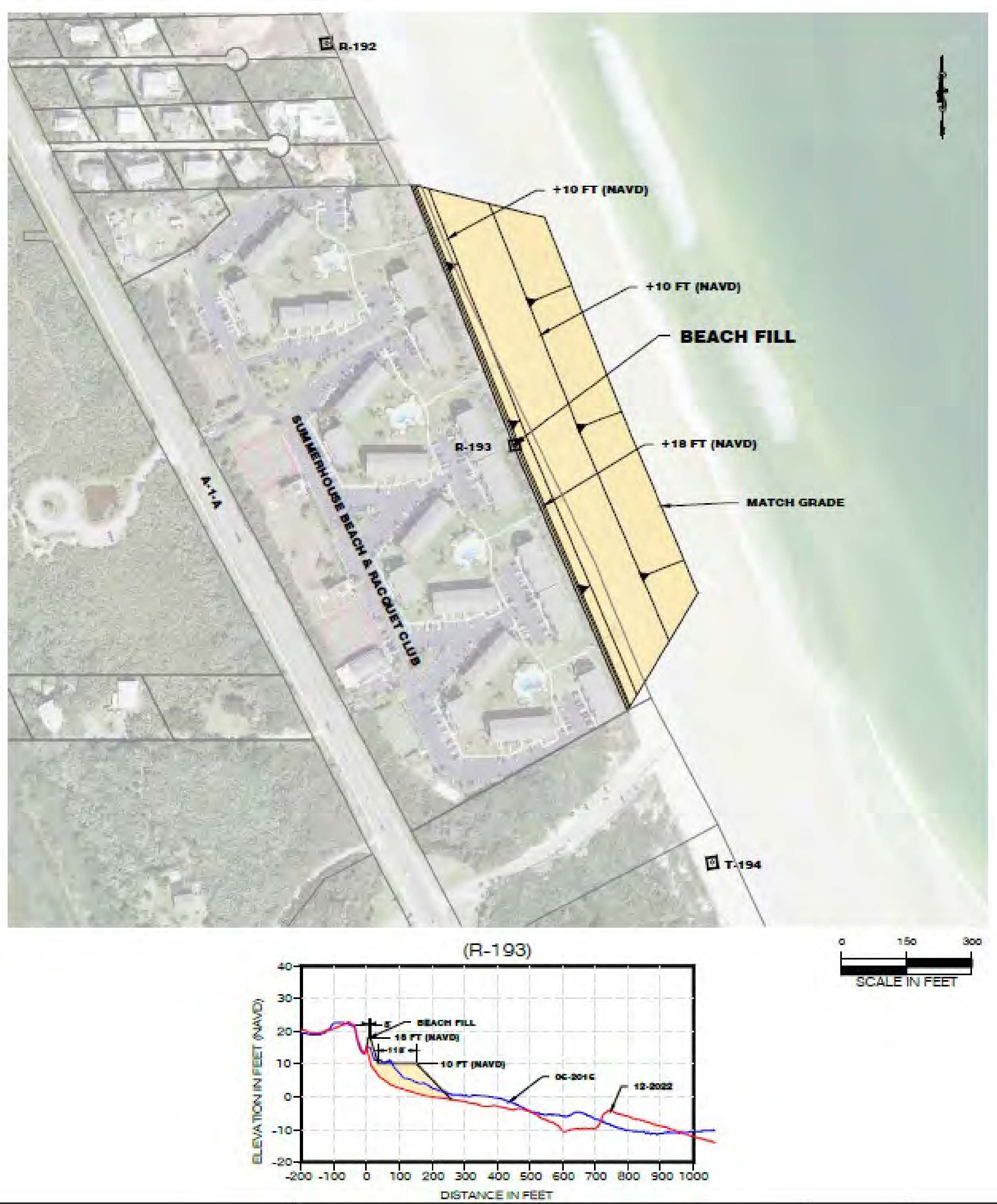


Figure 5.9 Concept Sketch – Beach and Dune Nourishment

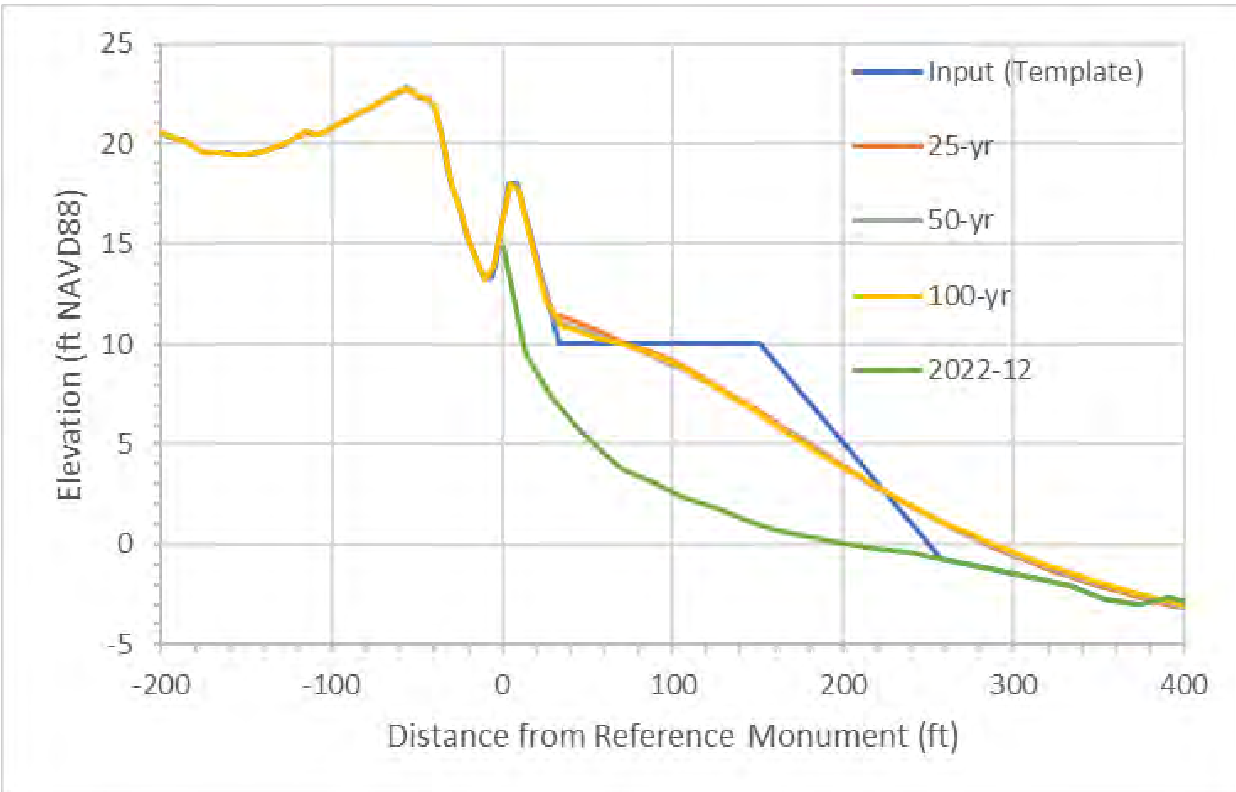


Figure 5.10 SBEACH Simulations for Beach and Dune Nourishment Alternative

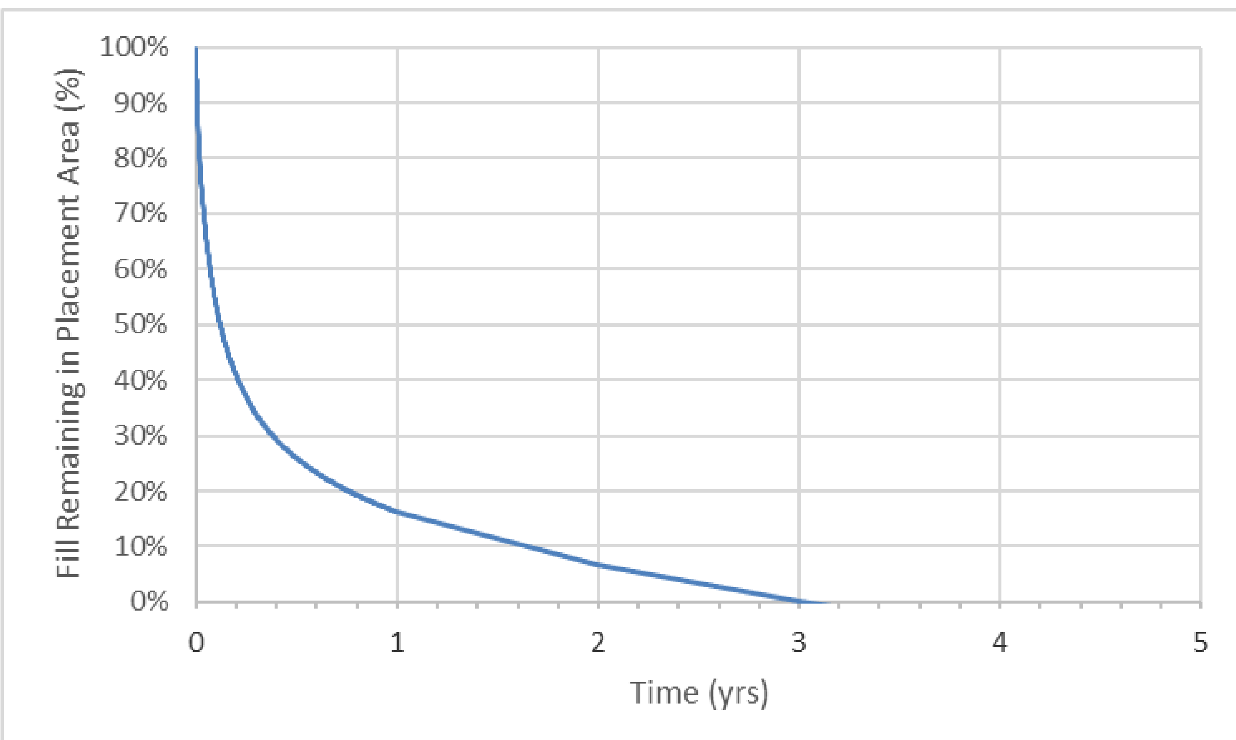


Figure 5.11 Prediction of Sand Remaining over Time

Note that a longer beach nourishment project could improve project longevity. Suppose two beach fill projects are exposed to the same wave climate but have different project lengths. The project with the greater length lasts longer. Per the above theory, project longevity varies as the square of the project length. For example, a one-mile-long project loses 50% of its material in a two-year period. Accordingly, a two-mile-long project (two times the previous project length) exposed to the same wave climate would lose 50% of its material in an eight-year period (two squared or four times the previous project period). Naturally occurring (background) erosion could reduce the longevity differences between the two projects. Therefore, benefits exist in trying to include neighboring properties into a beach nourishment project to help improve overall project performance.

In consideration of a Summerhouse only project, the relatively small fill quantity dictates use of commercial inland sand sources as the initial construction material source. The Matanzas Inlet flood shoal could serve as a borrow source after undergoing a detailed investigation like that described in the following paragraph. Alone, it likely could satisfy the needs of a Summerhouse shoreline fill project. After initial construction, approximate long-term needs could approach 75,000 cy every three years (approximately 25,000 cy/yr) depending on storm activity and material quality. The sediment budgets suggest the inlet annually traps 50,000-70,000 cy/yr (INTERA-GEC, 2023).

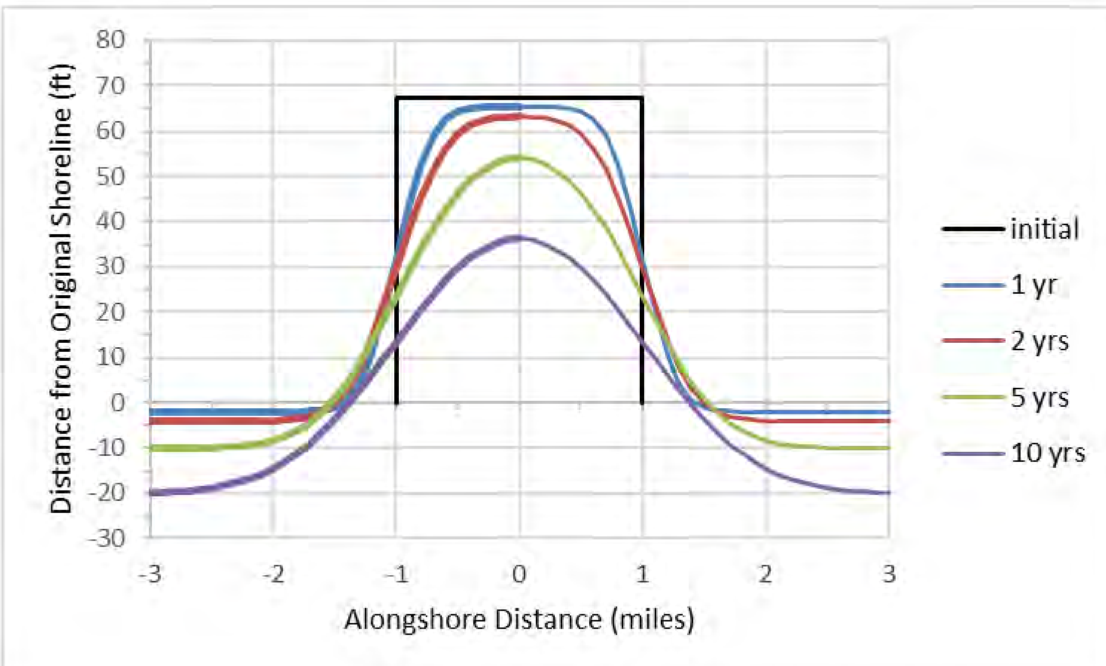
As discussed in Section 3.3.2.6, no proven offshore borrow area exists to solely provide beach fill for Matanzas area beach fill projects. Thus, a sand source investigation must identify a source of beach compatible sand to support a long-term beach nourishment plan in this area. The investigation's initial steps should include coordination with USACE to discuss existing knowledge (previously collected data, available sand volume, etc.) of the proven sources offshore Butler Beach and Flagler Beach and the unverified sources offshore Summer Haven. Exploration of the unverified sources would likely follow the typical protocol of conducting reconnaissance phase geophysical and geotechnical data collection over several potential sites followed by detailed phase geophysical, geotechnical, and cultural resources surveys targeting the most promising site(s). The initial reconnaissance and detail phases may take 6 – 12 months or longer and typically identify sufficient sand quantities for the first few nourishments; subsequent phases are typically required for further delineation and permitting of borrow areas for longer-term nourishment projects.

A privately funded beach and dune nourishment project only fronting the Summerhouse property does not require BOCC actions to implement. However, larger, more regional projects that can tap into additional funding (e.g., state and federal funding requiring local sponsor cost-sharing) will require BOCC or other governmental agency involvement.

Summerhouse could also indirectly benefit from beach fill projects placed adjacent beaches even if no government-sponsored beach project occurs directly on its beach. For generally any beach nourishment project, a shoreline perturbation forms that extends the shoreline planform within the fill placement area farther seaward than the adjacent shorelines. After construction, wave action tends to smooth the shoreline out, spreading the fill material alongshore beyond the project area to the adjacent beaches.

Figure 5.12 shows an example of nourishment project and its resulting theoretical dispersion along the shoreline according to Pelnard-Considere theory. The example of a two-mile-long beach fill project with a total volume of 1,000,000 cy (approximate 100 cy/ft fill density) and a background, ongoing erosion rate of -2 ft/yr shows that the material utilized to create the wider beach moves alongshore outside of its original placement area (denoted as "initial") to the benefit of neighboring shorelines. To see this effect better, **Figure 5.13** shows how the shoreline in the example varies with time and different locations along the shoreline. The example suggests that shorelines within one mile of the initial project fill limits receive some benefit in the form of reducing the background erosion normally present.

In summary, a small-scale beach restoration project covering the Summerhouse property could potentially provide sufficient storm protection, but the short project length results in rapid dispersion of fill and frequent renourishments to maintain the protective berm. A larger scale project spanning adjacent properties could significantly improve project longevity and prove more cost-effective; however, such a project would require a detailed study (see Section 5.5.1.1) and cooperation among multiple entities potentially including USACE, FDEP, the County, the National Park Service, and other adjacent property owners.



L= 2 miles, V = 1.5 mcy, H = 2 ft, Tp = 7 sec, G = 0.09 ft2/s, dc = 30 ft, h* = 8 ft, D50 = 0.35 mm, Uniform background erosion rate = 2 ft/yr

Figure 5.12 Example of Beach Fill Alongshore Dispersion

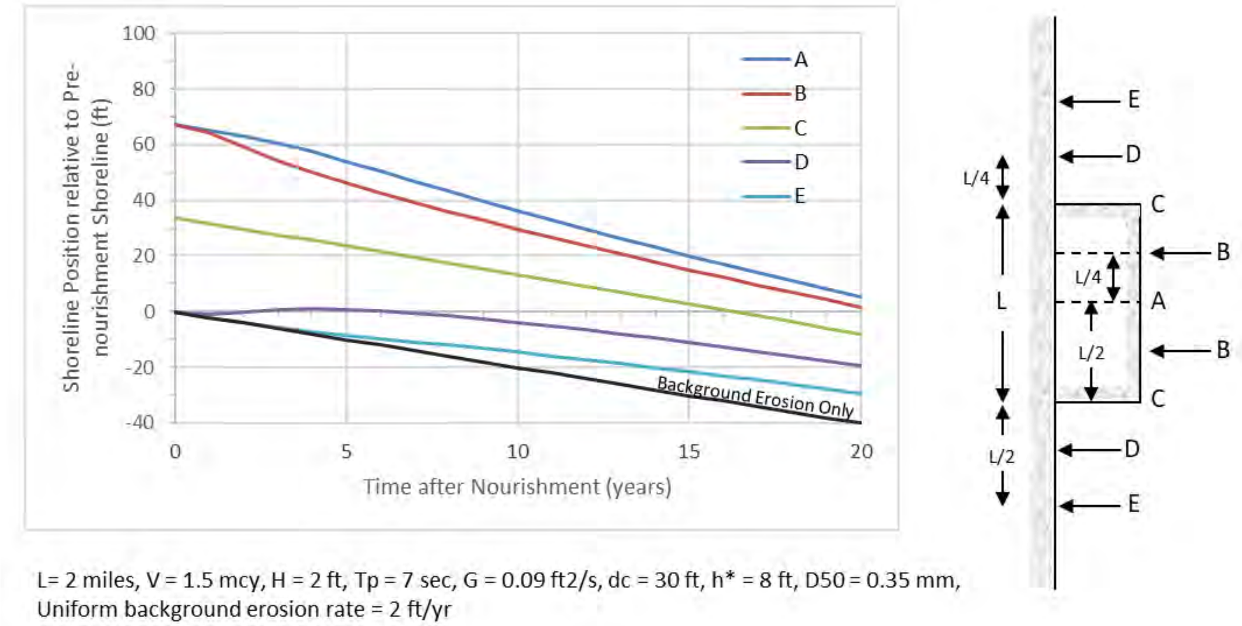


Figure 5.13 Example of Shoreline Advance with Time and Shoreline Location

5.2.2.1 Beach and Dune Nourishment with Shore Stabilization Structures

As mentioned above, structures like groins and breakwaters could help lessen the quantity and frequency of sand needed for subsequent beach renourishments. However, the determination of that need cannot occur until at least three years of monitoring of the initial nourishment has occurred. Typical Florida structures usually locate downdrift of inlets where the inlet's sediment bypass bar reconnects to the downdrift shoreline south of them.

Given Summerhouse's location relative to the inlet and the potential for the inlet to trap sediment intended for the north shoreline, a possibility exists that structures may prove warranted in improving beach nourishment performance.

Conceptually, a single T-head groin may have the following characteristics.

- Trunk and stem elevations: MHW
- Crest widths: 20 ft
- Side and seaward slopes: 2H:1V
- Bottom elevation: -5 ft NAVD88
- At least two layers of armor stone over geotextile

A breakwater might have the following characteristics.

- Crest elevation: -2.5 ft NAVD88
- Crest width: 20 ft
- Side slopes: 2H:1V
- Bottom elevation: -10 ft NAVD88
- At least two layers of armor stone over core material and geotextile

In most instances when needed to improve beach fill performance, usually three or more groins or breakwaters prove necessary to stabilize the target shoreline and smoothly transition the shoreline to adjacent areas.

Groin and breakwater maintenance requirements may consist of periodic replacement of rock following extreme storms. Groins and breakwaters, like other coastal structures, are designed to withstand certain design water level and wave conditions (e.g., a 50-year storm surge). If an extreme event that exceeds the design conditions occurs, the excess wave forces may displace some of the rock to varying degrees depending on the severity of the storm. Maintenance would entail reconstructing the structure to design parameters.

5.3 Non-engineering Alternatives

In addition to the engineering alternatives presented above, this study considered the costs of taking no action along the Summerhouse shoreline.

5.3.1 No Action

The no-action alternative consists of the County providing no direct assistance to the residents of Summerhouse. In this situation, the residents would have to fund their own initiatives without the benefit of a governmental sponsor. Under this alternative, the residents would likely continue to do what it has done since Hurricane Matthew — place sand fencing on its upper beach during periods of beach recovery with hopes of naturally building some dunes and count on FEMA emergency sand placement after storms. Absent these occurrences and other non-direct actions on the Summerhouse property (see Section 5.5), the property’s southernmost buildings may become vulnerable to high frequency storm events. Possible condemnation of some threatened or storm damaged buildings (if a strong storm occurs) could happen because of no fill placement or coastal armoring of the dune.

5.4 Conceptual Costs

After conceptually designing the range of alternatives, the next step in the evaluation process included developing conceptual level estimates of initial (construction) and maintenance costs. **Table 5.2** summarizes the initial and maintenance costs associated with the four alternatives. All initial construction cost estimates include mobilization costs associated with contractor’s operations to move personnel, equipment, supplies, and incidentals to the project site and establish temporary facilities. Item costs originate from a variety of sources including previous similar Florida jobs. All costs include 3-10% for engineering design, permitting, and construction phase services as well as 20% contingency. Appendix D contains the conceptual cost estimate details.

Note that assigning costs to maintenance activities proves difficult as doing so requires, for example, making many assumptions regarding frequency and severity of storms over the design life. Recognizing this challenge, this study assigned simple maintenance costs to provide some rough order-of-magnitude estimates for County planning purposes. For the beach and dune nourishment alternative, conceptual analyses have assumed replacing 90% of the initial fill every three years. For seawalls, experience suggests that they require much less maintenance, especially if they remain covered. For calculation purposes, an annualized maintenance cost of 1% of the initial cost, incurred every 10 years (i.e., 10% every 10 years), seems appropriate.

Table 5.2 Conceptual Level Initial and Maintenance Costs

Alternative	Initial Construction Cost (in millions)	50-year Maintenance Cost (in millions)[1]	50-year Total Cost (in millions)[1]
Seawall[2]	$1.24	$0.28	$1.52
Beach and Dune Nourishment[3,4]	$5.79	$47.10	$52.89
No Action	$0	$0	$0

[1]Dollar values represent present worth equivalents at the beginning of 2023 with a 4.75% discount rate and annual 2.2% inflation rate.
[2]Assumes seawall every 10 years at 1% of initial construction cost (i.e., $124,000 every 10 years) to protect building 20. Constructing a seawall to protect the entire 1,400-ft-long Summerhouse oceanfront could cost $7.02 million ($5.73 million initial cost plus $1.29 million maintenance cost).
[3]Assumes nourishment occurs every 3 years at 90% of the initial construction cost (i.e., $5.21 million every 3 years).
[4]Structures like T-head groins and breakwaters could decrease renourishment quantities and frequency and therefore, the beach nourishment maintenance costs. If constructed, the cost of groins or breakwaters could vary widely depending on the need to protect the entire length of beach fill or just an erosional hot spot. Protecting the entire 1,400-ft length project area may require 4 T-head groins or several breakwaters and initially cost over $12 million. Only after first constructing and monitoring the fill over three years will the need for structures possibly prove evident and cost worthy. If structures can extend the beach nourishment interval from 3 years to 6 years, the 50-year Beach and Dune Nourishment cost decreases to $22.7 million, a savings of $24.4 million that could offset the cost of structures.

5.5 Potential Funding Sources

Implementing the dune and beach nourishment or seawall alternatives will require significant funding to cover initial construction, maintenance, and monitoring. The following sections introduce state and federal funding sources to support these projects. Of note, this analysis excludes discussing local funding sources (e.g., municipal services benefit or taxing units, local option sales tax, tourist development tax, and special taxing district) of which the County is fully aware.

5.5.1 Federal

5.5.1.1 USACE Coastal Storm Risk Management Project

With a formal request to the USACE (specifically, the Jacksonville District Commander), the USACE can conduct a study to identify water resource problems, formulate and evaluate solutions, determine federal interest, and prepare recommendations. The USACE shares the cost of a study 50/50 with the requesting local sponsor, which can include a state, tribe, county, city, or town with the legal and financial authority and capability to provide funding and real property requirements needed for a study and a future project.

However, before USACE becomes involved in a study, it requires two types of Congressional authority. These include a study authority (typically in Water Resource Development Act [WRDA]) and a budget appropriation (allows expenditure of federal funds). If no study authority is currently available, community representatives may contact their Congressional delegation to request a new study authority and may also submit a proposal for Congressional consideration via the Assistant Secretary of the Army's Annual Report to Congress on future Water Resource Development acts. Once a study authority is available, USACE will request federal funding annually to initiate the study. Upon receiving budget appropriations, USACE can begin the study. The study officially begins when the USACE and local sponsor sign a feasibility cost share agreement. The USACE will complete the study within three years at a cost of no more than $3 million, and with the required three levels of USACE engagement (3-3-3). Note that funding is spread out over the three years of the study. The study ends when the Chief of Engineers signs a "Chiefs Report" and transmits it to the Assistant Secretary of the Army for Civil Works, then to the Office of Management and Budget, then to Congress for authorization to construct the project. Up to 65% federal funds and at least 35% local cost share funds finance federal projects. Finally, the federal government requires public access is available.

Note that the County has asked USACE to study Butler and Crescent beaches from R-151 south to the Matanzas Inlet, including Summerhouse (Stephen Hammond, St. Johns County Coastal Environment Project Manager, personal communication, March 28, 2023). This study could lead to future projects on the Summerhouse and adjacent northern beaches. As noted above, Summerhouse could benefit from beach fill projects placed near its shoreline even if its beachfront does not qualify for a federal project. Unfortunately, the time horizon between study initiation and initial construction can take many years. Although the USACE has now streamlined the study authorization process, the South Ponte Vedra-Vilano Beach CRSM project initiated its reconnaissance study in 2004 and began construction in summer/fall 2020.

5.5.1.2 Flood Control and Coastal Emergencies Program (PL 84-99)

Flood Control and Coastal Emergencies (FCCE) funds are ineligible to fund the initial construction of a project but may become available for post-storm recovery and repair efforts required after initial construction. For authorized and constructed federal projects by the USACE, monies from the FCCE program, under Public Law 84-99, will cover 100% of the costs to repair storm-related damages. The County currently experiences this benefit with its St. Johns County Shore Protection Project and South Ponte Vedra-Vilano Beach CSRM project. In fact, the USACE will repair the losses after hurricanes Ian and Nicole later this year at 100% federal cost.

5.5.1.3 Continuing Authorities Program

The Continuing Authorities Program (CAP) authorizes the USACE to implement certain types of water resources projects without project specific congregational authorization. The projects are limited in size, cost, scope, and complexity (https://www.saj.usace.army.mil/CAP/).

The CAP covers the following types of projects:

- Mitigation of Shore Damage Attributable to Federal Navigation Works (Section 111 of the River and Harbor Act of 1968 and amendments)
- Small Beach Protection Projects (Section 103 of the 1962 River and Harbor Act)
- Beneficial Uses of Dredged Material (Section 204 of the WRDA of 1992)
- Flood Risk Management (Section 205 of the Flood Control Act of 1948 and amendments)
- Snagging and Clearing for Flood Risk Management (Section 208 of the Flood Control Act and amendments)
- Emergency Streambank and Shoreline Protection (Section 14 of the Flood Control Act of 1946 and amendments)
- Environmental Restoration (Section 1135 of WRDA of 1986 and amendments)
- Aquatic Ecosystem Restoration (Section 206 of the Water Resources Development Act of 1996 and amendments)
- Small Navigation Projects (Section 107 of the 1960 River and Harbor Act and amendments)

For the first $100,000 of any study costs, USACE covers 100% of the cost. For anything over $100,000, USACE and the local sponsor cost share the study costs 50/50. Construction costs vary from project type to project type. However, typically USACE pays 50 to 75% of the initial design and construction costs with a cap of generally $5 to $10 million on federal costs.

Initiating a project requires a local sponsor notifying USACE of a problem by sending a letter of request to the USACE Jacksonville District. Upon receipt of a request, the USACE will investigate whether a federal interest exists and request feasibility study funds. This determination pivots on the problems and opportunities and potential solutions identified, the reasonableness of expected relative costs to relative benefits, and identification of environmental impacts associated with any contemplated solutions. If favorable, then, the local sponsor and USACE will sign an agreement to initiate study. USACE will conduct a feasibility study. Then, if both parties agree on the solution, they will sign an agreement to construct and maintain the project. Regarding timing, USACE determines federal interest in a project within four months of receiving funding. The feasibility study usually takes one to two years after execution of a feasibility cost-sharing agreement. Project design and implementation occur within six months of a project partnership agreement.

The USACE Jacksonville District has a CAP-funded study at Fort George Inlet (Fort George Inlet Erosion Control Project) under Section 111 of the River and Harbors Act. The study is investigating ways to reduce the continued shoreline erosion of Little Talbot Island because of the federal north jetty of Jacksonville Harbor.

The BOCC, serving as the proposed local sponsor on behalf of Summerhouse, could request the USACE investigate whether a federal interest might exist in protecting Summerhouse. The likelihood of receiving a favorable federal interest determination is low given that most of the buildings lie landward of a wide dune and limited public access exists. With a small structural inventory, damages would not likely justify a beach fill project.

5.5.1.4 FEMA Public Assistance Grants

FEMA grants are ineligible to fund the initial construction of a project but may become available for post-storm recovery and repair efforts required after initial construction.

FEMA provides post-disaster public assistance following a federal disaster declaration. FEMA provides public assistance as a cost share with the requesting state or local government. The federal share is 75% of eligible costs with possible increases to 90%. FEMA divides public assistance eligibility into two groups: (1) Emergency work and (2) Permanent work. FEMA (2020) states emergency work includes:

- Debris removal
- Private property demolition
- Emergency response activities
- Emergency protective measures
- Individual temporary facilities
- All donated resources for emergency work

Permanent work includes damaged facilities consisting of the following infrastructure categories:

- Transportation
- Flood control
- Education
- Housing
- Health
- Emergency service facilities
- Other governmental facilities
- Energy
- Water/Wastewater
- Communications/information technology
- Natural and cultural resources

Beaches may fall under either work. If a natural or engineered beach could incur damage from a five-year storm event, then that beach is eligible for emergency protective measures under FEMA's emergency work classification or so-called Category B funding. In this case, FEMA provides funding for the construction of emergency sand berms with up to 6 cy/ft to protect against additional damage from a five-year storm.

If the County incurs storm-related damage to an engineered and maintained beach, then the beach sand lost during the storm is eligible for replacement funding under the permanent work classification (so-called Category G funding, natural and cultural resources). Notably, a federally-funded beach nourishment project is ineligible for FEMA public assistance. Pre- and post-storm profiles determine the eligible volume of sand for replacement. FEMA typically only considers funding the volume of sand lost offshore the depth of closure (see Chapter 4) or beyond the longshore limits of the beach.

A compromised seawall could prove eligible for post-disaster public assistance under FEMA's permanent work classification (so-called Category D funding) if it provides flood control (or in this case, coastal shoreline protection) in protecting improved property and lives.

5.5.1.5 NOAA and NFWF Grant Programs

Among others, NOAA and NFWF offer grants for enhancing the resilience of coastal communities and improving habitat for fish and wildlife to nonprofit 501(c) organizations, state and territorial government agencies, local governments, municipal governments, Tribal governments and organizations, educational institutions, or commercial (for-profit) organizations. In 2023, NOAA and NFWF, through its National Coastal Resilience Fund (NCRF) established in 2018, will award approximately $140 million in grants. Last summer, it offered grants of over $7.7 million for projects related to restoring and enhancing, for example, wetlands, dunes, and tidal rivers in seven states (https://www.noaa.gov/news-release/). One of the awardees included a project in Hawai'i restoring dunes along one mile of shoreline to reduce impacts of erosion, sea level rise, and high wave flooding and enhance habitat for native plants and animals (including sea turtles). The awardee received over $1 million in grant money with a $417,000 match.

This fund, funded by Congress, provides competitive grants ranging from $100,000 to over $3 million for coastal projects that improve a community's resilience while also helping support or restore fish and wildlife habitat. While grants like these do not serve as long-term funding sources, they can provide supplemental funding. The grant only supports nature-based solutions that provide the dual benefits of reducing risks to communities from coastal hazards and enhancing habitats for fish and wildlife. In 2022, the NCRF received 455 pre-proposals and invited 200 of those to submit full proposals. Of those 200, 96 received funding. This equates to a success rate of 21% (96/455).

All proposals must address the following priorities.

- Nature-based solutions. Use of natural solutions like rebuilding dunes or installing living shorelines.
- Community resilience benefit. Reduction of natural hazard threats like storms and SLR.
- Fish and wildlife benefit. Must improve fish and wildlife habitat.
- Community impact and engagement. Priority for risk reduction or job creation benefits to underserved communities.
- Innovation, transferability, and sustainability

The NCRF funds projects in four categories including

- Community capacity and building and planning
- Site assessment and preliminary design
- Final design and permitting
- Restoration implementation

The NCRF will release its request for proposals for 2024 funding in February with pre-proposals due in April. It would send out full proposal invitations in May with a due date of the end of June. Awards usually take place in November.

To have a high chance of success in receiving an award, the project must address the grant's primary focus of resilience in terms of protecting vulnerable community infrastructure such as houses, public buildings like fire or police stations, roads, and utilities. The project must address making this infrastructure more resilient to coastal flooding and erosion. As noted above, it can only fund so-called green infrastructure portions of a project like living shorelines or dunes and not gray infrastructure like seawalls or groins. Given this information, the County would likely have to show the dunes are made more resilient to coastal storms through implementation of the project. This would likely prove relatively straightforward. However, discussions with NCRF staff suggest that a standalone beach nourishment project would not likely rate highly in its list of funded projects based on historical funding requests (Sarah Whitehouse, personal communication, May 11 and June 12, 2023; Courtney Greene, personal communication, May 10, 2023).

5.5.2 State

5.5.2.1 General Appropriation

As part of the state of Florida's annual budget appropriations process, the governor submits a plan to the legislature that recommends funding levels for each of the state's departments. Each house of the legislature prepares its own budget based on the governor's recommendation to develop and pass a general appropriations act to fund the state government. The County/Summerhouse could seek monies for a project by advocating for that project's inclusion in the governor's budget or through local elected state representatives or senators to include funding for the project in the legislature's budgets.

5.5.2.2 FDEP Beach Management Funding Assistance Program

The FDEP manages the Beach Management Funding Assistance (BMFA) Program, which provides funds to local, state, and federal governmental agencies for protecting, preserving, and restoring Florida's sand beaches along the Gulf of Mexico, Atlantic Ocean, and Straits of Florida. Financial assistance includes up to 50% of beach and up to 75% of inlet project costs. Section 161.101, FS, and rules of Chapter 62B-36, Florida Administrative Code (FAC) authorize the BMFA program.

Eligible activities include:

- Beach restoration and nourishment
- Project design and engineering studies
- Environmental studies and monitoring
- Inlet management planning
- Inlet management activities to reduce adjacent beach erosion (e.g., sand transfer)
- Dune restoration and protection
- Other beach erosion prevention related activities consistent with the adopted Strategic Beach Management Plan

The public must have access to the beach management projects. Additionally, the FDEP must have designated the shoreline as a critically eroded beach. The FDEP, as per Chapter 62B-36.002(5), FAC, defines a critically eroded beach as

"…a segment of the shoreline where natural processes or human activity have caused or contributed to erosion and recession of the beach or dune system to such a degree that upland development, recreational interests, wildlife habitat, or important cultural resources are threatened or lost. Critically eroded shorelines may also include peripheral segments or gaps between identified critically eroded areas which, although they may be stable or slightly erosional now, their inclusion is necessary for continuity of management of the coastal system or for the design integrity of adjacent beach management projects."

The FDEP solicits formal funding requests from local governments and agencies. Given the proposed activity is eligible, improving funding priorities includes scoring high in the following criteria:

- Tourism-related impacts
- Federal involvement
- Storm damage reduction benefits
- Cost effectiveness
- Previous state commitment
- Recreational benefits
- Mitigation of inlets
- Sand placement volumes
- Successive unfunded requests
- Environmental habitat enhancement
- Overall readiness to proceed

The first four criteria correspond to 65% of the total ranking points. The leveraging of federal funds helps a project rank more highly and, thus, increases its chances of receiving state funding.

Notably, the program explicitly excludes seawalls and revetments as eligible activities. Furthermore, the program only covers structures, such as T-heads groins and breakwaters, only if they enhance the longevity of a beach nourishment project. The FDEP does not usually fund groins and breakwaters until at least three years of beach monitoring data suggest their need to improve beach nourishment performance (Robert Brantly, FDEP, personal communication, March 1, 2023).

Beach-related funding requests for Fiscal Year 2022/2023 consisted of 20 different beach nourishment projects totaling $50.7 million (excluding annual post-construction physical monitoring funding requests). Of the top 10 ranked projects, nine have federal involvement and all span highly developed shorefronts, demonstrating the importance of the first four criteria listed above. Given the lack of federal involvement and short project length, Summerhouse beach nourishment likely would not receive a top 10 ranking but would remain eligible for funding (eight of the bottom 10 ranked projects did not have federal involvement). Of note, FDEP typically funds post-construction monitoring of projects that it contributes construction funds towards; thus, Summerhouse would likely qualify for a 50% state cost share of post-construction physical monitoring.

The FDEP's Strategic Beach Management Plan (FDEP, 2023b) does not address the Summerhouse shoreline, as FDEP only recently, in July 2023, designated Summerhouse and adjacent beaches (i.e., R-192 to R-196) as a critically eroded shoreline. However, the plan includes conducting a feasibility study to investigate alternatives to mitigate inlet impacts, developing a sediment budget, and adopting an inlet management plan to address the adjacent eroding beaches (FDEP, 2023b).

Given the latter elements, the County could explore serving as a potential local sponsor for developing and implementing an inlet management plan at Matanzas Inlet with the help of state funds. Although not a traditional navigation inlet, it is a man-influenced inlet given the southern bridge abutment of the bridge over the inlet and the revetted south inlet and Summer Haven shorelines. The sediment budgets

(INTERA-GEC, 2023) show that the inlet potentially traps sand intended for both sides of the inlet. Additionally, the inlet's effect on the north shoreline may extend as far north as R-184, approximately 2-3 miles north of the inlet, based a preliminary assessment of the inlet's alongshore influence. While not necessarily alleviating their full issues, Summerhouse and Summer Haven beaches could both benefit from the bypassed material. In addition to the ICWW material, the inlet's flood shoal could serve as a source for bypassing. Finally, any dredging and bypassing of the materials could lessen the shoaling rate within the ICWW, potentially benefiting FIND.

Inlet-related funding requests for Fiscal Year 2022/2023 consisted of eight different inlet projects requesting a total of $7.1 million (excluding annual post-construction physical monitoring funding requests) for feasibility studies, design and permitting activities, construction, and first-year post-construction monitoring. A total of four different projects (including three of the eight above projects) requested funding totaling $0.8 million for years two+ post-construction monitoring. FDEP evaluated and ranked the projects in accordance with Chapter 62B-36, FAC; unlike beach projects, federal involvement is not a factor. Of note, FDEP typically funds post-construction monitoring of projects that it contributes construction funds towards; thus, Summerhouse would likely qualify for a 50% state cost share of post-construction physical monitoring.

5.5.2.3 FIND Waterway Assistance Program

FIND and the Florida Legislature (authorized by Section 374.976, FS, and administered under Chapter 66B-2, FAC) established the Waterway Assistance Program (WAP) to annually support increases in public access associated with the ICWW and associated waterways within the FIND's 12 eastern Florida counties, including St. Johns County. Local governmental agencies — municipalities, counties, port authorities and special taxing districts located within the 12 counties — can seek support for waterway projects located on natural, navigable waterways. Projects may include navigation channel dredging and activities associated with channel markers, navigation signs or buoys, boat ramps, docking facilities, fishing and viewing piers, waterfront boardwalks, inlet management, environmental education, law enforcement equipment, boating safety programs, beach renourishment, dredge material management, environmental mitigation, and shoreline stabilization. FIND can provide up to 75% funding for public navigation projects and up to 50% funding for all other eligible projects.

As intimated above, FIND could have an interest in inlet management plan development and implementation to reduce the frequency and quantity of dredging at ICWW near Ft. Matanzas, one of the highest shoaling areas of ICWW in the state. The County could approach FIND through the WAP to support any cost shares for first, performing a study, and second, implementing any plan recommendations.

FIND allocates approximately $10-12 million dollars annually for the program, and the legislative limit on project funding is equal to the tax revenue that FIND receives from the county in which the applicant locates. Grant applications are due toward the end of March with funding for those projects approved by the FIND Board of Commissioners becoming available on October 1. Given the above-mentioned annual funding availability and funding limitation as well as the number of counties along the Florida east coast eligible for grant funding, WAP grants will likely remain relatively small in comparison to the conceptual cost estimates presented in **Table 5.2**.

5.6 Discussion

From the array of project possibilities and funding partners, the most prudent avenues for the BOCC to explore include (1) requesting the USACE perform a study on the shorelines north of the inlet to determine whether a federal interest exists in protecting these properties from coastal storms and (2) supporting development of an inlet management plan for Matanzas Inlet. The County has already begun the first by requesting USACE study Butler and Crescent beaches from R-151 south to the Matanzas Inlet, including Summerhouse. This study could lead to future projects on the Summerhouse and adjacent northern beaches. As documented in this report, Summerhouse could indirectly benefit from beach fill projects placed near its beach even if its beachfront does not receive direct sand placement. After executing a project partnership agreement with the USACE and having federal funds available to begin, the County can expect to contribute up to $1.5 million in financial or in-kind services to the study efforts. The County can help reduce some of its local sponsor cost by applying for state funding through the FDEP's BMFA program.

The County could concurrently explore serving as a potential local sponsor for developing and implementing an inlet management plan at Matanzas Inlet with the help of state funds through the FDEP's BMFA and FIND's waterway assistance programs. Although not a traditional navigation inlet, Matanzas Inlet is a man-influenced inlet given the southern bridge abutment of the bridge over the inlet and the revetted south inlet and Summer Haven shorelines limit the natural migration of the inlet. While not necessarily alleviating their full issues, Summerhouse and Summer Haven beaches could both benefit from the bypassed material. The flood shoal could serve as source for bypassing (and simultaneously relieve hydraulic stresses on the inlet's south shoreline). The current practice of placing ICWW material on the Summer Haven beaches could also help meet any bypassing objectives. However, that finer material may prove better suited for the beaches north of the inlet given its material is relatively fine. Finally, any dredging and bypassing of the materials could lessen the shoaling rate within the ICWW, potentially benefiting FIND. As such, FDEP, FIND (through its WAP), and the County could potentially cost share in a solution that addresses numerous sediment management issues within the Matanzas Inlet area. An inlet management study would likely cost approximately $500,000 to conduct.

Of note, Section 161.142, FS declares the state's public policy relating to improved navigation inlets as follows:

"The Legislature recognizes the need for maintaining navigation inlets to promote commercial and recreational uses of our coastal waters and their resources. The Legislature further recognizes that inlets interrupt or alter the natural drift of beach-quality sand resources, which often results in these sand resources being deposited in nearshore areas or in the inlet channel, or in the inland waterway adjacent to the inlet, instead of providing natural nourishment to the adjacent eroding beaches. Accordingly, the Legislature finds it is in the public interest to replicate the natural drift of sand which is interrupted or altered by inlets to be replaced and for each level of government to undertake all reasonable efforts to maximize inlet sand bypassing to ensure that beach-quality sand is placed on adjacent eroding beaches. Such activities cannot make up for the historical sand deficits caused by inlets but shall be designed to balance the sediment budget of the inlet and adjacent beaches and extend the life of proximate beach-restoration projects so that periodic nourishment is needed less frequently."

Appendix E contains FDEP's protocol for implementing an inlet management plan. Much of the data collection and analysis pertaining to the sediment budget presented INTERA-GEC (2023) and the area of inlet influence analysis presented herein are applicable to inlet management plan development. However, additional inlet-focused analyses are required to refine the inlet area of influence (including examining more time intervals and methods) and evaluate specific inlet management strategies.

6.0 Summary

Historically, the dune system fronting Summerhouse consisted of a wide series of three dunes with varying crest elevations. Before 2016, storms would erode some beach and dune but follow up with some beach recovery (like after the 2004 hurricane season). However, Hurricane Matthew, which caused significant erosion of the beach and dune system when it moved along Florida's east coast in October 2016, started the pattern of the beach unable to fully recover. With the remaining beach and dune system in an eroded state after Hurricane Matthew, the system became more vulnerable to more frequent, less intense storms including numerous northeasters and other named tropical systems like Irma (2017), Dorian (2019), Ian (2022), and Nicole (2022). Through analyses performed by INTERA (2020), the southernmost oceanfront buildings (15,16, and 20) met the FDEP's standard of eligibility for coastal armoring. In response to Hurricane Matthew, the County utilized Federal Emergency Management Agency (FEMA) Category B funds to place small quantities of fill to provide protection from a high frequency storm event. The fill alleviated the need for coastal armoring at the time. Post-Nicole observations show that some of this FEMA sand remained after the storm, while increased localized erosion occurred just south of building 20 due to the interaction of waves with the Fort Matanzas beach access ramp during high tide.

Because of the ongoing erosion occurring both south and north of the Matanzas inlet, St. Johns County BOCC commissioned this study to analyze the impact of inlet on surrounding properties, including Summerhouse, as well as identifying potential solutions to protect the Summerhouse property. Developing environmentally and financially sustainable long-term solutions requires a thorough understanding of the area's existing conditions, coastal processes, and the dominant processes that lead to the ongoing erosion.

Over the long-term, stronger flood tidal flows, because of the Matanzas inlet's location relative to St. Augustine and Ponce de Leon inlets, likely deposit more sediments inside the inlet than the ebb tidal flows remove. This net imbalance allows the flood shoals inside the inlet to grow with sand intended for the Summerhouse and Summer Haven beaches. With lesser amounts of sand reaching these beaches, they become more susceptible to storm-induced erosion as the beach is generally narrower and lower over time in the presence of storms. The lack of a wide dry beach can also contribute to the lack of or relatively small post-storm dune recovery in these areas.

Based on an understanding of the Matanzas Inlet and surrounding areas, this study identified two, potentially permissible (from an environmental regulatory standpoint), engineering solutions. They include:

- <u>Seawall</u>. This alternative intends on protecting building 20 and consists of locating a seawall approximately 30 ft seaward of the building footprint. The seawall concept consists of steel sheet pile with deadman anchors and concrete caps. The seawall reaches an elevation of +16 ft NAVD88. The seawall would have a length of approximately 300 ft including wingwalls. Conceptual initial and 50-yr maintenance costs, in 2023 present worth equivalents, equal approximately $1.24 million and $0.28 million, for a total of $1.52 million; and

- Beach and dune nourishment. This alternative consists of restoring a portion of the secondary dune and completely restoring the seaward tertiary dune that were eroded during Hurricane Matthew. The secondary dune crest reaches an elevation of +18 ft NAVD88 and the tertiary dune crest reaches +10 ft NAVD88 to match the peak historical dune conditions. The beach consists of a 118-ft wide beach crest at elevation +10 ft NAVD88 with a 10H:1V seaward slope until matching existing grade for a total initial nourishment volume of approximately 75,600 cubic yards. The beach fill would extend approximately 1,400 ft along the Summerhouse property. Conceptual initial and 50-yr maintenance costs, in 2023 present worth equivalents, equal approximately $5.79 million and $47.1 million, for a total of $52.89 million. Sand sources may consist of material from commercial inland sand mines, Matanzas Inlet flood shoal, or offshore sources (if quantities significantly increase).

The above solutions represent privately funded options and do not require BOCC actions to implement given their confinement to the Summerhouse property. The BOCC would likely become involved in the beach and nourishment alternative only should the project have regional benefits such as those associated with projects that span multiple properties or whose construction help alleviate other issues within the Matanzas Inlet area. As such, possible BOCC actions could include:

- Request to USACE to study Butler and Crescent beaches from R-151 south to the Matanzas Inlet. This study could lead to future projects on the Summerhouse and adjacent northern beaches. Summerhouse could indirectly benefit from beach fill projects placed on adjacent beaches even if no government-sponsored beach project occurs directly on its beach as the beach fill spreads the fill material alongshore beyond the project area to the adjacent beaches. After executing a project partnership agreement with the USACE and having federal funds available to begin, the County can expect to contribute up to $1.5 million in financial or in-kind services to the study efforts. The County can help reduce some of its local sponsor cost by applying for state funding through the FDEP's BMFA program; and
- Initiate a formal inlet management plan study. This study would help manage the ongoing erosion issues on both sides of the inlet. While not necessarily alleviating their full issues, Summerhouse and Summer Haven beaches could both benefit from the bypassed material. In addition to the ICWW material, the inlet's flood shoal could potentially serve as a source for bypassing. Any dredging and bypassing of the materials could lessen the shoaling rate within the ICWW, potentially benefiting FIND. Study costs would likely approach approximately $500,000. Costs to the BOCC may lessen through receipt of funds through the FDEP's BMFA program and FIND's WAP.

The County will likely have to leverage funds from various local, state, and possibly federal sources to implement these regional approaches. Sources may include raising local revenues through special purpose taxes and seeking state and federal programmatic funds and grants.

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Appendix A

Public Comments

1) October 10, 2022 Town Hall Meeting Notes
2) Comments Submitted by Summerhouse on August 24, 2023 Regarding the Draft Report
3) Comments Provided by Summerhouse Following the September 13, 2023 Meeting

October 10, 2022 Town Hall Meeting Notes

- Met with Dunes Committee and HOA board president
- Malcolm Fabre, board president, shared some opening remarks
- Mike Krecic gave INTERA-GEC presentation
- Public Comment Summary:
  - Summerhouse would like its shoreline to receive FDEP critical erosion area designation
  - Damon Douglas indicated that the County is seeking FEMA funds for emergency dune repairs after passage of Hurricane Ian (2022) in September
  - Approximately 250 homeowners in Summerhouse complex
  - Study assessing BOCC options
  - Some structures north of Summerhouse are dangerously close to collapsing
  - Is the Matanzas vehicular access ramp causing issues?
  - Can Summerhouse beach be used for pilot project site?
  - What about USACE CAP funding?
  - A USACE feasibility study is possible with post-Ian money
- Copy Damon Douglas on email portal to provide information

Comments Submitted by Summerhouse on August 24, 2023 Regarding the Draft Report

Executive Summary

1. Paragraph 1.
    a. To the sentence "The fill alleviated the need for coastal armoring.", add "… at that time".

       Response: Edit made.

    b. The purpose of the study should include 3) Assess whether the Matanzas Inlet has a contributing impact to the erosion noted on the north side of the inlet where Summerhouse is located. Rationale: The subject was discussed and agreed to at the initial meeting with Summerhouse and is covered in Section 4.3 Alongshore Area of Influence.

       Response: Added the following underlined text in the first paragraph of the Executive Summary: "…and (2) a list of potential projects<u>, which consider the potential effects of Matanzas Inlet on the adjacent beaches,</u> to address beach erosion threatening the Summerhouse complex north of Fort Matanzas.

    c. While not specifically covered in the initial scope of the study, the impact of Fort Matanzas beach continuing erosion (without mitigation) between the Matanzas ramp and Building 20 (Summerhouse southern-most oceanfront building) has a direct impact on Summerhouse beach erosion at that building. The "swirling impact" of waves hitting the dunes during storms at high tide causes much more erosion to occur at Building 20. This was shown anecdotally during the last series of storms in 2022 where FMEA sand was placed. Only 5' of dunes remain at the southern-most end of Building 20 compared to 20' or more north of Building 20. The situation has a direct impact on the study recommendations covered in the next two paragraphs of the Executive Summary.

       Response: Comment acknowledged. While the ramp may contribute to localized erosion between the ramp and building 20, the localized erosion is just a contributing part of a greater degree of regional erosion caused by storms and inlet effects. However, monitoring of the localized erosion may be warranted to observe any encroachment of dune erosion towards building 20 that may warrant mitigation (e.g., placement of fill trucked from an upland source).

2. Paragraph 2.
    a. Both recommendations listed (seawall for Building 20 only and a small-scale beach nourishment across 1,400 of Summerhouse's beachfront) would be problematic for Summerhouse. Both costs and feasibility of success are the primary reasons. Without a comprehensive solution like that recommended in Paragraph 3 (including participation by the NPS Matanzas Park and other stakeholders), the recommendations will not be successful. It is not a good use of public or private funds.

       Response: We understand the expressed concerns. Notably, the two alternatives represent the two currently feasible privately funded solutions identified by the study to provide storm protection to Summerhouse. The study presents these for Summerhouse's consideration and study completeness.

3. Paragraph 3.
    a. Good summary of potential study plans. However, the NPS as a stakeholder and participant needs to be included in any study plan.

       Response: Comment acknowledged. Coordination with NPS would occur during a federal study.

4. Paragraph 4.
    a. Again, good summary of implementation actions by local, state, and federal agencies to address erosion issue north of the inlet. As mentioned previously, NPS should be included as a stakeholder.

       Response: Comment acknowledged. Coordination with NPS and other stakeholders would occur during future studies.

Section 1.0 Introduction

- Expand purpose of study to include: Assess whether the Matanzas Inlet has a contributing impact to the erosion noted on the north side of the inlet where Summerhouse is located.

  Response: Added the following underlined text in the first paragraph of the Executive Summary: "…and (2) a list of potential projects<u>, which consider the potential effects of Matanzas Inlet on the adjacent beaches, </u>to address beach erosion threatening the Summerhouse complex north of Fort Matanzas.

1.1 Study Purpose and Scope

- First Paragraph 3rd to last sentence. Add: "… at that time."

  Response: Edit made.

- First Paragraph 2nd to last sentence. Suggest modifying sentence to say: "While some FEMA sand remained after Nicole along the Summerhouse beach, it was observed anecdotally that the "swirling action" of waves hitting the dunes between the Matanzas Park ramp and Building 20 (where no FEMA sand was placed) during Nicole at high tide caused much more erosion to occur at Building 20 at its southern end compared to other portions of Summerhouse's beach."

  Response: Added the following underlined text: "Post-Nicole observations show that some of this FEMA sand remained after the storm<u>; however, anecdotal evidence suggests that the interaction of waves with the Fort Matanzas beach access ramp during high tide exacerbated the dune erosion between the ramp and building 20</u>.

- While not covered specifically in this study, this "swirling action" of the waves that occurs between the ramp and Summerhouse's Building 20 where no FMEA sand was added, we suggest further study should be considered as it contributes to the erosion process. Inputs into this analysis could include (among others): 1) the Crescent shape of the southernmost portion of Crescent Beach; 2) potentially stronger wind speeds at the Southernmost part of Crescent Beach; and 3) the impact of dredging of the river next to the Inlet that potentially creates a suction-effect in taking sand from the Inlet to fill the sand void in the river with no exit path. The results of this analysis may prove useful for incorporation into the Inlet Management Plan discussed further in the study.

Response: Comment acknowledged. Of note, Section 4.4 of the study discusses the inlet's sand-trapping effect.

Section 2.0 Beach Management History

2.1 Summerhouse Dune and Beach System History

- Good thoroughly-written section – Explains how Summerhouse got from normal dune conditions to where we are today.

  Response: Comment acknowledged.

- Figure 2.10 – Suggest expanding nomenclature on graph to show date and after which storm for clarity. For example, orange line says, "post Irma", suggest it should say "Post Irma 2017". Also, include in title: "At Range Monument 193"

  Response: Edits made — added "Oct 2021" to the FEMA as-built label and "Sept 2017" to the post-Irma label, as well as "Reference Monument R-193" to the figure caption.

- Not sure where this should go in Study, but it may be prudent to say that the beach from the Matanzas Inlet north including Summerhouse has been designated as "Critically Eroded" in the 2023 edition of the FDEP Critically Eroded Beach Report. This is an important designation for Summerhouse as our beach is now recognized by FDEP for inclusion in their BMFA (Beach Management Assistance) program. Will expand opportunities for State and Federal funding going forward.

  Response: Added the following sentences to Section 2.1, second to last paragraph of the section. "In light of the persistent erosion, the FDEP (2023a) recently designated 4,000 ft of beaches north of the inlet, including Summerhouse's beaches, as critically eroding. Practically, this designation by the state makes the Summerhouse shoreline eligible for up to 50% cost-sharing from the state for all costs related to beach management activities. In addition, this designation makes a federal beach project more attractive given the state has already determined a need for some action to occur. See the Chapter 5 for additional information."

  Added the following underlined text to the second paragraph of Section 5.1.4: "In general, FDEP supports beach nourishment pursuant to Section 161.161, FS and 161.091, FS, which require FDEP to develop and maintain a comprehensive long-term beach management plan for the restoration and maintenance of the state's critically eroded beaches<u>, which includes Summerhouse FDEP (2023a)</u>, that…".

  Also added the following underlined text to Section 5.5.2.2: "The FDEP's Strategic Beach Management Plan (FDEP, 2023b) does not address the Summerhouse shoreline<u>, as FDEP only recently, in July 2023, designated Summerhouse and adjacent beaches (i.e., R-192 to R-196) as a critically eroded shoreline</u>." Additionally, updated the reference to the Strategic Beach Management Plan to reflect the final rather than draft plan.

2.3 Topographic and Bathymetric Survey Data

- First Paragraph and Figure 2.13. What conclusions/observations can be drawn from this critical (and expensive) work in understanding the impact of the inlet on the surrounding beach and dunes? Please expand this section if possible and articulate what it means to the overall study effort.

Response: Section 4.3 and 4.4 discuss the inlet's influence on adjacent beaches.

- Table 2.1. Suggest the survey taken by Atlantic Surveying in mid-2020 be included in the table. It was instrumental in FDEP designating Buildings 20, 16 and 15 as being considered vulnerable to a 15-year storm event as well as the Slope Stability Analysis completed by INTERA-GEC.

Response: Table 2.1 includes the Atlantic Surveying, but it mistakenly stated "n/a" as the source. Corrected the source of the 2020 survey in Table 2.1.

- Paragraphs 3 and 4. Suggest articulating whether the historical survey data was useful to draw any conclusions impacting the study results. If yes, how? If no, why not?

Response: Added the following sentence at the end of Section 4.3: "Chapter 4 further discusses data used in this study to determine the historical trend of beach and shoreline erosion and the inlet's effects on adjacent beaches".

3.0 Site Characteristics

3.2.3 Coastal Barrier Resources

- First Paragraph. Does the Coastal Barrier Resources Act prohibit the NPS Matanzas Park area designated "OPA P05AP" from using Federal funds for beach and dune nourishment that could ultimately benefit adjacent properties (e.g., Summerhouse)? Same question if funds used are not from the Federal government allowed?

Response: No. The OPA only would prevent federal spending on flood insurance.

3.3.1 Native Beach Sediment

- Good summary of where sand sources are currently located.

3.3.2.2 Intracoastal Waterway

- Please clarify – Sediment gathered via dredging the inlet for use as fill by Summerhouse and other nearby properties cannot be paid for using Federal funds funneled through the USACE. However, if paid for by some entity (e.g., local, state, private), the dredged sand can be used to build as fill material. Is this correct?

  Response: No. USACE can potentially place sand dredged from the ICWW onto the Summerhouse shoreline; however, the incremental increase in cost to shape the fill into a dune, as opposed to the least cost berm, is typically required to be funded by a non-federal stakeholder.

- The remaining portions of Section 3.0 are well done and could provide excellent input as to available sources of fill sand to support a long-term Beach and Dune nourishment plan for the properties north of the inlet (including Summerhouse) as shown in Section 5.0 of the report.

Response: Comment acknowledged.

4.0 Beach and Dune Conditions

4.1 MHW Shoreline Changes

- Great data collection and segmenting of data into 4 groups. Relative to analyzing the full impact of inlet on Summerhouse, a summary statement should be added that states that compared to MHW data collected further up north of Summerhouse (R189+), it appears the inlet has a greater influence on dunes recession at Summerhouse and the Matanzas Park just south of Summerhouse. The rash of storms that occurred between 2016 and 2022 further supports the point.

  Response: Added the following summary at the end of Section 4.1: "Overall, the 1984–2022 and 2007–2022 shoreline changes reveal a general trend of decreasing shoreline recession magnitudes northwards away from the inlet, suggesting the inlet contributes to the documented erosion along the Fort Matanzas National Park and Summerhouse shorelines."

4.2 Beach Volume Changes

- Suggest that the summary of data should state: "While the volume changes at R193 were minimal for both periods, data points just south of Summerhouse (at the Matanzas National Park) show significant erosion." This supports why Summerhouse's southernmost buildings (Building 20 in particular) show greater erosion. Again, support is needed for the NPS to become a partner in seeking solutions to mitigate erosion immediately north of the Park.

  Response: Added the following summary at the end of Section 4.2: "Overall, erosion of the dry beach (i.e., above MHW) occurred at Summerhouse over both the short and long terms. While the short-term volume changes at R-193 (i.e., center of Summerhouse property) were minimal, significant erosion occurred along the profiles immediately north and south of Summerhouse."

4.3 Alongshore Area of Inlet Influence

- Figure 4.6 Not sure why this is included in study due to the period chosen (1923-1986). Is it to show in earlier years the area north of the inlet grew in sediment vs. south of the inlet? Need to clarify.

  Response: Added the following sentence to the end of the 3rd paragraph of Section 4.3: "Their analysis demonstrates that the inlet's area of influence extends more than two miles north of the inlet."

- Figure 4.6 and related discussion. While somewhat difficult to follow, the results seem to confirm the inlet does impact the loss in dune (sand) volume north (including Summerhouse) and south of the inlet. If correct, suggest that it be stated in the summary sentence.

  Response: Expanded on the analysis and added to the discussion in Section 4.3.

4.4 Discussion

- First Paragraph. Good discussion. Is there supporting data available showing the net imbalance between tidal flow inward versus ebb flow outward (such as a shoal volume growth chart if available)? This would help confirm the inlet's sand-trapping effect is preventing sand growth both south and north (including Summerhouse) of the inlet.

Response: Due to the lack of good historic bathymetry data, such supporting information is not available.

- Second Paragraph. Seems to imply the loss of sand is primarily due to storm-induced erosion where the sand ends up in the inlet. If this is correct, it would still support the fact that the inlet being there, results in net erosion both north (and south) of the inlet. Correct? If yes, maybe state that in clearer terms. Also, are there any data charts from the sediment budgets completed by INTERA-GEC that could be included?

  Response: Added the following sentence at the end of the paragraph: "These results indicate the degree of erosion caused by the inlet may fluctuate depending on meteorological conditions, but inlet-induced erosion of the beach at or abutting Summerhouse appears to have occurred during all periods analyzed in this study."

- Last Paragraph. Suggest the first sentence be modified to say: "Based on the assessments included in this study (shoreline and volume changes, even/odd analyses, etc.) the inlet's possible influence …. appears to include Summerhouse beaches."

  Response: Added the following underlined text: "Based on an assessment of the inlet's possible influence on beaches north and south of the inlet<u>, as well as analysis of short- and long-term shoreline and beach volume changes,</u> the extent of the inlet's influence alongshore appears to include the Summerhouse beaches.

5.0 Identification and Evaluation of Potential Actions

5.1 Initial Screening of Potential Engineering Alternatives (including all sub-sections)

- This section is well done as it covers all known potential engineering solutions to the problem of erosion north (and south) of the inlet, including Summerhouse. This discussion, along with Sections 5.2, 5.3 and 5.4, provides much needed background data to make an educated decision on which alternative makes the most sense to pursue for addressing erosion issues surrounding the Matanzas Inlet.

  Response: Comment acknowledged.

5.2.2 Beach and Dune Nourishment

- Thinking this through after seeing Figures 5.9, 5.12 and 5.13 and the ensuring discussion, it becomes clear that the Beach and Dune Nourishment alternative will only work effectively if the adjacent properties north and south of Summerhouse (NPS Matanzas Park) participates in the long-term project. With only Summerhouse 1,400' of coverage, in 3 years the sand could disappear making Summerhouse oceanfront buildings subject to vulnerability. Renourishment could be extended several years if the project includes the adjacent properties to the greatest extent possible. It is therefore important that when soliciting state and federal funding discussed in Section 5 that this be a cooperative initiative with adjacent neighbors participating – particularly the NPS Matanzas Park (given the vulnerability of Summerhouse Building 20). Suggest this be reiterated and reinforced in the Beach and Dune Nourishment alternative summary somehow that multiple stakeholders are needed to make this alternative work over the long-term.

Response: Added the following paragraph at the end of Section 5.2.2: "<u>In summary, a small-scale beach restoration project covering the Summerhouse property could potentially provide sufficient storm protection, but the short project length results in rapid dispersion of fill and frequent renourishments to maintain the protective berm. A larger scale project spanning adjacent properties could significantly improve project longevity and prove more cost-effective; however, such a project would require a detailed study (see Section 5.5.1.1) and cooperation among multiple entities potentially including USACE, FDEP, the County, the National Park Service, and other adjacent property owners</u>."

Section 5.5 Potential Funding Sources

- This is an excellent summary for identifying potential funding. While Beach and Dune Nourishment appears to be the best long-term solution, it must be recognized that the problem is largely due to proximity of adjacent properties, including Summerhouse and the National Park to the inlet. As such, the solution needs to include an Inlet Management Plan developed by the state with the cooperation of the federal government.

  Response: Comment acknowledged.

5.5.2.2 FDEP Beach Management Funding Assistance Program

- While not known at the time this study draft was developed, the FDEP now recognizes that the beach in front of Summerhouse (and the NPS property) to be critically eroded (see FDEP Critically Eroded Beaches Report for 2023). The FDEP Beach Management Plan will need to be updated to address the new critically eroded beach designation north of the inlet. As such, it appears to be the best course of action to follow is through the FDEP-defined programs per Florida Statutes 161.101 and 161.161. Additionally, as defined in Florida Statute 161.143, FDEP needs to develop an Inlet Management Plan for the Matanzas Inlet for the purpose of mitigating the erosive effects of the inlet on surrounding properties including Summerhouse and other properties north (and south) of the inlet. Suggest that the final study be updated to include the critically eroded beach designation.

Response: Added the following underlined text to Section 5.5.2.2: "<u>The FDEP's Strategic Beach Management Plan (FDEP, 2023b) does not address the Summerhouse shoreline, as FDEP only recently, in July 2023, designated Summerhouse and adjacent beaches (i.e., R-192 to R-196) as a critically eroded shoreline</u>." Additionally, updated the reference to the Strategic Beach Management Plan to reflect the final rather than draft plan.

6.0 Summary

1. Paragraph 1. Suggest the last sentence be modified as follows: "While Post-Nicole observations did show some of the FEMA remained after the storm, further observations showed erosion at the southernmost end of Summerhouse Building 20 was greater than the remainder of Summerhouse's beach. The swirling action of title waves occurring between the Matanzas ramp and Building 20 (where no FMEA sand was placed) during recent storms is thought to be a major contributing factor to the potential demise of Building 20."

   Response: Added the following underlined text to the last sentence: "Post-Nicole observations show that some of this FEMA sand remained after the storm<u>, while increased localized erosion</u>

occurred just south of building 20 due to the interaction of waves with the Fort Matanzas beach access ramp during high tide."

2. Paragraph 2. Suggest modifying the first sentence as follows: "Because of the ongoing erosion occurring both south and north of the Matanzas inlet, St. Johns BOCC commissioned this study to analyze the impact of inlet on surrounding properties, including Summerhouse, as well as identifying potential solutions to protect the Summerhouse property."

   Response: Edits made as follows: "Because of the ongoing erosion occurring both south and north of the Matanzas inlet ~~around the inlet~~, St. Johns County BOCC commissioned this study to analyze the impact of inlet on surrounding properties, including Summerhouse, as well as identifying potential solutions to protect the Summerhouse property ~~identify potential solutions that will protect the Summerhouse property in addition to other objectives~~."

3. Paragraph 3. This is an excellent paragraph. Suggest including the essence of this paragraph in the Executive Summary.

   Response: Added the following paragraph to the Executive Summary: "Summerhouse lies within Matanzas Inlet's area of influence, which, in general, experiences beach erosion due to the inlet's sand-tapping effect. Over the long-term, stronger flood tidal flows deposit more sediments inside the inlet than the ebb tidal flows remove. This net imbalance allows the flood shoals inside the inlet to grow with sand that otherwise, without the presence of the inlet, would reach the Summerhouse and Summer Haven beaches. With lesser amounts of sand reaching these beaches, they become more susceptible to storm-induced erosion as the beach is generally narrower and lower over time in the presence of storms."

4. Paragraph 4. Suggest modifying the first sentence to say: "Based on an understanding of the impact the inlet has on the surrounding areas including Summerhouse, this study…"

   Response: Comment acknowledged; however, no changes made to the report. The list of potential solutions is based on a broader knowledge of the behavior of the inlet and adjacent beaches, not just the inlet's impacts. (Original sentence: "Based on an understanding of the Matanzas Inlet and surrounding areas, this study identified two, potentially permissible…")

5. Seawall: As mentioned in the Executive Summary comments, Summerhouse believes a partial seawall covering Building 20 only is problematic as presented. Based on what occurred at Daytona Beach during hurricane Ian (or Nicole not sure) in 2022, homes with seawalls still were damaged or destroyed. Tidal wave surges eventually worked their way around the backside of the seawalls causing sand to erode and buildings to collapse due to adjacent properties not being protected (with sand or a complementary seawall). The same could occur at Summerhouse with only Building 20 being protected with a seawall. We are concerned the adjacent National Park property not being fortified in some manner will eventually cause problems for Building 20, even with a seawall. A more complete solution with all stakeholders being involved (including NPS) is a more viable solution. As such, Summerhouse supports the next bullet point, Beach and Dune Nourishment, with some important modifications.

   Response: Comment acknowledged.

6. Beach and Dune Nourishment. The engineering solution as presented as a privately funded endeavor is not feasible due to costs (absorbed privately by Summerhouse we assume) and

lengthy and challenging permit approval process by multiple government agencies. However, the technical details presented are well done and make sense and should be considered as a long-term solution. Success can best be guaranteed if tackled by multiple stakeholders -- local, state and federal government entities.

Response: Comment acknowledged.

7. Paragraph 5 (and 6). Since the study has done an excellent job (within the St. Johns County's study budget) identifying that the inlet is a contributing factor to the surrounding area dunes erosion, including Summerhouse, the focus must be on a joint effort. The two actions presented in the next two bullet points in the study appear to be reasonable and should be pursued by St. Johns County. Request that NPS be included as a stakeholder in both efforts as they need to be part of the long-term solution.

   Response: Comment acknowledged. Future studies would approach the NPS as a stakeholder.

Comments Provided by Summerhouse Following the September 13, 2023 Meeting

The following summarizes the documents uploaded to the public portal.

- I am surprised and skeptical that "beach nourishment" costs so much more than "seawall" (initial costs $5.8M vs $1.2M and 50 year costs of $53M vs $1.5M).

  Response: Comment acknowledged. The costs presented in the report are reasonable conceptual-level costs.

- For an apples-to-apples comparison, the seawall should include all Summerhouse buildings, not just building 20.

  Response: The study included a seawall at building 20 only, because that is the only building currently vulnerable, as defined by FDEP standards, and potentially eligible for a seawall. The second footnote of Table 5.2 states a seawall to protect the entire 1,400-ft-long Summerhouse oceanfront could cost $7.02 million ($5.73 million initial cost plus $1.29 million maintenance cost).

- I think a seawall in just front of building 20 would not be effective and would cause problems on adjacent beach areas.

  Response: INTERA-GEC agrees that, once exposed to wave action, a seawall may cause erosion to adjacent areas. See comment above regarding seawall eligibility.

- I favor the proposal to use excess sand accumulating in Matanzas inlet to nourish the beach in front of Summerhouse.

  Response: Comment acknowledged.

Appendix B

SBEACH Cross-shore Erosion Modeling Summary

Introduction

This study employed the USACE Storm Induced Beach Change (SBEACH) cross-shore sediment transport model (Larson and Kraus, 1989a; Larson and Kraus, 1989b; Rosati et al., 1993) to predict beach profile change due to cross-shore transport of sediment under changing water levels and breaking waves. For present purposes, the model simulates potential storm-related dune and beach erosion for 25-, 50- and 100-yr storms for the dune only and dune and beach nourishment alternatives.

SBEACH, a two-dimensional cross-shore model, applies input parameters describing the physical characteristics of a storm event to predict the adjustment of a pre-storm to a post-storm beach profile. SBEACH simulates wave-induced erosion as well as formation and movement of offshore bars and troughs and accounts for hardbottom or seawall effects on dune and beach erosion. The model accommodates variable grid spaces, time-dependent water levels and wave characteristics, wave refraction and runup, water level setup due to breaking waves (wave setup) and wind (wind setup), and sediment overwash. As SBEACH only simulates beach erosion due to short-term events (storms), model results provide no indication of long-term trends of cross-shore sediment transport. The model neglects simulation of any longshore sediment transport processes.

Model simulations require a pre-storm beach profile, storm information for the duration of a storm event, and sediment transport parameters. The pre-storm beach profile input requirements include a pre-storm beach profile and sediment grain size. The storm information includes wave height and period and water level (storm surge) hydrographs for the duration of the storm event. Simulations did not apply the optional model input of wave direction and wind direction and speed. Additionally, input beach profiles for the SBEACH simulations excluded application of the hardbottom location feature.

Model Calibration

To calibrate the model, this study assessed pre- and post-Hurricane Matthew (2016) profiles at R-193 near Summerhouse Beach & Racquet Club on the north side of Matanzas Inlet. Hurricane Matthew produced measurable beach profile changes captured by the June and November 2016 beach profiles (Figure 1). The figure shows some placement of sand at the secondary dune near elevation +15 ft NAVD88 that SBEACH excludes. Wave and water level conditions originate from INTERA's SWAN+ADCIRC hindcast of Hurricane Matthew completed for multiple Florida clients. Figure 2 shows the wave heights and periods offshore the study area and the water levels during Hurricane Matthew.

The SBEACH model allows for calibration of four main parameters: the transport rate parameter (K), the slope-related sand transport rate parameter (ε), the spatial decay coefficient (λ), and the avalanching angle (Φ). The transport rate parameter governs the magnitude of sediment transport directly and influences the response time of the beach profile. Smaller values of K lead to longer time scales for equilibrium whereas larger K values result in faster response times and more beach erosion and larger offshore bars. The slope-related transport rate parameter mainly influences the bar volume with larger values of ε resulting in more subdued bars. The spatial decay coefficient influences the rate of decay of transport seaward of the break point with smaller values of λ resulting in slower rates of decay. The avalanching angle influences the steepness of the eroded profile with larger values causing steeper profiles. The first two parameters discussed above represent the main calibration parameters (Rosati et al., 1993). Table 1 presents the range of these and other adjustable parameters.

Figure 1 Pre- and Post-Storm Profiles at R-193 for Hurricane Matthew

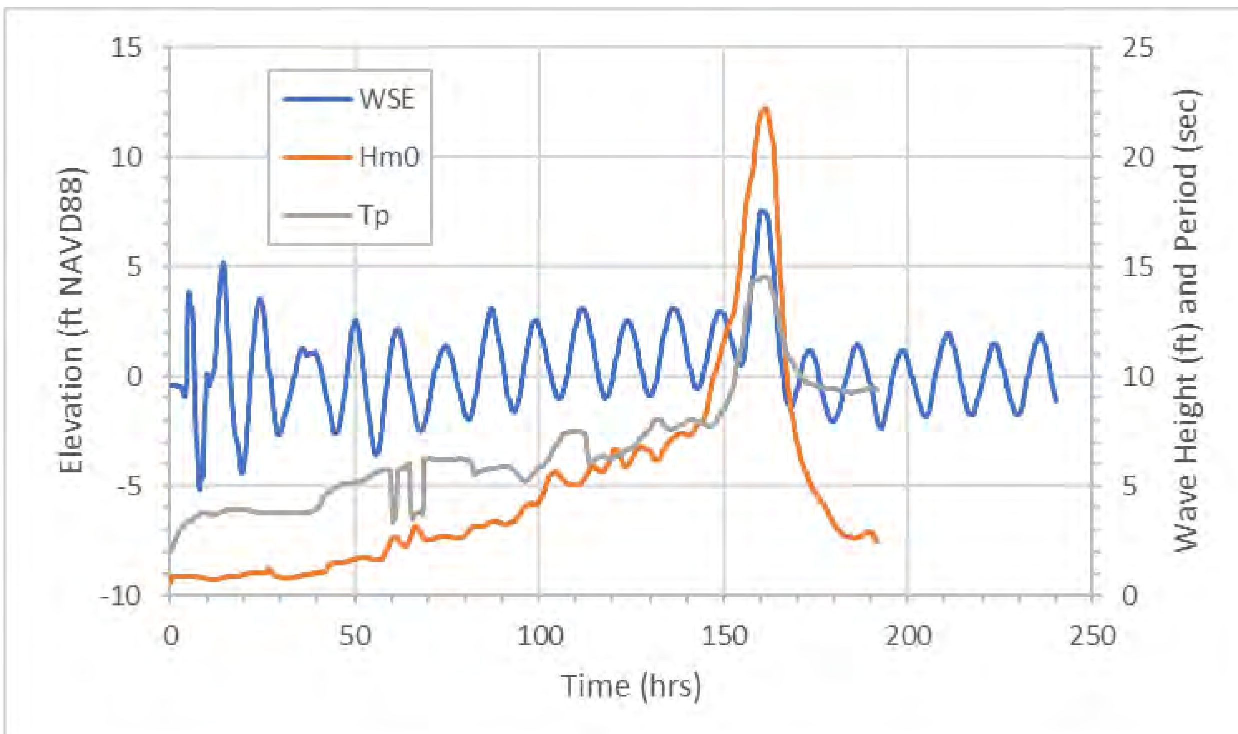

Figure 2 Hindcasted Waves and Water Levels for Hurricane Matthew

Table 1 SBEACH Parameters

Parameter	Symbol	Units	Default Value	Suggested Parameter Range	R1	R2	R3	R4
Transport Rate Coefficient	K	m^4/N	$1.75 * 10^{-6}$	$0.25 * 10^{-6} – 2.5 * 10^{-6}$	$2.50 * 10^{-6}$	$2.50 * 10^{-6}$	$2.50 * 10^{-6}$	$2.50 * 10^{-6}$
Slope Dependent Term	ε	m^2/s	0.002	0.001 – 0.005	0.005	0.005	0.005	0.005
Transport Rate Decay Coefficient	λ	1/m	0.5	0.1 – 0.5	0.5	0.5	0.5	0.1
Overwash Transport Parameter	Over	---	0.005	0.002 – 0.008	0.005	0.005	0.005	0.005
Avalanching Angle	Φ	deg	45	15 – 90	45	45	45	45
Cross-shore Spacing	DXc	ft	---**	---	5 – 20	5 – 20	5 – 20	5 – 20
Median Grain Size	D50	mm	---	0.15 – 1.0	0.25	0.25	0.23	0.23
Water Temperature	Temp	deg C	20	0 – 40	27	27	27	27
Landward Surfzone Depth	---	ft	1	0.05 – 1.6	1	1.6	1.6	1.6

**Applied 0.25 mm

FDEP (2009) provides SBEACH calibration parameters for high frequency storms around the state including on both sides of Matanzas Inlet (Table 2). These parameters generally served as starting points for this study's calibration effort.

The model setup included inputting the pre-Matthew beach profile from the back beach/dune offshore to an elevation of approximately -40 ft NAVD88, approximately 3,500 ft offshore. A variable grid spaced five feet across the active beach profile and 20 ft across the deeper beach profile represented the beach profile at R-193.

Figure 3 shows the measured and predicted contour changes from the pre-Matthew condition for the SBEACH simulations with default parameters and parameters indicated by columns R1-R4 in Table 1. This figure shows that all tested parameters produce results that underestimate the measured contour changes. However, the parameters represented by R4 best match the measured contour changes after Hurricane Matthew. Therefore, this study adopted those parameters for modeling hypothetical storms. Figure 4 shows the SBEACH results with the R4 parameters and the measured post-Matthew profile.

Table 2 FDEP (2009) SBEACH Calibration Parameters

Parameter	Symbol	Units	R-187 to R-195	R-198 to R-209
Transport Rate Coefficient	K	m^4/N	$2.50 * 10^{-6}$	$5.00 * 10^{-7}$
Slope Dependent Term	ε	m^2/s	0.005	0.002
Transport Rate Decay Coefficient	λ	1/m	0.5	0.5
Overwash Transport Parameter	Over	---	0.005	0.005
Avalanching Angle	Φ	deg	45	20
Cross-shore Spacing	DXc	ft	---	---
Median Grain Size	D50	mm	0.15	0.45
Water Temperature	Temp	deg C	27	27
Landward Surfzone Depth	---	ft	---	---

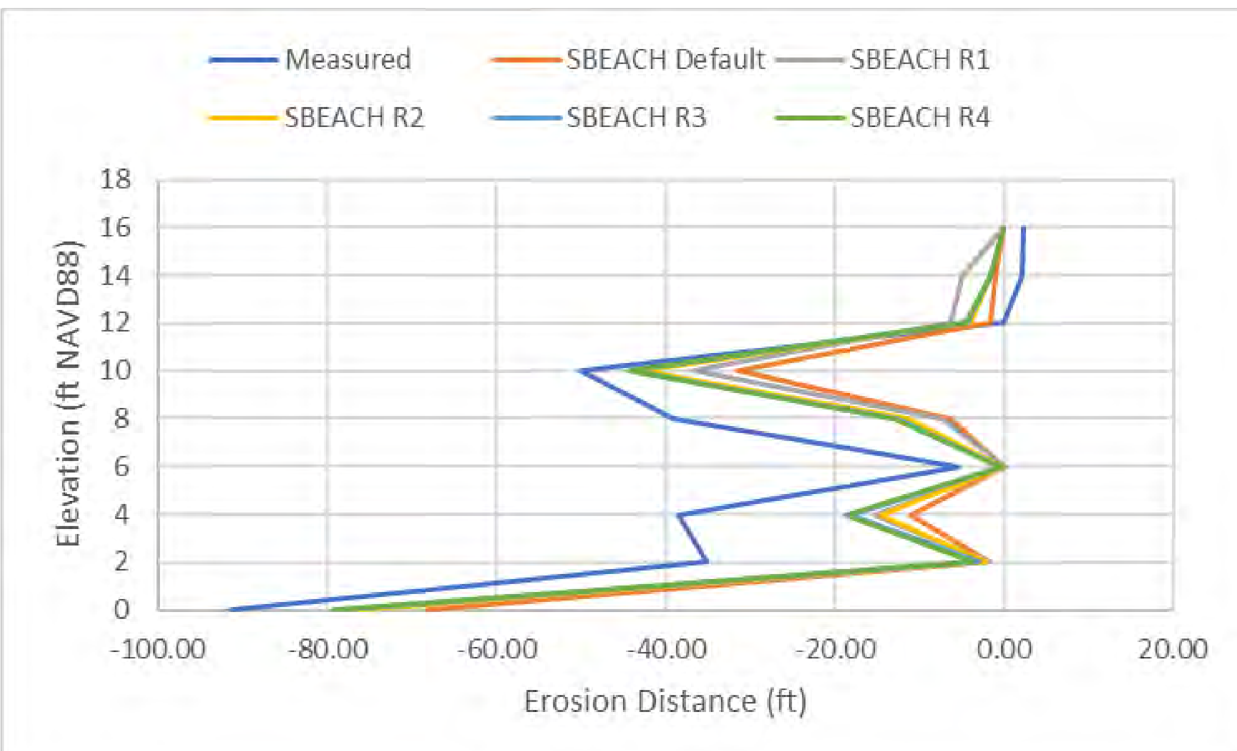

Figure 3 Measured and Predicted Contour Changes for Hurricane Matthew

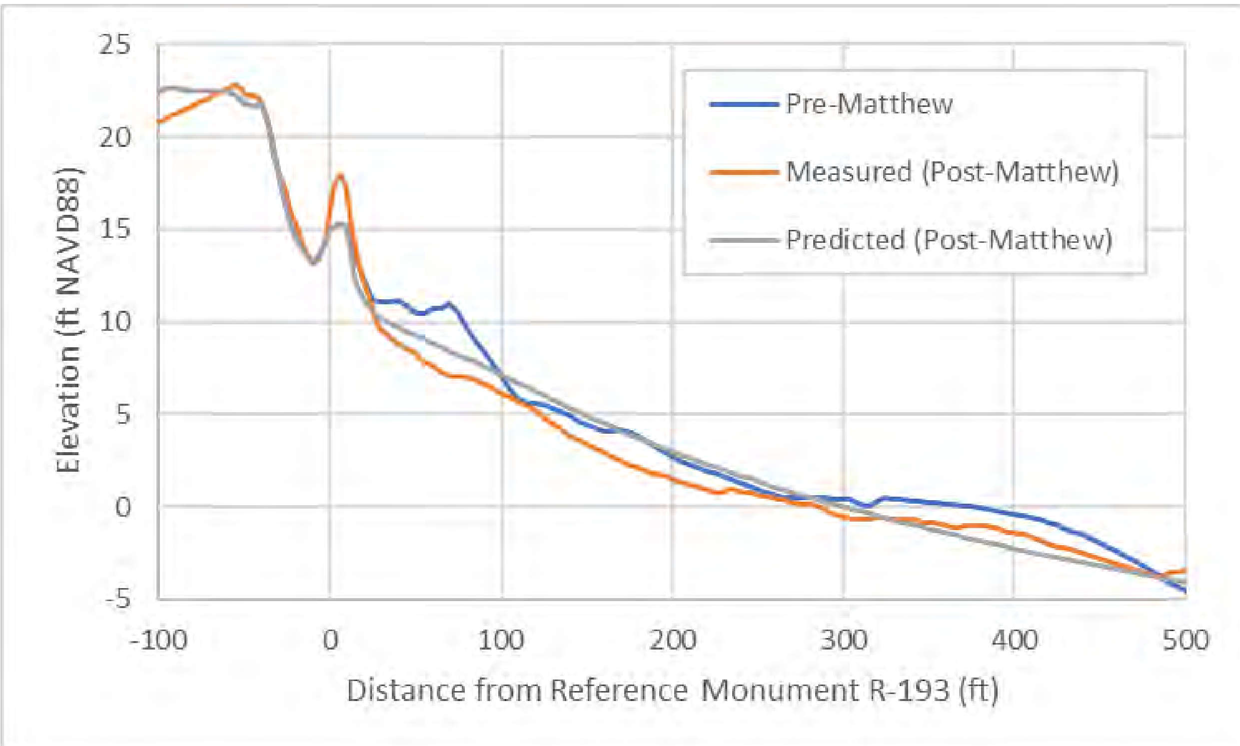

Figure 4 SBEACH Results with R4 Calibration Parameters and Measured Post-Matthew Profile

Return Period Storm Simulations

Determining the adequacy of an alternative required assessing its performance under 15-, 25-, 50-, and 100-yr storm events. Dean et al. (1987) and FDEP (2009) provide total storm tide elevations and 36-hr hydrographs including hurricanes only (Dean et al.) and hurricanes and tropical storms (FDEP) for the study area (Table 3). While both sources provide peak 50-yr storm tide values, this study adopts the higher (more conservative) value published by the FDEP.

Table 3 Peak Total Storm Tide Elevations near the Study Area

Return Period (yrs)	Total Storm Tide Elevation (ft NAVD88)	
	Dean et al.*	FDEP
5	---	4.4
10	2.6	6.0
15	---	6.8
20	4.1	7.4
25	---	***8.0***
30	---	8.4
50	8.2	***9.5***
100	***11.3***	---
200	13.5	---
500	15.3	---

*Converted from ft NGVD29 to ft NAVD88 by subtracting 1.037 ft

Both studies provide storm tide hydrographs, which this study adjusted so that the peak elevation matched the return period of the published peak storm tide elevation. Because both the hydrographs and SBEACH account for the effects of dynamic wave setup, the adjusted storm tide hydrographs underwent further iterative adjustment until the SBEACH-predicted water level matched the corresponding peak storm tide elevation. Despite FDEP providing all SBEACH calibration parameters, storm tide hydrograph, and constant wave height and period conditions, this study adopted the above approach for consistency in the development of the SBEACH inputs across the different return period events assessed.

The USACE Wave Information Study (WIS) (https://wis.erdc.dren.mil/) provides offshore wave conditions (wave height, period, and direction) for the period 1980-2020 for the SBEACH model. The WIS numerical hindcasts supply long-term wave climate information at locations (stations) of U.S. coastal waters. Station 63419 (29.75° N, 81.00° W; 20 meters water depth) represents conditions near the study area. Because extreme statistics were unavailable from USACE at the time of this writing, a peak-over-threshold analysis determined the deepwater wave heights associated with different return periods (Table 4). A best-fit curve of the largest wave heights at station 63419 with the form $y = \alpha * x^{\beta}$ determined the wave periods associated with the different return period wave heights. The SWAN wave model (described in the main report) transformed the waves from deepwater to an approximate 40-ft water depth, the most seaward extent of the beach profiles. The transformation of these waves from deepwater to 40-ft water depth provided storm wave conditions nearer to the study area.

Table 4 Peak Wave Heights and Periods

Return Period (yrs)	Deepwater Wave Height (ft)	Associated Deepwater Wave Period (sec)	Wave Height at 40-ft Water Depth (ft)	Associated Wave Period at 40-ft Water Depth (ft)
15	16.9	13.5	16.2	14.0
25	18.3	14.2	17.6	14.0
50	20.3	15.2	19.7	15.4
100	22.4	16.2	21.6	15.4

Developing wave height and period hydrographs from the peak wave characteristics required making some assumptions regarding their shape. With a typical storm event lasting about 36 hrs, distributing the peak storm characteristics over a 36-hr period simulated the passage of a storm and provided a realistic storm model. A sine squared distribution approximated the storm wave heights and periods over the 36-hr period. This distribution corresponds to

$$X(t) = (X_p - X_{min}) sin^2 \left(\pi \frac{t - 36}{36} \right) + X_{min}$$

where X is the wave height or period, X_p is the peak wave height or period, X_{min} is the minimum wave height or period before and after the storm, and t is time. For the hydrographs, storm wave heights begin and end with three-foot waves and storm wave periods begin and end with eight-second waves.

Figures 5-8 show the 15-, 25-, 50-, and 100-yr adjusted storm tide, wave height, and wave period hydrographs applied in SBEACH. The SBEACH model did not apply wave height randomization. This study applied a one-minute time step and variable grid spacing from 5 to 20 ft.

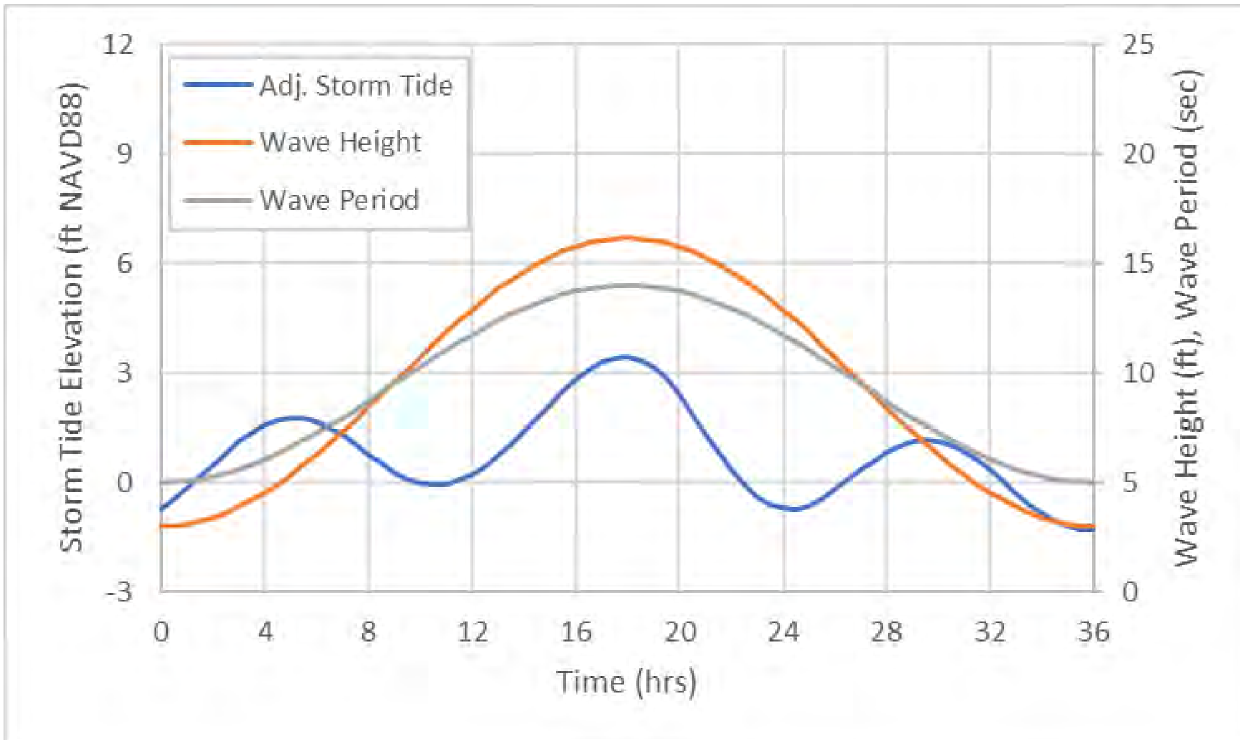

Figure 5 15-Yr Adjusted Storm Tide, Wave Height, and Wave Period Hydrographs

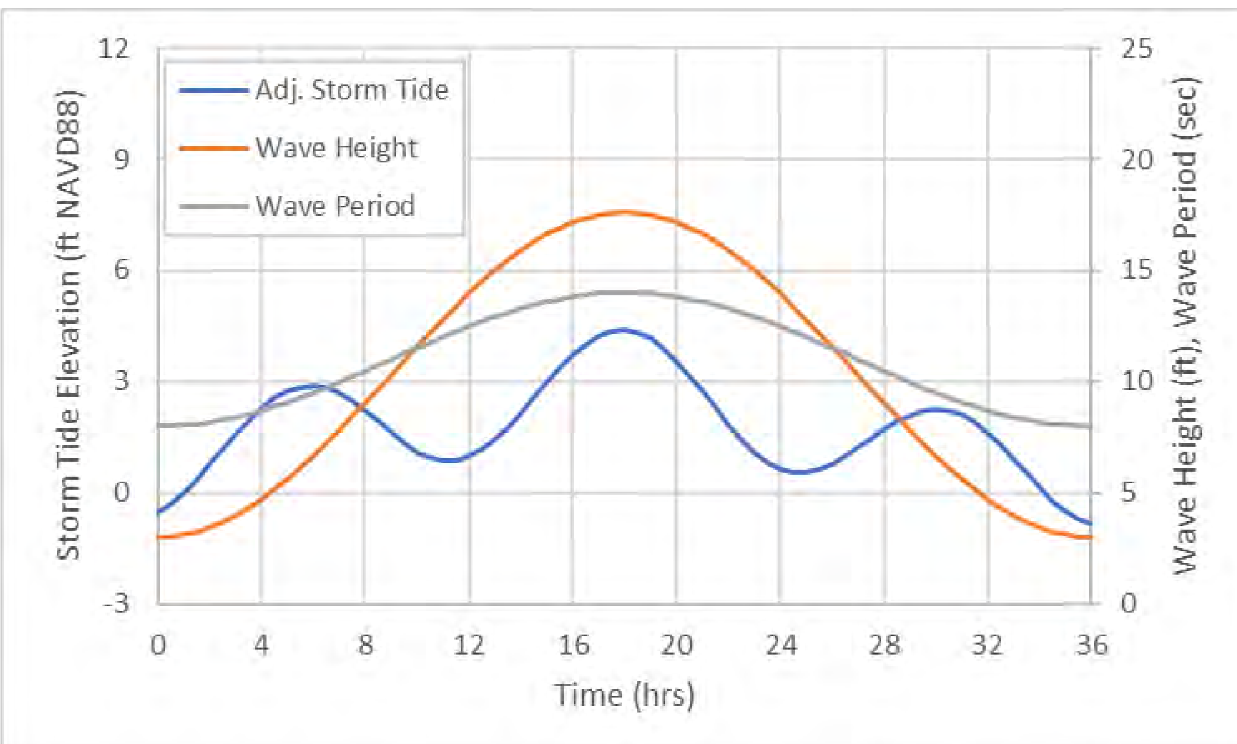

Figure 6 25-Yr Adjusted Storm Tide, Wave Height, and Wave Period Hydrographs

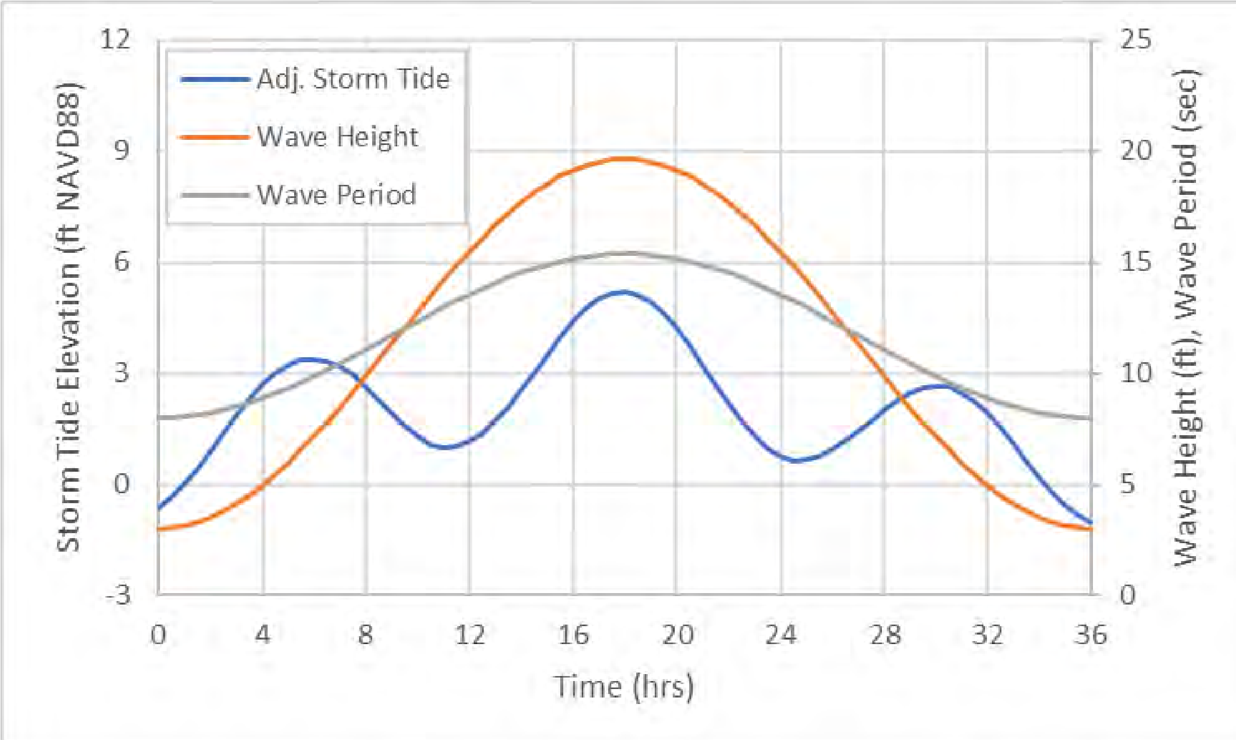

Figure 7 50-Yr Adjusted Storm Tide, Wave Height, and Wave Period Hydrographs

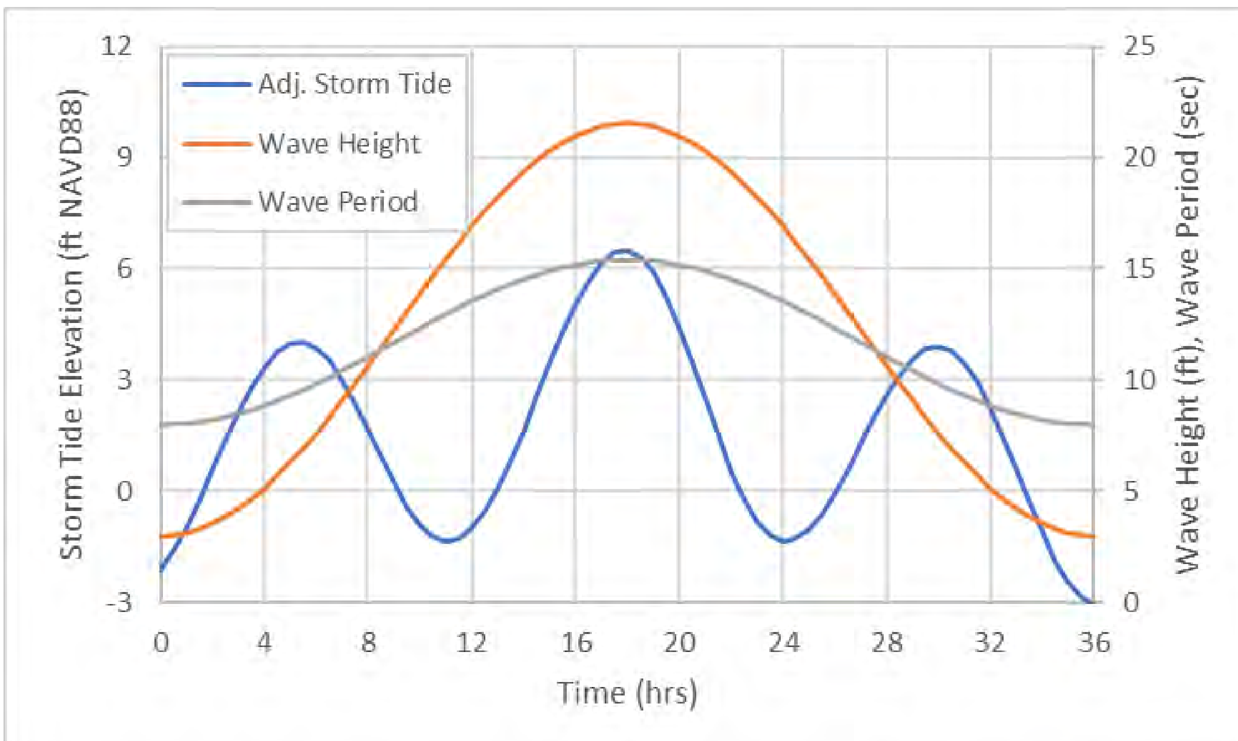

Figure 8 100-Yr Adjusted Storm Tide, Wave Height, and Wave Period Hydrographs

The following sections present the SBEACH modeling results for the seawall and dune and beach nourishment alternatives.

Seawall

To determine the lateral extents of any seawall, this study followed FDEP's rules for determining eligible structure vulnerability. These rules specifically include inputting certain SBEACH parameters (Table 2, fourth column), storm tide hydrograph, and constant wave height (10 ft) and period (10 seconds) for a 15-yr event. The storm tide hydrograph originated from FDEP (2009) with an adjustment of the peak elevation to account for the fact SBEACH and the unadjusted hydrograph both account for wave setup. Figure 9 shows the locations of the input pre-storm profiles. Figure 10 shows the adjusted hydrograph.

Figure 9 Pre-Storm Input Profiles (Based on December 2022 Survey)

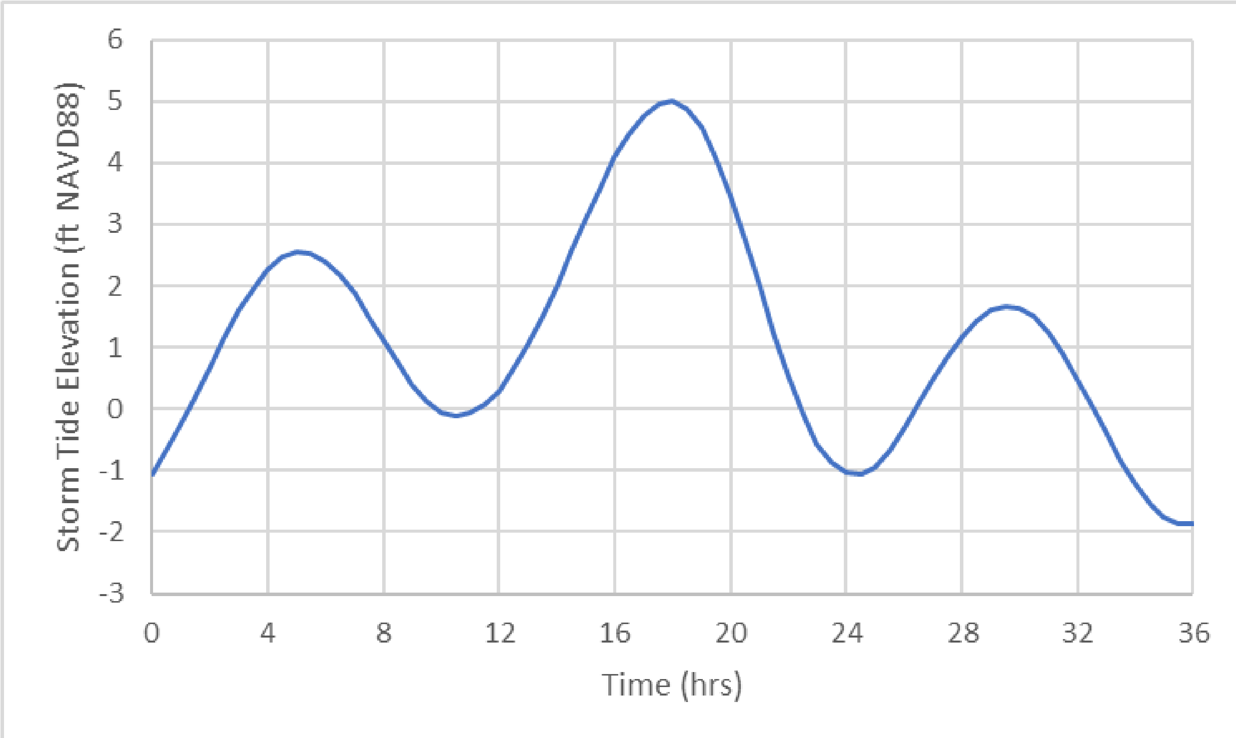

Figure 10 15-yr Adjusted Storm Tide Hydrograph

Figures 11-15 show the post-storm profiles relative to the seaward edge of the buildings. Because the storm-induced erosion falls landward of the existing dune escarpment and seaward of the buildings, the figures also show 2H:1V and 3H:1V slopes to approximate stable slopes from the dune toes of the 15-yr storm eroded profile. They indicate that only building 20 may need a seawall.

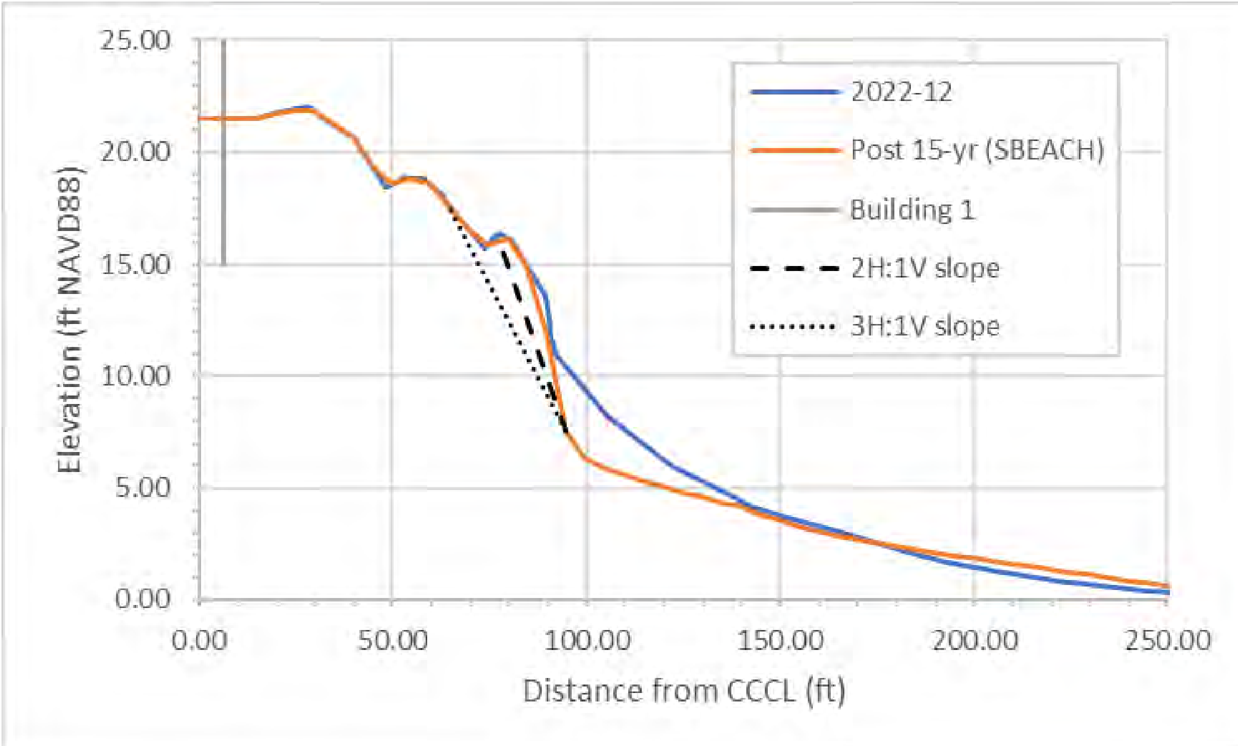

Figure 11 Conceptual Vulnerability of Building 1

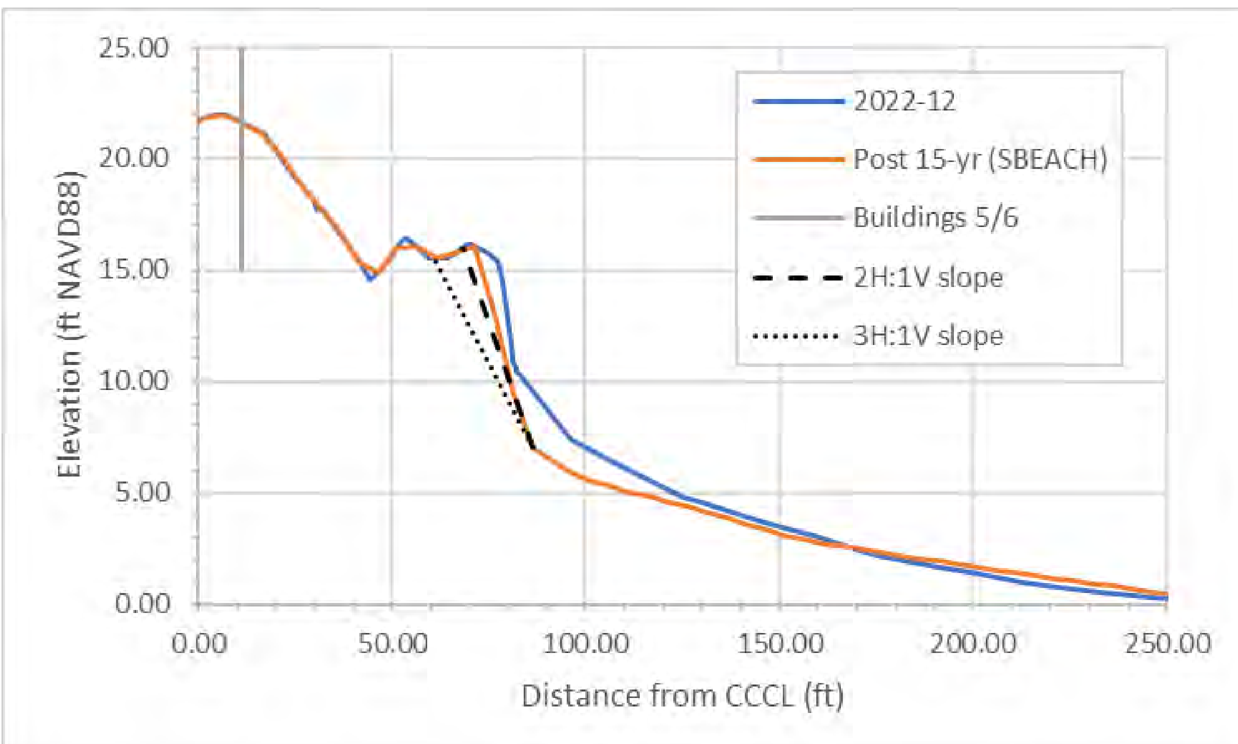

Figure 12 Conceptual Vulnerability of Buildings 5/6

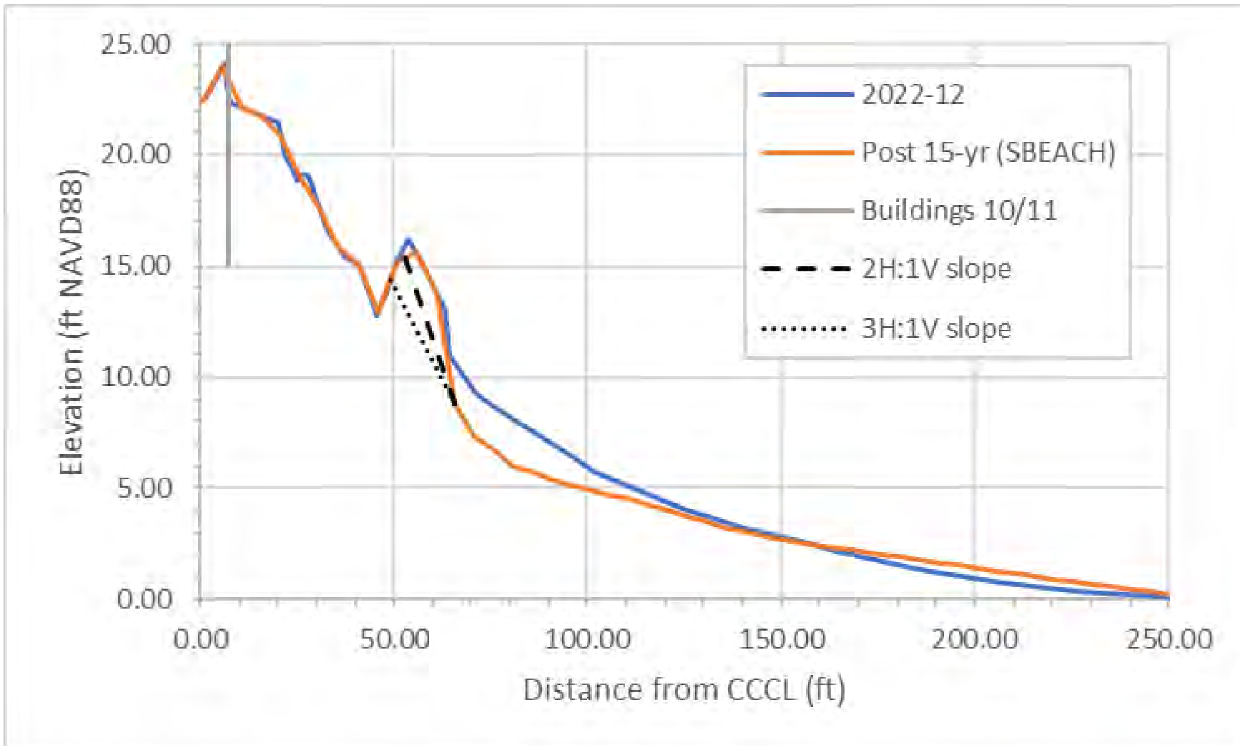

Figure 13 Conceptual Vulnerability of Buildings 10/11

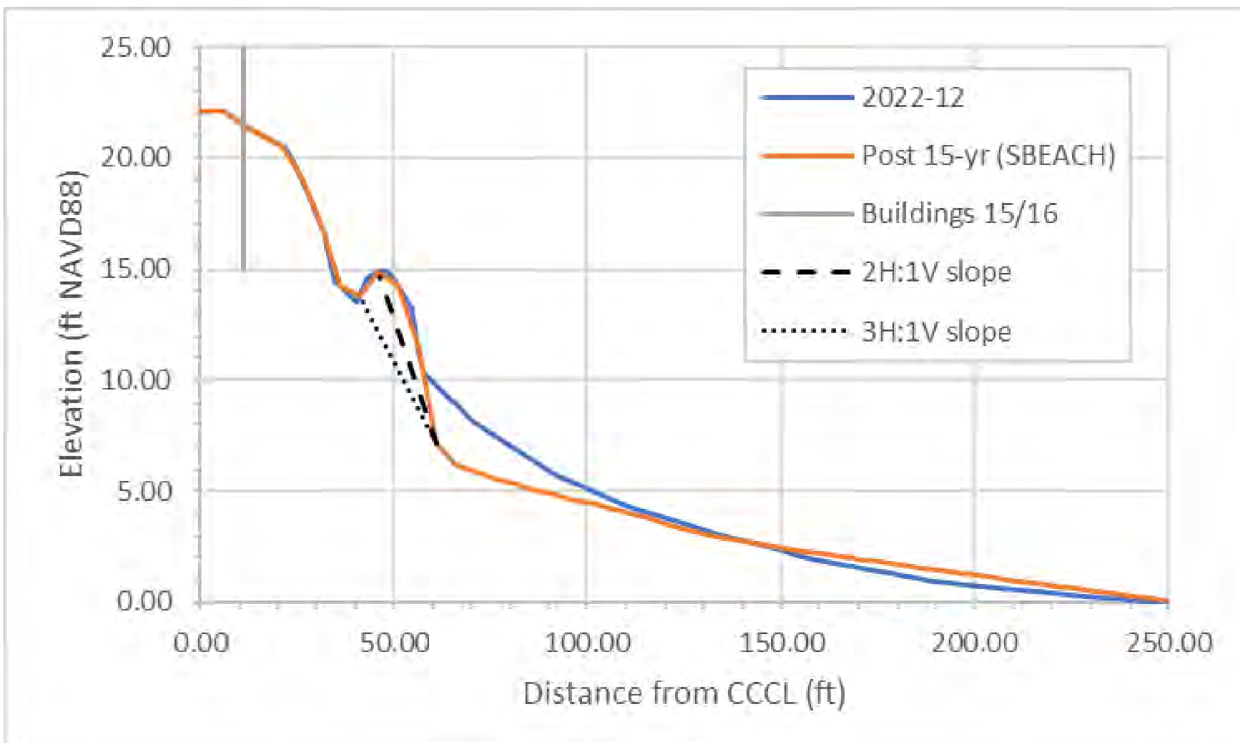

Figure 14 Conceptual Vulnerability of Buildings 15/16

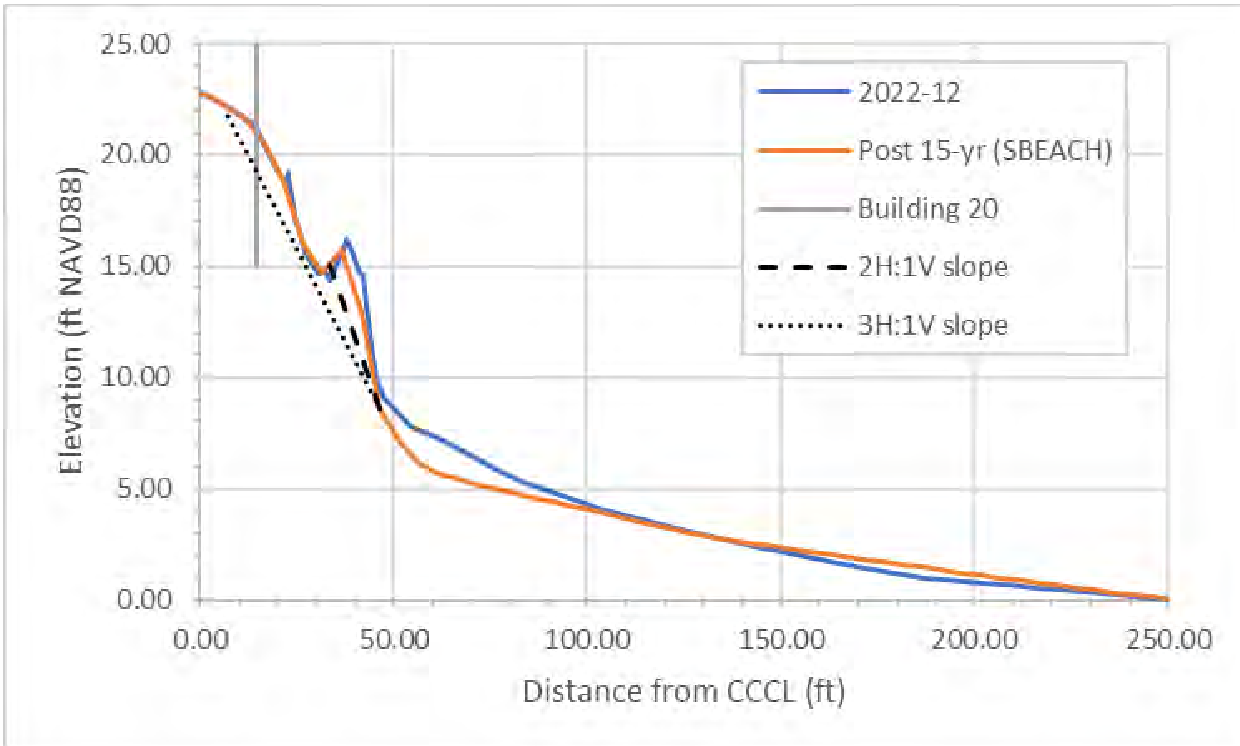

Figure 15 Conceptual Vulnerability of Building 20

Dune and Beach Nourishment

This alternative consists of restoring a portion of the secondary dune and completely restoring the seaward tertiary dune that were eroded during Hurricane Matthew. The secondary dune crest reaches an elevation of +18 ft NAVD88 and the tertiary dune crest reaches +10 ft NAVD88 to match the peak historical dune conditions. The beach consists of a 118-ft wide beach crest at elevation +10 ft NAVD88 with a 10H:1V seaward slope until matching existing grade (Figure 16). This study investigated use of median sand size of 0.23 mm that matches the native beach.

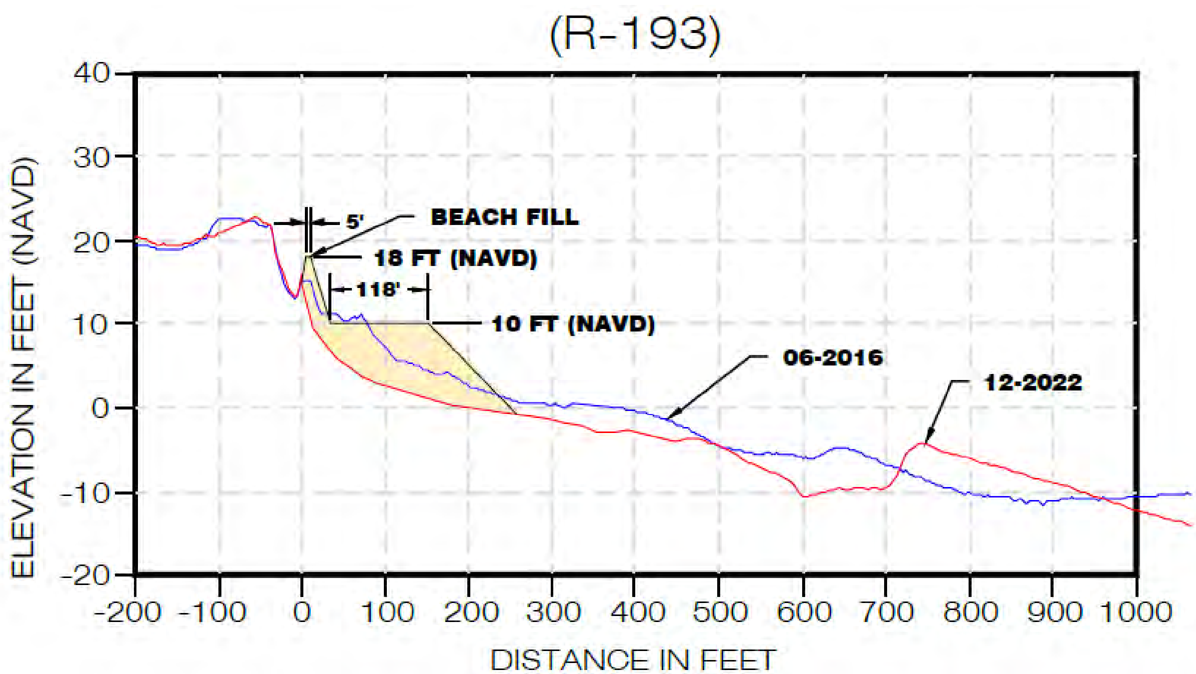

Figure 16 Dune and Beach Nourishment Concept

Figure 17 shows the erosion resulting from 25-, 50-, and 100-yr events for the dune and beach concept at R-193. Erosion caused from the 25- and 50-yr events confines itself to the historical tertiary dune. The 100-yr event's erosion minimally extends into the secondary dune.

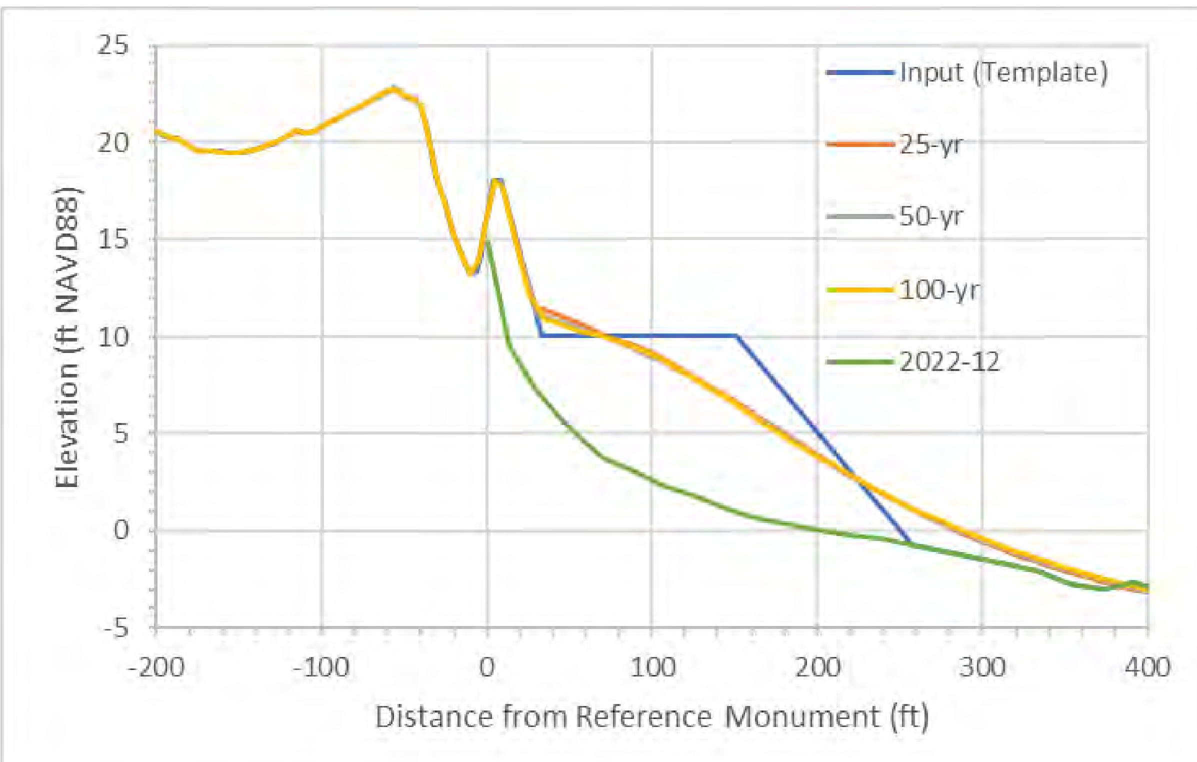

Figure 17 SBEACH Results – Dune and Beach Nourishment

<u>References</u>

Dean, R.G., Chiu, T.Y., and Wang, S.Y. 1987. *Combined Total Storm Tide Frequency Analysis for St. Johns County, Florida*. Beaches and Shores Resources Center, Florida State University, Tallahassee, FL.

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Larson, M. and Kraus, N.C. 1989a. *SBEACH: Numerical Model for Simulating Storm-Induced Beach Change, Report 1, Empirical Foundation and Model Development*. U.S. Army Waterways Experiment Station, Vicksburg, MS.

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Rosati, J.D., Wise, R.A., Kraus, N.C. and Larson, M. 1993. *SBEACH: Numerical Model for Simulating Storm-Induced Beach Change, Report 3, Users Manual*. U.S. Army Waterways Experiment Station, Vicksburg, MS.

Appendix C

Beach Fill Diffusion Analysis

Analysis

This study estimated a renourishment interval of three years for a beach fill project shown below. The next several paragraphs detail the basis for this interval.

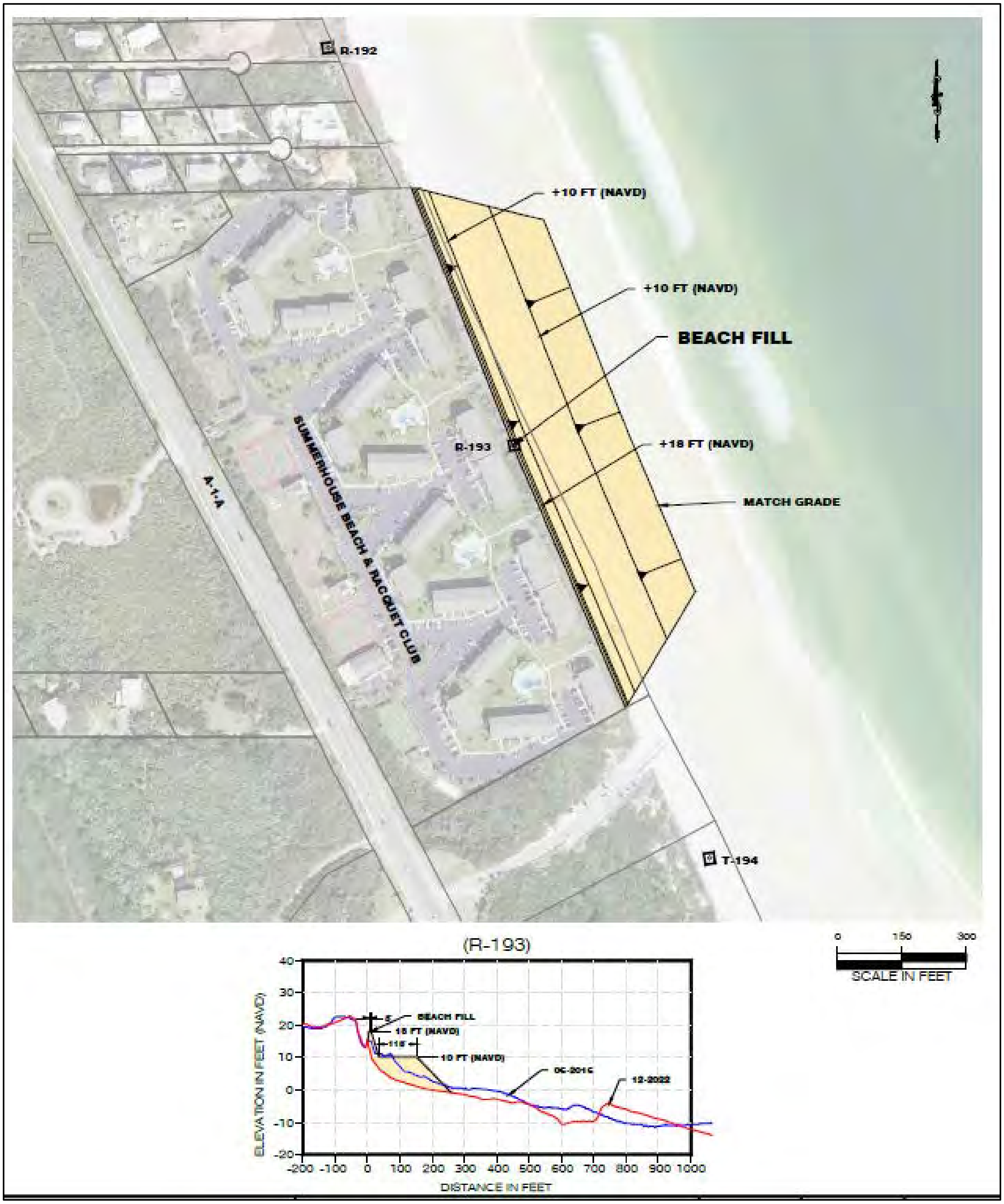

Figure 1 Dune and Beach Nourishment Concept

Following a theory based on Pelnard-Considere (1956), as cited in e.g., Dean and Dalrymple (2002), a beach fill represents a perturbation or a planform anomaly to the local uninterrupted shoreline, which over time, longshore sediment transport smooths. The present project acts as such an anomaly. A linearized approximation of the Pelnard-Considere "diffusion" equation that describes this process corresponds to

$$\frac{\partial y}{\partial t} = G\,\frac{\partial^2 y}{\partial x^2} \tag{1}$$

where *y* is the cross-shore position of the shoreline at time *t*, and *x* is the alongshore distance. This equation (a form of the well-known heat conduction equation) contains several possible analytical solutions; the boundary conditions (at the lateral ends) specify the solution. The longshore diffusivity parameter (*G*) governs the rate of evolution of the project. In this linearized treatment,

$$G = K\,\frac{H_0^{2.4}C_{G0}^{1.2}g^{0.4}}{8(s-1)(1-p)C_*\kappa^{0.4}(h_*+B)}\left[\frac{cos^{1.2}(\beta_0-\alpha_0)cos2(\beta_0-\alpha_*)}{\cos\,(\beta_0-\alpha_*)}\right] \tag{2}$$

where *K* is an empirical nondimensional constant, *H* is the wave height, C_G is the wave group velocity, *g* is the acceleration due to gravity, *s* is the specific gravity of sand (2.65), *p* is the sediment porosity (0.35), *C* is the wave velocity, *κ* is the ratio of the breaking wave height to the breaking water depth (0.78), h_* is the water depth of limiting sediment motion (depth of closure), *B* is the height of the berm above the water level, *β* is the shoreline azimuth, and *α* is the direction of the waves. The subscripts *0* and *** denote conditions in deep water and at the depth of limiting motion.

Given an initial shoreline like a rectangular planform, engineers may describe the evolution of the shoreline by

$$y(x,t) = \frac{Y}{2}\left\{erf\left[\frac{\gamma}{4}\left(\frac{2x}{L}+1\right)\right] - erf\left[\frac{\gamma}{4}\left(\frac{2x}{L}-1\right)\right]\right\} \tag{3}$$

where *Y* is the initial width of the planform beach fill, *L* is the project length, *erf[ ]* is the error function defined as

$$\mathrm{erf}(x) = \frac{2}{\sqrt{\pi}}\int_0^x e^{-u^2}du \tag{4}$$

and

$$\gamma = \frac{L}{\sqrt{Gt}} \tag{5}$$

governs the shoreline evolution rate. The fraction of the placed sand remaining within the placement area at time *t* is

$$M(t) = \frac{1}{YL}\int_{\frac{-L}{2}}^{\frac{L}{2}} y(x,t)dx = \frac{2}{\gamma\sqrt{\pi}}\left(e^{-\left(\frac{\gamma}{2}\right)^2}-1\right) + \mathrm{erf}\,\left(\frac{\gamma}{2}\right) - \frac{Et}{\Delta y_0} \tag{6}$$

where *E* is the background erosion rate and Δy_0 is the initial beach width, defined as

$$\Delta y_0 = \frac{V_0}{(h_* + B)l} \tag{7}$$

where V_0 is the total initial volume of placed sand.

This smoothing or diffusion of the beach fill by longshore sediment transport acts in conjunction with any background erosion (E) present without the beach fill.

With parameters shown in Table 1, Equation 2 yields a longshore diffusivity factor of 0.09 ft^2/s for the Marineland, FL area. Given this and the beach fill parameters provided in Table 2, the theory predicts the curve shown in Figure 1.

Table 1 Longshore Diffusivity Calculation Summary

Parameter	**Value**
Mean sand size (D50)	0.23 mm
Specific gravity (s)	2.65
Porosity (p)	0.35
Breaking parameter (κ)	0.78
Sediment transport coefficient (K)	1.35
Depth of closure (h_*)	30 ft
Effective wave height (H_0)	2 ft
Effective wave period (T)	7 sec
Wavelength at h_*	200 ft
Wave celerity in deep water (C_0)	35.9 ft/s
Deepwater wave group velocity (C_{G0})	17.9 ft/s
Wave celerity at h_* (C_*)	26.4 ft/s
Longshore Diffusivity (G)	0.12 ft^2/s

Table 2 Beach Fill Characteristics

Parameter	**Value**
Project length (l)	1,400 ft
Beach fill volume (V_0)	75,600 cy
Background erosion (E)	1.5 ft/yr
Depth of closure (h_*)	30 ft
Berm height (B)	8 ft

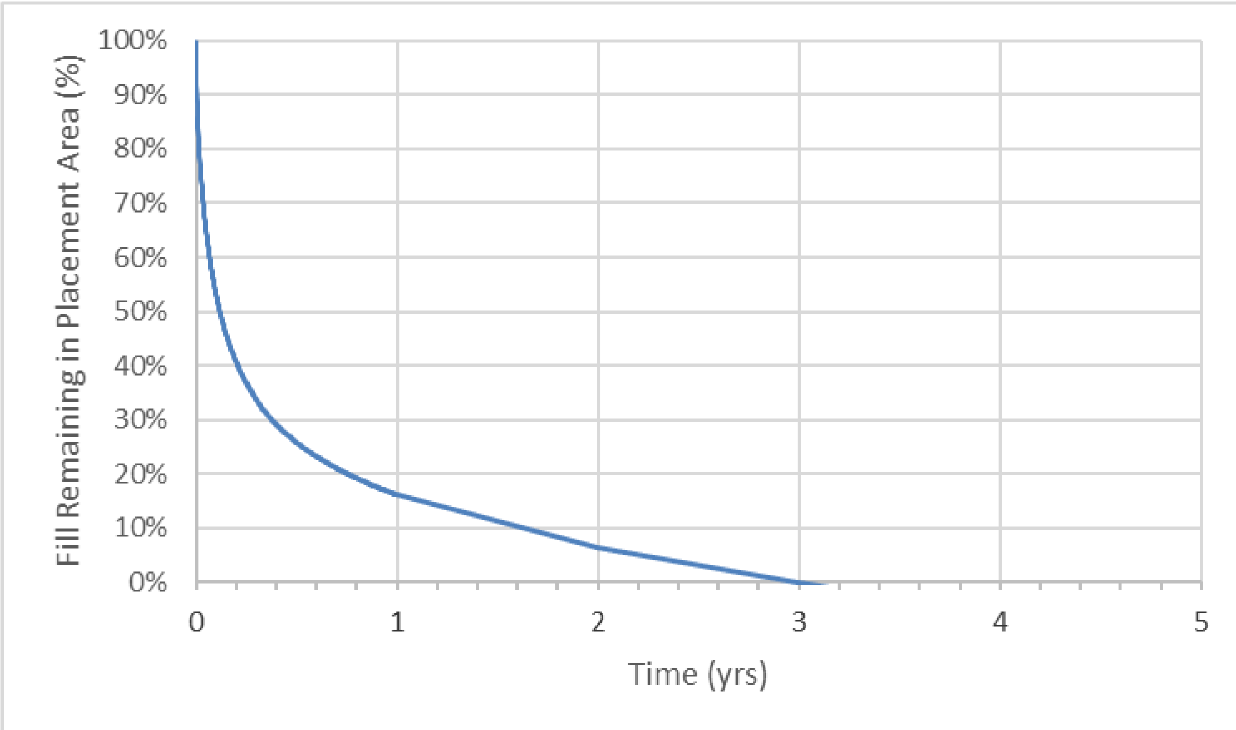

Figure 1 Prediction of Sand Remaining for 1,400-ft-long Project

Figure 1 shows that no fill remains after approximately three years. Therefore, the dune/beach needs renourishing every three years.

Note that a longer project significantly improves project longevity as shown in Figure 2 for a project with the same fill density (54 cy/ft) and a length of eight times the original project length (approximately two-mile-long project).

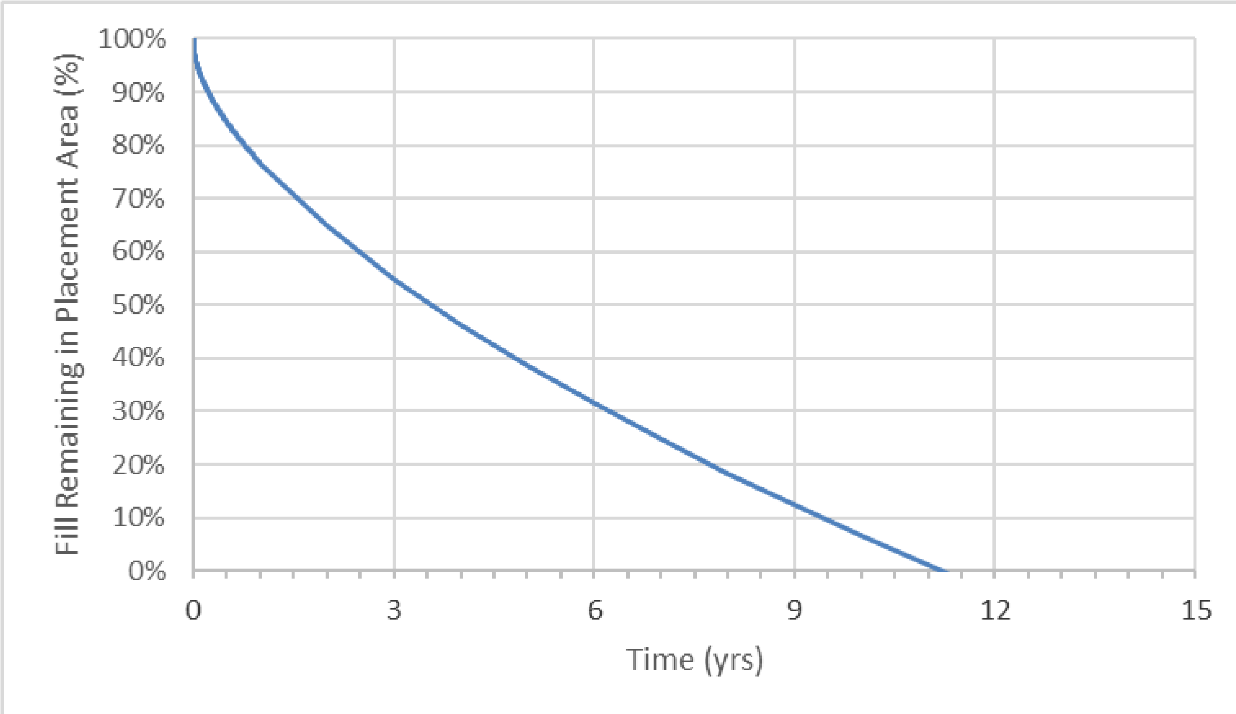

Figure 2 Prediction of Sand Remaining for Two-mile-long Project

References

Dean, R.G. and Dalrymple, R.A. 2002. *Coastal Processes with Engineering Applications*. Cambridge University Press, New York.

Appendix D

Conceptual Cost Estimates

Summerhouse Alternatives
Engineer's Opinion of Probable Costs - Detailed
March 30, 2023

Dune Restoration

Item	Description	Quantity		Unit Cost		Cost
1	Mobilization & Demobilization	1	LS	$80,000	/LS	$80,000
2	Furnish & Install Sand	87,750	CY	$52	/CY	$4,563,000
3	Permit Compliance	1	LS	$40,000	/LS	$40,000
4	Beach Tilling	1	LS	$20,000	/LS	$20,000
5	Furnish & Install Native Plants	2,889	Plant	$2	/Plant	$5,778
					Subtotal:	$4,708,778
					Engineering (3%) Design, Permitting, Construction Phase:	$141,263
				Contingency:	**20%**	$941,756
					Total:	**$5,791,797**

Segmented Seawall

Item	Description	Quantity		Unit Cost		Cost
1	Mobilization & Demobilization	1	LS	$35,000	/LS	$35,000
2	Seawall	295	LF	$3,000	/LF	$885,000
3	Site Restoration	1	LS	$30,000	/LS	$30,000
					Subtotal:	$950,000
					Engineering (10%) Design, Permitting, Construction Phase:	$95,000
				Contingency:	**20%**	$190,000
					Total:	**$1,235,000**

Appendix E

Protocol for State of Florida Authorized Inlet Management Studies, Pursuant to Section 161.143, Florida Statutes

Protocol for State of Florida Authorized Inlet Management Studies, Pursuant to Section 161.143, Florida Statutes

Inlet Management Study Guidelines

For a local government, inlet district, or navigation authority sponsored inlet management study to be considered in the adoption of an inlet management plan pursuant to Section 161.161 Florida Statutes, a scope of work shall be approved by the Department of Environmental Protection prior to initiation and the study shall be conducted pursuant to Section 161.143, Florida Statutes. The scope of work for a Department approved inlet management study shall include the following elements:

1. Establish a technical advisory committee (TAC) comprised of the Department of Environmental Protection, the U.S. Army Corps of Engineers (when a federal project exists), the local governments with jurisdiction adjacent to the inlet, an inlet district or navigation authority (if existing), and any other affected governmental entity.
2. Schedule TAC workshops, to include stakeholders, to present study results and to obtain directions for continued analyses.
3. Compile and evaluate existing historical inlet and shoreline surveys, dredging records, adjacent beach nourishment project data, astronomical tide and current data, storm tide data, and climatological and wave data. Determine the gaps in available bathymetric and topographic data within and adjacent to the inlet. Present the findings to the TAC.
4. Collect updated survey data as determined necessary by the TAC. The updated surveys may be approved by the Department in the original scope of work.
5. Analyze the updated survey data along with the historical data and develop a sediment budget.
6. If determined necessary by the TAC, perform numerical modeling to refine the sediment budget. The analytical methodology shall be approved by the Department and shall adhere to the Department's modeling guidelines.
7. Determine the area of inlet influence and the critically eroding beaches within the area of inlet influence. Present the modeling results to the TAC.

8. Evaluate inlet management strategies, as determined necessary by the TAC. Such strategies shall include balancing the inlet sediment budget with adjacent beaches and extending the life of proximate beach restoration projects. Strategies may also include the construction or modification of navigation or erosion control structures, development of bypassing operations, conducting channel realignment, excavation of sediment impoundment basins or sand traps, or other inlet management projects determined appropriate for the specific inlet.
9. Many developed inlets have considerable historic and on-going management strategies in place and are not in need of full scale inlet management studies. For example, there may only be a need to update or refine the inlet's sediment budget, or perhaps develop minor changes to existing inlet management strategies. Such studies of reduced scope may not require a TAC or all the listed elements 1 through 8, and such reduced scope studies may be tailored to the specific needs for updating an existing inlet management plan.
10. An approved scope of work will also include the timely submittal of deliverables to the Department and various TAC members in an acceptable electronic format.

Inlet Management Plan Adoption

Upon completion of an approved inlet management study (see study examples in OCULUS link – use the public login tab), the Department will develop an inlet management plan to implement those strategies determined necessary to balance the inlet sediment budget and to mitigate erosion to adjacent beaches.

- The plan shall include a beach and inlet monitoring element.
- The plan shall adopt a bypassing protocol with either a specified nourishment quantity, a dredged disposal directive, or a protocol based upon the monitoring element to determine the nourishment needs of adjacent beaches.
- The plan shall identify the beaches located in the areas of inlet influence and the inlet dredge material placement areas.
- The plan may include strategies recommended by the approved inlet management study.
- The plan may include strategies recommended in other Department sponsored inlet management studies conducted pursuant to Subsection 161.142 (2), Florida Statutes.

- The plan may include strategies recommended in studies conducted for the inlet by the U.S. Army Corps of Engineers.
- The adopted plan shall be determined consistent with the provisions of Sections 161.142, 161.143, and 161.161, Florida Statutes.

Following adoption, the inlet management plan will be made available on the Department's web site.

Inlet Management Plans