



SOVEREIGN CONSULTING INC.

Nonstructural and NNBF Alternatives for Collier County Coastal Storm Risk Management (CSRM) Feasibility Study (FS) - Final Concept Report

Prepared for:

Environmental Defense Fund

**136 4th Street North, Suite 317
St. Petersburg, Florida 33701**

Prepared by:

Sovereign Consulting Inc.

**100 Dobbs Lane, Suite 212
Cherry Hill, New Jersey 08034**

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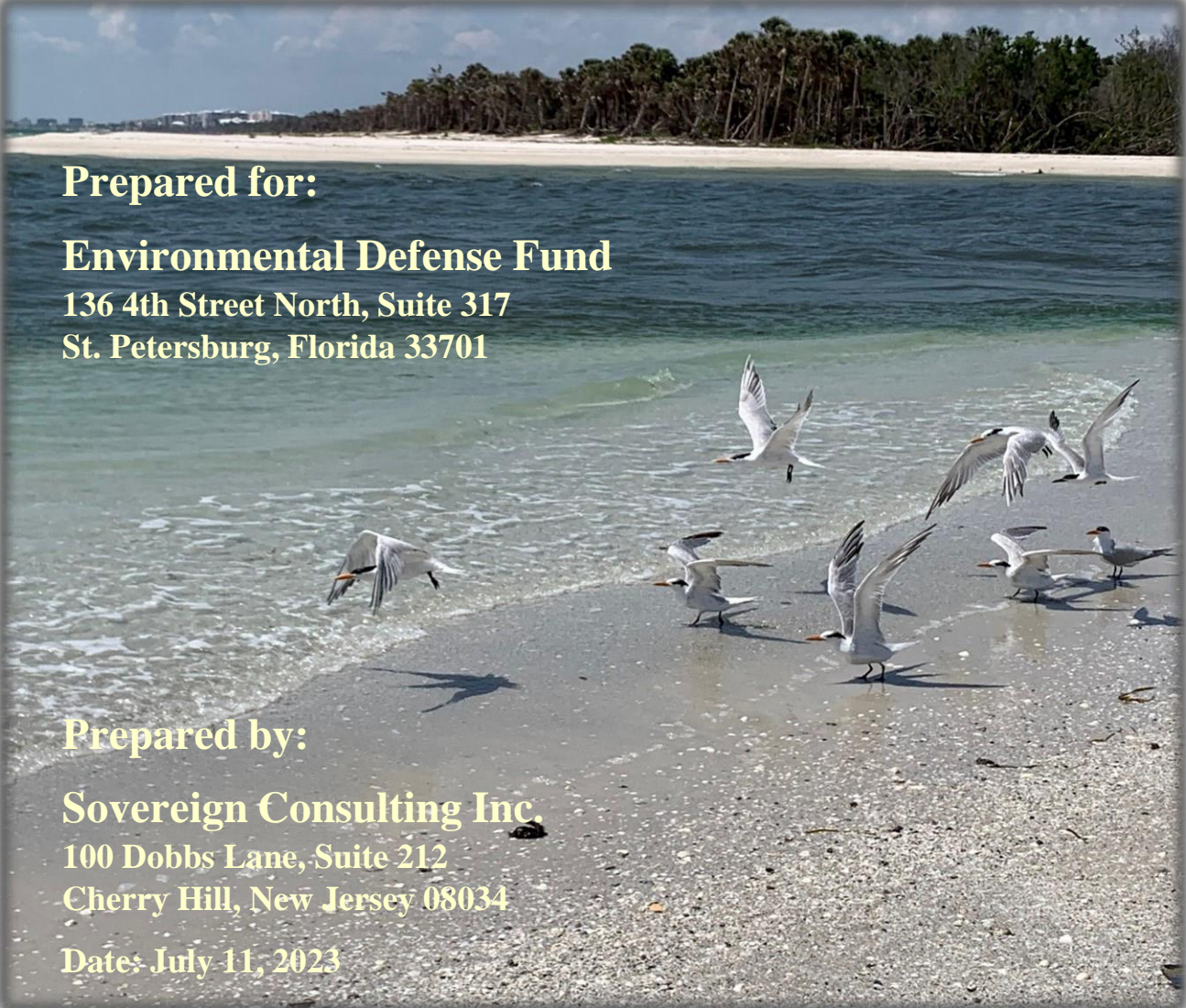


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Appendix A - Nonstructural and NNBF Alternatives for Collier County Coastal Storm Risk Management County (CSRM) Feasibility Study (FS) – Draft Concepts Presentation

1.0 SITE BACKGROUND

Collier County is currently undergoing a re-formulation of their Coastal Storm Risk Management (CSRM) Feasibility Study (FS). In the original study, the Tentatively Selected Plan focused primarily on structural measures to mitigate the risks associated with coastal storm surge. However, the Environmental Defense Fund (EDF) and their partners identified a need to incorporate nonstructural and natural and nature-based features (NNBF) to enhance the coastal resilience of the county, particularly if the study is expanded to address cumulative flooding (i.e., initial storm surge flooding compounded with secondary flooding, nuisance flooding, sea level rise (SLR), etc.).

Sovereign Consulting Inc. (Sovereign) was retained by the EDF to develop concepts for projects incorporating nonstructural, NNBF to submit to Collier County and the U.S. Army Corps of Engineers (USACE) for consideration during the development of the new CSRM FS. These concepts were intended to be large scale, resilient to storm events (i.e., protective to coastal communities), and provide both ecosystem and ecological uplift.

Sovereign reviewed the *Draft Feasibility Study and Environmental Impact Statement, July 31, 2020 (USACE, July 2020)*, including the associated appendices focusing on the five alternatives that were fully evaluated in detail to determine the potential environmental, cultural, and socioeconomic impacts resulting from the proposed action. They included: a Beach Nourishment Only Alternative; a Beach Nourishment plus Structural Alternative; a Beach Nourishment plus Nonstructural Alternative; a Combination Structural and Nonstructural Alternative; and a Combination Structural and Nonstructural Alternative (excluding Planning Area 4) and the No Action/Future Without Project Alternative.

The NNBF concepts developed for the project study area consist of features (artificial reefs, reinforced dunes, beach expansion, and/or energy dampening structures) for the protection of coastal communities and coastal habitats. Overall, the proposed concepts include combinations of beach replenishment/dredge reuse, wave attenuating reefs and enhanced low sloped dunes with a buried, or partially buried, structural toe and/or structural spines that can withstand tidal storm surges after the face (sand) of the dune has been eroded away. These principles elevate the resiliency of each concept, as compared to unprotected beach nourishment solutions, and the concepts greatly reduce or eliminate repeated, regular maintenance, thereby potentially providing reduced long-term maintenance costs.

2.0 DISCUSSION OF PROPOSED NONSTRUCTURAL AND NATURAL AND NATURE BASED FEATURE CONCEPTS

Sovereign reviewed the USACE, July 2020 report, reviewed pre and post-Hurricane Ian imagery, obtained verified storm surge data from state and national agencies and conducted field reconnaissance to identify specific beaches, passes and backwater areas that are suited to large-scale NNBS alternatives. Sovereign has developed preliminary concepts that are described below with supporting figures and photographs in Appendix A - Nonstructural and NNBF Alternatives for Collier County Coastal Storm Risk Management County (CSRM) Feasibility Study (FS) – Draft Concepts Presentation. In identifying these concepts, the primary goal was to improve protection and resilience against coastal storm events and ensure uninhibited drainage associated with secondary flooding during and after a storm event. Sovereign’s concepts focus on maximizing reduction of wave and storm surge energy prior to contact with susceptible features, minimizing landward migration of storm surge volumes and maximizing outward flow of post storm flood volumes. Other considerations included:

- Maximizing coastal habitat enhancements, restoration, and/or creation,
- Retaining or improving the land-water connection,
- Maintaining or improving aesthetics,
- Maintaining the beach/water access and improving water activities (e.g., fishing, snorkeling),
- Improving habitat resilience,
- Addressing specific regional ecological concerns (e.g., sea turtle nesting, shorebird nesting, SAV impacts),
- Minimizing impacts on Social/Environmental Justice areas,
- Reducing the need and/or frequency of beach nourishment,
- Providing areas for beneficial dredge reuse opportunities, and
- Integration with previous concepts or other new concepts being developed.

The following concepts were developed to allow for flexibility. For instance, a concept or a portion of the concept could potentially be incorporated into another concept not presented herein. Most of the concepts have a level of flexibility regarding project scale, project life, targeted storm event and SLR scenario(s) considered, and phased installation. Please note, slide references provided in the following text pertain to the presentation provided in Appendix A. In addition, the material depicted in the details found in Appendix A are provided to improve resolution and understanding of the associated concept; the concepts are generally not restrictive to the use of the material presented.

2.1. Wiggins Pass Concept

Wiggins Pass consists of a maintained boat channel where the Cocohatchee River enters the Gulf (Slide 6). Delnor-Wiggins Pass State Park is located immediately to the south and undeveloped portions of Barefoot Beach County Preserve lie to the immediate north. The pass is unarmored and subject to sediment (predominantly sand) movement during storms and normal tide conditions. The pass has several marina communities beginning approximately 0.5 miles to the east. During Sovereign's field inspection, significant beach erosion from Hurricane Ian was observed in the northern portion of Delnor-Wiggins Pass Park near the pass (Slide 7). Several sea turtle nesting sites were also identified (Slide 8).

Objective – The objective of the Wiggins Pass Concept is to provide added NNBS to stabilize the Pass by constructing a pair of reinforced dune systems on each side of the pass and protect the marina communities to the east on the Cocohatchee River by restoring/enhancing the island buffer area immediately west of the marinas (Slide 11).

Elements – This concept consists of installing dunes north and south of the pass that include an artificial reef-type energy attenuation structure toe at the base of both dunes (e.g., traditional WADs™ or Eco-WADs™; Slides 11 through 14). This reef structure would feature periodic, short, and perpendicular extensions towards the Gulf to reduce parallel scouring and promote Gulf-side accretion near the base of the reef toe. It should be noted that this toe structure could be buried if desired or may be covered by natural accretion. The dunes would include long-gentle sloped vegetated dunes to help dampen storm energy while providing high ecological function and maintaining the visual aesthetics associated with the area. Both dunes would include a buried spine which would serve as a wave energy dampening structure should the Gulf-side dune be eroded during a major storm or multiple storm events.

During a westerly storm approach, the existing pass currently acts as a funnel directing storm energy and increased water volume at the Cocohatchee River Park Marina, Pelican Isle Yacht Club, Marina Bay Club of Naples, and surrounding areas (Slide 9). These marinas had their boat docks and lower elevation amenities severely damaged or destroyed during Hurricane Ian (Slide 10). This

area would be protected by reinforcing/enhancing the patchy mangrove island area directly west of Pelican Island Yacht Club. The concept includes a wrack trap feature (Slide 15) to protect the vulnerable western shoreline of the fragmented mangrove islands. The wrack trap is a piling or hardwood timber-based structure that would naturally accumulate (i.e., trap) floating or storm transported debris and attenuate wave energy before it hits the mangrove islands. The trapped organic material works in conjunction with the structural elements to maximize energy attenuation while retaining a level of aesthetics compared to concrete or stone alternatives. The spacing of the pilings will dictate the extent of trapping efficiency, wave dampening, and wildlife passage through the structure. This concept also includes restoring/nourishing the island areas to an elevation that would accommodate new mangrove plantings that would be protected by the wrack trap structure.

Benefits – The proposed dunes at the entrance to Wiggins Pass should protect the pass and help maintain the channel. The long, low sloped dune structure (versus a steeper dune) should attenuate wave energy during major storm events and increase the beach area laterally while maintaining/improving the aesthetics and usability of the beach by the public. The dunes would provide added and more diverse habitat for planted native species. The improvements should also reduce the north-south scour of the beach, which would reduce beach and pass maintenance and the associated costs. The dune structures would also reduce the storm funneling effect and should reduce the energy entering the pass during a major storm approaching from the west.

The enhancement/restoration to the islands should reduce wave energy and storm surge impacting the marina communities to the east while increasing mangrove and other habitats that have been gradually degrading from recent and repeated storm events and SLR. Due to the distance from the protected communities, the island improvements should be largely unnoticed to the casual observer.

2.2. Clam Pass – South

Clam Pass consists of an unarmored channel connecting outer Clam Bay to the Gulf. The surrounding area is an undeveloped preserve and part of Collier County's Clam Pass Park. To the south of the pass is linear beach with the Gulf to the west and Outer Clam Bay to the east. The beach is naturally vegetated and provides a good storm barrier between the Gulf and the residential areas to the east of the bay. However, there is a stretch of the beach just north of Seagate Drive where the natural beach buffer is very narrow and is susceptible to a breach during a major storm (Slides 16 and 17).

Objective - The objective of the Clam Pass - South Concept is to widen approximately 0.25 miles of the natural coastline storm buffer between the Gulf and Outer Clam Bay to reduce the chance of a shoreline breach during a severe storm event (Slide 18). This Concept would provide additional storm surge protection to the communities to the east and south of Outer Clam Bay, including the associated backwater marina areas.

Elements – This concept includes nourishing the east side of the existing beach into Outer Clam Bay by approximately 300 feet to an elevation of twelve (12) inches above the existing mangrove platform (to allow for settlement) and planting mangroves and marsh grasses in the replenished area (Slide 19). This would decrease the chances of a breach and storm surge flooding into Outer Clam Bay and the surrounding residential areas.

Benefits – The primary benefits associated with this concept include improving the coastal buffer width to protect against storm surge and providing a greater resilience; while, providing additional mangrove and dune habitat. Due to the mangrove stands that are now present, the improvements should not significantly change the current vista other than the geography footprint of Outer Clam Bay.

2.3. Doctors Pass - South

Doctors Pass connects Inner Doctors Bay to the Gulf in Naples. The pass is currently heavily armored with large stone on both sides (Slide 23) and is surrounded by dense residential development along the beachfront and areas to the east. The backwater bay areas include private boat docks associated with the bay-front residences. The beaches to the south of the pass are frequented by storm sewer outfalls that extend into the Gulf below MLW and are protected by small stone jetties (Slide 20).

There is also a stone breakwater starting approximately 600 feet south of the center of the pass. This structure is approximately 250 feet long, running parallel to the beach in an apparent effort to protect a specific property(s) (near the Gulf View Beach Club; Slide 22).

Objective – The objective of the Doctors Pass Concept is to improve beach nourishment retention and reduce downdrift scouring of the beach south of the pass.

Elements – This concept focuses on retrofitting the breakwater structures immediately south of Doctors Pass with an artificial reef structure to provide a more resilient and even beachfront while increasing coastal habitat (Slide 24). This concept includes installing a (non-stone) wave-attenuating artificial reef from the western tip of the current stone armoring and tying the reef back into the beach which would create additional stable beach area and further protect the pass.

Additionally, artificial reefs would be placed extending from the existing jetties and stormwater outfalls at a south-west 45° angle to further protect the beach from north-south scour, create a more stable beach and reduce the needed frequency of replenishment. The top of the reef structure would not exceed MHW. The designated lengths of the artificial reefs are estimated at this time but would be designed to be proportional to the length of beach to be protected. The final height and position of the artificial reefs would minimize any negative aesthetic impact.

Benefits – The primary benefit of this concept is increasing the resilience (stability) of the beach and creating wider beaches to reduce wave energy impacts on the shoreline properties during storm events. It would also decrease north-south beach scour which would reduce beach renourishment frequencies and the associated costs. The artificial reefs would also provide additional aquatic habitat and improve local surf fishing.

2.4. Gordon Pass

Gordon Pass is located where Naples Bay enters the Gulf. The pass is approximately 500 feet wide and is currently heavily armored with large stone structures to the south and a shorter stone jetty to the north along the pass (Slide 25). Multiple T-groins are present beginning approximately 700 feet north of the pass. The T-groins were most likely designed to protect specific beach properties.

The pass provides access to the Gulf for many fishing and site seeing charter services out of Tin City as well as private craft from the backwater bay communities and marinas. East of the pass and at the first major bend north is an undeveloped area with red mangroves that has been adversely impacted by Hurricane Ian. There are also two large private properties to the south and beachfront development to the north of the pass.

Objective – The objective of the Gordon Pass concept is to stabilize the pass by placing a pair of low reefs (top at MHW) to the north and south of the pass opening and placing an energy dampening structure at the first bend to reduce storm energy, reducing scour and protecting the red mangrove buffer (Slide 26).

Elements – This concept includes the construction of two long, linear reef toe structures (one on each side of the pass) with periodic perpendicular extensions for reducing north-south scour. The extensions should also promote Gulf-side accretion which would conceal much of the toe of the

structure. The landward-side of the reef should accrete beach naturally or can be nourished creating a large beach area extending along the north-side of the pass. Any nourishment would be protected by the wave attenuating reef structures. The existing T-groins to the north of the pass would be left in place and mostly buried by new beach. The large flat beach areas of accretion should develop, creating a large wave break zone which should reduce the energy contacting the surrounding upland areas.

The concept also includes an interior channel reef to the east of the pass to create additional beach and provide scour protection at the first northern bend of the channel. This should reduce some of the storm energy moving around the first bend and protect the existing red mangrove stands that were damaged during the last two large hurricanes. Slide 26 illustrates the anticipated zones of accretion, but the area could also be used as a dredged material reuse site.

Benefits – The concept should reduce the funneling effect of the pass opening and reduce the volume and energy of a storm surge. It should also provide additional protection for the pass and residential areas to the north while creating additional beach to the north and south of the pass. The improvements should also reduce the frequency and magnitude of pass maintenance and provide for a more stable channel shoreline habitat.

2.5. Little Marco, Cannon, Umbrella and Johnson Island Complex

This area is north of Capri Pass, Isle of Capri and Marco Bay and is characterized by numerous northwest to southeast open channels (Slide 27).

Objective – This concept is intended to reduce north to south flood volumes and energy by reducing open channel flow while increasing mangrove habitat. This concept would help protect the northwestern exposure of the Isle of Capri and the adjacent natural areas.

Elements – This concept includes creating three (3) vegetated sand plugs northwest, west and southeast of Cannon Island. The plugs would be approximately 1 foot above MHW and would be planted with mangroves.

The concept also includes creating an irregularly shaped linear artificial reef at the northeastern tip of Johnson Island to facilitate natural accretion (Slide 27).

Benefits – This concept would reduce initial and post storm flood flows to protect the northwestern portion of the Isle of Capri and other natural areas located to the north. The project may utilize dredge material generated from maintaining Hurricane, Capri, and Big Marco Passes.

2.6. Marco Island - North

This area consists of areas north and south of Big Marco Pass and south of Isle of Capri and Marco Bay. The pass is approximately 0.7 miles wide from the northern tip of Sand Dollar Island due north to Sea Oat Island. During a storm from the west or northwest, the pass has a funneling effect, concentrating wave energy and storm surge toward the Isle of Capri and North Marco Island.

This concept also includes the narrow beaches from just north of South Point on Sand Dollar Island to North Point.

Objective - This concept is intended to create resilient NNBF to narrow, stabilize and protect Big Marco Pass, portions of Sand Dollar Island and North Point to provide storm surge protection to Marco Island – North and the Isle of Capri (Slide 31).

Additionally, this concept is intended to create resilient NNBF to protect the designated linear beach along Sand Dollar Island (Slides 28 through 30) to protect northwestern Marco Island.

Elements - This concept includes extending an artificial reef toe and reinforced dune system from the north side of the pass southward into Big Marco Pass to protect and increase the southerly footprint of the barrier island. The reinforced dune structure (Slides 31 and 32) includes a buried spine of wave attenuation devices to provide added protection should the front (Gulf-side) of the dune be eroded during a major storm event. The dune height is assumed to be 10 ft. NAVD88. The top of the toe structures would be at MHW. The front of the dune utilizes a gradual 1.0% slope as an additional means to increase wave attenuation. Passive accretion at the toe of the dune is anticipated. The front and back of the dune would be planted with the desired native dune grasses.

Similarly, North Point and linear beach portions of Sand Dollar Island north of South Point would receive similar beach replenishment with a stabilizing artificial reef toe similar to the above. These areas would not require a buried spine since there would be no elevated dune feature.

Benefits - This concept would protect Marco Island-North and the Isle of Capri by reducing storm surge energy from westerly and northwesterly storms; while, increasing the beach area and providing additional and varied habitat. The project may utilize dredge material generated from maintaining the local passes.

2.7. Marco Island - South

The Caxambas Pass is approximately 0.75 miles wide from Cape Marco to Dickmans Point at the northwestern end of Dickmans Island (Slides 33 through 35). On the north side of the pass, there are three stone breakwaters approximately 500 feet offshore, running parallel to the shoreline; and, one (1) approximately 150-foot jetty running perpendicular from the beach into the Gulf (Slide 33). Cape Marco received storm surge damage from Hurricane Ian. Many of the high-rise properties are currently building stone structures where their properties meet the beach in an apparent effort to protect against storm surge. Additionally, a beach replenishment project was underway just north of the cape during Sovereign's field reconnaissance (Slide 34).

The south pass is protected by a series of natural "anchor" landmasses (islands) that protect southern and southeastern Marco Island, Highland Point and Goodland from storm events from the west and southwest. These landmasses include Henry Key, Dickmans Island Ten Thousand Island and others.

Objective – This concept is intended to provide NNBF for the resilient stabilization and protection of Cape Marco to the north and Caxambas Pass, Cape Marco, Henry Key, Dickmans Island and northern Ten Thousand Island to the south.

On the north side of the pass, the existing breakwater configuration at Cape Marco splits the shoreline drift and northern storm vector which encourages scour.

On the south side of the pass, the island improvements would protect south and southeastern Marco Island, Highland Point and Goodland. Currently, these islands are susceptible to erosion during large storm events. Each of the designated islands would be enlarged through nourishment/accretion and stabilized with a reef toe and/or spine so they become more resilient and protective of the developed residential areas.

Elements –

For the north pass, the concept includes installing an artificial reef toe and nourishment to form a high beach/low dune to attenuate wave energy while expanding and stabilizing the local beach. This should protect the point from potential scour caused by the current stone structures and protect the development along the point.

For the south pass, the concept includes installing an artificial reef system along Dickmans Island, and northern Ten Thousand Island. Small wave attenuating reefs would be added to prevent north-

south scour and encourage natural accretion. Additionally, a gap reef would be constructed extending Henry Key to the west to narrow the pass and reduce the storm funneling effect from westerly storms. The gap reef should stabilize the Henry Key from incoming surge and outgoing storm flooding.

Benefits – The northern concept should reduce scour, protect the channel and add recreational beach in an area that has experienced recent erosion. It would also include and promote dune grass habitat that currently does not exist.

The southern concept should reduce the width of the pass, reduce the storm surge volume impacting southern and southeastern Marco Island and Highland Point, further stabilize the pass, reduce the need for pass maintenance and provide beneficial dredge reuse areas associated with the maintenance of the pass.

2.8. Everglades City and Chokoloskee

This area includes West Pass, Indian Key Pass, Sandy Pass and Chokoloskee Pass and the associated complex of mangrove islands that provide an excellent storm buffer protecting Everglades City, Plantation Island and Chokoloskee (Slide 36). The area is a significant tourist destination for sightseeing, birdwatching, and fishing charters. Though technically out of the official study area, the protective island complex is being degraded from natural processes, increasing storms and sea level rise.

Objective – This concept includes implementing a series of protective wave attenuating reefs to hold the toes of the island complex to offer additional NNBF protection without having a negative impact on existing navigational channels or habitats.

Elements – The concept would provide wave energy dampening that should encourage passive accretion leeward of the artificial reefs. It should be noted that this option may extend south beyond the Collier County limits.

Benefits – Once implemented, the concept should stabilize the island complex for more than 50 years without any maintenance. The accretion should encourage additional mangrove areas and shore bird breeding habitat. The implementation could be staged from Everglades City and Chokoloskee, infusing jobs and funding into the local economy.

3.0 DISCUSSION AND RECOMMENDATIONS

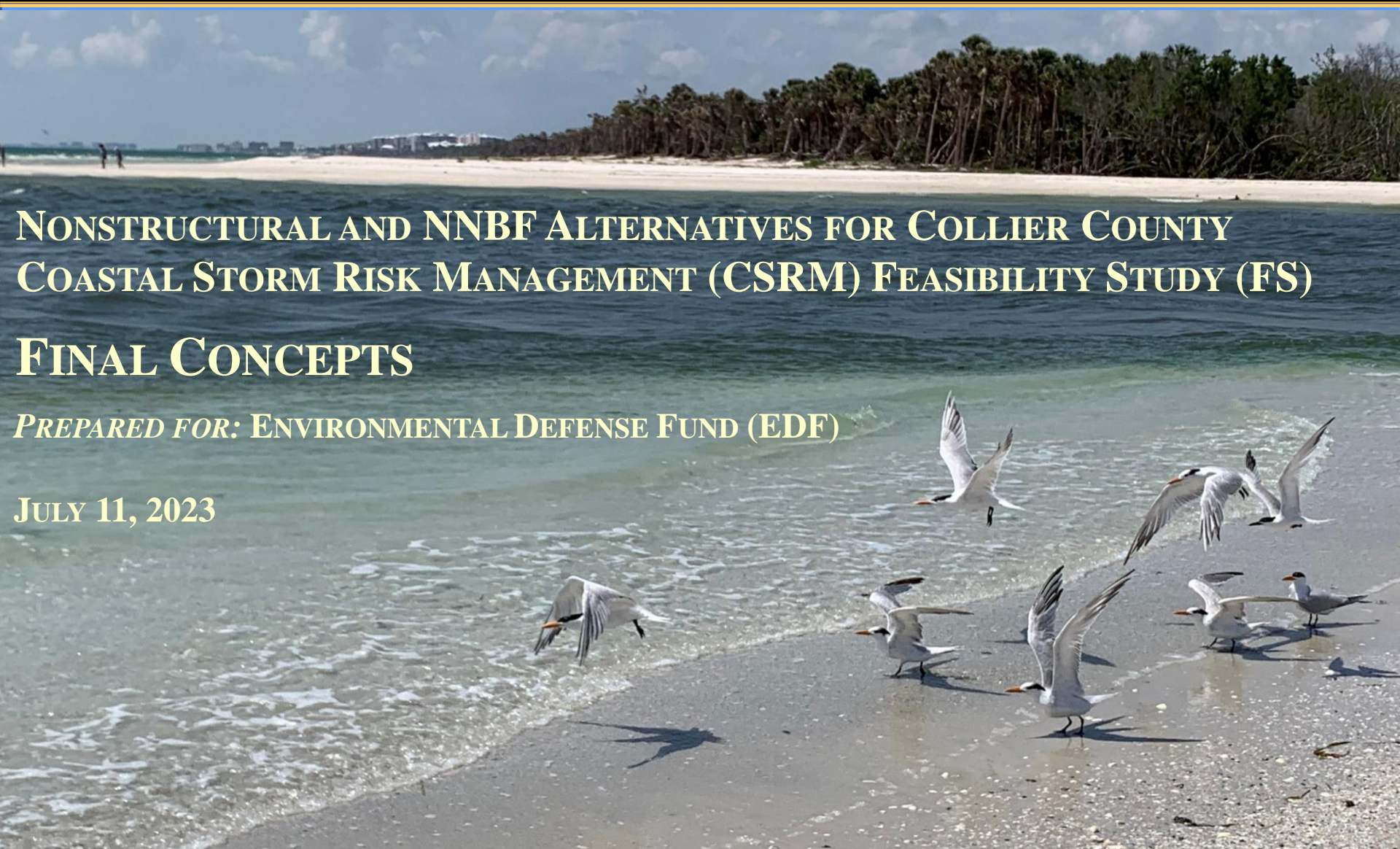
Sovereign offers the following additional discussion and recommendations regarding this project.

- A total of 8 concepts were developed. A cursory review and comparison of the benefits for each concept were performed. The considerations used in the comparison generally fell into 4 categories: ecosystem uplift; storm protection improvement; ecosystem services; or community acceptance (Slide 37). Of the 8 concepts, 4 were identified to be the top recommended concepts: Wiggins Pass; Marco Island – North; Marco Island – South; and Everglade City and Chokoloskee.
- Though these concepts were provided to EDF in response to the Collier County Coastal Storm Risk Management Feasibility Study, the individual concepts could also be designed and implemented using available state and federal resiliency grant sources, assuming the concepts gain the support of Collier County and the other applicable stakeholders.

ATTACHMENT A
NONSTRUCTURAL AND NNBF



SOVEREIGN CONSULTING INC.
AN ENVIRONMENTAL SERVICES FIRM



NONSTRUCTURAL AND NNBF ALTERNATIVES FOR COLLIER COUNTY COASTAL STORM RISK MANAGEMENT (CSRM) FEASIBILITY STUDY (FS)

FINAL CONCEPTS

PREPARED FOR: ENVIRONMENTAL DEFENSE FUND (EDF)

JULY 11, 2023

Concept Objectives

Objectives:

- Provide for large scale Natural and Nature-Based Features (NNBF).
- Improve protection from and resilience to coastal storm events.
- Maintain uninhibited drainage associated with secondary flooding.



Fundamental Perspective for Concepts

- During a severe tropical storm event, the storm surge and subsequent secondary flooding will impact (exploit) and exasperate, respectively, weak points along the coastline.
- Concepts were developed to:
 - Reduce the interaction of storm energies with sensitive areas along the coastline.
 - When possible, reduce storm flood volumes entering the mainland.
 - Allow for maximum passive flood withdraw back into the Gulf as soon as the surge event has passed.
 - Provide for NNBF concepts that are resilient.
 - When practical, allow for dredged material beneficial reuse.
- Multiple NNBF concepts were generated that are distributed along the entire Collier County coastline.
- Stabilized passes have a better chance of staying clear, requiring less maintenance.

Concept Considerations

Ecological:

- Maximize coastal habitat enhancements, restoration, and/or creation
- Retain Land-Water connection
- Improve habitat resilient
- Eco-Specifics:
 - Sea turtle nesting habitat
 - Shorebird nesting habitat
 - Avoid/limit coral/hard bottom habitat
 - Avoid/limit SAV habitat

Storm Protection:

- Maximize reduction of wave and surge energy prior to contact to sensitive features
- When possible, minimize (not block) landward migration of surge volumes
- Allow for post storm drainage of flood volumes

Ecosystem Services:

- Does not ignore or impact Social/Environmental Justice areas.
- Aesthetics
- Beach utilization
- Maintain water access & improved water activities (e.g., fishing, snorkeling)
- Reduced needs and frequencies associated with beach nourishment

Eight (8) Concepts

Concepts:

- Wiggins Pass
- Clam Pass – South
- Doctors Pass – South
- Gordon Pass
- Little Marco Is., Cannon Is., Umbrella Is. and Johnson Is. Complex
- Marco Island – North
- Marco Island – South
- Everglades City and Chokoloskee



Wiggins Pass



Wiggins Pass



- Persistent erosion scarring along forest edge.

Wiggins Pass



Wiggins Pass

Primary natural protection for the marina community is degrading.



Wiggins Pass

Prior to Hurricane Ian, the marina community was surrounded by docks.



Wiggins Pass

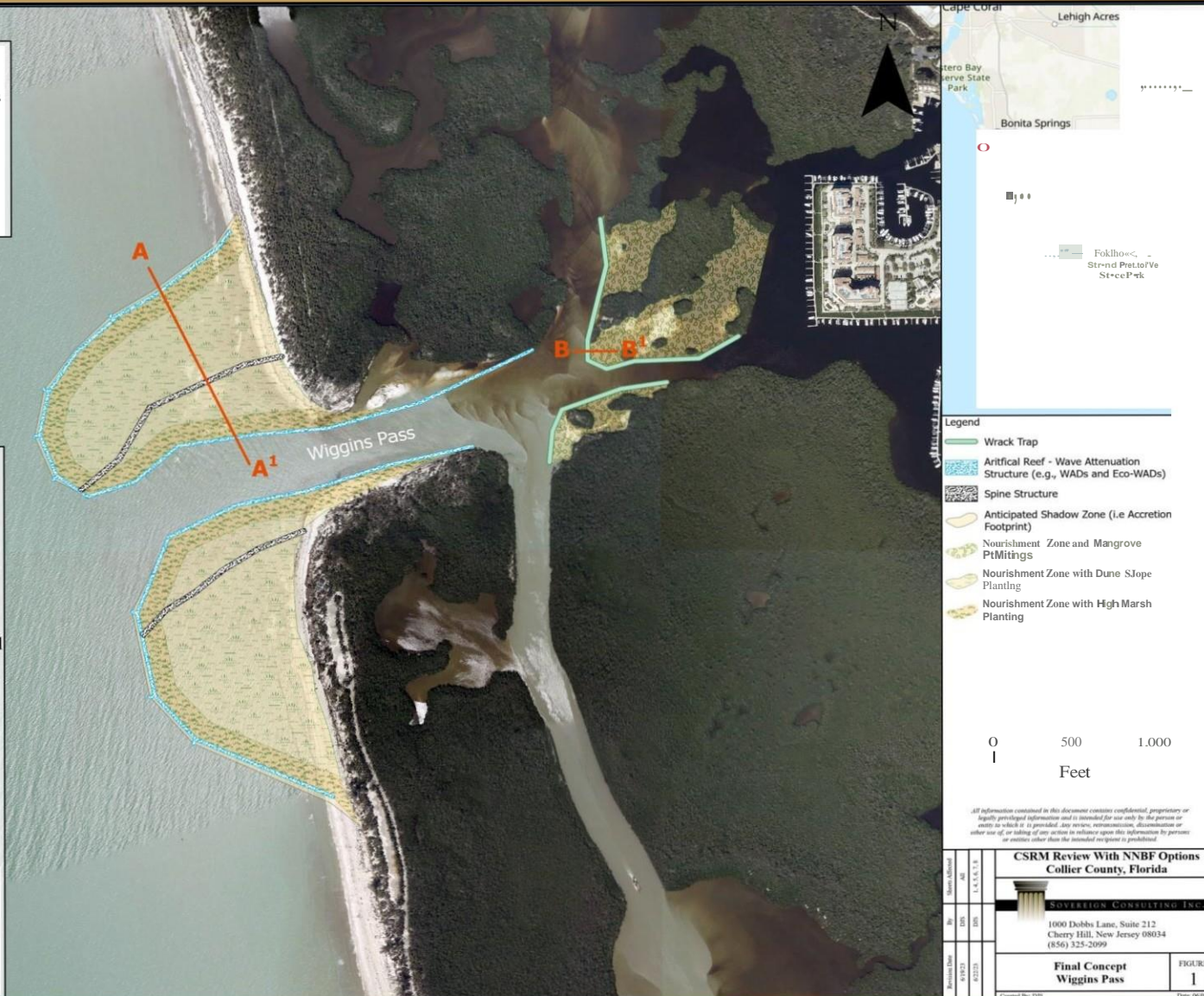
Objective:

Providing added NNBF for stabilization of Wiggins Pass by:

- Protecting the mouth of Wiggins Pass with a pair of reinforced dune systems.
- Protecting the complex of marinas located on the Cocohatchee River by restoring, reinforcing, and enhancing the western island buffers area.

Elements / Benefits:

- Dunes:
 - Installing an artificial reef-type energy attenuation structural toe at the base of the dune. The main reef structure includes periodic, short, perpendicular extensions to reduce parallel scouring and promote Gulf-side accretion near base of toe.
 - Creating long gentle-sloped, vegetated dunes to help dampen storm energy while providing high ecological function and maintaining aesthetics.
 - Installing a dune spine which would serve as a wave dampening structure should the dune be eroded during a major storm event.
- Buffering Islands:
 - Installing wrack trap-type toe protection at the base of the impacted and vulnerable shoreline at and near the fragmented mangrove islands.
 - Nourishing the protected areas to provide for the proper mangrove platform elevation for plantings.
 - Revegetating the unvegetated areas within project footprint.
- The proposed features will help reduce storm energy impacting Wiggins Pass without inhibiting post-flood event drainage.
- Structural components provide for long-term stabilization and resilience.



Wiggins Pass

A

A¹

Gulf of Mexico

Wiggins Pass

604 ft. Wide; 1.2% Slope

374 ft. Wide; 1.9% Slope

2 ft. Height

2 ft. Height - MHW
MLW

Passive
Accretion

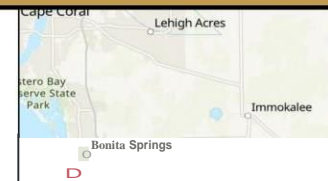
5 ft. Wave
Attenuation
(Toe)

Nourishment

Artificial Wave
Structures
(Dune Spine)

Artificial Wave
Structures
(Toe)

Profile View (nts)



Legend

- Conc. t.u. al Existing Substrate
- Nourishment Zone
- Passive Accretion Zone



CSRM Review With NNBF Options
Collier County, Florida

SOVEREIGN CONSULTING INC.

1000 Dobbs Lane, Suite 212
Cherry Hill, New Jersey 08034
(856) 325-2099

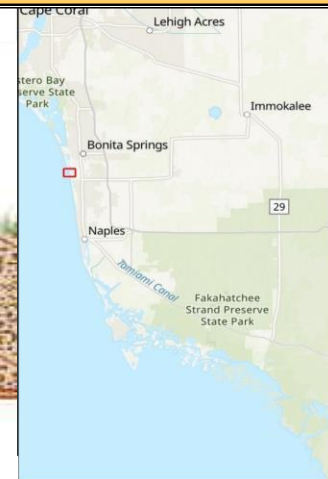
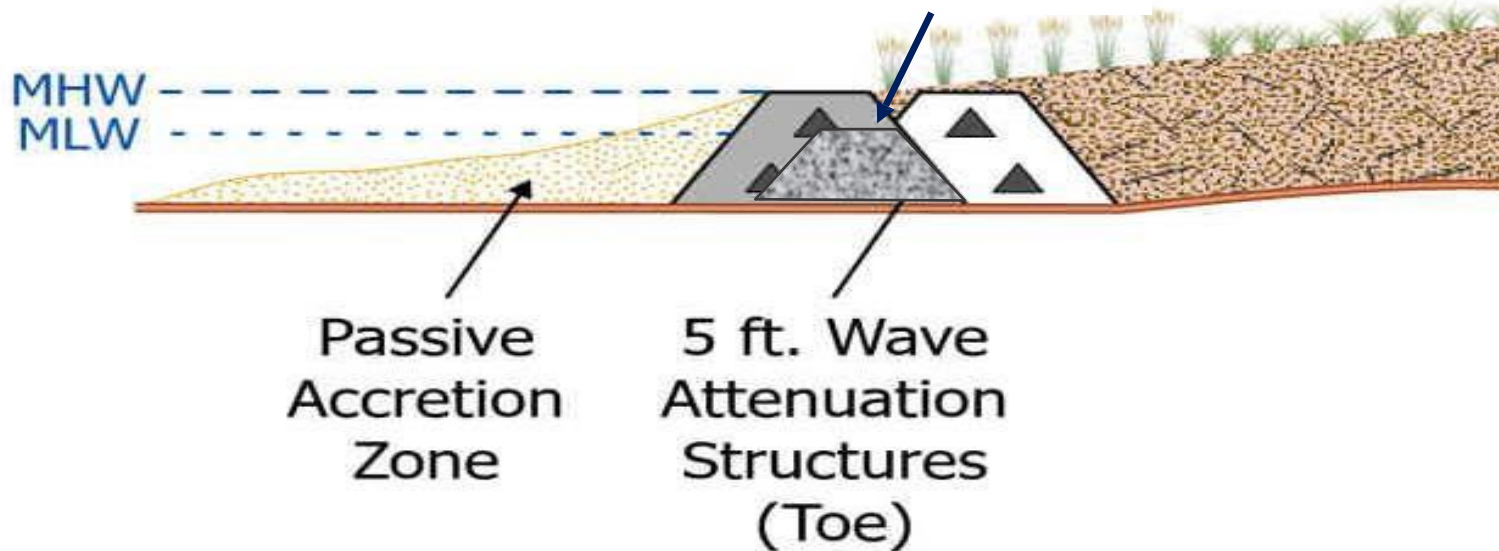
Final Concept
Wiggins Pass
Spine Detail

FIGURE:
1a

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Wiggins Pass

Size of structures at dune toe can be adjusted or stepped.



- Legend
- Conceptual Existing Substrate
 - Nourishment Zone
 - Passive Accretion Zone

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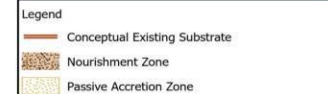
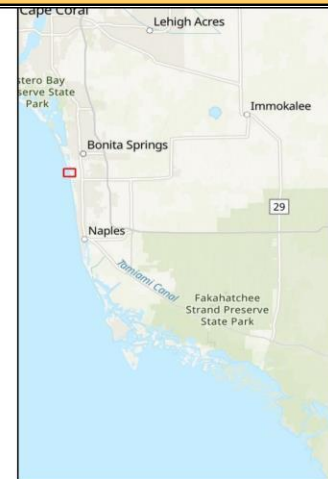
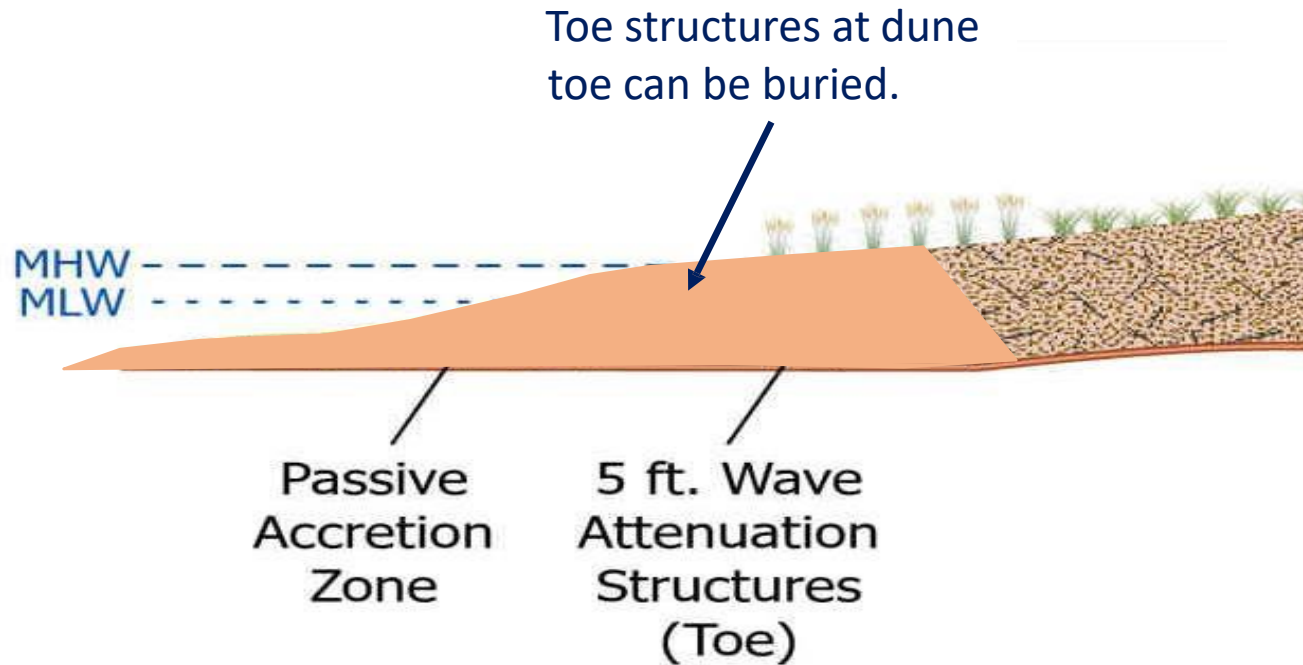
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| Final Concept Wiggins Pass Spine Detail | |
| Revised Date | 6/10/23 |
| By | DM |
| Checked | ALL |

FIGURE:
1a

Created By: DM Date: 06/10/23



Wiggins Pass



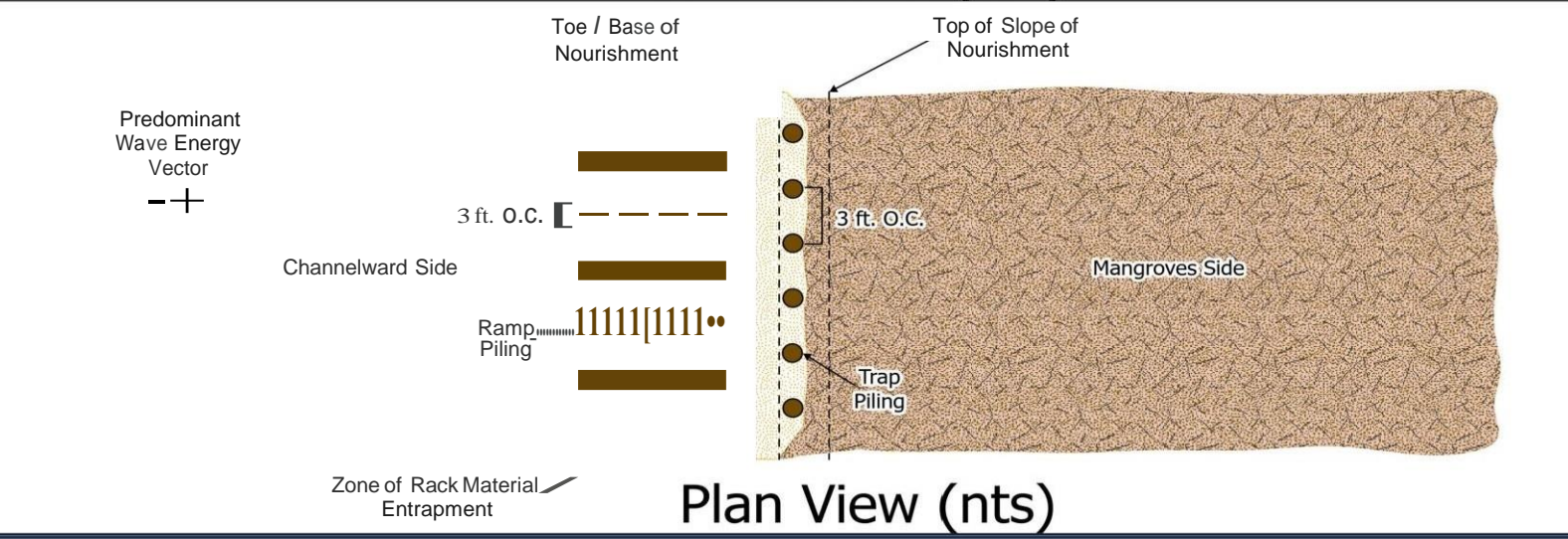
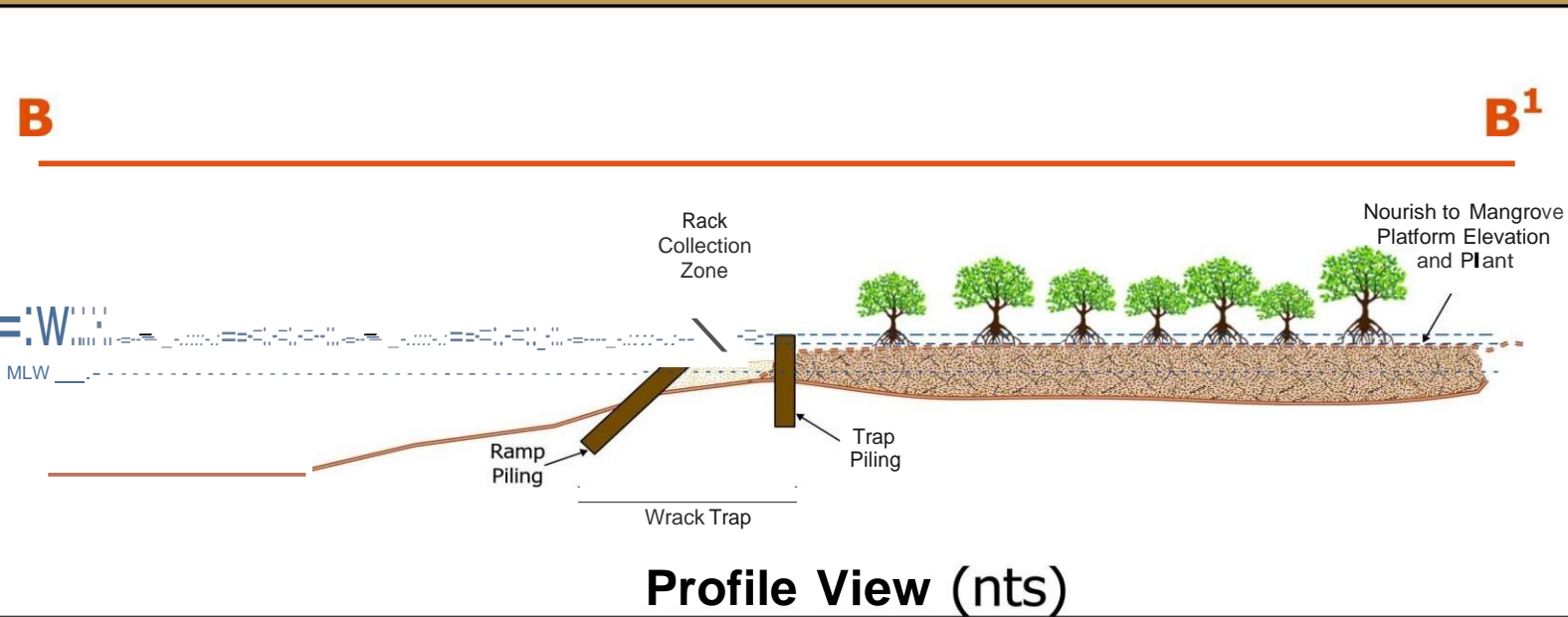
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| | DR | 1000 Dobbs Lane, Suite 212 | |
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| Final Concept | | | FIGURE: |
| Wiggins Pass | | | 1a |
| Spine Detail | | | |

Created By: DR Date: 06/10/23



Wiggins Pass



Cape Coral
Lehigh Acres
Immokalee
Bonita Springs
Naples
hUahat'lee Str'nd Preserve State Park

Legend

- Conceptual Existing Substrate
- Proposed Mangroves Platform
- Nourishment Zone
- Passive Accretion Zone
- Pilings

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| | | | |
| 1000 Dobbs Lane, Suite 212 Cherry Hill, New Jersey 08034 (856) 325-2099 | | | |
| Final Concept Wiggins Pass Wrack Trap Detail | | | FIGURE: 1b |

Clam Pass - South



Clam Pass - South



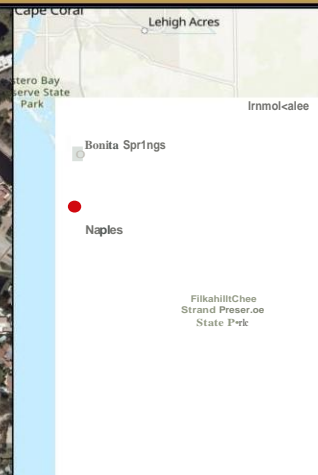
Clam Pass - South

Objective:

Widening of the natural coastal storm buffer. The widening of the buffer reduces the chance of a shoreline breach during severe storm event, which could put residents near Clam Bay at elevated risk.

Elements / Benefits:

- Nourishing the existing landside mangrove stand to 12 inches above existing mangrove platform (to allow for settlement).
- Planting with mangroves and marsh grasses.
- Providing greater resilience to coastal buffer.
- Strategically providing additional mangrove habitat.



Legend
Nourishment Zone and Planting Area

0 500 1,000
Feet

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Collier County, Florida

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Cherry Hill, New Jersey 08034
(856) 325-2099

**Final Concept
Clam Pass - South**

FIGURE:
2

Created By: DJS Date: 06/19/23



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Clam Pass - South



Doctors Pass - South



Doctors Pass - South



Doctors Pass - South



Doctors Pass - South



Doctors Pass - South

Objective:

Improving retention of beach nourishment by installing artificial reef structures, for:

- Attenuating parallel "shoreline drift" energies.
- Greatly reducing downdrift scouring,
- Providing for a more resilient and wider beaches.

Elements / Benefits:

- Retrofitting breakwater structures located immediately south of Doctors Pass with artificial reef structures to provide a more resilient and even beach front and increase coastal habitat.
 - Installing (non-stone) artificial reef structures at selected jetties/storm water (SW) outfalls
 - Starting 10 ft. landward of jetty/SW outfall (waterward end).
 - Tying in on the south- side of existing structures.
 - Artificial reefs extending from jetties and SW outfalls will extend out at a 45° angle with the top of structure elevations not exceeding the MHW.
- Designated lengths of artificial reefs are estimated but will be designed proportional to the length of beach being protected.
- The height and position of artificial reefs will be designed to minimize any aesthetic impacts.
- Creating stable and wider beaches.
- Reducing wave energy during storm events.
- Maximizing natural low or high dune development potential.



Gordon Pass



Gordon Pass

Objective:

Providing added NNBF for the stabilization of Gordon Pass by:

- Placing a pair of low reefs (top of reef at MHW) north and south of the pass opening.
- Placing a structural energy dampening structure at the first bend of the pass to reduce storm energy and scour.

Elements / Benefits:

ReefToe Structures:

- Two long, linear reef toe structures with periodic, short, perpendicular extensions for reducing parallel scouring and promoting Gulf-side accretion near base of toe.
- Allowing for the landward cells to be nourished.
- Providing for retention of nourishment.
- Interior channel reef/scour protection for:
 - Navigating energy around bend.
 - Zone of accretion is identified, however, this area may be nourished or used as a dredged material reuse site.
- Large natural areas of accretion can develop resulting in:
 - Depth-limited wave heights.
 - Development of a large wave break zone.
 - Reduction of the energy contacting uplands.
 - Reduced maintenance of pass channel.
 - More stable channel shoreline habitat.



Map of the study area showing the location of Gordon Pass relative to Naples, Bonito Springs, and Lehigh Acres. The map includes labels for 'Naples', 'Bonito Springs', 'Lehigh Acres', 'Sovereign Bay Preserve State Park', and 'Naples'. A red dot marks the location of the study area.

Legend

- Artificial Reef - Wave Attenuation Structure (e.g., WADs and Eco-WADs)
- Anticipated Shadow Zone (i.e. Accretion Footprint)

0 300 600
Feet

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| Final Concept Gordon Pass | FIGURE: 4 |

Revised Date: 8/19/2020
By: JCS
Checked By: JCS

Little Marco Is., Cannon Is., Umbrella Is. and Johnson Is. Complex



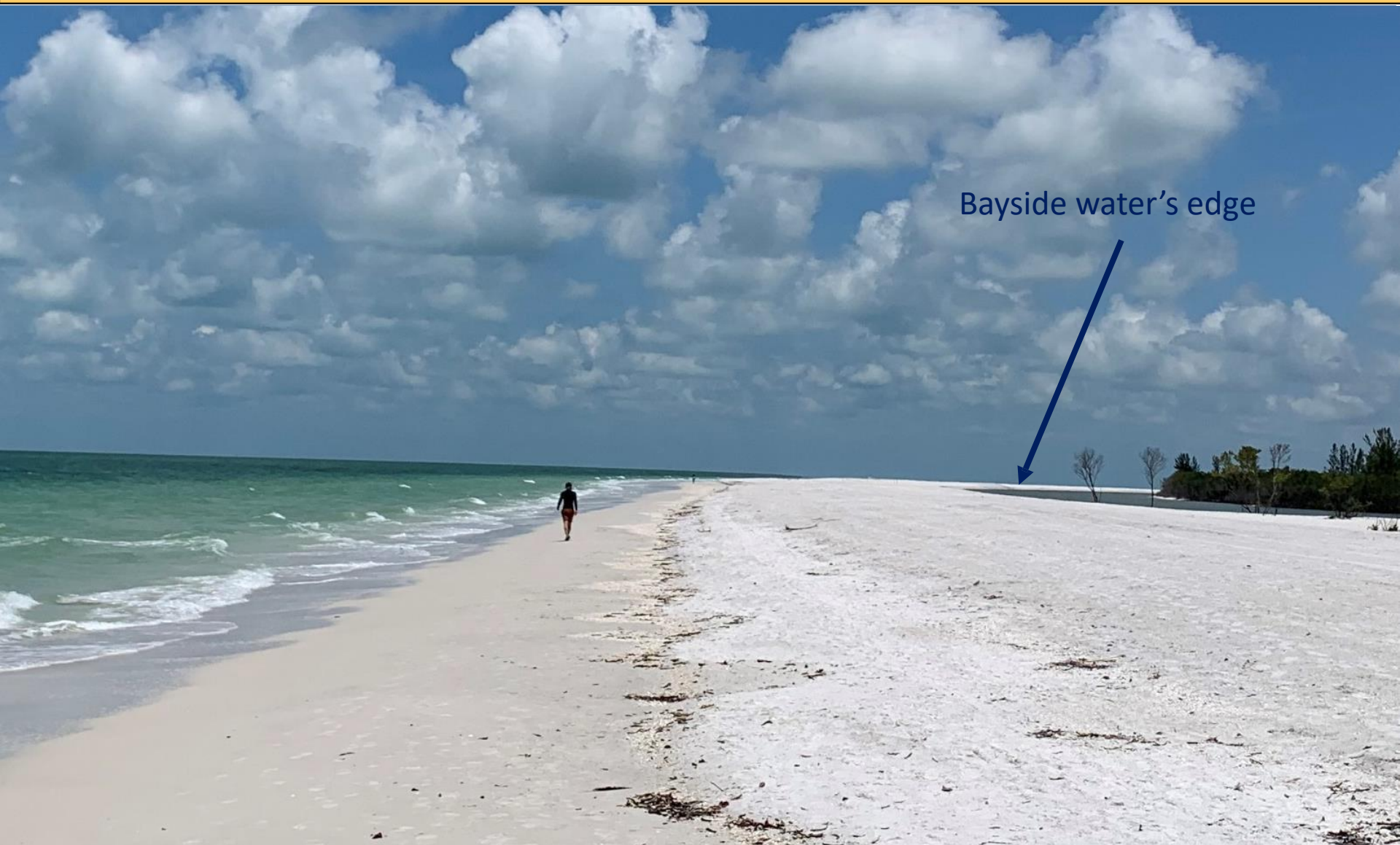
Marco Island - North



Marco Island - North



Marco Island - North



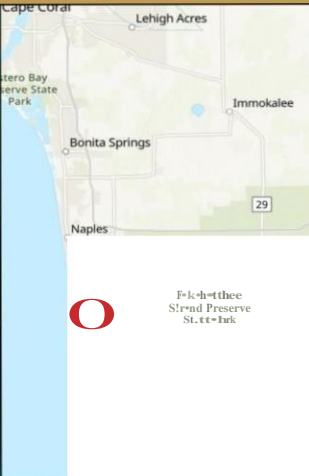
Bayside water's edge



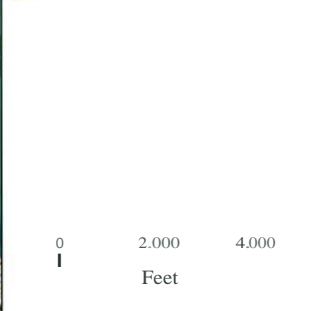
Marco Island - North

- Objective:**
- Providing NNBF for resilient stabilization and protection of Big Marco Pass, Isle of Capri, Coconut Island, North Point, and Hurricane Pass.
 - Features helping with the stabilizing of the size of the passes and providing for NNBF storm surge protection.

- Elements / Benefits:**
- Installing artificial reef toe and reinforced dune system to protect and increase the footprint of barrier islands and exposed linear land masses.
 - The nourishment area design may incorporate future dredged material re-use during pass maintenance.
 - The reef toe structure and dune spine would be buried, minimizing aesthetic issues.
 - The main reef structure includes periodic, short, perpendicular extensions for reducing parallel scouring and promoting Gulf-side accretion near the base of the toe.



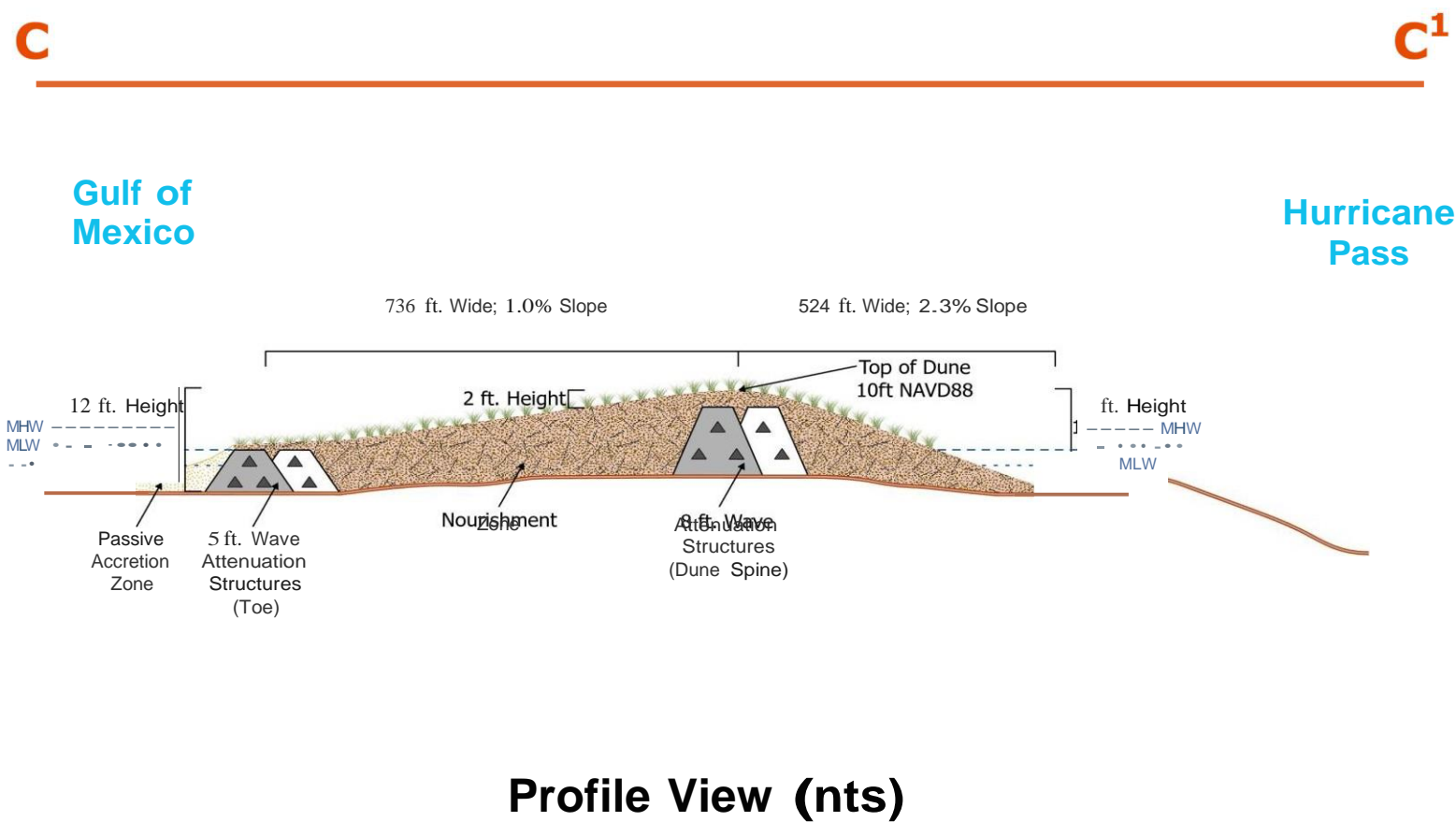
- Legend**
- Artificial Reef - Wave Attenuation Structure (e.g., WADs and Eco-WADs)
 - Spine Structure
 - Anticipated Shadow Zone (i.e. Accretion Footprint)
 - 9-10ft NAVD88 Planted Dune



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| Final Concept Marco Island - North | | | FIGURE 6 |

Marco Island - North



Profile View (nts)

Legend

- Conceptual Existing Substrate
- Nourishment Zone
- Passive Accretion Zone

CSRM Review With NNBF Options
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Final Concept
Marco Island - North
Spine Detail

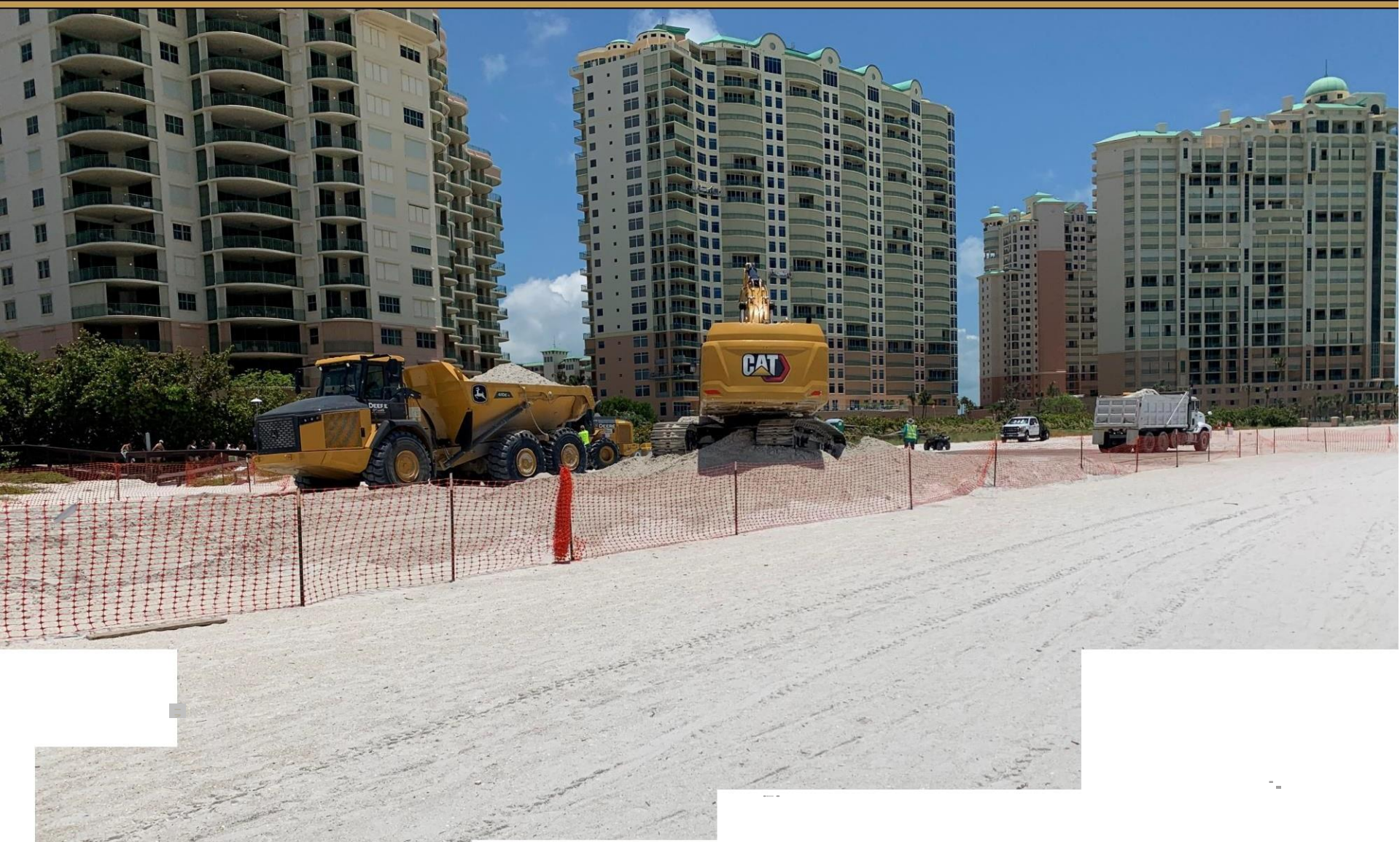
FIGURE:
6a

Date: 06/10/14

Marco Island - South



Marco Island - South



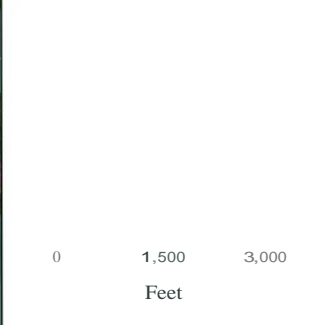
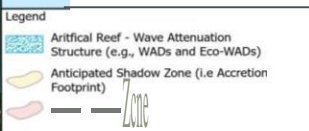
Marco Island - South

Objective:

- Providing NNBf for the resilient stabilization and protection of Caxambas Pass, Cape Marco, Henry Key, Dickmans Island, and Northern Ten Thousand Island.
- These features are “anchor” landmasses which protect the southern face of Marco Island and Highland Point.

Elements / Benefits:

- Installing artificial reef system will dampen wave energy and rejuvenate sand bar/beach complex along Dickmans Island and northern Ten Thousand Island by natural accretion or nourishment.
- The existing breakwater configuration at Cape Marco splits shoreline drift and northern storm vector, increasing scour. Installing an artificial reef toe and point nourishment will form high beach/low dune, resulting in:
 - Enlarged beach area.
 - Elimination of nearshore scour.
 - Improved aesthetics.
- Gap Reef:
 - Protecting Henry Key.
 - Reducing excessive width of pass.
 - Providing a more stabilized bar.
 - Configuration providing for:
 - Directed accretion.
 - More stable navigation channels.
 - Anticipated reduction of silting-in of channels (i.e., reduced routine maintenance).



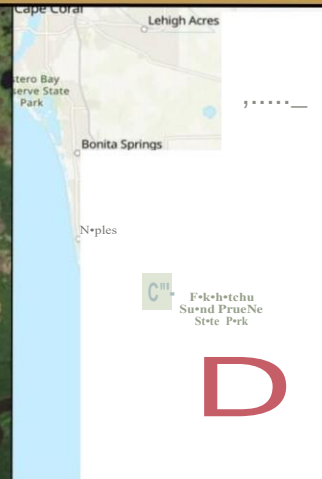
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| Final Concept Marco Island - South | | | FIGURE: 7 |

Everglades City & Chokoloskee

Objective:

- Existing mangrove island complex provides for an excellent natural buffer for Everglades City and Chokoloskee from storm events.
- The Island Complex is degrading.
- Providing a series of artificial reefs to hold the toe of the island complex and offer additional NNBF protection, without impacting the existing navigation.



- Legend
- Artificial Reef - Wave Attenuation Structure (e.g., WADs and Eco-WADs)
 - Anticipated Shadow Zone (i.e. Accretion Footprint)

0 5,000 10,000
Feet

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Cherry Hill, New Jersey 08034
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Final Concept
Everglades City & Chokoloskee
(Rabbit Key Pass north to West Pass)

FIGURE 8

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Elements / Benefits:

- Providing for passive accretion from the artificial reefs and providing for additional habitat and wave dampening.
- Work staging and barging from Everglades City and Chokoloskee, infusing money into the community.
- Note: Reef would need to extend into the south beyond County limits.

Pros, Cons, Benefits, Recommendations

| | Site | Ecosystem Uplift | Storm Protection Improvement | Ecosystem Services | Community Acceptance |
|---|---|------------------|------------------------------|--------------------|----------------------|
|  | Wiggins Pass | + | + | + | + |
|  | Clam Pass – South | + | + | + | + |
|  | Doctors Pass – South | + | + | 0 | 0 |
| | Gordon Pass | + | + | 0 | 0 |
| | Little Marco Is., Cannon Is., Umbrella Is. and Johnson Is. | + | + | - | - |
|  | Marco Island – North | + | + | + | + |
|  | Marco Island – South | + | + | + | 0 |
|  | Everglades City and Chokoloskee | + | + | 0 | + |

 Top Opportunities

 Low Hanging Fruit

+ Clear benefit(s)

- Unclear/absent benefit(s)

0 Pro/cons cancel or not obvious





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AN ENVIRONMENTAL SERVICES FIRM



NONSTRUCTURAL AND NNBF ALTERNATIVES FOR COLLIER COUNTY COASTAL STORM RISK MANAGEMENT (CSRM) FEASIBILITY STUDY (FS) DRAFT CONCEPTS

FOR ADDITIONAL INFORMATION:

GREG JANIEC – gjaniec@sovcon.com

DOUGLAS JANIEC – djaniec@sovcon.com