

Blue Lake Phase 2 Shoreline Stabilization Plan

CUMMINS | CEDERBERG
Coastal & Marine Engineering

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Key Team Members



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Goals

Conduct a Site Inspection

Conduct a site visit to **inform existing shoreline conditions** including topography, existing retaining wall condition, shelf width, exposure to wind and wave conditions

Characterize the Existing Shoreline and Retaining Wall

Create a series of criteria to characterize the Phase 2 shoreline in terms of shoreline exposure
(Immediate Action, Future Action, Monitor)

Develop Shoreline Stabilization Alternatives

Identify **viable shoreline stabilization solutions** to protect each criteria of shoreline against **toe scour, shelf erosion, seawall overloading** from wind and wave conditions (where exposed)

Create a Shoreline Stabilization Plan

Creation of a shoreline stabilization plan with recommended solutions for each section of shoreline based on **cost, aesthetic, constructability, CDD feedback, and monitoring**

Process

Site Visit

- *Observe existing shoreline topography, bathymetry, retaining wall condition, littoral shelf limitations, existing docks, vegetation, and surrounding land uses house-by-house*
- *Photograph and GPS*

Shoreline and Retaining Wall Criteria and Categorization

- *Create three criteria to characterize the shoreline based on exposure to wind and wave conditions, littoral shelf limitations, and the condition of the existing retaining wall*
- *Protected, Vulnerable, Vulnerable (Narrow)*

Shoreline Stabilization Alternatives

- *Develop a series of effective shoreline stabilization options for each criteria of shoreline.*
- *Perform a qualitative assessment of the pros/cons, evaluate effectiveness, and provide a rough order or magnitude cost*

Shoreline Stabilization Plan

- *Provide recommendations for each stretch of shoreline*
- *Provide recommendations for monitoring*
- *Provide recommendations for maintenance*
- *Provide recommendations for inspections*

Retaining Wall Condition Assessment

- The retaining wall was observed to be “intact and plumb” or “intact but undulated”
- Location-specific defects
 - Failed tie-rod
 - Small crack in wall
 - Loose tieback anchor plate
 - Loose tie-back anchor
 - Sheets cut at the mudline with a void underneath



Retaining wall “intact and plumb”



Retaining wall “intact but undulated”

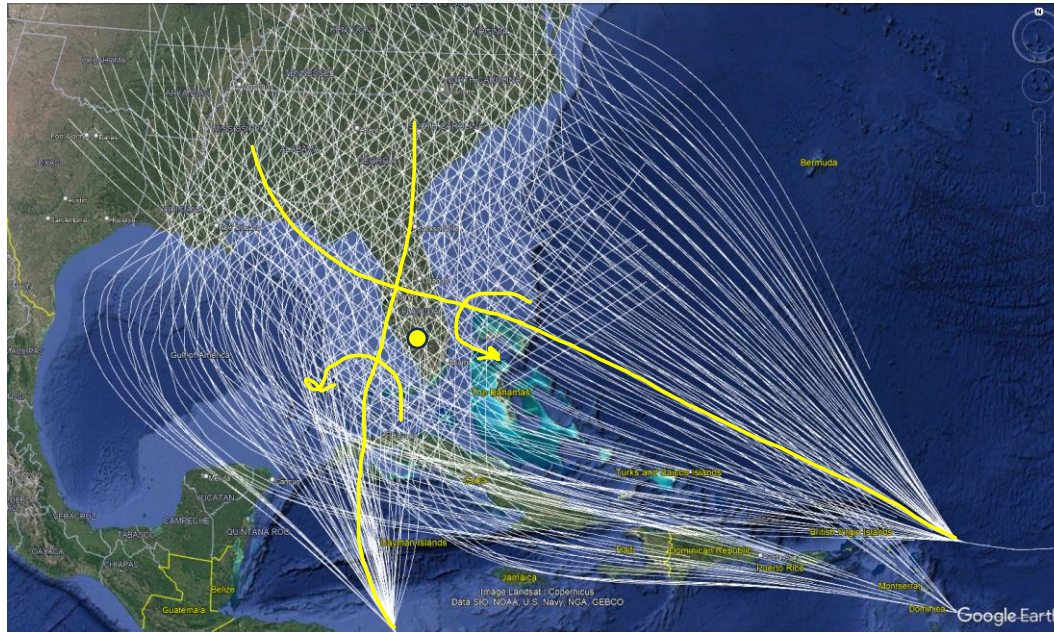
Retaining Wall Condition Assessment

- “Intact and Plumb” approximately 7,800 LF
- “Intact but Undulated” approximately 4,100 LF
- No large-scale repairs to the existing retaining wall are anticipated
- Minor repairs should be addressed during Phase 2

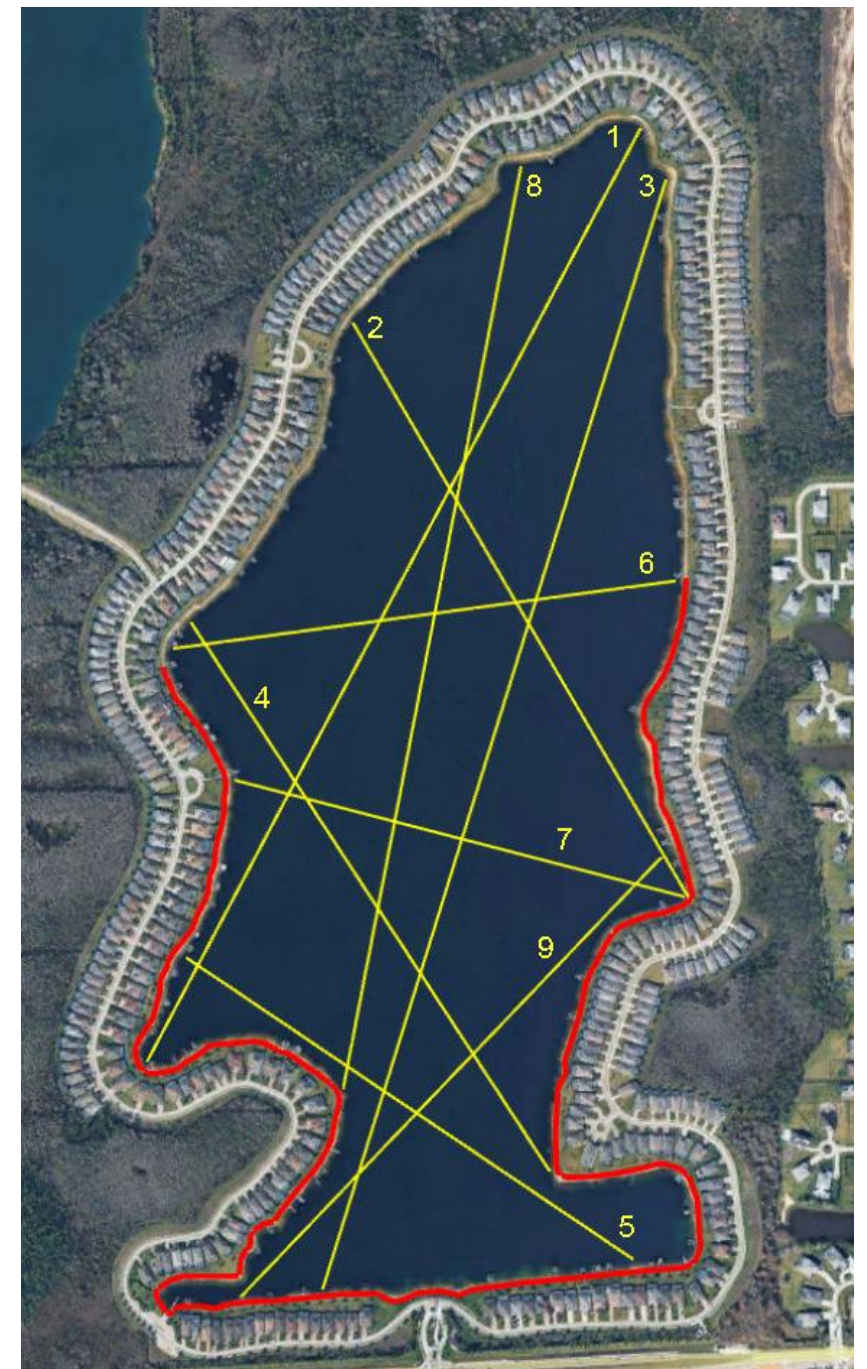


Fetch Analysis and Exposure

- Determine areas of wind-wave exposure and estimated wave heights



Potential Hurricane Tracks



Fetch Analysis

- Estimated wave heights of up to 1.56' across Project Area
- Wave height limited by water depth "depth limited"
- Water depth with 1' of surge assumed at 19.3' NAVD (C.E.)
- Water depth lowered due to conversations with residents/CDD claiming depths 2-3' lower than usual

TABLE 2: PRELIMINARY WAVE CONDITIONS

Fetch ID	Distance (ft)	10-Year Storm (10% Chance Per Year)		25-Year Storm (4% Chance Per Year)		50-Year Storm (2% Chance Per Year)	
		Wave Height (ft)	Wave Period (s)	Wave Height (ft)	Wave Period (s)	Wave Height (ft)	Wave Period (s)
1	5142	1.56	2.0	1.56	2.2	1.56	2.3
2	3247	1.56	1.7	1.56	1.9	1.56	2.0
3	5661	1.56	2.1	1.56	2.3	1.56	2.4
4	3200	1.56	1.7	1.56	1.9	1.56	2.0
5	2632	1.50	1.6	1.56	1.8	1.56	1.9
6	2477	1.45	1.6	1.56	1.7	1.56	1.8
7	2266	1.39	1.5	1.56	1.7	1.56	1.8
8	4569	1.56	2.0	1.56	2.1	1.56	2.2
9	2966	1.56	1.7	1.56	1.8	1.56	1.9

TABLE 3: EXTREME WIND SPEEDS (1-HR SUSTAINED)

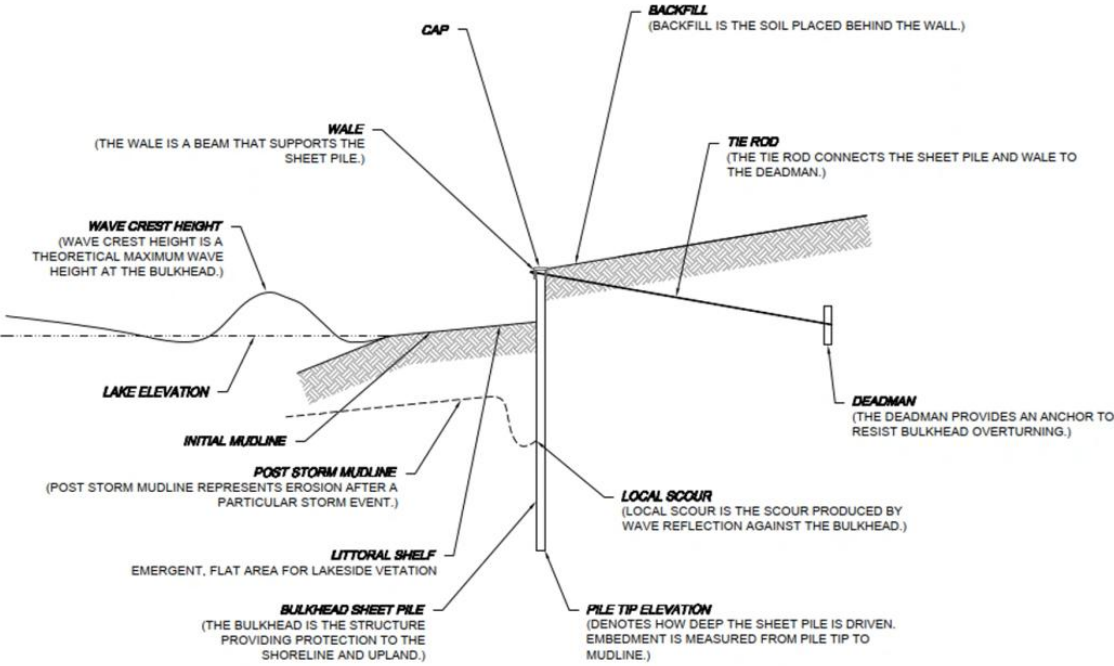
Return Period, Years	Wind Speed (mph)
10 (10% Chance Per Year)	60.5
25 (4% Chance Per Year)	72.6
50 (2% Chance Per Year)	83.8
100 (1% Chance Per Year)	93.9

Shoreline Condition and Exposure Criteria

- **Vulnerable** – exposed to wind and wave action with retaining wall intact – requires protection (~7500 LF)
- **Sheltered** – not anticipated to be impacted by future storms – needs little to no protection (~3200 LF)
- **Vulnerable (Narrow Shelf)** – still exposed to wind/waves with wall intact but have a narrow shelf (less than 15' – limits alternatives) (~1200 LF)



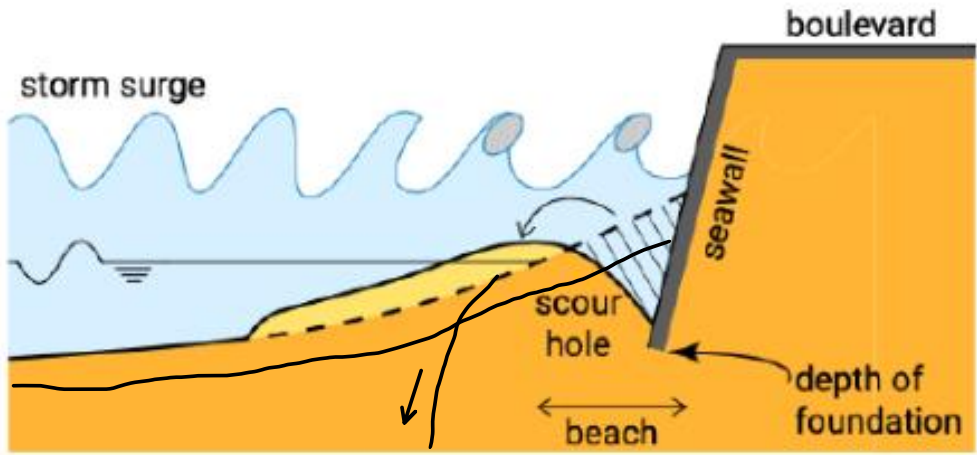
BULKHEAD PRIMER



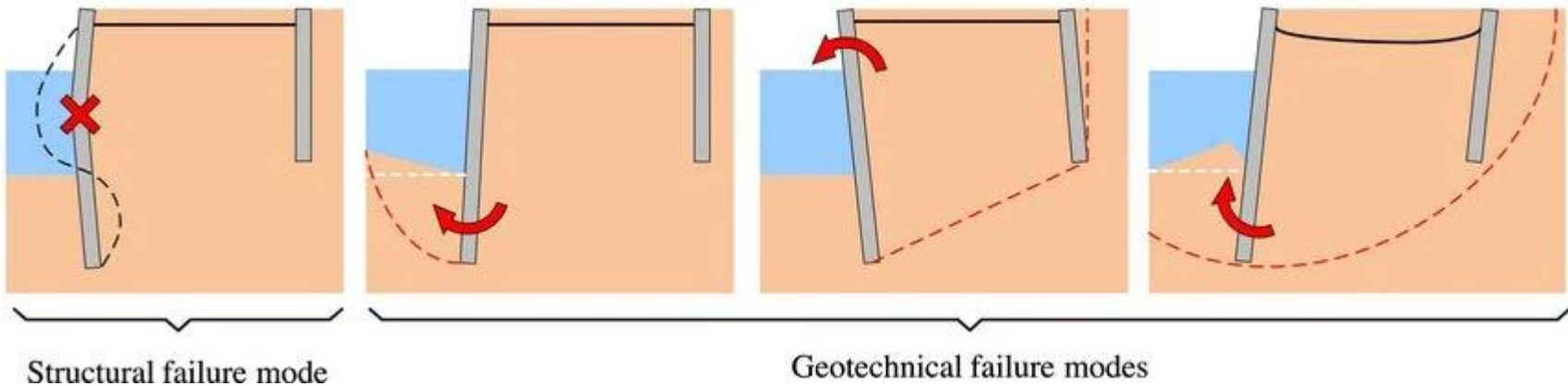
NOTE: NOT TO SCALE

Jonathan Armbruster (External) — +

Shoreline Failure



Erosion & Toe Scour



Seawall Failure

Sheltered (3 Alternatives)

- 1. Existing Conditions – Leaving shoreline as-is (minimal protection)
- 2. Shoreline Plantings – Provide limited erosion protection (Provide a level of service (LOS) of less than 5 years).
- 3. Concrete Erosion Control Mats – Small pre-cast concrete units embedded into a geogrid mesh. Provide erosion and scour protection but variable wave protection. Installed landward of the retaining wall (10 – 15 year LOS*).



Shoreline Plantings



Concrete Erosion Control Mats (FlexMat)

Sheltered (3 Alternatives)

- 1. Existing Conditions – Leaving shoreline as-is (least protection)
- 2. Shoreline Plantings – Provide minimal erosion protection (Provide a level of service (LOS) of <5 years).
- 3. Concrete Erosion Control Mats – Small pre-cast concrete units embedded into a geogrid mesh. Provide erosion and scour protection but variable wave protection. Installed landward of the retaining wall (10 – 15 Year LOS*).



Concrete Erosion Control Mats (FlexMat)



Anchor for Concrete Erosion Control Mats

Vulnerable (7 Alternatives)

- 1. Existing Conditions - leaving shoreline as-is (least protection)
- 2. Articulated Concrete Block Mats (ACB) - Heavy, pre-fabricated concrete block mats strung together by cables. Provide a high level of erosion, scour, and wave action. Installed waterward of retaining wall (50-Year LOS*).
- 3. Marine Mattresses - Polymer mesh filled with bedding stone installed landward of retaining wall. Provide a high level of erosion and scour protection (50-Year LOS*).



Open-Celled ACBs - vegetation can be installed



Marine Mattresses - vegetation will not develop

Vulnerable (7 Alternatives)

- 4. Rock Revetment – Multiple layers of armor stone installed waterward of retaining wall. Provides a high level of protection against erosion, scour, and withstands wave action. Unrestrained. 50-Year LOS*
- 5. Toe Stones – Thin layer of armor stone installed directly in front of retaining wall. Provides protection against scour. Erosion protection limited by small footprint. Unrestrained. 50-Year LOS*



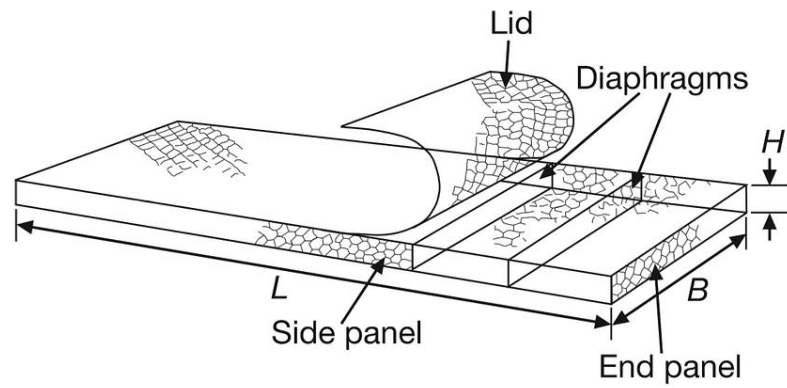
Rock Revetment



Retaining Wall with Toe Stones

Vulnerable (7 Alternatives)

- 6. Rock Revetment with Marine Mattresses – Highest level of protection against erosion, scour, and wave action. Phase 1 design. 50-Year LOS.
- 7. Metal Mattresses – Steel mesh filled with smaller stones to form a mattress. Provide a high level of protection against erosion, scour, and withstand wave action. Installed waterward of retaining wall. 50-Year LOS*



Link Mattress



Rock Revetment with Marine Mattresses



Metal Mattresses – Vegetation can be Incorporated

Vulnerable (Narrow Shelf) (4 Alternatives)

- Shelf is less than 15' wide (limited footprint)
- 1. Existing Conditions – Leaving shoreline as-is (least protection)
- 2. Vinyl Retaining Wall – Demolition of the existing wall and installing new, more robust wall. Designed for erosion, scour, and wave action. 50-Year LOS.
 - Longer Sheets
 - Longer Tie Backs (e.g., helicals)
 - Stronger Cap (e.g., concrete)



Existing Conditions (Narrow Shelf)



Vinyl Retaining Wall

Vulnerable (Narrow Shelf) (4 Alternatives)

- 3. Rock Revetment with Marine Mattresses and Rock Apron (Phase 1 Design) - Demolition of the existing wall with landward installation of armor stones, marine mattresses, and rock apron. 50-Year LOS.
- 4. Metal Mattresses - Demolition of the existing wall with landward installation of metal mattresses. 50-Year LOS.



Rock Revetment with Marine Mattresses and Rock Apron



Metal Mattresses - vegetation can be installed

Breakdown of Options

<u>Stabilization Alternative</u>	<u>Recommended Shoreline for Install</u>	<u>Protects Against Scour</u>	<u>Protects Against Erosion</u>	<u>Rated for Waves</u>	<u>Lower Cost</u>	<u>Aesthetically Pleasing</u>	<u>50-Year Level of Service</u>
Concrete Erosion Control Mats	Sheltered	X	X	X	X	X	*
Shoreline Plantings	Sheltered		X		X	X	
Existing Conditions	Any				X	X	
Articulated Concrete Blocks	Vulnerable	X	X	X			X
Marine Mattresses	Vulnerable	X	X	X	X		*
Toe Stones	Vulnerable	X		X	X	X	*
Rock Revetment	Vulnerable	X	X	X	X	X	*
Rock Revetment with Marine Mattresses	Vulnerable or Vulnerable (Narrow Shelf)	X	X	X			X
Metal Mattresses	Vulnerable or Vulnerable (Narrow Shelf)	X	X	X	X	X	X
Vinyl Retaining Wall	Vulnerable (Narrow Shelf)	X		X		X	X

Rough Order of Magnitude Cost-Estimate Per Linear Foot of Alternative

Shoreline Criteria	Stabilization Method	Cost (Per LF)
Any	Existing Conditions	\$0
Sheltered	Concrete Erosion Control Mat	\$165 - \$170
Sheltered	Shoreline Plantings	\$25 - \$30
Vulnerable	Articulated Concrete Block Mat (ACB)	\$900 - \$940
Vulnerable	Marine Mattresses	\$325 - \$420
Vulnerable	Toe Stones	\$80 - \$85
Vulnerable	Rock Revetment	\$345 - \$360
Vulnerable	Rock Revetment with Marine Mattresses	\$615 - \$640
Vulnerable	Metal Mattresses	\$225 - \$450
Vulnerable (Narrow Shelf)	Metal Mattresses (Demolition of Wall)	\$225 - \$450
Vulnerable (Narrow Shelf)	Rock Revetment with Marine Mattresses and Rock Apron (Demolition of Wall)	\$640 - \$670
Vulnerable (Narrow Shelf)	Vinyl Retaining Wall	\$2,950 - \$3,070

Maintenance & Enhancement Plan Recommendations

- **Sheltered** – Shoreline plantings to provide a degree of erosion protection where not significantly impacted by waves.
- **Vulnerable** – Metal mattresses to provide erosion and scour protection from waves. Incorporate vegetation. Adaptable.
- **Vulnerable (Narrow)** – Rock revetment with marine mattresses and rock apron (Phase 1). Demolition of existing retaining wall with landward installation. Provides erosion and scour protection and withstands wave action.



Metal Mattresses – vegetation can be installed



Rock Revetment with Marine Mattresses and Rock Apron

Maintenance & Enhancement Plan Recommendations

- **Sheltered** – Shoreline Plantings (~3200 LF of shoreline)
- **Vulnerable** – Metal Mattresses (~7500 LF of shoreline)
- **Vulnerable (Narrow Shelf)** – Rock Revetment with Marine Mattresses and Rock Apron with Demolition of Existing Retaining Wall (~1200 LF of Shoreline)
- Total Recommended Costs - **\$2.54M - \$4.25M**
- Cost per LF - **\$215-\$355/LF**

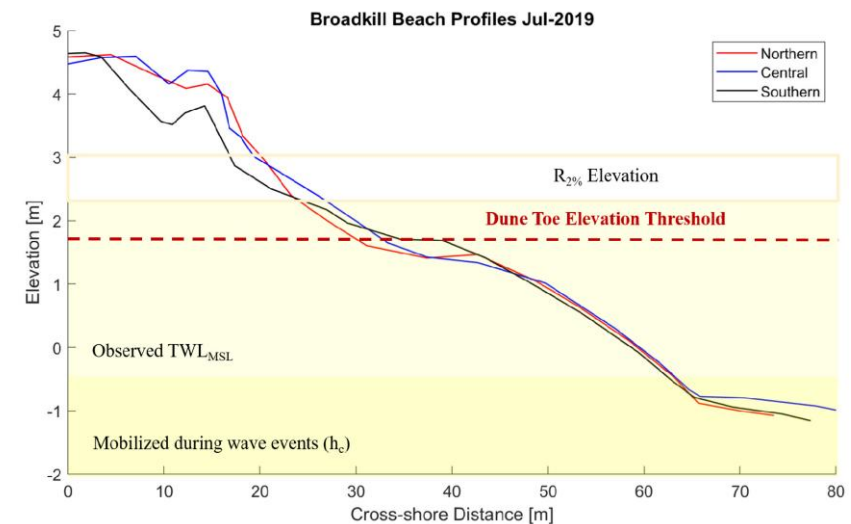
Shoreline Criteria	Stabilization Method	Length of Application (LF)	Total Cost
Sheltered	Shoreline Plantings	3,234	\$81k* - \$84.5k*
Vulnerable	Metal Mattresses	7,464	\$1.68M* - \$3.35M*
Vulnerable (Narrow Shelf)	Rock Revetment with Marine Mattresses and Rock Apron (Demolition of Wall)	1,211	\$775k* - \$810k*
			\$2.54M* - \$4.25M*

*Costs for material and install only. Mobilization, demolition, environmental compliance, layout/as-built surveys, and other associated soft costs (e.g., permitting, design, construction oversight) are not included.

*Final quantities and unit costs may vary as the design is refined

Cummins Cederberg Additional Recommendations

- 1. Establishment of an Annual Monitoring Plan to Evaluate Potential Shoreline Change (**\$25,000 - \$50,000 Annually Estimated**)
 - Similar style to FDEP Beach Monitoring conducted since the 1970s to provide representative cross-sections
 - Use of LiDAR to provide full coverage of shelf topography
 - Installing metal pipe into the existing shelf and monitoring changes visually (no cost anticipated)
 - Surveys recommended to be conducted annually, biannually, or after storm events
 - Recommended for data to be reviewed by a coastal engineer and presented in a Physical Monitoring Report to summarize shoreline position and volumetric changes over time to identify changes and potential recommended actions.



Cummins Cederberg Additional Recommendations

- 2. Develop a Planned Waterfront Inspection Assessment Program to Periodically Assess the Condition of Shoreline Protection Elements **(\$5,000-\$10,000 each inspection)**
 - No more than every 5-6 years (per ASCE MOP 130 for low-salinity conditions, after a severe coastal storm, vessel impact, or other atypical event)
 - Frequency may need to increase based on element conditions



Questions?

