Resilient PASCO

Robert k. Reese Memorial Park Living Shoreline, 2023

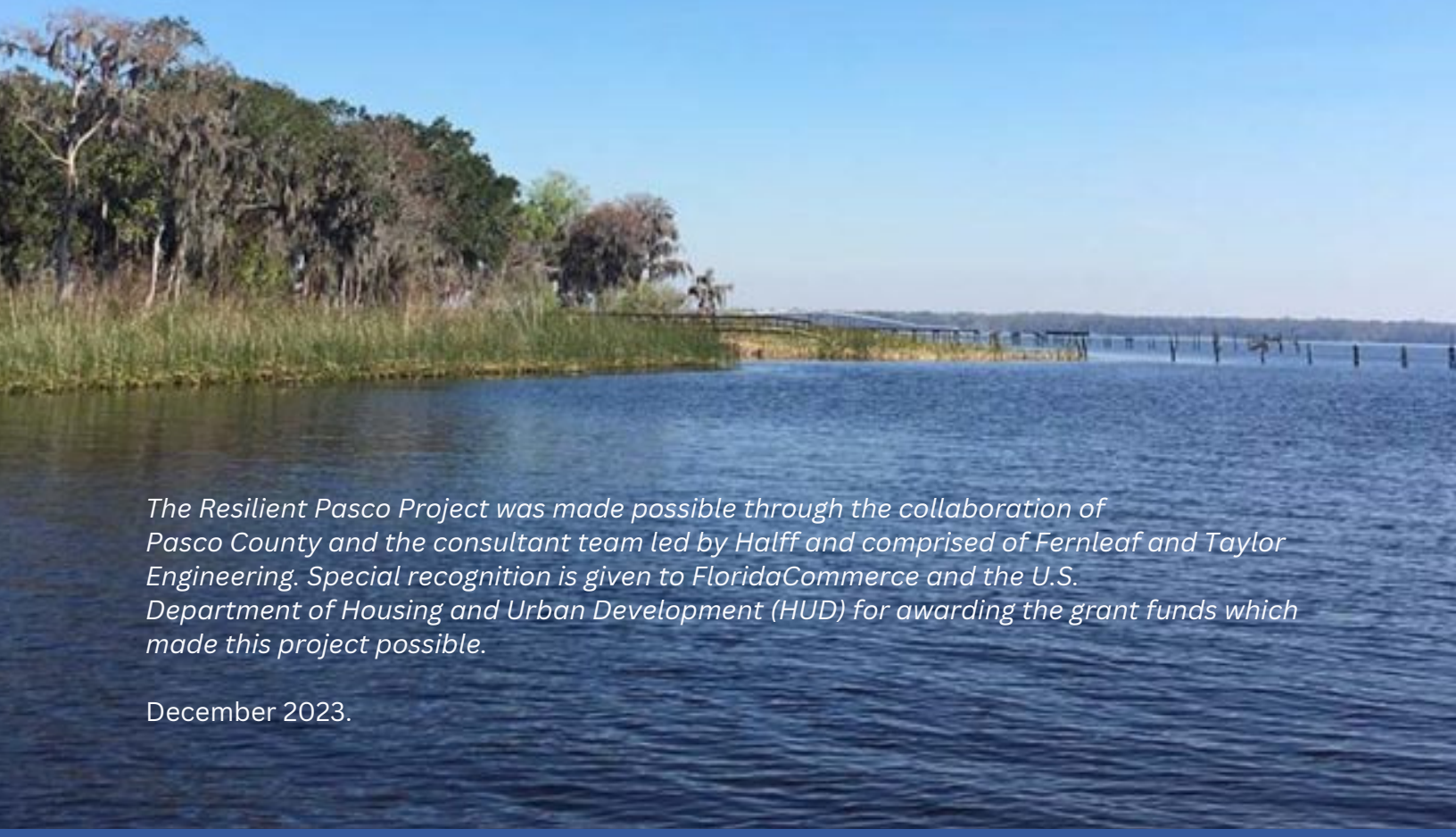
A Homeowner's Guide to Living Shorelines

INTRODUCTION

This guide provides information and resources on the necessary steps to identify, plan for, design, and implement living shorelines in your community.

This Homeowner Guide was developed as part of the Resilient Pasco Project, funded through FloridaCommerce and the U.S. Department of Housing and Urban Development (HUD).

The objective of this guide is to encourage local property owners to seek living shorelines and other types of nature-based solutions.



The Resilient Pasco Project was made possible through the collaboration of Pasco County and the consultant team led by Halff and comprised of Fernleaf and Taylor Engineering. Special recognition is given to FloridaCommerce and the U.S. Department of Housing and Urban Development (HUD) for awarding the grant funds which made this project possible.

December 2023.

WHAT ARE LIVING SHORELINES?

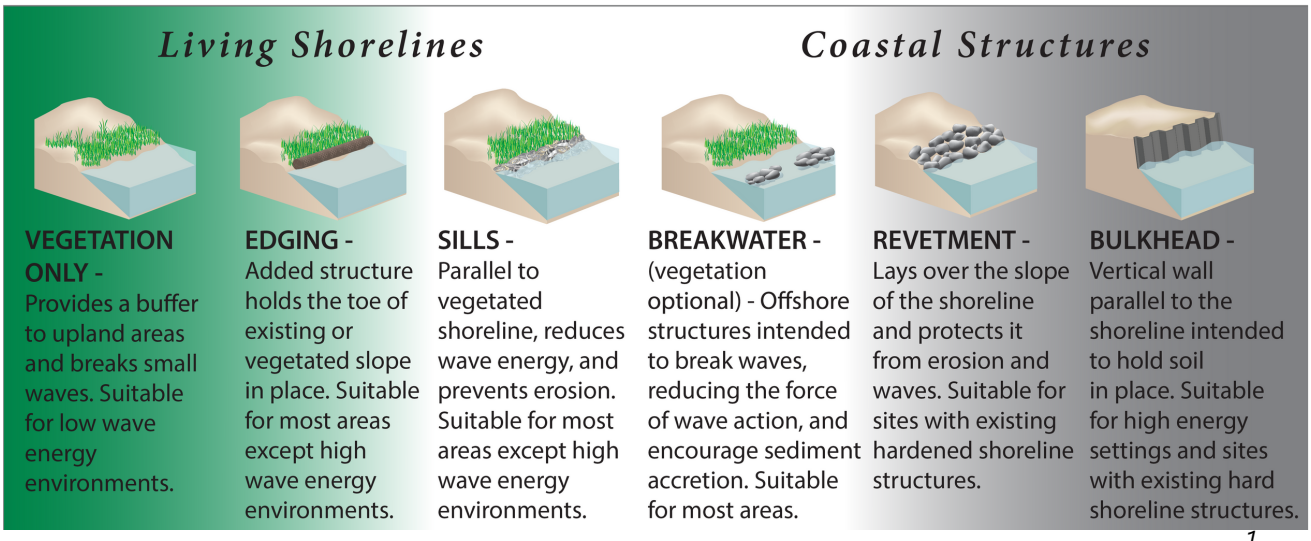
Living Shorelines *- A shoreline management practice that provides erosion control benefits; protects, restores, or enhances natural shoreline habitat; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural organic materials (e.g. biologs, oyster reefs, etc). – NOAA*

Green/ Soft Shorelines primarily use vegetation and natural materials, such as coir/fiber logs and oyster shells, to stabilize the shoreline. This approach often involves planting native vegetation, such as marsh grasses or other coastal plants, to absorb wave energy, reduce erosion, and provide habitat for various species. Soft living shorelines are designed to mimic natural coastal processes and enhance ecological aesthetics and functionality. Green/soft shorelines are commonly implemented in environments with lower wave energy and typically cost less than gray/hard shorelines.

Hybrid Shorelines combine elements of both green/soft and gray/hard shoreline techniques. It may include the use of natural materials, such as vegetation and sand, along with traditional hard structures like seawalls or riprap. The goal is to achieve a balance between the ecologic benefits of natural elements and the structural strength of harder materials. Hybrid approaches are often chosen to address specific site conditions and can significantly amplify the ecological benefits.

Gray/ Hard/ Structural Shorelines are designed for high wave energy environments and involve the use of rigid, engineered structures, typically made of concrete, steel, or stone to protect the shoreline from erosion and other natural forces. While these structures can be effective in providing immediate protection, they tend to have negative environmental impacts and can alter natural coastal processes. Gray shorelines are considered less environmentally friendly compared to living shorelines. Examples include seawalls, bulkheads, and revetments.

GREEN - SOFTER TECHNIQUES **GRAY - HARDER TECHNIQUES**

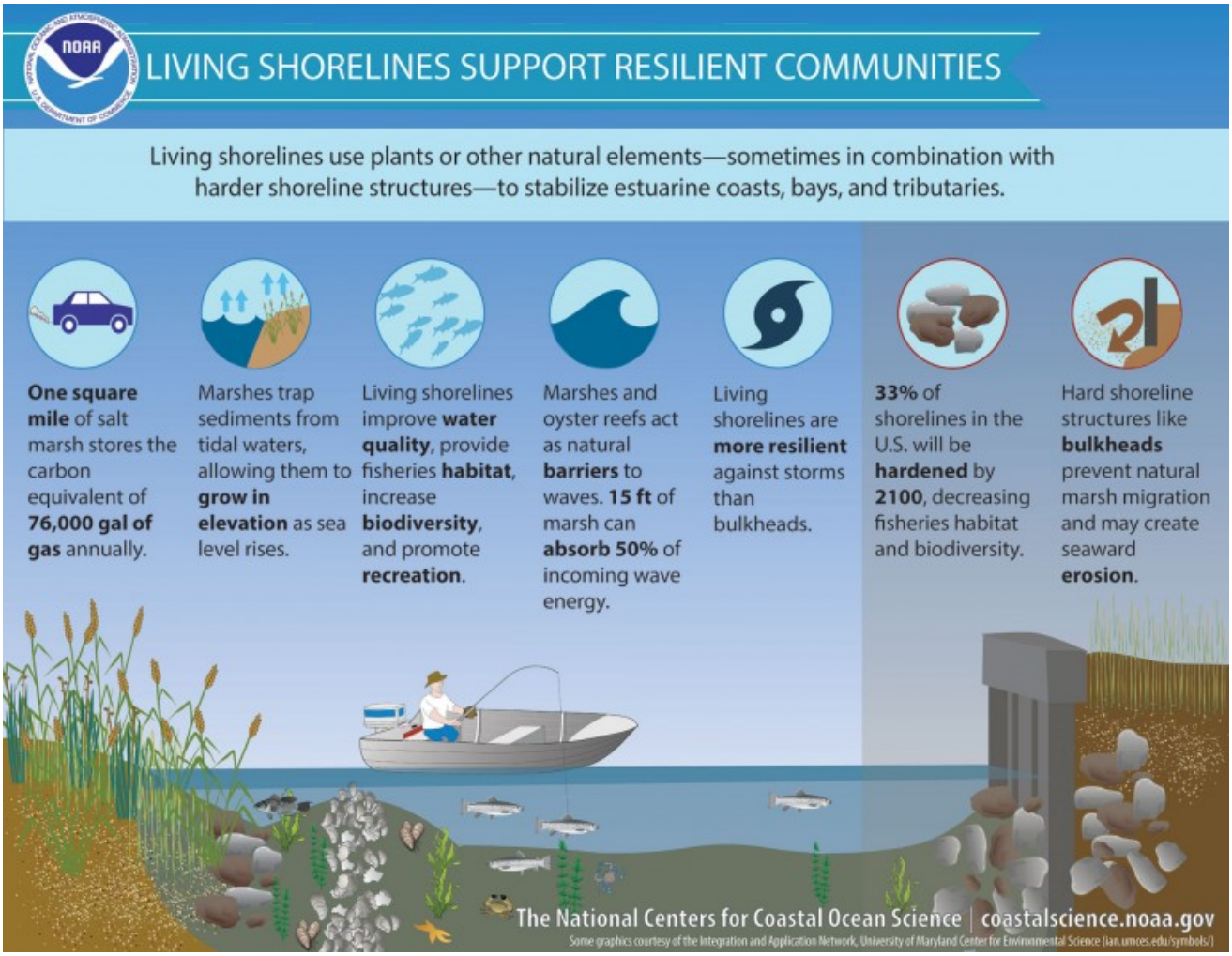


Source: NOAA. Understanding Living Shorelines. https://www.fisheries.noaa.gov/insight/understanding-living-shorelines [1]

BENEFITS OF LIVING SHORELINES

Living shorelines are both beautiful and practical[1]. They bolster ecosystems and allow for plants and animals to thrive in the natural environment, unlike hardened structures (gray/hard techniques). Living shorelines provide an array of benefits such as providing habitat for fish, plants, and animals, improves water quality and stores nutrients, protects shorelines from erosion, increases shoreline stability over time, and can prove to be cost effective long term.

By using green/soft techniques in living shorelines, residents can help their community's long-term resilience to storm surge and rising sea levels. Living shorelines, due to their increasing stability over time, demand less maintenance compared to hard shorelines. The costs associated with long term maintenance and installation of living shorelines are generally more affordable when compared to gray/hard techniques[2].



Source: NOAA. Understanding Living Shorelines. https://www.fisheries.noaa.gov/insight/understanding-living-shorelines [1]

BENEFITS OF LIVING SHORELINES

Ulele Springs Two Years Post Restoration[3]

Ulele Springs One Year Post Restoration [3]

Five Benefits of Living Shorelines:

1. Creates and enhances coastal wildlife habitats.
2. A natural buffer that reduces coastal erosion by absorbing wave energy.
3. Decreases harmful nutrients/pollutants from entering coastal waters.
4. Increases aesthetic value and privacy.
5. Cost efficient for stabilization in low-energy environments.

Ulele Springs Before Restoration, 2017 [3]

THE SIX STEPS TO A SUCCESSFUL LIVING SHORELINE PROJECT

The six steps outlined in this Guide provide key insights and the necessary information to complete a successful living shoreline project from start to finish[4].
While the information related to these steps is comprehensive, it is advised to reach out to your local Florida Department of Environmental Protection (FDEP) Office to answer any questions and to schedule a Pre-Application meeting prior to beginning your project.

Additional information provided in Step 4 of this Guide.

Southwest District (TP) [5]
13051 N Telecom Parkway
Temple Terrace,
FL 33637-0926

P: 813-470-5700
sw_erp@dep.state.fl.us

Step 1: Considerations
Why install a living shoreline? Identify the issue(s) you are trying to address and goals.

Step 2: Site Evaluations
What are the current conditions of the shoreline and aquatic resources?

Step 3: Site Design
The design will vary based on the type of shoreline, location, materials, and cost.

Step 4: Permitting
Is a permit needed? What type of permit? Know who to contact.

Step 5: Construction
Installation and time frame considerations.

Step 6: Assess and Maintain
Assess, monitor, and maintain your living shoreline to keep it healthy.

Anclote River

STEP 1: CONSIDERATIONS

Before starting the process of planning and establishing a living shoreline on your property, it is important to consider the specific concerns you aim to resolve. The site-specific characteristics of your shoreline will significantly impact the type of shoreline solution needed and the associated costs.

1. *What singular or combined objectives do you envision for your property's shoreline?*
2. *Are you addressing shoreline erosion?*
3. *Do you aim to enhance the ecological quality of the shoreline?*
4. *Do you want to beautify your property and create habitats for wildlife?*
5. *Would you like to increase the aesthetics of your shoreline or existing seawall?*

Other aspects of your living shoreline project that you should consider prior to beginning the process are the permitting requirements, available materials native to your location, budgetary constraints, and contractors and professionals to assist you through the process.

Do you experience shoreline erosion?

Do you want to naturally enhance your seawall?

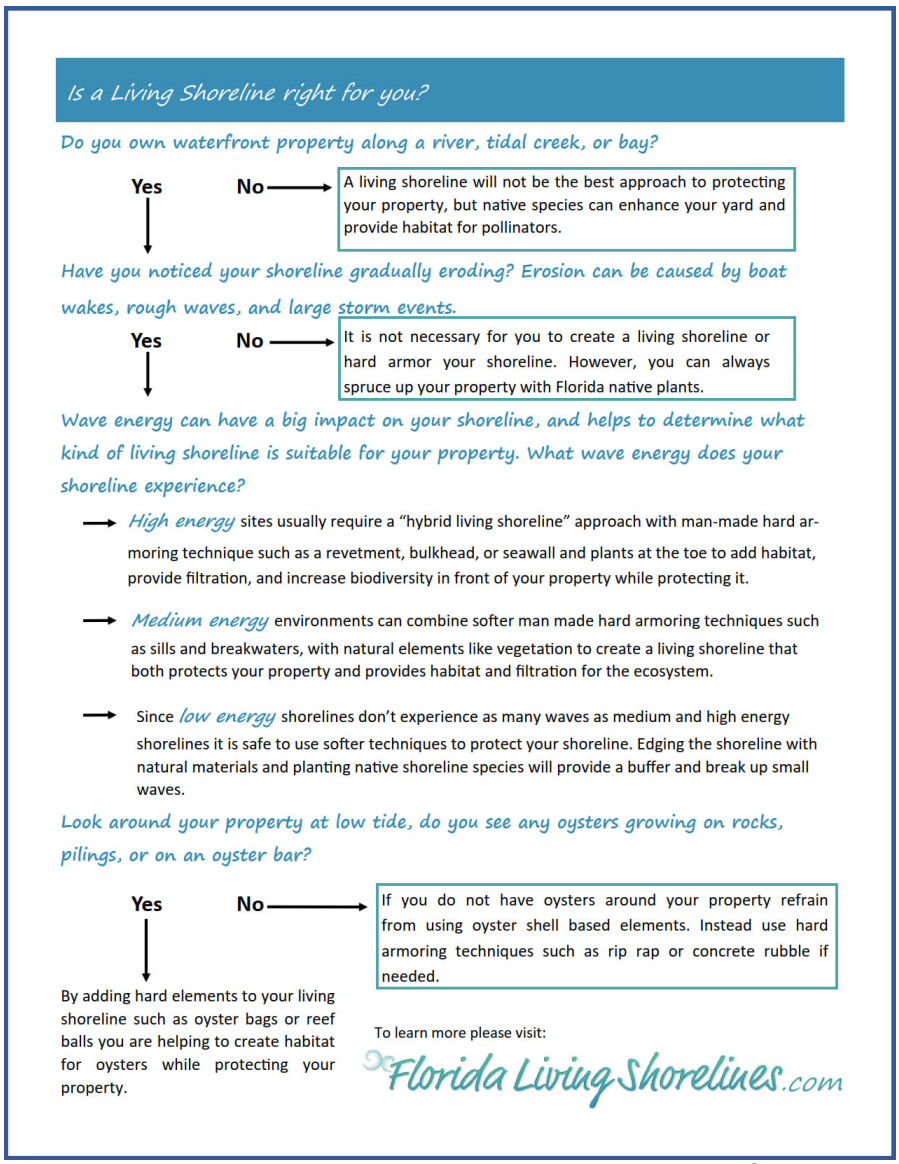
Do you want to build resilience against rising sea levels?

Do you want to create or enhance habitat for wildlife?

STEP 2: SITE EVALUATION

IS A LIVING SHORELINE RIGHT FOR YOU?

Once you understand the site-specific issues you are wanting to mitigate with your living shoreline, it is important to assess the current conditions of the site. You should conduct a site evaluation to determine if, and which type, of living shoreline is suitable for your property, based on the existing conditions. **Florida Living Shorelines**[6] is a great online resource that provides in depth information for all parts of the process. For site evaluations, the "**Is a living shoreline right for you?"** chart is the best place to start, shown below.



Source: Is a living shoreline right for you? - FloridaLivingShorelines.com[6]

Additional site conditions and the spatial dimensions between the **land**, **water**, and **existing vegetation** should be collected during this site evaluation. The best way to record this information is to create site sketches that show the profile (or cross-section) of the shoreline features and a plan view (or bird's eye view) to show the distance from your home or accessory buildings. Examples of site sketches are shown on the following pages.

These initial parameters and dimensions will provide you the starting point for your proposed design. Examples of living shoreline designs are shown in the Design phase of this Guide.

STEP 2: SITE EVALUATION

SITE SKETCHES

A profile or cross-section view illustrates the vertical elements along a line perpendicular to the shoreline, while a plan view offers a bird's eye perspective looking directly down from above. Site sketches offer an assessment ofrelationships between the existing features, slopes, vegetation, and water elevation.

Create a site profile detailing width and elevation measurements—a cross-section perpendicular to the shore, including details from the adjacent upland of your property to the Mean-Low-Water* line or beyond. Observe and record the water line at high and low tides to obtain the Mean-Low-Water and Mean-High-Water lines.

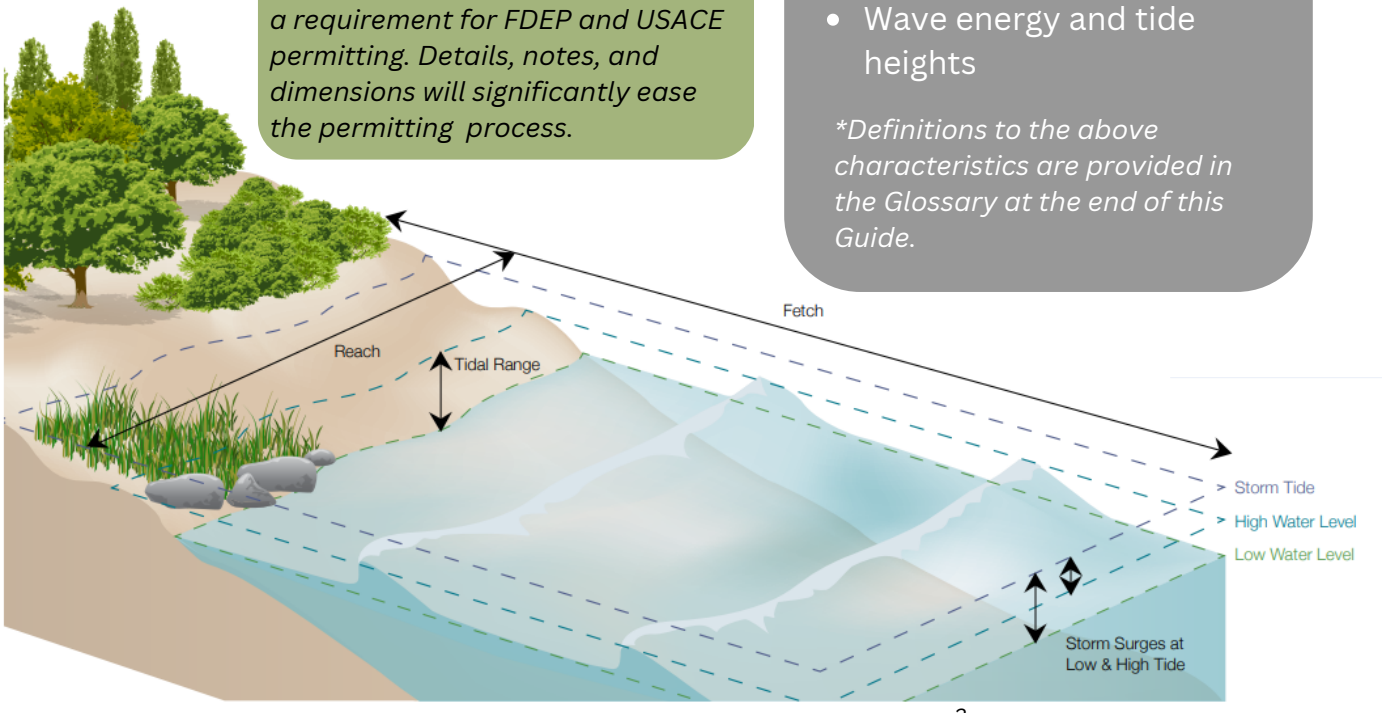
Clearly define what forms the backshore boundaries (e.g., dune, trees, infrastructure). Given the potential variability along the shore, with irregular pockets of beach, marsh, uplands, and existing structural alterations, it may be necessary to sketch multiple profiles to fully characterize a site.

Site Sketch Tip: *Design drawings are a requirement for FDEP and USACE permitting. Details, notes, and dimensions will significantly ease the permitting process.*

Site Specific Characteristics to Take into Account are:

- Type of Waterfront – river, creek, bay, oceanfront?
- Erosion* causes and rate – boat wakes, waves, storms?
- Grade (slope)*, crest*, and fetch* of the shoreline
- Mean-High-Water, and Mean-Low-Water Elevations*
- Existing environments and habitats – soil condition and type, wildlife, vegetation types, oysters, birds, turtles, etc.
- Wave energy and tide heights

**Definitions to the above characteristics are provided in the Glossary at the end of this Guide.*

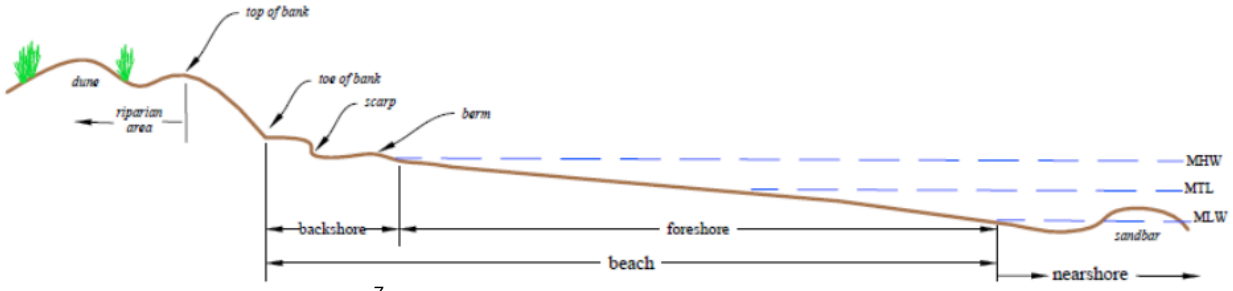


Source: Natural and Structural Measures for Shoreline Stabilization - SAGE, NOAA, USACE [2]

STEP 2: SITE EVALUATION

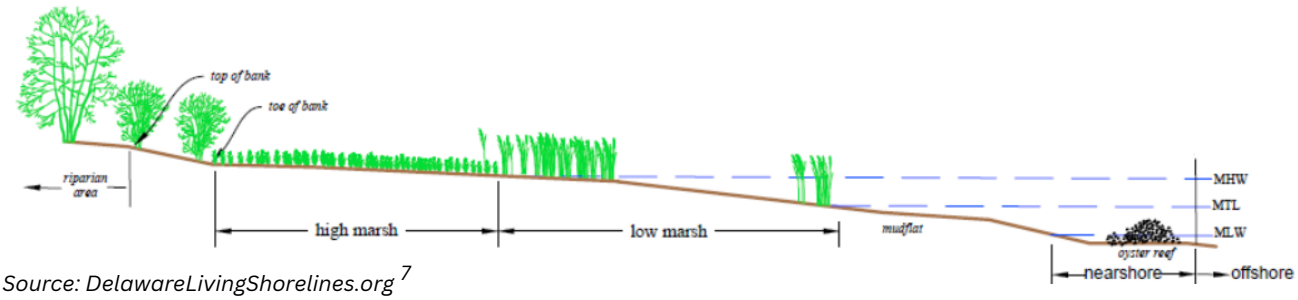
SITE SKETCH EXAMPLES

Profile or Cross Section Example:



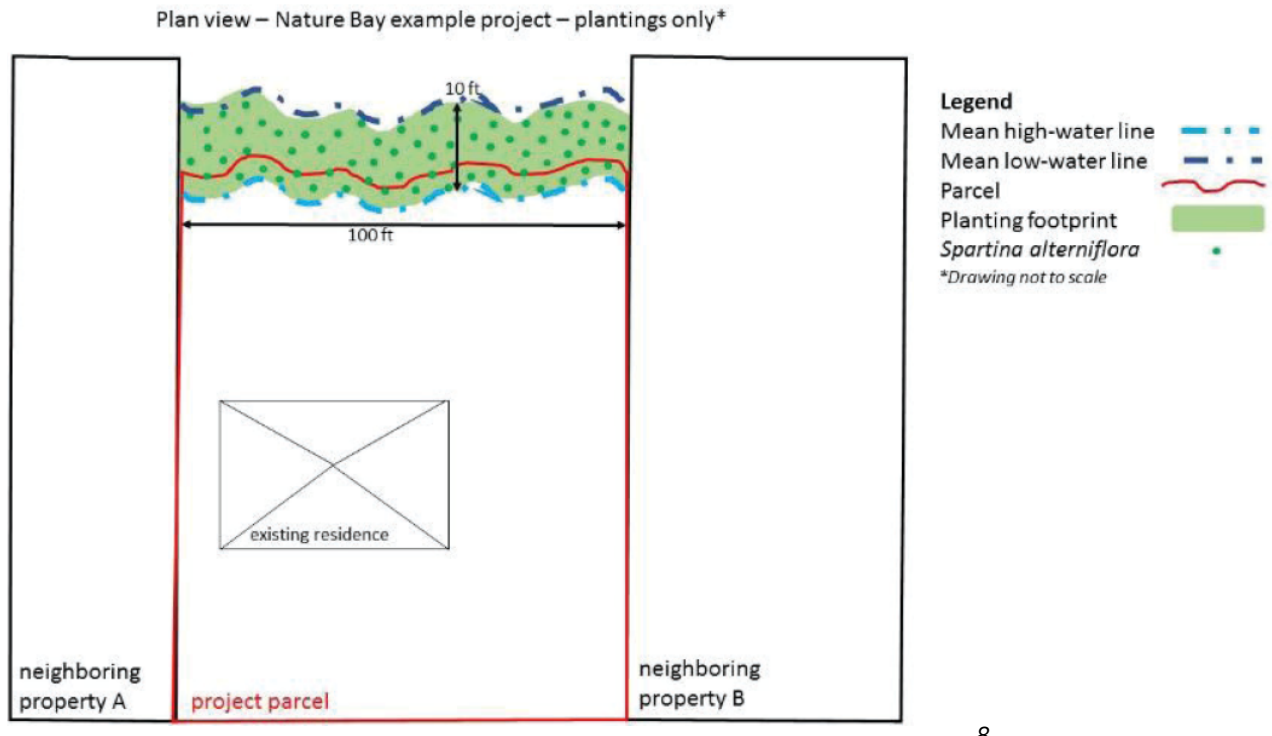
Source: DelawareLivingShorelines.org [7]

Profile or Cross Section Example:



Source: DelawareLivingShorelines.org [7]

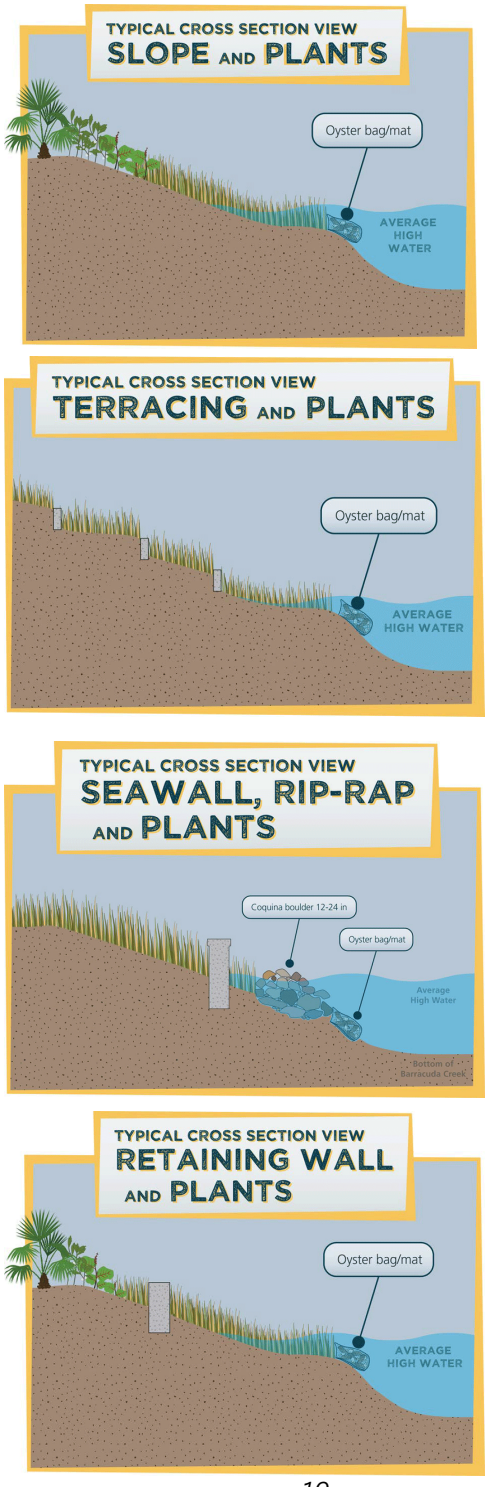
Plan View or Birds Eye Example:



Source: UF/IFAS A Homeowners Guide to the Living Shoreline Permit Exemption, Part 1: FDEP [8]

STEP 3: SITE DESIGN

WHAT TYPE OF DESIGN WILL YOUR LIVING SHORELINE NEED?



Living Shoreline Examples [10]
(Source: FloridaLivingShorelines.com)

The site sketches created during the site evaluation should contain observations and data of the existing site conditions. Once the initial conditions are established, the proposed design can be added to the sketches. Similar to traditional designs of hard and gray structures, living shorelines can provide shoreline stabilization. However, unlike traditional designs, living shorelines mimic natural conditions to provide a sustainable option for shoreline management[9].

Depending on the wave energy experienced at your specific site, the type of design needed will vary. Traditional living shorelines with vegetation, coir/fiber logs*, and other natural materials are sufficient in **low wave energy** areas while a hybrid solution that incorporates harder materials, such as rock or oyster shells, along with the natural materials will provide extra stabilization in **high wave energy** environments.

It is important to recognize that the design may change depending on specific requirements set forth in the FDEP and USACE permit process. It is recommended to review permit requirements prior to design of your site to ensure it is within set specifications.

Hiring or consulting a professional (contractor, engineer, biologist, etc.) is recommended, but not required, to ensure your shoreline is designed to meet all regulations and to streamline the permit application process.

Whichever option chosen to resolve your shoreline concerns, nature-based solutions will be the most resilient, long lasting, and affordable option. Examples of traditional and hybrid living shoreline designs are provided.

STEP 3: SITE DESIGN - NATIVE PLANTS

SOUTHWEST FLORIDA NATIVE PLANTS BY TIDAL ZONE

The **Florida Living Shorelines**[11] resource has a comprehensive list of native plants by region and tidal zone. Pasco County is considered the Southwest Florida region. It is recommended to consult a local nursery or coastal biologist to ensure that the existing vegetation and proposed plant species are companions and are appropriate for the current salinity* and site conditions. Samples of the native species to Southwest Florida by tidal marsh zones are provided below.

Low Marsh - the low marsh tidal zone occur seaward edge of the salt marsh. It floods daily and is usually exposed during low tide. Plants that grow in the low marsh:

- Smooth cordgrass (Spartina alterniflora)
- Saltwort (Batis maritima)
- Gulf cordgrass (Spartina spartinae)
- Glasswort (Sarcocornia ambigua)

Low Mid Marsh - Plants that grow in the low mid marsh:

- Saltmeadow cordgrass (Spartina patens)
- Red mangrove (Rhizophora mangle)
- Black mangrove (Avicennia germinans)
- Seashore paspalum (Paspalum vaginatum)
- Sea purslane (Sesuvium portulacastrum or maritimum)
- Saltgrass (Distichlis spicata)
- Seashore dropseed (Sporobolus virginicus)
- White mangrove (Laguncularia racemosa)

High Mid Marsh - Plants that grow in the high mid marsh:

- Saltbush or groundsel (Baccharis angustifolia or halimifolia)
- Railroad vine (Ipomoea spp.)
- Sweet acacia (Vachellia farnesiana)
- Green buttonwood (Conocarpus erectus)
- Marsh elder (Iva frutescens)
- Silver buttonwood (Conocarpus erectus var. sericeus)
- West coast dune sunflower (Helianthus debilis subspecies vestitus)
- Blanketflower (Gaillardia pulchella)
- Cabbage palm (Sabal palmetto)
- Sand cordgrass (Spartina bakeri)
- Wild lantana (Lantana involucrata)
- Sea ox-eye daisy (Borrichia frutescens)
- Muhle grass (Muhlenbergia capillaris)
- Seagrape (Coccoloba uvifera)
- Red bay (Persea borbonia)

High Marsh - the high marsh tidal zone is generally only flooded during above average high tides. Plants here do not get waterlogged or suffer sever salt stress. Plants that grow in the high marsh:

- Fakahatchee grass (Trypsacum dactyloides)
- False indigo (Amorpha fruticosa)
- Oak (Quercus spp.)
- Red cedar (Juniperus virginiana var. silicicola)
- Firebush (Hamelia patens)
- Milkweed (Asclepias spp.)
- Myrsine (Myrsine cubana)
- Gumbo limbo (Bursera simaruba)
- Florida privet (Forestiera segregata)
- Seaside goldenrod (Solidago sempervirens)
- Inkberry (Ilex glabra)
- White indigoberry (Randia aculeata)
- Herb of grace (Bacopa monnieri)
- Sweetbay (Magnolia virginiana)
- Snowberry (Chiococca alba)
- Beautyberry (Callicarpa americana)

Smooth cordgrass (Spartina alterniflora)

STEP 3: SITE DESIGN - COSTS

HOW TO BUDGET FOR YOUR LIVING SHORELINE

Living Shoreline Budget for Edging with Oyster Filled Gabions and Vegetation		
Materials		
Native Plants for planting	$	-
Erosion Control Blankets	$	-
Geotextile Tubes	$	-
Oyster Shell Bags (est. quantity: 300)	$	-
Stakes for Securing Materials (est. quantitiy: 300)	$	-
Rock Gabion Baskets	$	-
Materials Total	$	-
Additional Costs		
Tools	$	-
Professional Survey	$	-
Engineering Design	$	-
Contractor	$	-
Permit Application and License Fees	$	-
Transportation of Materials (truck, barge, boat)	$	-
Installation Labor & Materials	$	-
Monitoring Labor & Materials	$	-
Post-Contruction Site Assessment	$	-
Additional Total	$	-
TOTAL PROJECT COSTS	$	-

Table 1. Example of a Living Shoreline Budget [12]

The budget for your living shoreline project will vary significantly based on the type of shoreline design selected.

By now you should have a clear understanding of the issues you are aiming to address on your shoreline, the design and layout of your materials, and the type of materials you will use. This information will assist you in creating a budget with real dimensions and quantities. An example budget for a living shoreline for edging with oyster shell gabions* and native vegetation is provided in Table 1. The Additional Cost items are not all inclusive for every type of living shoreline design.

Type of Shoreline		Material Options	Initial Construction	Maintenance
Green	Vegetation Only	Native Plants	$	$
	Edging	Native Plants	$	$
		Erosion Control Blankets	$$	$
		Geotextile Tubes	$$	$
		Living Reef (oyster/mussel shells)	$$	$
		Rock Gabion Baskets	$$	$
	Sills	Stone	$$	$
		Sand Breakwaters	$$	$
		Living Reef (oyster/mussel shells)	$$	$
		Rock Gabion Baskets	$$	$
Gray	Bulkhead	Composite Carbon Fibers	$$$	$$
		Rock Gabion Baskets	$$$	$$
		Concrete	$$$	$$
		Timber	$$$	$$
		Steel Sheet Piles	$$$$	$$
	Seawall	Stone	$$$	$$
		Rock	$$$	$$
		Concrete	$$$	$$
		Steel/Vinyl Sheet	$$$$	$$$
		Steel Sheet Pile	$$$$	$$$

Table 2. Sample of Living Shoreline Types and Estimated Cost Ranges [2]

The USACE SAGE Brochure[2] provides estimates for initial construction and maintenance costs of a variety of shoreline designs. Table 2 summarizes a sample, taken from the Brochure, of green to gray shoreline techniques and associated estimate ranges. It clearly shows that green shoreline techniques are typically cheaper to install and maintain over time, compared to traditional gray infrastructure. The full brochure is provided in this guide.

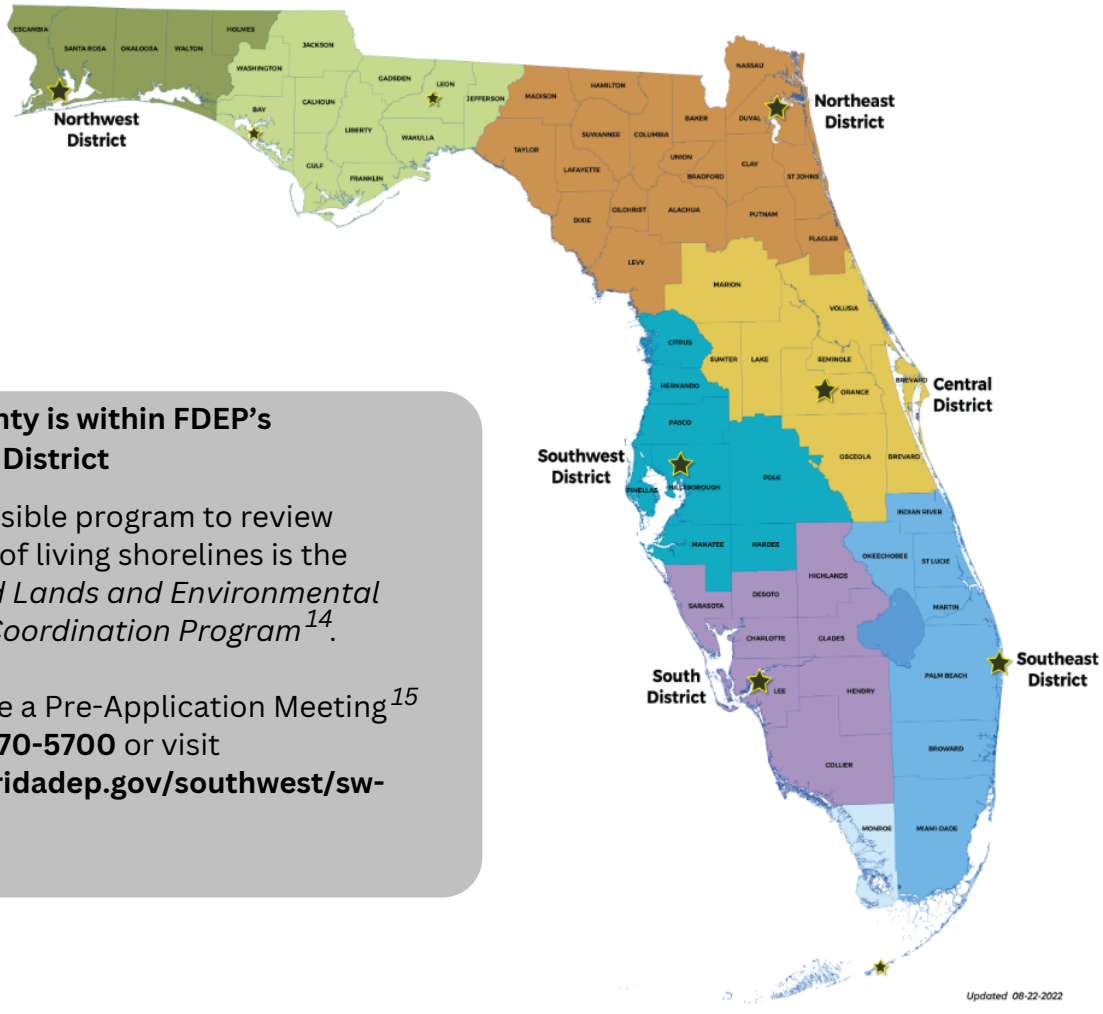
STEP 4: PERMITTING

Most living shorelines will require permitting on the state and federal levels prior to installation. The state permitting process is through the **Florida Department of Environment Protection (FDEP)** and the federal process is through the **Army Corps of Engineers (USACE)**. There are expedited permit processes at both levels to simplify the process.

For your project to qualify for these permits, it needs to meet specific criteria, adhere to maximum project dimensions in terms of length and width, and demonstrate minimal adverse effects on underwater lands, water quality, and habitat. There are exemptions available for some designs, but it is best to understand the permit process.

It is recommended to contact your local **FDEP** office to schedule a **Pre-Application** meeting. This meeting will identify the type of permit(s) required based on your design, ensure you have the necessary documents and information, explain the application process, and if an exemption is available.

While most residential living shoreline projects are small and may qualify for an exemption, **all property owners are encouraged to fill out and submit an application to FDEP for verification that the proposed project is exempt** [13].



Pasco County is within FDEP's Southwest District

The responsible program to review permitting of living shorelines is the *Submerged Lands and Environmental Resource Coordination Program* [14].

To schedule a Pre-Application Meeting [15] call **(813) 470-5700** or visit **https://floridadep.gov/southwest/sw-permitting**

STEP 4: PERMITTING

STATE Permits

All permits will go through the Florida Department of Environmental Protection (FDEP).

Types of Permits Available:

- Exemption
- General Permit
- Individual or Conceptual Approval Permit
- Joint Coastal Permit
- Permitting Thresholds

*If you qualify for an exemption from FDEP, you may be eligible for Federal permit exemption, but you should still submit an application to confirm.

FEDERAL Permits

All permits will go through the United States Army Corps of Engineers (USACE).
It typically takes 60 days to receive approval. Applications may be submitted to the regional office via email or mail.

Types of Permits Available:

- State Programmatic General Permit (SPGOP V-R1)
- Nationwide Permit 54

A Pre-Application Meeting with both FDEP and USACE is recommended.

USACE headquarters is located in Jacksonville and has a regional office in Tampa. It is recommended to contact a representative at the Permits Section to schedule a Pre-Application meeting to understand what permit is required[16].

Florida Headquarters:
Jacksonville Permit Section
701 San Marco Blvd
Jacksonville, FL 32207
(904) 232-1658

Tampa Regional Office:
Tampa Permits Section
10117 Princess Palm Avenue, Suite 120
Tampa, FL 33610
(813) 769-7073

If you qualify for an exemption, it is suggested to reference the **UF-IFAS Extension's A Homeowner's Guide to the Living Shoreline Exemption, Parts 1 and 2**, for step-by-step instructions to apply for permit exemption from FDEP and USACE, online and via mail[8, 17].

Shoreline Stabilization at Yellow River March Preserve State Park

STEP 5: CONSTRUCTION

Once you have successfully completed a site design, project budget, and received a construction permit or exemption, you are ready to construct your living shoreline. It is best practice to have a construction timeline, cost estimates, and material accessibility secured prior to beginning construction to ensure that your project stays on time and budget.

The duration of living shoreline installations can vary, contingent upon the project's design and timeline. If the project site is situated in an area with shorebirds, horseshoe crabs, or migratory fish, careful consideration must be given to avoid construction activities during their breeding periods. Optimal planting occurs in the spring to provide plants with ample time to establish and thrive before facing seasonal setbacks at the end of the year.

It is essential to recognize that the establishment of a properly installed living shoreline is a gradual process, taking a few years for the vegetation to fill in and resemble native habitats. During this growth period, maintain oversight for any abrupt changes or potential issues that may arise, ensuring the ongoing success and resilience of the living shoreline ecosystem.

Manatee Zone - Slow Speed Sign
(Source: Southwest Florida Water Management District


Manatee
(Source: Southwest Florida Water Management District


Royal Terns at Anclote Key Island
(Source: Oceanographic Magazine)


Living shoreline with oyster shell reef breakwaters and cordgrass.
(Source: Jennifer McPeak)

STEP 6: ASSESS AND MAINTAIN

Maintenance for your living shoreline project will be necessary during the initial years of establishment and may transition to only requiring annual upkeep. Extra maintenance might be necessary, especially if a severe storm or hurricane is experienced prior to the vegetation fully establishing in its new environment.

It's important to understand the type of upkeep your specific living shoreline design will need. It is recommended to consult with your contractor, engineer, material suppliers, or local nursery to ensure that your goals are met and that your project is designed and operating correctly.

Common issues that can be easily resolved with regular maintenance are outlined below. **If your living shoreline has structural damage or is causing significant adverse effects to your property or neighboring properties, contact a local professional immediately.**

Plants are Dying

Plants may not be acclimated to the temperature or salinity properly, causing them to not establish and die off. You may need to plant more plantings in favorable weather or raise the elevation above the waterline so the plants may grow without being fully submerged.

Wildlife Disturbances

If not properly designed for, you may encounter wildlife disturbing your living shoreline. Crabs and waterfowl may rip coir logs or feed on plantings. You should ensure that your design is appropriate for the native wildlife and utilize temporary fencing if necessary.

Section of the Living Shoreline is Moved or Missing

If you notice a piece of your shoreline has shifted or is gone entirely, this may be due to high wave action knocking the materials out of place. Consider if a recent storm has come through with high winds and waves. You may need to fill in the missing location and secure the material in place.

Drainage and Erosion Concerns

If you notice increased erosion on your living shoreline, water not draining properly, and dying plants, you may have a drainage problem. The shoreline's drainage channels may need to be stabilized further with coir logs or shell bags. You may need to contact a local professional to see what design solutions are best for you.

GLOSSARY

Benthic Survey - A survey that characterizes benthic (bottom) habitats within the survey area that may possibly be affected by the proposed project. These are often required in living shoreline permits.

Breakwater - A structure built to provide a barrier to or protection from waves. There are many definitions of the term "breakwater," but usually they are offshore structures designed to reduce incoming wave energy, resulting in calmer water between the shoreline and the structure. Oyster reef breakwaters are built at intertidal heights (submerged at high tide) out of materials conducive to colonization by oysters. In Florida, breakwaters built as part of small-scale living shorelines are only exempt from permitting if they are built no higher than the mean high-water line.

Bulkhead - A vertical or near-vertical, substantially impermeable structure that provides shoreline protection from waves while retaining upland soils.

Coir/ Fiber Logs - A material comprised of meshed natural fibers, such as coconut fiber, to create the shape of a tree log. Coir logs are used to provide temporary protection at the toe of a planting zone to retain sediment and reduce flow, helping to maintain soil in place while new plantings establish.

Crest - The highest portion of a shoreline feature.

Cross Section (Profile) Drawing - A depiction of your living shoreline project in cross-section, including information about the slope of the shoreline, approximate mean low-water and mean high-water locations, breakwater heights, spacing of plants, location of existing structures, etc.

Datum (vertical) - A base elevation used as a reference from which to reckon heights or depths.

Emergent Vegetation - *Wetland plants that are rooted with stiff or firm stems, like cattails. Emergent vegetation usually stands above the water surface, but in some cases can be found submerged during occasional periods of high water. Lily pads and many marsh plants are considered emergent plants.*

Environmental Resource Permit - A type of permit required before beginning any construction activity that would affect wetlands, alter surface water flows, or contribute to water pollution in Florida.

Erosion - Process of sediment being carried away from an area. In coastal environments, the major driving processes of erosion are storms, flooding, wave action, sea level rise, and human activities (i.e., boating, seawall construction, development). Erosion is a natural process in coastal ecosystems, but it becomes an issue when homes and other infrastructure are threatened.

Exotic/ Invasive Species - Exotic species are those that are not native to an ecosystem. Invasive species are those that are not native to and ecosystem and cause harm to native species and/or ecosystem functions. Examples of invasive plants in Florida's coastal environments include the invasive Brazilian pepper and Phragmites australis marsh grass.

Fetch - The distance of open water over which wind blows or waves propagate unobstructed.

Fill - Any material (sand, concrete, shell, etc.) imported into the project area and placed on uplands or submerged lands.

GLOSSARY

Gabion - A wire framework container that provides a structured foundation for shell material. Made of a material similar to chain-link fencing, gabions, are filled with shells and ballast, then stacked and wired together to construct sturdy, three-dimensional structures.

General Permit - A class of permit available from FDEP that allows expedited permitting for projects that meet certain criteria. If a project meets criteria for State Programmatic General Permit, the state can issue a general permit that also provides federal permission to construct the project.

Grade (slope) - A physical feature of a landform which is described by the tangent of the angle the surface makes to horizontal. Typically described by the ratio of "rise over run" or vertical to horizontal distance.

Green-Grey Infrastructure pr Green-Grey Materials - A combination of engineered and natural elements that provide environmental qualities, ecosystem value and protective services.

High Tide Flooding - Refers to king tides or exceptional high tides which occur seasonally around a new or full moon when the Moon and Sun are at their perigee (closest point to Earth).

Individual Permit - Class of permit available from FDEP. This class of permit is the highest standard of review. The federal (Army Corps) analog of this permit class is called a Standard Permit.

Intertidal - The area that is above water at low tide and under water at high tide (in other words, area between tide marks) commonly inhabited by oysters.

Living Shorelines - A shoreline management practice that provides erosion control benefits; protects, restores, or enhances natural shoreline habitat; provides wave energy dissipation benefits; and maintains coastal processes through the strategic placement of plants, stone, sand fill, and other structural organic materials (e.g. biologs, oyster reefs, etc).

Marsh Vegetation - Herbaceous (non-woody) plants that thrive in wetlands. Most living shorelines deal with the creation of low and middle marsh that are more frequently inundated by water then upper marsh zone.

Mean High-Water Line (MHWL) - The line on a chart or map that represents that intersection of the land with the water surface at the elevation of mean high water (the average of all high-water heights observed over the period of time defined by the National Tidal Datum Epoch). Homeowners can roughly estimate MHWL using physical markers like stakes or flags placed at high tide over a period of weeks, or by observing and marking the location of the tidal wrack lines (line formed by debris washing up at high tide), or by looking at aerial photos. FDEP suggests erring on the upland side instead of waterward side when approximating the MHWL. The MHWL can also be determined by a licensed surveyor.

Mean Low-Water Line (MLWL)- The line on a chart or map that represents the intersection of the land with the water surface at the elevation of mean low water (the average of all the low water heights observed in the period of time defined by the National Datum Epoch). Homeowners can roughly estimate the MLWL using physical makers like stakes or flags placed at low tide over a period of weeks or by observing aerial photos. The MLWL can also be determined by a licensed surveyor.

GLOSSARY

Nationwide Permit (NWP) - A class of permit available from the Army Corps of Engineers that provides expedited permission for projects that meet certain criteria. The most common NWP for living shorelines is NWP 54, but sometimes NWP 13 or NWP 27 will be used to permit living shorelines.

Native Vegetation - Plants that occur naturally in an area.

Nature Based Solutions (NBS) - NBS are sustainable and cost-effective approaches that harness the power of nature to address various environmental challenges. These solutions utilize natural processes and biodiversity to provide beneficial outcomes for both human communities and the ecosystem.

NOAA - *National Oceanographic and Atmospheric Administration*

Overtopping - Water levels or waves that are above the crest height of a shoreline treatment or seawall.

Regulatory Authority - Allows an entity of the government (e.g., FDEP, Army Corps of Engineers or U.S. Army Corps of Engineers, and Water Management District (WMD)) to limit certain activities on private and publicly owned lands, to some specific degree for the greater public good. This authority is the reason there is permitting for living shorelines.

Seawall - A vertical or near-vertical, substantially impermeable structure typically made of concrete, vinyl or steel, that provides shoreline protection from waves while retaining upland soils.

Sill - Material deployed at the base (toe) of a vegetated zone for the purpose of reinforcing and protecting the area from moderate energy waves and currents. Sills can be constructed out of materials such as shell, concrete, or coconut fiber logs. Sills differ from breakwaters in that they are constructed directly adjacent to the vegetated area.

Sovereign Submerged Lands (SSL) - Are those including but not limited to, tidal lands, islands, sand bars, shallow banks, and lands waterward of the ordinary or mean high-water line, beneath navigable fresh water or beneath tidally influenced waters, which the State of Florida acquired title to on March 3, 1845, by virtue of statehood, and which have not been heretofore conveyed or alienated. (18-21.003, Florida Administrative Code).

State Programmatic General Permit (SPGP) - An agreement between FDEP and Army Corps that allows FDEP (the state) to issue a joint permit that covers both state and federal requirements in cases that meet the criteria laid out in the agreement.

Storm Surge - An abnormal rise in sea level accompanying a hurricane or other intense storm, and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone. Storm surge is usually estimated by subtracting the normal or astronomic high tide from the observed storm tide.

Stormwater Runoff - Rainwater that flows over land or impervious surfaces (paved streets, parking lots, rooftops) and does not soak into the ground. Runoff can carry pollutants from the land into the waterways. Stormwater runoff from the uplands can also cause erosion and should be considered in living shoreline project designs.

Verification of Exemption - *A letter issued by the FDEP verifying that a proposed project meets exemption criteria and can proceed without additional permitting.*

GLOSSARY

Water Quality Certification (WQC) - Section 401 of the Clean Water Act requires any applicant for a federal license or permit to conduct any activity which results in a discharge into waters of the U.S. to provide the federal agency with certification from the certifying authority that the discharge will comply with applicable water quality standards.

Wetland - An area that is inundated or saturated by surface water or ground water a frequency and a duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils.

ADDITIONAL RESOURCES

FDEP Resilient Florida Program - Living Shorelines
https://floridadep.gov/rcp/resilient-florida-program/content/resilient-florida-program-living-shorelines

Florida Living Shorelines
https://floridalivingshorelines.com/

Florida Sea Grant - Solutions for Living Shorelines Material Challenges
https://www.flseagrant.org/projects/solutions-for-living-shorelines-material-challenges/

Naturally Resilient Communities
https://nrcsolutions.org/

NOAA Consultations and Permits
https://www.habitatblueprint.noaa.gov/living-shorelines/consultations-permitting/

NOAA Climate Resilience Toolkit
https://toolkit.climate.gov/topics/coastal-flood-risk/coastal-erosion

NOAA Fisheries - Understanding Living Shorelines
https://www.fisheries.noaa.gov/insight/understanding-living-shorelines

NOAA's Guidance for Considering the Use of Living Shorelines
https://www.habitatblueprint.noaa.gov/wp-content/uploads/2018/01/NOAA-Guidance-for-Considering-the-Use-of-Living-Shorelines_2015.pdf

NOAA Tools for Planning
https://www.habitatblueprint.noaa.gov/living-shorelines/applying-science/tools-for-planning/

Office for Coastal Management, Systems Approach to Geomorphic Engineering [SAGE], NOAA, & United States Army Corps of Engineers: Natural and Structural Measures for Shoreline Stabilization
https://coast.noaa.gov/data/digitalcoast/pdf/living-shoreline.pdf

UF/IFAS A Homeowners Guide to the Living Shoreline Permit Exemption, Part 1: Florida Department of Environmental Protection
https://edis.ifas.ufl.edu/publication/SG187

UF/IFAS A Homeowners Guide to the Living Shoreline Permit Exemption, Part 2: US Army Corps of Engineers
https://edis.ifas.ufl.edu/publication/SG189

Contact information for professionals working on living shorelines in your region can be found at http://floridalivingshorelines.com/contacts/ or your local UF/IFAS Extension Office.

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16. UF/IFAS A Homeowners Guide to the Living Shoreline Permit Exemption, Part 2: United States Army Corps of Engineers https://edis.ifas.ufl.edu/publication/SG189).

APPENDIX A

Natural and Structural Measures for Shoreline Stabilization

Office for Coastal Management, Systems Approach to Geomorphic Engineering [SAGE], NOAA, &
US Army Corps of Engineers [USACE]

HOW GREEN OR GRAY SHOULD YOUR SHORELINE SOLUTION BE?

GREEN - SOFTER TECHNIQUES

Small Waves | Small Fetch | Gentle Slope | Sheltered Coast

LIVING SHORELINE

VEGETATION ONLY

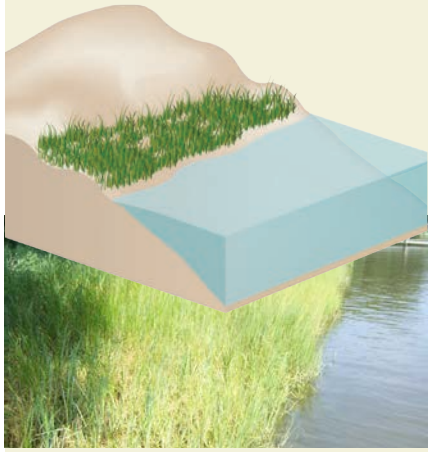

Photo Credit: Maryland Department of Natural Resources - Shoreline Conservation Service

Roots hold soil in place to reduce erosion. Provides a buffer to upland areas and breaks small waves.

Suitable For

Low wave energy environments.

Material Options

- Native plants*

Benefits

- Dissipates wave energy
- Slows inland water transfer
- Increases natural storm water infiltration
- Provides habitat and ecosystem services
- Minimal impact to natural community and ecosystem processes
- Maintains aquatic/terrestrial interface and connectivity
- Flood water storage

Disadvantages

- No storm surge reduction ability
- No high water protection
- Appropriate in limited situations
- Uncertainty of successful vegetation growth and competition with invasive

Initial Construction: ●
Operations & Maintenance: ●

EDGING

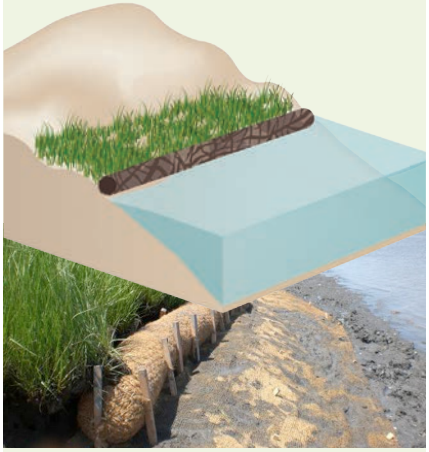

Photo Credit: Partnership for Delaware Estuary

Structure to hold the toe of existing or vegetated slope in place. Protects against shoreline erosion.

Suitable For

Most areas except high wave energy environments.

Vegetation* Base with Material Options

(low wave only, temporary)
- "Snow" fencing
- Erosion control blankets
- Geotextile tubes
- Living reef (oyster/mussel)
- Rock gabion baskets

Benefits

- Dissipates wave energy
- Slows inland water transfer
- Provides habitat and ecosystem services
- Increases natural storm water infiltration
- Toe protection helps prevent wetland edge loss

Disadvantages

- No high water protection
- Uncertainty of successful vegetation growth and competition with invasive

Initial Construction: ● ●
Operations & Maintenance: ●

SILLS

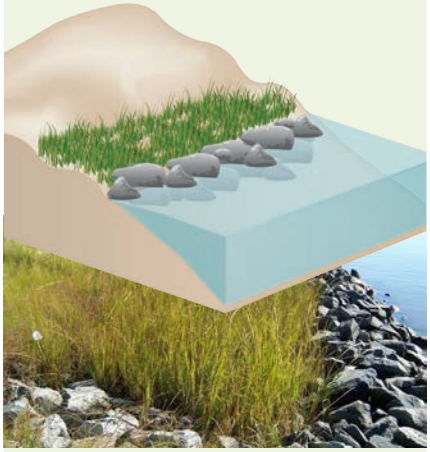

Photo Credit: Maryland Department of Natural Resources - Shoreline Conservation Service

Parallel to existing or vegetated shoreline, reduces wave energy and prevents erosion. A gapped approach would allow habitat connectivity, greater tidal exchange, and better waterfront access.

Suitable For

Most areas except high wave energy environments.

Vegetation* Base with Material Options

- Stone
- Sand breakwaters
- Living reef (oyster/mussel)
- Rock gabion baskets

Benefits

- Provides habitat and ecosystem services
- Dissipates wave energy
- Slows inland water transfer
- Provides habitat and ecosystem services
- Increases natural storm water infiltration
- Toe protection helps prevent wetland edge loss

Disadvantages

- Require more land area
- No high water protection
- Uncertainty of successful vegetation growth and competition with invasive

Initial Construction: ● ●
Operations & Maintenance: ●

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* Native plants and materials must be appropriate for current salinity and site conditions.

Initial Construction: ● = up to $1000 per linear foot, ● ● = $1001 - $2000 per linear foot, ● ● ● = $2001 - $5000 per linear foot, ● ● ● ● = $5001 - $10,000 per linear foot
Operations and Maintenance (yearly for a 50 year project life): ● = up to $100 per linear foot, ● ● = $101 - $500 per linear foot, ● ● ● = over $500 per linear foot

HOW GREEN OR GRAY SHOULD YOUR SHORELINE SOLUTION BE?

GREEN - SOFTER TECHNIQUES

Small Waves | Small Fetch | Gentle Slope | Sheltered Coast

LIVING SHORELINE

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BEACH NOURISHMENT ONLY

Photo Credit: USACE New York District Public Affairs

Large volume of sand added from outside source to an eroding beach. Widens the beach and moves the shoreline seaward.

Suitable For

Low-lying oceanfront areas with existing sources of sand and sediment.

Material Options

- Sand

Benefits

- Expands usable beach area
- Lower environmental impact than hard structures
- Flexible strategy
- Redesigned with relative ease
- Provides habitat and ecosystem services

Disadvantages

- Requires continual sand resources for renourishment
- No high water protection
- Appropriate in limited situations
- Possible impacts to regional sediment transport

Initial Construction: ●●●
Operations & Maintenance: ●●

BEACH NOURISHMENT & VEGETATION ON DUNE

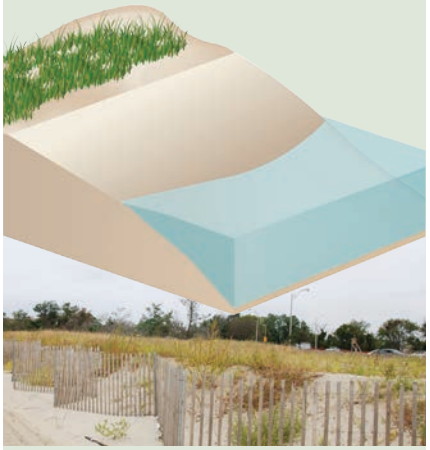

Photo Credit: USACE New York District Public Affairs

Helps anchor sand and provide a buffer to protect inland area from waves, flooding and erosion.

Suitable For

Low-lying oceanfront areas with existing sources of sand and sediment.

Material Options

Sand with vegetation
Can also strengthen dunes with:

- Geotextile tubes
- Rocky core

Benefits

- Expands usable beach area
- Lower environmental impact
- Flexible strategy
- Redesigned with relative ease
- Vegetation strengthens dunes and increases their resilience to storm events
- Provides habitat and ecosystem services

Disadvantages

- Requires continual sand resources for renourishment
- No high water protection
- Appropriate in limited situations
- Possible impacts to regional sediment transport

Initial Construction: ●●●
Operations & Maintenance: ●●

Initial Construction: ● = up to $1000 per linear foot, ●● = $1001 - $2000 per linear foot, ●●● = $2001 - $5000 per linear foot, ●●●● = $5001 - $10,000 per linear foot
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HOW GREEN OR GRAY SHOULD YOUR SHORELINE SOLUTION BE?

GRAY - HARDER TECHNIQUES

Large Waves | Large Fetch | Steep Slope | Open Coast

COASTAL STRUCTURE

BREAKWATER

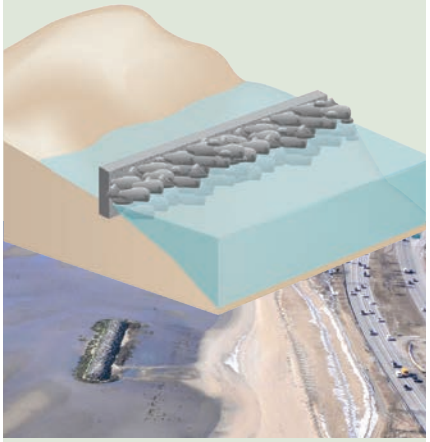

Photo Credit: USACE New York District Public Affairs

Offshore structures intended to break waves, reducing the force of wave action and encourages sediment accretion. Can be floating or fixed to the ocean floor, attached to shore or not, and continuous or segmented. A gapped approach would allow habitat connectivity, greater tidal exchange, and better waterfront access.

Suitable For

Most areas except high wave energy environments often in conjunction with marinas.

Material Options

- Grout-filled fabric bags
- Armorstone
- Pre-cast concrete blocks
- Living reef (oyster/mussel) if low wave environment
- Wood
- Rock[†]

Benefits

- Reduces wave force and height
- Stabilizes wetland
- Can function like reef
- Economical in shallow areas
- Limited storm surge flood level reduction

Disadvantages

- Expensive in deep water
- Can reduce water circulation (minimized if floating breakwater is applied)
- Can create navigational hazard
- Require more land area
- Uncertainty of successful vegetation growth and competition with invasive
- No high water protection
- Can reduce water circulation
- Can create navigation hazard

Initial Construction: ●●●●
Operations & Maintenance: ●●●

GROIN

Photo Credit: USACE New York District Public Affairs

Perpendicular, projecting from shoreline. Intercept water flow and sand moving parallel to the shoreline to prevent beach erosion and break waves. Retain sand placed on beach.

Suitable For

Coordination with beach nourishment.

Material Options

- Concrete/stone rubble[†]
- Timber
- Metal sheet piles

Benefits

- Protection from wave forces
- Methods and materials are adaptable
- Can be combined with beach nourishment projects to extend their life

Disadvantages

- Erosion of adjacent sites
- Can be detrimental to shoreline ecosystem (e.g. replaces native substrate with rock and reduces natural habitat availability)
- No high water protection

[†] Rock/stone needs to be appropriately sized for site specific wave energy.

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GRAY CAN BE GREENER: e.g., 'Living Breakwater' using oysters to colonize rocks or 'Greenwall/Biowall' using vegetation, alternative forms and materials

Initial Construction: ●●●
Operations & Maintenance: ●●

Initial Construction: ● = up to $1000 per linear foot, ●● = $1001 - $2000 per linear foot, ●●● = $2001 - $5000 per linear foot, ●●●● = $5001 - $10,000 per linear foot
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HOW GREEN OR GRAY SHOULD YOUR SHORELINE SOLUTION BE?

GRAY - HARDER TECHNIQUES

Large Waves | Large Fetch | Steep Slope | Open Coast

COASTAL STRUCTURE

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REVETMENT

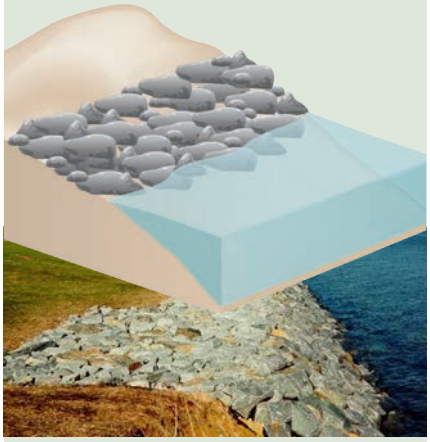

Photo Credit: Maryland Department of Natural Resources - Shoreline Conservation Service

Lays over the slope of a shoreline. Protects slope from erosion and waves.

Suitable For

Sites with pre-existing hardened shoreline structures.

Material Options

- Stone rubble†
- Concrete blocks
- Cast concrete slabs
- Sand/concrete filled bags
- Rock-filled gabion basket

Benefits

- Mitigates wave action
- Little maintenance
- Indefinite lifespan
- Minimizes adjacent site impact

Disadvantages

- No major flood protection
- Require more land area
- Loss of intertidal habitat
- Erosion of adjacent unreinforced sites
- Require more land area
- No high water protection
- Prevents upland from being a sediment source to the system

† Rock/stone needs to be appropriately sized for site specific wave energy.

Initial Construction: ●●●●
Operations & Maintenance: ●●

BULKHEAD

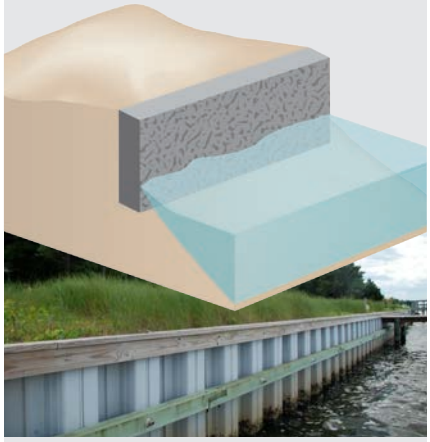

Photo Credit: North Carolina Department of Environment and Natural Resources

Parallel to the shoreline, vertical retaining wall. Intended to hold soil in place and allow for a stable shoreline.

Suitable For

High energy settings and sites with pre-existing hardened shoreline structures. Accommodates working water fronts (eg: docking for ships and ferries).

Material Options

- Steel sheet piles
- Timber
- Concrete
- Composite carbon fibers
- Gabions

Benefits

- Moderates wave action
- Manages tide level fluctuation
- Long lifespan
- Simple repair

Disadvantages

- No major flood protection
- Erosion of seaward seabed
- Erosion of adjacent unreinforced sites
- Loss of intertidal habitat
- May be damaged from overtopping oceanfront storm waves
- Prevents upland from being a sediment source to the system
- Induces wave reflection

Initial Construction: ●●●
Operations & Maintenance: ●●

SEAWALL

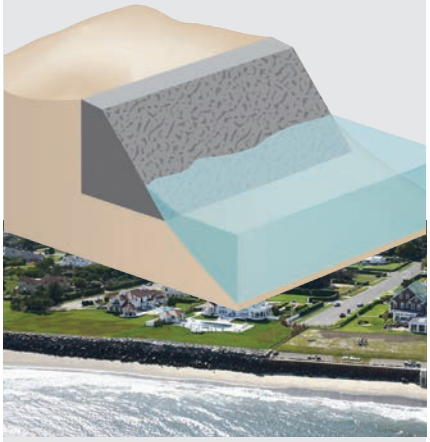

Photo Credit: USACE New York District Public Affairs

Parallel to shoreline, vertical or sloped wall. Soil on one side of wall is the same elevation as water on the other. Absorbs and limits impacts of large waves and directs flow away from land.

Suitable For

Areas highly vulnerable to storm surge and wave forces.

Material Options

- Stone
- Rock
- Concrete
- Steel/vinyl sheets
- Steel sheet piles

Benefits

- Prevents storm surge flooding
- Resists strong wave forces
- Shoreline stabilization behind structure
- Low maintenance costs
- Less space intensive horizontally than other techniques (e.g. vegetation only)

Disadvantages

- Erosion of seaward seabed
- Disrupt sediment transport leading to beach erosion
- Higher up-front costs
- Visually obstructive
- Loss of intertidal zone
- Prevents upland from being a sediment source to the system
- May be damaged from overtopping oceanfront storm waves

Initial Construction: ●●●●
Operations & Maintenance: ●●●

GRAY CAN BE GREENER: e.g., 'Living Breakwater' using oysters to colonize rocks or 'Greenwall/Biowall' using vegetation, alternative forms and materials

Initial Construction: ● = up to $1000 per linear foot, ●● = $1001 - $2000 per linear foot, ●●● = $2001 - $5000 per linear foot, ●●●● = $5001 - $10,000 per linear foot
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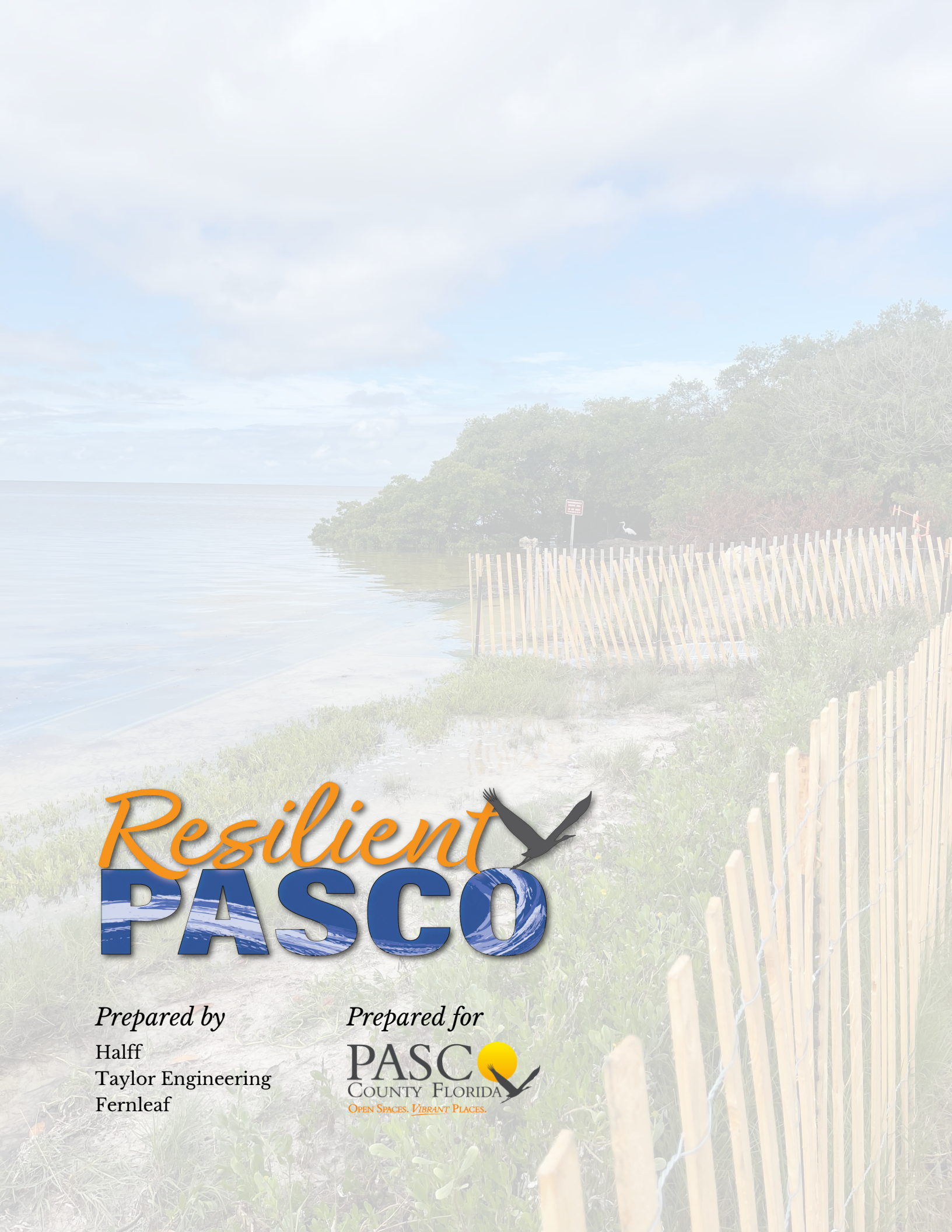

Resilient PASCO

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Prepared for

PASCO County Florida
Open Spaces. Vibrant Places.