LIVING SHORELINE SITE DESIGN OPTIONS

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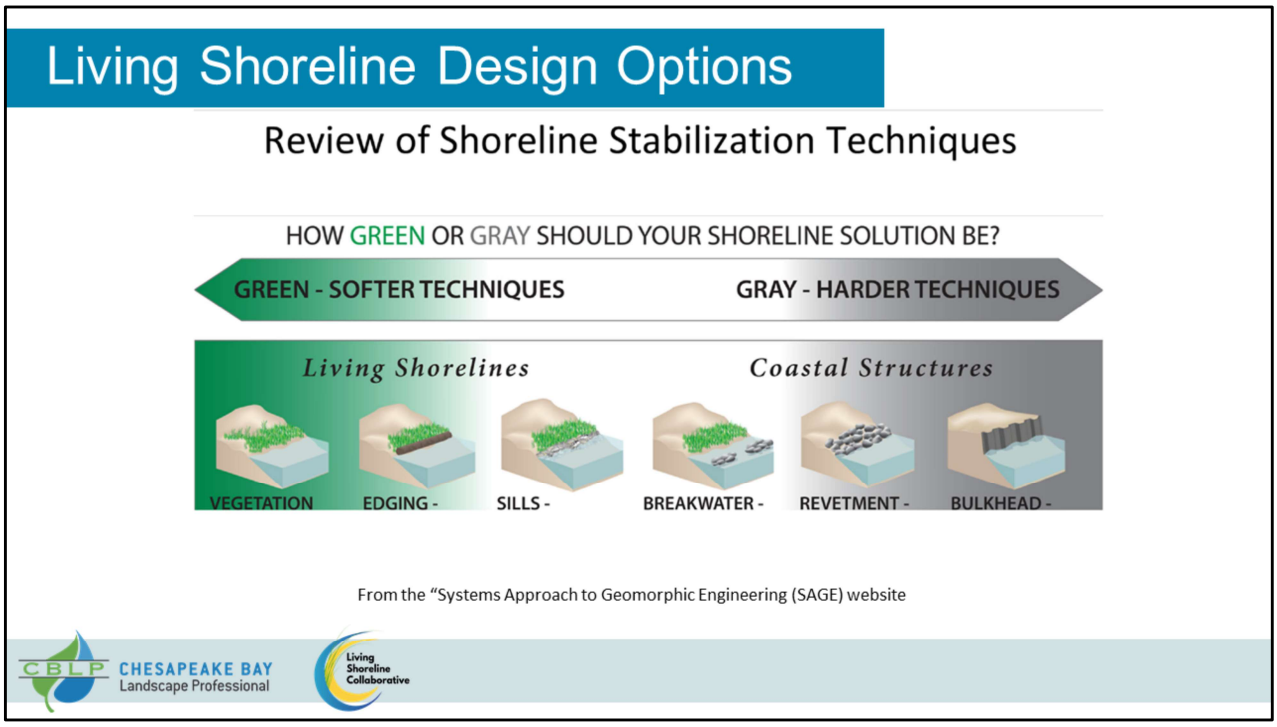
Living Shoreline Collaborative

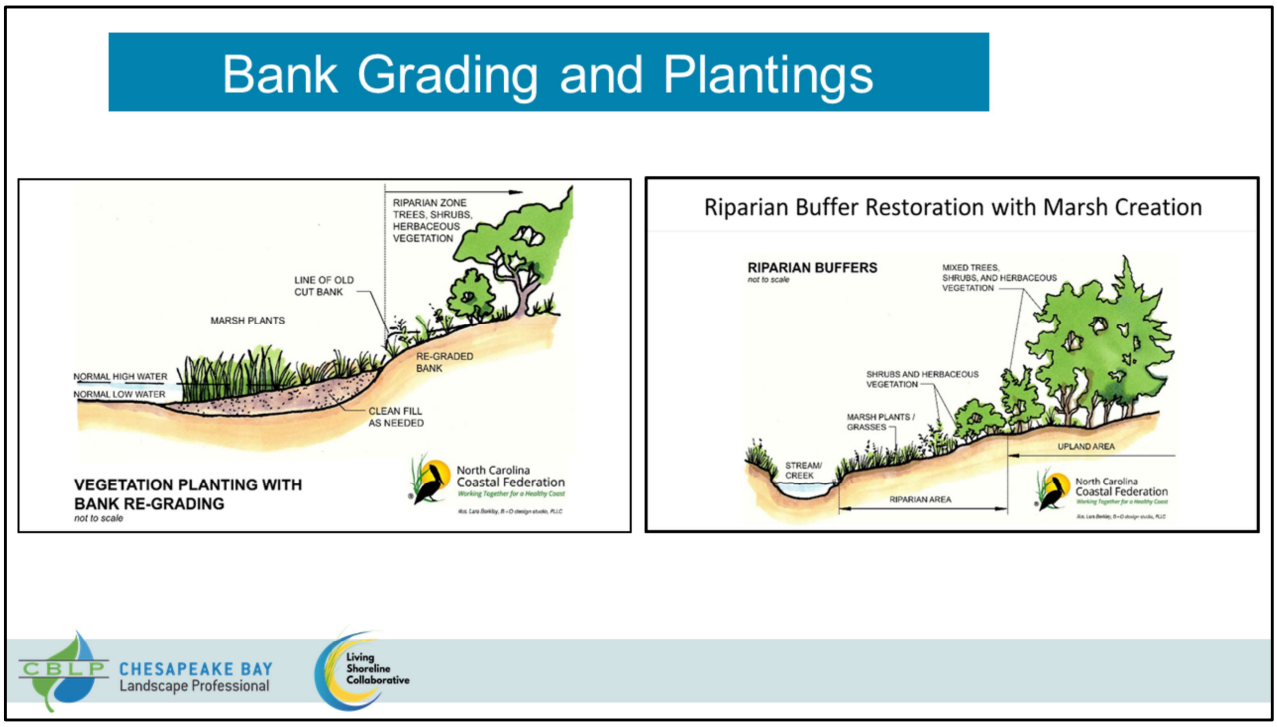
Tracy E. Skrabal



Many eroding shorelines could be stabilized using one of a number of erosion control strategies. They range from vegetation, or softer techniques, to shorelines protected by engineered structures, such as sills, revetments, and bulkheads. Living shorelines can be adapted to most shoreline types and energy levels, combining native plantings with structural elements where needed.

A good resource for considering different options is the "Systems Approach to Geomorphic Engineering" or "SAGE" website: http://sagecoast.org/. The SAGE brochure (in your packets) highlights the different levels of "green" and "gray." The highlights include:

- Structural options for various environments and site conditions
- Material options
- Benefits
- Disadvantages



For lower energy regimes, the easiest and least expensive option is often re-grading the eroded slope and planting with native vegetation, such as marsh and/or dune grasses. However, for any eroding shoreline, the predicted energy levels and the cause of the erosion must be addressed (e.g. minimum wake zone enacted or wave energy protection installed) before selecting re-grading and/or plantings as the preferred approach along the shoreline.

Bank Grading and Plantings

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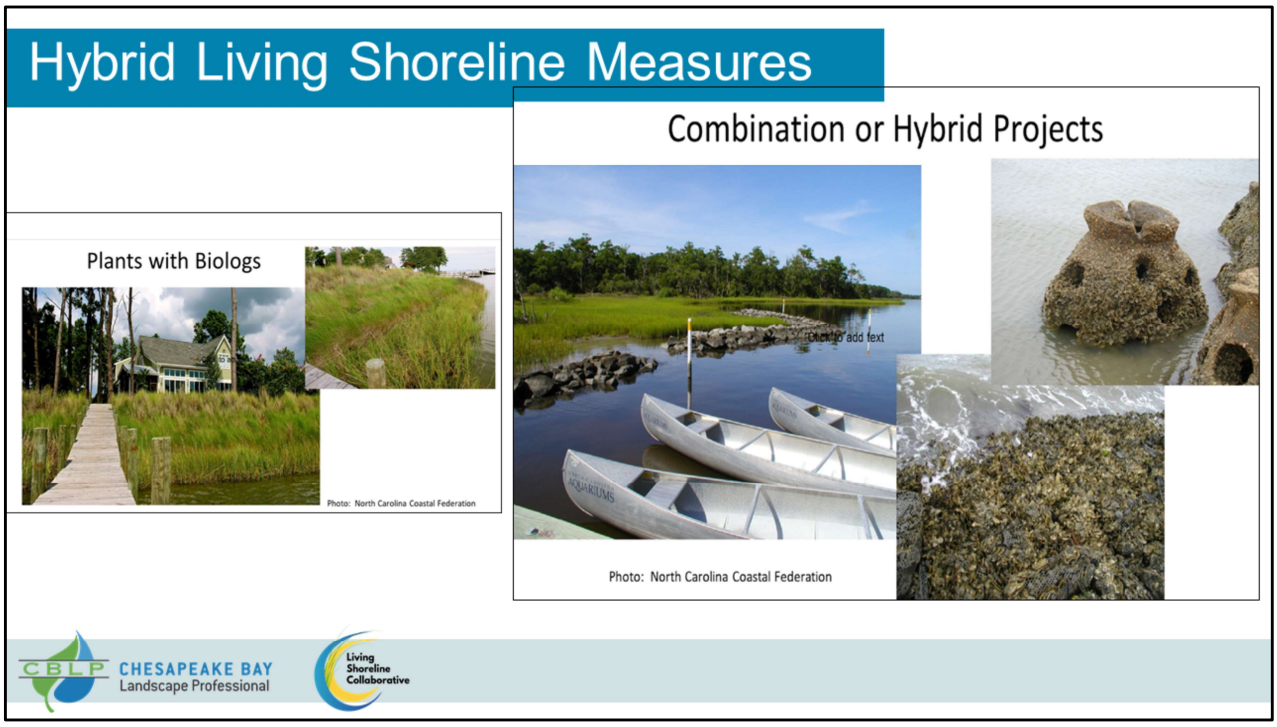
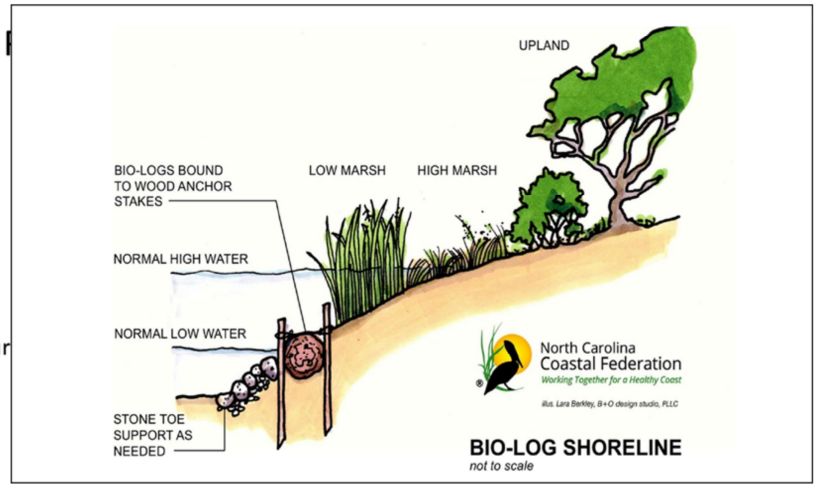


As energy levels and the resultant potential for erosion increases, so might the need to design projects that include both structural and non-structural elements. There are many design options for these “hybrid” living shoreline projects, however, all living shoreline projects should include some vegetation, which is either existing, restored, or enhanced.

Coir Log Methods

- Works in areas with minimal wave energy
- Can be combined with other measures
- Biologs provide temporary protection for juvenile plants
- Need initial monitoring and minimal maintenance to ensur plants are growing



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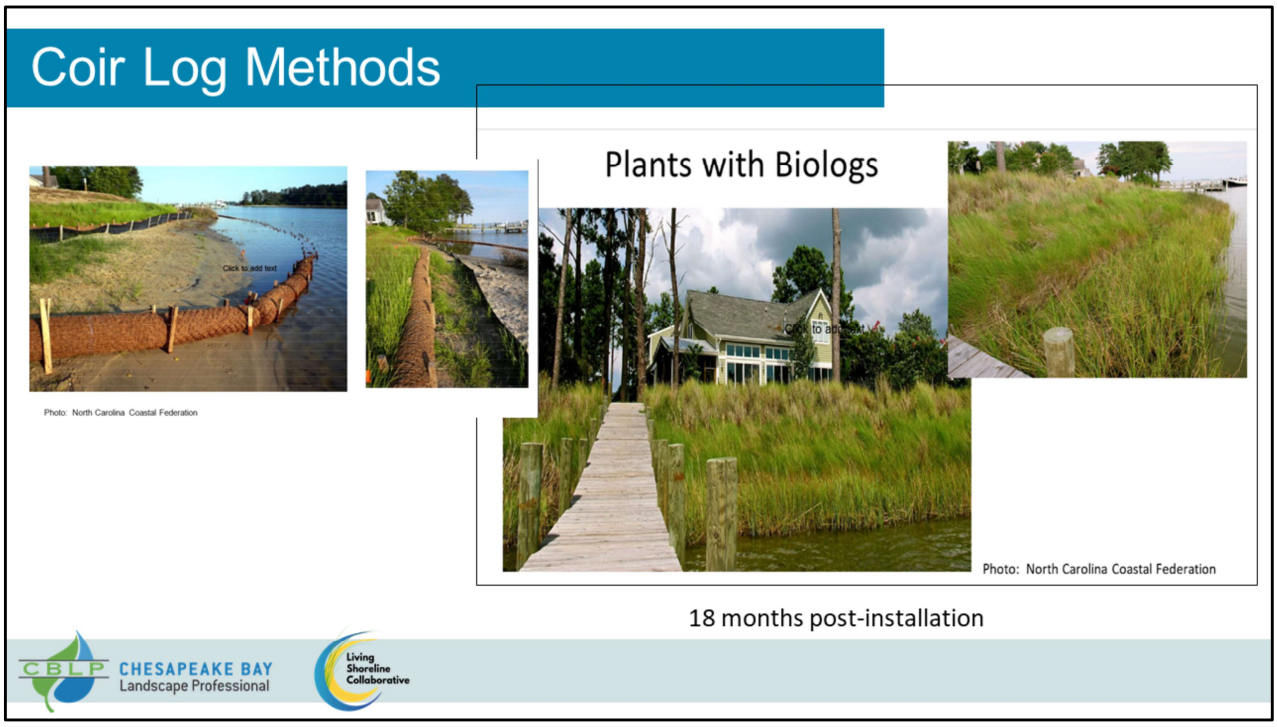
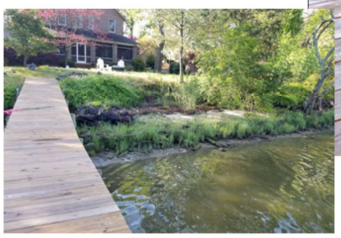
In areas with minimal to moderate wave energy, plantings with temporary protection, in the form of coconut fiber logs (often called coir logs or biologs) can provide temporary protection while the plants are growing. This approach works best in brackish and freshwater areas, but can be successful in saltwater environments. To extend the life of the logs and the upper energy threshold for application of this technique, a small amount of stone can be used as toe protection channelward of the line of biologs.



In most cases, coir log measures are designed to provide energy dissipation for up to 18 months (generally more in freshwater than saltwater systems), which should allow the plants the time necessary to become established. These applications do need initial monitoring and potentially some maintenance to ensure that the plants are growing and expanding as anticipated, and the structure remains intact.

Coir Log Methods



Krause Site, Norfolk, VA, photos/plans from Barbara Gavin

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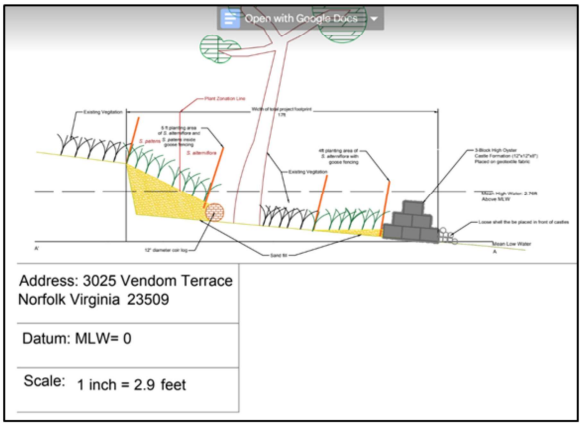
Coir Log Methods



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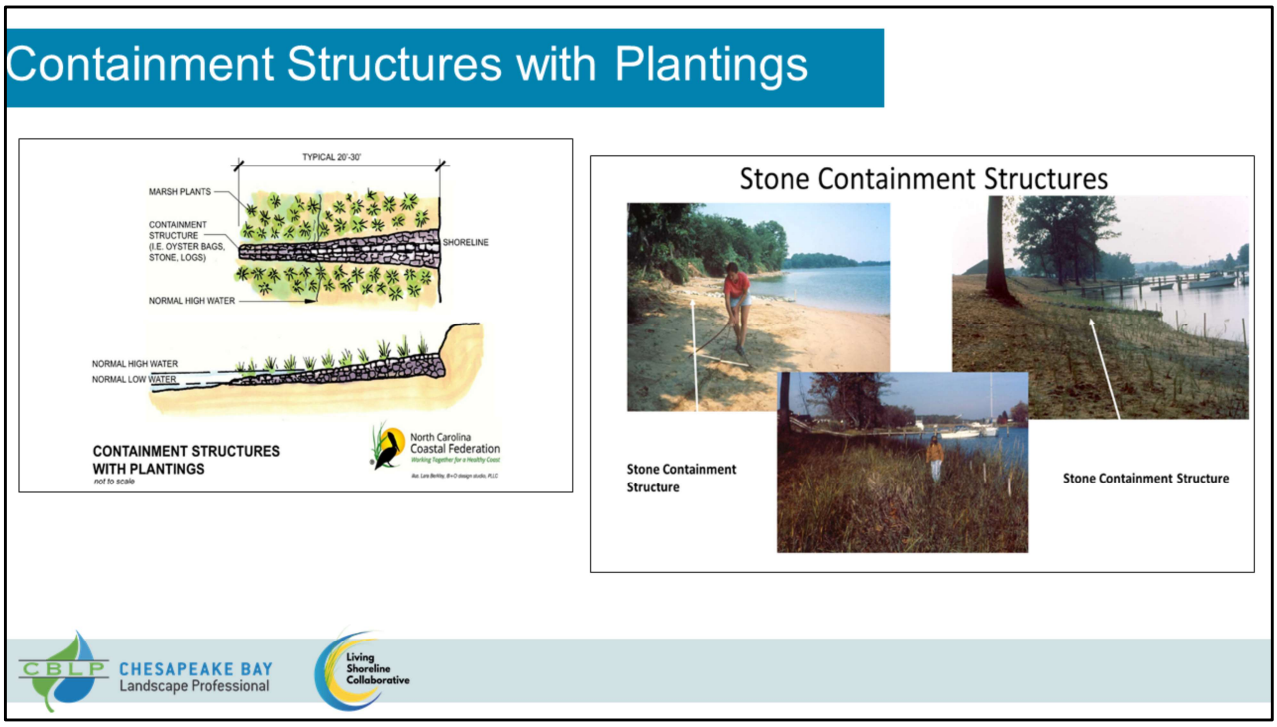
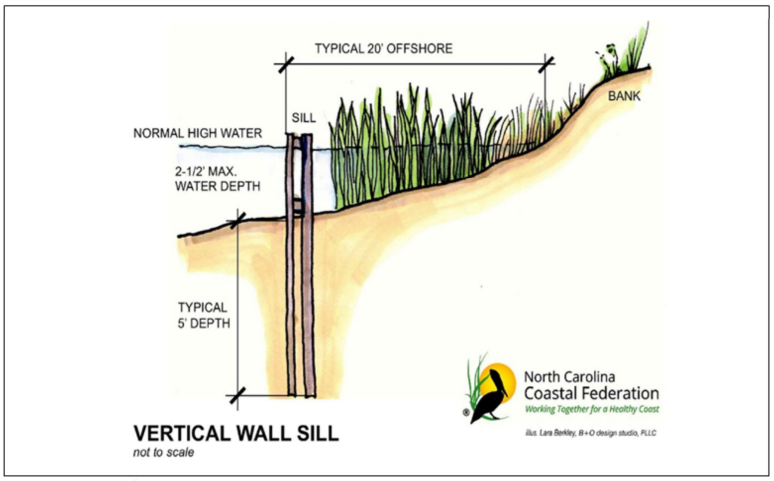
Krause Site, Norfolk, VA, photos/plans from Barbara Gavin



For fetch-limited settings where the forces of erosion energy may be due to boat wakes and alongshore currents, the use of stone containment structures with marsh plantings can be a successful approach. The containment structures slow the alongshore energy and hold the existing soil in place until the marsh can become established. This approach provides great access for fishes and other animals who rely on marsh habitats for their survival. At this relatively narrow tidal creek site in Maryland, an eroded, oversteepened bank was re-graded to establish a suitable shoreline for marsh restoration, which included the placement of stone containment

structures to hold the soil in place, giving stability to the shoreline until the marshes became established.

Vertical Wall Sills



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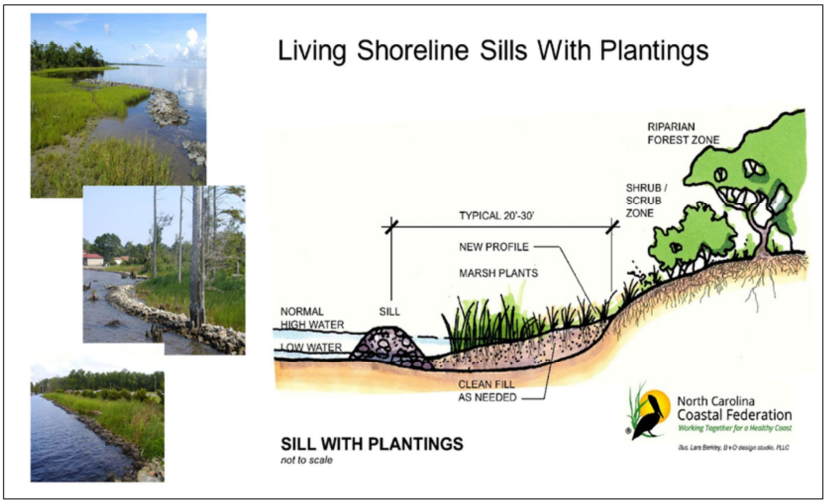
Unlike bulkheads and revetments, sills are designed to be placed channelward of the existing or restored marsh and shallow intertidal zones, providing both erosion control and a resilient estuarine ecosystem. Vertical wall sills are often a great option adjacent to narrow channels, where substrate conditions do not support the weight of other measures, where oysters or other shellfish exist, and where access to the site may be limited for equipment. They are generally constructed as gapped wooden and/or vinyl structures.

Vertical wall sills are designed to allow some water to pass through the structure, while still dissipating wave and current energy. As with any piling- supported structure placed in estuarine conditions, it is critical to design and size the structure to withstand the expected energy forces at that site.

This vertical wall sill (upper right) is constructed along a relatively high energy site adjacent to Albemarle Sound near Nags Head. The construction materials are wood, and the design encouraged the protection of the shoreline and the restoration of a sandy shoreline and

marsh fringe (primarily black needlerush) and riparian buffer.

Sills With Plantings



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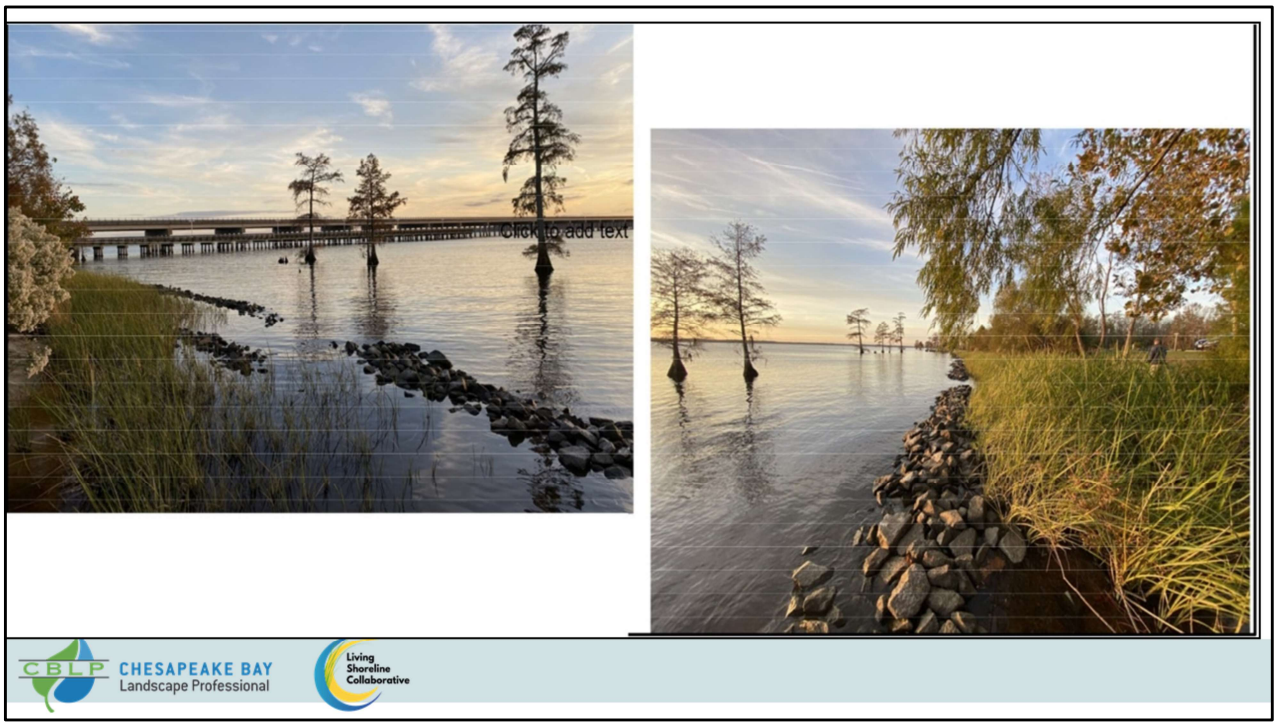
For certain moderate to higher energy sites, stone sills may be the best design option to ensure adequate erosion control and long term resilience. Sills are placed channelward of the marsh zones, and break down wave energy from storms or boat wakes. They are pervious, allowing waters to flow through and over them at higher tides, which sustains the landward marsh, but often result in trapping of sediment and supporting marsh enhancement. Longer structures often have constructed gaps, that allow for better fish passage around and through the sills.



This compilation of photos shows the project progression from removal of the aging bulkhead, through construction and planting efforts. It should be noted that the project required some repair of the shoreline and additional plantings after a hurricane passed over in 2006, but the stone sill was virtually unchanged.

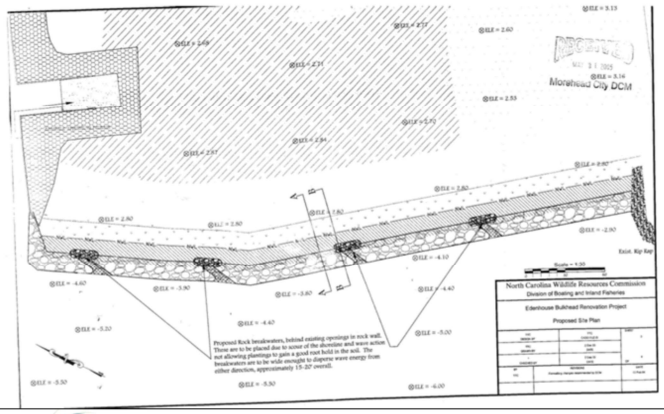
At this site, freshwater/brackish plant species were included in the planting design including wetland plants, shrubs, and trees. The planted

and naturally occurring species included:

- Shallow/inundated zone: *Zizaniopsis miliacea* (Water Millet), *Pontederia cordata* (Pickerelweed), *Cladium jamaicense* (Sawgrass), *Sagittaria latifolia* (Duck Potato), *Schoenoplectus tabernaemontani* (Softstem Bullrush), and Lilaeopsis spp.
- Frequent but not continuous inundation: Scirpus americanus (Threesquare), Juncus effusus (Softrush), Impatiens capensis, and Polygonum spp.
- Occasionally inundated higher marsh/upland: *Spartina patens* (Saltmeadow Cordgrass), *Platanus occidentallis* (Sycamore) and *Taxodium distichum* (Bald Cypress).
- Upper berm/riparian buffer: *Morella cerifera* (Wax Myrtle), *Rosa palustris* (Swamp Rose), *Callicarpa Americana* (American Beautyberry), *Rhus copallina* (Dwarf Sumac) and *Aronia arbutifolia* (Red Chokeberry)

Stone Sills With Freshwater Plants

Stone Sill Living Shoreline in Freshwater Environment
Edenhouse Boat Ramp, Chowan River, Edenton, NC (2004-2005)



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Edenhouse Living Shoreline: 450’ of stone sill with small offset sill structures for gap openings.

- Text on the drawing: Proposed rock sills, behind existing openings in rock wall. These are to be placed due to scour of the shoreline and wave action not allowing plantings to gain good root hold in the soil. The sills are to be wide enough to disperse wave energy from either direction, approximately 15-20 feet overall.
- ~1.2 tons riprap per linear foot

Living shorelines can provide very effective stabilization in high energy areas, such as this project on the Chowan River. In addition, many shorelines can be enhanced to include zones of restored marsh grasses, higher marsh shrub/scrub, and native riparian tree buffers.

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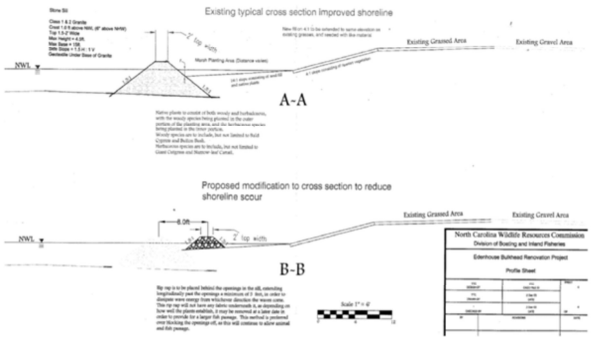

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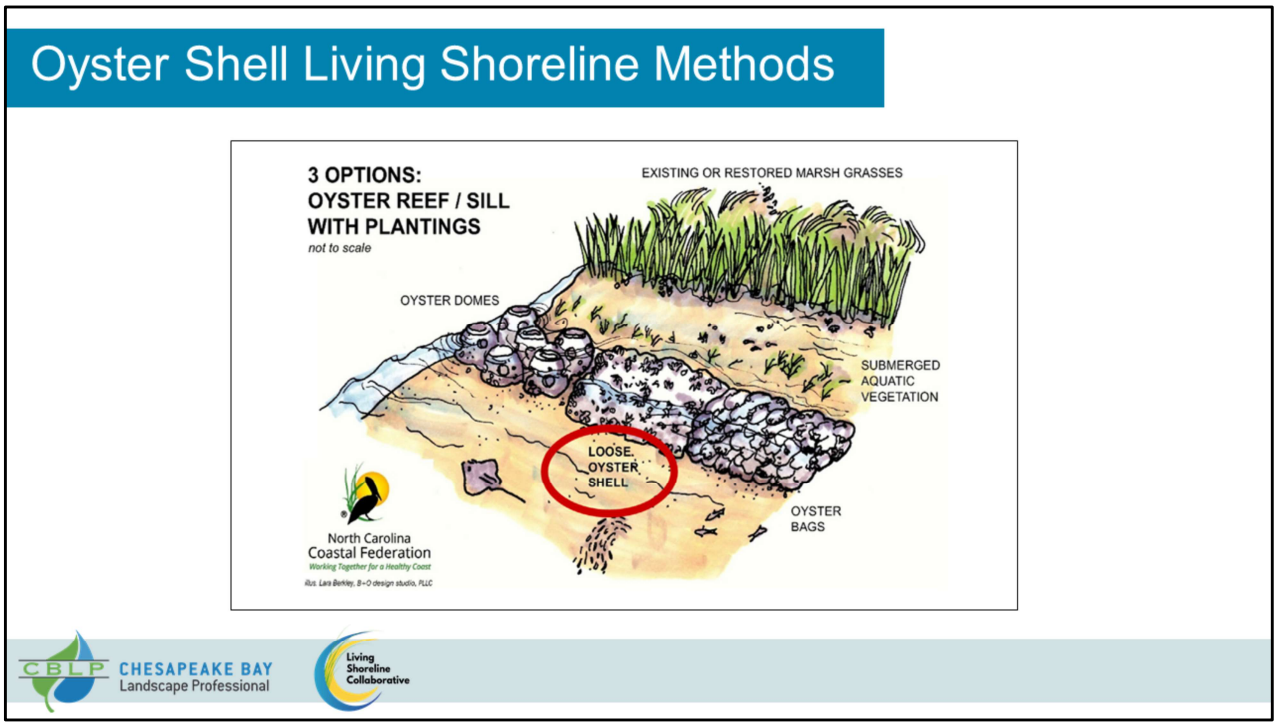
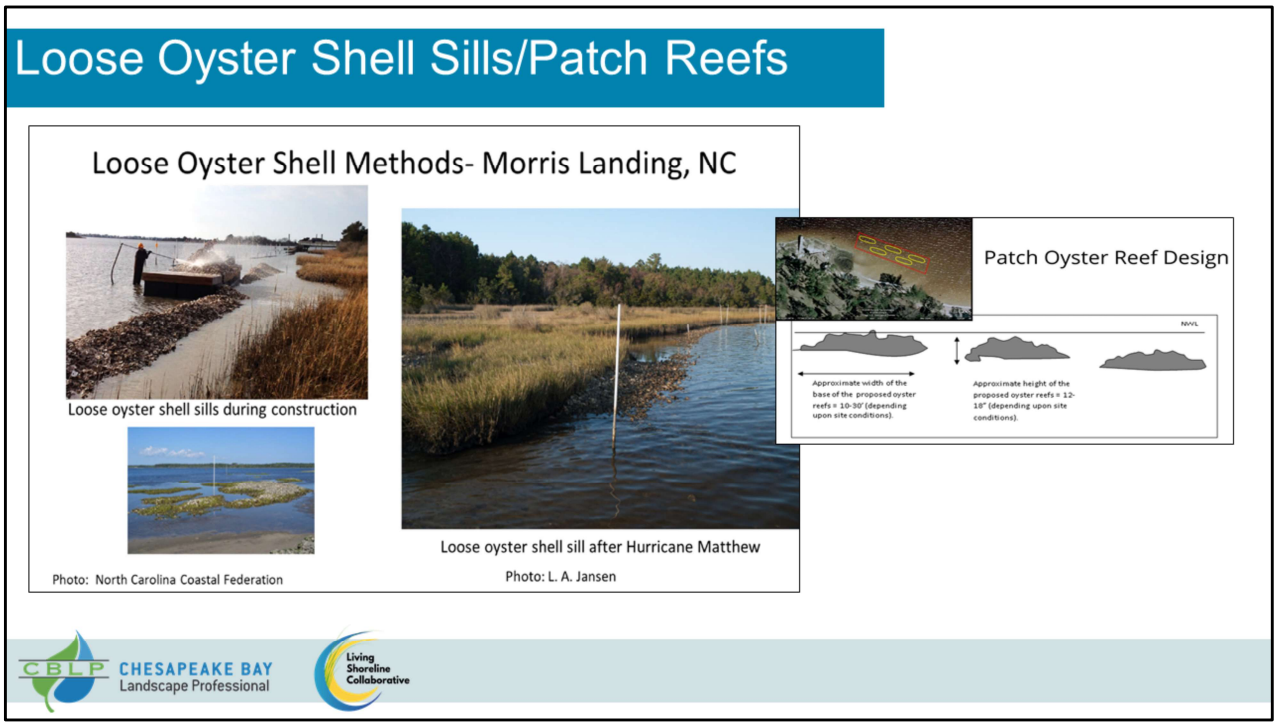


In areas of our estuaries where oysters grow naturally, but may be limited by lack of structures on which to attach, loose oyster shells, bagged or innovative structural oyster shell reefs may be a very effective living shoreline option. Recycled and bagged oyster shells, as well as a number of innovative structural approaches can help to restore diminished oyster reefs and provide excellent erosion control, encourage habitat restoration and provide water quality benefits. There are many design options available to create a sill

structure, which provides shoreline stabilization and a reef structure for new oyster settlement and growth. As with all living shoreline structures, marshes are a critical component of this approach.

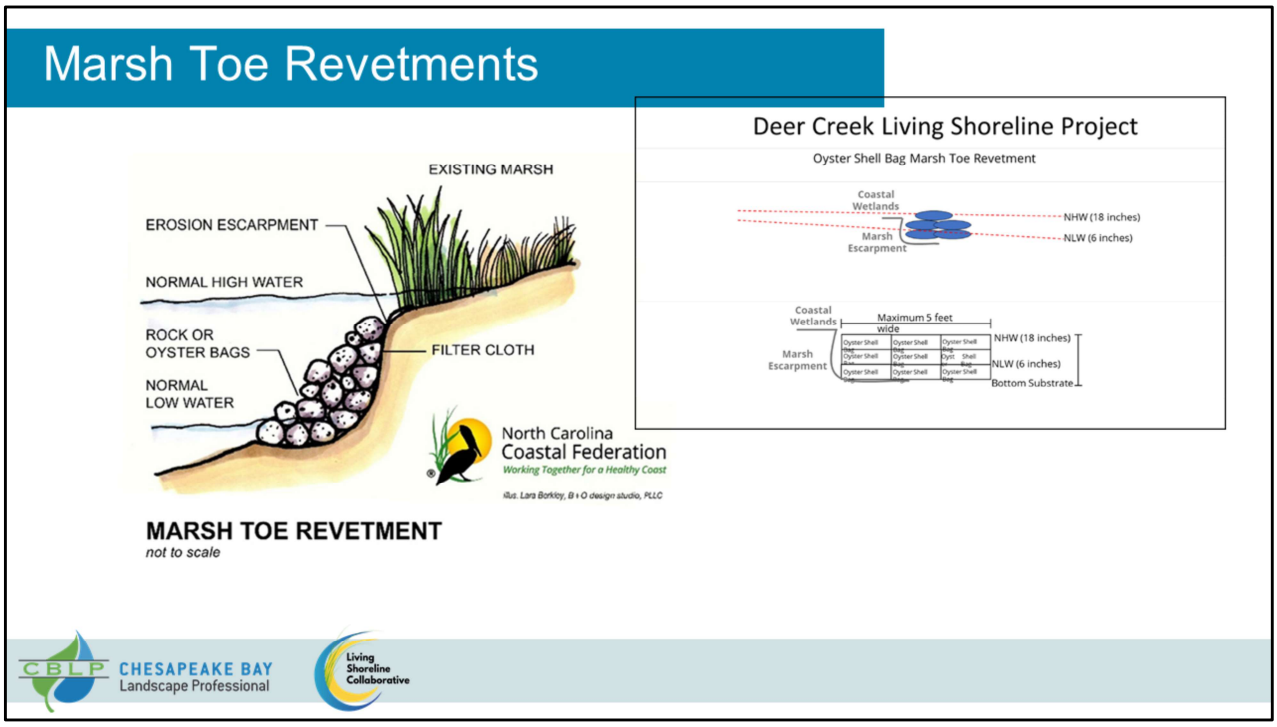
In selecting this living shoreline option, it is critical to ensure that oysters are naturally occurring in the area. Varying salinities, water circulation, bottom conditions, sedimentation, and the oyster growing elevation ranges are key factors in the determining if an oyster- growing structure will succeed at a proposed site.



Where conditions are appropriate (eg. lower energy, low boat wakes, firm bottoms, naturally occurring oyster reefs) loose oyster shell patch reefs can be “hand” placed or washed into place using commercial water jet systems. It is critical to design and place the shell to closely mimic the natural oyster reefs in the area.

With loose oyster shell sills/reefs, the material is often “overbuilt” which allows for waves, tides and currents to redistribute the material into a more natural, sustainable structure. During

Hurricane Matthew, some loose shell was lost into the marsh, but the overall structure was maintained and functioning adjacent to the tidal marsh.



Similar in function and relative design to sills, marsh toe revetments can provide excellent erosion control and oyster reef restoration. These structures are placed directly adjacent to the scarped edges of eroding marshes, and are designed with a maximum crest elevation of 0.5’ above the existing marsh grades.

Marsh Toe Revetments

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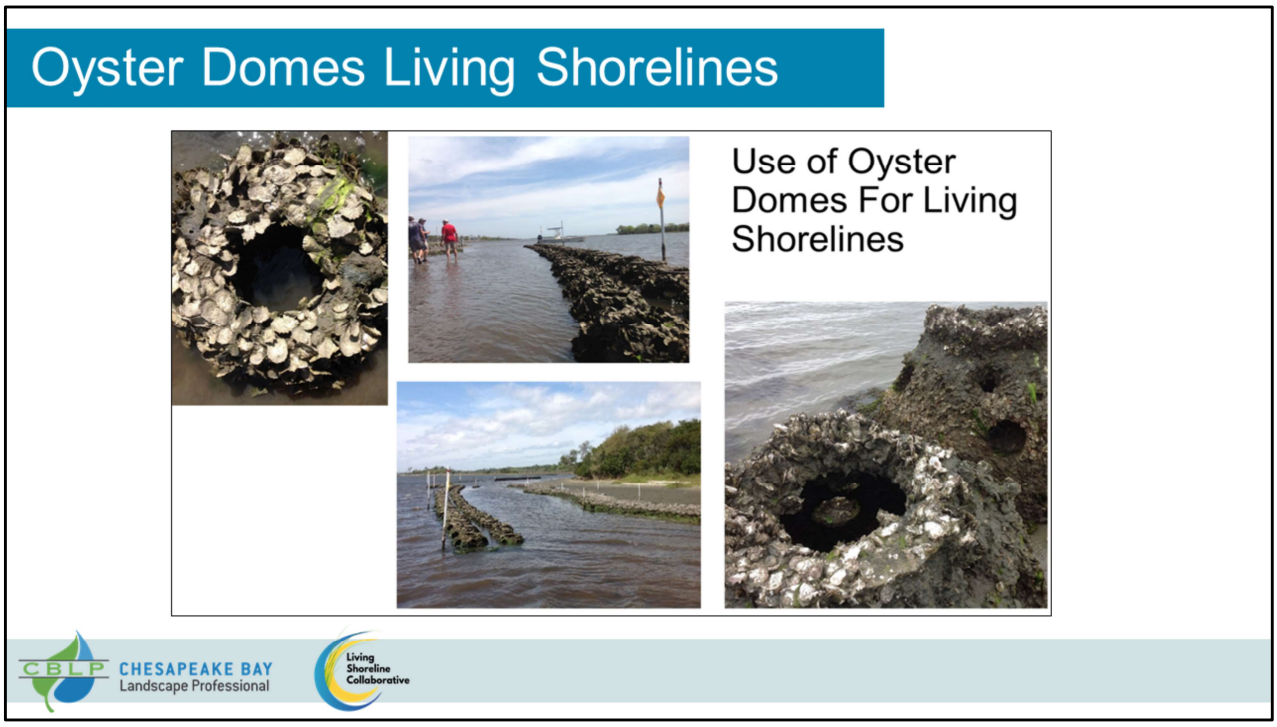
Photos from North Carolina Coastal Federation



In many areas of the country, the use of prefabricated pre-cast oyster domes have been used as a successful erosion control and oyster reef restoration projects. They can be placed in a variety of designs and alignments. For this design, it is important to understand the natural oyster growing ranges for each site, and place them accordingly to ensure maximum oyster establishment.

Oyster domes are sold commercially and available regionally throughout the United

States. Some organizations, such as the non-profit conservation organization Tampa Bay Watch (https://tampabaywatch.org/) have built forms to create oyster domes with volunteer or student assistance.

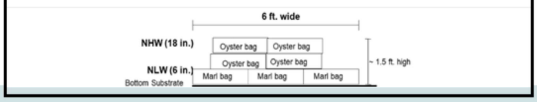
Oyster Shell Bag Sill

Oyster Shell Bag Sills at Jones Island

Before

After

Oyster Shell Bag Sill Design



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NOTE** Before selecting any innovative approach, contractors and other design professionals and/or property owners should ask for references, design and cost information, and performance monitoring results of existing projects for areas with similar site and energy level conditions.

Innovative Living Shoreline Design

Sandbar Oyster Co. Oystercatcher™ Tables and Pillow Living Shoreline 08/12/22 Photos NC Coastal Federation

January 8, 2023 Photo from Kyle Breuer

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Innovative Living Shoreline Design

Oyster Castles™- Photo by Barbara Gavin

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Pre-cast concrete structures, such as the Oyster Castles®, provide flexibility in design widths and heights, with a focus on interlocking modules to increase stability. The relatively portable and lightweight nature of the modules allow for "hand" construction of the structure, where conditions are optimal.

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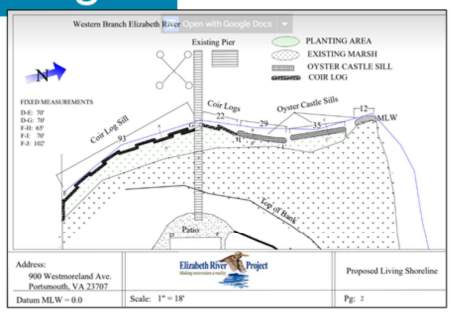
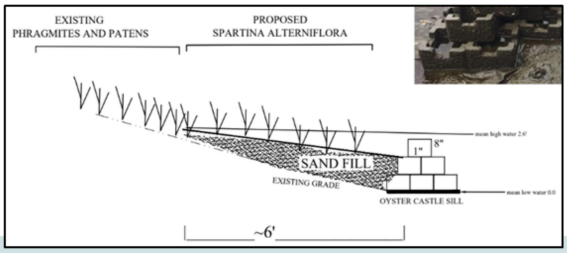
*Note: Typical or specific costs for materials, design and installation of Oyster Castles® should be requested from Allied Concrete.

Innovative Living Shoreline Design





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Rollings Oyster Castles- Photos and Plans Provided by Barbara Gavin

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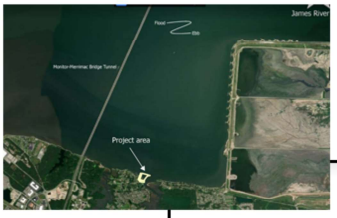

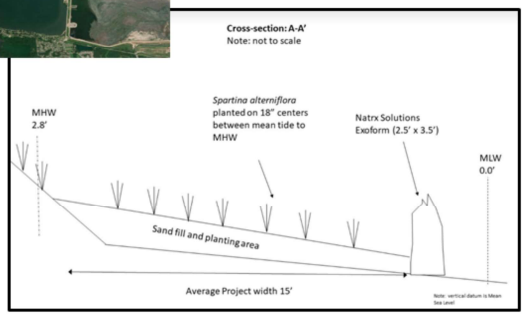

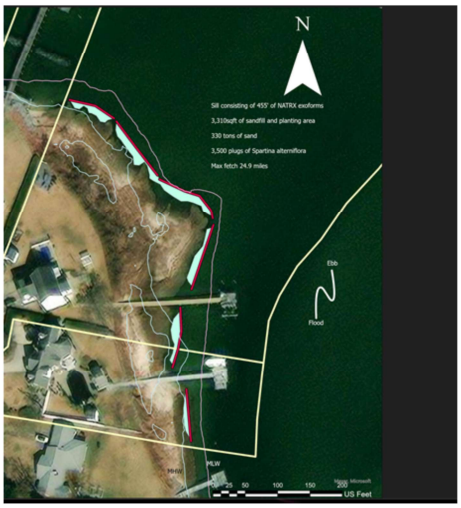

Natrx™ Living Shoreline Design Project, Norfolk, Va. From Ryan Walsh

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Natrx Solutions™ Project design plans provided by Ryan Walsh

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Questions? Tracy Skrabal skrabalt@gmail.com

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