Shore Erosion Control Guidelines

Marsh Creation

Maryland Department of the Environment
Wetlands and Waterways Program

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This guidance is part of a comprehensive effort to update the 1992 document *Shore Erosion Control Guidelines for Waterfront Property Owners* by the Tidal Wetlands Division, Water Resources Administration, Maryland Department of Natural Resources (now Water Management Administration, Maryland Department of the Environment). Background text from the 1992 document is included in this updated guidance.

Background

Background language is from *Shore Erosion Control Guidelines for Waterfront Property Owners*, Tidal Wetlands Division, Maryland Department of Natural Resources (1992) unless otherwise noted. The Tidal Wetland Division is now part of the Maryland Department of the Environment.

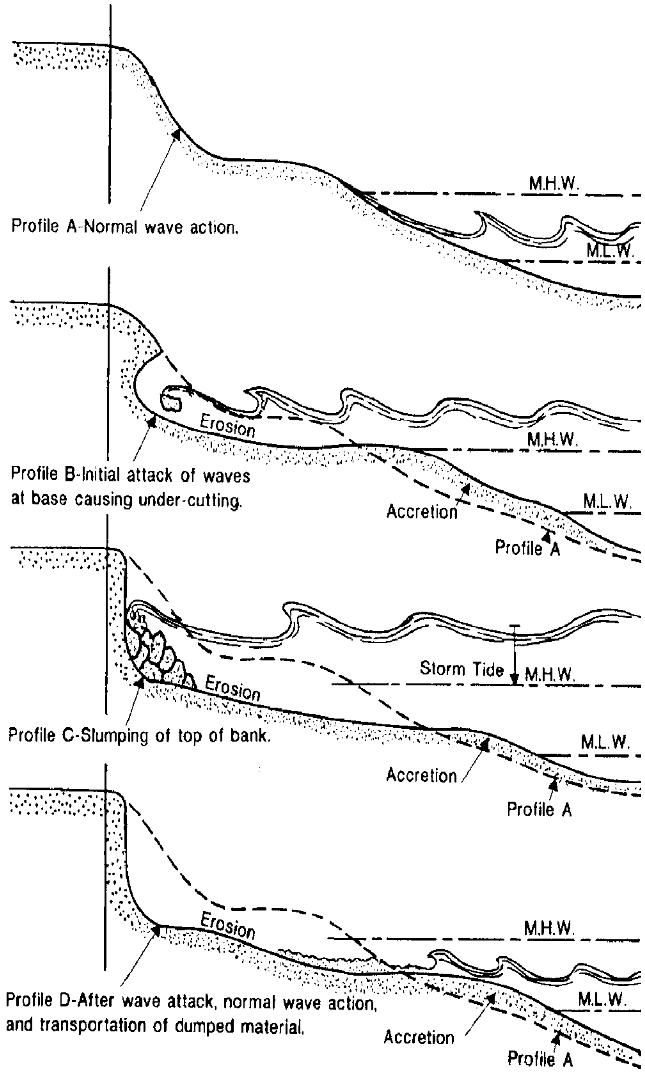
Understanding Shore Erosion

Erosion and sedimentation (the deposition of sediment) are natural processes, but often are in conflict with our use of the shoreline. The most noticeable problem created by erosion is the loss of waterfront property. Waterfront property values are high, so many owners spend considerable time and money protecting their shorelines from erosion.

Shore erosion is caused primarily by wind driven waves and to a minor extent by wakes from passing boats. Wind velocity, duration, and the expanse of open water (fetch) the wind blows over are the predominant factors generating waves that attack and erode the shoreline. Wave height and strength are generally greater in areas exposed to the main stem of the Chesapeake Bay than in rivers and creeks.

The basic progression of erosion resulting from wave action, diagramed in Figure 1, includes: A) attack by waves, B) erosion of a bank and beach causing undercutting, C) slumping of the bank, and D) removal, transportation, and deposition of the bank sediments along the shoreline.

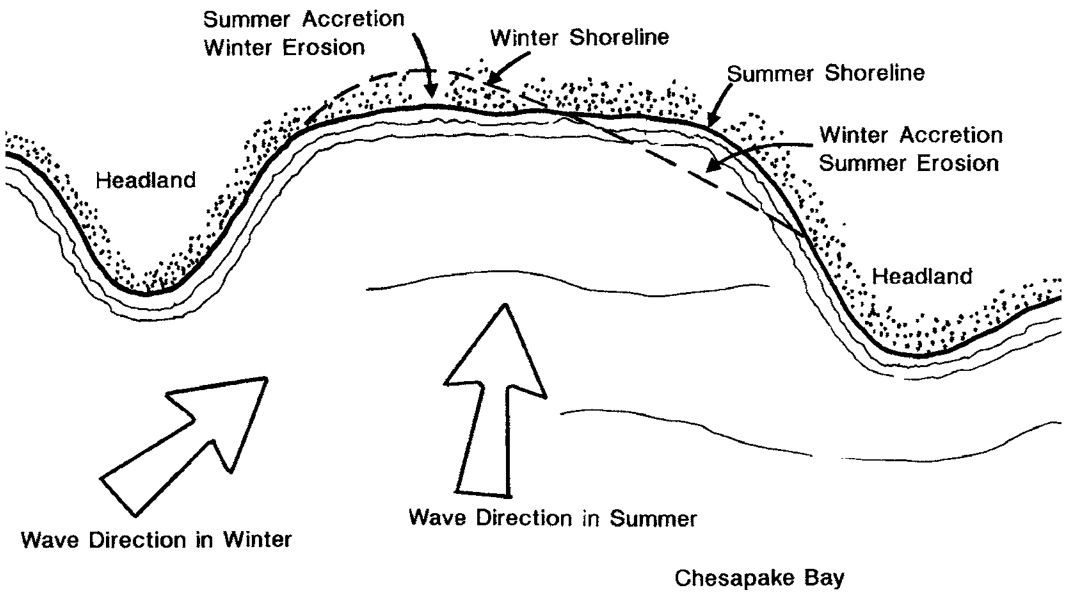
Figure 1. Wave erosion and transportation of sediments along a beach (DNR, 1992)



Shallow bottoms near the shore reduce wave action. Therefore, a shoreline is likely to receive fewer waves if there are shoals, tidal flats, offshore bars and/or a marsh near the shore. Also a wide beach can withstand more waves than a narrow beach, therefore reducing erosion of the shoreline.

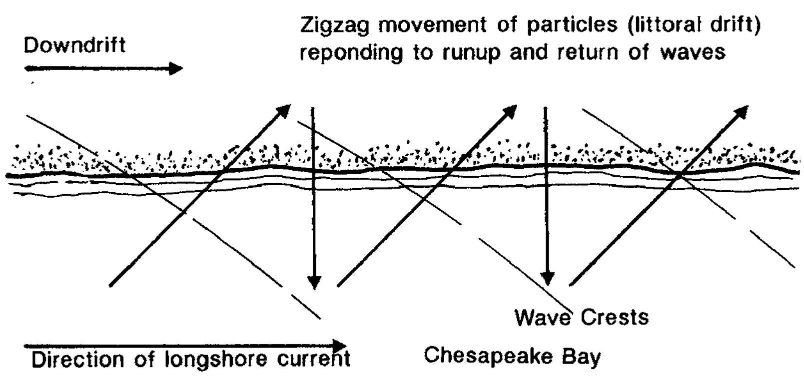
Water level also affects the amount of erosion. Water levels are influenced by the seasons, tides, storms, seiches (sloshing action of water in a basin, similar to a wave set up in a bathtub), droughts, floods and the general rise of global sea level. New areas of the shoreline are exposed to erosion by these changes in water level. Seasonal storms affect the level and movement of water, the intensity and direction of wind, and changes in the patterns of erosion and deposition (Figure 2).

Figure 2. Seasonal changes in erosion and depositional patterns due to changing wave direction exposing new surfaces. (DNR, 1992)



Often, changes in the pattern of a shoreline are mistakenly measured as an overall net gain or loss of sand when the changes are only seasonal. Sand is carried onshore and offshore by the action of waves. Sand is also moved along the shore. Waves most often arrive at an angle with the shoreline creating a current along the shoreline. These currents move sand along the shoreline in a zigzag pattern as successive waves advance and retreat (Figure 3).

Figure 3. The zigzag pattern of sand movement along a shoreline.(DNR, 1992)



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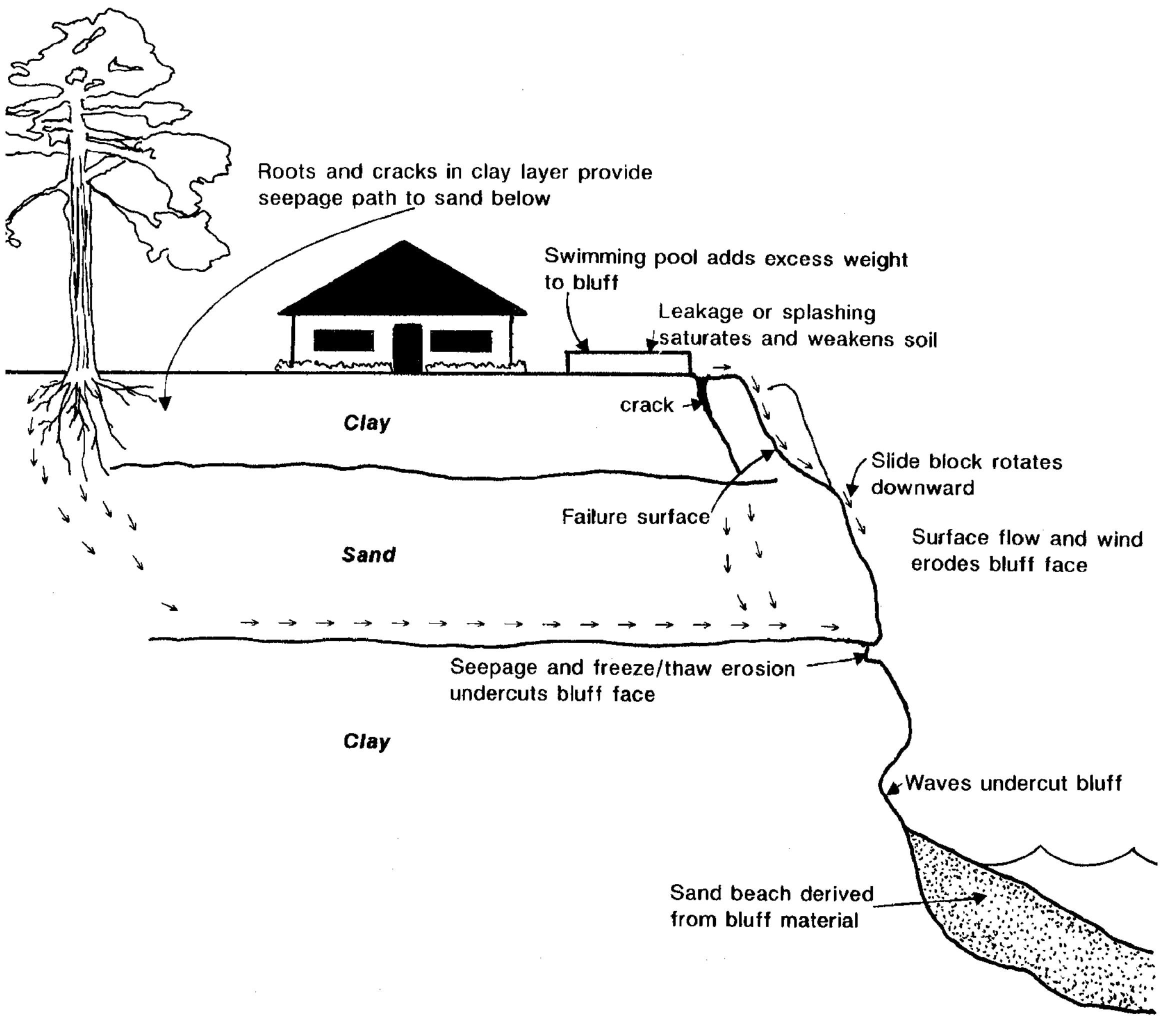
A stabilized beach is dependent on the balance between sand supplied from the bank or transported along the shore, and sand lost to erosion. The movement of sand is essential to maintaining beaches and deterring erosion. The velocity (speed and direction) of water determines the amount of sand moved. Larger quantities and heavier sands can be transported by larger waves or fast moving currents along the shoreline. Fine grained sediments (silts and clays) are generally transported to the deeper sections offshore while larger grained sands are deposited along the shoreline. Groundwater discharge through cracks (joints) in sediments as well as wave action contributes to shoreline erosion by causing the slumping of sediments from high banks (Figure 4).

Figure 4. The combination of wave and groundwater erosion on a high bank. (DNR, 1992)



Runoff of surface water also causes erosion of high and low banks and beaches. The amount and velocity of the water, the height and slope of a bank, and the amount of vegetation determine the amount of material eroded and deposited along the shoreline.

There are natural defenses for shoreline protection. Gently sloping shorelines, beaches and marshes are a good defense against erosion. A beach prevents average high water from reaching upper areas of the shore. Marsh plants decrease the rate of erosion by breaking up waves and trapping sediment carried by currents along the shoreline. Where these features exist they must be managed wisely.

Erosion Rates

Erosion of the shoreline in Maryland varies from less than two to greater than eight feet per year. The rate is dependent upon the erosional forces, mentioned previously, attacking the shoreline and the soil composition of the bank, beach or marsh. The rate is also influenced by erosion control structures built along a shoreline. Often the protection of a single waterfront property has a negative effect (increased erosion) on adjoining properties. Therefore, coordinated protection of an entire segment of shoreline is highly recommended.

Determining the Need for Shore Erosion Protection

Erosion problems are site specific. There are a variety of procedures and devices designed to protect against erosion. Selecting an appropriate erosion control measure for your property requires planning.

The loss of property resulting from shore erosion is a serious problem for many waterfront property owners. It is important to determine the degree of erosion to your waterfront property before you or your community decide on a plan of action.

To determine if a shore erosion problem exists, you should consider the following questions:

- Has your shoreline noticeably receded during the last two years?
- If you have marsh along your shoreline, has it been disappearing?
- Do you have to step down to walk on your beach?
- Are trees along your shoreline falling into the water?
- Is your beach submerged at high tide?
- Have your neighbors installed shore erosion control measures?

If you answer yes to one or more of these questions you should contact the Tidal Wetlands Division in MDE at (410) 537-3745, or Shore Erosion Control Program in DNR, at (410) 260-8909 or (410) 260-8926, the local Soil Conservation District Office or consult the telephone directory for engineering or marine contracting firms in your area

From Bosch et al. (2006):

Marsh Creation

Marshes are a vital part of the Chesapeake Bay ecosystem, and serve as a transition zone between open water and land. Marshes provide excellent habitat for many plant and animal species, many of which are of recreational and commercial importance. Marsh plants also filter sediment, prevent erosion and even improve water quality. Therefore, planting a marsh along the shoreline (Figure 5) can be an effective way of stabilizing the shoreline and enhancing the Bay ecosystem. Wetlands also have the ability to protect property from hurricane damage by reducing storm tidal surge and diminishing storm intensities, which can be an added benefit for homeowners (Farber, 1987). Many environmental factors influence whether or not a marsh will thrive, so it is important that the site meet certain requirements. The requirements include low wave action, shallow slope, and low boat traffic along the shoreline. Marshes can be used in conjunction with sills, low lying rock walls several feet out from the shore, or biologs, bundles of natural materials (e.g. coconut fibers) staked into the ground along the shoreline, to protect the marsh from waves. In an appropriate setting, marshes are often less costly than structural measures and are an attractive way to preserve the shore. (Maryland Department of Natural Resources, 1992).

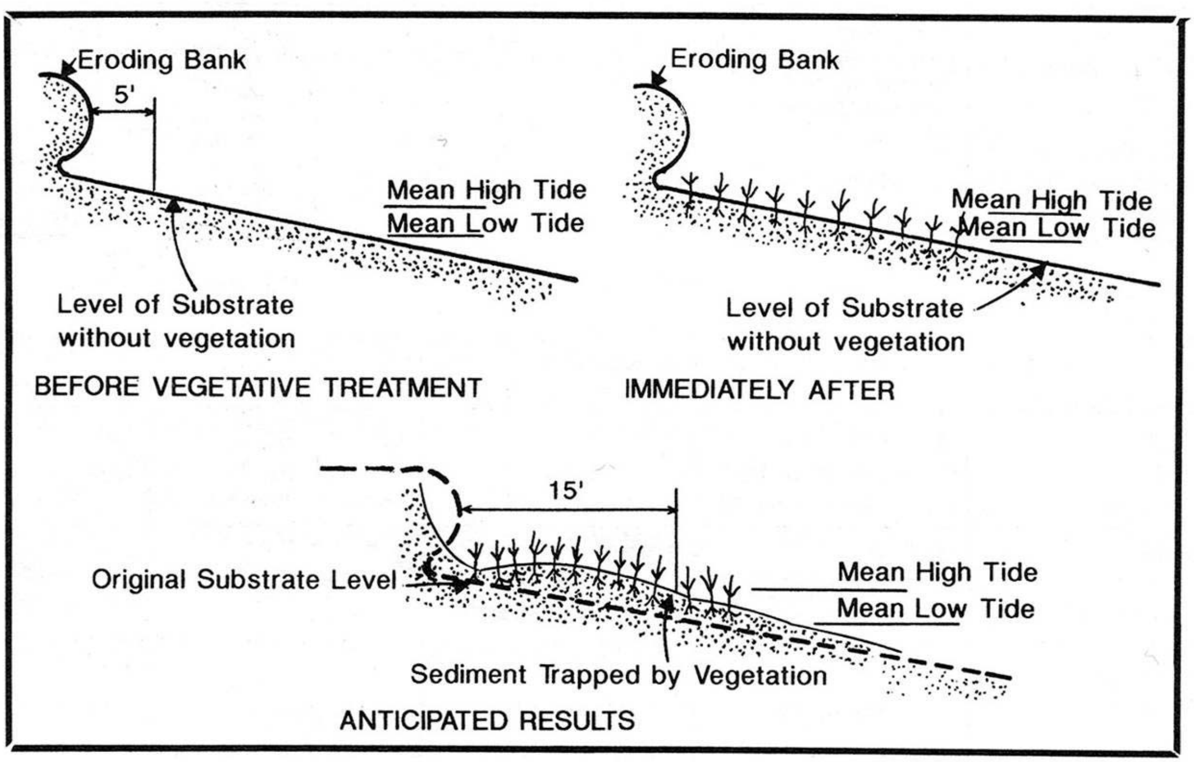


Figure 5. Marsh creation viewed cross-sectionally over time (Maryland Department of Natural Resources, 1992).

The role of wetlands in controlling erosion

Wetlands play a functional role in erosion control along the shorelines of the Chesapeake and its tributaries. In particular, wetlands have important filtering capabilities for intercepting surface water runoff from higher land as the runoff approaches coastal waters. As runoff water passes through, the wetlands retain excess nutrients and some pollutants, and reduce sediment that would clog waterways and affect fish and amphibian egg development; they accomplish this to such a degree that wetlands are often constructed specifically for the purpose of wastewater treatment. Wetlands also provide natural flood protection by acting as sponges to absorb excess water (Mitsch and Gosselink, 2000).

In addition to erosion control, wetlands offer a number of valuable environmental benefits along the shores where they occur naturally. Boyland and Maclean (1997) have estimated that 46% of the nation's endangered species either live in wetlands or are wetland-dependent (as cited in Whigham, 1999). Wetlands provide habitat to thousands of animals and plants in addition to providing stopping points for migratory birds. They are diverse and dynamic ecosystems teeming with biodiversity that includes fish, wildlife, and plants of economic and social value. Because of their unique ecosystems, wetlands provide aesthetic and recreational opportunities for millions of people and communities. Examples of such recreational activities include hunting, fishing, and bird watching (U.S. Fish and Wildlife Service, 1997).

The ability of wetlands to control erosion is so valuable that artificial wetlands are being constructed along coastal areas to buffer the storm surges from hurricanes and tropical storms. Wetlands at the margins of lakes, rivers, bays, and the ocean protect shorelines and stream banks against erosion. Wetland plants hold the soil in place with their roots, absorb the energy of waves, and slow the flow of stream or river currents along the shore (Mitsch and Gosselink, 2000). Utilizing wetlands in erosion control can therefore achieve homeowner's goals by maintaining the integrity of the shoreline and can simultaneously enhance the Bay ecosystem.

Recommendations for Non-structural Shore Erosion Control Projects: Marsh Creation for Habitat and Shoreline Stabilization

The following recommendations summarize design and construction guidelines. Each is discussed in greater detail.

1) Design project to allow for adequate sunlight.

2) Use primarily sandy soil as a substrate for plants. No more than 10% of the fill substrate shall pass through a standard number 100 sieve.

3) Grade site at 10:1 so that low marsh extends to mean low water line.

4) Use proper planting. Establish both high and low marsh if this reflects the natural community on the waterway.

5) Use fencing if necessary to prevent waterfowl from eating new plantings.

6) Stabilize adjacent cliffs.

7) Protect shoreline from excessive wave action.

   Use a low profile structure. Do not place rock directly on marsh or as a revetment. Place base of sill channelward of mean low water line. Sides of the sill should be at a 1.5:1 slope.

   The low marsh is covered by open water during the mean high tide. The height of the sill should range from 0 - +1 foot above mean high water

   Include openings through vents with staggered placement or place additional rock to line the bottom of the opening to allow for flushing, sediment accretion, and wildlife access.

8) Proper maintenance will help ensure that the marsh creation project remains successful at preventing erosion and providing wildlife habitat.

Design the Project to Allow for Adequate Sunlight. The marsh plantings should get sun—without sufficient sunlight, they will not be able to grow and form a healthy project. It is important, especially on cliff properties, to trim back limbs trees so that the *Spartina* grasses can get enough sunlight. Be certain to contact your local Chesapeake or Coastal Bay Critical Area contacts about restrictions on removal of vegetation in buffers to waterways.

In Figure 6, a property is shown where shade from trees growing on the edge of the cliff bank behind the marsh have stunted the growth of *Spartina alterniflora* and destroyed much of the high marsh.

Figure 6

Proper Grading and Filling. Proper filling is important for the stability of the marsh and the health of the flora and fauna. Placement of the inappropriate substrate (lacking in sand) can lead to sinkholes forming in the marsh and plants will not be able to take root.

A 10:1 slope is recommended to allow creation of both high and low marsh. Contractors should use material such that no more than 10% of the fill substrate shall pass through a standard number 100 sieve.

Figure 7 shows a marsh that was planted on material dredged from under a nearby pier. The resulting substrate was not firm enough for the high marsh to take root resulting in large patches of sunken soil covered with dead *Spartina patens.*

Figure 7

In another example of improper fill, Figure 8 depicts a marsh project where the high marsh was planted on rocky rubble that proved inhospitable to the marsh grasses; it is only in predominantly sandy areas that any grasses remain.

Figure 8

Proper planting. It is important to have both high and low marsh for a successful project, as shown in Figure 9. A 50/50 split between high and low marsh helps to fully stabilize an eroding bank and provide the desired wildlife habitat. A 50/50 split may indicate that the contractor has successfully located the mean high water line; *Spartina alterniflora* thrives in the intertidal zone, and *Spartina patens* lives in the high marsh zone. Both types of marsh plants are important, although *Spartina* grasses are recommended for both. Where applicable, *Spartina* grasses are preferred to plants such as three-square which die during the winter, thus failing to provide erosion control benefits all year round. In upstream areas (fresher water), *Juncus effusus* (soft rush) and *Panicum virgatum* (switchgrass) are good substitutes for *Spartina*.

Figure 9

Use fencing if necessary to prevent waterfowl from eating new plantings. Waterfowl such as geese may eat all plants, especially newly planted plugs. Lack of vegetation may result in the sand fill washing away and the project to fail. Fencing as shown in Figure 10 can prevent or limit waterfowl access to the marsh while allowing smaller aquatic species (fish, crabs, turtles) to use the marsh for habitat.

Figure 10

Stabilize adjacent cliff. In properties with high cliffs, the marsh will not prevent the top of the cliff from eroding due to run off—this erosion may ultimately bury the marsh with eroded sediments. The cliff should be stabilized by either grading with upland plant stabilization or by installing a structural solution such as a retaining wall or ground mesh to hold back erosion. With the cliff stabilized, the marsh can then be used to prevent undercutting at the base of the cliff. Figure 11 is an example of a situation in which the marsh is doing little to prevent further erosion of the cliff behind it; rainwater run-off and storm damage is still a threat to these properties.

Figure 11

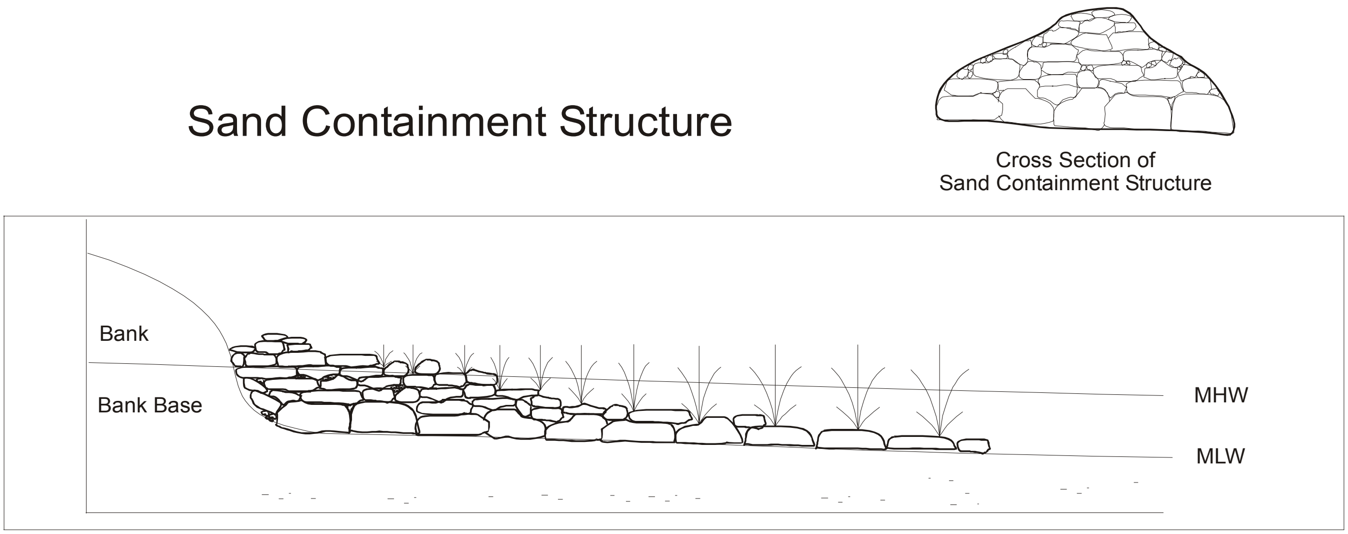
Figure 12 is an example of a marsh project in which the cliff has been properly stabilized, allowing for a healthy marsh to grow at the base of the cliff.

Protect shoreline from excessive wave action. Marsh creation projects have proven successful with or without protective structures such as sills. Projects without protective structures are most likely to be successful on sheltered waterways where there is low natural wave action and limited wave action from boating activities.

Figure 13

Protect shoreline from excessive wave action cont. Marshes may be protected by an offshore structure such as a low profile sill or breakwater, or a sand containment structure. Containment structures are placed perpendicular to the shoreline and help trap sediment to maintain the marsh. The channelward end of the structure should be at the approximate edge of the plantings at mean low water.

Figure 14



Protect shoreline from excessive wave action. One of the most serious threats to a wetland is the action of waves. Boat wakes and waves propagated by long fetches can slap against a shoreline and wash away all traces of a marsh. Careful design and construction can result in a sill that both protects against erosion while allowing wildlife to use the marsh as habitat.

Use a low profile structure that can protect the shoreline from wave action while allowing access by wildlife. The structure should not be placed directly on the marsh, as for a revetment. The toe of the sill should be channelward of the mean low water line so that the low marsh is covered by open water at mean high tide. The height of the sill should extend 0 to 1 foot above mean high water.

Figure 15

Marsh Creation With Sill

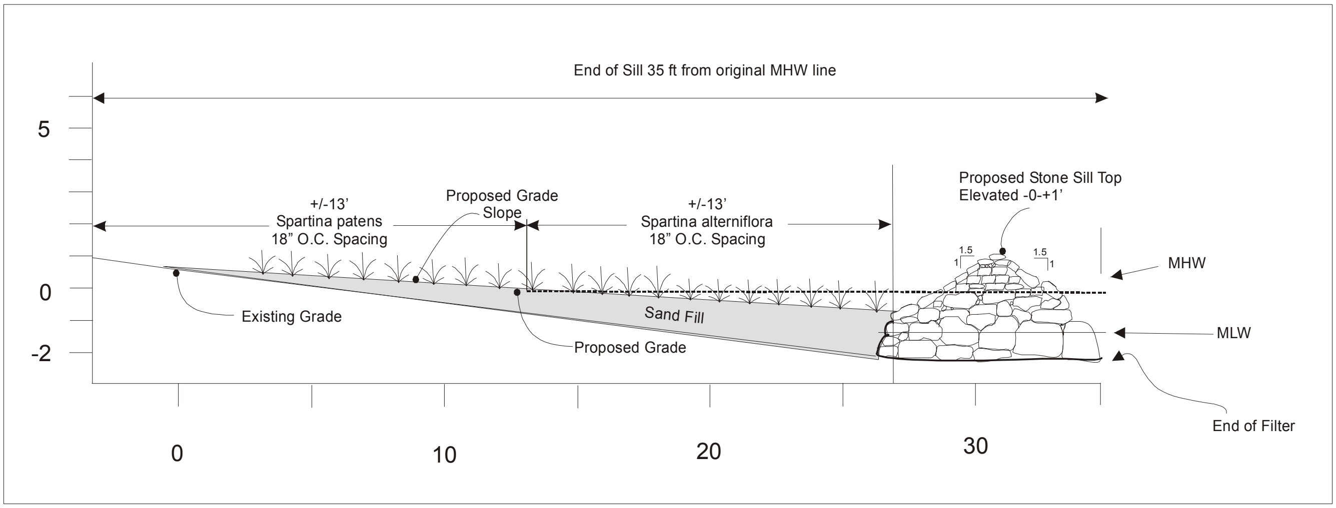


Figure 16

1. **Use primarily sandy soil as a substrate for plants. No more than 10% of the fill substrate shall pass through a standard number 100 sieve.**

2. **Design and construct project so that the low marsh is covered by open water during the mean high tide.**

3. **Grade site at 10:1 so that the low marsh extends to the mean low water line.**

4. **Retain natural bank vegetation. Trim limbs as needed to prevent shading of marsh plants.**

5. **Use a low profile structure. Do not place rock directly on marsh or as a revetment. Place base of sill channelward of mean low water line. Sides of the sill should have an approximate 1.5:1 slope.**

6. **The height of the sill should range from 0 - +1 foot above the mean high water line.**

7. **Include openings through vents with staggered placement or additional rock to line the bottom of the opening to allow for flushing, sediment accretion, and wildlife access.**

Staggered or dog-legged vents in sills. While sills are often important for a successful project, it is essential that they be constructed in such a way that allows for flushing and wildlife access to the shore. Large obtrusive sills without vents prevent proper flushing of marsh and trap sediment and dead vegetation, which can strangle the marsh, in addition to blocking wildlife access. However, vents can facilitate erosion where the wave action is persistent. Therefore, it is recommended that vents are constructed such that they are placed in a doglegged or staggered system or contain additional stone on a liner when sills are placed in a linear manner.

Figure 17a

Offset or Staggered Vented Sill

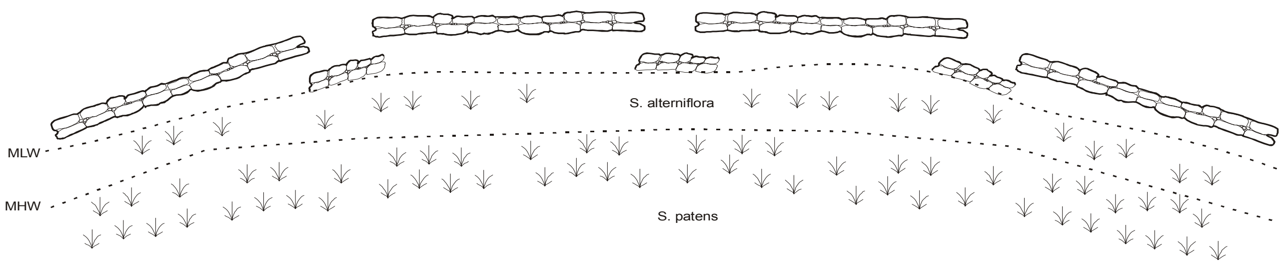
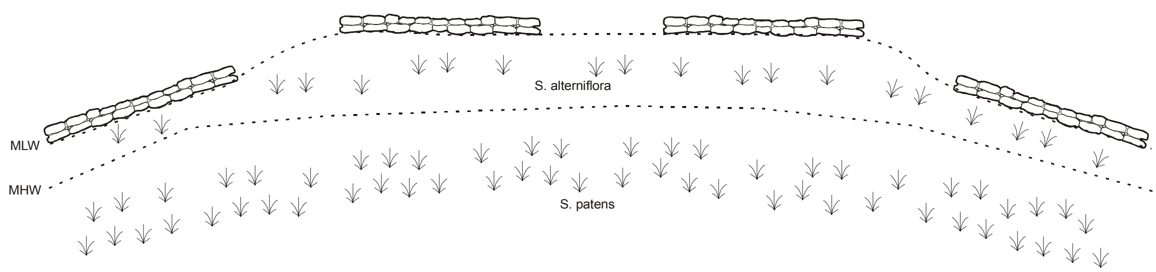
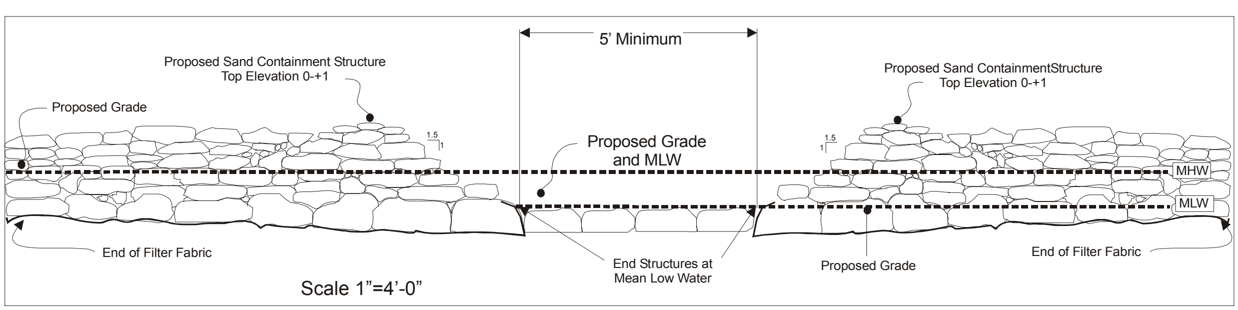


Figure 17b.

Linear Vented Sill



Linear Sill Vent Detail With Armor



The following photograph is an example of marsh creation project that failed due to improper grading and a structure that was too large and close to the marsh. An excessive amount of riprap was used and was placed directly on the marsh, eliminating access by aquatic wildlife.   The elevation of the marsh is too high due to improper grading that limits tidal flooding of the marsh plants.

Figure 18

Properly maintain the marsh creation project. Proper maintenance will help ensure that the marsh creation project remains successful at preventing erosion and providing wildlife habitat. Maintenance suggestions:

1) Remove debris and trash.
2) Do not mow vegetation.
3) Limit use of lawn fertilizers.
4) Re-plant as necessary.

References

Bosch, Justin, and C. Foley, L. Lipinsky, C. McCarthy, J. McNamara, A. Naimaster, A. Raphael, A. Yang, and A. Baldwin. 2006. *Constructed Wetlands for Shoreline Erosion Control: Field Assessment and Data Management*. Prepared for Maryland Department of the Environment for submittal to the U.S. Environmental Protection Agency.

Farber, S. (1987). The value of coastal wetlands for protection of property against hurricane wind damage. *Journal of Environmental Economics and Management, 14*, 143-151.

Maryland Department of Natural Resources. (1992). *Shore Erosion Control Guidelines for Waterfront Property Owners.*

Mitsch, W.J. & Gosselink, J.G. (2000). *Wetlands:* Third Edition. John Wiley & Sons, Inc: New York.

U.S. Fish and Wildlife Service. (1997). *Status and Trends of the Nations Wetlands: 1997 Report.* Retrieved January 15, 2005 from www.nwi.fws.gov/bha/SandT/download/SandTPaper.pdf.

Whigham, D.F. (1999). Ecological issues related to wetland preservation, restoration, creation, and assessment. *The Science of the Total Environment, 240*, 31-40.