4.4. Shoreline and Streambank Stabilization

Management Measure for Shoreline and Streambank Stabilization:

Where shoreline or streambank erosion is a nonpoint source pollution problem, shorelines and streambanks should be stabilized. Vegetative methods are strongly preferred unless structural methods are more cost-effective, considering the severity of wave and wind erosion, offshore bathymetry, and the potential adverse impact on other shorelines, streambanks, and offshore areas.

Protect shorelines and streambanks from erosion due to uses of either the shorelands ar adjacent surface waters.

Management Measure Description

Streambank erosion is used in this guidance to refer to erosion along nontidal streams and rivers.

Shoreline erosion is used here to refer to erosion in tidal portions of coastal bays and estuaries.

Erosion is a natural process that results from water acting on streambanks and shorelines. Erosion along a river or stream removes material from one area and deposits it elsewhere, and beaches are constantly and naturally eroded and resupplied with sediment from other areas. Streambank and shoreline stabilization may be needed where natural erosion is occurring to protect shoreline structures.

Induced erosion often occurs where soil, streambanks, or shorelines have been disturbed. Removing vegetation from any streambank or shoreline exposes soil to the erosive energy of waves and currents. Altering a watercourse (for instance, by installing a breakwater or a dam) or artificially affecting the course of water (perhaps by channelizing a river) can cause erosion because the manner in which energy is transmitted through a waterbody can be affected. In the latter case, erosion sometimes occurs far from the location of the channelization. Properly designed erosion control measures and structures can reduce natural as well as induced erosion.

In a marina, structural elements are often necessary to protect boats and the marina perimeter from waves or water current energy. Hence, the marina basin is often a fairly calm, nonerosive environment. Erosion can still occur along the perimeter, however, and wave energy reflected off a structure, such as an improperly designed breakwater, or from boat wakes may be a contributing factor. Bank erosion may result where it is desirable to hold a given slope. Scour along the bottom of a structure such as a breakwater or at the abrupt junction of two unlike materials, such as river bottom sediments and a cement boat ramp, can also be a problem. Bank erosion and scour can result in sediment filling in a marina basin (and the need for maintenance dredging) or erosion at the edges of a boat ramp. Minimizing shoreline erosion can protect marina shorelines and can reduce the need for or frequency of maintenance dredging. Less frequent dredging also reduces the need for proper and potentially costly disposal of dredged material.

A vegetated shoreline can minimize the transmission of wave energy to other locations. Vegetation is also a relatively low-cost means to stabilize a shoreline, and it can add a natural, attractive element to an otherwise engineered environment. Used by itself, vegetation is most effective where waves or currents are low in energy and the soil is stable enough for plant growth. Another site factor conducive to vegetative stabilization is shallow sloped banks. Where wave or current energy is too strong for vegetation to gain a foothold, temporary structures can be used to protect vegetation until it can establish itself, or permanent structures might be necessary.

Permanent streambank or shoreline protection structures could be needed where wave or current energy is too great for establishing and maintaining vegetation. Some structural methods to stabilize shorelines and navigation channels are gabions, riprap, sloping revetments, bulkheads, jetties, and breakwaters. The first three dissipate incoming wave energy more effectively than the rest and usually result in less scouring than the last three. Bulkheads are appropriate in some circumstances where other preferred alternatives are not feasible. Vegetation can often be added at the edges of these structural elements to control erosion from storm water runoff and to serve as a landscaping element.

The type of perimeter stabilization might be dictated in both inland and coastal marinas by local variations in water level due to dam drawdown in a reservoir, natural fluctuation in a lake, or tides along the coast. In some of these instances, shoreline stabilization might not be practical. Because rivers are hydrographically complex and many factors need to be taken into account when determining how to correct erosive problems, shoreline stabilization might not be sufficient to eliminate an erosion problem. Streambank and river restoration projects, of which erosion is usually only a small part, can encompass anywhere from a small section of a river or stream to the entire watershed.

Herrington Harbour Marina South (Maryland) retained and enhanced much of the natural shoreline during a recent rebuilding, modernization, and expansion program. An old, failing bulkhead was removed, and rock riprap and filter cloth were placed on the regraded shoreline. Native shore species were planted along the shore, and nearby wetlands were cleaned and restored to native marsh grasses. Over a few years, the shoreline vegetation filled in and created a very attractive and effective buffer that helps control erosion and storm water runoff. Wildlife diversity also increased in the surrounding shoreline area, including several blue herons that have taken up year-round residence.

Some specialized locations along the banks of rivers, reservoirs, and lakes, however, may be ideal candidates for shoreline stabilization. Such locations may be severely eroded soils around a storm sewer discharge point, disturbed soils where a boat ramp has been installed or is in need of maintenance, or overused shoreline areas in or next to established recreational areas.

Examples of vegetative and structural methods are presented below. Before selecting any of them for a particular erosion problem, it is important to identify the cause of the erosion, which, especially in rivers and coastal environments, could be extremely complex. Selecting the appropriate technique to remedy an erosion problem might require analysis by a professional.

Applicability

This management measure is applicable to new and expanding marinas where site changes might result in shoreline erosion.

Best Management Practices

- ♦ *Use vegetative plantings, wetlands, beaches, and natural shorelines where space allows.*

Vegetative plantings, wetland enhancements, beaches, and preservation of natural shorelines, where feasible, can be the most effective means of shoreline stabilization. Plantings can be in the form of a grassed buffer strip that serves the triple purpose of shoreline stabilization, establishing a visually aesthetic area, and controlling polluted runoff. If natural wetlands are found or were present within the boundaries of a marina before its development, their preservation or re-creation can protect shorelines, dissipate low wave energy, provide wildlife habitat, and filter pollutants out of the water and storm water runoff. A sloping beach is the best surface for attenuating wave action, though such beaches can occupy more space than other perimeter stabilization methods.

Establishing a "no wake zone" in nearshore, shallow aquatic areas can also be effective to reduce impacts from boat wave energy.

♦ *Where shorelines need structural stabilization and where space and use allow, riprap revetment is preferable to a solid vertical bulkhead.*

In some cases, primarily because of space limitations or elevation differences between the land and water surface, steep slopes are necessary within marinas. Riprap is a common and economical revetment that can withstand substantial wave energy. Its irregular surface also reduces wave energy transmission better than a solid vertical bulkhead does. Natural rock is the best material. Concrete rubble can be used, but its many flat surfaces transmit more wave energy than do irregular natural rocks. Gabions (rock in heavy-duty wire mesh baskets) can be used where a slope steeper than that which can be obtained with riprap is needed. Gabions function best where waves do not exceed 12 inches. The irregular surface of riprap revetment can provide habitat for shore and nearshore plants and animals.

♦ *Where reflected waves will not endanger shorelines or habitats and where space is limited, protect shorelines with structural features such as vertical bulkheads.*

Vertical bulkheads reflect waves and are not a good choice for shoreline stabilization where waves or surges occur in the marina basin and are not mitigated in the stabilization design. They are usually more costly to install than other forms of shoreline protection but might be necessary where boats are hauled and launched, where the marina cannot be moved farther into the water, and where valuable real estate needs protection. They can be constructed of concrete, treated timbers, steel, aluminum, or vinyl. Vertical bulkheads can be combined with riprap by placing the former at the upper portion of a bank and riprap along the lower edge. Scour protection at the toe of the bulkhead should be incorporated into the structural design.

♦ *At boat ramps, retain natural shoreline features to the extent feasible and protect disturbed areas from erosion.*

Near boat ramps, shorelines can be damaged during ramp construction. Shorelines are also susceptible to erosion from runoff that is channeled alongside the ramp (especially if the site has been sloped for the ramp), boat wakes, waves, and currents after initial installation. During boat ramp construction, therefore, retention of natural shoreline features to the extent possible generally saves maintenance or corrective costs later. Natural-appearing shorelines are also aesthetically appealing, and they can minimize the likelihood of invasion by unwanted or exotic plant species later.

BMP Summary Table 4 summarizes the BMPs for Shoreline Stabilization mentioned in this guidance.

BMP Summary Table 4. SHORELINE AND STREAMBANK STABILIZATION MANAGEMENT

MANAGEMENT MEASURE: Where shoreline or streambank erosion is a nonpoint source pollution problem, shorelines and streambanks should be stabilized. Vegetative methods are strongly preferred unless structural methods are more cost-effective, considering the severity of wave and wind erosion, offshore bathymetry, and the potential adverse impact on other shorelines, streambanks, and offshore areas.

APPLICABILITY: New and expanding marinas where site changes may result in shoreline erosion.

ENVIRONMENTAL CONCERNS: Erosion in any waterbody is a natural process that results when moving water and waves undermine, collapse, and wash out banks and shorelines. Banks erode along nontidal lakes, rivers, and streams; shorelines erode along intertidal portions of coastal bays and estuaries. Eroding streambanks and shorelines do not protect the land and structures during storm events. Such erosion contributes to nonpoint source pollution problems, turbidity, and shoaling increases the need for maintenance dredging in marina basins and channels. Vegetation and structural methods have been shown to be effective for mitigating shoreline erosion and for filtering pollutants from overland and storm water runoff.

SHORELINE AND STREAMBANK STABILIZATION PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Use vegetative plantings, wetlands, beaches, and natural shorelines where space allows	Marina shores and banks; generally recommended	MODERATE to HIGH; reduce frequency of maintenance dredging; provide recreational areas for customers; attractive; eliminate wave refraction	HIGH; effective shoreline stabilization that also filters pollutants from runoff and provides wildlife habitat	LOW to MODERATE	LOW to MODERATE	Includes vegetative plantings, wetland enhancements, beaches, and preservation of natural shorelines; suitable for low-energy waves and currents, low sloping shores. No-wake zones are also effective
Where shorelines need structural stabilization and where space and use allow, riprap revetment is preferable to a solid vertical bulkhead	Marina shores and banks; generally recommended	HIGH; revetments withstand substantial wave energy and reduce wave energy transmission; lowered erosion rate reduces need for maintenance dredging	HIGH; the irregular surface provides excellent habitat for aquatic plants and animals through reduced sedimentation and dissipated wave action	EXPENSIVE	LOW to MODERATE vertical bulkheads require ongoing maintenance; gabion baskets are subject to failure	Natural rock set over filtercloth is commonly used; concrete rubble transmits more wave energy; gabions permit steeper slopes
Where reflected waves will not endanger shorelines or habitats and where space is limited, protect shorelines with structural features such as vertical bulkheads	Marina shoreline, particularly in areas of deep water and boat lift/haulout wells; generally recommended	HIGH to MODERATE; easy to install; occupy little horizontal space	LOW; vertical surfaces reflect waves; can increase bottom scour along wall base; limit aquatic habitat	EXPENSIVE	NONE to LOW	Allows marinas to locate closer to shore; can help reduce dredging frequency
At boat ramps, retain natural shoreline features to the extent possible and protect disturbed areas from erosion	Boat ramp shores and banks; generally recommended	MODERATE to HIGH; can save on maintenance or corrective costs; retain the natural appearance of the shoreline	MODERATE to HIGH; reduce damage from boat wakes and waves, and currents; stabilize shoreline; retain habitat for plants and animals	MODERATE to HIGH	LOW to MODERATE	Refer to the boat launch ramp design booklet published by the States Organization for Boating Access (SOBA); blend shoreline features with functionality of the ramp and access ways