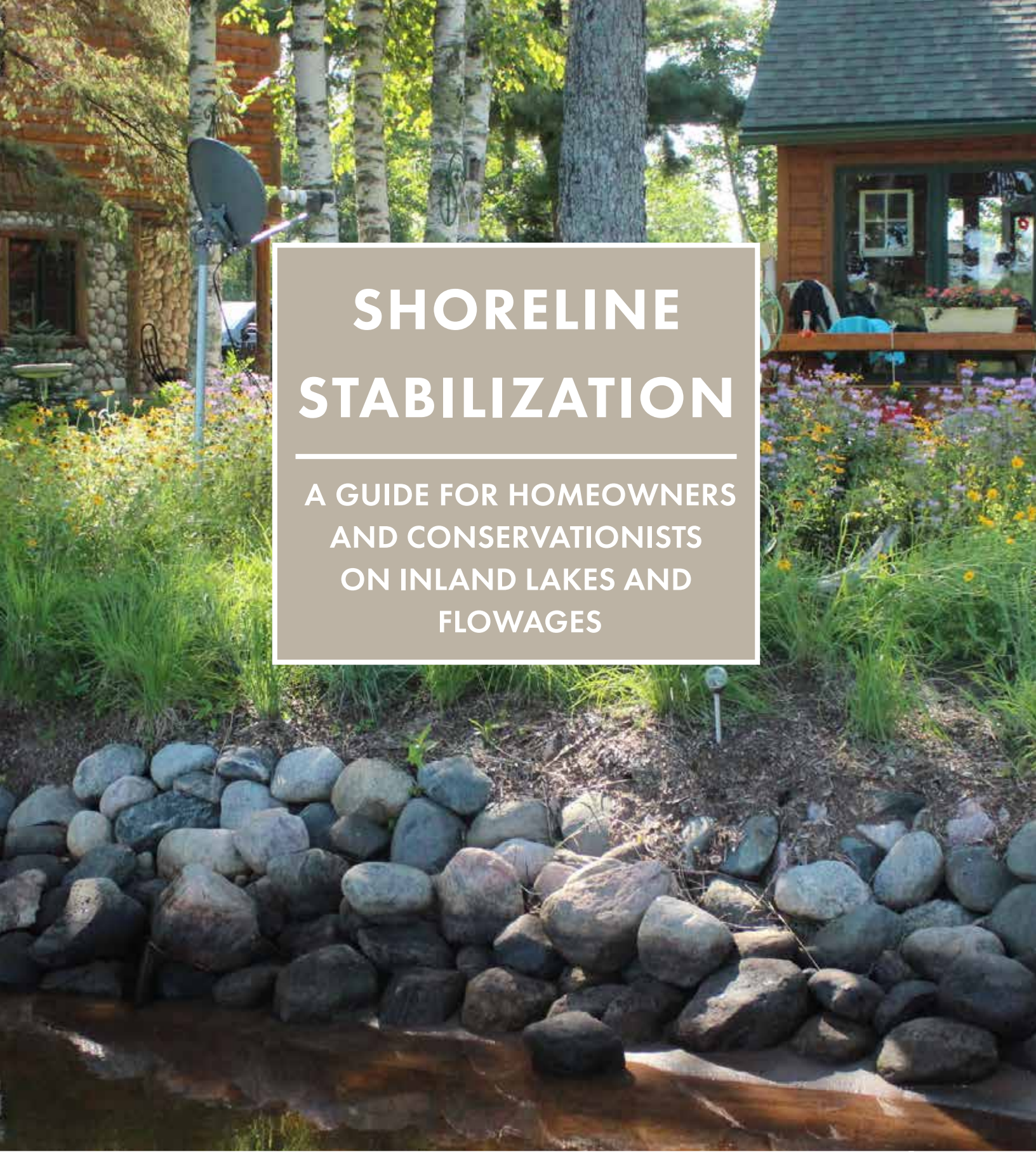


SHORELINE STABILIZATION

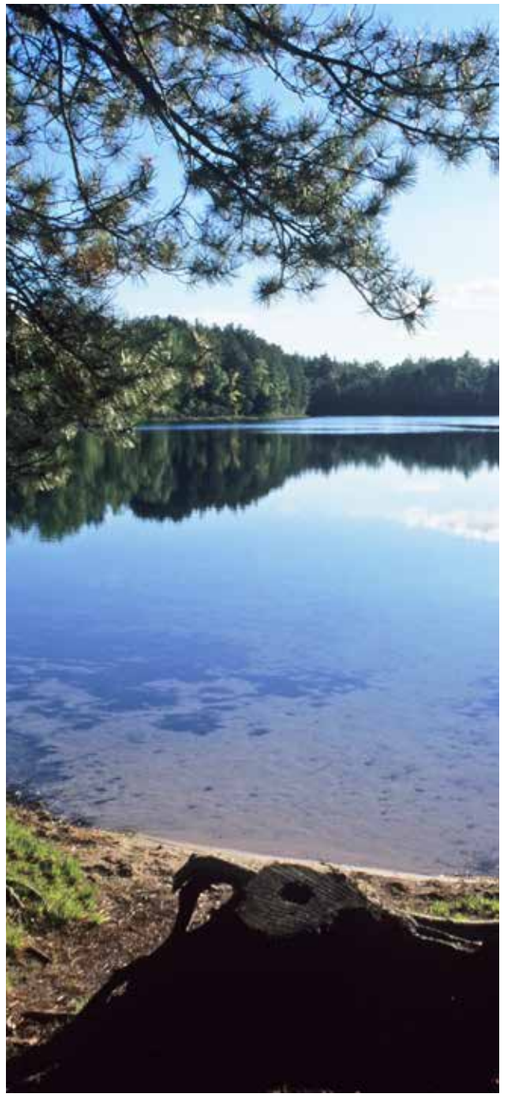
A GUIDE FOR HOMEOWNERS AND CONSERVATIONISTS ON INLAND LAKES AND FLOWAGES

THE WISCONSIN SHORELINE STABILIZATION OUTREACH PROJECT

WITH ASSISTANCE FROM

THE WISCONSIN LAND AND WATER CONSERVATION ASSOCIATION

2021



Firefly Lake, Vilas County

YOUR PERSONAL CONTRIBUTION TO CLEANER LAKES

The configurations of our lake shorelines in Wisconsin have been constantly changing over the last few thousand years. Soil erosion is a natural process that is part of that configuration. Unfortunately, when the rate of erosion speeds up due to loss of vegetation, physical disturbances, changes in water levels, or increases in wave action, the increased soil loss and removal of native vegetation is bad for the health of the lake. Soil eroding into the lake can reduce water quality, and increase the growth of algal blooms and aquatic plants. Eroding soil also has a damaging effect on fish and wildlife habitat. The negative effects of shoreline erosion are a concern for landowners who care about the health of their lake and their property.

The native plant community that makes up a lake's shoreline buffer helps filter water and pollutants before they reach the lake edge, provides habitat for wildlife, and stabilizes slopes. The loss of native shoreline habitat contributes to those indicators of poor lake health such as cloudy water, more algae, increased plant growth including invasive plants, and loss of habitat for frogs, fish, and other wildlife.

There are different techniques landowners can use to control and repair soil erosion and to restore native shoreline buffers. This guide shows examples of those techniques so that when you speak with your local county land and water conservation department or a contractor, you will be able to visualize what different practices look like. A matrix is also included to help landowners identify erosion problems or deficiencies in shoreline buffer plantings, and to suggest possible remedies.

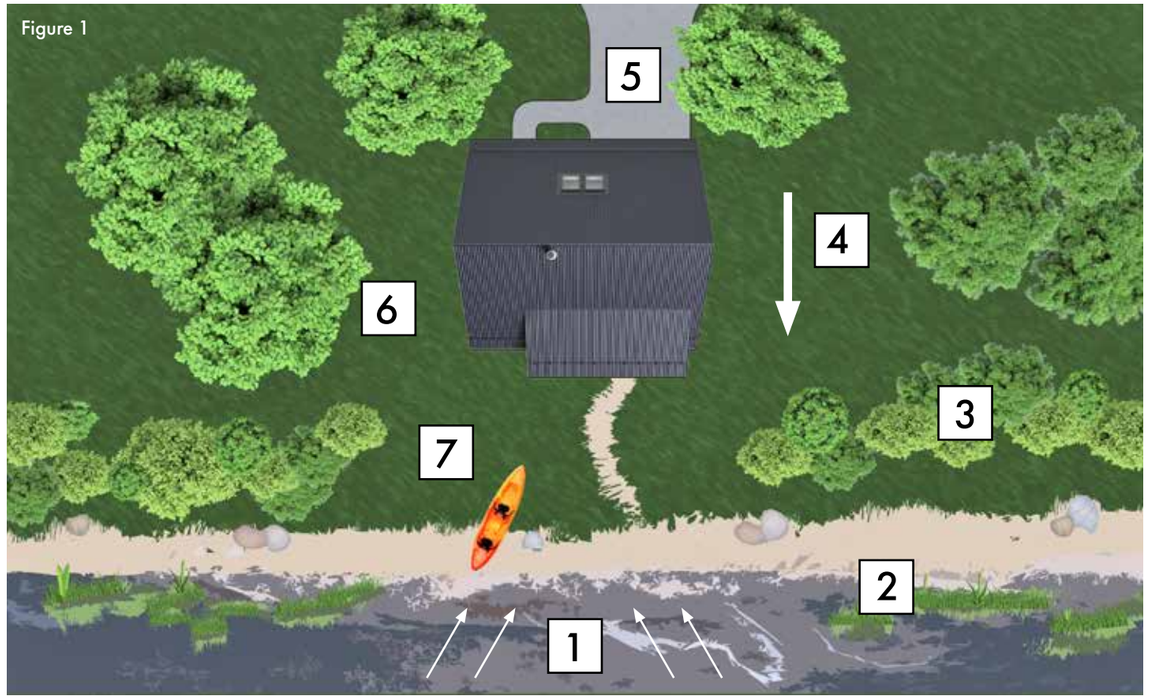
Contact your local county land and water conservation department for more information and to request a complimentary visit to your shoreline to discuss any concerns you have. Many county conservation departments are able to provide technical assistance and even some partial funding assistance. The shoreline area is governed by state and local ordinances to protect public interests under the Wisconsin Public Trust Doctrine and to ensure only suitable activities occur. It is the landowner's responsibility to ensure you are in compliance with applicable ordinances and laws.

This guide provides basic information to lake property owners about shoreline erosion and potential options for addressing those erosion problems. The guide is intended only as an educational document. As a homeowner, please do more research and seek professional guidance before installing any of these practices.

Don't forget your permit!

Before starting <u>any</u> alteration of your shoreline, make sure you have any required permits from the appropriate local municipalities, county government, tribal government, Wisconsin Department of Natural Resources, and the U.S. Army Corps of Engineers, as needed.

Figure 1



ASSESSING YOUR SHORELINE

Every shoreline is different, even along the same lake. There are many different solutions that homeowners can choose to improve and protect the natural integrity of their shorelines for years to come.

Choosing the right shoreline stabilization technique for each property requires a thorough site assessment. A proper site assessment helps determine the factors that affect rates of erosion and can point to effective, site-specific solutions.

Use the numbers in Figure 1 above to help guide you through your shoreline assessment. Starting in category one below, select one of the three options on the right in each category that best reflects the characteristics of your lakeshore property. Then add up the scores of all seven categories to determine your shoreline's total score. Your shoreline's total score will help guide you toward choosing appropriate protective measures for your shoreline.

	SCORING	
1. WAVE ENERGY Breaking waves and near-shore currents have the ability to dislodge soil and cause erosion along the shoreline. This wave energy is categorized into three levels: low, medium, and high. Length of fetch (distance across open water), boat activity, and shoreline orientation all play a role in the amount of wave energy your shoreline receives.		**On my shoreline, the farthest distance to the opposite shore from my property is...**
	☐ **1**	less than ½ mile;
	☐ **2**	between ½ mile and one mile;
	☐ **3**	more than one mile.
2. AQUATIC VEGETATION Aquatic vegetation near the shoreline can provide protection from wave energy and reduce erosion. Evaluation of the type and abundance of nearshore, aquatic vegetation can give insight into erosion concerns and indicate potential issues.		**In front of my property, near-shore aquatic vegetation is...**
	☐ **1**	plentiful;
	☐ **2**	sparse;
	☐ **3**	absent.

	SCORING	
3. SHORELAND VEGETATION Roots of vegetation hold soil in place and reduce erosion. Vegetation will be a component of every shoreline stabilization practice and will be the only practice required in some situations. Evaluation of the amount and type of existing vegetation should be one of the first steps in planning for shoreline stabilization.		**In the area within 35 feet from the water's edge...**
	☐ **1**	three layers of vegetation (grasses/wildflowers, shrubs, and trees) are present;
	☐ **2**	one or more layers of vegetation is absent;
	☐ **3**	only turf grass, bare soil, and/or sand are present.
4. SLOPE Steep slopes along the shore are subject to more erosion and less stability. This erodibility is amplified by soil type and removal or lack of vegetation. Some shoreline practices require the bank slope to be no greater than 2:1 slope (two horizontal feet by one vertical foot) to be effective.		**The land on the property heading to the lake has...**
	☐ **1**	no slope and is very flat;
	☐ **2**	moderate slope;
	☐ **3**	steep slope.
5. IMPERVIOUS SURFACES Hard structures such as buildings and pavement do not allow for water to infiltrate into the soil. These impervious surfaces lead to significant overland runoff and increased erosion. This is especially true on lakeshore lots. Reduction of impervious surfaces is a simple step to reduce erosion.		**My entire lakeshore property...**
	☐ **1**	is mostly natural with a few hard surfaces (buildings or pavement);
	☐ **2**	has a moderate amount of hard surfaces;
	☐ **3**	has several buildings and other hard surfaces.
6. SOIL TYPE Soil type plays a major role in stability of the shoreline. Sandy soils are more susceptible to erosion as they crumble and fall away easily once disturbed. *To best determine your property's soil type, refer to the Simple Soil Test on page 22.*		**Soils on my property are...**
	☐ **1**	Silty (smooth and spongy);
	☐ **2**	clayey (stiff and sticky);
	☐ **3**	sandy (coarse and gritty).
7. RECREATIONAL USE The amount of activity along your shoreline can be considered in three levels - *little recreation* (e.g. light, irregular foot traffic), *moderate recreation* (e.g. some storage, fire pit, trampled paths), and *heavy recreation* (e.g. boat storage and/or launch, developed paths, hard-packed ground).		**In the area within 35 feet of the lake, there is...**
	☐ **1**	little recreational activity;
	☐ **2**	moderate recreational activity;
	☐ **3**	heavy recreational activity.
TOTAL SCORE		

10 OR LESS

You have few impacts to the shoreline. Creating a no mow zone or restoring native vegetation may be enough to protect your shoreline.

BETWEEN 10 AND 15

Your shoreline has only moderate erosion impacts and may be a good candidate for a bioengineered erosion control practice.

GREATER THAN 15

Your shoreline is impacted by numerous sources and may require hard armoring or multiple practices to protect it from further erosion.

DECISION TABLE FOR TYPES OF PRACTICES

APPROPRIATE USE & BENEFITS

STABILIZATION PRACTICE		Site Access and Recreation Friendly	Provides Aquatic Habitat	Enhances Fish Habitat	Improves Wildlife Habitat	Little Site Disturbance	Useful Where Space is Limited	Flexible Molded to Existing Contours			Maintains Bank's Natural Appearance	Immediate Protective Cover	Appropriate Above and Below OHWM	Survives Fluctuating Water Levels	Increase Slope Stability	Reduces Slope Length	Reduces Surface Erosion	Reduces Toe Erosion	Reduces Wave Energy Hitting Bank	Steep or Vertical Banks
Vegetated Buffers	No Mow	X		X	X	X		X			X	X	X	X	X		X			
	Native Plantings	X		X	X	X		X			X	X	X		X		X			X
Bioengineering with Natural Fiber Products	Natural Fiber Rolls and Logs	X				X		X			X		X			X	X	X		
	Natural Fiber Blocks	X				X		X			X		X	X				X		
	Natural Fiber Mats	X				X		X			X	X					X			
Wave-Reducing Natural Timbers	Log Revetment		X	X	X		X				X	X	X	X				X	X	
	Log and Root Wad Revetment		X	X	X						X	X	X	X				X	X	
	Fish Sticks/Tree Drop		X	X	X						X			X					X	
Riprap with Bioengineering Techniques	Rock Riprap Toe						X					X	X	X	X			X	X	
	Rock Riprap Toe with Native Plantings				X			X				X	X	X	X			X	X	X
	Vegetated Rock Riprap Toe				X		X	X				X	X	X	X			X	X	X
	Rock Riprap Toe with Geotextile Bags				X			X				X	X	X	X			X	X	X
	Rock Riprap Toe with Geogrid Lifts				X			X				X	X	X	X			X	X	X
	Synthetic Engineered Matting	X																	X	X

LAKESHORE EROSION

Lakeshore erosion can be caused by a number of different reasons, from natural processes to human disturbances. It can be localized or widespread and may be the result of more than one factor.

The natural energy of waves, currents, and ice move soil particles, causing erosion and soil displacement. Human disturbances can include powerboat wakes, vegetation removal, foot traffic, dredging, filling, or construction along the shoreline. Understanding these impacts will better help you contextualize your shoreline and how to be a better steward of your property along a lake.

The natural processes that cause erosion can be grouped into two categories - aquatic (water) and terrestrial (land).

There are several different aquatic elements that can cause erosion. Precipitation falling directly on exposed soils can move soil, often displacing soil downslope or even into nearby lakes and streams. Wind-driven waves, known as wave action, can impact an area of unprotected or exposed soils. Ice sheets transported by wind or just the mere formation of ice during winter months on lakeshores can push in or lift a shoreline with tremendous force.

The most common terrestrial element is the downward movement of soil caused by a combination of aquatic forces and gravity. Additionally, the freeze-thaw cycle of groundwater, especially in poorly drained soils, causes the soil to shift or move.

The third factor is human disturbances or activities. Heavy recreational activities on a lake, particularly the wave action and wake from powerboats, significantly impacts a shoreline.

The removal of native vegetation along the shoreline (or buffer zone) eliminates the root structure that holds the soil in place. Additionally, impervious surfaces such as roofs, driveways, and walkways prevent precipitation from being absorbed into the ground and can channel stormwater runoff towards fragile or exposed soils.

Typically, natural erosion along shorelines proceeds very slowly, and the plants and animals that live along the shoreline can adjust to these slow changes, maintaining a healthy and productive ecosystem. However, when the erosion is accelerated by a catastrophic natural or human disturbance, the equilibrium is no longer balanced and the ecosystem becomes unstable.

Consequences of accelerated erosion along shorelines include:

- Degraded wildlife habitat and killing of aquatic organisms;
- Reduced water clarity, light penetration and near-shore aquatic plant growth;
- Release of excessive nutrients that stimulate undesirable algae growth;
- Change of bottom substrate, impacting spawning areas; and
- Potential loss of valuable waterfront property.

Depending on the risk or causes and severity of erosion along a shoreline, the following practices in the next four sections can help a homeowner build resiliency along their shoreline, protecting both their property and the water quality of their lake.

Level 1

FIGURE 2

LEVEL 1: VEGETATIVE BUFFERS

A vegetative buffer is an intentionally protected area of vegetation along the water's edge. Vegetative buffers provide many natural benefits to a shoreline, including erosion prevention, water quality protection and improvement, natural scenic beauty, privacy from boaters and neighbors, healthy habitats for fish and wildlife, and increased property value.

A complete and functional shoreland buffer includes three layers of native vegetation: trees, shrubs, and ground covers. Ground covering should be natural, non-invasive species of wildflowers, grasses, sedges, and ferns.

Any shoreline property owner can implement the two basic practices that keep vegetative buffers healthy - no mow and native plantings - without much technical knowledge or costs. These two practices simply require seasonal maintenance and an attention to detail, but can significantly enhance the health of a shoreline.

NO MOW

Allowing natural regeneration of native plant species is a simple method to reestablish a vegetative buffer zone. Focus on areas with weak or no turf grass and with limited foot traffic.

Although traditional lawns may seem more aesthetically pleasing, allowing native grass to grow creates a much more durable landscape that filters pollutants in runoff and cuts down on lawn maintenance. One way to make a no mow area more attractive is to add some cues to care, like edging, birdhouses, or signs.

NO MOW

Appropriate Uses & Benefits

- Location with weak or no turf grass
- Native seed bank present in the location
- Areas with little or no traffic
- Areas with no invasive plants present
- Free

Limitations

- Not for use on sites with active erosion
- May take time to establish
- Less control over plant layout or design
- Not appropriate for areas with invasive plants
- Requires weeding to control non-native or aggressive plants

NATIVE PLANTINGS

Planting native plant species and properly maintaining them is another environmentally friendly way to reestablish a vegetative buffer zone. Depending on the type of plantings, this zone can be a diverse collection of species, as well as encourage pollinator habitats.

There are many different types of native plants property owners can choose to enhance their buffer zone. Attention and care by the property owner is needed to ensure the plants establish and remain healthy. Typically, this means fencing, watering, and seasonal weeding throughout the buffer zone.

NATIVE PLANTINGS

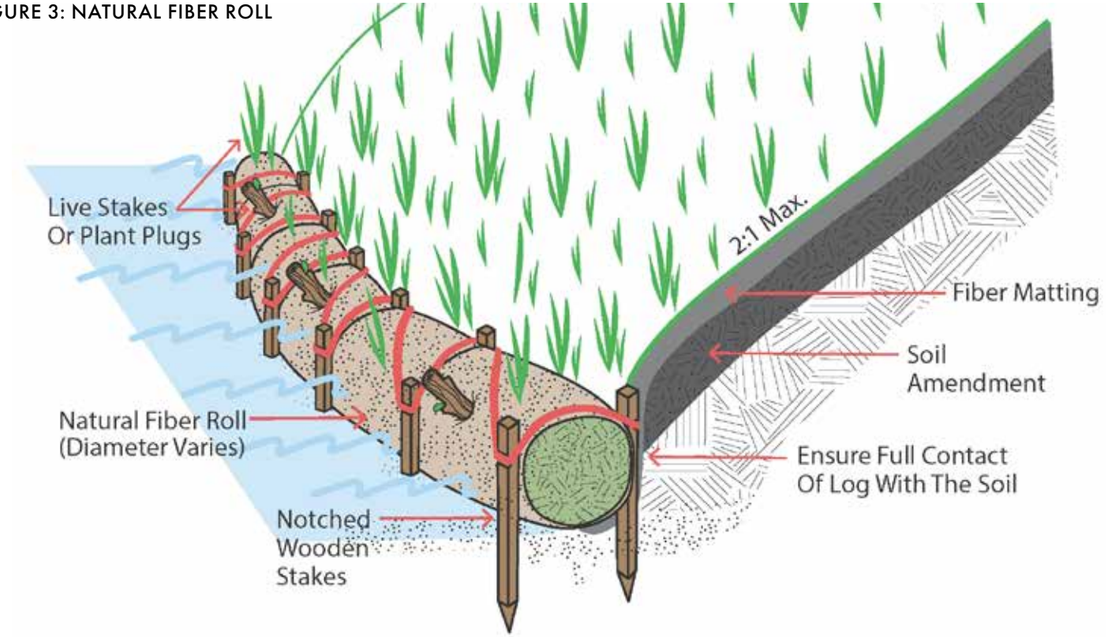
Appropriate Uses & Benefits

- Most sites are appropriate
- Areas with little or no traffic are best
- Areas with little or no wave action

Limitations

- Cost
- Maintenance is required (e.g. fencing, watering, and weeding)
- Deer browse may be an issue
- Not for use on sites with active erosion issues
- May need additional practices to address erosion

FIGURE 3: NATURAL FIBER ROLL



LEVEL 2: BIOENGINEERING WITH NATURAL FIBER PRODUCTS

Bioengineering with natural fiber products uses a combination of native plants and natural or biodegradable materials to provide shoreline protection. When natural fiber products and native plantings are installed properly, they can reduce erosion, stabilize the shoreline, and provide habitat for wildlife. It can also be used upland or at the lake edge to reduce sediment, nutrient, and pollutant runoff.

NATURAL FIBER ROLLS

Appropriate Uses & Benefits

- Lightweight (when not saturated with water)
- Easy to install
- Little site disturbance
- Builds to existing contours
- Provides nutrients to plants as it biodegrades

Limitations

- Works best in low energy locations
- Can be damaged by ice or move if not staked
- Water level fluctuation affects plants
- Small surface area contact with bank
- Fiber may be non-native

NATURAL FIBER ROLLS

Natural fiber rolls are rolls of natural materials like wood excelsior, coconut husk fiber, straw, or flax wrapped in a biodegradable fiber net.

Ranging from 8 to 20 inches in width and 10 to 20 feet in length, these rolls are often placed along the shoreline to stabilize banks. The rolls are held in place by dead or live stakes, with the ends buried into the ground or shoreline.

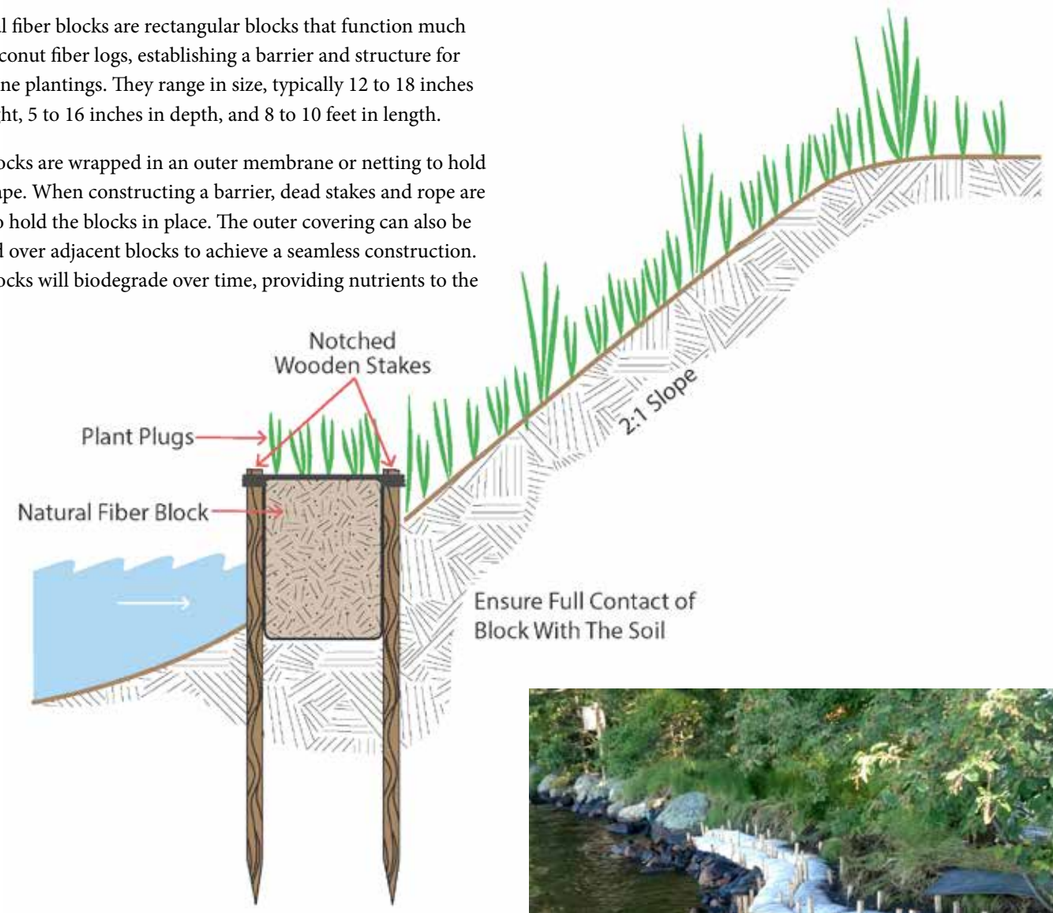
Natural fiber rolls are also commonly known as coir logs, biologs, wattles, filter logs, or sediment logs.

NATURAL FIBER BLOCKS

Natural fiber blocks are rectangular blocks that function much like coconut fiber logs, establishing a barrier and structure for shoreline plantings. They range in size, typically 12 to 18 inches in height, 5 to 16 inches in depth, and 8 to 10 feet in length.

The blocks are wrapped in an outer membrane or netting to hold the shape. When constructing a barrier, dead stakes and rope are used to hold the blocks in place. The outer covering can also be sleeved over adjacent blocks to achieve a seamless construction. The blocks will biodegrade over time, providing nutrients to the plants.

FIGURE 4: NATURAL FIBER BLOCK



NATURAL FIBER BLOCKS

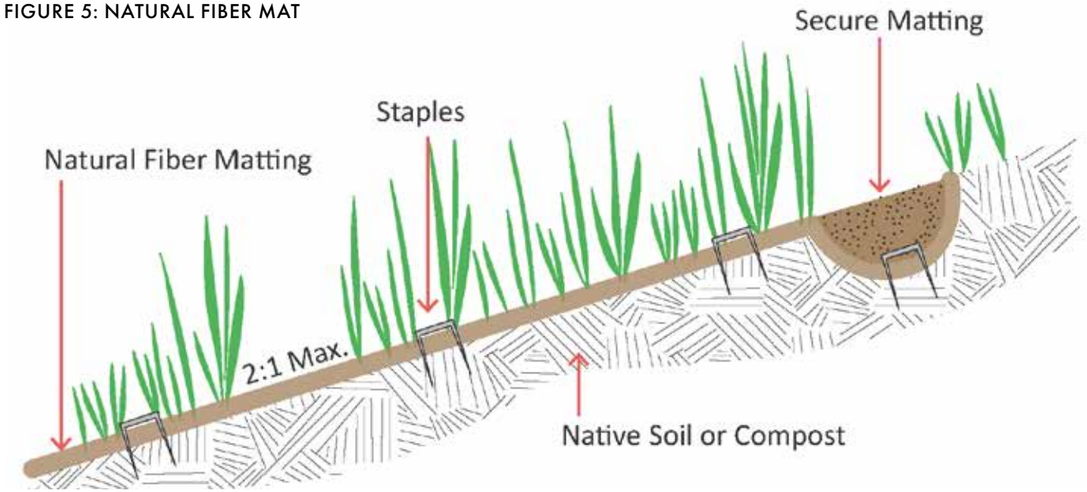
Appropriate Uses & Benefits

- Lightweight (when not saturated with water)
- More surface area contact with bank than a fiber roll
- Plant growth covers most of the structure
- Good in low and medium wave energy sites
- Can be made from regional fiber, specifically Great Lakes aspen

Limitations

- Works best in low energy locations
- Can be damaged by ice or move if not staked
- Water level fluctuation affects plants
- Fiber may be non-native

FIGURE 5: NATURAL FIBER MAT



NATURAL FIBER MATS

Natural fiber mats are an erosion control device for large areas. These come in a wide variety of materials, weights, and sizes. In general, they are made from aspen or coconut fibers and are rolled over a large area on the ground. They may be reinforced with a fiber mesh or webbing. The type and weight of the fiber mat should be determined by a project engineer.

Much like other natural fiber products, native plantings and seed can be sown under or in the mat. When installed correctly, natural fiber mats reduce runoff and erosion problems and allow plants to establish root structures to stabilize the soil. The mats biodegrade over time, feeding nutrients to the plants, and can be used in combination with natural fiber sediment logs on steeper slopes.

NATURAL FIBER MATS

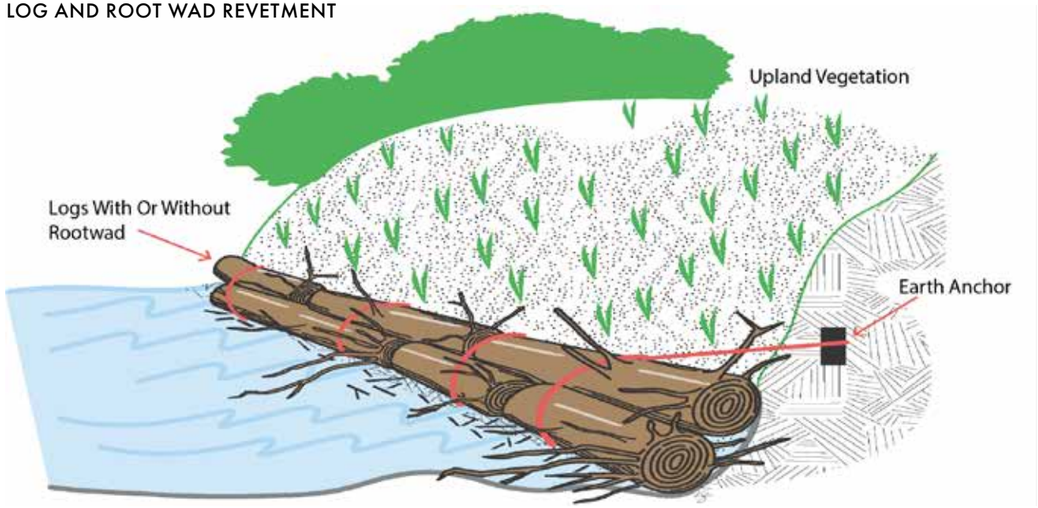
Appropriate Uses & Benefits

- Quick installation
- Can be used on either flat or sloped ground
- Reduces runoff and erosion of bare soil
- Plants are easily sown throughout mat
- Seed sown underneath mat will grow through
- Feeds nutrients to the plants as it biodegrades
- Retains moisture for plant growth

Limitations

- Can be dislodged by wind or water
- Must be properly stapled to the ground
- Can be expensive for large areas
- Not appropriate for steep slopes
- Potential for wildlife entanglement

FIGURE 6: LOG AND ROOT WAD REVETMENT



LEVEL 3: WAVE-REDUCING NATURAL TIMBERS

As the frequency of intense storms increases across the Great Lakes region, so are the water levels and wave energy. It is becoming even more important that shorelines can absorb this energy.

Wave-reducing natural timbers are an excellent tool to protect land integrity and water quality, as well as provide aquatic habitat. There are two types of practices that use natural timber - log or root wad revetment and tree drops or fish sticks.

LOG AND ROOT WAD REVETMENT

Appropriate Uses & Benefits

- Both high and low energy sites
- Improves spawning habitat
- Economical

Limitations

- Limits shoreline access
- Creates shoreline disturbance
- May need to be replaced eventually
- Transporting and access to trees

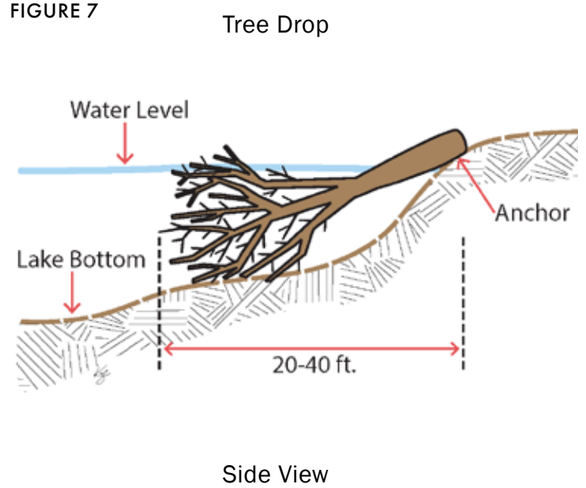
LOG AND ROOT WAD REVETMENT

A *log revetment* is constructed from whole trees, minus the branches and root wad. The trees are cabled together and anchored to the bank. By removing the branches and root wad, it is easier to stack the logs or structure the rock riprapping above and below the logs.

A *root wad revetment* is a large tree trunk with the root flare buried into a shoreline to protect against erosion and create habitat for aquatic organisms.

Both log and root wad revetments protect the toe of a bank and should be used in combination with other soil bioengineering practices or vegetative plantings to stabilize the upper bank.

FIGURE 7



FISH STICKS AND TREE DROPS

Fish sticks and tree drops use whole trees to dampen wave energy and reduce direct wave action along the shoreline. This is ideal for shoreline protection and provides a buffer for other shoreline restoration work to mature.

Fish sticks are large structures of whole trees that are grouped together. *Tree Drops* are single trees placed at least 50 feet apart along the shoreline. For both types, the trees are placed canopy-first in the water with the base of the trunk anchored to the shore. The structures are either partially or fully submerged.

These structures also provide woody habitat for fish and wildlife in the near-shore area. An ideal project location is a shoreline with low ice and wave energy, such as protected bays or shorelines leading to and from bays. Ideally, the water depth 50 feet from shore should be greater than 2 feet to receive the maximum benefits of these wood additions.

Contact your local Wisconsin DNR fisheries biologist to ensure your shoreline is well suited for this practice.

FISH STICKS AND TREE DROPS

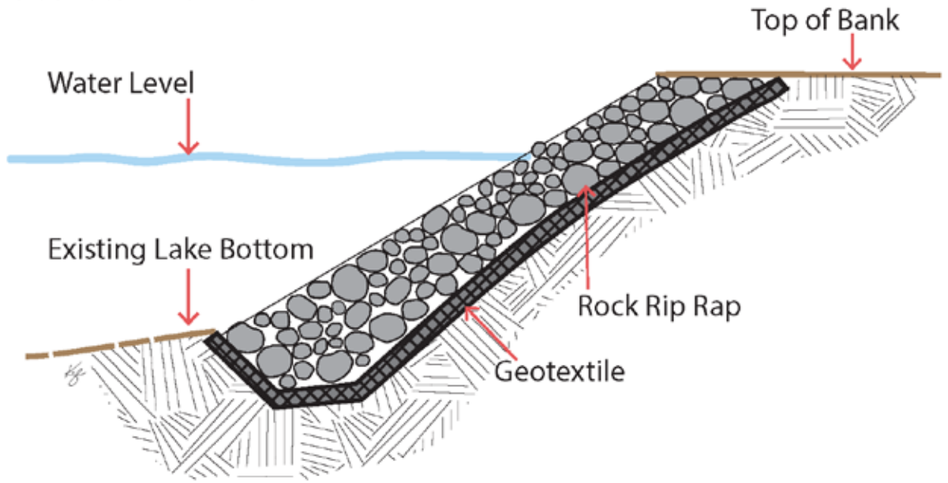
Appropriate Uses & Benefits

- Reduces wave energy and limits bank erosion
- Provides habitat for a variety of species
- Provides an environment for establishing aquatic plants
- Restores natural structure to lakes

Limitations

- Accessing and transporting trees
- Not suitable for high energy sites
- Not suitable near heavy boat traffic
- Avoid walleye spawning areas
- Ice conditions can delay installation

FIGURE 8: ROCK RIPRAP TOE WHERE NATIVE VEGETATION CANNOT BE ESTABLISHED



LEVEL 4: RIPRAP WITH BIOENGINEERING TECHNIQUES

Rock riprap is an erosion-resistant ground cover made up of a variety of rock sizes that are angular or round with geotextile or granular layer underneath. Rock Riprap is commonly used to stabilize and protect eroding banks of streams or constructed channels, shorelines of lakes, reservoirs, or estuaries.

ROCK RIPRAP TOE WHERE NATIVE VEGETATION CANNOT BE ESTABLISHED

Riprap is reserved for use in extreme undercut toe situations or locations where vegetation cannot be established (e.g. boathouse or structure). It is an important foundation that provides stability from ice shoves and wave action. Maintenance may be necessary after severe ice push events.

ROCK RIPRAP TOE WHERE NATIVE VEGETATION CANNOT BE ESTABLISHED

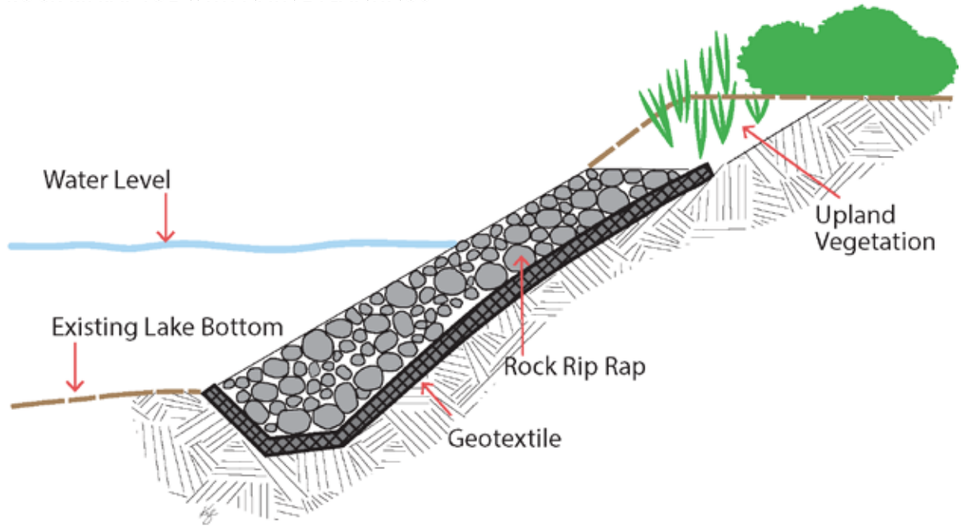
Appropriate Uses & Benefits

- Severe erosion
- Bank undercutting
- High wave energy
- Unstable soils

Limitations

- Cost and labor intensive
- Loss of habitat and ecosystem benefits
- Ice shoves
- Requires engineering
- Accessibility issues
- Side or flank erosion concerns

FIGURE 9: ROCK RIPRAP TOE WITH NATIVE PLANTINGS



ROCK RIPRAP TOE WITH NATIVE PLANTINGS

Rock riprap is commonly used in combination with other upland stabilization techniques to protect eroding shorelines of lakes. Native vegetation is an ideal upland companion to rock riprap. These native shoreline plantings create a natural buffer which stabilizes the shore from the action of waves, provides habitat for wetland birds, and shades and cools the water while helping fish to thrive. Natural shoreline plantings in combination with rock riprap capture sediment and reduce nutrient runoff from reaching the lake.

ROCK RIPRAP TOE WITH NATIVE PLANTINGS

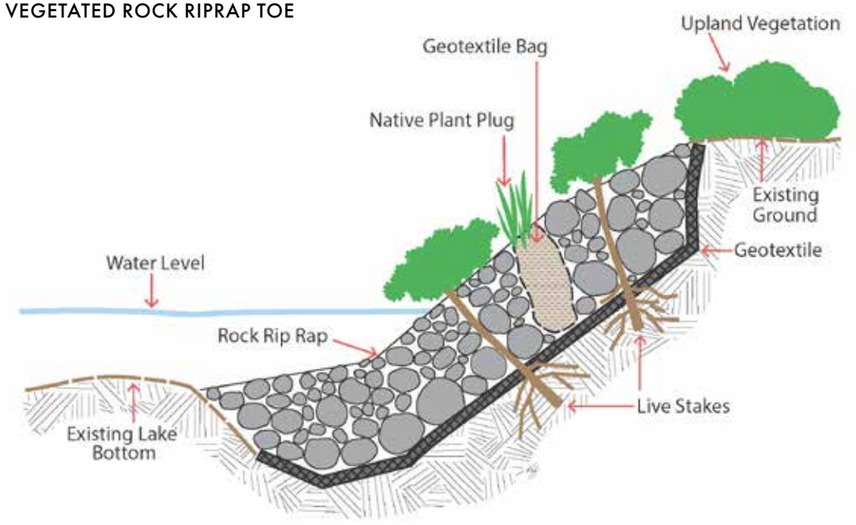
Appropriate Uses & Benefits

- Severe erosion
- Bank undercutting
- High wave energy
- Oversplash of waves on low bank

Limitations

- Cost
- Labor intensive
- Requires engineering
- Plant knowledge and maintenance

FIGURE 10: VEGETATED ROCK RIPRAP TOE



VEGETATED ROCK RIPRAP TOE

A combination of rock riprap and vegetation can improve the overall performance of the rock. Woody vegetation often grows through the stone layer of riprap, adding strength, durability, and reliability over time. This vegetation can be accelerated with various methods that incorporate plant materials within the rock cross section.

Vegetation also improves fish and wildlife habitat, water quality, and aesthetics with a diverse community of woody plant material.

VEGETATED ROCK RIPRAP TOE

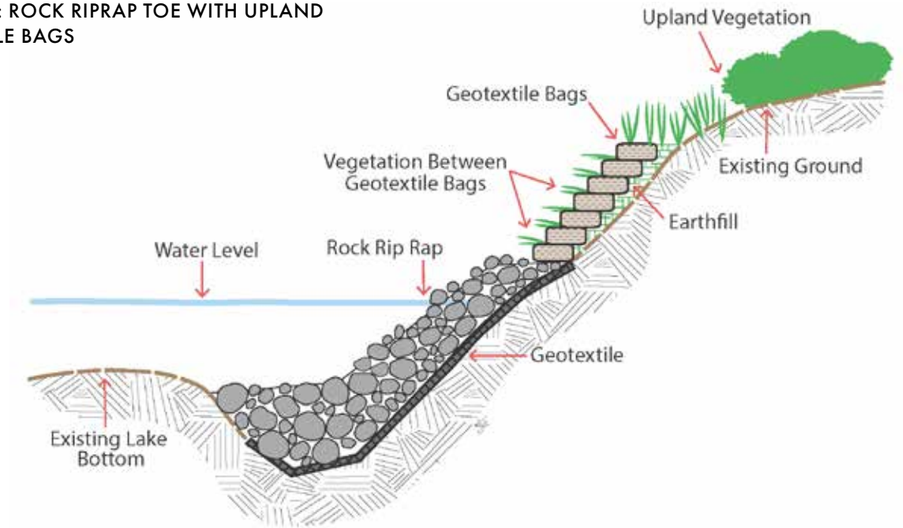
Appropriate Uses & Benefits

- Wildlife habitat
- Adds strength and durability to landscape
- Immediately camouflages rocks to look more natural with the shoreline
- Fills voids within rock to reduce entrapment of critters
- Instead of covering rock with soil and seeding it

Limitations

- Ice shoves
- Deer browse
- Labor intensive
- Requires engineering and accessibility
- Time for plants to establish
- Damage and maintenance

FIGURE 11: ROCK RIPRAP TOE WITH UPLAND GEOTEXTILE BAGS



ROCK RIPRAP TOE WITH UPLAND GEOTEXTILE BAGS

Traditional bank restoration practices focus either on hard armoring or bioengineered solutions. Geotextile bags combines the best principles of these two approaches in order to provide a permanent vegetative solution that will stabilize and protect in the most challenging of conditions. Permanent encapsulation eliminates sediment loss and provides ideal growing conditions for riparian vegetation. Geotextile bags are engineered to strengthen banks while improving aquatic and terrestrial habitat.

ROCK RIPRAP TOE WITH UPLAND GEOTEXTILE BAGS

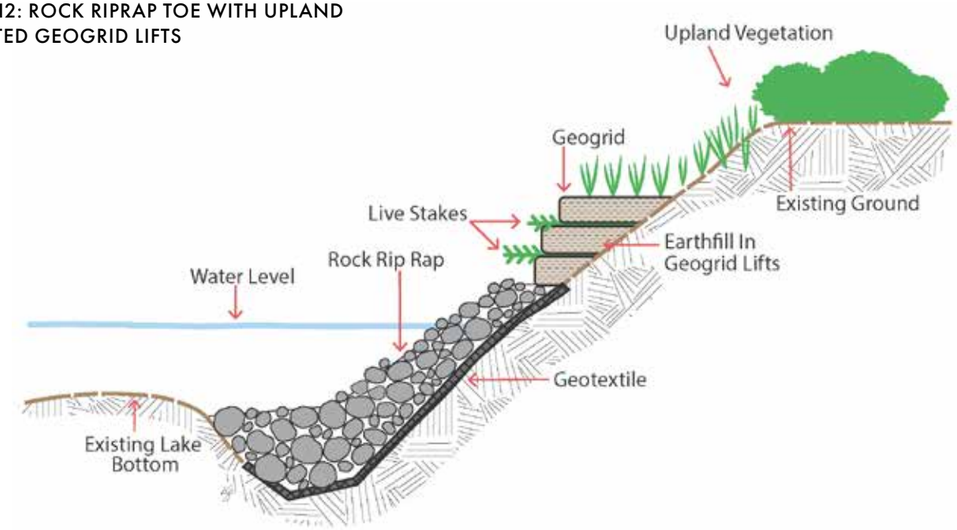
Appropriate Uses & Benefits

- Steeper slopes
- Quickly establish riparian vegetation
- Effectiveness increases with time
- Smaller areas of unvegetated banks between trees and shrubs
- Best for areas of limited access with existing vegetation
- Environmentally friendly alternative to hardscape retaining walls

Limitations

- Expensive
- Labor intensive
- Requires engineering
- Soil-filled bags require site to be accessible

FIGURE 12: ROCK RIPRAP TOE WITH UPLAND VEGETATED GEOGRID LIFTS



ROCK RIPRAP TOE WITH UPLAND VEGETATED GEOGRID LIFTS

Vegetated geogrids use natural or synthetic geotextile materials that are wrapped around each soil lift with live branch cuttings or plant plugs layered between them. Rock Riprap is used as the foundation for this type of protection.

ROCK RIPRAP TOE WITH UPLAND VEGETATED GEOGRID LIFTS

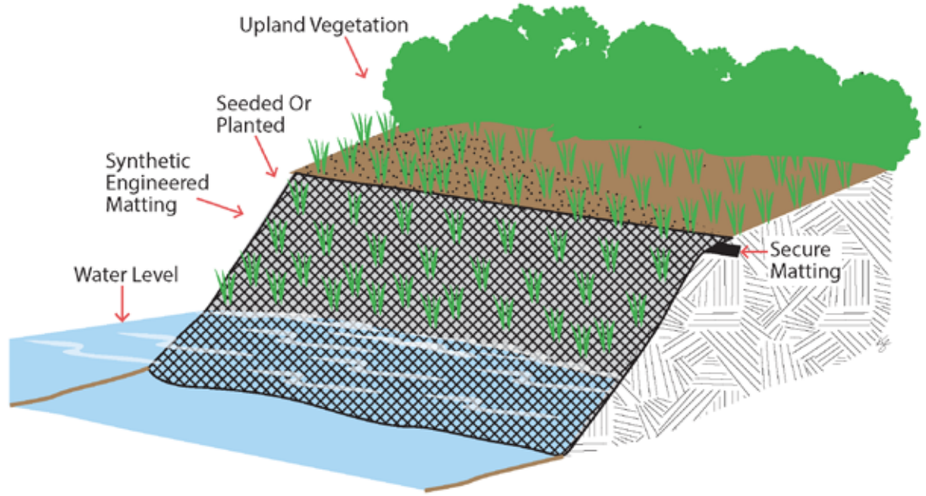
Appropriate Uses & Benefits

- Steeper slopes
- Quickly establish riparian vegetation
- Effectiveness increases with time
- Best for large, unvegetated areas
- Environmentally friendly alternative to hardscape retaining walls

Limitations

- Cost
- Labor intensive
- Deer browsing issues
- Requires engineering
- Accessibility for fill and materials

FIGURE 13: SYNTHETIC ENGINEERED MATTING



SYNTHETIC ENGINEERED MATTING

Synthetic Engineered Matting are soft revetment, scour protection mats designed as mechanical protection over highly erosive areas. These products protect against much higher shear stresses and velocities than biodegradable mats alone. The system is comparable to hard armor products such as rock riprap in turbulent flow and wave action applications.

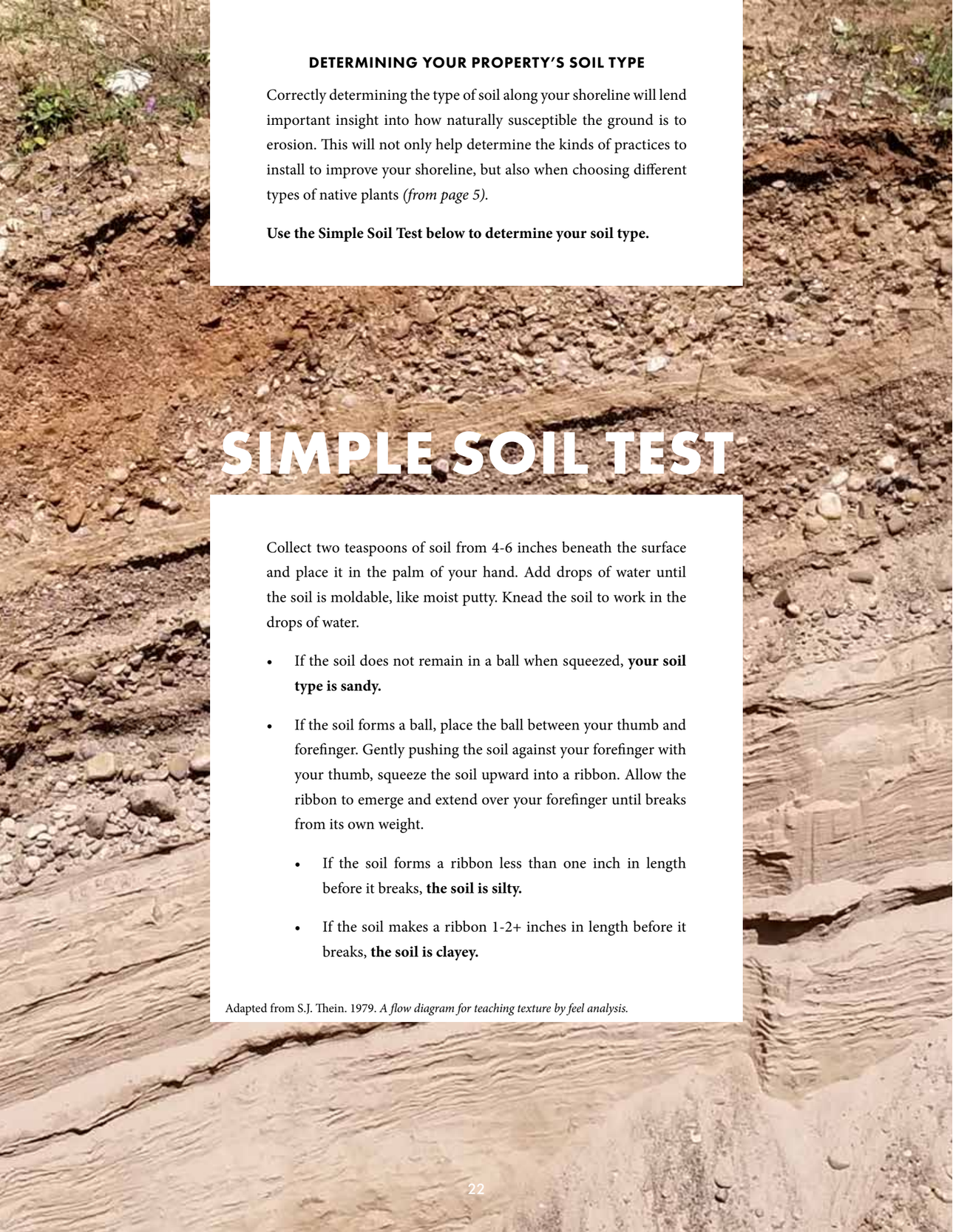
SYNTHETIC ENGINEERED MATTING

Appropriate Uses & Benefits

- High traffic areas
- Low to medium slopes
- Small non-motorized watercraft walk in access

Limitations

- Suggested to combine with other erosion control products
- Potential for wildlife entanglement



DETERMINING YOUR PROPERTY'S SOIL TYPE

Correctly determining the type of soil along your shoreline will lend important insight into how naturally susceptible the ground is to erosion. This will not only help determine the kinds of practices to install to improve your shoreline, but also when choosing different types of native plants *(from page 5)*.

Use the Simple Soil Test below to determine your soil type.

SIMPLE SOIL TEST

Collect two teaspoons of soil from 4-6 inches beneath the surface and place it in the palm of your hand. Add drops of water until the soil is moldable, like moist putty. Knead the soil to work in the drops of water.

- If the soil does not remain in a ball when squeezed, **your soil type is sandy.**
- If the soil forms a ball, place the ball between your thumb and forefinger. Gently pushing the soil against your forefinger with your thumb, squeeze the soil upward into a ribbon. Allow the ribbon to emerge and extend over your forefinger until breaks from its own weight.
    - If the soil forms a ribbon less than one inch in length before it breaks, **the soil is silty.**
    - If the soil makes a ribbon 1-2+ inches in length before it breaks, **the soil is clayey.**

Adapted from S.J. Thein. 1979. *A flow diagram for teaching texture by feel analysis.*

Terminology

Bank height – Vertical measure from the bank toe to the top of the bank lip, irrespective of changes in the water level.

Bioengineering – Using a combination of native planting and natural, or biodegradable materials to provide shoreline protection.

Biological materials – Living or organic materials that are biodegradable such as native grasses, sedges, forbs, shrubs and trees; live stakes and posts; non-treated wood; jute netting; fiber rolls and mats; logs; and branches.

Earth anchor – A device designed to support structures, most commonly used in geotechnical and construction applications. Also known as a ground anchor, it may be impact driven into the ground or run in spirally, depending on its design and intended force-resistance characteristics.

Energy category – There are three categories: low, moderate, and high. A category is calculated by using three variables: wind speed, fetch, depth along that fetch. The energy category is used to determine type of erosion control protection allowed and type of permit.

Erosion – The wearing away of the land by the natural forces of wind, water, or gravity.

Erosive energy – Refers to the energy potential of the water affecting a particular site and the habitat features as indicators of this energy.

Fetch – The longest unobstructed straight line distance originating from the shore protection site across the water surface to the opposite intersect with the shore. Used to calculate wave energy and is one factor in determining the shoreline protection to be used.

Filter cloth/geotextile – Material used under riprap to prevent erosion from the bank on which it was placed.

Hard armoring – A shore erosion control structure that relies solely on inert materials and includes but is not limited to riprap and seawalls.

Impervious – An area that releases as runoff all or a majority of the precipitation that falls on it. "Impervious surface" excludes frozen soil but includes rooftops, sidewalks, driveways, parking lots, and streets unless specifically designed, constructed, and maintained to be pervious. Check with your county zoning office for guidance.

Integrated toe protection – A structure combining two separate treatments: toe protection at the base of the bank and vegetation establishment on the remaining upper portion of the bank above the ordinary high water mark.

Live stakes or live branch cuttings – Dormant, live woody cuttings of a species with the branches trimmed off. Live stakes can be inserted into a bank or can be placed in between layers in geogrids. Dogwoods and willows are commonly used.

Ordinary high water mark (OHWM) – The point on the bank or shore up to which the presence and action of water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognizable characteristic (as defined in NR328). The OHWM is set by WDNR or county zoning.

Natural fiber products – Shoreline restoration products made from natural fibers such as aspen fiber, coconut husks, straw, or other natural materials. These products include erosion blankets, coir rolls or logs and blocks.

Revetment – Sloping structures placed on banks or cliffs in such a way as to absorb the energy of incoming water.

Riparian – An owner of land abutting a navigable waterway.

Riprap – A layer or layers of rock, including filter material, placed on the bed and bank of a navigable waterway to prevent erosion, scour or sloughing of the existing bank.

Runoff – Rainfall that is not absorbed by soil. Such as rain that flows off from the land in streams.

Seawall – An upright structure steeper than 1.5 to 1, installed parallel to the shore to prevent sliding or slumping of the land and to protect the upland from wave action.

Shear stress – A force that causes layers or parts to slide upon each other in opposite directions.

Shoreline buffer or vegetated buffer – The area from the water's edge 35 feet upland. Healthy buffers are comprised of a 3-tiered system of native trees, shrubs, and grasses or wildflowers. A healthy buffer stabilizes the shoreline, while providing habitat for wildlife.

Slope – In mathematics, slope = rise/run. This the measurement of the steepness, incline, gradient, or grade of a straight line. Slope is often written as ratio like "2:1," which is understood as 2 horizontal units of measurement to 1 vertical unit of measurement.

Structural protection – Using a structure with defined shape, size, form and utility constructed and maintained for the purpose of protecting a shoreline from erosion. Shore erosion control structures include vegetated and hard armoring.

Synthetic engineered mat – Matting made from synthetic materials installed to withstand heavy traffic such as pathways or boat landings where it is difficult to establish plant material. These mats allow the weight to be evenly distributed and protect the roots of grass planted under the mat to assist in stabilizing the shoreline.

Toe – The most waterward edge of a shore erosion control structure.

Toe of bank – The break in slope at the foot of a bank where it meets the lakebed

Vegetated armoring – A shore erosion control structure that combines biological and inert materials and includes three types: integrated toe protection, vegetated riprap, and vegetated geogrids.

Vegetated geogrids – Consists of alternating layers of live branch cuttings and compacted soil with geotextiles (natural or synthetic) wrapped around each soil lift.

ACKNOWLEDGEMENT & INTENDED USE

Shoreline Stabilization: A Guide for Homeowners and Conservationists is result of the collective effort by the Wisconsin Shoreline Stabilization Outreach Project (SSOP). The members of the group are conservationists, technicians, and outreach specialists from 11 county conservation departments across Wisconsin, with assistance from Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP).

This guide is an educational tool for both homeowners and conservationists that explains the basic principles of shoreline management on residential properties. The information within is based on Wisconsin topography, soils, and shoreline dynamics.

The guide is intended only as an educational document. As a homeowner, please do more research and seek professional guidance before installing any of these practices.

Before starting any alteration of your shoreline, make sure you have any required permits from the appropriate local municipalities, county government, tribal government, Wisconsin Department of Natural Resources (DNR), and the U.S. Army Corps of Engineers, as needed.

Special thanks to Karen Engelbretson of KJE Design, LLC and Elliot Meyer of WI Land+Water for their contributions to the guide.

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EDITORIAL REVIEW

Shoreline Stabilization: A Guide for Homeowners and Conservationists was reviewed by multiple state and local conservation departments to ensure the information adheres to state standards and is applicable to the varying regions across Wisconsin.

Zach Lawson, Kay Lutze, and Kyle McLaughlin at the Wisconsin DNR provided content review and feedback for this publication.

Patricia Cicero from Jefferson County Land and Water Conservation Department and Matt Repking from Marathon County Conservation, Planning, and Zoning Department also provided content review and feedback.

Thank you to all who assisted the SSOP in developing and reviewing this guide.

IMAGE CAPTIONS & CREDITS

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3D Polyamide molten filament mat, Range Line Lake, Onieda County