STREAMBANK AND SHORELINE STABILIZATION

- Techniques to Control Erosion and Protect Property -

Coconut logs, live stakes, toe of slope protection and riparian restoration - Photograph courtesy of Register-Nelson Environmental Consultants.

Table of Contents

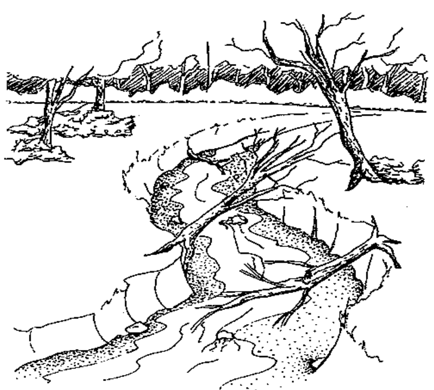
Introduction

Appropriate selection and application of streambank or shoreline protection measures should vary in response to specific objectives and site conditions.

Streambank and shoreline stabilization consists of vegetative, structural and bioengineering methods to stabilize AND protect streambanks and shorelines. This document presents diagrams of the methods and practices listed in the Georgia DNR – Environmental Protection Division's (EPD) July 2007 "Streambank and Shoreline Stabilization Guidance" document and provides information about preferred riparian vegetation for stabilization projects.

Stabilizing streambanks with natural vegetation has many advantages over hard armoring such as riprap, seawalls and gabions. Streams with well-established vegetation on their banks provide for better water quality and fish and wildlife habitats. Vegetation is extremely important for the biological, chemical and physical health of the stream as well as the stability of the system.

Vegetation is not a panacea for controlling erosion and must be considered in light of site-specific characteristics. When vegetation is combined with low-cost building materials or engineered structures, numerous techniques can be created for streambank erosion control. This document summarizes a number of methods that utilize vegetation and bioengineering.



Illustrated Streambank Restoration

NOTE: This handbook does not attempt to assume that bioengineering for streambank protection is a cure unto itself. First, streambed stability, another whole subject area, must be achieved before banks are addressed. Therefore, careful study should be made to determine the causes of erosion before bioengineering is considered. If streambeds are not stable, it does little good to attempt streambank stabilization. This document does not attempt to address the details of fluvial geomorphology involved in streambed stabilization.

Causes of Erosion

Streambank and shoreline erosion is a natural process. Human activities often contribute to or accelerate the natural streambank or shoreline erosion process, exacerbating the negative effects. However, with thought and planning, such activities can be modified to avoid or reduce those effects. Human activities contributing to or accelerating the natural streambank or shoreline erosion process include:

Clearing Natural Vegetation
Often done by landowners to expand views or increase recreational areas, it destroys the roots of plants that provide significant streambank and shoreline stabilization.

Construction or Development (Urbanization)
Construction and development uphill of a streambank or shoreline can result in increased stormwater runoff, resulting in increased pollutant and sediment loads to the waterbody. Urbanization can lead to extensive loss of natural vegetation along the streambanks and shorelines, which increases the rate of erosion.

Impervious Surfaces and Structures (Stormwater Runoff)
Pavement, buildings, roofs, drainage ditches, etc. increase the amount, velocity and energy of stormwater, resulting in more runoff being routed to streams and lakes (and less into the ground), and increasing erosion.

Agricultural Practices
These can modify the rate of erosion and increase levels of nutrients in streams and lakes. Agricultural practices, such as plowing, drainage ditches, irrigation and grazing, can increase the rate of erosion.

Streambank or Shoreline Stabilization Projects
Erecting seawalls and other such projects reduce habitat and commonly affect other properties due to the redirection of waves and energy away from the area in which the seawall was installed.

Planning a Streambank or Shoreline Stabilization Project

Stream channel and shoreline erosion problems vary widely in type and scale, and there is no one measure that works in all cases. Stabilization structures and vegetative measures should be planned and designed by a design professional with experience in this field. Many of the practices involve the use of manufactured products and should be installed in accordance with the manufacturer's specifications. In ordered to determine what type of streambank or shoreline project needs to be implemented, you should first determine the severity of your erosion problem. *Severe erosion covers a large area of bank (linear extent greater than three times average bank height) and is occurring at a rate in excess of one foot per year or a rate that is unacceptable for safety, environmental or economic reasons.*

If your streambank or shoreline is severely eroded, you will need to stabilize the soil to promote plant growth. There are three general approaches to bank stabilization:

- **Live Planting**
- **Bioengineering**
- **Hard Armoring**

The best method for stabilizing and protecting your streambank or shoreline depends upon your specific situation. Factors to consider include the size and location of your stream or shoreline as well as the cause and severity of the erosion. In many cases, the best approach is to use a combination of methods. Before attempting any streambank or shoreline stabilization activities, you should obtain all applicable permits or approvals.

Preferred Practices

Preserving the Natural Streambank or Shoreline

Stabilization of your streambank or shoreline can be as simple as not mowing the grass or not cutting the trees and shrubs along the edge of the banks. This allows natural vegetation to grow or become re-established. A naturally vegetated shoreline has many benefits. It prevents contaminants or excess nutrients from entering the water; it prevents erosion caused by rain, wind, wave and ice action; and it provides food, shade and cover for fish and wildlife. If some vegetation must be removed, limit the amount. Try to prune trees and shrubs back instead of removing them altogether.

Soil Bioengineering Systems

Projects incorporating bioengineering practices using native riparian vegetation are preferred for streambank and shoreline stabilization. However, certain structural components of stabilization are highly effective and occasionally necessary. Natural approaches seek to restore hydrological and ecological balance by using methods that are structurally sound, economically feasible and ecologically sustainable. While there are many ways to protect an existing streambank/shoreline or restore an eroded one, choosing appropriate materials and design is important. Some methods may include planting native, deep-rooting vegetation, as well as bioengineering. Consult with a plant materials specialist for guidance on plant selection. Species that root easily, such as willows, are required for measures such as live staking and live fascines. Lists of Georgia's native vegetation for soil bioengineering and related systems are provided in the appendices.

Planting Densities

EPD recommends that trees be planted at a density of 10 feet on center (ft o.c.) or 436 trees per acre. If planted alone, shrubs should be planted at an average density of 6 ft o.c. (1210 shrubs per acre) and groundcovers (4" containers) at an average density of 1.5 ft o.c. (19,360 containers per acre). When combined with planting trees, shrubs and/or groundcover may be planted at a density of 774 shrubs per acre and 18,150 containers per acre. Live stakes are typically planted at 2 ft o.c. Please reference http://www.soundnativeplants.com/calculator.htm for further planting density information.

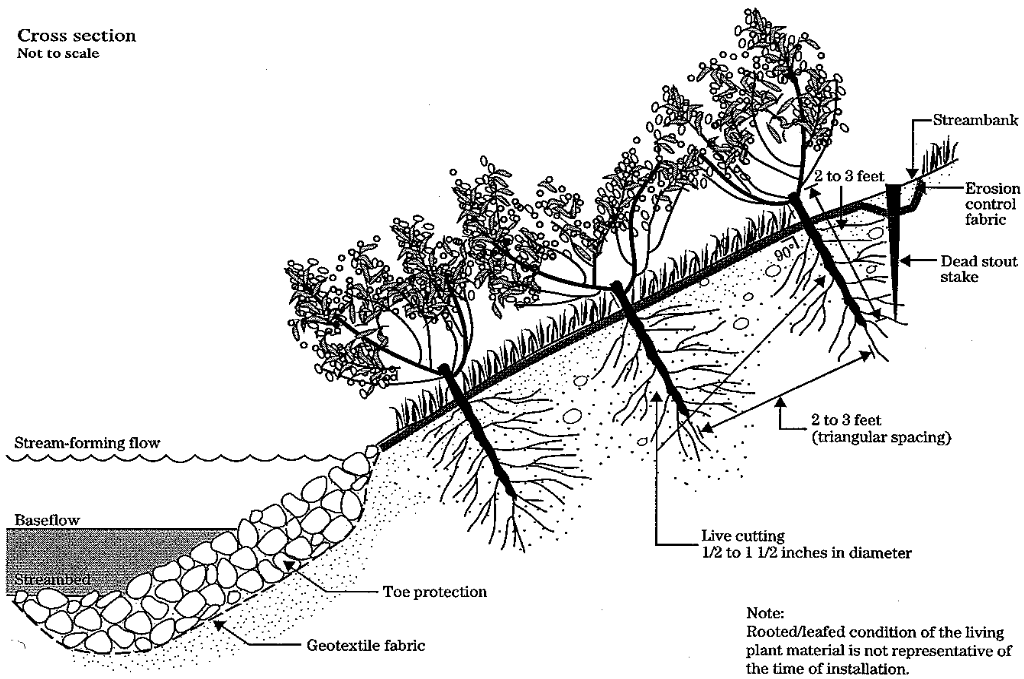
Soil Bioengineering Systems

Some of the most common and useful soil bioengineering systems for restoration and protection of streambanks and shorelines are described in the following sections.

Live Staking

Live stakes are living, woody plant cuttings capable of rooted when inserted into the banks. These stakes, commonly willow species, can root and grow into shrubs that overtime will stabilize the streambank or shoreline and provide riparian habitat.

Figure 1. Live stake details

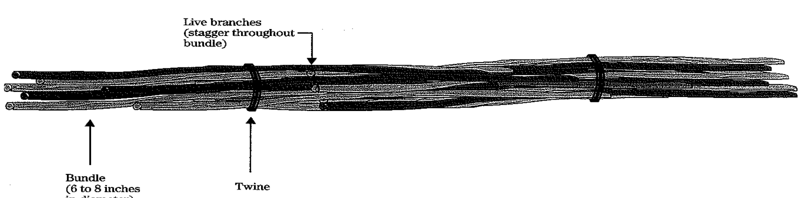


NRCS Engineering Field Handbook (210-vi-EFH, December 1996)

Live Fascines (Fascine Rolls/Wattles)

Live facines are bound bundles of live branch cuttings that are buried onto the bank and staked into place along the slope contour. Willow branches are the most commonly used for this method.

Figure 2. Live fascine details



NRCS Engineering Field Handbook (210-vi-EFH, December 1996)

Figure 3. Live fascine details

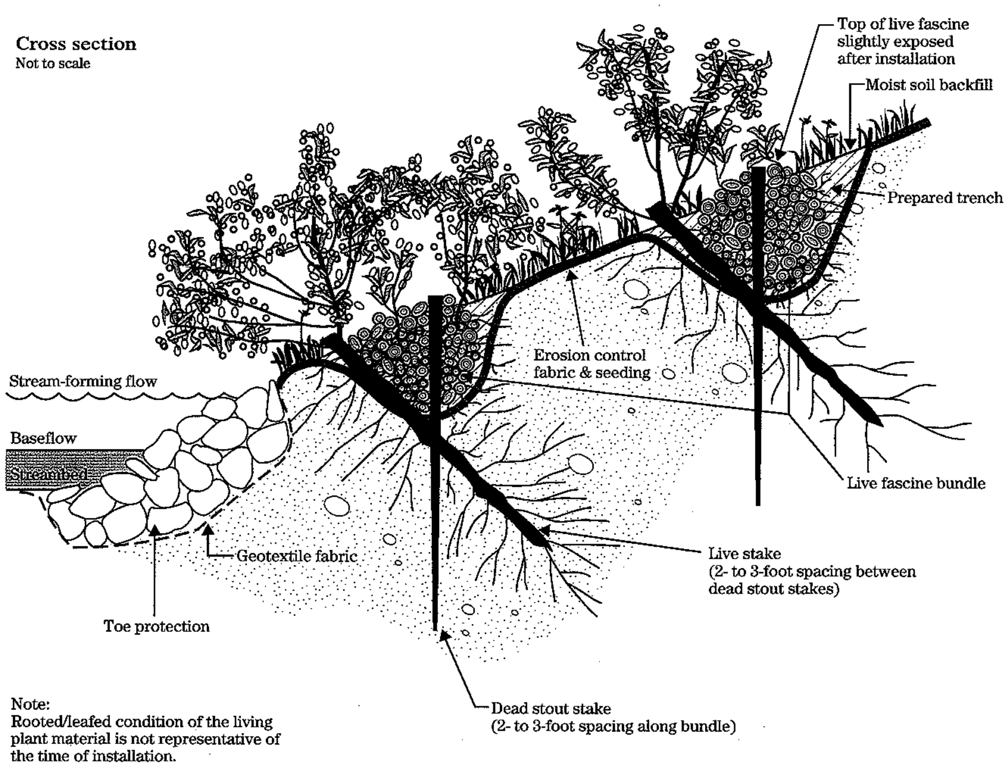


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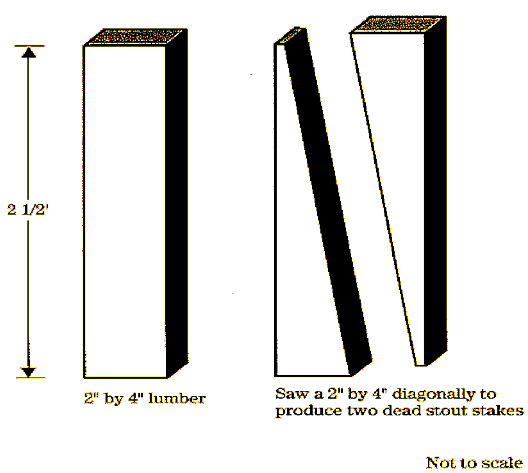
Figure 4. Preparation of a dead stout stake



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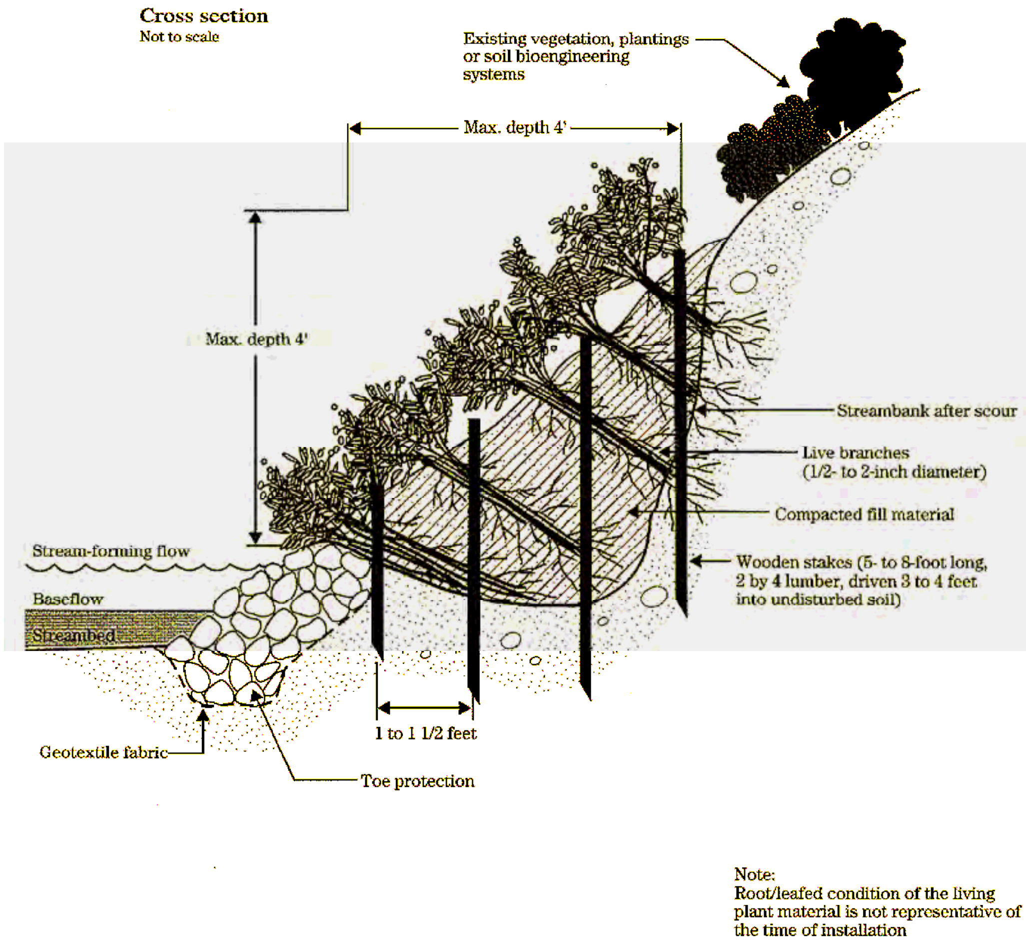
Branchpacking

Branchpacking is the process of incorporating alternating layers of live branch cuttings and compacted soils into a hole, gully or slump. This method is used to fill in depressions along the streambank or shoreline.

Figure 5. Branchpacking details



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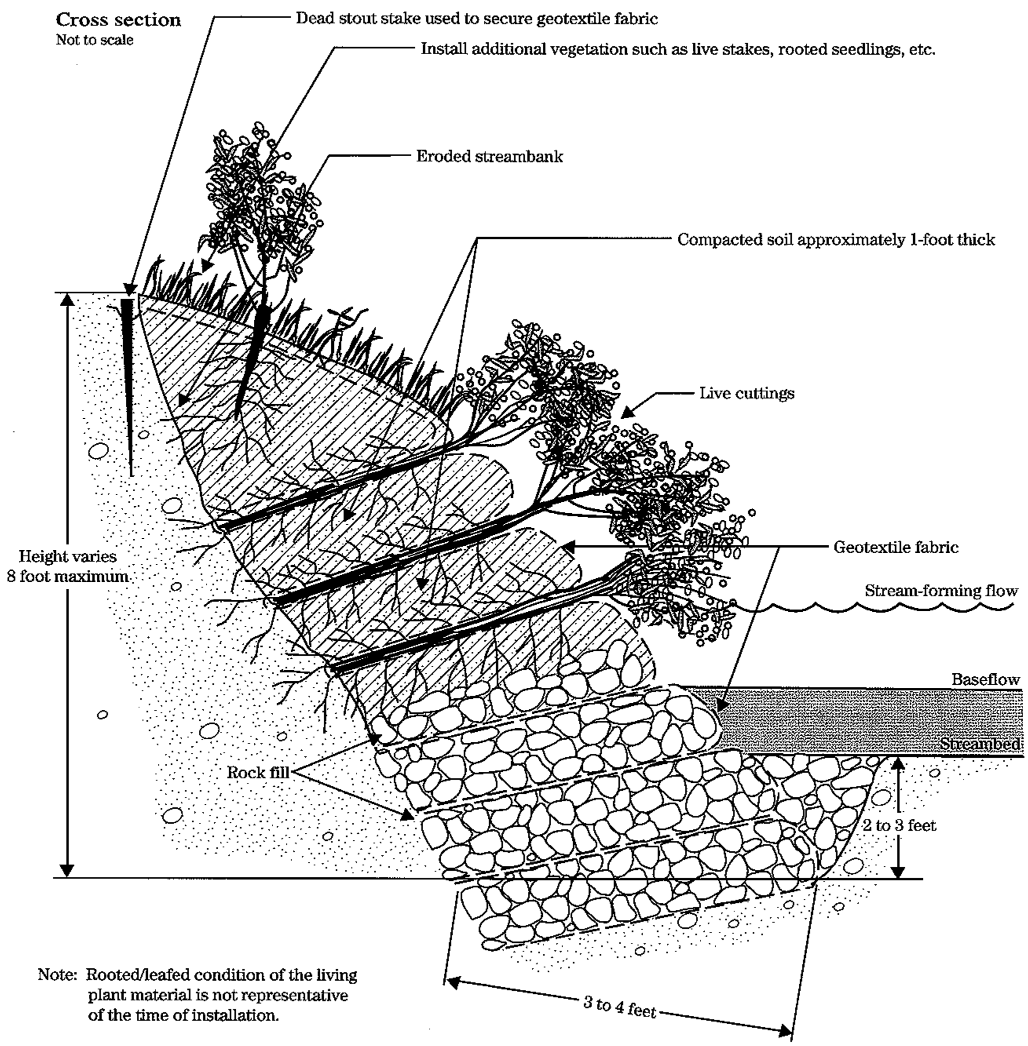
Vegetated Geogrid

Vegetated geogrids are similar to branchpacking except that natural or synthetic geotextile materials are wrapped around each soil lift between the layers of live branch cuttings.

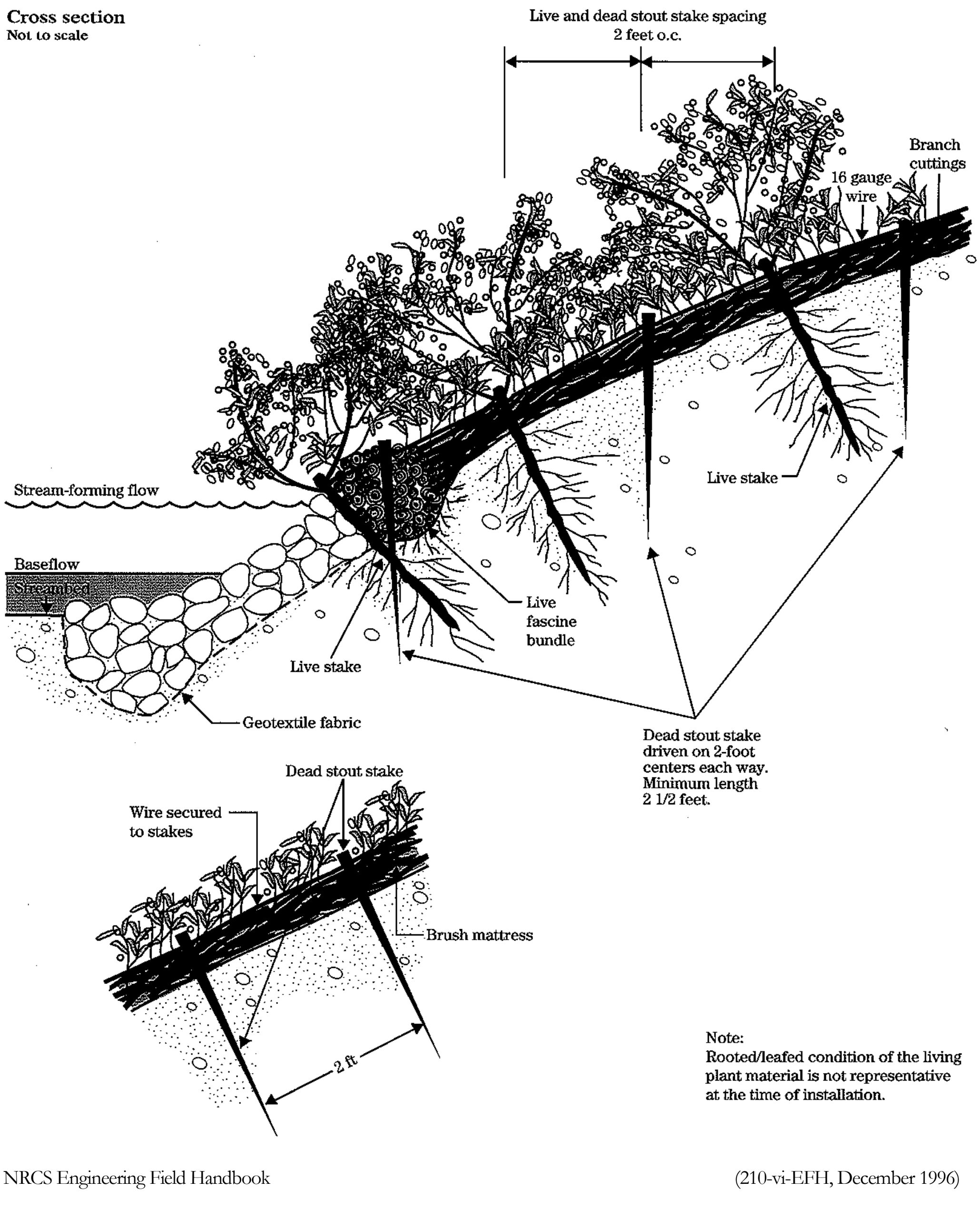
Figure 6. Vegetated geogrid details



Brushmattress

A brushmattress system consists of live branch cuttings, live stakes, and live fascines installed to cover and stabilize the entire streambank/shoreline and secured in place. This method is installed above the normal stream flow and provides immediate protective coverage of the bank.

Figure 7. Brushmattress details



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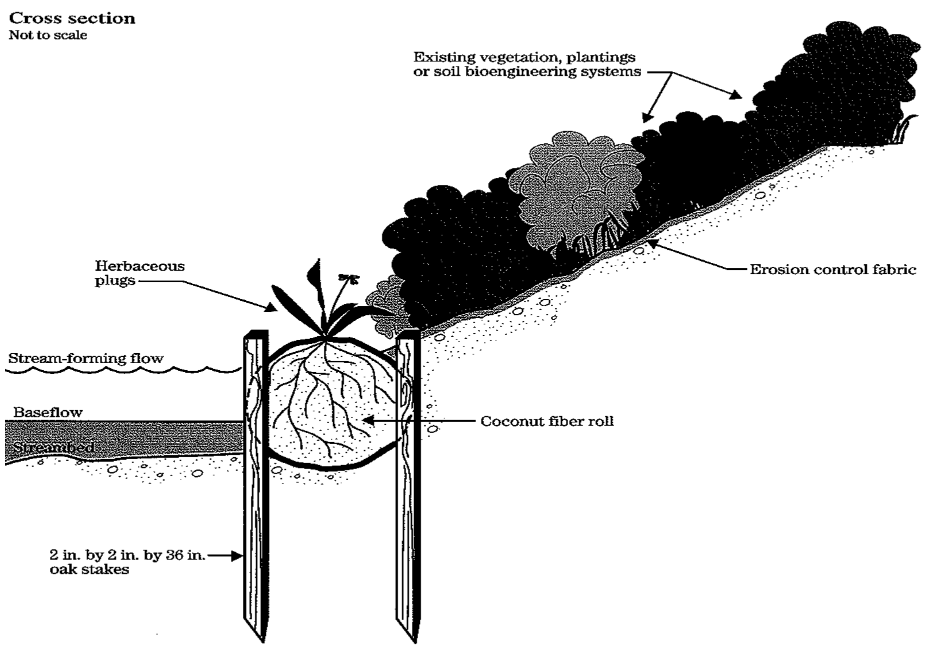
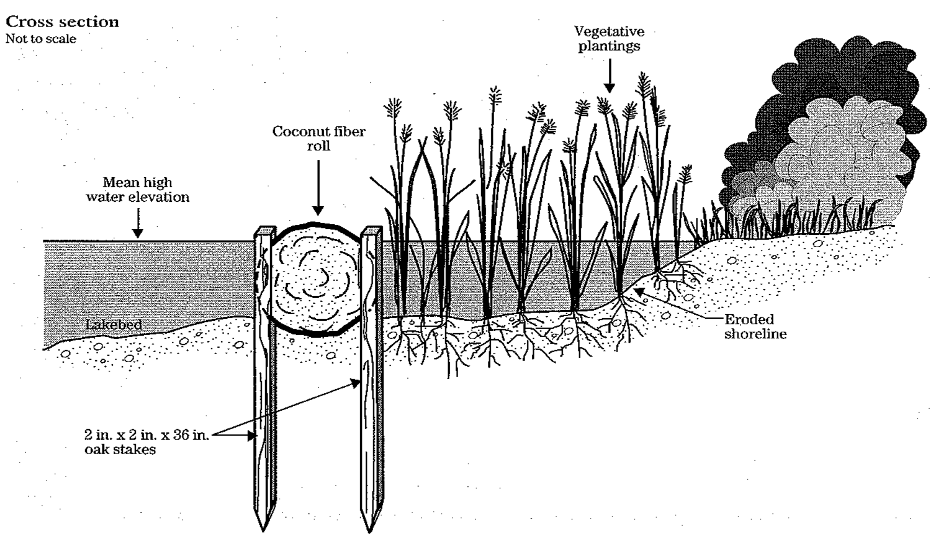
Coconut Fiber Roll

A coconut fiber roll is a flexible "log" made from coconut hull fibers, staked at the toe of the bank. The technique is often used in conjunction with native plants to trap sediment and encourage plant growth.

Figure 8. Coconut fiber rolls detail

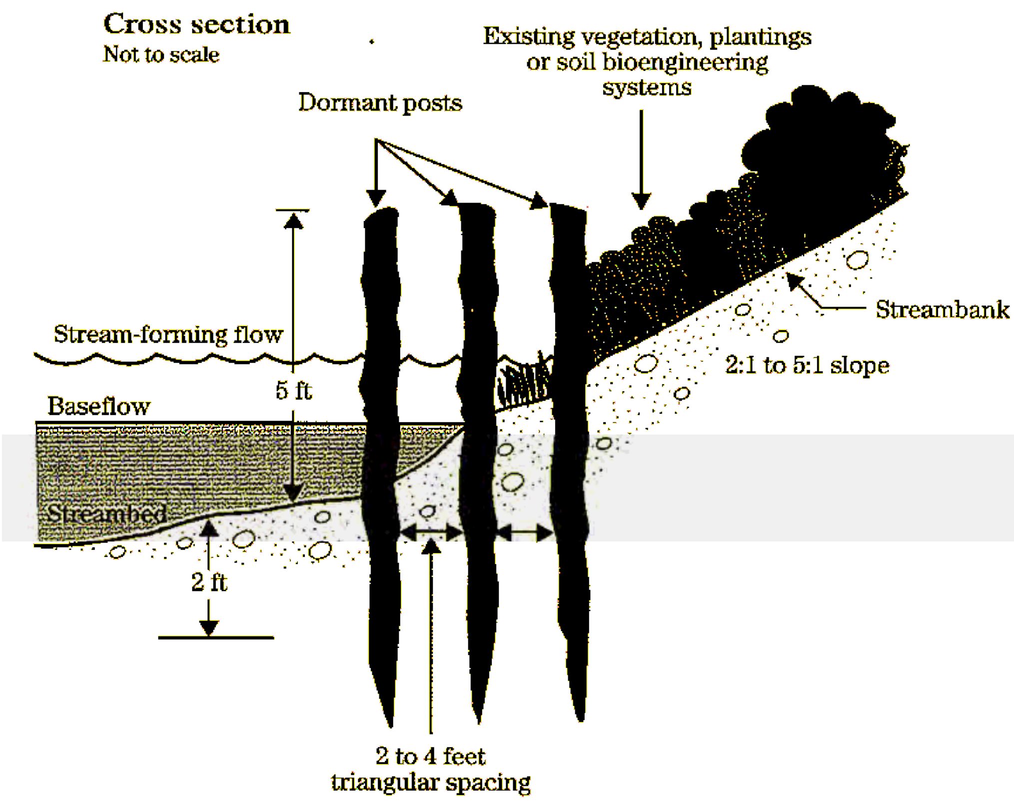




Dormant Post Plantings (Live Posts)

Dormant post plantings form a permeable revetment that is constructed from rootable vegetative material placed along streambanks in a square or triangular pattern.

Figure 9. Dormant post details



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Acceptable Practices

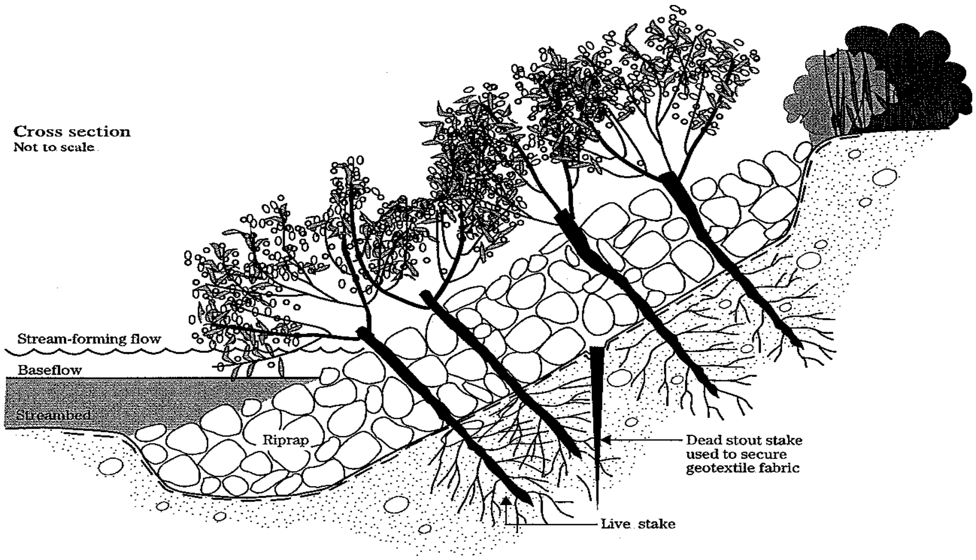
Integrated Bioengineering Practices

Acceptable stabilization methods are integrated bioengineering with one or more structural component useful in areas with higher velocity flows and/or wave action. This is most often appropriate at the "toe" of the bank or shoreline to prevent additional bank slumping. Structural components should be minimal and only used when necessary to ensure long-term success of the stabilization efforts.

Joint Planting

Joint planting or vegetated riprap involves tamping live stakes into joints or open spaces in rocks that have been placed on a slope. Vegetation, especially deep rooting species, planted above and immediately behind the rock will greatly increase the stability of the slope

Figure 10. Joint planting details



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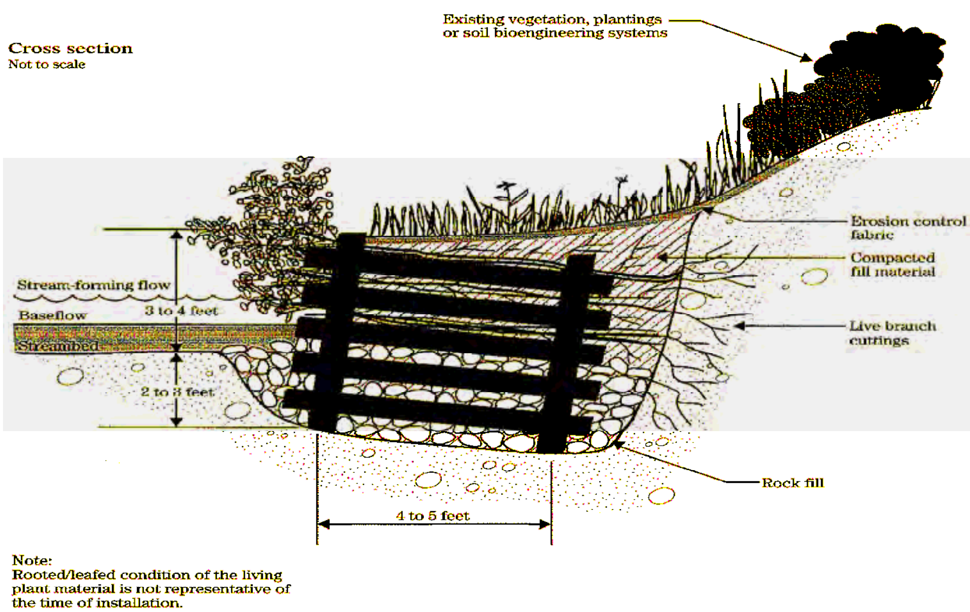
Live Cribwall

A live cribwall is a box-like structure with a framework of logs or timbers, rock and live cuttings that can protect eroding streambanks or shorelines. Once live cuttings become established, mature vegetation gradually takes over the structural functions of the logs or timbers.

Figure 11. Live cribwall details



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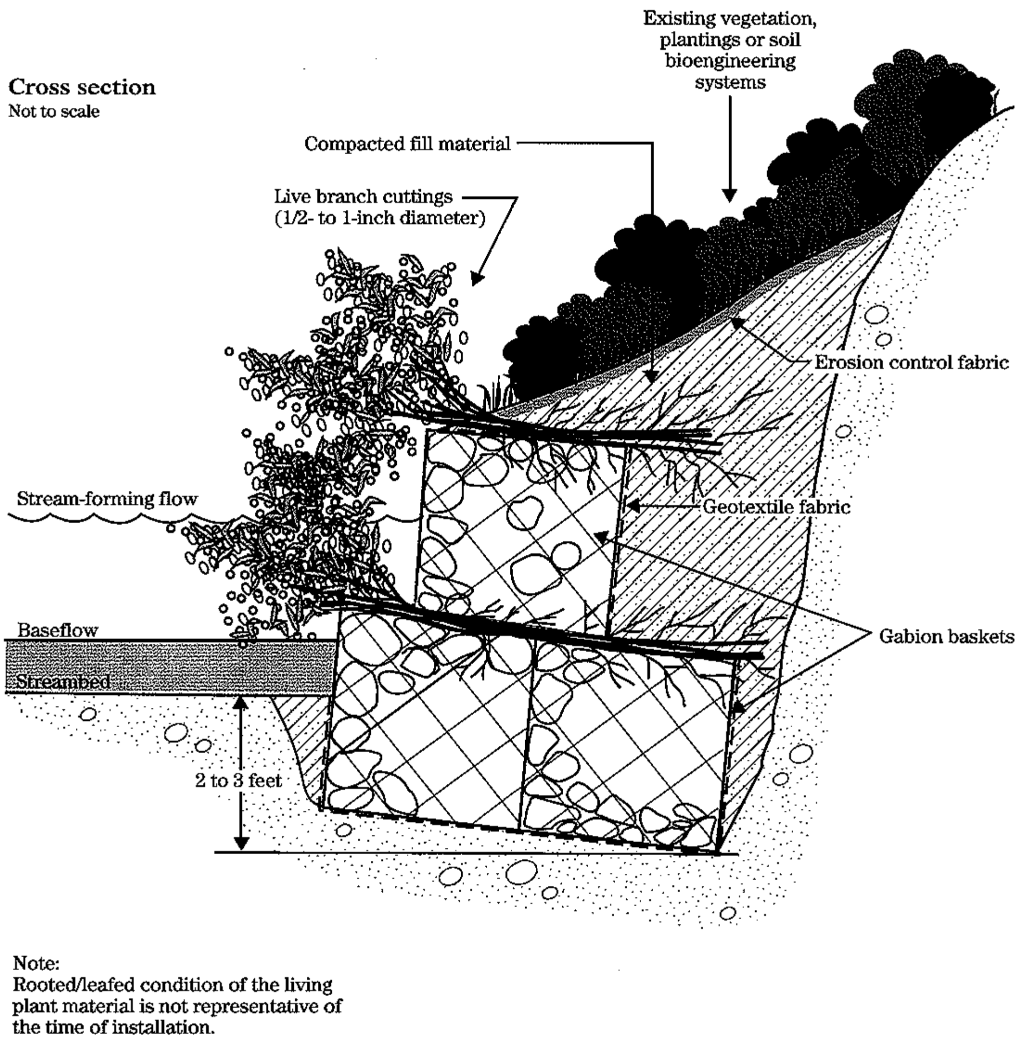
Vegetated Rock Gabions

Gabion baskets are rectangular containers fabricated from a heavily galvanized steel wire or triple twisted hexagonal mesh. These empty gabions are placed in position, wired to adjoining gabions, filled with stones, and then wired shut. Vegetation is incorporated into rock gabions by placing live branches on each consecutive layer between the rock filled baskets.

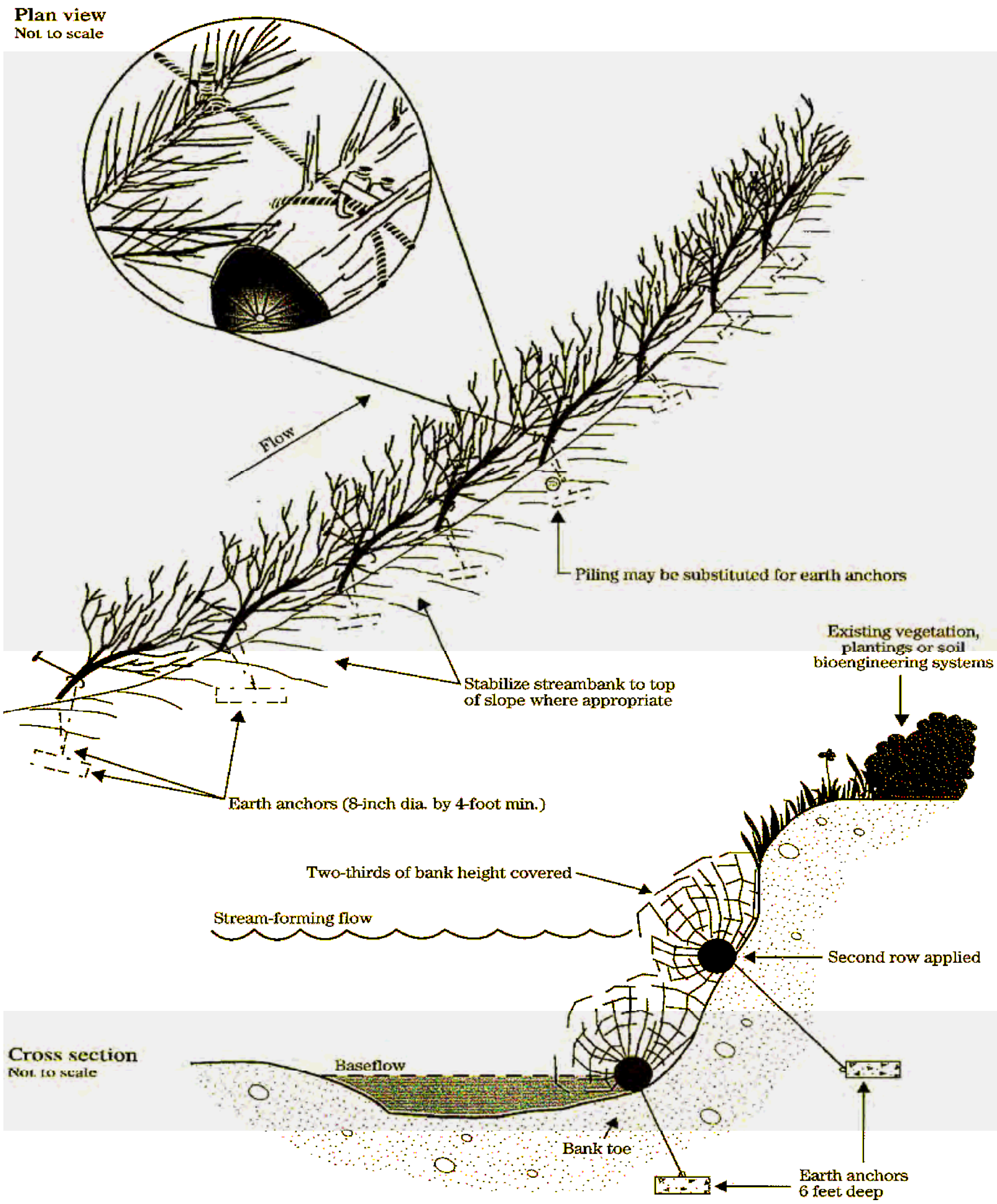
Figure 12. Vegetated gabion details



Tree Revetments

Tree revetments are rows of cut trees anchored to the toe of the bank. This is a low cost method, often used for toe protection with other bioengineering techniques.

Figure 13. Tree revetment details



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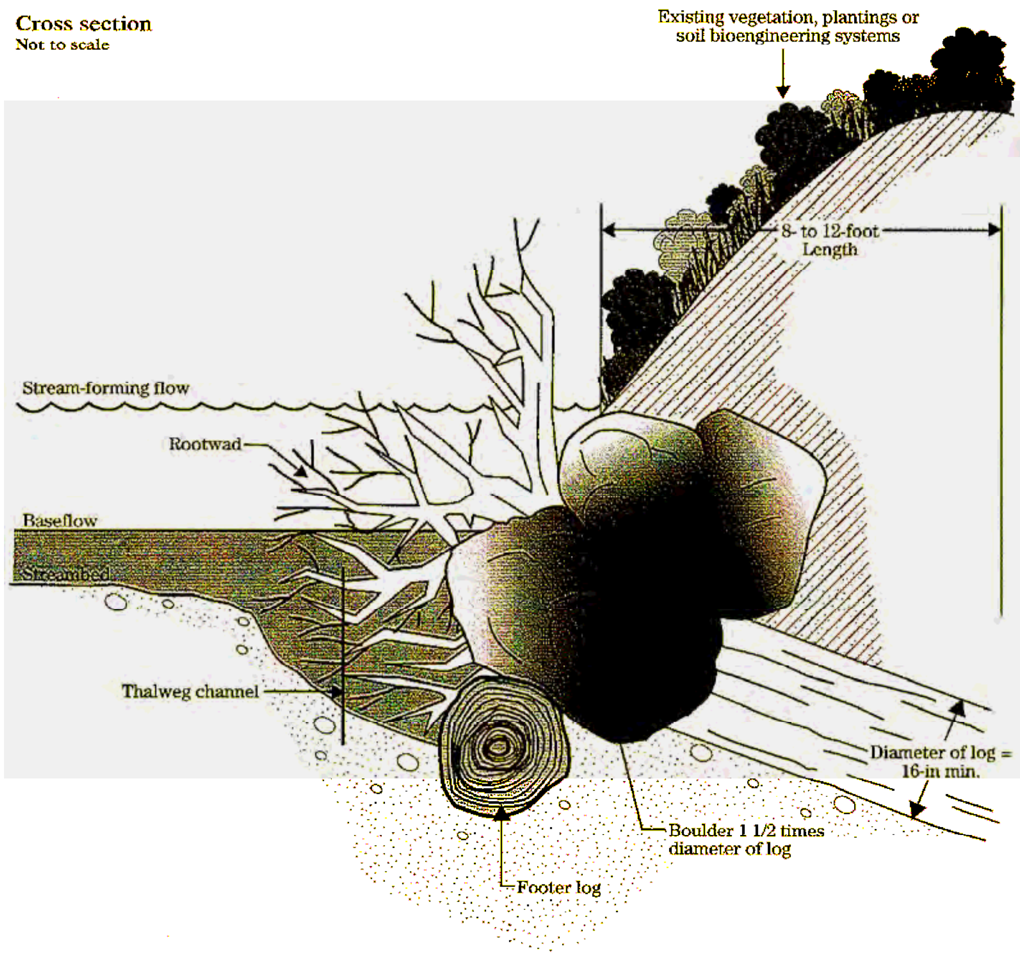
Log, Rootwad, and Boulder Revetments

These revetments are systems composed of logs, rootwads, and boulders selectively placed in and on streambanks.

Figure 14. Log, rootwad, and boulder revetment details



Discouraged Practices

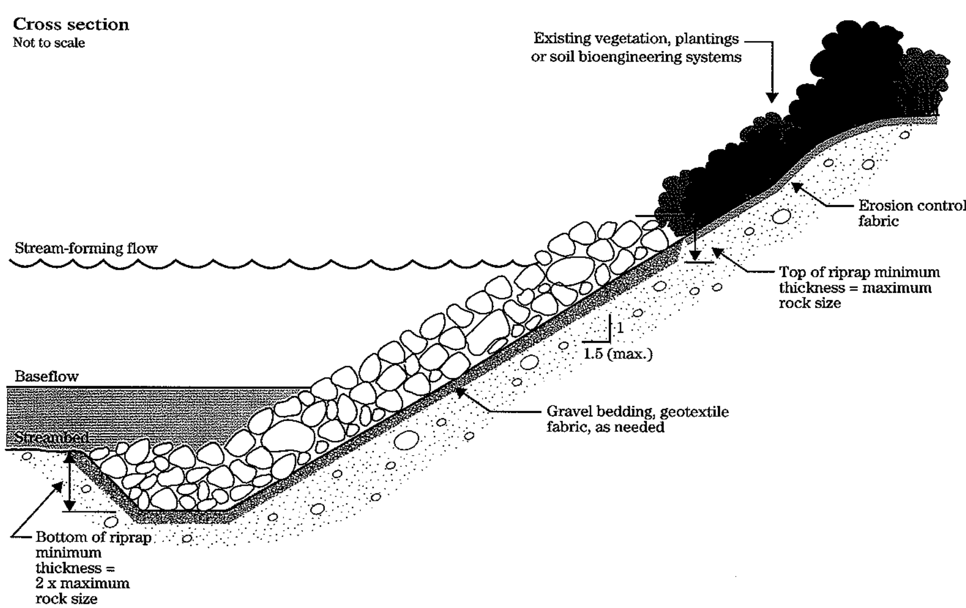
Discouraged practices are structural practices with limited or minimally functional vegetation, or no re-vegetation. These are traditional and conventional methods of hard-armoring streambanks and shorelines to address erosion problems. These methods often degrade the quality of aquatic habitat and contribute to erosion in other areas, either downstream or along other shorelines. Since newer practices are available and more contractors are familiar with better stabilization practices, the use of hard armoring is discouraged, however, there are severely eroded locations where hard-armoring is necessary.

Rock Riprap

Riprap stabilization designs should include appropriate bank slope and rock size to protect the bank from wave and current action and to prolong the life of the embankment. A final slope ratio of at least 1:2 (vertical to horizontal) is recommended, and a more stable 1:3 slope should be used where possible.

A layer of gravel, small stone, or filter cloth placed under and/or behind the rock helps prevent failure. In many cases, only the toe of the slope may need rock reinforcement; the remainder can be planted with native vegetation.

Figure 15. Rock riprap details



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Rock Gabions

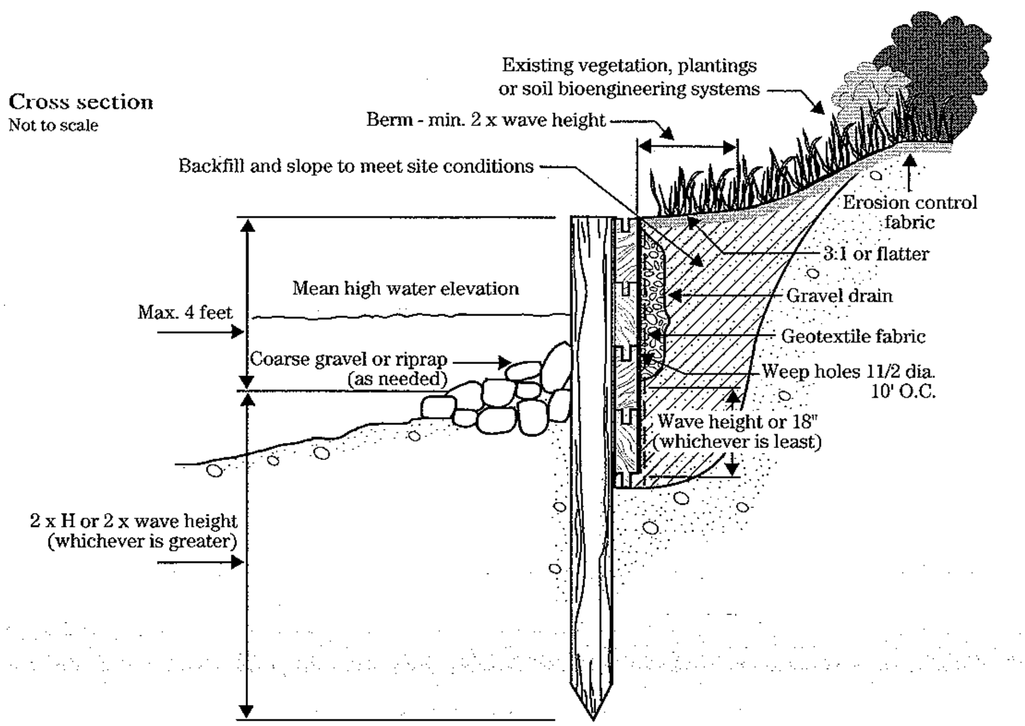
Rock gabions with vegetation are a more acceptable stabilization practice. See details for gabion baskets on page 13.

Bulkheads and Seawalls

Bulkheads and seawalls are not encouraged and generally are not approved. These structures (typically sheet steel, concrete or wood) produce a sterile, vertical, flat-faced object that is of little use to aquatic organisms and other wildlife. They also tend to reflect wave energy rather than dissipate it, usually resulting in erosion problems in front of the "fix" and elsewhere.

However, when erosive forces are severe, existing building foundations or structures are threatened, and other stabilization approaches would not be effective, a new or replacement retaining wall may be warranted. In these cases, rock should be placed at the toe to reduce the adverse impacts of reflected wave energy.

Figure 16. Timber bulkhead detail



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Summary

Streambank and shoreline work should be proposed only when a problem exists and needs fixing (i.e., to stabilize identified erosion areas) - not to decorate, landscape or reclaim land. When work is necessary, natural approaches should be considered first. **Permits and buffer variances may be required from the following agencies:**

U.S. Army Corps of Engineers
Savannah District
100 W. Oglethorpe Avenue
Savannah, GA 31401
(912) 652-5279/5770

U.S. Fish and Wildlife Service
Southeast Region
1875 Century Blvd, Suite 400
Atlanta, GA 30345
(404) 679-4000

Georgia DNR - Environmental Protection Division
Watershed Protection Branch
4220 International Parkway, Suite 101
Atlanta, GA 30354
(404) 675-6240

Georgia DNR - Coastal Resources Division
One Conservation Way
Brunswick, GA 31520
(912) 264-7218

Georgia DNR – Historic Preservation Division
254 Washington Street SW
Atlanta, GA 30334
(404) 656-2840

Local Governments (Cities, Counties)

Other Entities (Utilities, Authorities)

Please contact appropriate agencies BEFORE beginning any stabilization activities.

Additional Resources

Plants

Calculating Plant Quantities for Restoration Projects
http://www.soundnativeplants.com/calculator.htm

Sources for Native Plants and Seed
http://gnps.org/resources/Native_Nurseries.php

Streambank and Shoreline Stabilization

Guidelines for Streambank and Shoreline Restoration
http://www.files.georgia.gov/SWCC/Files/Guidelines_Streambank_Restoration.pdf

Natural Resources Conservation Service – Handbooks – Part 650 Engineering Field Handbook, Chapter 16 Streambank and Shoreline Protection
http://directives.sc.egov.usda.gov/

The Shoreline Stabilization Handbook
http://nsgd.gso.uri.edu/lcsg/lcsgh04001.pdf

Streambank and Shoreline Stabilization Guidance
http://www.gaepd.org/Files_PDF/techguide/wpb/Streambank_and_Shoreline_Stabilization_Guidance.pdf

Appendix A – Woody Plants for Soil Bioengineering and Associated Systems in Georgia

Scientific Name	Common Name	Plant Type	Region *	Establishment Speed
Acer negundo	boxelder	small to medium tree		fast
Acer rubrum	red maple	medium tree	M, P, C	fast
Alnus serrulata	smooth alder	large shrub	M, P, C	medium
Amorpha fruitcosa	false indigo	shrub	M, P, C	fast
Aronia arbutifolia	red chokeberry	shrub	M, P, C	fast
Asimina triloba	pawpaw	small tree	M, P, C	
Betula nigra	river birch	medium to large tree	M, P, C	fast
Carpinis caroliniana	american hornbeam	small tree	M, P, C	slow
Carya cordiformis	bitternut hickory	tree	P, C	
Catalpa bignonioides	southern catalpa	tree	P, C	fair
Celtis laevigata	sugarberry	medium tree	P, C	slow
Celtis occidentalis	hackberry	medium tree	P, C	slow
Cephalanthus occidentalis	buttonbush	large shrub	M, P, C	medium
Chionanthus virginicus	fringe tree	small tree	P, C	
Clethera ainifolia	sweet pepperbush	shrub	P, C	
Cornus amomum	silky dogwood	small shrub	M, P	medium
Cornus florida	flowering dogwood	small tree	M, P, C	fair
Cyrilla racemiflora	titi	small tree	C	
Diospyros virginiana	persimmon	medium tree	M, P, C	fair
Fraxinus caroliniana	carolina ash	large tree	C	fast
Fraxinus pennsylvanica	green ash	medium tree	M, P, C	fast
Gleditsia triacanthos	honeylocust	medium tree	P, C	fast
Hibiscus aculeatus	hibiscus	shrub	C	
Ilex coriacea	sweet gallberry	small to large shrub	C	
Ilex decidua	possomhaw	large shrub to small tree	P, C	
Ilex glabra	bitter gallberry	small shrub	C	
Ilex opaca	american holly	small tree	M, P, C	medium
Ilex verticillata	winterberry	small to large shrub	M, P	
Ilex vomitoria	yaupon	large shrub	C	
Juglans nigra	black walnut	medium tree	M, P	fair
Juniperus virginiana	eastern redcedar	large tree	M, P, C	medium
Leucothoe axillaries	leucothoe	small to large shrub	C	
Lindera benzoin	spicebush	shrub	M	
Liquidambar styraciflua	sweetgum	large tree	M, P, C	
Liriodendron tulipifera	tulip poplar	large tree	M, P	fast
Lyonia lucida	fetterbush	small to large shrub	C	

Scientific Name	**Common Name**	**Plant Type**	**Region ***	**Establishment Speed**
Magnolia virginiana	sweetbay	small tree	P, C	
Myrica cerifera	southern waxmyrtle	small shrub	C	slow
Nyssa aquatica	swamp tupelo	large tree	C	slow
Nyssa ogeeche	ogeeche lime	large shrub to small tree	C	medium
Nyssa sylcatica	blackgum	tall tree	M, P, C	slow
Ostrya virginiana	hophornbean	small tree	M, P, C	slow
Persea borbonia	redbay	small to large tree	C	slow
Platanus occidentalis	sycamore	large tree	M, P, C	fast
Populus deltoides	eastern cottonwood	tall tree	M, P, C	fast
Quercus alba	white oak	large tree	M, P, C	slow
Quercus laurifolia	swamp laurel oak	tree	C	fast
Quercus lyrata	overcup oak	medium tree	P, C	slow
Quercus michauxii	swamp chestnut oak	medium tree	M, P, C	fair
Quercus nigra	water oak	medium tree	M, P, C	slow
Quercus palustris	pin oak	large tree	M	fast
Quercus phellos	willow oak	medium to large tree	M, P, C	medium
Quercus shumardii	shumard oak	large tree	P, C	slow
Rhododendron atlanticum	coast azalea	small shrub	P, C	
Rhododendron viscosum	swamp azalea	shrub	P, C	
Salix nigra	black willow	small to large tree	M, P, C	fast
Taxodium distichum	baldcypress	medium tree	C	fast
Tsuga canadensis	eastern hemlock	large tree	M	slow
Viburnum nudum	swamp haw	large shrub	M, P, C	

*M=Mountain, P=Piedmont, C=Coastal

NOTE: EPD recommends that trees be planted at a density of 10 feet on center (ft o.c.) or 436 trees per acre. If planted alone, shrubs should be planted at an average density of 6 ft o.c. (1210 shrubs per acre) and groundcovers (4" containers) at an average density of 1.5 ft o.c. (19,360 containers per acre). When combined with planting trees, shrubs and/or groundcover may be planted at a density of 774 shrubs per acre and 18,150 containers per acre. Live stakes are typically planted at 2 ft o.c. Please reference http://www.soundnativeplants.com/calculator.htm for further planting density information.

Appendix B – Plants Suitable for Rooting as Cuttings (Live Stakes) in Georgia

Scientific Name	Common Name	Plant Type	Rooting Ability*	Region
Acer negundo	boxelder			M, P, C
Asimina triloba	pawpaw	small tree	poor to fair	M, P, C
Baccharis halimifolia	groundsel bush	medium shrub	good	P, C
Cephalanthus occidentalis	buttonbush	large shrub	fair to good	M, P, C
Cornus amomum	silky dogwood	small shrub	fair	M, P
Cornus sericia	red osier dogwood			M, P
Gleditsia triacanthos	honeylocust	medium tree	poor to fair	P, C
Populus deltoides	eastern cottonwood	tall tree	very good	M, P, C
Robinia sp.	black locust			P, M
Salix discolor	pussy willow	large shrub	very good	
Salix nigra	black willow	small to large tree	good to excel	M, P, C
Salix purpurea	purpleosier willow	medium tree	excel	M, P, C
Sambucus canadensis	american elder	medium shrub	good	M, P
Viburnum dentatum	arrowwood	medium to tall shrub	good	M, P, C
Viburnum lentago	nannyberry	large shrub	fair to good	M, P, C

*Rooting ability from cutting

Appendix C – Grasses and Forbs Useful in Conjunction with Soil Bioengineering and Associated Systems in the Southeast

Scientific Name	Common Name	Soil Preference	Drought Tolerance	Shade Tolerance	Flood Tolerance
Ammophila breviligulata	american beachgrass	sands	fair	poor	
Andropogon gerardii	big bluestem	loams	good	poor	fair
Arundo donax	giant reed	sandy	good	poor	poor
Herarthria altissima	limpograss	sandy	poor	poor	good
Panicum amarulum	coastal panicgrass	sands to loams	good	poor	good
Panicum virgatum	switchgrass	loams to sands	good	poor	good
Paspalum vaginatum	seashore paspalum	sandy		poor	good
Pennisetum purpureum	elephant grass			poor	
Spartina pectinata	prarie cordgrass	sands to loams	good	fair	fair
Zizaniopsis miliacea	giant cutgrass	loam	poor	poor	good

Georgia Environmental Protection Division
Watershed Protection Branch
4220 International Parkway, Suite 101
Atlanta, GA 30354
(404) 675-6240

www.gaepd.org

Georgia Soil and Water Conservation Commission
State Headquarters
4310 Lexington Road
P. O. Box 8024
Athens, GA 30603
(706) 552-4470

www.gaswcc.georgia.gov

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