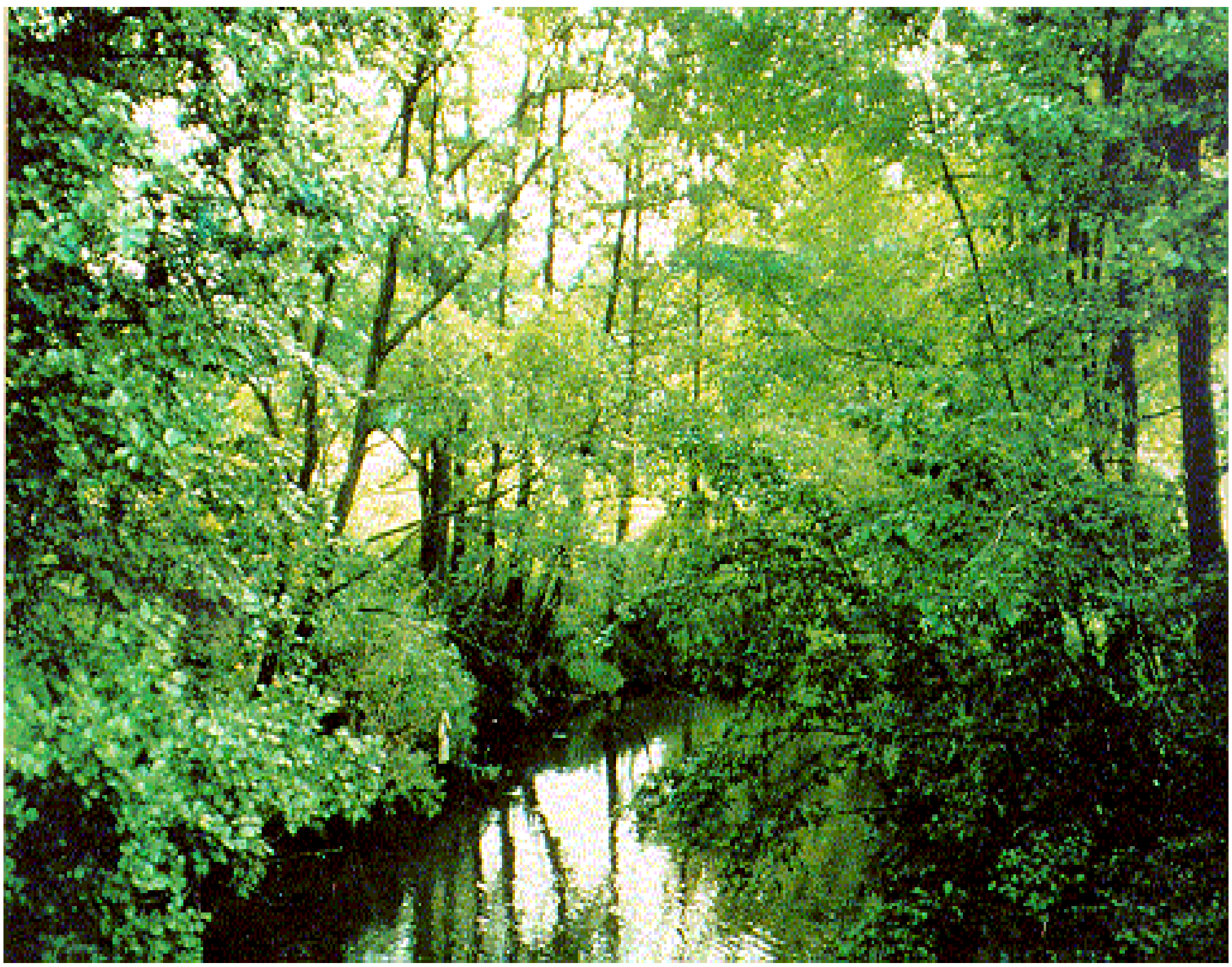
GUIDELINES FOR

STREAMBANK

RESTORATION

Revised March/2000



Developed by the Georgia Soil and Water Conservation Commission, in cooperation with Metro Atlanta Association of Conservation Districts, USDA Natural Resources Conservation Service and Georgia Environmental Protection Division. The preparation of this publication was financed through a grant from the U.S. Environmental Protection Agency under the provisions of Section 319 (h) of the Federal Pollution Control Act, as amended.

PREFACE

This booklet has been published by the Georgia Soil and Water Conservation Commission to help owners of streamside property understand how to prevent and, if necessary, correct simple streambank erosion problems. The booklet will describe the interactions of stream flows, streambanks, sediment, and streamside vegetation. An understanding of this information is intended to help a property owner appreciate the need for streambank protection and assist in selecting the most appropriate natural methods for correcting streambank erosion problems. Streambank stabilization techniques utilize live plant materials, structural measures, or a combination of both. The techniques described in this manual are intended for small stream systems with uncomplicated erosion problems.

Cover Photograph by Robbin B. Sotir & Associates.

ACKNOWLEDGEMENTS

The assistance, guidance, secretarial support, and technical consultations of Robbin B. Sotir & Associates and permission to use figures and photographs are gratefully acknowledged by the Soil and Water Conservation Commission. Gratitude is also extended to the following for their review and assistance in preparing this manual: Nelson R. Nunnally, Robbin B. Sotir & Associates, Mike Owsley, USDA Natural Resources Conservation Service; Jim Durrett, Trustee of the Georgia Conservancy; and John Gries, USDA Forest Service. Agency reviews were made by: The Atlanta Regional Commission, Georgia Cooperative Extension Service, Georgia Environmental Protection Division, Georgia Forestry Commission, and USDA Natural Resources Conservation Service.

Quotations and figures from the following publications are also acknowledged: 1) Pennsylvania Department of Environmental Resources Division of Scenic Rivers, “A Streambank Stabilization Manual” (1986); 2) North Carolina Sedimentation Control Commission, “Erosion and Sediment Control Planning and Design Manual” (undated); and 3) USDA Natural Resources Conservation Service, Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection and Chapter 18, “Soil Bioengineering for Upland Slope Protection and Erosion Reduction” (1992).

Elaine Nash and Ted Mikalsen were responsible for the overall organization and assembling of this manual.

Many people have contributed to the writing and review of this document. We would especially like to thank Donna Black, David Burgdorf, Donald H. Gray, Jim Helm, Sandie Hoover, Marian Hrubovcak, Devony Lehner, Esther Lev, Ed Moorhead, Ann Riley, Pat Stevens, and Virginia Tiernan for their contributions.

F. Graham Liles, Jr.
Executive Director
Georgia Soil and Water Conservation Commission

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BEFORE YOU BEGIN

This document was created to inform landowners of streambank property how to use ready available native plant materials to restore and repair small streambank erosion problems. These techniques are also useful in the maintenance and enhancement of streambanks, as well as preventing streambank damage. The primary emphasis of this document is on woody vegetative treatments and as such does not cover most conventional structural techniques.

If you are considering a streambank stabilization project, please read this entire booklet before you begin and consider the following general advice. Because a number of technical disciplines are involved in stream work, you may encounter terms with which you are not familiar. These are defined in the glossary of this document.

First, it is important to realize that each stream and stream segment has its own unique qualities. Before you select a streambank stabilization technique, take the time to study and understand the cause of the problem you intend to address. The types and causes of streambank erosion are described in the Streambank Erosion section.

Second, ask for advice. Contract your local Soil and Water Conser-vation District, the Georgia Cooperative Extension Service in your county, or the Natural Resources Conservation Service for more infor-mation about streambank erosion problems, stabilization procedures, and the availability of plant and structure materials. Talk to your neighbors about the erosion conditions. Frequently, it is necessary to assess a long length of stream to fully understand the problem and to develop a lasting solution.

Third, there are many state and local ordinances in addition to federal laws that may apply to your streambank stabilization project. Be sure to check with all appropriate authorities before beginning any land-disturbing activities, particularly those adjacent to or in a stream. A listing of these agencies may be found in the appendix.

Finally, consider that any work you do on a stream may affect people upstream and downstream. Your property is only a small part of the overall steam and watershed system.

If you take the time to carefully plan your project, taking into account the factors that influence the behavior of your stream, you are more likely to be rewarded by a successful solution to your streambank erosion problem.

PLANNING AND CARRYING OUT YOUR PROJECT

Careful thought, planning and execution will be required to assure that your streambank stabilization project is done efficiently and correctly. Some steps in planning and carrying out your project area as follows:

1. Identify the Cause and Nature of the Problem – Identify upstream and watershed activities which may affect stream flow, observe upstream bank conditions, consult with up and downstream neighbors to determine if they too have a problem and if they would like to participate in a repair project. Contact your Natural Resources Conservation Service office and identify the type and severity of your bank erosion problems (see section on Streambank Erosion).

2. Contact Your Local Government – Local ordinances and State laws protect vegetative buffers along streambanks from land-disturbing activities. Before beginning any work, contact your local government regarding erosion and sedimentation to determine necessary procedures for the approval of the project and obtain guidance for protecting the stream during construction.

3. Contact the US Army Corps of Engineers – (1-800-448-2402) Savannah District, Regulatory Branch, P.O. Box 889, Attention SASOP-F, Savannah, Georgia 31402-0889, to determine whether a permit will be needed for your construction activity. In most cases, minor streambank restoration is already covered by a general permit.

4. Evaluate Alternatives and Select Appropriate Streambank Erosion Protection Measure(s) – Selected erosion protection measures which may be applied to specific erosion problems are listed in order of environmental benefits in Table 4. Table 4 also references the page where the measure is described. Table 5 describes the relative cost and complexity of each measure.

5. Determine When You Will Do the Project – Some practices must be installed during the dormant season.

6. Locate Underground Services Which Could be Affected by Construction Activities – Sewer lines, underground utilities, wells, septic tanks and drainfields, etc.

7. Plan or Design Erosion Protection Measures - Using the streambank protection measures (in the following section) that you have selected, design necessary structures, and define specific techniques on a sketch of your stream and streambanks. The sketch should be of sufficient scale and accuracy to allow you to estimate the amount of materials which will be needed for the project. Be sure to include erosion control items such as silt fence and hay bales.

8. List and Acquire Materials and Necessary Tools - Estimate and develop a list of the type and number of tools required (purchase or rental) and the amount of materials necessary to protect the stream and complete the project. Determine the source of tools and materials. In some cases, you may have to locate and secure permission to harvest suitable plant materials or find a plant nursery which handles appropriate species.

9. Determine Access and Clean-up Cost – Be sure to consider access to the stream for machinery and vehicles onto your property and possibly your neighbors'. Typically, due to various site elements such as existing landscaping, irrigation systems, etc., urban sites have major access considerations. The costs for repairing construction damage also needs to be calculated.

10. Develop a Safety Plan – You may be working with power tools in wooded areas and adjacent to flowing and sometimes, deep water. Have appropriate safety devices such as goggles, leather work gloves and chaps for chain saw use. Consider insect and snake hazards, and avoid deep or stormwater flows.

11. Identify – Estimate the number of people that will be needed to complete the job, the time to complete the job, and assign responsibilities to individuals or teams.

But before you install your project, consider the following tips:

1. Be sure you have contacted the local unit of government for required permits (i.e. public works, engineering or planning and zoning offices). They can direct you to appropriate state and federal agencies if additional authorization is required.
2. Take steps to ensure that soil does not get pushed or washed into the stream during this project. Install and maintain sediment control devices where needed.
3. Start your work at the upstream end and work your way downstream.
4. Do not implement measures that restrict the size of the channel. Practices that restrict channel flow can cause flooding or increased erosion. Never plan to build out into the stream.
5. Do not use materials that may be poisonous to fish and aquatic life such as asphalt or wood treated with creosote.
6. Keep the stream channel and the banks as natural as possible to maintain habitats for fish, aquatic organisms, birds, and other animals.
7. Begin and end all streambank protection projects at stable points along the bank. This may be a point at which the main thrust of the flow is parallel to the bank, or at a stable structure such as a bridge or culvert. This may require cooperative efforts by several landowners.
8. Divert intensive sources of runoff such as gutter downspouts or street drainage away from the area to be treated and be sure to include appropriate drainage facilities for this flow.
9. Make sure you have protected the submerged part of the bank all the way to the channel bottom, and in some cases where undercutting has occurred, below the streambed. As a matter of course, it is better to start stabilization projects below the bed (bottom) of the stream; otherwise, the current may undermine the erosion control measures installed.

10. Be prepared to maintain your project. Inspect the project regularly, particularly after heavy rains and high flows, and make necessary repairs as soon as possible.

11. Reestablish streambank vegetation using native shrubs and trees.

A FEW COMMENTS ABOUT STREAMS

HOW STEAMS "BEHAVE" (Stream Dynamics)

River, stream, creek, brook, tributary, or branch — these words all mean different things to different people. Throughout this publication, the word "stream" means any continuous or intermittent flowing water — regardless of the channel size.

It is the nature of a stream to change its course, constantly shift, and meander. Erosion of streambanks is a natural part of this process by which the steam adjusts to changing conditions within the channel and its watershed. If you try to interfere with this process, you will be in a long-term battle against the natural tendency of the stream to move and change. However, because of man's development, especially in urban areas, this process may be accelerated.

The shape of the stream channel is a result of the flow of the water, the sediment carried, and the composition of the streambed and streambank materials. A stream channel must simultaneously accommodate the flow and carry its sediment load within the streambanks. The stream forms a continuous system of pools, riffles, bars, and curves to absorb the energy of the flow. See Figure 1. The adjustments a stream makes create a balance between the amount of water flowing in the channel, the amount of sediment it is transporting through the channel, and the changing slope and size of the channel. The erosion of channel bends along outside banks is usually offset by deposition along inside banks.

Streams are rarely perfectly straight. What appears to be a "straight" stream is in reality made up of small curves not easily recognized. Flowing water has a natural tendency to meander from one side to of a channel to the other, and soil, sand, and gravel are washed away from the areas where the current is fastest and deposited where the water moves more slowly.

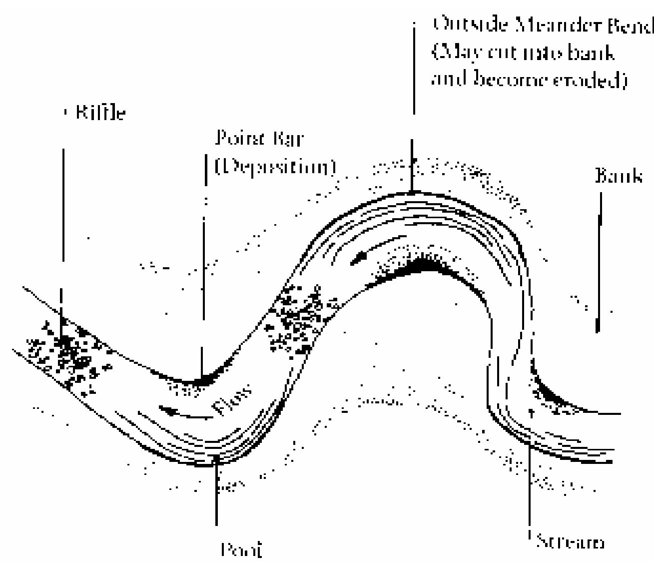

Figure 1 Illustration of streambank erosion and deposition.

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Changes in stream flow, sediment load, and erosion or deposition on the streambanks will cause the stream to seek a new balance. Increasing paved areas or removing vegetative ground cover in the watershed will reduce the infiltration of rainfall and cause more runoff from the land. This leads to higher stream flows with an increased capacity to scour streambeds and undercut streambanks. Soil erosion from adjacent lands will cause increased sediment build up if the stream flow is insufficient to carry the load of soil (sediment) along the stream.

For those of you who live in urban or suburban areas, it is likely that your stream channel has or is in the process of adjusting to increased runoff by eroding deeper and/or wider. Many urban streams which have eroded their banks so that the channel can carry greater flows will have lost the streamside vegetation that helps control bank erosion.

Fish and Wildlife Habitat Values of Streams

A healthy aquatic population in a stream depends on maintaining a variety of suitable habitats, adequate food supply, and clean water. Fish and the aquatic organisms on which they feed require a mixture of habitats such as fast-flowing riffles, deep pools cool water, rocks, snags, and overhanging vegetation. Streamside vegetation is important to wildlife because it provides a food supply, shade to cool the water, and cover for roosting, resting, nesting, and protection.

Stream Vegetation Zones

Different natural vegetation zones adjacent to the stream should be considered when selecting an appropriate streambank stabilization technique. The typical natural zones of a stable streambank community are shown in Figure 2. These vegetation zones are distinguished by site conditions such as shape, steepness, soil make-up of the bank, variations in stream water depth, duration of flow, bank seepage, and flow rate.

Figure 2 Photograph of the vegetated zones in a healthy diverse riverine system.

STREAMBANK EROSION PROCESSES AND TYPES

This section describes streambank erosion processes, common types and causes of erosion and guidelines for evaluating streambank and streambed erosion problems.

Streambank Erosion Processes

Streambank erosion is a natural process that occurs when the forces of flowing water exceed the ability of the soil and vegetation to hold the banks in place. Natural rates of streambank erosion vary with stream size, the amount of vegetative cover, and the type of soil in the streambank. Under well-vegetated conditions, the smallest streams (those without any tributaries) may show little evidence of erosion over periods of several decades unless subjected to extreme flood events. Large streams, on the other hand, often show evidence of noticeable erosion, especially on outside bends. The forces that cause erosion increase during flood events, and most erosion occurs at these times. Human disturbances to watersheds that increase frequency and magnitude of runoff events also increase streambank erosion. Human disturbances include logging, mining, agriculture, and urbanization. Typical urban or suburban developments which may impact a stream include houses, garages, parking lots, and walkways, including areas cleared of forest and replaced by tailored lawns.

Loss of streambank and streamside vegetation reduces the resisting forces and makes streambanks more susceptible to erosion. This is often the single greatest contributing factor to harmful or accelerated erosion on small and medium-size streams. Streambank vegetation may be removed intentionally for various reasons, or its loss may be inadvertent due to trampling by animals or humans.

The erosive ability of a stream is a function of velocity, flow depth, and slope. Therefore, on small streams, erosion is largely a function of the size and frequency of storm flows. Small watersheds may have a tendency for very "flashy" flows that move stormwater quickly through the channel. Watershed changes that increase the size of floods and frequency of flooding, such as deforestation, agriculture and urbanization, are major contributors of streambank and streambed erosion. Woody bank vegetation helps reduce flow velocity in the vicinity of the bank. Thus, loss of woody vegetation increases the potential for streambank erosion. Channel modifications for flood control, drainage, or other purposes often increase stream energy enough to cause widespread erosion problems, especially if soils are easily erodible.

The resistance to erosion provided by soil depends on its cohesiveness and texture. Sandy soils have low cohesion, and particles are small enough to be moved by flows with velocities of one or two feet per second. Lenses or layers of erodible soil material are frequently susceptible to erosion problems. Fines are selectively removed from cohesionless soils that are heter-ogeneous mixtures of sand and gravel, leaving behind an armor of gravel that protects the streambed against further erosion. Deeply rooted bank vegetation, especially woody vegetation, develops a network, which increases resistance to erosion by adding strength to the bank materials.

If your stream has been straightened and widened (channelized), the stream channel will probably be making changes to recreate the shape and slope it used to have before it was changed (modified). It is not uncommon for the upper or middle reaches of these modified streams to erode because the straightened channel has increased the velocity of the stream flows. In the lower reaches of these modified streams it is common for the channel to fill up with sediment because the greater upstream flows and velocities are carrying more sediments downstream. If the channel is eroding, you can slow the stream velocities and rate of erosion by planting shrubs, trees, and other plants. If the channel is filling with sediments, one possibility for helping correct that is to make the channel narrower using plants and other means. Ask local experts for advice in this case.

Some common problems creating streambank erosion are logs, shopping carts, or debris jams which deflect flows off banks. One of the most useful activities a property owner can be involved in is organizing your up and downstream neighbors to remove these obstructions. This will reduce potential bank erosion problems and increase the capacity of your stream channel to carry storm flows without over topping. Channel constrictions caused by rocks, old tires, cars, oil drums, etc. cause erosion up and downstream.

Some Common Types of Streambank and Streambed Erosion and Their Causes

Common types of streambank and streambed erosion problems and their causes are described below and summarized in Table 1. These are photographically illustrated in Figure 3.

General bank scour

General bank scour is widespread erosion of streambanks caused by excessive velocities. General scour of streambanks usually is confined to banks composed of easily eroded, unconsolidated material (such as sand) lacking adequate vegetative cover. Streambanks covered with a thick sod or with brushy vegetation seldom experience widespread scour, except during major flooding. Extensive reaches of exposed soils on sloping banks may be evidence of general scour.

Toe erosion and upper bank failure

Undercutting or removal of toe support usually leads to failure of the upper bank. Undercutting is the major cause of bank erosion or failure on the outside of meander bends. Bank failures attributable to loss of toe support are often identifiable by their characteristic nearly vertical slopes which lack vegetation. If the area is accessed soon after failure, you would notice the presence of failed masses of bank materials in the stream, and the location of the thalweg near the failed bank. The thalweg is the thread of deepest, fastest flowing water. Streambank degradation as described above can be responsible for erosion also.

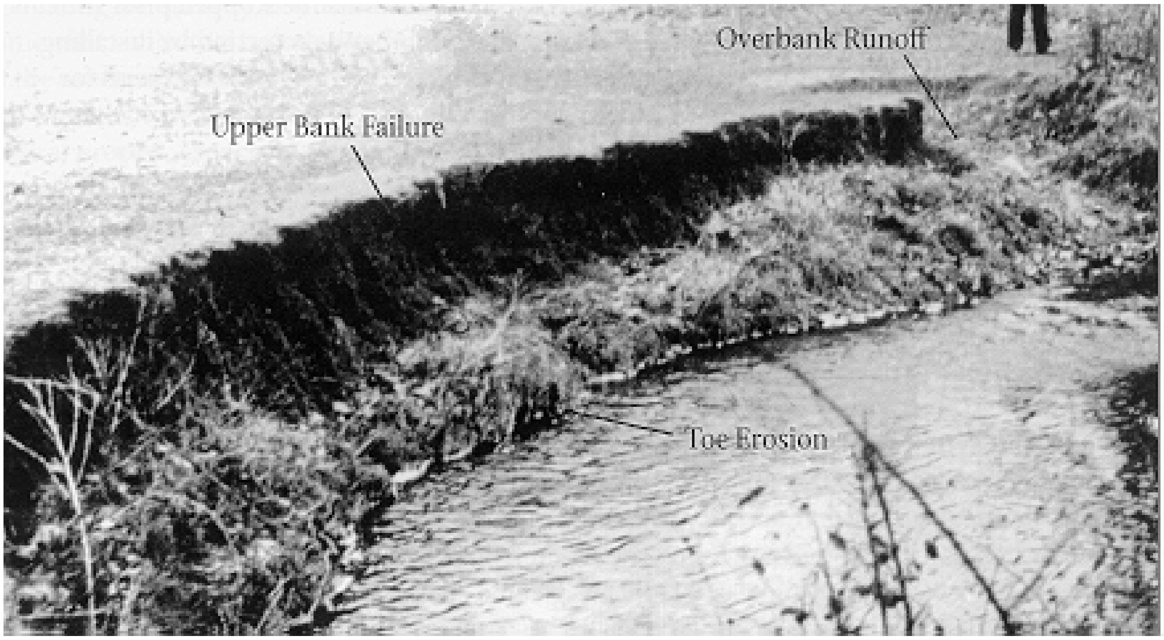
Local streambank and streambed scour

Localized scour is observed when isolated sections of eroding banks are found within otherwise stable reaches. Local bank scour may be associated with the presence of sand or other highly erodible material that is unable to maintain long term vegetative cover. Channel constrictions and flow obstructions may produce secondary currents that scour bed and banks.

TABLE 1
EROSION TYPES AND CAUSES

Type of Erosion	Causes
General bank scour	Increased discharge resulting from watershed changes; increased flow velocities caused by reduction in channel roughness or increased gradients; removal or loss of bank vegetation.
Toe erosion and upper bank failure	Removal of unconsolidated or loose lower bank materials, especially along outside bends. Widespread toe erosion may be associated with bed lowering
Local streambank and streambed scour	Scour of local lenses or deposits of unconsolidated material; erosion by secondary currents caused by flow obstructions and channel irregularities; loss of bank vegetation. Local bed scour may be caused by channel constrictions and flow obstructions. Some bed scour generally occurs below culverts.
Overbank runoff	Failure to provide adequate means of directing concentrated flows from overbank areas into the channel.

Adapted from Nelson R. Nunnally



Toe erosion, upper bank failure and overbank runoff.

Figure 3 Local streambed scour, note undercutting of the vegetation.

Photographs by Robbin B. Sotir & Associates

Bed scour is indicated by the presence of a hole (an area in the bed of a stream which has deepened due to a local increase in flow, increased flow velocity or the presence of secondary currents created by obstructions to flow).

Widespread erosion of the streambed that progressively lowers (deepens) the bed is referred to as bed degradation. This condition typically can not be handled by a single landowner since it most often results from watershed changes such as development which lessens water infiltration due to an increase in paved areas or open areas. Rainfall moves more rapidly to the stream channel increasing the size and frequency of runoff events. Streambed degradation also results from channel modifications that increase flow depths and/or slopes. To identify a degrading channel look for exposed foundations of bridge piers and drops of a foot or more at the downstream ends of culverts. A general absence of sediment in the creek bottom and lack of vegetation on the lower streambank may be evidence of general bed degradation. Bed degradation must be stopped prior to installation of streambank protection by installing structures in the bed. Again, ask local experts for advice in this case.

Overbank Runoff

Surface runoff coming from lawns, streets, parking lots, etc. can flow over the streambank and cause erosion problems. Overbank erosion is usually indicated by gully-like scars in the streambank.

Evaluating Streambank Erosion Problems

Whether an eroding bank needs to be repaired or protected from additional erosion depends on several factors, including type, extent, severity, and location of the erosion. Streambanks that appear to be well vegetated are usually stable. However, often banks that appear to be unstable and eroding are actually relatively stable. Differentiating between stable and eroding banks involves careful observation and evaluation of evidence about bank conditions. General conditions frequently associated with stable and eroding banks are summarized in Table 2.

TABLE 2
GENERAL CONDITIONS
FREQUENTLY ASSOCIATED WITH STABLE AND ERODING BANKS

Characteristic	Stable Bank	Eroding Bank
Bank slope	**1H to 1V (Horizontal to Vertical) or** flatter; may be stepped or benched with vegetated berm at toe	often vertical or near vertical; may have mass of sod or other failed material at toe
Bank cover	may have variety of vegetation growing on slope, including ferns or moss	general absence of vegetation
Trees	often has trees growing on bank or on the bed at toe	standing live or dead trees inside the bank line, often leaning toward channel; fallen trees may obstruct flow
Bankline	relatively uniform or smoothly curving	irregular, sometimes with scalloped appearance
Sediment	sediment located in bars; bars may be partially stabilized by vegetation especially along bank toe	entire bed may be covered with sediment, bars not stabilized

Adapted from Nelson R. Nunnally

Evaluating the severity of streambank erosion is a somewhat subjective task that may involve the amount or the rate of erosion, relative location of the problem, and even the type of erosion involved. Erosion is a natural process, especially on sinuous or winding streams, and several feet of streambank erosion in a bend, or meander, might be no cause for concern. But, if erosion threatens structures such as bridges, roads, or homes; causes loss of valuable land; causes sedimentation that damages fish spawning grounds; or is in a highly visible location it might be considered severe. Table 3 provides some general guidance for establishing severity, but it should be used with considerable discretion.

TABLE 3
GENERAL GUIDANCE
FOR ESTABLISHING SEVERITY OF EROSION

Degree of Erosion	Characteristics
Stable to Mild	Little or no evidence of erosion; if eroding banks are present, they are small in extent (linear extent less than average bank height) and rates are modest (less than ½ foot per year); greater erosion may be tolerated at bends if it causes no associated problems.
Moderate	Extent of problem or rate of erosion exceeds criteria for stable class, but is less than severe.
Severe	Erosion covers large area of blank (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.

From Robbin B. Sotir & Associates

MANAGING STREAMBANK EROSION

Managing streambank erosion problems is less expensive than repairing damage from erosion. It is important to take steps to prevent streambank erosion problems from occurring. Preservation and protection of the native streamside vegetation community is an important key to streambank protection.

Since woody vegetation usually is the best streambank stabilizer, every effort should be made to maintain existing trees and shrubs. These plants will lessen the impact of rain directly on the soil, will trap sediment from adjacent land and will hold the soil in place with their root structures thereby, forming a root mat that stabilizes and reinforces the soil on the streambank. Plants also enhance the appearance of the stream and serve as wildlife habitat. Trees provide additional benefits by shading the stream to maintain the lower summertime water temperatures which are necessary for a healthy aquatic population. They prevent the stream channel from being choked by sun loving vegetation like rushes and reeds.

Here are some practical measures that can protect streambanks from erosion:

Maintain an Undisturbed Buffer Zone at least 25 Feet Wide (from the top of the bank back) on Both Sides of the Stream. This area needs the protection of a permanent vegetative cover. Where adjacent slopes are steep, a wider corridor of woody plant and shrubs is appropriate.

Restrict the Operation of Heavy Machinery, Construction, Animal Grazing, and Other Intensive Activities within the Buffer Zone. These activities compact the soil, decreasing infiltration, percolation, and soil aeration that leads to destruction of plants and plant habitat. Increased runoff and sedimentation are likely results.

Wise Management Practices for Agricultural and Forestry Activities. In agricultural areas, adopt practices such as con-servation tillage, contour cultivation, etc. to prevent erosion on cropland. Maintain an undisturbed riparian corridor of woody vegetation (filter strip) next to the stream. Keep livestock off the streambanks. Fencing can be used t o prevent livestock from damaging streambanks. Best management practices manuals are available from the Georgia Forestry Commission and the Georgia Soil and Water Conservation Commission.

Plant Vegetation. Where existing vegetation is sparse, planting site-specific native plants can be less expensive, offer higher survival rates, and give more protection than ornamental or non-native plants. Native self-maintaining perennial species can be selected and planted using the guidelines in this booklet.

Do Not Straighten Channels. This procedure, although it is quick and easy, is almost never effective in controlling erosion. Past experience has shown that channel straightening will simply change the location and nature of the erosion problem and will usually make the problem worse due to increased velocity and downstream impact.

PROTECTING STREAMBANKS AGAINST EROSION

This section discusses a number of approaches to protecting streambanks, list steps and considerations in planning and carrying out streambank stabilization projects, and describes some types of streambank erosion control measures.

Approaches to Streambank Protection

Streambank stabilization measures work either by reducing the force of flowing water, by increasing the resistance of the bank to erosion, or by some combination of both. Generally speaking, there are four (4) approaches to streambank protection: 1) the use of vegetation; 2) soil bioengineering; 3) the use of rock work in conjunction with plants; and 4) conventional bank armoring. Re-vegetation includes seeding and sodding of grasses, seeding in combination with erosion control fabrics, and the planting of woody vegetation (shrubs and trees). Soil bioengineering systems use woody vegetation installed in specific configurations that offer immediate erosion protection, reinforcement of the soils, and in time a woody vegetative surface cover and root network. The use of rock work in conjunction with plants is a technique which combines vegetation with rock work. Over time, the plants grow and the area appears and functions more naturally. Conventional armoring is a fourth technique which includes the use of rock, known as riprap, to protect eroding streambanks. This document emphasizes the use of woody vegetative techniques, therefore conventional armoring will not be covered here.

Revegetation measures may suffice if the stream is small, the bed is stable, and banks are not seriously eroded (see Table 2-3). These relatively low cost procedures can usually be accomplished by a homeowner.

A range of effective soil bioengineering re-vegetative measures may be used to solve common streambank erosion problems. These techniques are relatively inexpensive, can be implemented by landowners, provide environmental benefits such as habitat for fish and wildlife, and are aesthetically pleasing. When appropriately used and properly installed and maintained, vegetative systems usually provide the best and longest erosion protection. However, care must be taken to understand, design, and properly install these systems, some of which should be installed during the vegetation's dormant season (approximately November to March in Georgia).

Soil Bioengineering Erosion Control

This material is meant to be utilized as general information to better understand the merits of woody plant soil bioengineering systems. It is intended to better acquaint the reader with the "tools" of the technology and the terms. The systems described may be useful for small, simple problems where installed with appropriate guidance from knowledgeable professionals.

For soil bioengineering repairs, it will be necessary to locate and seek permission to cut native vegetation which roots easily from cuttings. A few examples of such vegetation are privet, willow, hawthorn, viburnum, and dogwood. Areas which frequently have such material are typically found in wetlands, sewer line easements, gravel pits, retention ponds, or along other stretches of stream. For the highest success rate, these need to be selectively harvested in the dormant season (November to March) and installed within a day or two. See Appendix I, Plant List for Unrooted Cuttings at the back of this document. These cuttings are typically combined with supplemental rooted plantings. A listing of these may also be found at the back of this document.

Woody vegetation

Shrub dogwoods, alders, and willows, (Banker's dwarf willow, Streamco purpleosier willow, black willow, sandbar willow, meadow willow, heart-leaved willow, and Ward's willow), can be put into the soil either as cuttings or as nursery-grown seedlings. In dense shade, shrubs such as silky dogwood or evergreen ground covers such as Hall's honeysuckle are appropriate. Silky dogwood also does well in sunny and shady areas. See Appendix I for common and associated botanical names. It is important to remember that plant cuttings must be used during the dormant season (approximately November to March in Georgia), and seedlings should be planted in early spring or late fall. Planting willows harvested from a nearby area with soil and moisture conditions similar to the problem area will help increase their survival. Collect willows during the dormant season, and when storing or transporting the plans keep them cool and slightly moist. When purchasing rooted stock from a nursery, select native species to enhance survival, and decrease competition from other plants. Plant them as soon as possible. Alders should be nursery-grown seedlings one to two years old.

Nutrient testing

The streambank soils should be tested for nutrients. Fertilizer and limestone should be incorporated into the soil when necessary. When fertilizer is applied on the surface, it is best to apply about one-half at planting, one fourth when new growth is about two (2) inches tall, and one-fourth about six (6) weeks later. Split applications of fertilizers will reduce the potential for nutrient losses into the stream.

Soil samples

Take at least two (2) soil samples in two (2) different locations at approximately six (6) inches below the surface. In a long reach, a soil sample should be taken every one hundred (100) feet. Ask the laboratory to recommend rates to improve the soil conditions if fertilizers are needed to improve fertility for pioneer woody plants. Your local nursery will also be helpful. The Georgia Cooperative Extension Service, universities, and private laboratories do such tests. Be sure to check on time frames and costs.

Bank preparation

Typically, the eroded streambank will need to be graded back prior to the installation of the soil bioengineering systems. See Figure 4 for horizontal to vertical bank configurations.

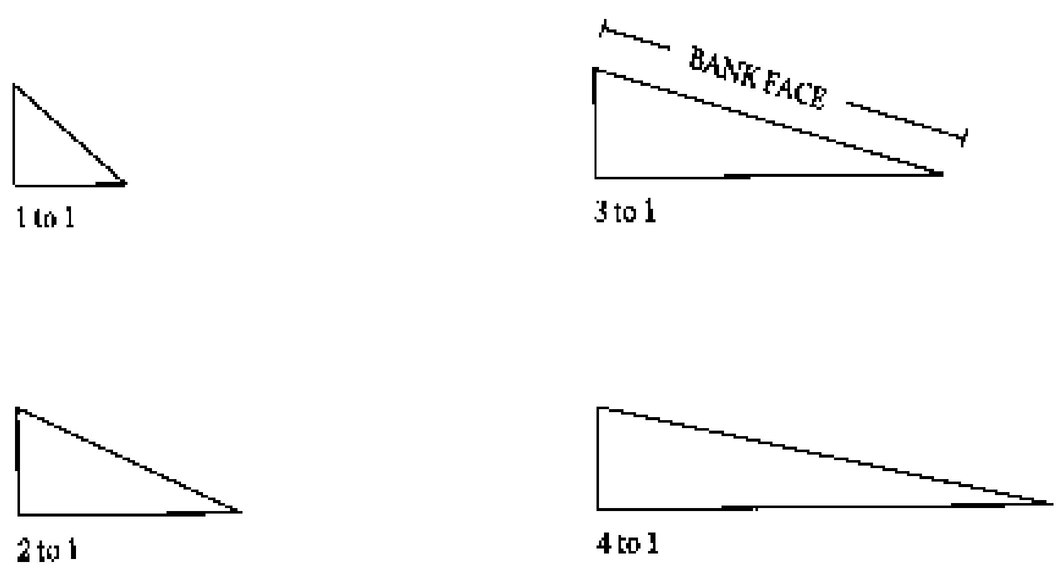


Figure 4 Illustrating different horizontal to vertical bank face configurations.

TABLE 4
SELECTED EROSION PROTECTION MEASURES FOR STREAMBANKS

Erosional Problems	Streambank Protection Measures Ranked by Environmental Benefits	Page No.
General bank scour	1. Brushmattress 2. Live fascine 3. Live staking 4. Joint planting	27 21 16 19
Toe erosion and upper bank failure	1. Live cribwall 2. Brushmattress with rock toe 3. Joint planting	31 27 19
Local streambank scour	1. Branchpacking 2. Live cribwall 3. Live fascine with erosion control fabric 4. Joint planting	35 31 21 19
Overbank runoff	Intercept and divert runoff and repair damage with : 1. Branchpacking 2. Live Fascine 3. Live staking with erosive control fabric	 35 21 16

Adapted from Robbin B. Sotir and Associates

TABLE 5
STREAMBANK EROSION PROTECTION MEASURES RELATIVE COSTS AND COMPLEXITY

Measure	Relative Cost	Relatively Complexity
Live stake	Low	Simple
Joint planting	Low*	Simple*
Live fascine	Moderate	Moderate
Brushmattress	Moderate	Moderate to Complex
Live cribwall	High	Complex
Branchpacking	Moderate	Moderate to Complex
Conventional vegetation	Low to Moderate	Simple to Moderate
Conventional bank armoring (riprap)	Moderate to High	Moderate to Complex

Assumes rock is in place. ***From Robbin B. Sotir and Associates***

Live Stake

Description

Live stakes are living, woody plant cuttings capable of rooting with relative ease. Willow species work best for this system. The cuttings are large enough and long enough to be tamped into the ground as stakes. They are intended to root and grow into mature shrubs that, over time, will serve to stabilize the soils and restore the riparian zone habitats. When first installed, they offer no immediate stabilization to the streambank. See Figures 5 through 8.

Advantages

- This is an effective stabilization and re-naturalization method for simple, or small problem sites.
- This technique is effective when construction time is limited and an inexpensive and simple method will handle the repair.
- Live staking is an effective system for securing natural geotextiles (erosion control fabrics) such as jute mesh, coir or other blanket surface treatments.

Live Materials

- The cuttings must be freshly cut and alive, with side branches removed, and with bark intact. They must be taken from species that root easily from cuttings, such as willow.
- The basal or butt ends (the end of the cutting closest to the ground) should be cut cleanly at an angle to facilitate easy insertion into the soil. The top should be cut square or blunt for tamping.
- Cuttings must be fresh and must be kept moist after they have been prepared into appropriate lengths.
- The live stake cuttings shall be prepared from 0.5 to 2-inch diameter stock. They work best when they are 2 to 3 feet in length.

Installation

- The cuttings should be tamped into the ground at right angles to the slope and angled downstream. They should be tamped into the ground carefully for approximately 4/5 of their length. A dead blow hammer works best to tamp the live stakes into the ground.
- Stakes should be spaced so that there are 2 to 4 cuttings per square yard. They should be placed in a random configuration to prevent gullies from forming and to produce a more natural effect in the re-vegetation area.

Tips for Success

- Care must be taken to ensure that the live stakes do not become stripped during the removal of the side branches and during actual installation. Cuts should be done with a saw rather than an ax.
- Install the live stakes the same day they are prepared.
- Start the installation at the water's edge and work up the bank.
- Cuttings that split or become "mushroomed" during tamping should be replaced.
- It is important to foot compact around each live stake after it has been installed.
- Install the cuttings right side up. Be sure that the buds are pointing upward.
- It is best when the slope has been graded back to at least 2H (Horizontal) to 1V (Vertical) or flatter when room is available.
- Erosion control fabrics can greatly enhance soil stabilization and in this case the live stakes can be used to secure down the fabric.

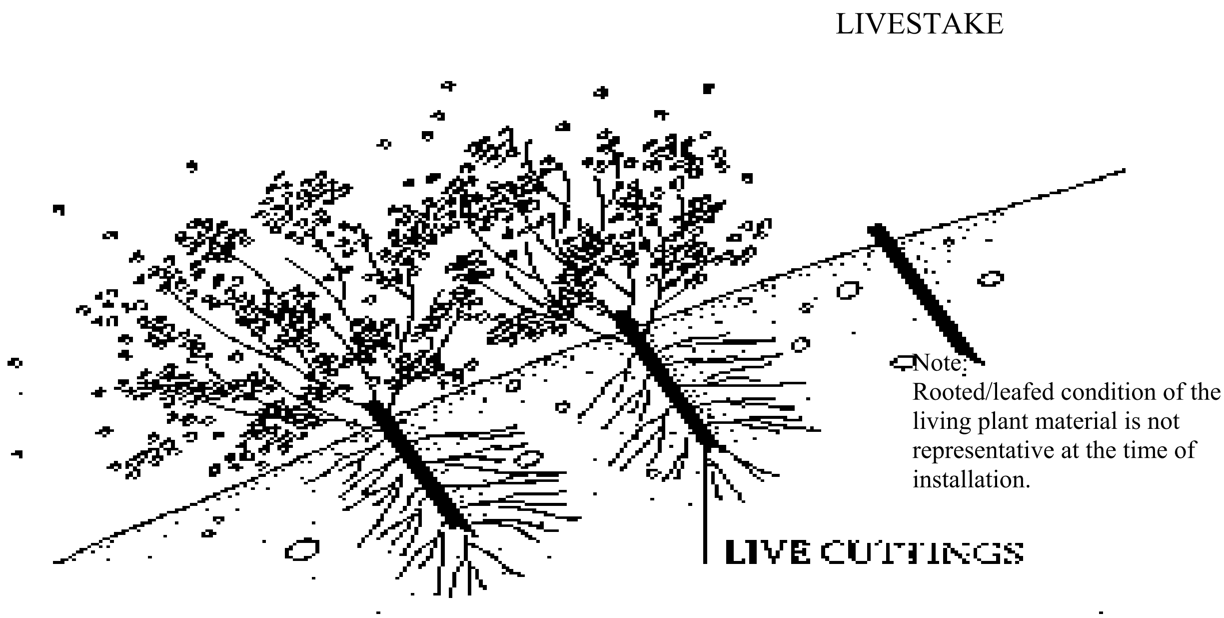


Figure 5 Illustration of a live stake. *Robbin B. Sotir & Associates*

Figure 6 A prepared livestake. *Photograph by Robbin B. Sotir & Associates*

Figure 7 Installation of a live stake.

Figure 8 Live stake after 2 years of growth. *Photographs by Robbin B. Sotir & Associates*

Joint Planting

Description

Joint planting is a system that installs live willow stakes (as previously described) between rock placed previously along the streambank. It is intended to increase the effectiveness of the rock system by forming a living root mat in the base upon which the rock has been placed and to improve the environmental function and aesthetics of the rocked bank. The rock needs to be loosely dumped or hand placed and no thicker than 2 feet. This is an excellent method to combine soil bioengineering with conventional systems. See Figures 9 through 11.

Advantages

- A joint planting system is typically used with a previously installed conventional riprap rock bank. It will enable a streambank to become naturalized.

- This system assists in dissipating energy and causes deposition to occur along the streambanks, thus developing a more natural look and function over time.

- Joint planting provides shade over water, thus reducing the temperature of the stream and making it more suitable for aquatic habitat.

Live Materials

- The cuttings must be freshly cut and alive, with side branches removed and with bark intact. They must be taken from a species that roots easily from cuttings.

- The basal ends should be cleanly cut at an angle, for easy insertion into the soil. The top should be cut square or blunt for tamping. Cuttings must be fresh and must be kept moist after they have been cut into appropriate lengths.

- The cuttings shall be 1 to 2 inches in diameter. They work best when they are 3 to 3.5 feet in length.

Installation

- At least two thirds of the length of t he live stake needs to be in the ground below the previously placed rock layer. A dead blow hammer works well to tamp the live stakes into the ground.

- The density of the installation generally ranges from 3 to 5 cuttings per square yard (slightly higher than for live stakes alone). The survival rate is usually a little lower in this system, due to the possibility for dryness and to the difficulty of getting the living unit installed deep enough.

- The stakes should be placed in a random configuration for a more natural effect, and better function.

Tips for Success

- The live stakes should be installed the same day they are prepared.

- The rock needs to be loosely dumped or hand placed and no thicker than 2 feet.

- Cuts should be done with a saw rather than an ax.

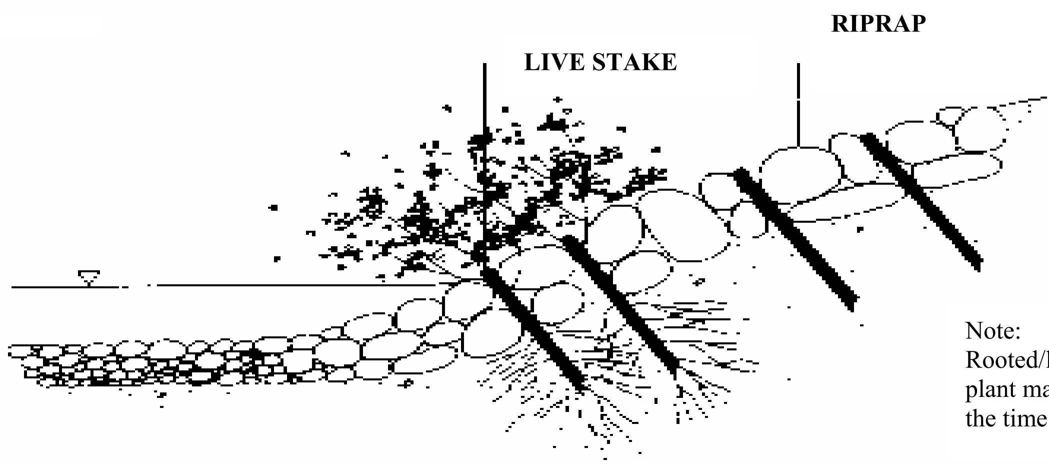
- Start the installation at the water's edge and work up the bank.

- It may be difficult to install live stakes in old riprap since the base will be very compacted. A pipe or rod can be used to make a pilot hole for the live stakes. After the rod has been driven in it must be carefully removed so as not to over enlarge the hole. You may want to add soil to the spaces around the rock.

- Replace any cuttings that split or lose their bark layer during tamping or that develop mushroom-like tops.

- Install the cuttings with the buds pointing upward.

JOINT PLANTING



Note:
Rooted/leafed condition of the living plant material is not representative at the time of installation.

Figure 9 Illustration of joint planting *Robbin B. Sotir & Associates*

Figure 10 ***Installation of a live stake in joint planting*** **Photograph by Robbin B. Sotir & Associates**

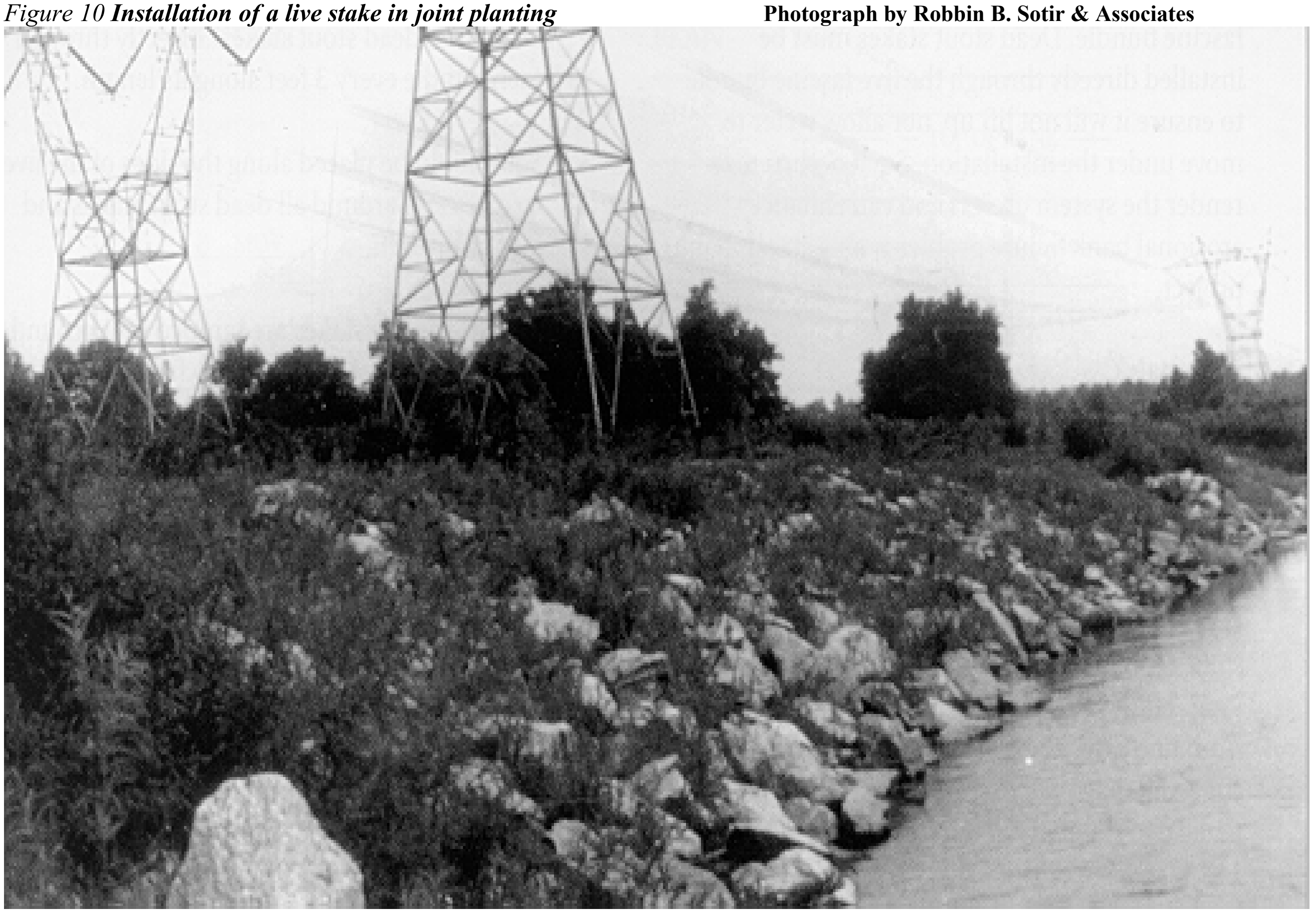


Figure 11 Joint planted bank after 2 years of growth. *Photograph by Robbin B. Sotir & Associates*

Live Fascine

Description

Live fascine structures are sausage-like bundles of live cut branches. Willow makes the best live fascines. They are placed into trenches along the streambank. Live fascine bundles are installed with live stakes and dead stout stakes. Successful use of live fascines requires careful assessment of site conditions, knowledge of installation procedures, and proper maintenance. See Figures 12 through 18.

Advantages

- This method offers reasonably inexpensive and immediate protection from erosion when properly used and installed.

- They are installed shallowly and create very little site disturbance as compared to other systems.

- The live fascines tend to break up the bank length into a series of shorter slopes separated by benches and serve to slow surface water flows and allow for more infiltration on droughty sites;

- Live fascines are capable of holding soil on the face of the streambank. They work especially well when they are combined with a surface cover such as jute mesh or coir fabrics.

  - Live fascines provide surface stability and connecting support for the invasion of the surrounding aquatic, riparian, or upland slope vegetation.

Live Materials

- Live cuttings are placed in bundles and tied together. Live stakes are tamped in with a dead blow hammer on the downslope of the live fascine bundle.

Dead stout stakes must be installed directly through the live fascine bundle to ensure it will not lift up, nor allow water to move under the installation. Such occurrences render the system useless and can enhance erosional bank failure problems on a streambank project.

Dead Materials

- Natural, undyed baling twine is used to tie the live fascine bundles together.

- Dead stout stakes (see Figure 13) are used to secure the live fascines. They should be fabricated in the following manner. The dead stout stakes should be a minimum of 30 to 36 inches long. These are cut to the appropriate length from untreated 2x4 lumber. Each length shall be cut again diagonally across the 4 inch face, to make two stakes from each length (see Figure 14). The diagonal cut begins and ends 1/8 to ¼ inch from the edge of the piece so the finished stake will have a 1/8 to ¼ inch tip.

Installation

- The slope should be graded back to a 3H (Horizontal) to 1V (Vertical). See Figure 4 and Table 6.

- Live fascines are installed in shallow trenches that usually are a shovel deep and a shovel wide.

- Place live fascine bundles into the trenches.

- Drive the "dead stout stakes" directly through each bundle every 3 feet along its length.

- Soil should be placed along the sides of the live fascines and around all dead stout stakes and foot tamped in.

- Finally, the live stakes are tamped into the ground on the downslope sides of the live fascine bundles, halfway between each of the dead stout stakes.

Tips for Success

- These systems are installed shallowly and may dry out and become damaged over periods of drought. However, if they are well installed, they will act mechanically even if they do not grow.

- Be sure the bundles are well secured to the ground so that water cannot wash the soil out from under the live fascine bundles. This would preclude rooting and mechanical effectiveness as well.

- Use on banks with a face length of 15 feet or less.

- Be careful not to completely bury the live fascine. You should be able to see the top edge of the branches in the trench, given that the soil is adequately worked into and around the live fascine bundle.

TABLE 6

RECOMMENDED SPACING FOR LIVE FASCINES
(Measured Along the Bank Face)

Slope Steepness	Undisturbed Erosive Soils	Undisturbed Cohesive Soils	Fill Soils
3H to 1V or flatter	3' – 5'	5' – 7'	*3' – 5'
Steeper than 3H to 1V (up to 1H to 1V)	3'	3' – 5'	-0-

**not recommended along – use with erosion control fabrics*

From Robbin B. Sotir and Associates

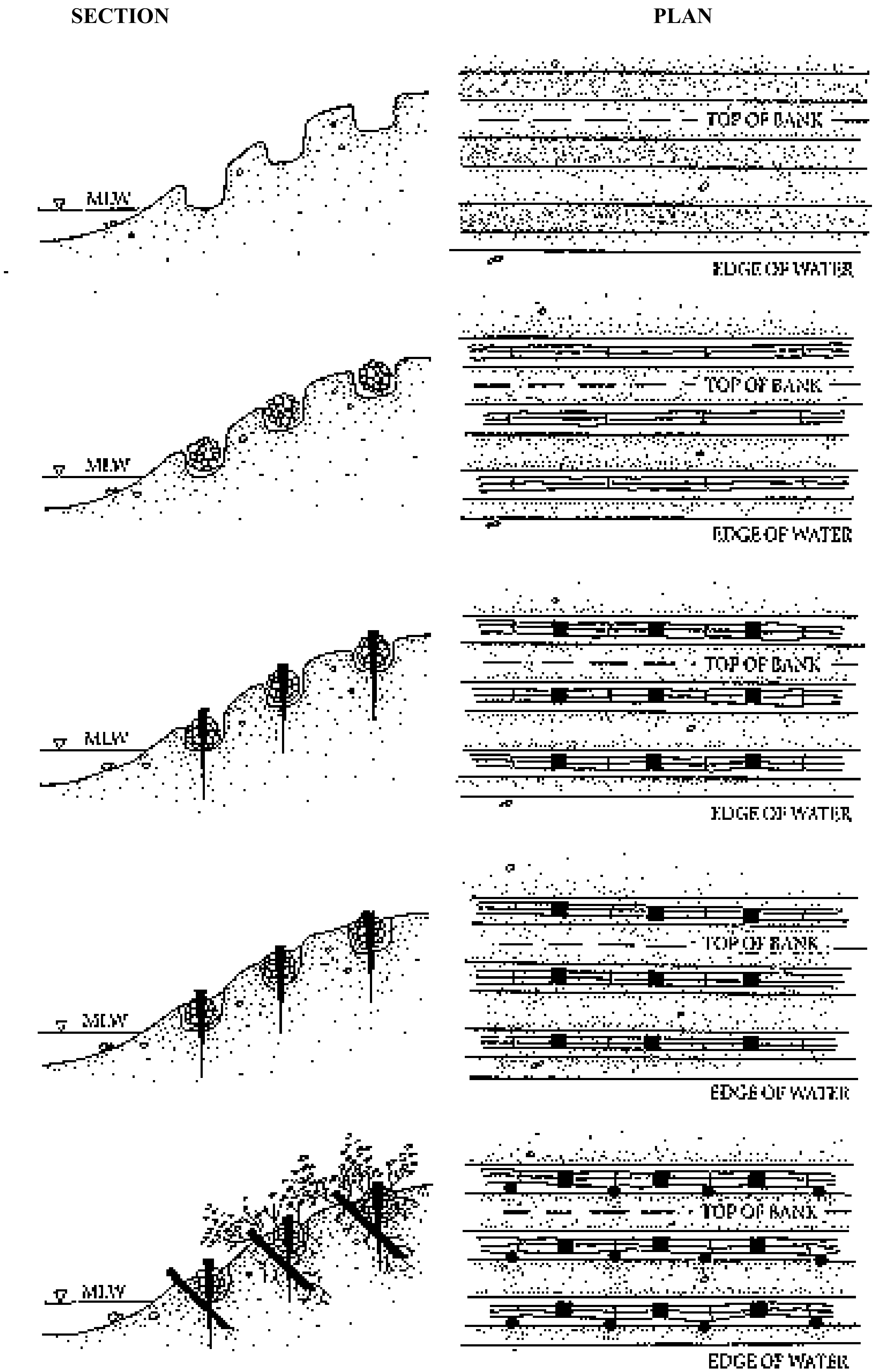
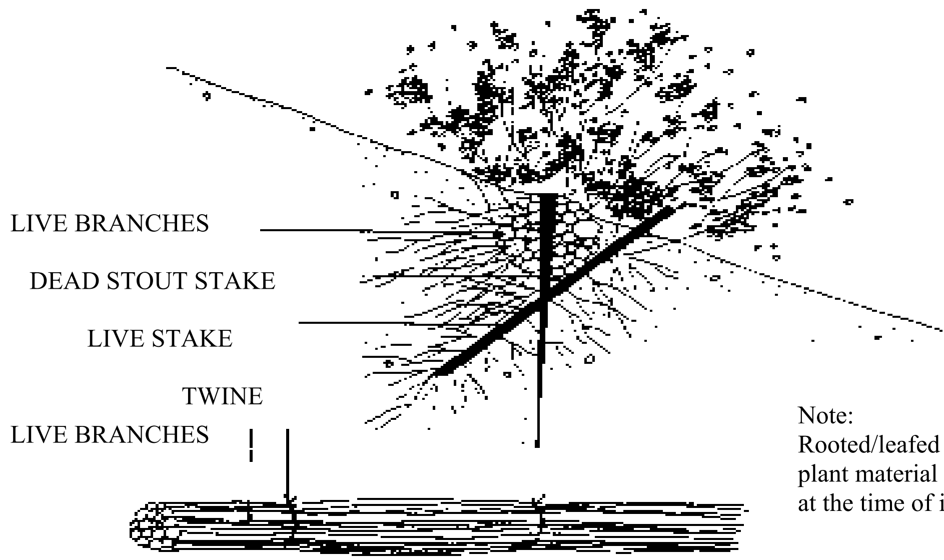


Figure 2 Live fascine installation procedures ***Robbin B. Sotir & Associates***

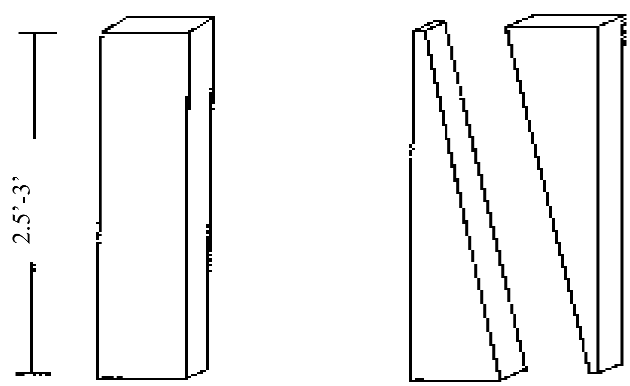
LIVE FASCINE



Note:
Rooted/leafed condition of the living plant material is not representative at the time of installation.

Figure 13 Illustration of a live fascine. *Robbin B. Sotir & Associates*

DEAD STOUT STAKE



Saw 2 x 4 timber diagonally to produce 2 Dead Stout Stakes.

Figure 14 Illustration of a dead stout stake ***Robbin B. Sotir & Associates***

Figure 15 Live fascine fabrication

Figure 16 Trenches being dug for live fascine installation, on a prepared bank.

Photographs by Robbin B. Sotir & Associates

Figure 17 Initial step in live fascine Installation

Figure 18 Live fascine in the second growing season.

Photographs by Robbin B. Sotir & Associates

Brushmattress

Description

The brushmattress is a combination of living units that forms an immediate, protective surface cover over the streambank. The living units used are as follows: live stakes, live fascines and a mattress branch cover. Brushmattress systems require a great deal of live material. They are all intended to root and grow to stabilize the bank soil. This is a more complicated and expensive system to evaluate, design, and install. See Figures 19 through 23.

Advantages

- This installation produces an immediate surface protection against floods.

- Brushmattress installations are able to capture sediment during flood conditions and assist in the rebuilding of the bank.

- They produce habitat rapidly and assist in enhancing the wildlife habitat value. They work well and quickly develop a healthy riparian zone.

Live Materials

- Cuttings must be taken from species that root rapidly and have long flexible branches.

- The branches are used in 3 ways:
  1. Live stakes – See Live Stake
  2. Live fascines – See Live Fascine
  3. Brushmattress – Long flexible branches placed against the bank surface.

- Live branches and live stakes for this installation should be .5 to 1 inch in diameter.

Dead Materials

- Undyed natural twine for bundling the live fascines.
- Wire to tie down and secure the branch mattress against the bank face.
- Dead stout stakes (see Figure 14) to secure the live fascines and branch mattress in place.

Installation

- The slope shall be machined back and carefully shaped to a 3H (Horizontal) to 1V (Vertical) or flatter. In very tight areas where space is limited and the soils are stiff (such as clays), it is possible that the bank can be steepened to a 2H (Horizontal) to a 1V (Vertical). See Figure 4.

- Beginning at the base of the slope, excavate the trench for the live fascine bundle installation, and place the live fascine directly into the excavated trench. Tamp live stakes and dead stakes over the slope face in a square pattern.

- Place the basal ends of the brushmattress at the base of the slope under the live fascine and the growing tips towards the top. The branches should lie smoothly against the bank.

- Drive dead stout stakes directly through the live fascine bundles.

- Wire down the mattress branches as close to the slope face as possible using the live and dead stout stakes and cover with soil.

Tips for Success

- Water must not drain over the bank through the installed brushmattress. This would cause gullies to form easily because the branches are placed up and down the slope.

- This system must be installed on a smoothly graded bank.

- It is important that the branches not be held under tension as this would raise the branches off the slope face.

- Be sure that after the brushmattress has been covered with soil, the branches are visible. Do not bury.

- Use on banks with a face length of 10 feet or less.

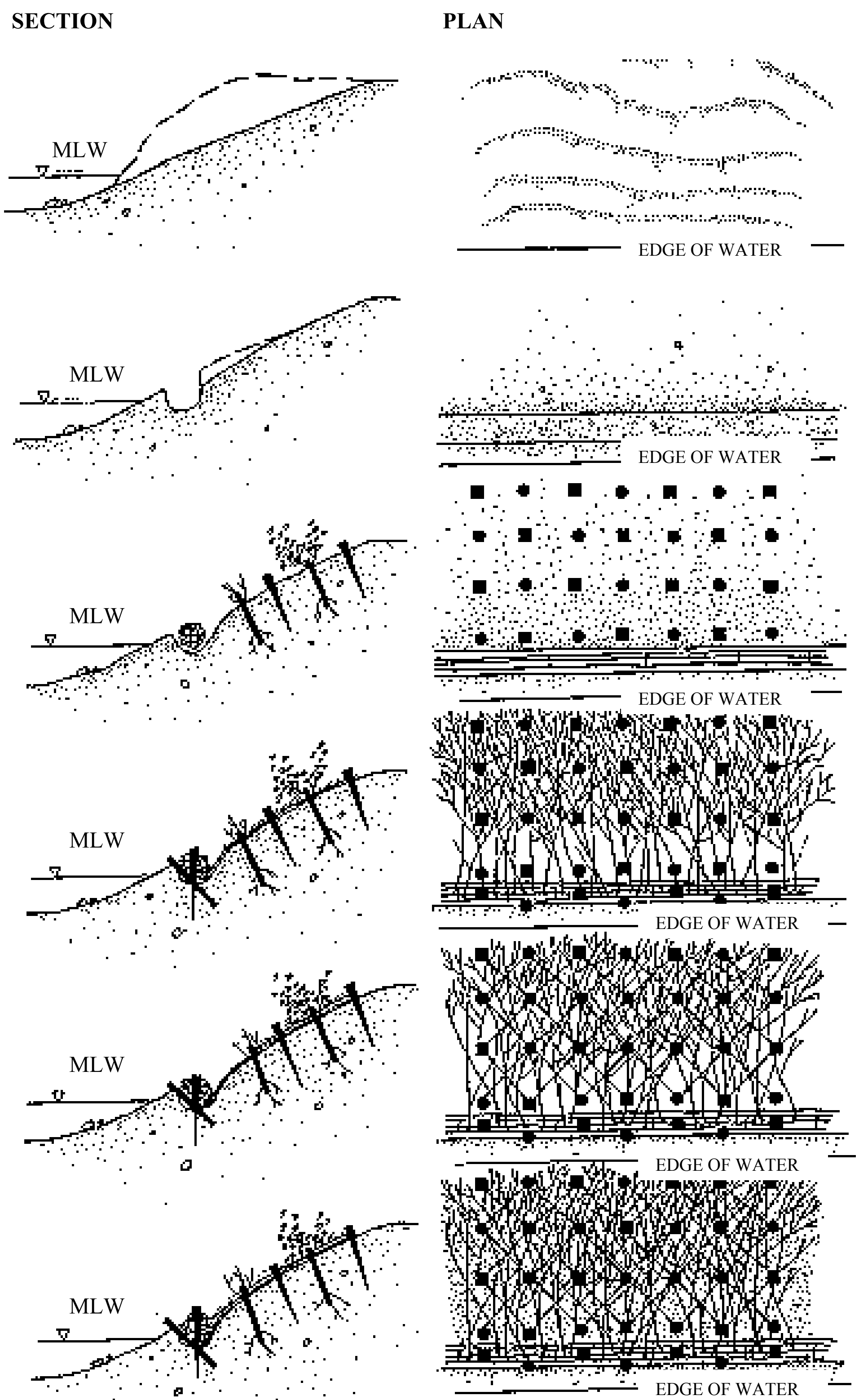


Figure 19 **Brush Mattress installation procedures.** ***Robbin B. Sotir & Associates***

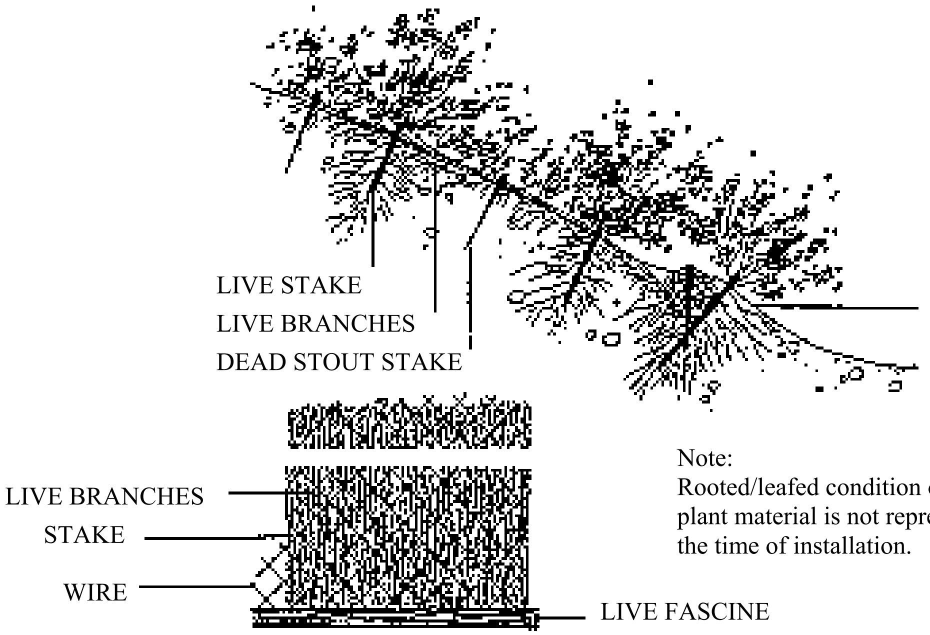


Figure 20 Ilustration of a brushmattress. *Robbin B. Sotir & Associates*

Figure 21 Brushmattress installation on a previously prepared 3H to 1V slope.

Photographs by Robbin B. Sotir & Associates

Figure 22 Brushmattress growth after 2 months.

Figure 23 Brushmattress growth after 2 years.

Photographs by Robbin B. Sotir & Associates

Live Cribwall

Description

A live cribwall installation is a rectangular framework of logs or timbers, rock, and woody cuttings that can protect an eroding streambank. These systems require a great deal of assessment and understanding of stream behavior. These can be complicated and expensive systems if you do not have a supply of wood and some volunteer help to install it. See Figures 24 through 28.

Advantages

- This system develops a natural streambank or upland slope appearance after it has begun to grow.

- These installations provide excellent habitat for a variety of fish, birds and animals.

- Live cribwalls are very useful where space is limited on small, narrow stream corridors.

Construction Guidelines

- The live cribwall system should be built during low to normal flow conditions.

- Construction is simplified by diverting flow from the construction site with berms or barriers.

Live Materials

- Live branches required for the installation should be .5 to 2 inches in diameter and 4 to 6 feet long.

Dead Materials

- 4 to 6 inch diameter or logs or timber in varying lengths are required.

- Fill material must drain well and must be capable of supporting plant growth.

Installation

- Excavation two (2) to three (3) feet below the surface of the streambed or bottom is necessary for live cribwall installation.

- First, place the long parallel and short right angle logs or timbers in the bottom of the excavation, all the way to the back of the bank.

- Secure the logs or timbers with nails or rebar at each crossing point. Fill with 2 to 4 inch rock and compact.

- Place the next layer of logs and stone fill. Continue until rock is above mean low water level (MLW). Above MLW fill with soil.

- Place the live brushy branches on the fill with the growing tips towards the stream and the basal ends oriented towards the slope. They should protrude from the front of the live cribwall construction.

- Continue with the logs or timbers, fill material, and brush placement to the top of the live cribwall and slope.

- The final layer should reach the top of the original bank. The wooden crib system should not protrude into the stream but rather be flush with the existing bank face on either side.

Tips for Success

- Live cribwall installations can fail if they are not placed on a competent foundation. These systems must be installed well into the bed to prevent washouts from occurring at the toe.

- The upstream and downstream ends are also prone to scour, and must be well keyed into the bank where they start and finish.

- Use in an area with a bank height of 4 feet or less.

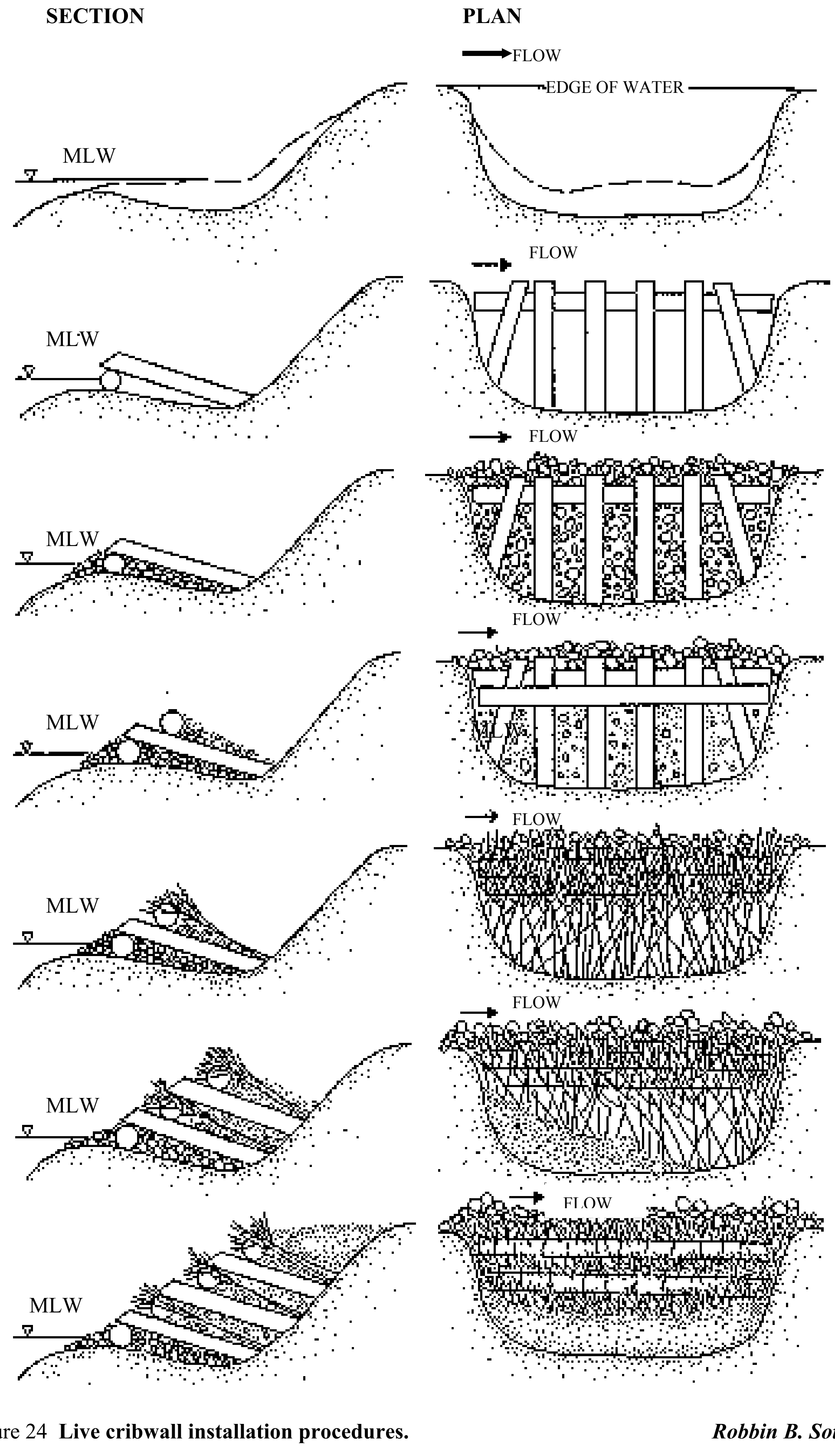


Figure 24 **Live cribwall installation procedures.** ***Robbin B. Sotir & Associates***

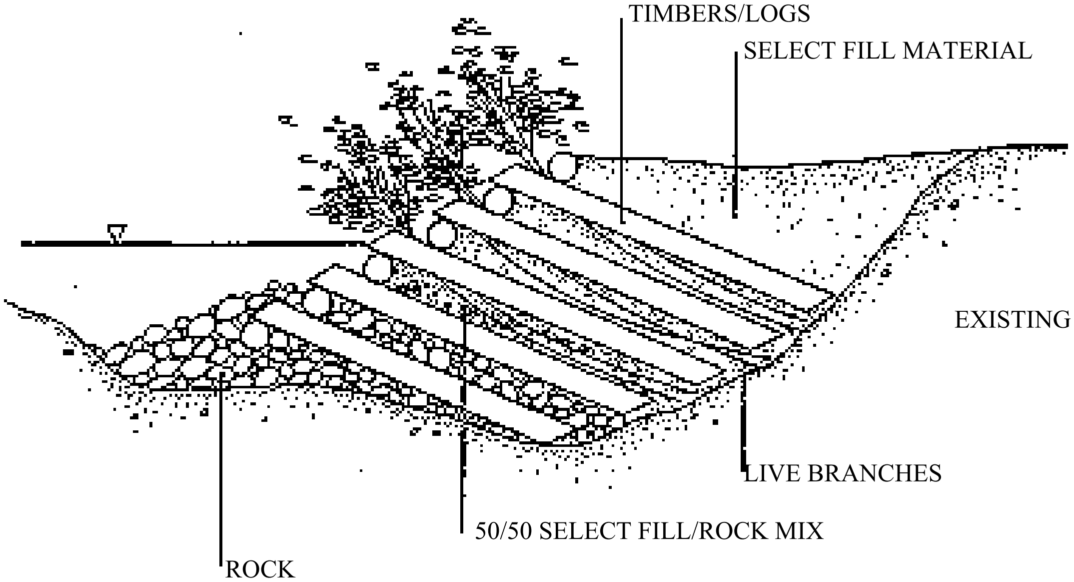


Figure 25 Illustration of a live cribwall. *Robbin B. Sotir & Associates*

Figure 26 Rock placement into the bottom of the structure.

Photograph by Robbin B. Sotir & Associates

Figure 27 Brush and wooden member placement.

Figure 28 Completed frontal view of the live cribwall.

Photographs by Robbin B. Sotir & Associates

Branchpacking

Description

Branchpacking is the process of alternating layers of live branches and soil, incorporated into a hole, gully or slumped out area in a slope or streambank. It has some similarities to a live cribwall in terms of branch orientation. The branches root to form a permanent reinforced installation, while the tips produce vegetative top growth that is intended to slow runoff and reduce erosion. This system offers a moderate to complex level of difficulty for construction. See Figures 29 through 34.

Advantages

- The branchpacking installation produces an immediate filter barrier, reducing scouring conditions, repairing gully erosion, and providing habitat cover and bank reinforcement.

- Branchpacking is one of the most effective and inexpensive methods for repairing holes in earthen embankments along small stream sites.

Live Materials

- Live cuttings, which root readily, are required.

- They should be .5 to 2 inches in diameter and 3 to 5 feet long.

Dead Materials

- Poles or timbers, such as 2 x 4 or 4 x 4, should be 5 to 8 feet long, depending on the specific site requirements.

- Backfill is used in between the layers of the brush.

Installation

- Starting at the lowest point, clean out the bottom and be sure it slopes towards the bank.

- Drive the poles or timbers vertically into the bottom of the washout approximately 4 feet deep and 1 foot apart.

- A thick layer of live branches is installed with the growing tips of the branches oriented toward the stream. The branches are placed in a fan-like and criss-cross fashion.

- The first layer of branches is followed by a mixed layer of rock and backfill.

- Each successive layer of branches should be followed by a layer of backfill. Compact the backfill thoroughly between each layer, until the top of the bank has been reached.

Tips for Success

- The system must be well compacted between each layer of branches and between the branches to prevent the soil from being washed out and to enhance the opportunity for rooting.

- The branches must be very brushy to be most effective.

- It is important to keep the branchpacking installation even with the existing bank and not allow it to protrude into the stream.

- Use on areas up to 4 feet high and 4 feet wide.

- The living branches must reach the back and sides of the repair site.

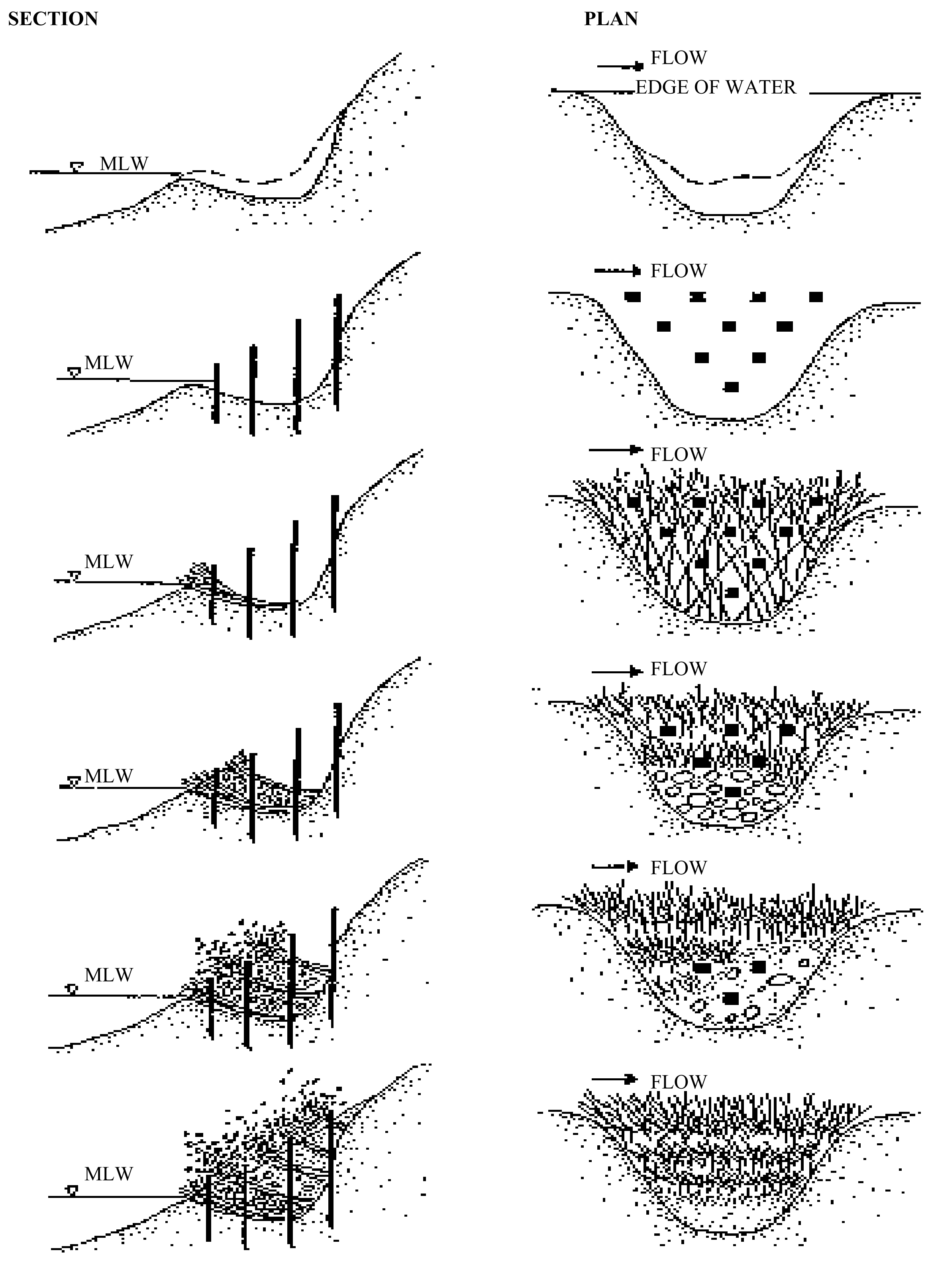


Figure 29 **Branchpacking installation procedures.** ***Robbin B. Sotir & Associates***

BRANCHPACKING

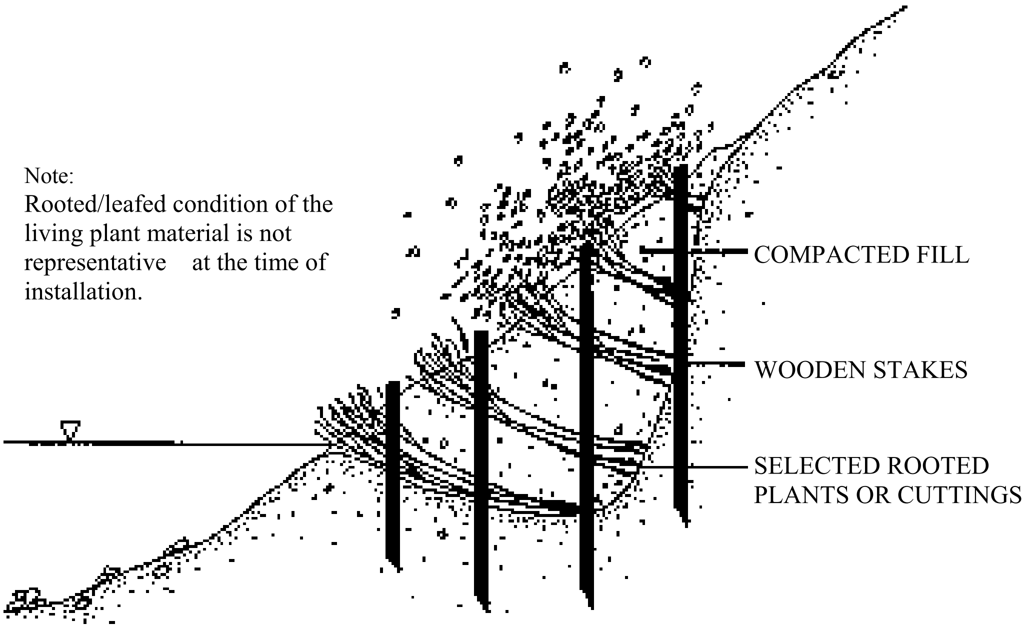


Figure 30 Illustration of branchpacking. *Robbin B. Sotir & Associates*

Figure 31 Excavating out the bottom in preparation for the installation.

Photograph by Robbin B. Sotir & Associates

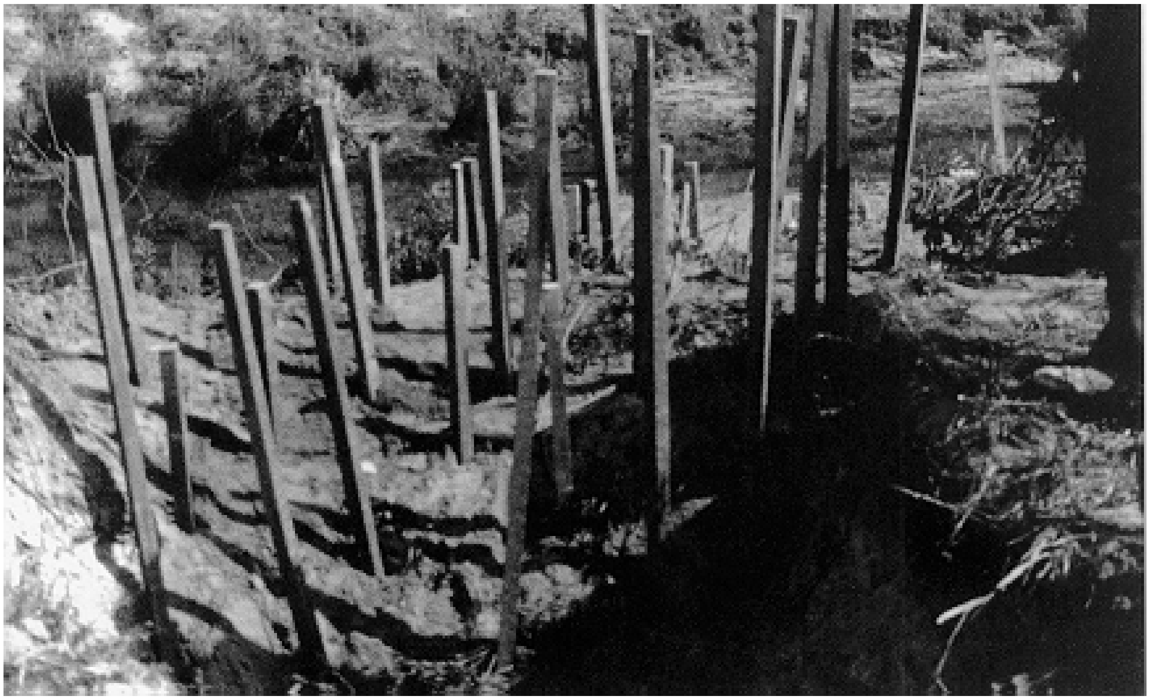


Figure 32 Illustrating the fill material and wooden placement.

Figure 33 Illustrating the branch fan-like criss-cross placement/configuration.

Photographs by Robbin B. Sotir & Associates

Figure 34 Example of a healthy 1 year old branchpacking structure

Photograph by Robbin B. Sotir & Associates

Maintenance of Vegetative Practices

Vegetated streambanks are always vulnerable to damage and repairs may be needed periodically. Check the banks after every high-water event, fixing gaps in the vegetative cover at once with structural materials or new plants, and mulching if necessary. Fresh cuttings from other plants on the bank may be used, or they can be taken from mother-stock plantings.

Other Structural Measures

There are many structural measures forstreambank protection that are not covered in this document for various reasons. Some, such as rock riprap, concrete bank paving, gabions, and drop structures used to control bed degradation, are intended for use where special problems or constraints exist. If you think your problem is larger or complex enough to need one of these alternatives, you are advised to contact your local Natural Resources Conservation Service office or Soil and Water Conservation District for advice prior to proceeding. These kinds of designs usually require detailed analysis by a professional and should be designed and installed by persons experienced in their use.

Many manufacturers produce a variety of materials intended for use in erosion control and streambank protection. Some of these products may be suitable for your needs and might provide cost effective alternatives where vegetative solutions are not preferred. It would be impractical to describe all of these materials, and any selective examples might be misinterpreted as an endorsement of those proprietary systems.

GLOSSARY

Alluvium – Sediment deposited by flowing water.

Bar – A bed form that is created by deposition of sediments and which extends above water at low flow.

Berm – A bench or terrace within a stream channel. Berms can be erosional or depositional features.

Dead Blow Hammer – A hammer filled with lead shot or sand.

Deposition – The accumulation of soil particles on the channel bed and banks.

Dormant Season – The time of year when plants are not growing and deciduous plants shed their leaves.

Duration of Flow – Length of time a stream floods.

Entrained – Picked up by flowing water.

Filter Strip – A strip of vegetation left undisturbed along a stream to prevent erosion and promote sediment deposition.

Flow Rate – Volume of flow per unit time. Usually expressed as cubic feet per second.

Meander – A broad, looping bend in a stream channel.

MLW – Mean Low Water.

Native Vegetation – Vegetation that is indigenous to our area and adapted to local conditions.

Non-cohesive – Friable, loose, or lacking internal strength.

Lenses – Non continuous layers of alluvium surrounded by alluvium of a different character.

Pool – A topographical low in the stream that is produced by scour and that generally contains fine-grained sediments.

Riffle – A topographical high area in a channel created by the accumulation of relatively coarse grained sediments.

Rill Erosion – Removal of the soil particles from a streambank slope by surface runoff moving through relatively small channels.

Riparian Buffer – An undisturbed, vegetated strip of land adjacent to a water course.

Riprap – Rock used to protect streambanks from erosion.

Riverine – The corridor or area along or near the banks of a river, stream, creek, etc., which have been produced by the waterway and is influenced by it.

Scour – The erosive action of flowing water that removes and carries away material from the streambed and banks.

Seepage – Groundwater emerging on the face of the streambank.

Secondary Currents – Currents that flow at an angle to the main downstream flow direction. Secondary currents are caused by channel restrictions and obstructions to flow.

Select Fill Material – Soil which is to be used for installation around the live cut plant materials. It should be natural and capable of supporting plant growth, and typically is mixed with fertilizer to improve its nutrient quality for the successful rooting of the live cuttings.

Sheet Erosion – The removal by surface runoff of a fairly uniform layer of soil from a bank slope.

Sinuous – Refers to a meandering or winding stream configuration.

Slump – The mass movement of soil, similar to a landslide. Bank failure is a type of slump.

Thalweg – A line connecting the deepest points along a channel.

Toe – The break in the slope at the foot of a bank where the bank meets the streambed.

Unconsolidated – Friable or loose material lacking internal cohesion.

Velocity – (Average Mean Velocity) Speed of the water typically measured in feet per second.

Watershed – The area that contributes runoff to a stream.

Wise Management Practice – Land treatments and land uses that enhance water quality most by reducing pollutant and sediment loads.

APPENDIX

PLANTS SUITABLE FOR USE AS UNROOTED (HARDWOOD) CUTTINGS

Species	Region	Tolerance To Flooding	Tolerance To Drought	Tolerance To Deposition	Tolerance To Shade
Acer negundo Boxelder	C,P,M	H	H	H	L
Baccharis halimifolia Groundsel bush	C,P (lower)	M	M	H	L
Cornus amomum Silky dogwood	P,M	L	M	L	M
Cornus sericia Ssp. stolonifera Red osier dogwood	P,M	L	M	H	M
Crataegus sp. Hawthon	C,P,M	M	H	L	L
Populus deltoids Eastern cottonwood	C,P,M	M	M	H	L
Salix sp. interior Sandbar willow	C,P,M	H	L	H	L
Salix nigra Black willow	C,P,M	H	H	H	L
Salix purpurea Streamco willow	C,P,M	H	M	H	L
Salix x cotteti Bankers willow	P,M	H	M	H	L
Sambucus canadensis American elderberry	P,M	H	M	M	M
Viburnum dentatum Arrowwood viburnum	C,P,M	M	M	M	M
Viburnum lentago Nannyberry viburnum	C,P,M	M	M	L	M
Robinia sp. Black locust	P,M	L	H	M	L

Adapted from the USDA/NRCS Engineering Field Handbook, Chapter 18

Legend:

Tolerance to Flooding, Drought, Deposition, and Shade
H = High
M = Medium
L = Low

Region
C = Coastal
P = Piedmont
M = Mountain

Rooting of all species will be improved if nearby vegetation is pruned to increase sunlight penetration.

Whenever possible, harvest hardwood cuttings as close to the repair site as possible.

Many of the above grow naturally along streams, in adjacent wetlands, along sewer and power line easements, and where streams enter lakes and along lake shores. Willows generally grow profusely in stormwater detention ponds in urban areas.

ALWAYS OBTAIN PERMISSION FROM THE PROPERTY OWNER BEFORE HARVESTING PLANTS!

NATIVE PLANT GUIDE FOR STREAMBANK PLANTING ROOTED STOCK

Species	Region	Stream Zone	Wildlife Value	Notes
Acer rubrum Red maple	M,P,C	Tree	High Seeds & browse	Rapid growth.
Alnus serrulata Smooth alder	M,P,C	Shrub	Moderate, Cover	Rapid growth. Stabilizes stream- banks. Sun.
Amorpha fruticosa False indigo	M,P,C	Shrub	Moderate	Sun.
Aronia arbutifolia Red chokeberry	M,P,C	Shrub	Moderate Cover & Food	Rhizomatous Colonial Shrub.
Asimina triloba Pawpaw	M,P,C	Tree	Important food for fox & possum	
Betula nigra River burch	M,P,C	Tree	Good for cavity nester	Full sun.
Carpinus caroliniana American hornbeam	M,P,C	Tree	Low	Partial shade.
Carya cordiformis Bitternut hickory	P,C	Tree	Moderate, food	Wet bottoms.
Catalpa bignonioides Catalpa tree	P,C	Tree	Unknown	
Celtis laevigata Sugarberry	P,C	Tree	High food cover	Partial shade.
Celtis occidentalis Hackberry	P,C	Tree	High	Partial shade.
Cephalantus occidentalis Buttonbush	M,P,C	Shrub	Moderate, ducks & Shorebirds are users. Nectar for humming- birds.	Sun.
Chionanthus virginicus Fringe tree	P,C	Tree	Moderate	Tolerant of shade.
Clethra alnifolia Sweet pepperbush	P,C	Shrub	Moderate	Partial shade. Good landscape value.
Cornus amomum Silky dogwood	M,P	Shrub	High, songbirds, Mammals	Shade tolerant. Good bank stabilizer.

Species	Region	Stream Zone	Wildlife Value	Notes
Cornus stricta Swamp dogwood	M,P	Shrub	High	Good bank stabilizer in shade.
Cornus florida Flowering dogwood	M,P,C	Tree	High, birds, food	Shade tolerant.
Cyrilla racemiflora Titi	C	Tree	Low	Light shade.
Diospyros virginia Persimmon	M,P,C	Tree	Extremely high Mammals	Not shade tolerant.
Fraxinus caroliniana Carolina ash	C	Tree	Moderate	Rapid growing. Streambank grower. Sun to partial shade.
Fraxinus pennsylvanica Green ash	M,P,C	Tree	Low	Rapid grower. Full sun.
Gleditsia aquatica Water locust	P,C	Tree	Low	Sun.
Gleditsia triacanthos Honey locust	P,C	Tree	Low	Full sun, thorns.
Hibiscus aculeatus Hibiscus Comfort root	C	Shrub	Unknown	Use on open level floodplain areas & Depressions in C.
Hibiscus militaris Hibiscus Halberd-leaved Marsh-mallow	C	Shrub	Unknown	Use on open level floodplain areas & Depressions in C.
Hibiscus lasiocarpus Hibiscus	C	Shrub	Unknown	Use on open level floodplain areas & Depressions in C.
Hibiscus moscheutos Hibiscus	C	Shrub	Unknown	Use on open level floodplain areas & Depressions in C.
Ilex coriacea Sweet Gallberry	C	Shrub	Unknown	
Ilex decidua Possumhaw	P,C	Shrub	High, food, nest sites	Sun or shade.
Ilex glabra Bitter gallberry or Inkberry	C	Shrub	High	Stoloniferous. Sun to some shade.

Species	Region	Stream Zone	Wildlife Value	Notes
Ilex opaca American holly	M,P, C	Tree	High, food, cover nests	prefers shade.
Ilex verticilata Winterberry	M,P	Shrub	High, cover & fruit for birds. Holds berries in winter.	Full sun to some shade. Seasonally flooded areas.
Ilex vomitoria Yaupon	C	Shrub	High, songbirds	Small tree, very adaptable, suckers.
Juglans nigra Black walnut	M,P	Tree	Good	Temporarily flooded wetlands along floodplains.
Juniperus virginiana Eastern red cedar	M,P,C	Tree	High, food	Tolerant to some shade in youth.
Leucothoe axillaris Leucothoe	C	Shrub	Low	Partial shade.
Lindera benzoin Common spicebush	M	Shrub	High, songbirds	Shade, acidic soils. Good understory.
Liriondendron tulipefera Tulip poplar	M,P	Tree	Low	Tolerant to partial Shade.
Liquidambar styraciflua Sweetgum	M,P,C	Tree	Low	Partial shade.
Lyonia lucida Lyonia or Fetterbush	C	Shrub	Low	Sun.
Magnolia virginia Sweetbay	P,C	Tree	Very low	Shade tolerant.
Myrica cerifera Southern wax myrtle	C	Shrub	Moderate	Light shade.
Nyssa ogeche Ogeechee lime	C	Tree	High, fruit, Cavity nesters	Wetland tree
Nyssa sylvatica Blackgum or sourgum	M,P,C	Tree	Moderate, seeds	Sun to partial shade.
Nyssa aquatica Swamp tupelo	C	Tree	High	Prefers shade.
Ostrya virginiana Hophornbeam	M,P,C	Tree	Moderate	Tolerant of all sun-light conditions.

Species	Region	Stream Zone	Wildlife Value	Notes
Persea borbonia Red bay	C	Tree	Good food, for quail and bluebirds.	Understory tree.
Pinus taeda Loblolly pine	P,C	Tree	Moderate	Poor sites.
Platanus occidentalis Sycamore	M,P,C	Tree	Low. Cavity Nesters	Transplants well. Rapid growth in full sun.
Populus deltoides Eastern cottonwood	M,P,C	Tree	High	Invasive roots. Rapid growth.
Quercus alba White oak	M,P,C	Tree	High, food	Prefers moist well drained soil.
Quercus laurifolia Swamp laurel oak	C	Tree	High	
Quercus lyrata Overcup oak	P,C	Tree	High	Sloughs & bottoms.
Quercus michauxii Swamp chestnut oak	M,P,C	Tree	High	Wetter sites than white oak.
Quercus nigra Water oak	M,P,C	Tree	High	
Quercus pagoda Cherrybark oak	M,P	Tree	High	
Quercus phellos Willow oak	M,P,C	Tree	High, mast	Full to partial sun.
Quercus shumardii Shumard oak	P,C	Tree	High	
Salix nigra Black willow	M,P,C	Shrub & Tree	Nesting	Rapid growth, full sun.
Rhododendron atlanticum Coast azelea	P,C	Shrub	Very low	Very fragrant, Suckers.
Rhododendron viscosum Swamp azelea	C	Shrub	Low	
Styrax american	C	Shrub	Unknown	

Species	Region	Stream Zone	Wildlife Value	Notes
Taxodium distichum Bald cypress	C	Tree	Good perching site	Full sun.
Tsuga canadensis Eastern hemlock	M	Tree	Moderate	Tolerates all light conditions.
Viburnum nudum Swamp haw	M,P,C	Shrub	High	Shade tolerant.

Legend:

Region

M = Mountains
P = Piedmont
C = Coastal Plain

Plant List Sources:

Brown, Claude L. & Kirkman, Katherine L. 1990. Trees of Georgia and Adjacent States.

Foote, Leonard E. & Jones, Samuel B., Jr. 1989. Native Shrubs and Woody Vines of the Southeast.

Georgia Cooperative Extension Service. Native Plants for Georgia Gardens.

Hightshoe, Gary L. 1988. Native Trees, Shrubs and Vines for Urban & Rural America.

USDA Natural Resources Conservation Service. 1973. Seacoast Plants of the Carolinas.

USDA Natural Resources Conservation Service, Engineering Field Handbook, Chapter 18, Soil Bioengineering for Upland Slope Protection and Erosion Reduction.

Suggested Hand Tools Typical Costs

Axe – regular size	@ $17.75 each
Chain saw	Rental
Chain saw chains	@ $25.00 each
Chain saw pants	@ $50.00 each
Dead blow hammers – 4 lbs.	@ $25.00 each
Eye protection goggles	@ $10.95 each
Files chain saw	@ $3.95 each
Files loppers	@ $9.95 each
Files – shovels & hand clippers	@ $5.25 each
Hammers – regular	@ $5.00 each
Hand pruning shears	@ $8.75 each
Leather work gloves	@ $9.95 each
Loppers	@ $24.90 each
Mattock Pick & Hoe	@ $21.50 each
Measuring Tapes – 100 feet	@ $20.95 each
Round point shovels	@ $23.95 each
Shovel handles	@ $8.60 each
Sledge hammer – regular size 8 lbs.	@ $33.70 each
Sledge hammer handle – 8 lbs.	@ $14.95 each
Sledge hammer hand size – 2 lbs..	@ $18.00 each
Sledge hammer handles – 2 lbs.	@ $ 8.60 each
Water pump & hoses	Rental
Wire cutters	@ $ 7.95 each

Suggested Materials List

Dead stout stakes
Fertilizer

Fill material

Filter cloth

Grass seed

Hay bales

Jute mesh fabric

Long straw for mulch

Nursery source for rooted stock

Rock

Silt fence

Source for branches (unrooted cuttings)

Twine (Baling)

Wire (20 gage electrical fencing)

Wooden stakes – 2.5 to 3.0 feet long

Wooden timber or logs

September 1994

Cost $28,000
Quantity 20,000

STATE SOIL & WATER CONSERVATION COMMISSION

SOIL-
OUR BASIC HERITAGE

1937

GEORGIA