SECTION 4
EROSION CONTROL - PART 2
SOIL STABILIZATION

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EROSION CONTROL - PART 2
SOIL STABILIZATION

Scope and Discussion

Soil stabilization is the second step in controlling erosion on a construction site or a disturbed area. Erosion is the gradual wearing away of the land surface as a result of uncontrolled wind and water energy. Sedimentation is the result of transport and delivery of eroded particles, deposited at some point. Erosion and sediment control is a complex interaction of soils, engineering water management, agronomic, and horticultural practices. Decisions for resolving erosion conditions, both on the site and within the upper watershed, are formulated based on surface and subsurface water, soil material, climatic conditions, and anticipated land use. Creating a stable slope is necessary prior to vegetating. Sloughing and slumping impede establishment of a uniform protective cover. Stabilizing onsite surfaces can be done with vegetation in the form of various seed mixes and mulch, land shaping, and using woody plants specifically selected for site specific applications, also known as a bio-technical stabilization approach.

General planning considerations for vegetating a steep slope will include evaluating the soil. Factors such as soil texture and steepness affect the stability of the slope. Texture also influences the permeability and water holding capacity of the soil. Many slopes are stripped of their topsoil during the construction phase, leaving an infertile, compacted soil surface, void of valuable organic matter. Topsoil must be reapplied. Overly compacted soil must be decompacted with appropriate equipment. Soil pH and nutrient level are determined by obtaining a representative soil sample for analysis from an accredited lab. Appropriate plant material is designed and selected to meet the final slope and soil conditions for the site. These same concerns and practices also apply to flatter slopes and level areas.

When specifying a fertilizer mix for an area, design the appropriate proportions to meet the nutrients needs for the specific site. Always apply as closely as possible the required amount of fertilizer to meet the needs for the site soils. Adding surplus nitrogen may cause pollution of drinking water and saltwater ecosystems. Excessive phosphorus may accelerate the aging process of freshwater ecosystems. Excessive amounts of Nitrogen (N) and Potassium Oxide (K2O) may result in 'burning' the grass and killing it. **All fertilizer applications will be in accordance with the Nutrient Runoff Law – ECL Article 17, Title 21, January 1, 2012.**

Principles of Biotechnical Practices

The implementation of Biotechnical practices is the specialized use of woody plant materials to stabilize soil enhance structural practices, and provide added support to habitat. One of the factors that affects erosion is vegetative cover. The more cover soil has, the more protected it is from the attacking forces of rainfall and runoff. Also working to hold the soil in place is the root mass that vegetation produces. Biotechnical measures generally combine basic engineering principles with plant science to create a system of stability and resource management for critical areas such as streambanks, roadside slopes, and large exposed areas. These systems may combine with structural measures to effect a strengthening of the soil structure and improve vegetative cover to resist surface erosion.

There are many advantages to Biotechnical practices:

- they are often less expensive to install
- they do not require specialized skills to install
- generally, heavy equipment is not required
- they are environmentally compatible since the design selects natural and native plant materials
- they provide a natural aesthetic appearance
- they provide wildlife habitat and cover and provide a food source to many land and aquatic species
- they mitigate thermal impacts to structural stream stabilization practices such as rock riprap and retaining walls by providing shade
- they can be self repairing during and after stress

On the other hand, there are some disadvantages to these measures:

- requires planning to obtain sources of plant materials
- higher risk due to less control with vegetation compared to structural practices
- require higher maintenance attention
- need an establishment period
- more sensitive to seasonal changes and seasonal

restrictions on planting may apply

The use of Biotechnical practices is actually an old technology. These techniques have been practiced for centuries in Europe. The Natural Resource Conservation Service used and promoted this technology in the 1940's in Vermont on the Winooski River and also in New York on Buffalo Creek, where plant materials (willows) were used in combination with rock riprap, concrete slabs, pinned rock, and cellular modules to halt streambank erosion.

These biotechnical approaches have been "rediscovered" primarily due to their cost effectiveness over more traditional structural measures (hard armor) and for their environmental compatibility, aesthetics, and wildlife benefits. There are many areas in towns and counties in New York that experience erosion on streambanks or sloughs on roadside slopes that could be controlled with biotechnical protection measures. The low cost and ease of installation is very attractive to units of government and highway departments looking to maximize their budget dollars.

Generally a biotechnical slope protection system consists of both a structural or mechanical element and vegetative elements working together to stabilize a site-specific condition. Structural components are employed in such a way to allow establishment of vegetative elements, while at the same time providing a level of protection for stability. The vegetative components are not just landscaping plantings for a structural project; they also perform a functional role in preventing erosion by protecting the surface, while also stabilizing soil by preventing shallow mass movements. These practices also provide a food source to both land based animals as well as smaller aquatic species along streambank revetments. Once established, the plantings provide shade in areas where mitigation of thermal impacts is needed due to hardened structural practices.

Woody plant materials (usually dormant shrub willow branches) are placed into the soil in ways that provide an immediate degree of stability to the slope. As the branches take root and grow, the slope becomes more and more resistant to failure by shallow mass movements due to:

1. Mechanical reinforcement from the root system,
2. Soil moisture reduction through transpiration and plant uptake, and
3. Buttressing and soil arching action from embedded stems.

The vegetation also tends to prevent (surface) erosion by:

1. Binding and restraining soil particles in place,
2. Filtering soil particles from runoff,
3. Absorb raindrop energy prior to impact,
4. Retarding velocity of runoff, and
5. Maintaining infiltration.

As the stability improves, native vegetation will volunteer, helping to blend the site into the surroundings.

There are many techniques used in biotechnical work. Some of the most common are:

Vegetated Rock Gabions—This is a combination of vegetation and rock gabions generally used for slope stabilization. Live branch cuttings are layered through the rock gabion structure to anchor in select earthfill. The cuttings protrude beyond the face of the gabion. The gabion standard is covered in the "Standard Specifications for Retaining Walls". See Figure 4.20 on page 4.67 for details.

Live Fascines—This technique uses bundles of branches which are staked into shallow trenches, then filled with soil. They are oriented along the contour and are placed in multiple rows to help stabilize a slope. See Standard and Specifications for Live Fascines.

Brush Mattress—This method uses hardwood brush layered along a streambank as a mattress and anchored in place with a grid of stakes and wire. The toe below the waterline is anchored by rock. This living blanket acts as a mulch for seedlings and plantings established in the bank. It also prevents erosion of sloped surfaces. See Standards and Specifications for Brush Mattress.

Live Staking—These are large stakes or poles sharpened at the bottom end and forced vertically into the soft earth along the waterline, usually about 1 foot apart. Depending on the size of the poles and the composition of the streambank, machinery may be required to force them into the ground or to prepare holes for planting. The poles will grow forming a very thick barrier to flow. See Figure 4.14 and Figure 4.15.

Brush Layering—This technique is generally used to stabilize slope areas above the flow line of streambanks as well as cut and fill slopes. It involves the use of long branches that are placed with cut ends into the slope on bulldozed terraces. The tops protrude outside the finished slope. A layer usually includes three layers of brush separated with a thin (3 in.) layer of soil. On this layer a "lift" of 3-5 feet of soil is placed to form the next terrace and so forth. See Figure 4.6.

Live Cribwall—This is a combination of vegetation and structural elements generally used along streams where flowing water is a hazard. Layers of logs are alternated with long branches protruding out between them. The logs are spiked together and anchored into the bank with earthfill behind them to create a wall. The live stems help tie the logs together and screen the wall. See Figure 4.12.
Tree Revetment—This method incorporates entire trees (without the root wad) for bank stabilization in areas that are eroded or undercut, but not flashy or in need of heavy maintenance. Trees are overlapped and anchored to the earth for the purpose of absorbing energy and reducing velocity, capturing sediment, and enhancing conditions for colonization of native species. See Figure 4.19.

Branchpacking—This technique alternates live branch cuttings with tamped backfill to repair small, localized slumps and holes in slopes. The alternating layers of branches and soil are placed between long posts driven in to the ground for support. This method is inappropriate for areas larger than 4-feet deep or 6-feet wide. See Figure 4.5.

Fiber Roll—A fiber roll is a coconut fiber, straw, or excelsior woven roll encased in netting of jute, nylon, or burlap used to dissipate energy along bodies of water and provide a good medium for the introduction of herbaceous vegetation. This technique works best where water levels are relatively constant. The roll is anchored into the bank and, after suitable backfill is placed behind the roll, herbaceous or woody vegetation can be planted. See Figure 4.8.

Properly designed structural measures may be necessary to help protect the toe or face of a slope against scour or erosion from moving water and against mass-moving of soil. These structures are generally capable of resisting much higher lateral earth pressures and higher shear values than vegetation. They can be natural, such as fieldstone, rock and timbers; or, they can be artificial like concrete and steel. Some structural measures can be a combination like gabions, which are wire baskets containing stone. Gabions can be used as retaining walls, grade stabilization structures and slope protection. Many of these types of structures can be planted or vegetated with materials to strengthen the system.

Note: Performing activities within or adjacent to wetlands, streams and waterbodies may require permits from the New York State Department of Environmental Conservation (NYSDEC) pursuant to Article 15 (Protection of Waters), Article 24 (Freshwater Wetlands) and Article 25 (Tidal Wetlands) of the Environmental Conservation Law (ECL). Project owners should contact NYSDEC's Regional Division of Environmental Permits early in the site planning process to discuss the requirements for meeting permit issuance standards. Following the New York State Standards and Specifications for Erosion and Sediment Control may not ensure compliance with the above referenced sections of the ECL.

Planning Considerations

There are many facets that need to be considered when designing a biotechnical system for a site:

Method – What is the appropriate method or practice for the particular problem encountered?

Materials – What type should be selected? How much is needed to do the job? Where can they be obtained?

Schedule – When is the best time to maximize the successful rooting or germination of materials?

Equipment – Since this process is somewhat labor intensive, it is necessary to make sure the proper type and amount of tools, such as shovels, pick axe, tile spade, hammers, etc. are available for proper installation of material.

Site characteristics – The need for engineering structures will depend on potential hazards, management of site water, soil conditions, and site access. Aesthetics and follow-up maintenance are also important considerations. Protection from livestock is mandatory.

Streambanks – Generally applicable where flows are less than 6 feet per second and the stream bottom is not subject to degradation and scour. Protection should be carried to the average high water elevation.

Plant Materials

Plant materials for biotechnical slope protection may be obtained in two basic ways. One method is to locate stands of appropriate species and obtain easements to harvest materials from these stands for incorporation into the project. Criteria for selecting native species are: easy rooting; long, straight, flexible whips; and plentiful supply near the site.

A second method is to grow and harvest materials from

managed production beds that are maintained for commercial distribution. This allows selection of cultivars that have proven performance records and high survival rates.

The most popular materials in use today are the shrub willows. Willows have a tremendous ability to sprout roots and stems when in contact with moist soil. Willows are found growing in all parts of the world, so biotechnical slope protection techniques employ them more than any other group of plants. Two of the tested, proven willow cultivars in the Northeast are:

- 'Streamco' purple osier willow (*Salix purpurea*)
- 'Bankers' dwarf willow (*Salix cottetii* – hybrid)

'Streamco' and 'Bankers' willow are both shrubs. 'Streamco' has an ultimate height of 15-20 feet, while 'Bankers' is limited to 6-8 feet. Commercial and state nurseries in the Northeast are producing supplies of both species.

In addition to willows, red osier dogwood and poplars are other groups of plants effective for use in biotechnical systems. Species such as elderberry or forsythia can also be used to add biodiversity to a site.

All plant materials should be installed on site within 8 hours of cutting, unless provisions for proper storage are made. Materials should be fresh, dormant, and non-desiccated when installed.

STANDARD AND SPECIFICATIONS FOR ANCHORED STABILIZATION MATTING

Definition and Scope

A **temporary** or **permanent** protective covering placed on a prepared, seeded planting area that is anchored in place by staples or other means to aid in controlling erosion by absorbing rain splash energy and withstand overland flow as well as provide a microclimate to protect and promote seed establishment.

Conditions Where Practice Applies

Anchored stabilization mats are required for seeded earthen slopes steeper than 3 horizontal to 1 vertical; in vegetated channels where the velocity of the design flow exceeds the allowable velocity for vegetation alone (usually greater than 5 feet per second); on streambanks and shorelines where moving water is likely to erode newly seeded or planted areas; and in areas where wind prevents standard mulching with straw. This standard does not apply to slopes stabilized with sod, rock riprap or hard armor material.

Design Criteria

Slope Applications - Anchored stabilization mats for use on slopes are primarily used as mulch blankets where the mesh material is within the blanket or as a netting over previously placed mulch. These stabilization mats are NOT effective in preventing slope failures.

1. Required on all slopes steeper than 3:1
2. Matting will be designed for proper longevity need and strength based on intended use.
3. All installation details and directions will be included on the site erosion and sediment control plan and will follow manufactures specifications.

Channel Applications - Anchored stabilization mats, for use in supporting vegetation in flow channels, are generally a non-degradable, three dimensional plastic structure which can be filled with soil prior to planting. This structure provides a medium for root growth where the matting and roots become intertwined forming a continuous anchor for the vegetated lining.

1. Channel stabilization shall be based on the tractive force method.
2. For maximum design shear stresses less than 2 pounds per square foot, a temporary or bio-degradable mat may be used.
3. The design of the final matting shall be based on the mats ability to resist the tractive shear stress at bank full flow.
4. The installation details and procedures shall be included on the site erosion and sediment control plan and will follow manufacturers specifications.

Construction Specifications

1. Prepare soil before installing matting by smoothing the surface, removing debris and large stone, and applying lime, fertilizer and seed. Refer to manufacturers installation details.
2. Begin at the top of the slope by anchoring the mat in a 6” deep x 6” wide trench. Backfill and compact the trench after stapling.
3. In channels or swales, begin at the downslope end, anchoring the mat at the bottom and top ends of the blanket. When another roll is needed, the upslope roll

should overlay the lower layer, shingle style, so that channel flows do not peel back the material.

4. Roll the mats down a slope with a minimum 4" overlap. Roll center mat in a channel in direction of water flow on bottom of the channel. Do not stretch blankets. Blankets shall have good continuous contact with the underlying soil throughout its entire length.

5. Place mats end over end (shingle style) with a 6" overlap, use a double row of staggered staples 4" apart to secure mats.

6. Full length edge of mats at top of side slopes must be anchored in 6" deep x 6" wide trench; backfill and compact the trench after stapling.

7. Mats on side slopes of a channel must be overlapped 4" over the center mat and stapled.

8. In high flow channel applications, a staple check slot is recommended at 30 to 40 foot intervals. Use a row of staples 4" apart over entire width of the channel. Place a second row 4" below the first row in a staggered pattern.

9. The terminal end of the mats must be anchored in a 6"x6" wide trench. Backfill and compact the trench after stapling.

10. Stapling and anchoring of blanket shall be done in accordance with the manufactures recommendations.

Maintenance

Blanketed areas shall be inspected weekly and after each runoff event until perennial vegetation is established to a minimum uniform 80% coverage throughout the blanketed area. Damaged or displaced blankets shall be restored or replaced within 2 calendar days.

STANDARD AND SPECIFICATIONS FOR ARMORED SLOPE AND CHANNEL STABILIZATION

Definition & Scope

A **permanent** layer of stone designed to protect and stabilize areas subject to erosion by protecting the soil surface from rain splash, sheet flow, rill and gully erosion and channel erosion. It can also be used to improve the stability of soil slopes that are subject to seepage or have poor soil structure.

Conditions Where Practice Applies

Riprap is used for cut and fill slopes subject to seepage, erosion, or weathering, particularly where conditions prohibit the establishment of vegetation. Riprap is also used for channel side slopes and bottoms, temporary dewatering diversion channels where the flow velocities exceed 6 feet/second, grade sills, on shorelines subject to erosion, and at inlets and outlets to culverts, bridges, slope drains, grade stabilization structures, and storm drains.

Slope Stabilization Design Criteria

Gradation – Riprap shall be a well-graded mixture with 50% by weight larger than the specified design size. The diameter of the largest stone size in such a mixture should be 1.5 times the d_{50} size with smaller sizes grading down to 1 inch. The designer should select the size or sizes that equal or exceed that minimum size based on riprap gradations commercially available in the area.

Thickness – The minimum layer thickness shall be 1.5 times the maximum stone diameter, but in no case less than 6 inches.

Quality – Stone for riprap shall be hard, durable field or quarry materials. They shall be angular and not subject to breaking down when exposed to water or weathering. The specific gravity shall be at least 2.5.

Size – The sizes of stones used for riprap protection are determined by purpose and specific site conditions:

1. Slope Stabilization – Riprap stone for slope stabilization not subject to flowing water or wave action shall be sized for the proposed grade. The gradient of the slope to be stabilized shall be less than the natural angle of repose of the stone selected. Angles of repose of riprap stones may be estimated from Figure 4.1.

   Riprap used for surface stabilization of slopes does not add significant resistance to sliding or slope failure and should not be considered a retaining wall. Slopes approaching 1.5:1 may require special stability analysis. The inherent stability of the soil must be satisfactory before riprap is used for surface stabilization.

2. Channel Stabilization - Design criteria for sizing stone for stability of channel side slopes are presented under Channel Stabilization Design Criteria on page 4.10.

2. Outlet Protection – Design criteria for sizing stone and determining dimensions of riprap aprons are presented in Standards and Specifications for Rock Outlet Protection on page 3.39.

Filter Blanket – A filter blanket is a layer of material placed between the riprap and the underlying soil to prevent soil movement into or through the riprap. A suitable filter may consist of a well-graded gravel or sand-gravel layer or a synthetic filter fabric manufactured for this purpose. The design of a gravel filter blanket is based on the ratio of particle size in the overlying filter material to that of the base material in accordance with the criteria below. Multiple layers may be designed to affect a proper filter if necessary.

A gravel filter blanket should have the following relationship for a stable design:

$$\frac{d_{15}\ \text{filter}}{d_{85}\ \text{base}} \leq 5$$

$$5 < \frac{d_{15}\ \text{filter}}{d_{50}\ \text{base}} \leq 40$$

and

$$\frac{d_{50}\ \text{filter}}{d_{50}\ \text{base}} \leq 40$$

Filter refers to the overlying material while base refers to the underlying material. These relationships must hold between the base and filter and the filter and riprap to prevent migration of material. In some cases, more than one filter may be needed. Each filter layer should be a minimum of 6 inches thick, unless an acceptable filter fabric is used.

A synthetic filter fabric may be used with or in place of gravel filters. The following particle size relationships should exist:

1. Filter fabric covering a base containing 50% or less by weight of fine particles (#200 sieve size):

   A. $$\frac{d_{85}\ \text{base (mm)}}{\text{EOS} \times \text{filter fabric (mm)}} > 1$$

   B. total open area of filter fabric should not exceed 36%

2. Filter fabric covering other soils:

   A. EOS is no larger than 0.21 mm (#70 sieve size)

   B. total open area of filter fabric should not exceed 10%

*EOS – Equivalent opening size compared to a U.S. standard sieve size.

No filter fabric should have less than 4% open area or an EOS less than U.S. Standard Sieve #100 (0.15 mm). The permeability of the fabric must be greater than that of the soil. The fabric may be made of woven or nonwoven monofilament yarns and should meet the following minimum requirements:

Thickness 20-60 mils

grab strength 90-120 lbs.

conform to ASTM D-1682 or ASTM D-177

Filter blankets should always be provided where seepage is significant or where flow velocity and duration of flow or turbulence may cause underlying soil particles to move though the riprap.

Construction Specifications

Subgrade Preparation – Prepare the subgrade for riprap and filter to the required lines and grades shown on the plans. Compact any fill required in the subgrade to a density approximating that of the undisturbed material or overfill depressions with riprap. Remove brush, trees, stumps, and other objectionable material. Cut the subgrade sufficiently deep so that the finished grade of the riprap will be at the elevation of the surrounding area. Channels shall be excavated sufficiently to allow placement of the riprap in a manner such that the finished inside dimensions and grade of the riprap meet design specifications.

Sand and gravel filter blanket – Place the filter blanket immediately after the ground foundation is prepared. For gravel, spread filter stone in a uniform layer to the specified depth. Where more than one layer of filter material is used, spread the layers with minimal mixing.

Synthetic filter fabric – Place the cloth directly on the prepared foundation. Overlap the edges by at least 2 feet, and space the anchor pins every 3 feet along the overlap. Bury the upper and lower ends of the cloth a minimum of 12 inches below ground. Take precautions not to damage the cloth by dropping the riprap. If damage occurs, remove the riprap and repair the sheet by adding another layer of filter fabric with a minimum overlap of 12 inches around the damaged area. Where large stones are to be placed, a 4-inch layer of fine sand or gravel is recommended to protect the filter cloth. Filter fabric is not recommended as a filter on slopes steeper than 2 horizontal to 1 vertical.

Stone placement – Placement of the riprap shall follow immediately after placement of the filter. Place riprap so that it forms dense, well-graded mass of stone with a minimum of voids. The desired distribution of stones throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement. Place riprap to its full thickness in one operation. Do not place riprap by dumping through chutes or other methods that cause segregation of stone sizes. Be careful not to dislodge the underlying base or filter when placing the stones.

The toe of the riprap shall be keyed into a stable foundation at its base as shown in Figure 4.2 - Typical Riprap Slope Protection Detail. The toe should be excavated to a depth of 2.0 feet. The design thickness of the riprap shall extend a minimum of 3 feet horizontally from the slope. The finished slope should be free of pockets of small stone or clusters of large stones. Hand placing may be necessary to achieve proper distribution of stone sizes to produce a relatively smooth, uniform surface. The finished grade of the riprap should blend with the surrounding area.

Maintenance

Riprap shall be inspected periodically for scour or dislodged stones. Control weed and brush growth as needed.

Figure 4.1
Angles of Repose of Riprap Stones (FHWA)

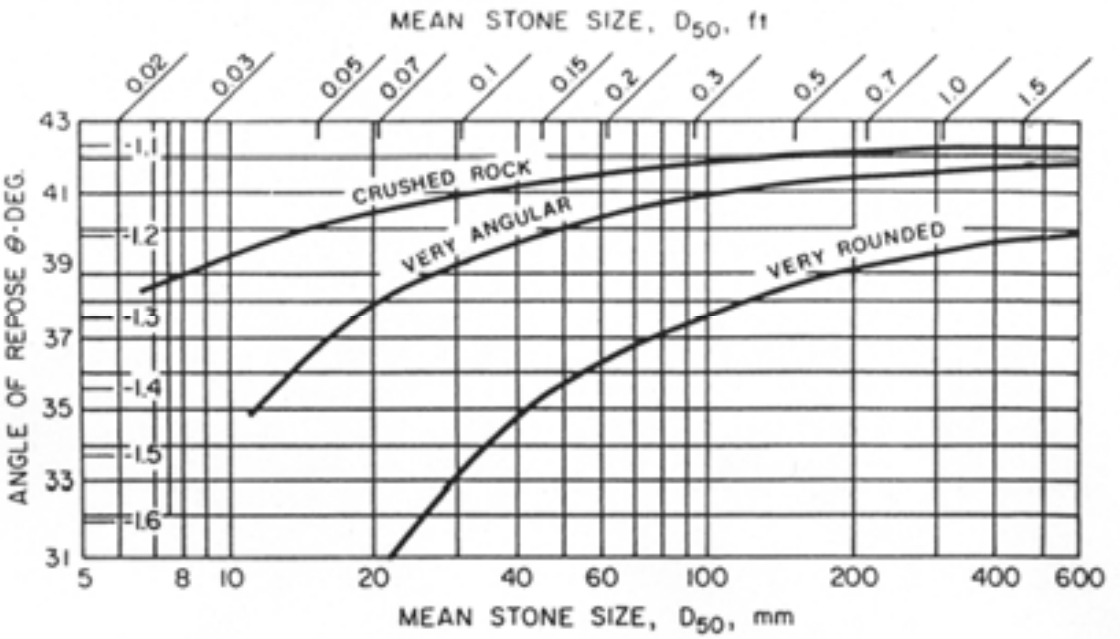
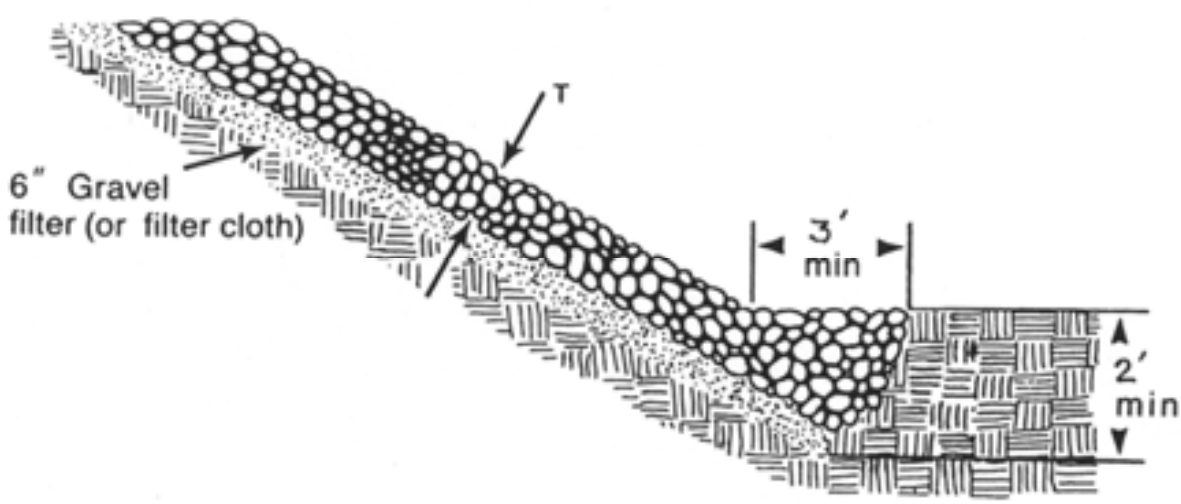


Figure 4.2
Typical Riprap Slope Protection Detail



Channel Stabilization Design Criteria

1. Since each channel is unique, measures for structural channel stabilization should be installed according to a design based on specific site conditions.

2. The plan and profile of the design reach should approximate a naturally stable channel from the project area, based on a stable "reference reach" for the subject channel type.

3. Develop designs according to the following principles:

   - Make protective measures compatible with other channel modifications planned or being carried out in the channel reaches.
   - Whenever excavation and re-shaping work is proposed within channels, the design should provide functional channel dimensions and geometry at each section. Work proposed within a stream channel may require permits from the NYS DEC and US Army Corps of Engineers.
   - Use the design velocity of the peak discharge of the 10-year storm or bankfull discharge, whichever is less. Structural measures should be capable of withstanding greater flows without serious damage.
   - Ensure that the channel bottom is stable or stabilized by structural means before installing any permanent slope protection.
   - Channel stabilization should begin at a stable location and end at a stable point along the bank.
   - Changes in alignment should not be done without a complete analysis of the environmental and stability effects on the entire system.
   - Provisions should be made to maintain and improve fish and wildlife habitat. For example, restoring lost vegetation will provide valuable shade, food, and/or cover.
   - Ensure that all requirements of state law and all permit requirements of local, state, and federal agencies are met.

Construction Specifications

Riprap – Riprap is the most commonly used material to structurally stabilize a channel. While riprap will provide the structural stabilization necessary, the side slope can be enhanced with vegetative material to slow the velocity of water, filter debris, and enhance habitat. See Principles of Biotechnical Practices on page 4.1, for more information.

1. Side slope – slopes shall be graded to 2:1 or flatter prior to placing bedding, filter fabric, or riprap.

2. Filter – filters should be placed between the base material and the riprap and meet the requirements of criteria listed pages 4.7 and 4.8.

3. Gradation – The gradation of the riprap is dependent on the velocity expected against the bank for the design conditions. See Table 4.1 on page 4.12. Once the velocity is known, gradation can be selected from the table for the appropriate class of rock. Note, this table was developed for a 2:1 slope; if the slope steepens to 1.5:1 the gradations should be increased 20%. The riprap should extend 2 feet below the channel bottom and be keyed into the side slope both at the upstream end and downstream end of the proposed work or reach.

See Figure 4.3 on page 4.13 for details.

Reinforced Concrete - Is often used to armor eroding sections of flow channel by constructing walls, bulk heads, or stabilize bank linings in urban areas for redevelopment work. Provide positive drainage behind these structures to relieve uplift pressures.

Grid Pavers – Modular concrete units with or without void areas can be used to stabilize flow channel. Units with void areas can allow the establishment of vegetation. These structures may be obtained in a variety of shapes (Figure 4.4) or they may be formed and poured in place. Maintain design and installation in accordance with manufacturer's instructions.

Revetment – Structural support or armoring to protect an embankment from erosion. Riprap and gabions are commonly used. Also used is a hollow fabric mattress with cells that receive a concrete mixture. Any revetment should be installed to a depth below the anticipated channel degradation and into the channel bed as necessary to provide stability.

Modular Pre-Cast Units – Interlocking modular precast units of different sizes, shapes, heights, and depths, have been developed for a wide variety of applications. They provide vertical support in tight areas as well as durability. Many types are available with textured surfaces. They also act as gravity retaining walls. They should be designed and installed in accordance with the manufacturer's recommendations (Figure 4.4). All areas disturbed by construction should be stabilized as soon as the structural measures are complete.

Maintenance

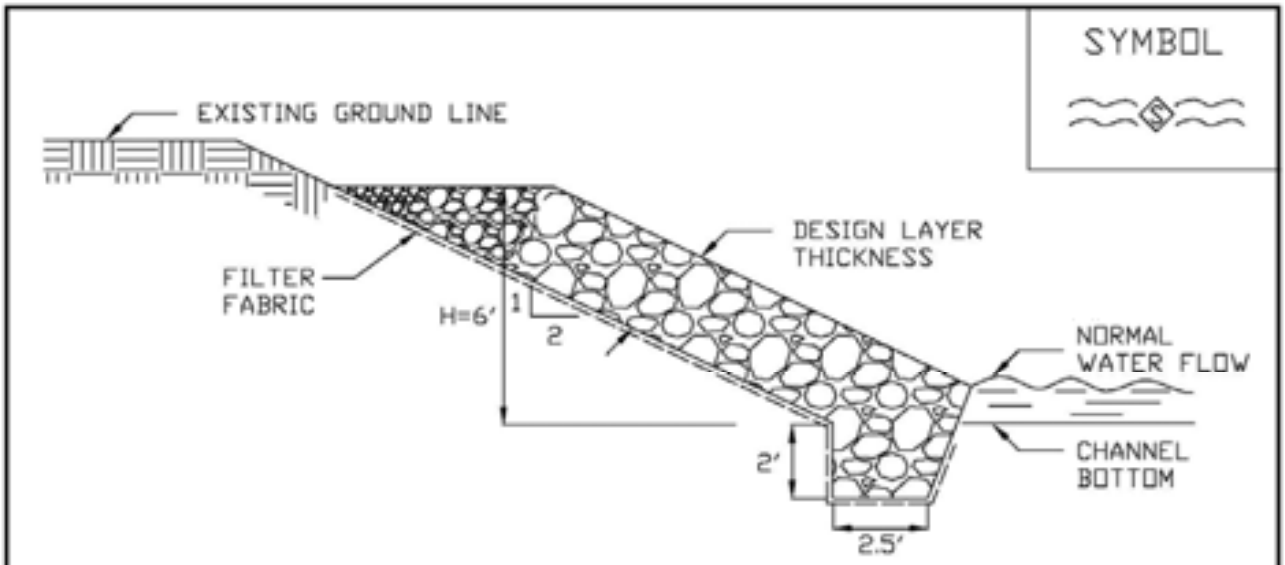
Check stabilized flow channel sections after every high-water event, and make any needed repairs immediately to prevent any further damage or unraveling of the existing work.

Table 4.1 - Riprap Gradations for Channel Stabilization

Class	Layer Thickness (in.)	Max. Velocity (ft/s)	Wave Height (ft.)		PERCENT FINER BY WEIGHT											
					D_{10}			D_{50}			D_{85}			D_{100}		
					Wt. (lbs.)	d_o (in.)	d□ (in.)	Wt. (lbs.)	d_o (in.)	d□ (in.)	Wt. (lbs.)	d_o (in.)	d□ (in.)	Wt. (lbs.)	d_o (in.)	d□ (in.)
I	18	8.5	-		5	5	4	50	10	8	100	13	10	150	15	12
II	18	10	-		17	7	6	170	15	12	340	19	15	500	22	18
III	24	12	2		46	10	8	460	21	17	920	26	21	1400	30	24
IV	36	14	3		150	15	12	1500	30	25	3000	39	32	4500	47	36
V	48	17	4.8		370	20	16	3700	42	34	7400	53	43	11,000	60	49

d_o = gravel material d□ = angular rock riprap
Wt = weight in pounds

Figure 4.3
Riprap Channel Stabilization



RIPRAP DESIGN TABLE

REACH	CLASS	THICKNESS	LAYER	HEIGHT	D10	D50	D85	D100	FILTER

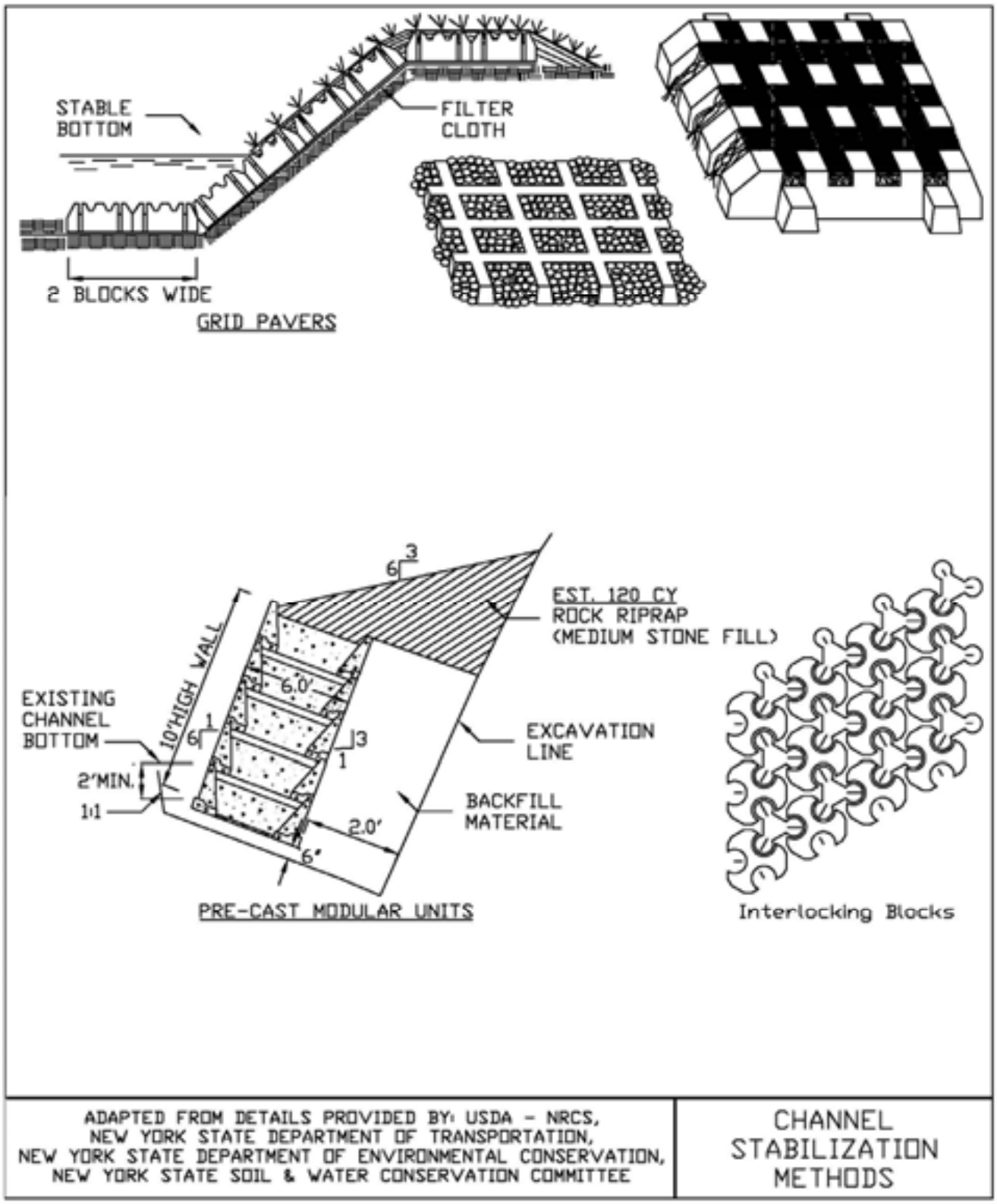
CONSTRUCTION SPECIFICATIONS

1. SLOPE SHALL BE GRADED TO 2:1 OR FLATTER PRIOR TO PLACING FILTER, FILTER FABRIC, OR RIPRAP.
2. RIPRAP SHALL BE PLACED TO MAINTAIN A UNIFORM GRADATION. LARGER STONE SHALL BE PLACED AT THE TOE.
3. ENDS OF THE RIPRAP SHALL BE KEYED INTO A STABLE BANK. WHEN TYING INTO OTHER STRUCTURES, LARGER RIPRAP CAN BE LAID IN STEPS OR STACKED AS NEEDED TO FIT. STONES LARGER THAN THOSE DESIGNED FOR FLOW SHALL BE USED FOR THIS PURPOSE.
4. REMAINING DISTURBED AREAS SHALL BE GRADED AND PERMANENTLY SEEDED AND MULCHED.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS,
NEW YORK STATE DEPARTMENT OF TRANSPORTATION,
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION,
NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE

RIPRAP CHANNEL STABILIZATION

Figure 4.4
Channel Stabilization Methods



STANDARD AND SPECIFICATIONS FOR BRANCHPACKING

Definition & Scope

Branchpacking consists of alternate layers of live branch cuttings and tamped backfill to repair small, localized slumps and holes in slopes to provide repair to existing slopes that have small slips or slumps by filling in the failed area with plant materials and soil.

Conditions Where Practice Applies

This is an appropriate technique for repairing slip areas that do not exceed 4 feet deep or 6 feet wide. It should not be used as a slope stability measure if structural embankment support is needed.

Design Criteria

1. The live branch cuttings shall be 1/2 - 2 inches in diameter and long enough to touch the undisturbed soil at the back of the area to be repaired. They should extend 4 - 6 inches beyond the finished backfill grade.

2. Wooden posts should be used to secure the plant material in place. They should be 6 - 8 feet long and 3 - 4 inches in diameter. If lumber is used, it shall be a minimum standard two by four.

3. Wooden posts shall be driven vertically 3 feet deep and placed in a grid pattern 1 - 2 feet apart.

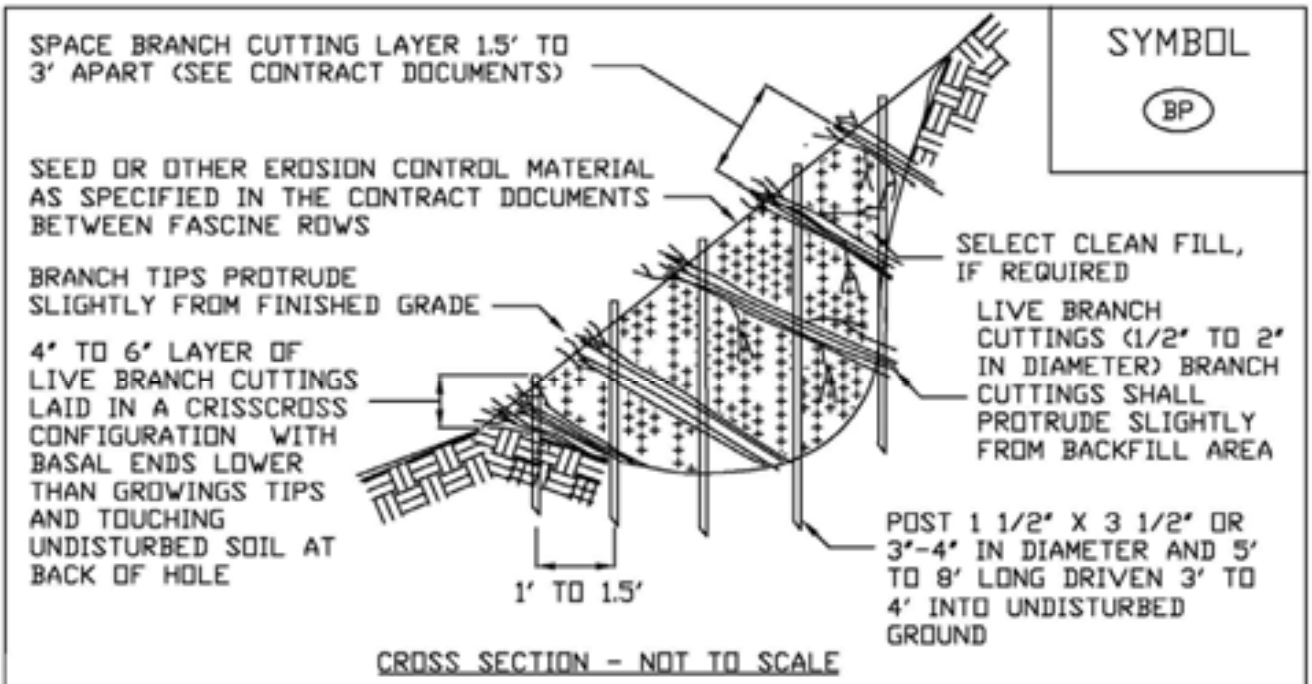
4. Beginning at the bottom of the slip area, 4 - 6 inch layers of live branch cuttings are placed in angled layers, 1.5 to 3 feet apart. Compacted moist soil is placed between the layers (see Figure 4.5).

5. Seasonal planting restriction may have to be considered.

Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability.

Figure 4.5
Branchpacking



CONSTRUCTION SPECIFICATIONS

1. STARTING AT THE LOWEST POINT DRIVE THE WOODEN POSTS VERTICALLY 3' TO 4' INTO THE GROUND. SET THEM 1' TO 1.5' APART.
2. A LAYER OF LIVING BRANCHES 4" TO 6" THICK IS PLACED IN THE BOTTOM OF THE HOLE, BETWEEN THE VERTICAL POSTS. THEY SHALL BE PLACED IN A CRISSCROSS CONFIGURATION WITH THE GROWING TIPS GENERALLY ORIENTED TOWARD THE SLOPE FACE. SOME OF THE BASAL ENDS OF THE BRANCHES FROM EACH LAYER SHALL TOUCH THE BACK OF THE HOLE OR SLOPE.
3. EACH LAYER OF BRANCHES SHALL BE INSTALLED WITH THE BASAL ENDS LOWER THAN THE GROWING TIPS OF THE BRANCHES.
4. THE FINAL INSTALLATION SHALL MATCH THE EXISTING SLOPE. BRANCHES SHOULD PROTRUDE ONLY SLIGHTLY FROM THE FILLED FACE.
5. EACH LAYER OF BRANCHES SHALL BE FOLLOWED BY A 1' LAYER OF SOIL HAND TAMPED TO ENSURE CONTACT WITH THE BRANCH CUTTINGS.
6. THE SOIL SHALL BE MOIST OR MOISTENED TO ENSURE THAT LIVE BRANCHES DO NOT DRY OUT.
7. WHERE SPECIFIED, LIVE STAKES SHALL BE USED IN PLACE OF POSTS.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE	BRANCHPACKING

STANDARD AND SPECIFICATIONS FOR BRUSH LAYER

Definition & Scope

A brush layer is a horizontal row of live branch cuttings placed in soil with other similar rows, spaced a specific vertical distance apart to stabilize cut and fill slope areas by reinforcing the soil with uprooted branch stems, trapping debris on slope, drying excessively wet sites, and redirecting adverse slope seepage by acting as horizontal drains.

Conditions Where Practice Applies

Generally applicable to stabilize slope areas above the flow line of streambanks as well as cut and fill slopes. Brush layers can be used on slopes up to 2:1 in steepness and 20 feet in height.

Design Criteria

The spacing requirements for brush layer rows is dependent on the slope steepness and moisture content. Spacing shall conform with the following table.

Slope Distance Between Layers (feet)			
Slope H : V	Wet Slope	Dry Slope	Max Slope Length
2 to 2.5:1	3’	3’	15’
2.5 to 3.5:1	3’	4’	15’
3.5 to 4.0:1	4’	5’	25’

Brush layer cuttings shall be 1/2 to 2 inches in diameter and be from dormant plants. No leaf buds shall have initiated growth beyond 1/4" and the cambium layer shall be moist, green, and healthy. The cuttings shall be long enough to contact the back of the bench with the growing tips protruding out of the slope face.

Care shall be taken not to severely damage the live branch cuttings during installation. Damaged cuttings will be replaced prior to backfilling.

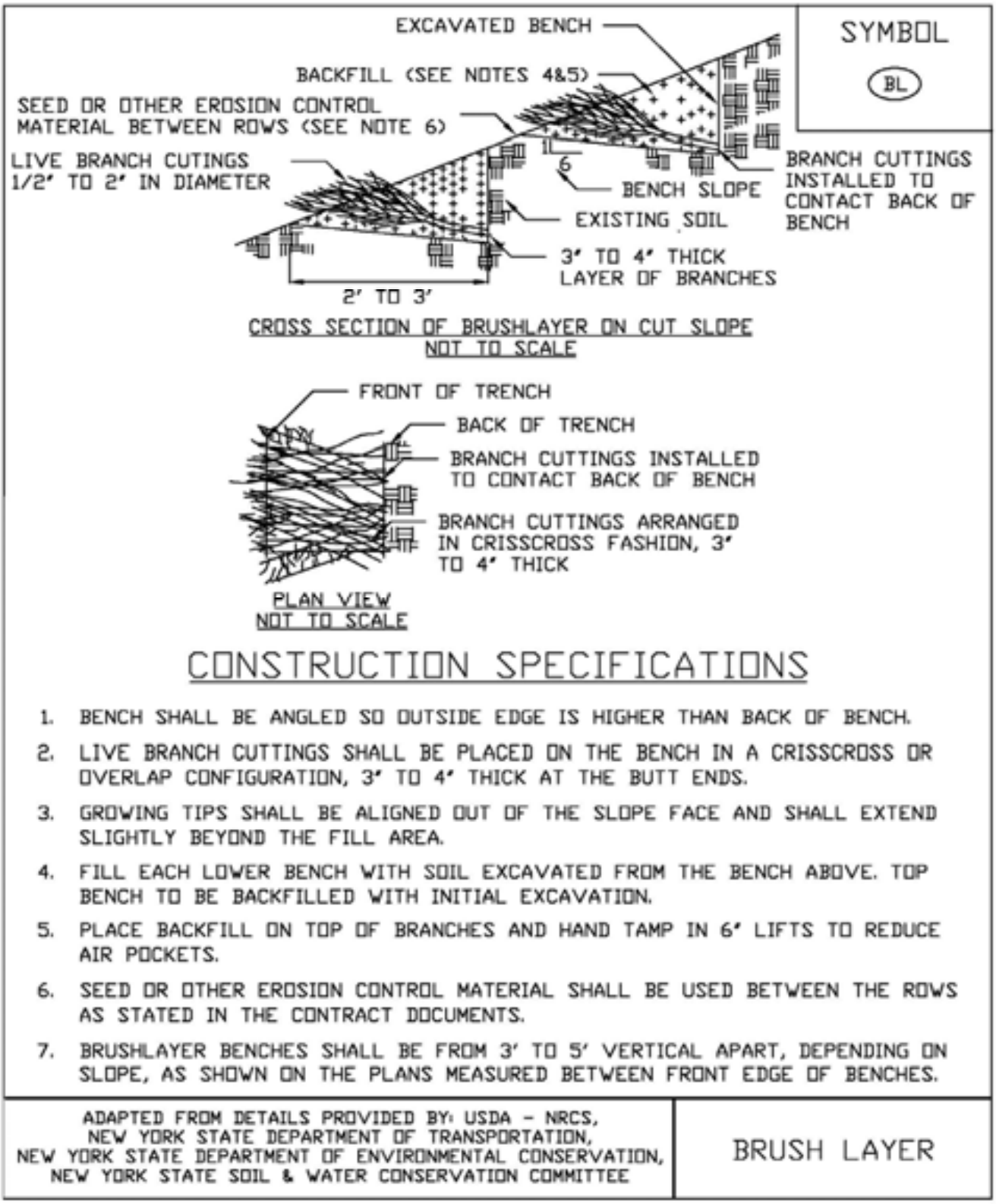
Starting at the toe of the slope, excavate benches along the contour of the slope. The benches shall range from 2 to 3 feet wide and the surface of the bench shall be angled so the front edge is higher than the back of the bench (See Figure 4.6). The benches shall be spaced according to the previous table, Slope Distance Between Layers (ft).

Live branch cuttings shall be placed on the bench in a crisscross or overlapping configuration in layers 3 - 4 inches thick at the butt ends. Backfill shall be placed on top of the live branch cuttings and tamped in 6 inch lifts. Small plate compactors may be used to settle the soil. Areas between the rows of brush layers shall be stabilized by seeding or other appropriate erosion control method.

Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability. The brush layer may need to be watered periodically during the first year if installation is done during the summer months.

Figure 4.6
Brush Layer



CONSTRUCTION SPECIFICATIONS

1. BENCH SHALL BE ANGLED SO OUTSIDE EDGE IS HIGHER THAN BACK OF BENCH.
2. LIVE BRANCH CUTTINGS SHALL BE PLACED ON THE BENCH IN A CRISSCROSS OR OVERLAP CONFIGURATION, 3" TO 4" THICK AT THE BUTT ENDS.
3. GROWING TIPS SHALL BE ALIGNED OUT OF THE SLOPE FACE AND SHALL EXTEND SLIGHTLY BEYOND THE FILL AREA.
4. FILL EACH LOWER BENCH WITH SOIL EXCAVATED FROM THE BENCH ABOVE. TOP BENCH TO BE BACKFILLED WITH INITIAL EXCAVATION.
5. PLACE BACKFILL ON TOP OF BRANCHES AND HAND TAMP IN 6" LIFTS TO REDUCE AIR POCKETS.
6. SEED OR OTHER EROSION CONTROL MATERIAL SHALL BE USED BETWEEN THE ROWS AS STATED IN THE CONTRACT DOCUMENTS.
7. BRUSHLAYER BENCHES SHALL BE FROM 3' TO 5' VERTICAL APART, DEPENDING ON SLOPE, AS SHOWN ON THE PLANS MEASURED BETWEEN FRONT EDGE OF BENCHES.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE

BRUSH LAYER

STANDARD AND SPECIFICATIONS FOR BRUSH MATTRESS

Definition & Scope

A mulch or mattress of living brush laid on a slope and fastened down with stakes and wire to protect the soil surface on slopes from erosive forces through the generation of a dense stand of woody vegetation.

Conditions Where Practice Applies

Brush mattresses are used primarily on streambanks where the velocity is less than 6 feet per second and excessive streamflow has created erosive conditions. This practice can resist temporary inundation, but not scour or undercutting.

Design Criteria

Layer Thickness—The brush shall be a minimum of 3 inches thick (excluding top soil layer).

Height—The mattress shall be placed up the bank to the bankfull elevation. The toe of the mattress should be located in a fascine trench.
Slope—The maximum slope shall be 1.5:1.

Anchoring—The mattress shall be anchored on the slope by a grid of 3-foot stakes driven on 3-foot centers each way. No. 9 wire is then wound between the stakes, which are driven to secure the mattress. The upstream edge of the mattress should be keyed into the bank 2 feet.

Materials—The plant materials should be willow or dogwood brush placed as shown in Figure 4.7.

Construction Specifications

1. Prepare slope surface by grading to a uniform, smooth surface, clear of obstruction. Slopes should be graded before the brush mattress is installed.

2. The fascine toe should be installed first. Then lay brush beginning at the downstream end of the work. The toe below the waterline may be anchored by rock.

3. The butt end of the brush will be placed upstream and plant materials inclined approximately 30 degrees.

4. The upstream edge of the mattress will be keyed into the slope 2 feet. Stakes will be driven throughout the mattress on 3-foot centers each way beginning along the toe of the mattress.

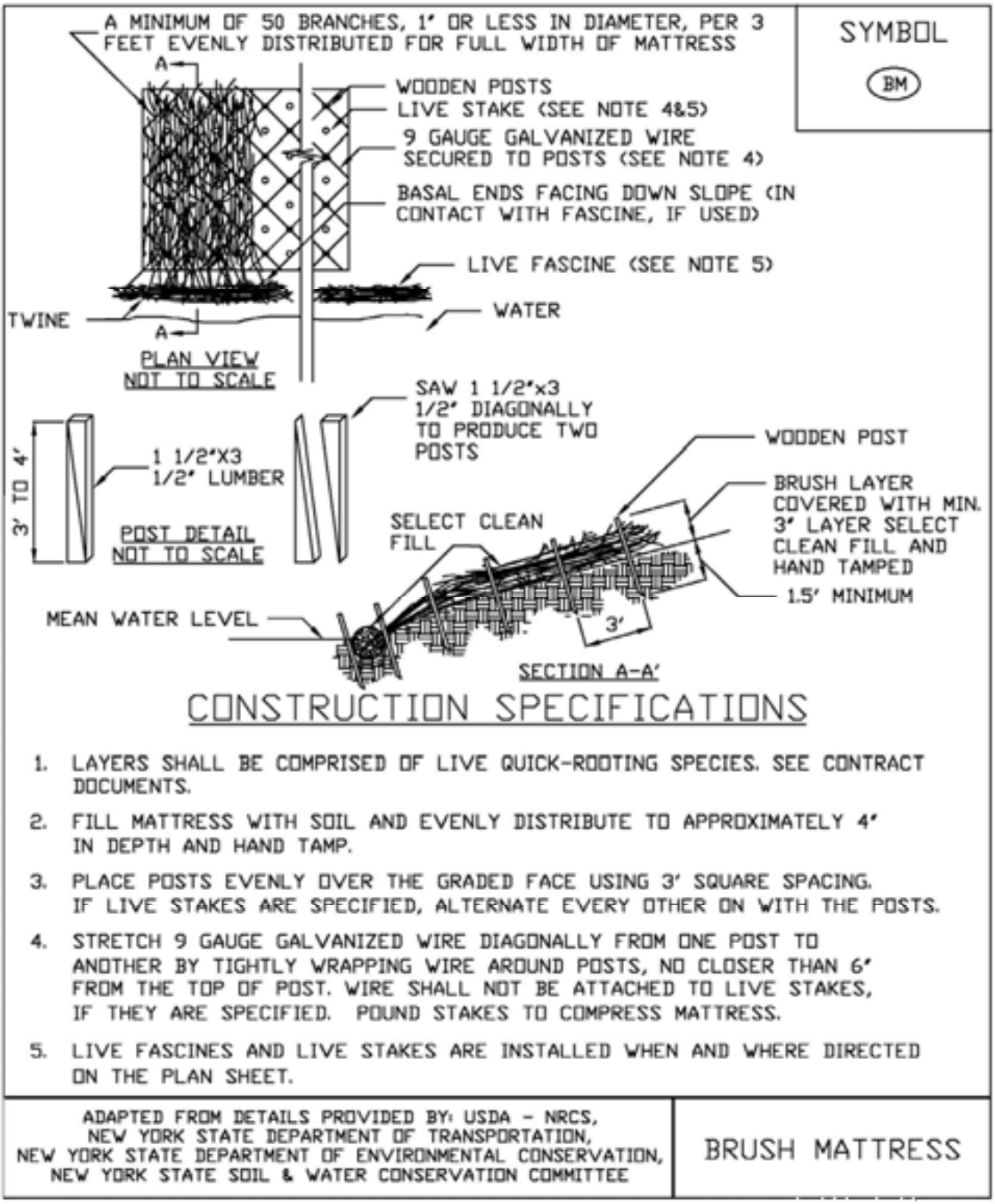
5. No. 9 wire will be attached to the stakes and tightened to secure the mattress.

6. Slope areas above the mattress will be shaped and seeded.

Maintenance

Scheduled inspections the first year are necessary to make sure the anchoring system is sound. Broken wire or missing stakes shall be replaced immediately. Any missing toe material shall be replaced. The brush mattress may need to be watered periodically during the first year if installation is done during the summer months.

Figure 4.7
Brush Mattress



CONSTRUCTION SPECIFICATIONS

1. LAYERS SHALL BE COMPRISED OF LIVE QUICK-ROOTING SPECIES. SEE CONTRACT DOCUMENTS.
2. FILL MATTRESS WITH SOIL AND EVENLY DISTRIBUTE TO APPROXIMATELY 4" IN DEPTH AND HAND TAMP.
3. PLACE POSTS EVENLY OVER THE GRADED FACE USING 3' SQUARE SPACING. IF LIVE STAKES ARE SPECIFIED, ALTERNATE EVERY OTHER ON WITH THE POSTS.
4. STRETCH 9 GAUGE GALVANIZED WIRE DIAGONALLY FROM ONE POST TO ANOTHER BY TIGHTLY WRAPPING WIRE AROUND POSTS, NO CLOSER THAN 6" FROM THE TOP OF POST. WIRE SHALL NOT BE ATTACHED TO LIVE STAKES, IF THEY ARE SPECIFIED. POUND STAKES TO COMPRESS MATTRESS.
5. LIVE FASCINES AND LIVE STAKES ARE INSTALLED WHEN AND WHERE DIRECTED ON THE PLAN SHEET.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE

BRUSH MATTRESS

STANDARD AND SPECIFICATIONS FOR FERTILIZER APPLICATION

Definition & Scope

The **permanent** incorporation of fertilizer into the planting zone of the soil profile to provide nutrient amendments to the soil for vigorous support to plant and vegetation growth.

Conditions Where Practice Applies

This standard applies to all areas where permanent seeding, sodding, and plant establishment is required. All application of fertilizer shall be in accordance with Nutrient Runoff Law - ECL Article 17, Title 21. Phosphorus runoff poses a threat to water quality. Therefore, under New York Law, fertilizer containing phosphorus may only be applied to lawn or non-agricultural turf when:

1. A soil test indicates that additional phosphorus is needed for growth of that lawn or non-agricultural turf, or

2. The fertilizer is used for newly established lawn or non -agricultural turf during the first growing season.

For projects located within watersheds where enhanced phosphorus removal standards are required as part of its post-construction stormwater management plan, use of any fertilizer containing more than 0.67 percent phosphate (P_20_5) content will be done only with a valid soil test demonstrating the need for that formulation.

Design Criteria

Fertilizer is sold with an analysis printed on the tag or bag shown as three numbers separated by a dash, such as 5-10-5. The first number is the percent of the total weight of the bag that is nitrogen (N), the second is the percent of phosphate (phosphorus, P), and the third is the percent of potash (potassium, K). Other elements are sometimes included and are listed with these three basic components.

For example a 40 lb bag of 5-10-5 fertilizer contains 5% of 40 lbs of Nitrogen which equals 2 lbs. There is 10% of 40 lbs of phosphate (phosphorus) which equals 4 lbs, and there is 5% of potash (potassium), another 2 lbs., for a total of 8 lbs of active fertilizer in the 40 lb bag. The rest is filler to aid in spreading the material over the area to be treated.

Specify the design fertilizer mix and application rates based on the results of the soil tests.

Specifications

1. In no case shall fertilizer be applied between December 1 and April 1 annually.

2. Fertilizer shall not be spread within 20 feet of a surface water.

3. Any fertilizer falling or spilled into impervious surface areas such as parking lots, roadways, and sidewalks should be immediately contained and legally applied or placed in an appropriate container.

4. Incorporate the fertilizer, and lime if specified, into the top 2-4 inches of the topsoil or soil profile.

5. When applying fertilizer by hydro seeding care should be taken to apply mix only to seed bed areas at an appropriate flow rate to prevent erosion and spraying onto impervious areas.

STANDARD AND SPECIFICATIONS FOR FIBER ROLL

Definition & Scope

A fiber roll is a coir (coconut fiber), straw, or excelsior roll encased in netting of jute, nylon, or burlap to dissipate energy along streambanks, channels, and bodies of water and to reduce sheet flow on slopes.

Conditions Where Practice Applies

Fiber rolls are used where the water surface levels are relatively constant. Artificially controlled streams for hydropower are not good candidates for this technique. The rolls provide a good medium for the introduction of herbaceous vegetation. Planting in the fiber roll is appropriate where the roll will remain continuously wet.

Design Criteria

1. The roll is placed in a shallow trench dug below baseflow or in a 4 inch trench on the slope contour and anchored by 2” x 2”, 3-foot long posts driven on each side of the roll (see Figure 4.8).

2. The roll is contained by a 9-gauge non-galvanized wire placed over the roll from post to post. Braided nylon rope (1/8" thick) may be used.

3. The anchor posts shall be spaced laterally 4 feet on center on both sides of the roll and driven down to the top of the roll.

4. Soil is placed behind the roll and planted with suitable herbaceous or woody vegetation. If the roll will be continuously saturated, wetland plants may be planted into voids created in the upper surface of the roll.

5. Where water levels may fall below the bottom edge of the roll, a brush layer of willow should be installed so as to lay across the top edge of the roll.

6. Where fiber rolls are used to reduce sheet flow on slopes they should be at least 12” in diameter and spaced according to the straw bale dike standard for sediment control.

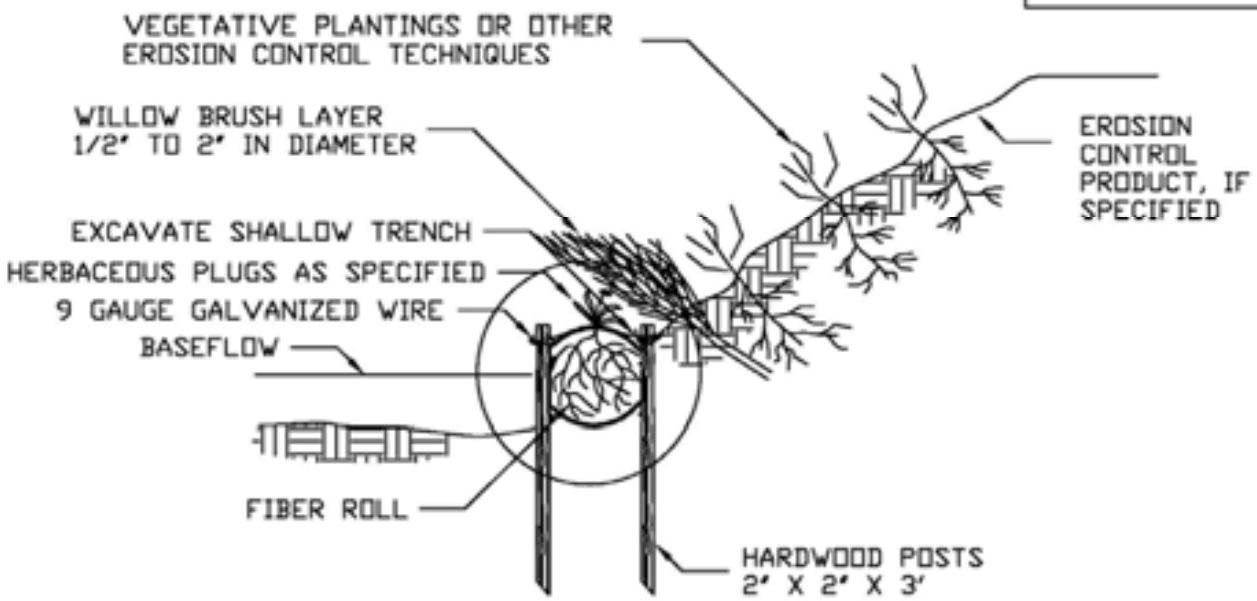
Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability.

Figure 4.8
Fiber Roll

SYMBOL

FR



CROSS SECTION
NOT TO SCALE

CONSTRUCTION SPECIFICATIONS

1. EXCAVATE A SHALLOW TRENCH SLIGHTLY BELOW BASEFLOW OR A 4" TRENCH ON SLOPE CONTOURS.
2. PLACE THE ROLL IN THE TRENCH AND ANCHOR WITH 2" x 2" POSTS PLACED ON BOTH SIDES OF THE ROLL AND SPACED LATERALLY ON 2' TO 4' CENTERS. TRIM THE TOP OF THE POSTS EVEN WITH THE EDGE OF THE ROLL, IF NECESSARY.
3. NOTCH THE POSTS AND TIE TOGETHER, ACROSS THE ROLL, WITH 9 GAUGE GALVANIZED WIRE OR 1/8" DIAMETER BRAIDED NYLON ROPE..
4. PLACE SOIL EXCAVATED FROM THE TRENCH BEHIND THE ROLL AND HAND TAMP. PLANT WITH SUITABLE HERBACEOUS OR WOODY VEGETATION AS SPECIFIED ELSEWHERE IN THE CONTRACT DOCUMENTS. VEGETATION SHALL BE PLACED IMMEDIATELY ADJACENT TO THE ROLL TO PROMOTE ROOT GROWTH INTO THE FIBER. HERBACEOUS VEGETATION, IF SPECIFIED, SHALL BE PLANTED INTO THE FIBER ROLL.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE	FIBER ROLL

STANDARD AND SPECIFICATIONS FOR LANDGRADING

Definition & Scope

Permanent reshaping of the existing land surface by grading in accordance with an engineering topographic plan and specification to provide for erosion control and vegetative establishment on disturbed, reshaped areas.

Design Criteria

The grading plan should be based upon the incorporation of building designs and street layouts that fit and utilize existing topography and desirable natural surrounding to avoid extreme grade modifications. Information submitted must provide sufficient topographic surveys and soil investigations to determine limitations that must be imposed on the grading operation related to slope stability, effect on adjacent properties and drainage patterns, measures for drainage and water removal, and vegetative treatment, etc.

Many municipalities and counties have regulations and design procedures already established for land grading and cut and fill slopes. Where these requirements exist, they shall be followed.

The plan must show existing and proposed contours of the area(s) to be graded. The plan shall also include practices for erosion control, slope stabilization, safe disposal of runoff water and drainage, such as waterways, lined ditches, reverse slope benches (include grade and cross section), grade stabilization structures, retaining walls, and surface and subsurface drains. The plan shall also include phasing of these practices. The following shall be incorporated into the plan:

1. Provisions shall be made to safely convey surface runoff to storm drains, protected outlets, or to stable water courses to ensure that surface runoff will not damage slopes or other graded areas; see standards and specifications for Grassed Waterway, Diversion, or Grade Stabilization Structure.

2. Cut and fill slopes that are to be stabilized with grasses shall not be steeper than 2:1. When slopes exceed 2:1, special design and stabilization consideration are required and shall be adequately shown on the plans. (Note: Where the slope is to be mowed, the slope should be no steeper than 3:1, although 4:1 is preferred because of safety factors related to mowing steep slopes.)

3. Reverse slope benches or diversion shall be provided whenever the vertical interval (height) of any 2:1 slope exceeds 20 feet; for 3:1 slope it shall be increased to 30 feet and for 4:1 to 40 feet. Benches shall be located to divide the slope face as equally as possible and shall convey the water to a stable outlet. Soils, seeps, rock outcrops, etc., shall also be taken into consideration when designing benches.

   A. Benches shall be a minimum of six feet wide to provide for ease of maintenance.

   B. Benches shall be designed with a reverse slope of 6:1 or flatter to the toe of the upper slope and with a minimum of one foot in depth. Bench gradient to the outlet shall be between 2 percent and 3 percent, unless accompanied by appropriate design and computations.

   C. The flow length within a bench shall not exceed 800 feet unless accompanied by appropriate design and computations; see Standard and Specifications for Diversion on page 3.9

4. Surface water shall be diverted from the face of all cut and/or fill slopes by the use of diversions, ditches and swales or conveyed downslope by the use of a designed structure, except where:

   A. The face of the slope is or shall be stabilized and the face of all graded slopes shall be protected from surface runoff until they are stabilized.

   B. The face of the slope shall not be subject to any concentrated flows of surface water such as from natural drainage ways, graded ditches, downspouts, etc.

   C. The face of the slope will be protected by anchored stabilization matting, sod, gravel, riprap, or other stabilization method.

5. Cut slopes occurring in ripable rock shall be serrated as shown in Figure 4.9 on page 4.26. The serrations shall be made with conventional equipment as the excavation is made. Each step or serration shall be constructed on the contour and will have steps cut at nominal two-foot intervals with nominal three-foot horizontal shelves. These steps will vary depending on the slope ratio or the cut slope. The nominal slope line is 1 ½: 1. These steps will weather and act to hold moisture, lime, fertilizer, and seed thus producing a much quicker and longer-lived vegetative cover and better slope stabilization. Overland flow shall be diverted from the top of all serrated cut slopes and carried to a suitable outlet.

6. Subsurface drainage shall be provided where necessary to intercept seepage that would otherwise adversely affect slope stability or create excessively wet site conditions.

7. Slopes shall not be created so close to property lines as to endanger adjoining properties without adequately protecting such properties against sedimentation, erosion, slippage, settlement, subsidence, or other related damages.

8. Fill material shall be free of brush, rubbish, rocks, logs, stumps, building debris, and other objectionable material. It should be free of stones over two (2) inches in diameter where compacted by hand or mechanical tampers or over eight (8) inches in diameter where compacted by rollers or other equipment. Frozen material shall not be placed in the fill nor shall the fill material be placed on a frozen foundation.

9. Stockpiles, borrow areas, and spoil shall be shown on the plans and shall be subject to the provisions of this Standard and Specifications.

10. All disturbed areas shall be stabilized structurally or vegetatively in compliance with the Permanent Construction Area Planting Standard on page 4.42.

Construction Specifications

See Figures 4.9 and 4.10 for details.

1. All graded or disturbed areas, including slopes, shall be protected during clearing and construction in accordance with the erosion and sediment control plan until they are adequately stabilized.

2. All erosion and sediment control practices and measures shall be constructed, applied and maintained in accordance with the erosion and sediment control plan and these standards.

3. Topsoil required for the establishment of vegetation shall be stockpiled in amount necessary to complete finished grading of all exposed areas.

4. Areas to be filled shall be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots, or other objectionable material.

5. Areas that are to be topsoiled shall be scarified to a minimum depth of four inches prior to placement of topsoil.

6. All fills shall be compacted as required to reduce erosion, slippage, settlement, subsidence, or other related problems. Fill intended to support buildings, structures, and conduits, etc., shall be compacted in accordance with local requirements or codes.

7. All fill shall be placed and compacted in layers not to exceed 9 inches in thickness.

8. Except for approved landfills or nonstructural fills, fill material shall be free of frozen particles, brush, roots, sod, or other foreign objectionable materials that would interfere with, or prevent, construction of satisfactory fills.

9. Frozen material or soft, mucky or highly compressible materials shall not be incorporated into fill slopes or structural fills.

10. Fill shall not be placed on saturated or frozen surfaces.

11. All benches shall be kept free of sediment during all phases of development.

12. Seeps or springs encountered during construction shall be handled in accordance with the Standard and Specification for Subsurface Drain on page 3.48 or other approved methods.

13. All graded areas shall be permanently stabilized immediately following finished grading.

14. Stockpiles, borrow areas, and spoil areas shall be shown on the plans and shall be subject to the provisions of this Standard and Specifications.

Figure 4.9
Typical Section of Serrated Cut Slope

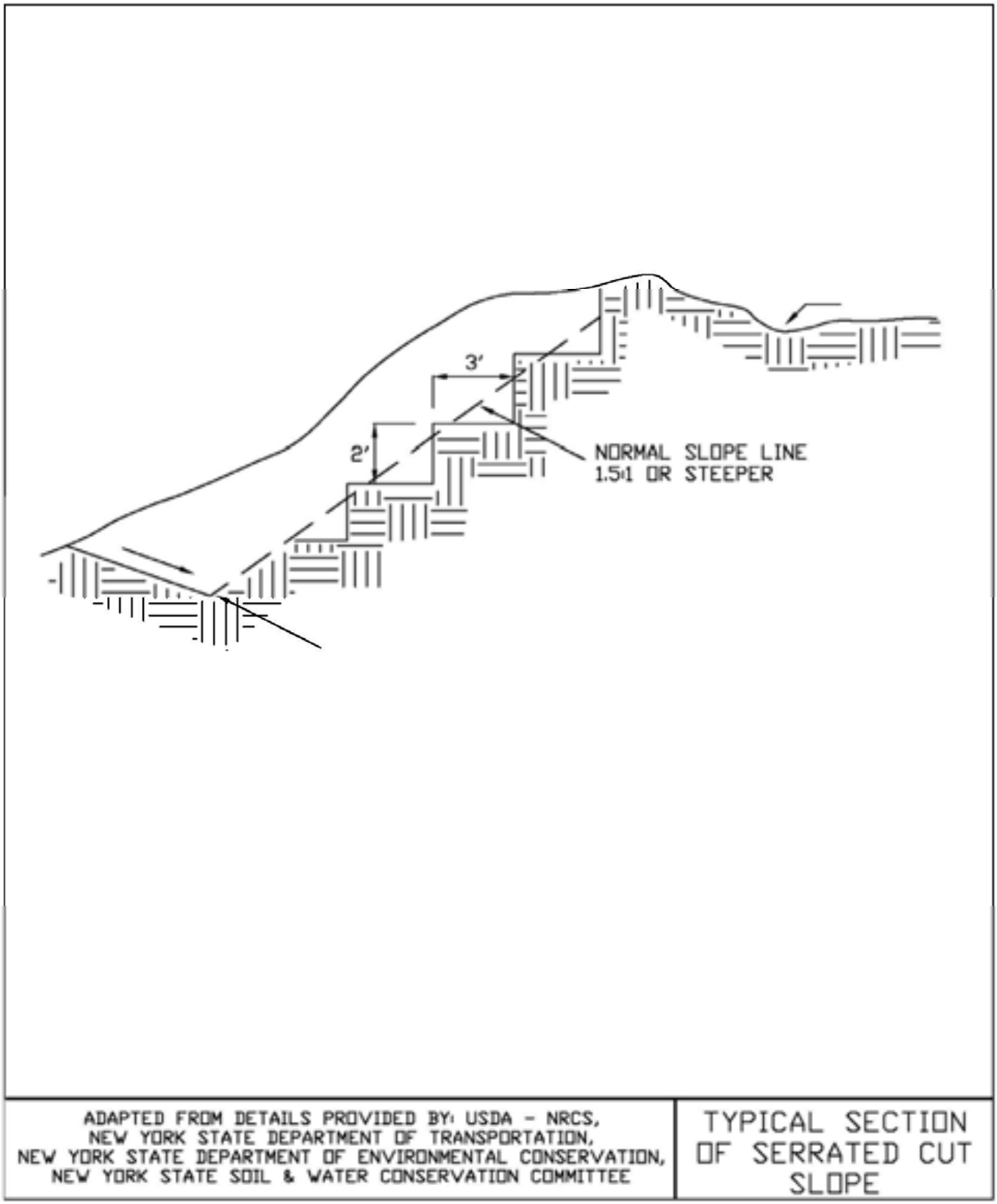


Figure 4.10
Landgrading

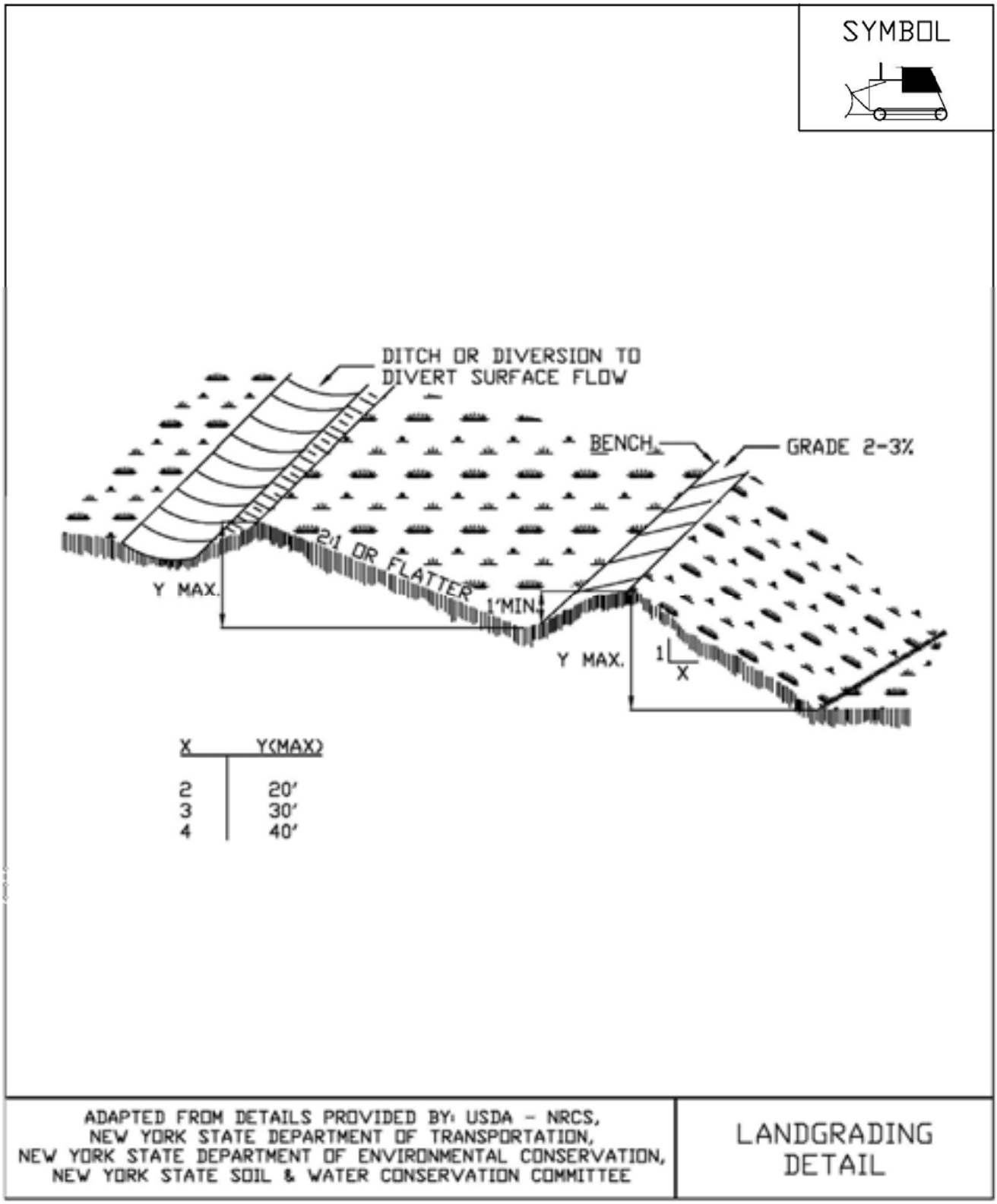


Figure 4.11
Landgrading - Construction Specifications

CONSTRUCTION SPECIFICATIONS

1. ALL GRADED OR DISTURBED AREAS INCLUDING SLOPES SHALL BE PROTECTED DURING CLEARING AND CONSTRUCTION IN ACCORDANCE WITH THE APPROVED EROSION AND SEDIMENT CONTROL PLAN UNTIL THEY ARE PERMANENTLY STABILIZED.
2. ALL SEDIMENT CONTROL PRACTICES AND MEASURES SHALL BE CONSTRUCTED, APPLIED AND MAINTAINED IN ACCORDANCE WITH THE APPROVED EROSION AND SEDIMENT CONTROL PLAN.
3. TOPSOIL REQUIRED FOR THE ESTABLISHMENT OF VEGETATION SHALL BE STOCKPILED IN AMOUNT NECESSARY TO COMPLETE FINISHED GRADING OF ALL EXPOSED AREAS.
4. AREAS TO BE FILLED SHALL BE CLEARED, GRUBBED, AND STRIPPED OF TOPSOIL TO REMOVE TREES, VEGETATION, ROOTS OR OTHER OBJECTIONABLE MATERIAL.
5. AREAS WHICH ARE TO BE TOPSOILED SHALL BE SCARIFIED TO A MINIMUM DEPTH OF FOUR INCHES PRIOR TO PLACEMENT OF TOPSOIL.
6. ALL FILLS SHALL BE COMPACTED AS REQUIRED TO REDUCE EROSION, SLIPPAGE, SETTLEMENT, SUBSIDENCE OR OTHER RELATED PROBLEMS. FILL INTENDED TO SUPPORT BUILDINGS, STRUCTURES AND CONDUITS, ETC. SHALL BE COMPACTED IN ACCORDANCE WITH LOCAL REQUIREMENTS OR CODES.
7. ALL FILL SHALL BE PLACED AND COMPACTED IN LAYERS NOT TO EXCEED 9 INCHES IN THICKNESS.
8. EXCEPT FOR APPROVED LANDFILLS, FILL MATERIAL SHALL BE FREE OF FROZEN PARTICLES, BRUSH, ROOTS, SOD, OR OTHER FOREIGN OR OTHER OBJECTIONABLE MATERIALS THAT WOULD INTERFERE WITH OR PREVENT CONSTRUCTION OF SATISFACTORY FILLS.
9. FROZEN MATERIALS OR SOFT, MUCKY OR HIGHLY COMPRESSIBLE MATERIALS SHALL NOT BE INCORPORATED IN FILLS.
10. FILL SHALL NOT BE PLACED ON SATURATED OR FROZEN SURFACES.
11. ALL BENCHES SHALL BE KEPT FREE OF SEDIMENT DURING ALL PHASES OF DEVELOPMENT.
12. SEEPS OR SPRINGS ENCOUNTERED DURING CONSTRUCTION SHALL BE HANDLED IN ACCORDANCE WITH THE STANDARD AND SPECIFICATION FOR SUBSURFACE DRAIN OR OTHER APPROVED METHOD.
13. ALL GRADED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY FOLLOWING FINISHED GRADING.
14. STOCKPILES, BORROW AREAS AND SPOIL AREAS SHALL BE SHOWN ON THE PLANS AND SHALL BE SUBJECT TO THE PROVISIONS OF THIS STANDARD AND SPECIFICATION.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE	LANDGRADING SPECIFICATIONS

STANDARD AND SPECIFICATIONS FOR LIME APPLICATION

Definition & Scope

Permanent incorporation of agricultural ground limestone within the top 2 to 6 inches of the soil profile to increase the soil pH from an acidic level to a neutral level to provide an active growth medium for vegetation.

Conditions Where Practice Applies

At all locations where a vigorous growth of vegetation is desired and the soil pH is less than 7.0 or neutral.

Design Criteria

Liming material sold in New York varies considerably in several ways. The mineral content (calcium and magnesium) of the limestone may be high or low and, the fineness or particle sizes vary between suppliers. Two types of limestone are sold. The most common is limestone high in calcium. Dolomitic limestone contains magnesium (Mg) and calcium (Ca). Limestone sold in NY varies from 0 to 20% Mg while the calcium content of lime varies from 14.7% to 51.5%. Particle size determines how rapidly the calcium and magnesium will react with the acid in the soil. The finer the particle sizes, the quicker the reaction.

When obtaining agricultural limestone, one should state on the specification that the amount should be adjusted to 100% effective neutralizing value (ENV). This is the way to compare materials as it adjusts for the reactive Ca and Mg and the particle size. The ENV is stated as the ratio needed to convert a limestone recommendation to 100% ENV. Thus, if the recommendation is 4 tons/acre of 100% ENV lime and the lime being used had an 80% ENV (1/ENV = 1.25), 4 times 1.25 or 5 tons/acre would be required.

The amount of limestone needed can be estimated by using the following table. A soil test is the only way to determine the soil pH. This table is very general, but it is useful for planning.

General lime guidelines (at 100% ENV)				
Initial Soil pH	Sands	Sandy Loams	Loam and Silt Loams	Silty Clay Loams
4.5	2.5	6.0	9.5	13.0
4.6-4.7	2.5	6.0	9.0	12.5
4.8-4.9	2.5	5.5	8.5	12.0
5.0-5.1	2.0	5.0	7.5	10.5
5.2-5.3	1.5	4.0	6.5	8.5
5.4-5.5	1.0	3.0	4.0	6.0
5.6-5.7	1.0	2.0	3.0	4.5
5.8-5.9	0.7	1.5	2.5	3.5
6.0-6.1	0.6	1.5	2.0	3.0
6.2-6.3	0.4	1.0	1.5	2.0
6.4-6.5	0.3	0.7	1.0	1.5
6.6-6.7	0.2	0.5	0.7	1.0

Lime guidelines are in tons per acre and are based on a plow depth of 8.0 inches. Correct rate if plowing to a different depth.

Conversion for small areas: 1 ton/acre = 2,000#/43,560 ft^2, 46#/1,000 ft^2

Note: Lime should not be applied within 50 feet of streams and wetlands.

STANDARD AND SPECIFICATIONS FOR LIVE CRIB WALL

Definition & Scope

A hollow box-like structure made with an interlocking arrangement of untreated logs or timber members spiked together and anchored into the slope. The structure is filled with suitable earthfill materials and layers of live branch cuttings which root inside the structure and extend into the slope. This protects exposed or eroded streambanks from the erosive forces of flowing water and stabilize the toe of slope to reduce slope steepness.

Conditions Where Practice Applies

Generally applicable where flows are less than 6 feet per second and no degradation of the streambed occurs. Can reduce steepness and provide stability where space is limited and a vertical structure is needed. It is not intended to be used where the integrity of a road or structure is dependent on the cribwall since it is not designed to resist large lateral earth pressures.

Design Criteria

1. The vegetated cribwall structure shall be designed to a height for its intended purpose.

2. Live branch cuttings should be 1/2 to 2 inches in diameter and long enough to reach from the front of the structure to the undisturbed soil.

3. The structure will be built with a batter of 1 to 12. Large spikes or rebar are required to secure the logs or timbers together (10 inches minimum).

4. Only untreated logs or timber shall be used in the cribwall.

5. Installation begins with excavating to a stable foundation 2' - 3' below the ground elevation at the toe of slope with the back of the excavation (to the slope) slightly deeper than the front.

6. The first course of logs is placed along the front and back of the excavated foundation approximately 4-5 feet apart and parallel to the slope contour.

7. The next course is placed at right angles on top of the previous course to overhang the front and back of the previous logs by 3-6 inches.

8. Each course is placed in the same manner and fastened to the preceding course to the desired grade.

9. Stone fill is placed in the bottom of the structure up to the ground level and up to the base flow in a stream channel.

10. Once the cribwall structure reaches the existing ground elevation, live branch cuttings are placed on the stone fill parallel with the slope contour.

11. The cuttings are then covered with select clean fill with a maximum size of 3 inches and not more than 20 percent passing a 200 sieve size.

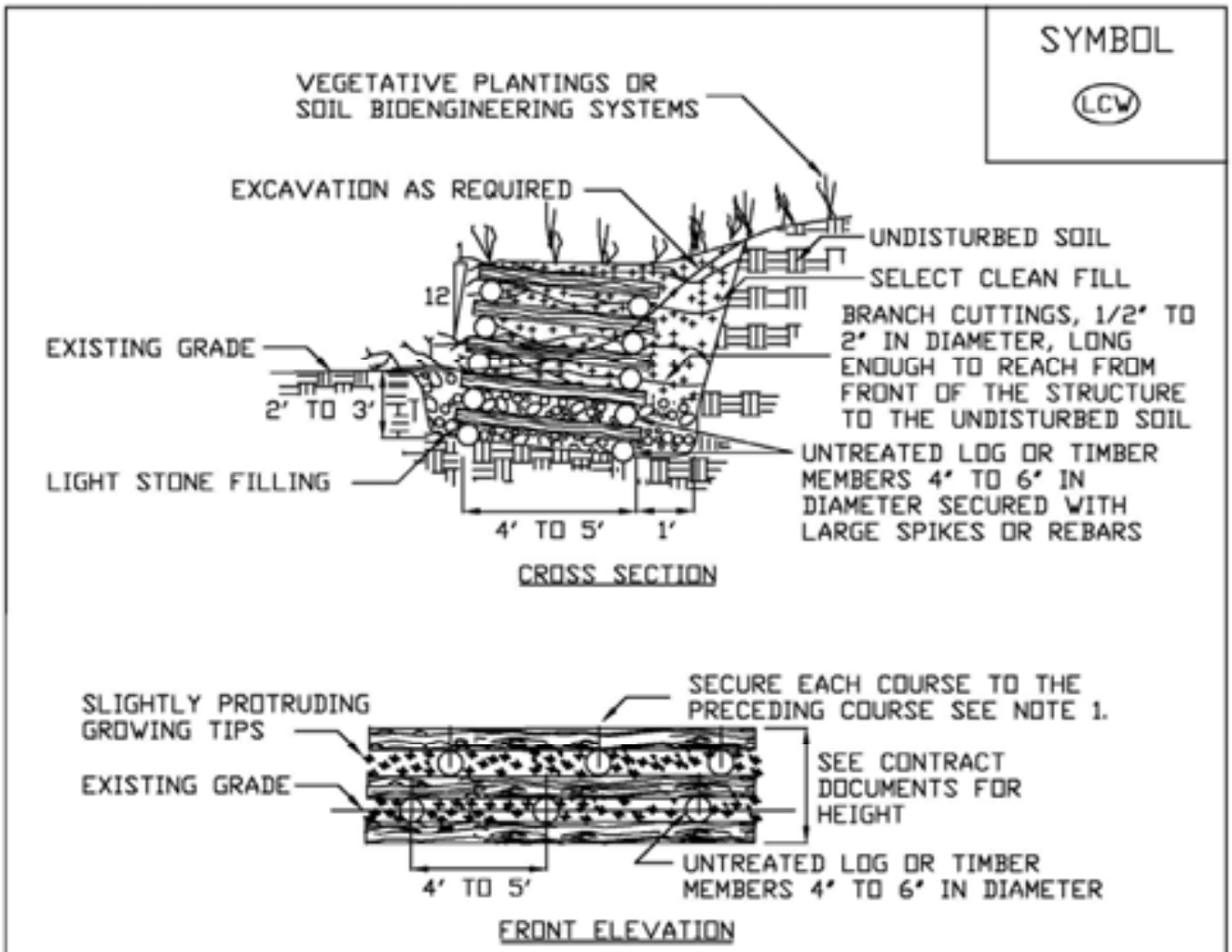
12. The live branch cuttings shall be placed at each course followed by the select fill to the top of the structure with the growing tips slightly protruding from the cribwall face.

13. The plant materials shall be kept in a healthy growing condition by watering. Also see maintenance below.

Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability. Plant materials may need to be watered periodically during the first growing season if installed during summer months.

Figure 4.12
Live Cribwall



CONSTRUCTION SPECIFICATIONS

1. EACH COURSE SHALL BE SECURED TO THE PRECEDING COURSE WITH SPIKES OR REBARS. SEE CONTRACT DOCUMENTS FOR SIZE AND LENGTH.
2. BACKFILL IN AND AROUND TIMBER CRIB WITH RIPRAP (LIGHT FILL) FROM BOTTOM OF EXCAVATION TO THE LOWER GROUND LEVEL, OR WHEN IN STREAM CHANNEL UP TO BASEFLOW.
3. EACH TRANSVERSE LOG COURSE CONTAINS LIVE CUTTINGS FOLLOWED BY A LAYER OF TAMPED BACKFILL.
4. EACH FACE LOG COURSE (FRONT AND REAR), AND THE AREA BEHIND THE STRUCTURE SHALL BE BACKFILLED AND HAND TAMPED.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE	LIVE CRIBWALL

STANDARD AND SPECIFICATIONS FOR LIVE FASCINES

Definition & Scope

The placement of groups or bundles of twigs, whips, or branches in shallow trenches, on the contour, on either cut or fill slopes. To stabilize slopes by slowing water movement down the slope, increasing infiltration, trapping slope sediments, and increasing soil stability with root systems.

Conditions Where Practice Applies

On sloping areas such as road cuts, slumped areas, road fills, gullies, and streambanks subject to erosion, seepage, or weathering, which have a low to medium hazard potential should slope failure occur. Slopes must be 1:1 or flatter.

Design Criteria

Materials—Shall be a native or nursery grown cultivar that is capable of performing the intended function.

Fascines—Shall be made by forming the bundles 8-15 feet long, 4 inches minimum in diameter, from stems no more than 1 inch in diameter.

Overlap—Fascines should be overlapped at the tapered ends a minimum of 1-foot.

Vertical Spacing—The spacing of the contours for the fascines is dependent on the degree of erosion or potential erosion at the site. Factors include slope steepness, soil type, drainage, and existing ground cover. The following is a general guide to selecting contour interval:

Slope	Contour Interval
1:1	3’
1.5:1	3’
2:1	4’
2.5:1	4’
3:1	5’
3.5:1	5’
4:1	6’
6:1	8’

See Figure 4.13 for details.

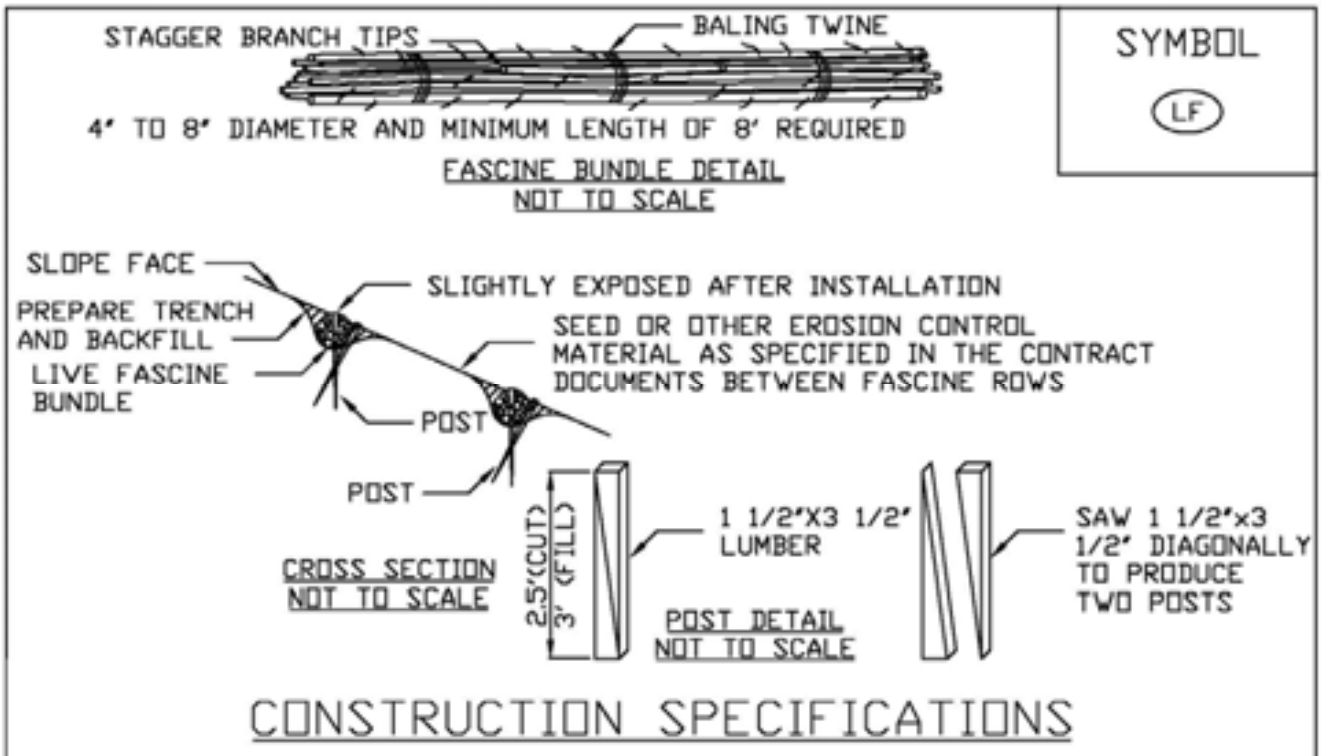
Construction Specifications

1. Fascines shall be 4 inches minimum in diameter.
2. Prior to placing the fascines, the slope shall be smoothed and graded with obstructions removed. Any structural measures for revetment, drainage, or surface water management will be installed first.
3. Working from the bottom of the slope to the top, excavate the fascine trench. Place fascines in trench and anchor with stakes spaced at 24 inches. Cover fascines with soil leaving about 10% exposed to view. Fascines shall be overlapped 12 inches minimum in the trench.
4. Soil shall be worked into the fascine and compacted by walking on the fascine being covered.
5. All disturbed areas should be seeded upon completion of fascine placement.

Maintenance

Regular inspection and maintenance of fascine installations should be conducted especially during the first year of establishment. Loose stakes should be reset and settled fill areas should be brought back to grade. Prompt corrections to gullies, sloughs or other evident problems shall be made.

Figure 4.13
Live Fascine



CONSTRUCTION SPECIFICATIONS

1. LIVE FASCINES SHALL BE PREPARED FROM FRESHLY CUT DORMANT PLANTS AND INSTALLED WITHIN 8 HOURS OF THE TIME THE MATERIAL IS HARVESTED, UNLESS PROPERLY STORED.
2. LIVE FASCINE SHALL BE OBTAINED FROM SOURCES APPROVED BY THE ENGINEER.
3. LIVE FASCINES SHALL BE 4" TO 8" IN DIAMETER. LENGTHS MAY VARY TO SUIT CONDITIONS. A MINIMUM LENGTH OF 8' IS REQUIRED.
4. THE TIPS OF THE BRANCHES WITHIN THE LIVE FASCINE SHALL BE STAGGERED.
5. LIVE FASCINES SHALL BE PLACED AS INDICATED IN THE CONTRACT DOCUMENTS.
6. BEGINNING AT THE BASE OF THE SLOPE, A TRENCH SHALL BE DUG LARGE ENOUGH TO CONTAIN THE LIVE FASCINES. THE LIVE FASCINES SHALL BE PLACED IN THE TRENCH. WHERE ENDS MEET IN THE TRENCH, THE FASCINES SHALL OVERLAP BY 18".
7. WOOD POSTS SHALL BE INSTALLED FLUSH TO THE TOP OF THE FASCINE EVERY 18" ALONG THE LENGTH OF THE BUNDLES AS SHOWN ON THE CROSS SECTION. WHERE SPECIFIED LIVE STAKES MAY BE USED IN PLACE OF POSTS.
8. THE TRENCH SHALL BE BACKFILLED WITH MOIST SOIL AND HAND TAMPED. THE TOP OF THE FASCINE SHALL BE SLIGHTLY EXPOSED WHEN THE INSTALLATION IS COMPLETE AS SHOWN ON THE CROSS SECTION.
9. SEED OR OTHER EROSION CONTROL MATERIAL SHALL BE USED BETWEEN THE FASCINE ROWS, AS SPECIFIED IN THE CONTRACT DOCUMENTS.
10. LIVE FASCINE TRENCHES SHALL BE FROM 3' TO 8' APART, ACCORDING TO SLOPE AND/OR THE CONTRACT DOCUMENTS.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE

LIVE FASCINE

STANDARD AND SPECIFICATIONS FOR LIVE STAKES

Definition & Scope

A stake or pole fashioned from live woody material to create a living root mat that stabilizes the soil by reinforcing and binding soil particles together and by contributing to the reduction of excess soil moisture.

Conditions Where Practice Applies

Live stakes are an appropriate technique for repair of small earth slips and slumps that are frequently wet and for stabilizing raw streambanks. This technique is for relatively uncomplicated site conditions when construction time is limited and an inexpensive vegetative method for stabilization is derived. It is not intended where structural integrity is required nor to resist large, lateral earth pressures.

Design Criteria

1. Live stakes shall be 1 - 2 inches in diameter and 2-6 feet long, depending on site application.

2. No leaf buds shall have initiated growth beyond 1/4" and the cambium layer shall be moist, green and healthy.

3. All material shall be maintained in a continuously cool, covered, and moist state prior to use and be in good condition when installed.

4. Materials harvested on site shall be installed the same day they are prepared. Nursery grown material shall be maintained in a moist condition until installed.

5. Installation Details

   A. The lengths of live cuttings/live stakes depends upon the application. If through riprap, the length shall extend through the surface of the stone fill. At least half the length shall be inserted into the soil, below the stone fill. Spacing along the waterline is usually 1 foot.

   B. Minimum 2 to 4 inches and two live buds of the live stake shall be exposed above the stone filling.

   C. Live stakes shall be cut to a point on the basal end for insertion in the ground.

   D. Use a dead blow hammer to drive stakes into the ground. The hammer head should be filled with shot or sand. A dibble, iron bar, or similar tool shall be used to make a pilot hole to prevent damaging the material during installation.

   E. Live cuttings shall be inserted by hand into pilot holes.

   F. When possible, tamp soil around live stakes.

   G. Care shall be taken not to damage the live stakes during installation. Those damaged at the top during installation shall be trimmed back to undamaged condition.

Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability. Plant materials may need to be watered periodically during the first growing season if installed during summer months.

Figure 4.14
Live Stake

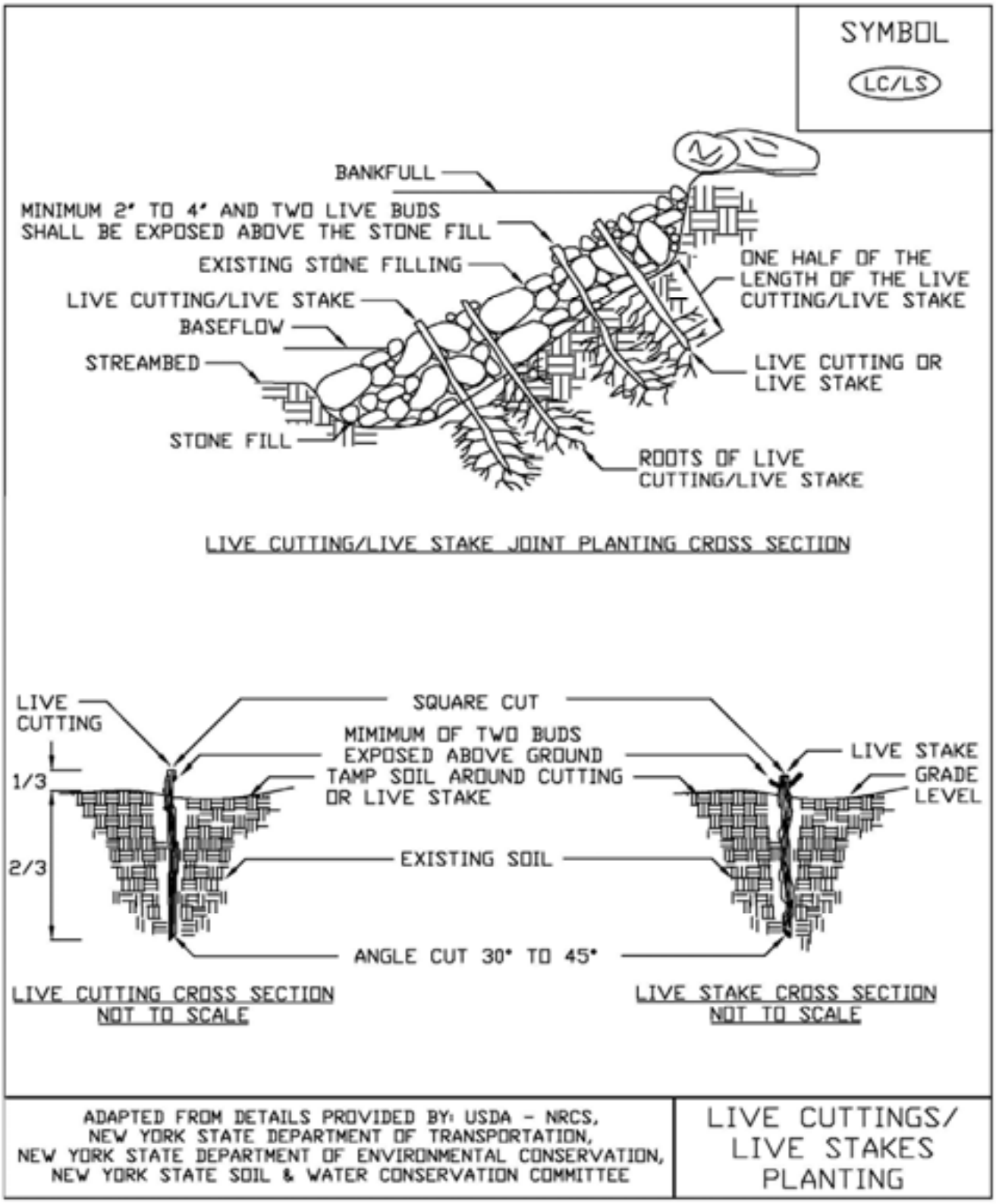


Figure 4.15
Live Stake Construction Specifications

SYMBOL

LC/LS

CONSTRUCTION SPECIFICATIONS

1. CARE SHALL BE TAKEN NOT TO DAMAGE THE LIVE CUTTINGS/LIVE STAKES DURING INSTALLATION. THOSE DAMAGED SHALL BE LEFT IN PLACE AND SUPPLEMENTED WITH AN INTACT LIVE CUTTING/LIVE STAKE.
2. THE LENGTHS OF LIVE CUTTINGS/LIVE STAKES DEPENDS UPON THE APPLICATION. THE LENGTH SHALL EXTEND THROUGH THE SURFACE OF THE STONE FILL. AT LEAST HALF THE LENGTH SHALL BE INSERTED IN TO THE SOIL, BELOW THE STONE FILL.
3. A PILOT HOLE IS REQUIRED TO ENSURE THAT THE LIVE CUTTING/LIVE STAKE IS NOT DAMAGED WHEN DRIVEN THROUGH THE STONE FILLING. ACCESS SHALL BE MADE THROUGH THE USE OF A DIBBLE BAR, OR SIMILAR TOOL TO WORK AN OPENING THROUGH THE ROCK LAYER.
4. MINIMUM 2" TO 4" AND TWO LIVE BUDS OF THE LIVE CUTTING/LIVE STAKE SHALL BE EXPOSED ABOVE THE STONE FILLING.
5. LIVE CUTTINGS SHALL RANGE FROM 1/2" TO 1" IN DIAMETER AND BE FROM 1' TO 4' IN LENGTH.
6. LIVE STAKES SHALL RANGE FROM 1" TO 4" IN DIAMETER AND BE FROM 5' TO 6' IN LENGTH.
7. SEE CONTRACT DOCUMENTS FOR SPECIES, SIZE, SPACING, LOCATION, AND FINAL DETERMINATION ON USE OF CUTTINGS OR STAKES.
8. LIVE CUTTINGS/LIVE STAKES SHALL BE CUT TO A POINT ON THE BASAL END FOR INSERTION IN THE GROUND.
9. USE A DEAD BLOW HAMMER TO DRIVE STAKES INTO THE GROUND. (HAMMER HEAD FILLED WITH SHOT OR SAND.) A DIBBLE, IRON BAR, OR SIMILAR TOOL SHALL BE USED TO MAKE A PILOT HOLE TO PREVENT DAMAGING THE MATERIAL DURING INSTALLATION.
10. LIVE CUTTINGS SHALL BE INSERTED BY HAND INTO PILOT HOLES.
11. WHEN POSSIBLE, TAMP SOIL AROUND LIVE CUTTING/LIVE STAKES.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS,
NEW YORK STATE DEPARTMENT OF TRANSPORTATION,
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION,
NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE

LIVE CUTTINGS/
LIVE STAKES
PLANTING SPECS

STANDARD AND SPECIFICATIONS FOR LOOSE STABILIZATION BLANKETS

Definition and Scope

Blankets of various materials placed pneumatically, hydraulically, or other means on a prepared planting area or a critical area where existing vegetation can remain to reduce rain splash and sheet erosion and promote vegetative stabilization.

Conditions Where Practice Applies

Loose blankets are an appropriate stabilization practice for any soil surface that is rocky, frozen, flat, or steep. They can be used on streambanks, road cuts and embankments, and construction site areas where stormwater runoff occurs as sheet flow. They should not be used in areas of concentrated flow.

Design Criteria

Compost Blanket

Material: The compost infill shall be well decomposed (matured at least 3 months), weed-free, organic matter. It shall be aerobically composted, possess no objectionable odors, and contain less than 1%, by dry weight, of man-made foreign matter. The physical parameters of the compost shall meet the standards listed in Table 5.2 - Compost Standards Table. **Note: All biosolids composts produced in New York State (or approved for importation) must meet NYS DEC's 6 NYCRR Part 360 (Soild Waste Management Facilities) requirements. The Part 360 requirements are equal to or more stringent than 40 CFR Part 503 which ensure safe standards for pathogen reduction and heavy metal content. When using compost blankets adjacent to surface waters, the compost should have a low nutrient value.**

Placement: The method of application and depth of compost depend upon site conditions. Vegetation of the compost blanket is generally archived by incorporating seed into the compost before it is applied. However, seeding may occur after the application if needed.

The compost application rate will be in accordance with the following table. Compost is not recommended for slopes steeper than 2H:1V. Slopes with problem soils and more runoff will require greater application rates.

Compost Application Rates		
Slope Length (ft)	<3H:1V Slopes	3H:1V to 2H:1V Slopes
20 or less	270 cy/acre (2" Layer)	540 cy/acre (4" Layer)
20 to 60	405 cy/acre (3" Layer)	675 cy/acre (5" Layer)
60 to 100	540 cy/acre (4" Layer)	810 cy/acre (6" Layer)*
* For slopes between 2H:1V and 1H:1V use this rate with a max. slope length of 40 ft.		

Construction Specifications

1. Compost shall be placed evenly and must provide 100% soil coverage (no soil visible). On highly unstable soils, use compost in conjunction with appropriate structural measures.

2. Spread the compost uniformly to the design thickness by hand or mechanically (e.g. with a manure spreader, front end loader, dozer, pneumatic blower, etc.) and then track (compact) the compost layer using a bulldozer or other appropriate equipment.

3. When using a pneumatic (blower) unit, shoot the compost directly at soil, to provide a tighter interface between the soil and compost and prevent water from moving between the two layers.

4. Apply compost layer approximately 3 feet beyond the top of the slope or overlap it into existing vegetation.

5. Follow by seeding or ornamental planting as specified.

6. When planting immediate grass, wildflower, or legume seeding or ornamental planting, use only a well composted product that contains no substances toxic to plants.

7. Very coarse composts should be avoided if the slope is to be landscaped or seeded, as it will make planting and crop establishment more difficult. Composts containing fibrous particles that range in size produce a more stable mat.

Hydraulically Applied Blankets

These blankets are formed by mixing different types of materials with water and are then applied using standard hydroseeding equipment. These blankets should not be used in areas of concentrated flow such as ditches and channels.

A. Bonded Fiber Matrix (BFM) - This method makes use of a cross-linked hydrocolloid tackifier to bond thermally processed wood fibers. Application rates vary according to site conditions. For slopes up to 3H:1V the BFM should be applied at a rate of 3,000 lb/acre. Steeper slopes may need as much as 4,000 lb/acre in accordance with the manufacturer's recommendations.

   BFMs should only be used when no rain is forecast for at least 48 hours following the application. This is to allow the tackifier sufficient time to cure properly. Once properly applied, a BFM is very effective in preventing accelerated erosion. **Bonded Fiber Matrix should not be applied between September 30 and April 1 to allow for proper curing of the polymer.**

B. Flexible Growth Medium (FGM) - This method has the added component of 1/2 inch long, crimped manmade fibers which add a mechanical bond to the chemical bond provided by BFMs. This increases the blanket's resistance to both raindrop impact and erosion due to runoff. Unlike BFMs, a flexible growth medium typically does not require a curing time to be effective. Properly applied, an FGM is also very effective.

   There is no need to smooth the slope prior to application. In fact some roughening of the surface (either natural or mechanically induced) is preferable. However, large rocks (≥ 9 inches) and existing rills should be removed prior to application. Mixing and application rates should follow manufacturer's recommendations.

C. Polymer Stabilized Fiber Matrix (PSFM) - PSFMs make use of a linear soil stabilization tackifier that works directly on soil to maintain soil structure, maintain pore space capacity and flocculate dislodged sediment that will significantly reduce runoff turbidity. PSFMs can be used in re-vegetation applications and for site winterization and/or dormant seeding - fall planting for spring germination - applications. Application rates vary according to site conditions and should be in accordance with manufacturers recommendations.

Construction Specifications

BFMs, FGMs and PSFMs are typically applied in two stages. Unless specifically recommended to be applied in one application by the manufacturer, the seed mixture and soil amendments should be applied first. If the seed is applied at the same time as the hydraulically applied blankets, the bonded fibers may keep the seed from making sufficient contact with the soil to germinate. After the seed mixture is applied, the hydraulically applied blankets should be sprayed over the area at the required application rate, according to the manufactures recommendations.

STANDARD AND SPECIFICATIONS FOR MULCHING

Definition and Scope

Applying coarse plant residue or chips, or other suitable materials, to cover the soil surface to provide initial erosion control while a seeding or shrub planting is establishing. Mulch will conserve moisture and modify the surface soil temperature and reduce fluctuation of both. Mulch will prevent soil surface crusting and aid in weed control. Mulch can also be used alone for temporary stabilization in non-growing months. Use of stone as a mulch could be more permanent and should not be limited to non-growing months.

Conditions Where Practice Applies

On soils subject to erosion and on new seedings and shrub plantings. Mulch is useful on soils with low infiltration rates by retarding runoff.

Criteria

Site preparation prior to mulching requires the installation of necessary erosion control or water management practices and drainage systems.

Slope, grade and smooth the site to fit needs of selected mulch products.

Remove all undesirable stones and other debris to meet the needs of the anticipated land use and maintenance required.

Apply mulch after soil amendments and planting is accomplished or simultaneously if hydroseeding is used.

Select appropriate mulch material and application rate or material needs. Hay mulch shall not be used in wetlands or in areas of permanent seeding. Clean straw mulch is preferred alternative in wetland application. Determine local availability.

Select appropriate mulch anchoring material.

NOTE: The best combination for grass/legume establishment is straw (cereal grain) mulch applied at 2 ton/ acre (90 lbs./1000sq.ft.) and anchored with wood fiber mulch (hydromulch) at 500 – 750 lbs./acre (11 – 17 lbs./1000 sq. ft.). The wood fiber mulch must be applied through a hydroseeder immediately after mulching.

Table 4.2
Guide to Mulch Materials, Rates, and Uses

Mulch Material	Quality Standards	per 1000 Sq. Ft.	per Acre	Depth of Application	Remarks
Wood chips or shavings	Air-dried. Free of objectionable coarse material	500-900 lbs.	10-20 tons	2-7”	Used primarily around shrub and tree plantings and recreation trails to inhibit weed competition. Resistant to wind blowing. Decomposes slowly.
Wood fiber cellulose (partly digested wood fibers)	Made from natural wood usually with green dye and dispersing agent	50 lbs.	2,000 lbs.	—	Apply with hydromulcher. No tie down required. Less erosion control provided than 2 tons of hay or straw.
Gravel, Crushed Stone or Slag	Washed; Size 2B or 3A—1 1/2”	9 cu. yds.	405 cu. yds.	3”	Excellent mulch for short slopes and around plants and ornamentals. Use 2B where subject to traffic. (Approximately 2,000 lbs./cu. yd.). Frequently used over filter fabric for better weed control.
Hay or Straw	Air-dried; free of undesirable seeds & coarse materials	90-100 lbs. 2-3 bales	2 tons (100-120 bales)	cover about 90% surface	Use small grain straw where mulch is maintained for more than three months. Subject to wind blowing unless anchored. Most commonly used mulching material. Provides the best micro-environment for germinating seeds.
Jute twisted yarn	Undyed, unbleached plain weave. Warp 78 ends/yd., Weft 41 ends/ yd. 60-90 lbs./roll	48” x 50 yds. or 48” x 75 yds.	—	—	Use without additional mulch. Tie down as per manufacturers specifications. Good for center line of concentrated water flow.
Excelsior wood fiber mats	Interlocking web of excelsior fibers with photodegradable plastic netting	4’ x 112.5’ or 8’ x 112.5’.	—	—	Use without additional mulch. Excellent for seeding establishment. Anchor as per manufacturers specifications. Approximately 72 lbs./roll for excelsior with plastic on both sides. Use two sided plastic for centerline of waterways.
Straw or coconut fiber, or combination	Photodegradable plastic net on one or two sides	Most are 6.5 ft. x 3.5 ft.	81 rolls	—	Designed to tolerate higher velocity water flow, centerlines of waterways, 60 sq. yds. per roll.

Table 4.3
Mulch Anchoring Guide

Anchoring Method or Material	Kind of Mulch to be Anchored	How to Apply
1. Peg and Twine	Hay or straw	After mulching, divide areas into blocks approximately 1 sq. yd. in size. Drive 4-6 pegs per block to within 2" to 3" of soil surface. Secure mulch to surface by stretching twine between pegs in criss-cross pattern on each block. Secure twine around each peg with 2 or more tight turns. Drive pegs flush with soil. Driving stakes into ground tightens the twine.
2. Mulch netting	Hay or straw	Staple the light-weight paper, jute, wood fiber, or plastic nettings to soil surface according to manufacturer's recommendations. Should be biodegradable. Most products are not suitable for foot traffic.
3. Wood cellulose fiber	Hay or straw	Apply with hydroseeder immediately after mulching. Use 500 lbs. wood fiber per acre. Some products contain an adhesive material ("tackifier"), possibly advantageous.
4. Mulch anchoring tool	Hay or straw	Apply mulch and pull a mulch anchoring tool (blunt, straight discs) over mulch as near to the contour as possible. Mulch material should be "tucked" into soil surface about 3".
5. Tackifier	Hay or straw	Mix and apply polymeric and gum tackifiers according to manufacturer's instructions. Avoid application during rain. A 24-hour curing period and a soil temperature higher than 45^0 Fahrenheit are required.

STANDARD AND SPECIFICATIONS FOR PERMANENT CONSTRUCTION AREA PLANTING

Definition & Scope

Establishing **permanent** grasses with other forbs and/or shrubs to provide a minimum 80% perennial vegetative cover on areas disturbed by construction and critical areas to reduce erosion and sediment transport. Critical areas may include but are not limited to steep excavated cut or fill slopes as well as eroding or denuded natural slopes and areas subject to erosion.

Conditions Where Practice Applies

This practice applies to all disturbed areas void of, or having insufficient, cover to prevent erosion and sediment transport. See additional standards for special situations such as sand dunes and sand and gravel pits.

Criteria

All water control measures will be installed as needed prior to final grading and seedbed preparation. Any severely compacted sections will require chiseling or disking to provide an adequate rooting zone, to a minimum depth of 12", see Soil Restoration Standard. The seedbed must be prepared to allow good soil to seed contact, with the soil not too soft and not too compact. Adequate soil moisture must be present to accomplish this. If surface is powder dry or sticky wet, postpone operations until moisture changes to a favorable condition. If seeding is accomplished within 24 hours of final grading, additional scarification is generally not needed, especially on ditch or stream banks. Remove all stones and other debris from the surface that are greater than 4 inches, or that will interfere with future mowing or maintenance.

Soil amendments should be incorporated into the upper 2 inches of soil when feasible. **The soil should be tested to determine the amounts of amendments needed.** Apply ground agricultural limestone to attain a pH of 6.0 in the upper 2 inches of soil. If soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 600 lbs. per acre of 5-5-10 or equivalent. If manure is used, apply a quantity to meet the nutrients of the above fertilizer. This requires an appropriate manure analysis prior to applying to the site. Do not use manure on sites to be planted with birdsfoot trefoil or in the path of concentrated water flow.

Seed mixtures may vary depending on location within the state and time of seeding. Generally, warm season grasses should only be seeded during early spring, April to May. These grasses are primarily used for vegetating excessively drained sands and gravels. See Standard and Specification for Sand and Gravel Mine Reclamation. Other grasses may be seeded any time of the year when the soil is not frozen and is workable. When legumes such as birdsfoot trefoil are included, spring seeding is preferred. See Table 4.4, "Permanent Construction Area Planting Mixture Recommendations" for additional seed mixtures.

General Seed Mix:	Variety	lbs./ acre	lbs/1000 sq. ft.
Red Clover[1] OR	Acclaim, Rally, Red Head II, Renegade	8[2]	0.20
Common white clover[1]	Common	8	0.20
PLUS			
Creeping Red Fescue	Common	20	0.45
PLUS			
Smooth Bromegrass OR	Common	2	0.05
Ryegrass (perennial)	Pennfine/Linn	5	0.10

[1] add inoculant immediately prior to seeding
[2] Mix 4 lbs each of Empire and Pardee OR 4 lbs of Birdsfoot and 4 lbs white clover per acre. All seeding rates are given for Pure Live Seed (PLS)

Pure Live Seed, or (PLS) refers to the amount of live seed in a lot of bulk seed. Information on the seed bag label includes the type of seed, supplier, test date, source of seed, purity, and germination. Purity is the percentage of pure seed. Germination is the percentage of pure seed that will produce normal plants when planted under favorable conditions.

To compute Pure Live Seed multiply the "germination percent" times the "purity" and divide that by 100 to get Pure Live Seed.

$$\text{Pure Live Seed (PLS)} = \frac{\text{\% Germination} \times \text{\% Purity}}{100}$$

For example, the PLS for a lot of Kentucky Blue grass with 75% purity and 96% germination would be calculated as follows:

$$\frac{(96) \times (75)}{100} = 72\% \text{ Pure Live Seed}$$

For 10lbs of PLS from this lot =

$$\frac{10}{0.72} = 13.9 \text{ lbs}$$

Therefore, 13.9 lbs of seed is the actual weight needed to meet 10lbs PSL from this specific seed lot.

Time of Seeding: The optimum timing for the general seed mixture is early spring. Permanent seedings may be made any time of year if properly mulched and adequate moisture is provided. Late June through early August is not a good time to seed, but may facilitate covering the land without additional disturbance if construction is completed. Portions of the seeding may fail due to drought and heat. These areas may need reseeding in late summer/fall or the following spring.

Method of seeding: Broadcasting, drilling, cultipack type seeding, or hydroseeding are acceptable methods. Proper soil to seed contact is key to successful seedings.

Mulching: Mulching is essential to obtain a uniform stand of seeded plants. Optimum benefits of mulching new seedings are obtained with the use of small grain straw applied at a rate of 2 tons per acre, and anchored with a netting or tackifier. See the Standard and Specifications for Mulching for choices and requirements.

Irrigation: Watering may be essential to establish a new seeding when a drought condition occurs shortly after a new seeding emerges. Irrigation is a specialized practice and care must be taken not to exceed the application rate for the soil or subsoil. When disconnecting irrigation pipe, be sure pipes are drained in a safe manor, not creating an erosion concern.

80% Perennial Vegetative Cover

50% Perennial Vegetative Cover

Table 4.4
Permanent Construction Area Planting Mixture Recommendations

Seed Mixture	Variety	Rate in lbs./acre (PLS)	Rate in lbs./ 1, 000 ft^2
Mix #1			
Creeping red fescue	Ensylva, Pennlawn, Boreal	10	.25
Perennial ryegrass	Pennfine, Linn	10	.25
*This mix is used extensively for shaded areas.			
Mix #2			
Switchgrass	Shelter, Pathfinder, Trailblazer, or Blackwell	20	.50
*This rate is in pure live seed, this would be an excellent choice along the upland edge of a wetland to filter runoff and provide wildlife benefits. In areas where erosion may be a problem, a companion seeding of sand lovegrass should be added to provide quick cover at a rate of 2 lbs. per acre (0.05 lbs. per 1000 sq. ft.).			
Mix #3			
Switchgrass	Shelter, Pathfinder, Trailblazer, or Blackwell	4	.10
Big bluestem	Niagara	4	.10
Little bluestem	Aldous or Camper	2	.05
Indiangrass	Rumsey	4	.10
Coastal panicgrass	Atlantic	2	.05
Sideoats grama	El Reno or Trailway	2	.05
Wildflower mix		.50	.01
*This mix has been successful on sand and gravel plantings. It is very difficult to seed without a warm season grass seeder such as a Truax seed drill. Broadcasting this seed is very difficult due to the fluffy nature of some of the seed, such as bluestems and indiangrass.			
Mix #4			
Switchgrass	Shelter, Pathfinder, Trailblazer, or Blackwell	10	.25
Coastal panicgrass	Atlantic	10	.25
*This mix is salt tolerant, a good choice along the upland edge of tidal areas and roadsides.			
Mix #5			
Saltmeadow cordgrass (Spartina patens)—This grass is used for tidal shoreline protection and tidal marsh restoration. It is planted by vegetative stem divisions. 'Cape' American beachgrass can be planted for sand dune stabilization above the saltmeadow cordgrass zone.			
Mix #6			
Creeping red fescue	Ensylva, Pennlawn, Boreal	20	.45
Chewings Fescue	Common	20	.45
Perennial ryegrass	Pennfine, Linn	5	.10
Red Clover	Common	10	.45
*General purpose erosion control mix. Not to be used for a turf planting or play grounds.			

STANDARD AND SPECIFICATIONS FOR RECREATION AREA SEEDING

Definition & Scope

Establishing **permanent** grasses, legumes, vines, shrubs, trees, or other plants, or selectively reducing stand density and trimming woody plants, to improve an area for recreation. To increase the attractiveness and usefulness of recreation areas and to protect the soil and plant resources.

Conditions Where Practice Applies

On any area planned for recreation use, lawns, and areas that will be maintained in a closely mowed condition.

Specifications

ESTABLISHING GRASSES (Turfgrass)

The following applies for playgrounds, parks, athletic fields, camping areas, picnic areas, passive recreation areas such as lawns, and similar areas.

1. Time of Planting

Fall planting is preferred. Seed after August 15. In the spring, plant until May 15.

If seeding is done between May 15 and August 15, irrigation may be necessary to ensure a successful seeding.

2. Site Preparation

   A. Install needed water and erosion control measures and bring area to be seeded to desired grades. A minimum of 4 in. topsoil is required.

   B. Prepare seedbed by loosening soil to a depth of 4-6 inches and decompacting required areas per Soil Restoration Standard.

   C. See Standard and Specification of Topsoiling.

   D. Lime to a pH of 6.5. See Lime Application Standard.

   E. **Fertilize as per soil test** or, if soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 850 pounds of 5-5-10 or equivalent per acre (20 lbs/1,000 sq. ft.). See Fertilizer Application Standard.

   F. Incorporate lime and fertilizer in top 2-4 inches of topsoil.

   G. Smooth. Remove sticks, foreign matter, and stones over 1 inch in diameter, from the surface. Firm the seedbed.

3. Planting

Use a cultipacker type seeder if possible. Seed to a depth of 1/8 to 1/4 inch. If seed is to be broadcast, cultipack or roll after seeding. If hyroseeded, lime and fertilizer may be applied through the seeder, and rolling is not practical.

4. Mulching

Mulch all seedings in accordance with Standard and Specifications for Mulching. Small grain straw is the best material.

5. Seed Mixtures

Select seed mixture for site conditions and intended use from Table 4.5.

6. Contact Cornell Cooperative Extension Turf Specialist for suitable varieties.

Turf-type tall fescues have replaced the old KY31 tall fescues. New varieties have finer leaves and are the most resistant grass to foot traffic. Do not mix it with fine textured grasses such as bluegrass and red fescue.

Common ryegrass and redtop, which are relatively short lived species, provide quick green cover. Improved lawn cultivars of perennial ryegrass provide excellent quality turf, but continue to lack winter hardiness.

Common white clover can be added to mixtures at the rate of 1-2 lbs/acre to help maintain green color during the dry summer period; however, they will not withstand heavy traffic. Avoid using around swimming areas as flowers attract bees which can be easily stepped on.

Table 4.5
Recreation Turfgrass Seed Mixture

Site - Use	Species (% by weight)	lbs/1.000 ft^2 (PLS)	lbs/acre (PLS)
Sunny Sites (well, moderately well, and somewhat poorly drained soils)	***Athletic fields and similar areas***		
	80% Hard fescue	2.4-3.2	105-138
	20% Perennial ryegrass	0.6-0.8	25-37
		3.0-4.0	130-175
	OR, for southern and eastern, NY 50% Hard fescue	1.5-2.0	65-88
	50% perennial ryegrass	1.5-2.0	65-87
		3.0-4.0	130-175
	OR, 100% Creeping Red Fescue	3.4-4.6	150-200
	General recreation areas and lawns (Medium to high maintenance)		
	65% Creeping red fescue	2.0-2.6	85-114
	20% Perennial ryegrass	0.6-0.8	26-35
	15% Fine fescue	0.4-0.6	19-26
		3.0-4.0	130-175
	OR, 100% Creeping red fescue	3.4-4.6	150-200
Sunny Droughty Sites (general recreation areas and lawns, low maintenance) (somewhat excessively to excessively drained soils, excluding Long Island)	65% Fine fescue	2.6-3.3	114-143
	15% Perennial ryegrass	0.6-0.7	26-33
	20% Creeping red fescue	0.8-1.0	35-44
		4.0-5.0	175-220
	OR, 100% Creeping red fescue	3.4-4.6	150-200
Shady Dry Sites (well to somewhat poorly drained soils)	65% fine fescue	2.6-3.3	114-143
	15% perennial ryegrass	0.6-0.7	26-33
	20% Creeping red fescue	0.8-1.0	35-44
	OR	4.0-5.0	174-220
	80% blend of shade-tolerant Ceral rye	2.4-3.2	105-138
	20% perennial ryegrass	0.6-0.8	25-37
	OR	3.0-4.0	130-175
	100% Creeping red fescue	3.4-4.6	150-200
Shady Wet Sites (somewhat poor to poorly drained soils)	70% Creeping red fescue	1.4-2.1	60-91
	30% blend of shade-tolerant Hard fescue	0.6-0.9	25-39
	OR	2.0-3.0	85-130
	100% Chewings fescue	3.4-4.6	150-200

For varieties suitable for specific locations, contact Cornell Cooperative Extension Turf Specialist.
Reference: Thurn, M.C., N.W. Hummel, and A.M. Petrovic. Cornell Extension Pub. Info. Bulletin 185 Revised. HomeLawns Establishment and Maintenance. 1994.

7. Fertilizing—First Year

Apply fertilizer as indicated by the soil test three to four weeks after germination (spring seedlings). If test results have not been obtained, apply 1 pound nitrogen/1,000 square feet using a complete fertilizer with a 2-1-1 or 4-1-3 ratio. Summer and early fall seedings, apply as above unless air temperatures are above 85ºF for an extended period. Wait for cooler temperatures to fertilize. Late fall/ winter seedings, fertilize in spring.

8. Restrict Use

New seedlings should be protected from use for one full year or a spring and fall growth cycle where possible to allow development of a dense sod with good root structure.

MAINTAINING GRASSES

1. Maintain a pH of 6.0 - 7.0.

2. Fertilize in late May to early June as follows with 5-5-10 analysis fertilizer at the rate of 5 lbs./1,000 sq. ft. and repeat in late August if sod density is not adequate. Avoid fertilizing when heat is greater than 85ºF. Top dress weak sod annually in the spring, but at least once every 2 to 3 years. **Fertilize in accordance with soil test analysis**, after determining adequate topsoil depth exists.

3. Aerate compacted or heavily used areas, like athletic fields, annually as soon as soil moisture conditions permit. Aerate area six to eight times using a spoon or hollow tine type aerator. Do not use solid spike equipment.

4. Reseed bare and thin areas annually with original seed mix.

STANDARD AND SPECIFICATIONS FOR RETAINING WALLS

Definition & Scope

A **permanent** structural wall constructed and located to prevent soil movement by retaining soil in place and preventing slope failures and movement of material down steep slopes.

Conditions Where Practice Applies

A retaining wall may be used where site constraints will not allow slope shaping and seeding to stabilize an area. Slope areas that demonstrate seepage problems or experience erosive conditions at the toe can utilize retaining walls to help stabilize these areas. Retaining walls can be built from mortared block or stone, cast-in-place concrete, railroad ties, gabions, and more recently, precast concrete modular units and segmented walls that form a gravity retaining wall (see Figure 4.16 and 4.17). These precast units allow for ease and quickness of installation while their granular backfill provides drainage. Selection of materials and type of wall should be based on hazard potential, load conditions, soil parameters, groundwater conditions, site constraints, and aesthetics.

Design Criteria

The design of any retaining wall structure must address the aspects of foundation bearing capacity, sliding, overturning, drainage and loading systems. **These are complex systems that should be designed by a licensed professional engineer.**

Bearing Capacity – A minimum factor of safety of 1.5 should be maintained as the ratio of the ultimate bearing capacity to the designed unit loading. Spread footers and other methods may be used to meet factor requirements.

Sliding – A minimum factor of 2.0 should be maintained against sliding. This factor can be reduced to 1.5 when passive pressures on the front of the wall are ignored.

Overturning – A minimum factor of safety of 1.5 should be used as the ratio of the resisting moment (that which tends to keep the wall in place) to the overturning moment.

Drainage – Unless adequate provisions are made to control both surface and groundwater behind the retaining wall, a substantial increase in active pressures tending to slide or overturn the wall will result. When backfill is sloped down to a retaining wall, surface drainage should be provided. Drainage systems with adequate outlets should be provided behind retaining walls that are placed in cohesive soils. Drains should be graded or protected by filters so soil material will not move through the drainfill.

Load systems – Several different loads or combination of loads need to be considered when designing a retaining wall. The minimum load is the level backfill that the wall is being constructed to retain. Its unit weight will vary depending on its composition.

Additional loads such as line loads, surcharge loads, or slope fills, will add to make the composite design load system for the wall.

Construction Specifications

Concrete Walls

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings and removing all objectionable material.
2. Subgrade will be compacted and kept moist at least 2 hours prior to placement of concrete.
3. Steel reinforcing will be in accordance with the schedule on the drawings and kept free of rust, scale, or dirt.
4. Exposed edges will be chamfered ¾ inches.
5. Drainfill will meet the gradations shown on the drawings.

6. Weep holes will be provided as drain outlets as shown on the drawings.

7. Concrete will be poured and cured in accordance with American Concrete Institute (ACI) specifications.

Precast Units

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings.

2. Subgrade will be compacted and trimmed to receive the leveling beam.

3. Precast units will be placed in accordance with the manufacturers recommendation.

4. Granular fill placed in the precast bins shall be placed in 3-foot lifts, leveled off and compacted with a plate vibrator.

Segmented Walls

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings.

2. Sub-grade will be compacted and screeded to form the base for the first course of wall units.

3. Units will be placed in accordance with the manufacturers recommendations, with each succeeding lift anchored and pinned as specified.

4. Granular fill will be placed behind the segmented wall to provide drainage. It shall be compacted with a plate vibrator. A drainage outlet will be provided as specified on the construction drawings.

Gabions

1. Foundation will be prepared by excavating to the lines and grades shown on the drawings.

2. Subgrade will be compacted and leveled to receive first layer of gabions. The first row will be keyed into the existing grade at the toe, a minimum of 1.5 feet.

3. Gabions will be placed according to the manufacturers recommendations.

4. Gabions will be filled with stone or crushed rock from 4 to 8 inches in diameter.

Non-Mortared Stone Walls

1. Foundation will be prepared by excavating to the lines and grade shown on the drawings.

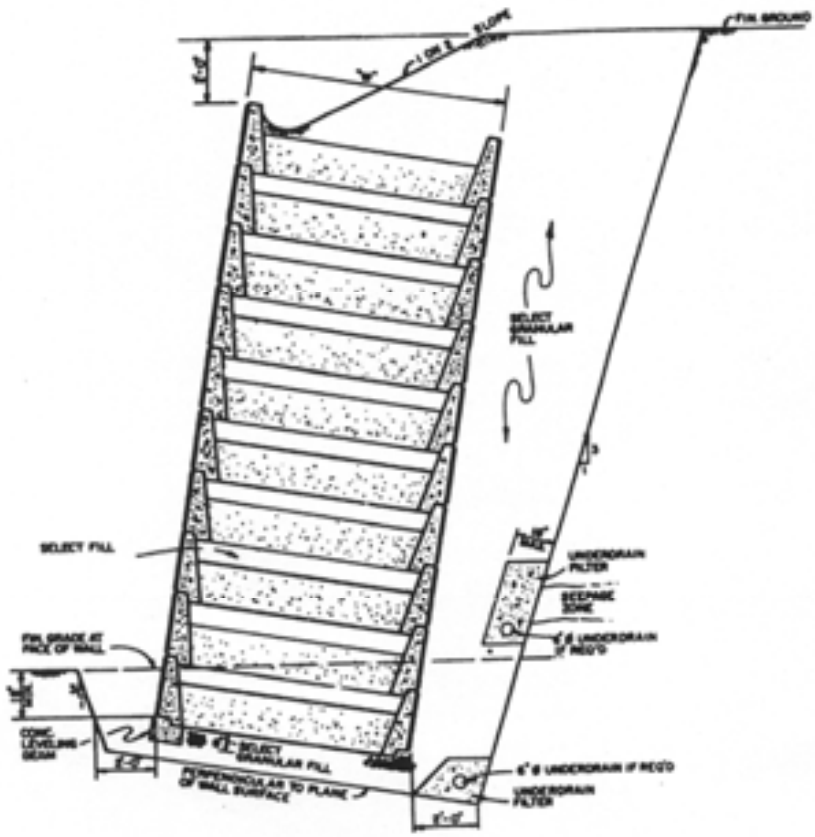
2. Subgrade will be compacted and leveled to receive monolithic stone. First row will be placed 1.0 feet below design toe elevation.

3. Stone will be placed horizontally with long dimension parallel to face of wall except at return ends.

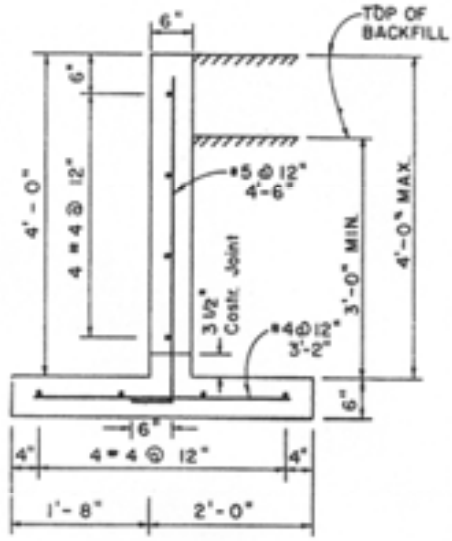
4. Maximum of 3 lifts of stone each approximately 2' thick without pinning. Where stones do not fit in good ontact, pinning with two steel #8 re-bar dowels is required.

5. Backside of stone will be filled with a minimum of 2' of #1 and #2 stone between filter fabric against parent soil and rock to provide drainage.

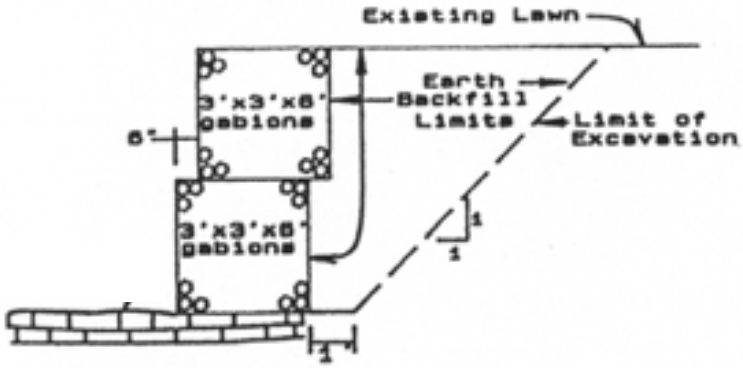
Figure 4.16
Typical Retaining Wall Examples
(Schematic only - not to be used for design)



Precast Units

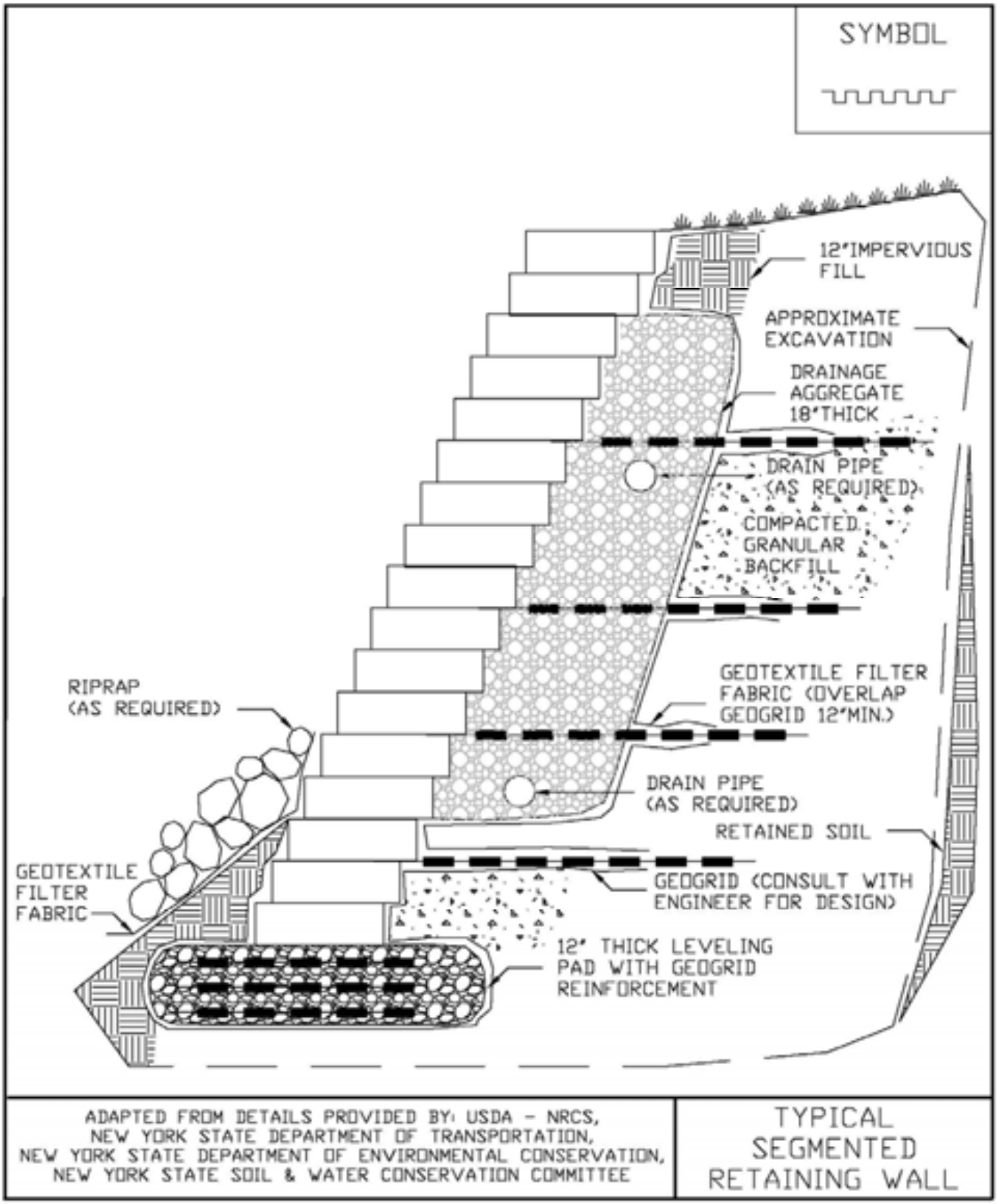


Cast In Place Concrete



Gabions

Figure 4.17
Typical Segmented Retaining Wall Example
(Schematic only - not to be used for design)



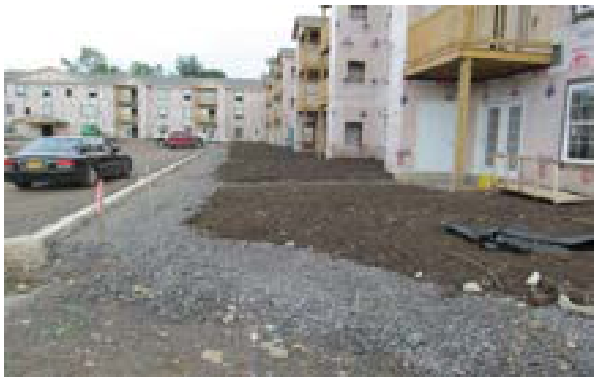
STANDARD AND SPECIFICATIONS FOR SOIL RESTORATION

Definition & Scope

The decompaction of areas of a development site or construction project where soils have been disturbed to recover the original properties and porosity of the soil; thus providing a sustainable growth medium for vegetation, reduction of runoff and filtering of pollutants from stormwater runoff.

Conditions Where Practice Applies

Soil restoration is to be applied to areas whose heavy construction traffic is done and final stabilization is to begin. This is generally applied in the cleanup, site restoration, and landscaping phase of construction followed by the permanent establishment of an appropriate ground cover to maintain the soil structure. Soil restoration measures should be applied over and adjacent to any runoff reduction practices to achieve design performance.



Design Criteria

1. Soil restoration areas will be designated on the plan views of areas to be disturbed.
2. Soil restoration will be completed in accordance with Table 4.6 on page 4.53.

Specification for Full Soil Restoration

During periods of relatively low to moderate subsoil moisture, the disturbed subsoils are returned to rough grade and the following Soil Restoration steps applied:

1. Apply 3 inches of compost over subsoil. The compost shall be well decomposed (matured at least 3 months), weed-free, organic matter. It shall be aerobically composted, possess no objectionable odors, and contain less than 1%, by dry weight, of man-made foreign matter. The physical parameters of the compost shall meet the standards listed in Table 5.2 - Compost Standards Table, except for "Particle Size" 100% will pass the 1/2" sieve. **Note: All biosolids compost produced in New York State (or approved for importation) must meet NYS DEC's 6 NYCRR Part 360 (Solid Waste Management Facilities) requirements. The Part 360 requirements are equal to or more stringent than 40 CFR Part 503 which ensure safe standards for pathogen reduction and heavy metals content.**

2. Till compost into subsoil to a depth of at least 12 inches using a cat-mounted ripper, tractor mounted disc, or tiller, to mix and circulate air and compost into the subsoil.
3. Rock-pick until uplifted stone/rock materials of four inches and larger size are cleaned off the site.
4. Apply topsoil to a depth of 6 inches.
5. Vegetate as required by the seeding plan. Use appropriate ground cover with deep roots to maintain the soil structure.
6. Topsoil may be manufactured as a mixture or a mineral component and organic material such as compost.

At the end of the project an inspector should be able to push a 3/8" metal bar 12 inches into the soil just with body weight. This should not be performed within the drip line of any existing trees or over utility installations that are within 24 inches of the surface.

Maintenance

Keep the site free of vehicular and foot traffic or other weight loads. Consider pedestrian footpaths.

Table 4.6
Soil Restoration Requirements

Type of Soil Disturbance	Soil Restoration Requirement		Comments/Examples
No soil disturbance	Restoration not permitted		Preservation of Natural Features
Minimal soil disturbance	Restoration not required		Clearing and grubbing
Areas where topsoil is stripped only - no change in grade	HSG A&B	HSG C&D	Protect area from any ongoing construction activities.
	Apply 6 inches of topsoil	Aerate* and apply 6 inches of topsoil	
Areas of cut or fill	HSG A&B	HSG C&D	
	Aerate* and apply 6 inches of topsoil	Apply full Soil Restoration**	
Heavy traffic areas on site (especially in a zone 5-25 feet around buildings but not within a 5 foot perimeter around foundation walls)	Apply full Soil Restoration (decompaction and compost enhancement)		
Areas where Runoff Reduction and/or Infiltration practices are applied	Restoration not required, but may be applied to enhance the reduction specified for appropriate practices.		Keep construction equipment from crossing these areas. To protect newly installed practice from any ongoing construction activities construct a single phase operation fence area
Redevelopment projects	Soil Restoration is required on redevelopment projects in areas where existing impervious area will be converted to pervious area.		

* Aeration includes the use of machines such as tractor-drawn implements with coulters making a narrow slit in the soil, a roller with many spikes making indentations in the soil, or prongs which function like a mini-subsoiler.
** Per "Deep Ripping and De-compaction, DEC 2008".

STANDARD AND SPECIFICATIONS FOR STABILIZATION WITH SOD

Definition & Scope

Stabilizing restored, exposed soil surfaces by establishing long term stands of grass with sod to reduce damage from sediment and runoff to downstream areas and enhance natural beauty.

Conditions Where Practice Applies

On exposed soils that have a potential for causing off site environmental damage where a quick vegetative cover is desired. Moisture, either applied or natural, is essential to success.

Design Criteria

1. Sod shall be bluegrass or a bluegrass/red fescue mixture or a perennial ryegrass for average sites. (CAUTION: Perennial ryegrass has limited cold tolerance and may winter kill.) Use turf type cultivars of tall fescue for shady, droughty, or otherwise more critical areas. For variety selection, contact Cornell Cooperative Extension Turf Specialist.

2. Sod shall be machine cut at a uniform soil thickness of 3/4 inch, plus or minus 1/4 inch. Measurement for thickness shall exclude top growth and thatch.

3. Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.

4. Sod shall be free of weeds and undesirable coarse weedy grasses. Wild native or pasture grass sod shall not be used unless specified.

5. Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.

6. Sod shall be harvested, delivered, and installed within a period of 36 hours. Sod not transplanted within this period shall be inspected and approved by the contracting officer or his designated representative prior to its installation.

Site Preparation

Fertilizer and lime application rates shall be determined by soil tests. Under unusual circumstances where there is insufficient time for a complete soil test and the contracting officer agrees, fertilizer and lime materials may be applied in amounts shown in subsection 2 below. Slope land such as to provide good surface water drainage. Avoid depressions or pockets.

1. Prior to sodding, the surface shall be smoothed and cleared of all trash, debris, and of all roots, brush, wire, grade stakes and other objects that would interfere with planting, fertilizing or maintenance operations.

2. **The soil should be tested to determine the amounts of amendments needed.** Where the soil is acid or composed of heavy clays, ground limestone shall be spread to raise the pH to 6.5. If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 20 lbs. of 5-5-10 (or equivalent) and mix into the top 3 inches of soil with the required lime for every 1,000 square feet. Soil should be moist prior to sodding. Arrange for temporary storage of sod to keep it shaded and cool.

Sod Installation

1. For the operation of laying, tamping, and irrigating for any areas, sod shall be completed within eight hours. During periods of excessively high temperature, the soil shall be lightly moistened immediately prior to laying the sod.

2. The first row of sod shall be laid in a straight line with subsequent rows placed parallel to, and tightly wedged against, each other. Lateral joints shall be staggered to promote more uniform growth and strength. Ensure that sod is not stretched or overlapped and that all joints are butted tight in order to prevent voids which would cause air drying of the roots. On sloping areas where erosion may be a problem, sod shall be laid with the long edges parallel to the contour and with

staggered joints.

3. Secure the sod by tamping and pegging, or other approved methods. As sodding is completed in any one section, the entire area shall be rolled or tamped to ensure solid contact of roots with the soil surface.

4. Sod shall be watered immediately after rolling or tamping until the underside of the new sod pad and soil surface below the sod are thoroughly wet. Keep sod moist for at least two weeks.

Sod Maintenance

1. In the absence of adequate rainfall, watering shall be performed daily, or as often as deemed necessary by the inspector, during the first week and in sufficient quantities to maintain moist soil to a depth of 4 inches. Watering should be done in the morning. Avoid excessive watering during applications.

2. After the first week, sod shall be watered as necessary to maintain adequate moisture and ensure establishment.

3. The first mowing should not be attempted until sod is firmly rooted. No more than 1/3 of the grass leaf shall be removed by the initial cutting or subsequent cuttings. Grass height shall be maintained between 2 and 3 inches unless otherwise specified. Avoid heavy mowing equipment for several weeks to prevent rutting.

4. If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply fertilizer three to four weeks after sodding, at a rate of 1 pound nitrogen/1,000 sq.ft. Use a complete fertilizer with a 2-1-1 ratio.

5. Weed Control: Target herbicides for weeds present. Consult current Cornell Pest Control Recommendations for Commercial Turfgrass Management or consult the local office of Cornell Cooperative Extension.

6. Disease Control: Consult the local office of the Cornell Cooperative Extension.

Additional References

1. Home Lawns, Establishment and Maintenance, CCE Information Bulletin 185, Revised November 1994. Cornell University, Ithaca, NY.

2. Installing a Sod Lawn. CCE Suffolk County, NY. Thomas Kowalsick February 1994, Revised January 1999. www.cce.cornell.edu/counties/suffolk/grownet

STANDARD AND SPECIFICATIONS FOR SURFACE ROUGHENING

Definition & Scope

Roughening a bare soil surface whether through creating horizontal grooves across a slope, stair-stepping, or tracking with construction equipment to aid the establishment of vegetative cover from seed, to reduce runoff velocity and increase infiltration, and to reduce erosion and provide for trapping of sediment.

Conditions Where Practice Applies

All construction slopes require surface roughening to facilitate stabilization with vegetation, particularly slopes steeper than 3:1.

Design Criteria

There are many different methods to achieve a roughened soil surface on a slope. No specific design criteria is required. However, the selection of the appropriate method depends on the type of slope. Methods include tracking, grooving, and stair-stepping. Steepness, mowing requirements, and/or a cut or fill slope operation are all factors considered in choosing a roughening method.

Construction Specifications

1. Cut Slope, No mowing.

   A. Stair-step grade or groove cut slopes with a gradient steeper than 3:1 (Figure 4.18).

   B. Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes of soft rock with some soil are particularly suited to stair-step grading.

   C. Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" to the vertical wall.

   D. Do not make vertical cuts more than 2 feet in soft materials or 3 feet in rocky materials.

Grooving uses machinery to create a series of ridges and depressions that run perpendicular to the slope following the contour. Groove using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth of a front-end loader bucket. Do not make the grooves less than 3 inches deep or more than 15 inches apart.

2. Fill Slope, No mowing

   A. Place fill to create slopes with a gradient no steeper than 2:1 in lifts 9 inches or less and properly compacted. Ensure the face of the slope consists of loose, uncompacted fill 4 to 6 inches deep. Use grooving as described above to roughen the slope, if necessary.

   B. Do not back blade or scrape the final slope face.

3. Cuts/Fills, Mowed Maintenance

   A. Make mowed slopes no steeper than 3:1.

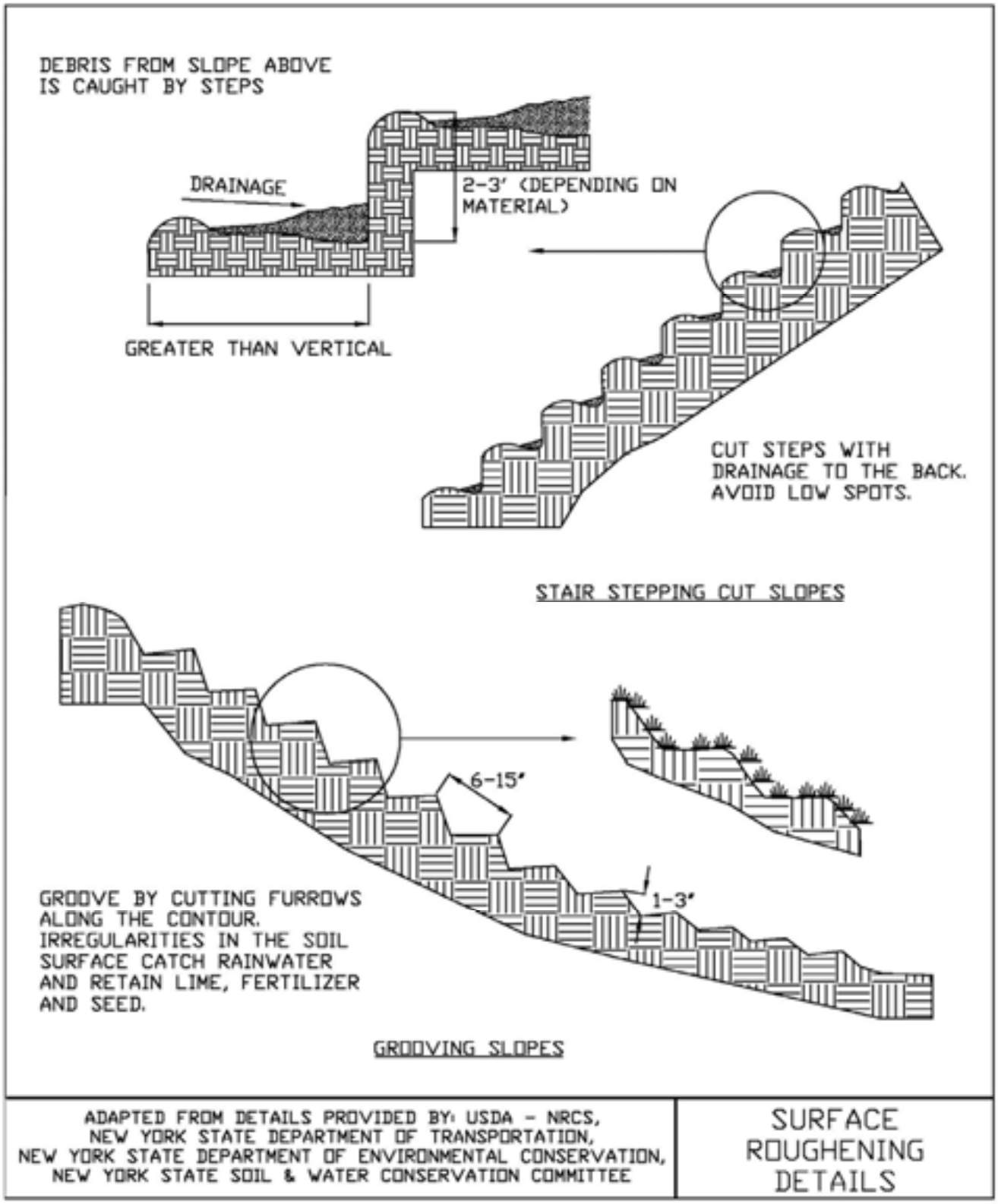
   B. Roughen these areas to shallow grooves by normal tilling, disking, harrowing, or use of cultipacker-seeder. Make the final pass of such tillage equipment on the contour.

   C. Make grooves at least 1 inch deep and a maximum of 10 inches apart.

   D. Excessive roughness is undesirable where mowing is planned.

Tracking should be used primarily in sandy soils to avoid undue compaction of the soil surface. Tracking is generally not as effective as the other roughening methods described. (It has been used as a method to track down mulch.) Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.

Figure 4.18
Surface Roughening



STANDARD AND SPECIFICATIONS FOR TEMPORARY CONSTRUCTION AREA SEEDING

Definition & Scope

Providing temporary erosion control protection to disturbed areas and/or localized critical areas for an interim period by covering all bare ground that exists as a result of construction activities or a natural event. Critical areas may include but are not limited to steep excavated cut or fill slopes and any disturbed, denuded natural slopes subject to erosion.

Conditions Where Practice Applies

Temporary seedings may be necessary on construction sites to protect an area, or section, where final grading is complete, when preparing for winter work shutdown, or to provide cover when permanent seedings are likely to fail due to mid-summer heat and drought. The intent is to provide temporary protective cover during temporary shutdown of construction and/or while waiting for optimal planting time.

Criteria

Water management practices must be installed as appropriate for site conditions. The area must be rough graded and slopes physically stable. Large debris and rocks are usually removed. Seedbed must be seeded within 24 hours of disturbance or scarification of the soil surface will be necessary prior to seeding.

Fertilizer or lime are not typically used for temporary seedings.

IF: Spring or summer or early fall, then seed the area with ryegrass (annual or perennial) at 30 lbs. per acre (Approximately 0.7 lb./1000 sq. ft. or use 1 lb./1000 sq. ft.).

IF: Late fall or early winter, then seed Certified 'Aroostook' winter rye (cereal rye) at 100 lbs. per acre (2.5 lbs./1000 sq. ft.).

Any seeding method may be used that will provide uniform application of seed to the area and result in relatively good soil to seed contact.

Mulch the area with hay or straw at 2 tons/acre (approx. 90 lbs./1000 sq. ft. or 2 bales). Quality of hay or straw mulch allowable will be determined based on long term use and visual concerns. Mulch anchoring will be required where wind or areas of concentrated water are of concern. Wood fiber hydromulch or other sprayable products approved for erosion control (nylon web or mesh) may be used if applied according to manufacturers' specification. Caution is advised when using nylon or other synthetic products. They may be difficult to remove prior to final seeding and can be a hazard to young wildlife species.

STANDARD AND SPECIFICATIONS FOR TOPSOILING

Definition & Scope

Spreading a specified quality and quantity of topsoil materials on graded or constructed subsoil areas to provide acceptable plant cover growing conditions, thereby reducing erosion; to reduce irrigation water needs; and to reduce the need for nitrogen fertilizer application.

Conditions Where Practice Applies

Topsoil is applied to subsoils that are droughty (low available moisture for plants), stony, slowly permeable, salty or extremely acid. It is also used to backfill around shrub and tree transplants. This standard does not apply to wetland soils.

Design Criteria

1. Preserve existing topsoil in place where possible, thereby reducing the need for added topsoil.

2. Conserve by stockpiling topsoil and friable fine textured subsoils that must be stripped from the excavated site and applied after final grading where vegetation will be established. Topsoil stockpiles must be stabilized. Stockpile surfaces can be stabilized by vegetation, geotextile or plastic covers. This can be aided by orientating the stockpile lengthwise into prevailing winds.

3. Refer to USDA Natural Resource Conservation Service soil surveys or soil interpretation record sheets for further soil texture information for selecting appropriate design topsoil depths.

Site Preparation

1. As needed, install erosion and sediment control practices such as diversions, channels, sediment traps, and stabilizing measures, or maintain if already installed.

2. Complete rough grading and final grade, allowing for depth of topsoil to be added.

3. Scarify all compact, slowly permeable, medium and fine textured subsoil areas. Scarify at approximately right angles to the slope direction in soil areas that are steeper than 5 percent. Areas that have been overly compacted shall be decompacted in accordance with the Soil Restoration Standard.

4. Remove refuse, woody plant parts, stones over 3 inches in diameter, and other litter.

Topsoil Materials

1. Topsoil shall have at least 6 percent by weight of fine textured stable organic material, and no greater than 20 percent. Muck soil shall not be considered topsoil.

2. Topsoil shall have not less than 20 percent fine textured material (passing the NO. 200 sieve) and not more than 15 percent clay.

3. Topsoil treated with soil sterilants or herbicides shall be so identified to the purchaser.

4. Topsoil shall be relatively free of stones over 1 1/2 inches in diameter, trash, noxious weeds such as nut sedge and quackgrass, and will have less than 10 percent gravel.

5. Topsoil containing soluble salts greater than 500 parts per million shall not be used.

6. Topsoil may be manufactured as a mixture of a mineral component and organic material such as compost.

Application and Grading

1. Topsoil shall be distributed to a uniform depth over the area. It shall not be placed when it is partly frozen, muddy, or on frozen slopes or over ice, snow, or standing water puddles.

2. Topsoil placed and graded on slopes steeper than 5 percent shall be promptly fertilized, seeded, mulched, and stabilized by “tracking” with suitable equipment.

3. Apply topsoil in the amounts shown in Table 4.7 below:

Table 4.7 - Topsoil Application Depth		
Site Conditions	**Intended Use**	**Minimum Topsoil Depth**
1. Deep sand or loamy sand	Mowed lawn	6 in.
	Tall legumes, unmowed	2 in.
	Tall grass, unmowed	1 in.
2. Deep sandy loam	Mowed lawn	5 in.
	Tall legumes, unmowed	2 in.
	Tall grass, unmowed	none
3. Six inches or more: silt loam, clay loam, loam, or silt	Mowed lawn	4 in.
	Tall legumes, unmowed	1 in.
	Tall grass, unmowed	1 in.

STANDARD AND SPECIFICATIONS FOR TREE REVETMENT

Definition & Scope

A tree revetment consists of a tree trunk and branches, without root wad, cabled to an earth anchor, which is buried in the streambank to reduce streambank erosion by absorbing energy and reducing velocity, capturing sediment, and enhancing conditions for planting or colonization of native species.

Conditions Where Practice Applies

This practice is appropriate for streambanks that are eroded or undercut. It should not be used near bridges or other structures where there is a potential for downstream damage if a revetment dislodges. Their use should be limited to non -flashy streams where the needs for future maintenance are less critical.

Design Criteria

1. Trees shall be sound, recently felled spruce or fir of 6" or greater diameter and at least 20 feet in length.

2. Trees are placed initially at the base flow elevation with the butt end upstream. Multiple tree revetments shall be overlapped by 25% of their length, working from downstream to upstream.

3. Each tree shall have their branches trimmed off on the bank side and have two anchors, one near the butt end and the other at 3/4 distance up the trunk.

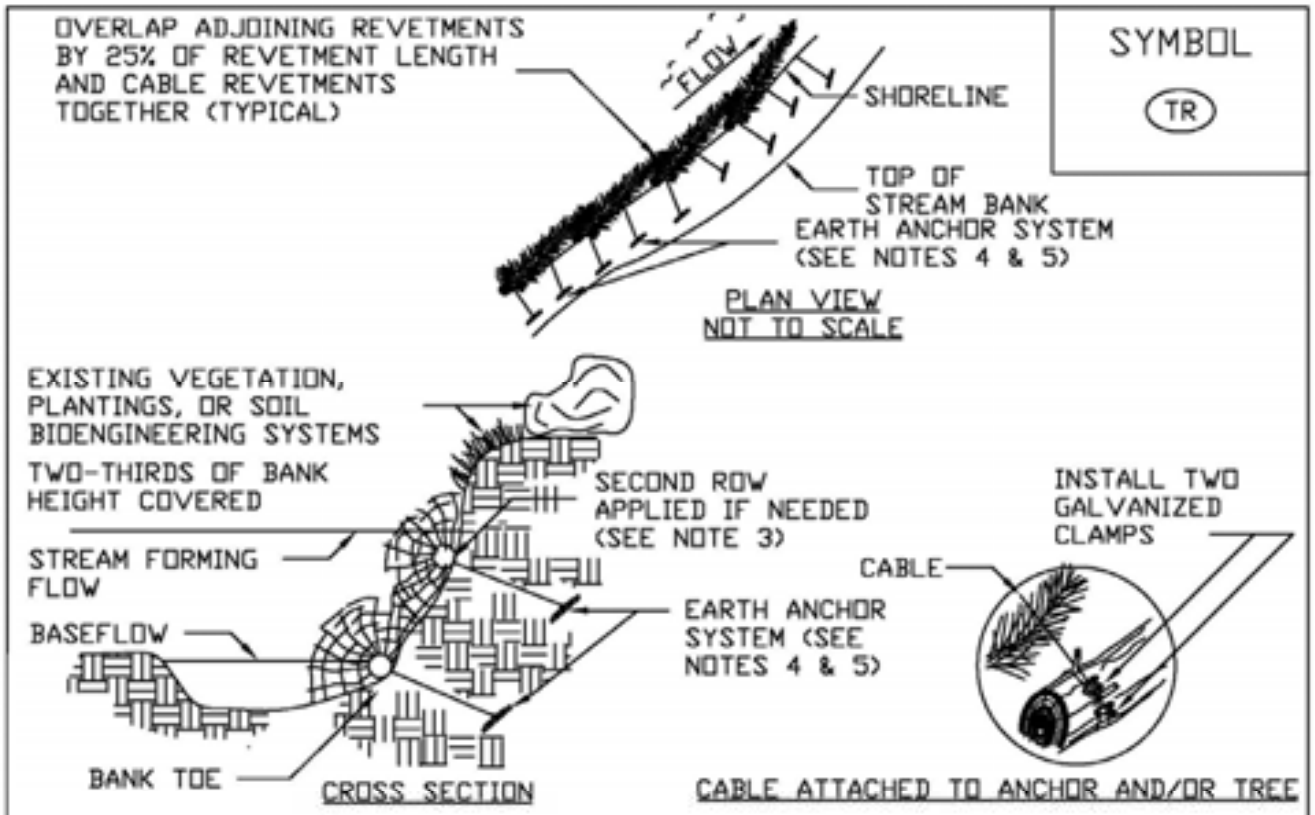
4. The tree shall be fastened with galvanized cable to the anchors, which will be commercially manufactured earth anchoring systems. The butt end cable shall also be attached to the stem of the next tree at 3/4 the distance from the base, as it is placed to the outside of the previous tree.

5. Excavate and backfill as necessary to fit the tree revetment to the site.

Maintenance

Due to the susceptibility of plant materials to the physical constraints of the site, climate conditions, and animal populations, it is necessary to inspect installations frequently. This is especially important during the first year or two of establishment. Plant materials missing or damaged should be replaced as soon as possible. Sloughs or breaks in drainage pattern should be reestablished for the site as quickly as possible to maintain stability.

Figure 4.19
Tree Revetment



CONSTRUCTION SPECIFICATIONS

1. TREES SHALL BE STRUCTURALLY SOUND, RECENTLY FELLED CONIFERS OF 6" DIAMETER OR GREATER AND AT LEAST 20' IN LENGTH
2. TREES SHALL BE PLACED WITH THE BUTT END OF THE STEM PLACED UPSTREAM. TREES SHALL BE OVERLAPPED BY 25% OF THEIR LENGTH.
3. EACH TREE SHALL HAVE TWO GALVANIZED CABLES. THE FIRST ATTACHED NEAR THE BUTT END, THE SECOND AT 3/4-TRUNK WITH BOTH ATTACHED TO AN ANCHOR USING TWO GALVANIZED CLAMPS AT EACH CONNECTION.
4. THE ANCHORS SHALL BE COMMERCIALLY MANUFACTURED EARTH ANCHORING SYSTEMS AS SPECIFIED IN THE CONTRACT DOCUMENTS. THE ANCHORING SYSTEM SHALL BE INSTALLED AS PER THE MANUFACTURER'S SPECIFICATIONS.
5. GALVANIZED CABLES SHALL BE INSERTED THROUGH A DRILLED HOLE AND WRAPPED AT LEAST ONE AND ONE-HALF TIMES AROUND THE MAIN STEM OF THE TREE OR ANCHOR, THEN CLAMPED. SEE CONTRACT DOCUMENTS FOR CABLE SIZE.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE	TREE REVETMENT

STANDARD AND SPECIFICATIONS FOR TREES, SHRUBS, AND VINES

Definition & Scope

Establishing trees, shrubs, and vines or selectively reducing stand density and trimming woody plants to protect the soil and plant resources, improve an area for recreation and increase the attractiveness and usefulness of areas.

Conditions Where Practice Applies

On any area planned for recreation or landscape use such as yard areas, leisure areas, picnic areas, and park lands providing outdoor recreational opportunities.

Criteria and Specifications

1. Planting nursery stock

   A. Select species to serve the intended purpose. See Appendix G, Table G.1**,** "Trees Suitable for Landscape and Conservation Plantings in New York." Where planting of trees is to be done in recreation areas, use those species resistant to compaction listed in Table G.2, "Susceptibility of Tree Species to Compaction" whenever possible.

   B. Plant Materials

      1) Plants shall conform to the species, variety, size, number, and conditions as stated in a conservation plan or on a plant list shown on landscape drawings. "American Standard for Nursery Stock," by American Association of Nurserymen, shall be used to develop the plant list for landscape drawings and to check quality of plant materials.

      2) Durable, legible labels with the scientific and common name and cultivar shall be securely attached to plants, bundles of seedlings, containers, and/or flats.

   C. Plant Protection

      Prior to delivery, the trunk, branches, and foliage of the plants shall be sprayed with non-toxic antidesiccant, applied according to the manufacturer's recommendations. This does not apply to state nursery seedlings.

   D. Planting Time

      Deciduous trees and shrubs: April 1 to June 1 and October 15 to December 15. Evergreen trees and shrubs: April 1 to June 1 and September 1 to November 15.

   E. Spacing

      Plant all trees and shrubs well back from buildings to allow for mature crown size. The following are guides for planning:

Large Trees	50-60 feet apart
Small Trees	20-30 feet apart
Columnar Species	6-8 feet apart
Hedges	1-4 feet apart
Shrubs	For clumps, plan spacing so mature shrubs will be touching or overlapping by only 1 or 2 feet

   F. Site Preparation

      1) Individual sites for planting seedlings can be prepared by scalping the sod away from a four foot square area where the seedling is to be planted.

      2) All planting beds shall be cultivated to a depth of 8 inches, or chemically treated for weed control. Remove objectionable objects that will interfere with maintenance of site.

   G. Planting

      1) Plants shall be located as shown on plans and/or drawings and, where necessary, located on the site by stakes, flags or other means.

      2) Prior to planting, remove galvanized wire basket securing root ball, untie and roll down burlap covering from around the stem.

3) The plants shall be set upright in holes as illustrated in Figure G.1 in Appendix G.

4) All plants shall be thoroughly watered on the same day of planting. Plants that have settled shall be reset to grade.

H. Wrapping

Immediately after planting, wrap deciduous tree trunks from the bottom to the first limb with a 4 inch wide bituminous impregnated, insect resistant tape or paper manufactured for that purpose. Tie with jute (bag strings) at top and bottom. The wrap should be removed per nursery recommendations.

I. Mulching

Mulch the disturbed area around individual trees and shrubs with a 2-3" layer of wood chips. Pull wood chips 1 inch away from the base of shrubs to avoid fungus development.

J. Pruning

After planting, prune to remove injured twigs and branches. The natural shape of the plant should not be changed.

K. Cleanup and Maintenance

1) After all work is complete, all excess soil, peat moss, debris, etc., shall be removed from the site.

2) Water plants two weeks after planting. For two years, water plants every two weeks during dry periods, which exceed three weeks without a good soaking rain, or water as needed in accordance with local conditions. Shrubs may require 5 to 10 gallons and trees, 20 to 30 gallons for each watering.

3) Remove trunk wrap per nursery recommendation.

2. Transplanting "Wild" Stock

Successful transplanting of wild stock will require heavy equipment and considerable labor as a large weight of soil must be moved with the roots.

A. Select trees and shrubs with good form and full crowns.

B. Transplant only when plants are dormant and soil is moist. Wrap soil ball with burlap to prevent soil from separating from roots.

C. Table 4.8 shows minimum diameter and approximate weight of soil ball that must be moved with each size plant.

D. Plant and maintain as described above for nursery stock.

PRUNING AND THINNING

Use	Cleared Width Each Side of Trail Tread (ft.)	Cleared Height (ft.)
TRAILS		
Hiking	1	8
Bicycle	2	10
Motorbike	2	10
Horse	2	12
X-Country Ski	Total: 3-12	12[1]
Snowmobile	Total: 6-12	12[1]
PICNIC & CAMPING AREAS		
Campfire/Grill	10 ft. diam.	15

[1] Includes allowance for snow depth and snow load on branches

1. Pruning

A. Remove trees, limbs, and limb stubs to the above widths and heights specified for the intended use.

B. Remove dead, diseased, or dying limbs that may fall.

C. Do not remove more than one-third of the live crown of a tree in a year.

D. Cut limbs flush to the branch bark ridge.

E. Use the 3 or 4 cut pruning method on all branches over 2 inches in diameter: First cut about one-third the way through the underside of the limb (about 6-12 inches from the tree trunk). Then (approximately an inch further out) make a second cut through the limb from the upper side. When the branch is removed, there is no splintering of the main tree trunk. Remove the stub. If the branch is larger than 5-6 inches in diameter, use the four cut system. Cuts 1 and 2 remain the same and cut 3 should be from the underside of the limb, on the outside of the branch collar. Cut 4 should be from the top and in alignment with the 3rd cut. Cut 3 should be 1/4 to 1/3 the way through the limb. This will prevent the bark from peeling down the trunk. Do not paint the cut surface.

2. Thinning

   A. Remove dead, diseased, dying, poorly anchored, or ice damaged trees that pose a hazard to recreationists or that interfere with intended use.

   B. To maintain grass cover in a wooded area, thin according to formula Dx3 (average diameter of the trunk of overstory trees, in inches, times three—the answer is the spacing between trees to be left, in feet). For example, for trees with average diameter of 6 inches, spacing after thinning should leave trees 18 feet apart on average. Crown cover after thinning should be about 50 percent.

   C. Selectively thin as needed to favor those trees that are most "resistant" to compaction around their roots. See Table G.2**,** "Susceptibility of Tree Species to Compaction" in Appendix G. If the soil on the site is naturally well drained, those species in the "intermediate" group may also be favored.

Table 4.8
Size and Weight of Earth Ball Required to Transplant Wild Stock

Shade Trees (Maple, Ash, Oak, Birch, etc.)			Small Trees & Shrubs (Crabapple, Thornapple, Viburnum, Dogwood, etc.)		
Caliper[1] (Inches)	Minimum Diameter Ball (Inches)	Weight of Ball (lbs.)	Up to 6 ft. Height — 6 ft. and Caliper[1]	Minimum Diameter Ball (Inches)	Weight of Ball (lbs.)
1/2	14	88	2	12	55
3/4	16	130	3	14	88
1	18	186	4	16	130
1-1/4	20	227	5	18	186
1-1/2	22	302	3/4	18	186
1-3/4	24	390	1	20	227
2	28	621	1-1/2	22	302
3	32	836	1-3/4	24	390
3-1/2	38	1,400	2	28	621
4	42	1,887	2-1/2	32	836
			3	38	1,400

[1]Caliper is a diameter measurement of trees at a height of 6 inches above the ground.

STANDARD AND SPECIFICATIONS FOR VEGETATED ROCK GABIONS

Definition & Scope

A combination of vegetation with rock filled gabions used for slope stabilization by providing a retaining wall with plant canopy to reduce runoff, temperature, and provide a vegetated cover to hardened surfaces.

Conditions Where Practice Applies

On steep sloping areas such as road cuts, slumped areas, gully cuts, low fill areas, or areas that are subject to erosion, seepage and weathering and have a low to medium hazard potential should slope failure occur.

Design Criteria

Materials - shall be a native or nursery grown cultivars capable of performing intended function. The live branch cutting shall be 1/2" to 1" in diameter and long enough for each gabion row to extend the tops a minimum of 1 foot beyond the next upper gabion row and be in contact with the undisturbed soil behind the gabion wall.

Spacing - The plant cuttings shall be placed tightly side by side with stem contact with each other on top of each gabion row on a 1" layer of raked backfill.

Note: These can be complex systems that should be designed by a licensed professional engineer.

Construction Specifications

1. Prepare the foundation for the gabions by excavating to the lines and grades shown on the drawings.
2. Subgrade will be compacted and leveled to receive the first layer of gabions. The first row will be keyed into the existing grade at the toe, a minimum of 1.5 feet.
3. Gabions will be placed according to the design and filled with stone or crushed rock from 4-8 inches in diameter. A geotextile should be draped over the basket prior to placement of backfill or plant bedding.
4. Backfill behind with select clean fill and compact by hand tamping, or light mechanical tampers, in 6" lifts.
5. On top of each row of gabions place 1" of select backfill as a plant bedding prior to placement of plant cuttings.
6. Place plant cuttings in a tight configuration with stem to stem contact so plants extend beyond the next gabion facing by 1 foot and beyond the back of the wall in contact with native soil.
7. Grade above the final row of plant cuttings with select clean fill to a slope no steeper than 2 horizontal to 1 vertical.

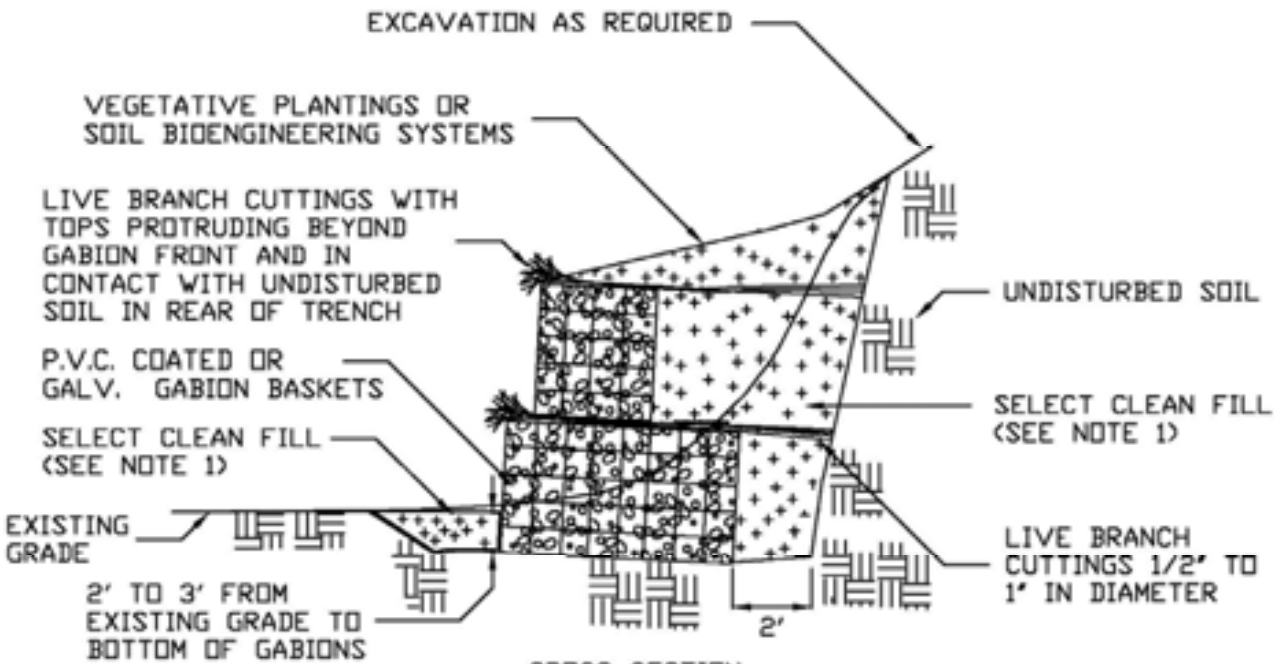
Maintenance

Regular inspection and maintenance of this system should be conducted especially during the first year of establishment. Repairs should be made to gabions as necessary and all settled areas should be brought back to grade.

Figure 4.20
Vegetated Rock Gabions

SYMBOL

VRG



CROSS SECTION
NOT TO SCALE

CONSTRUCTION SPECIFICATIONS

1. ALL SELECT CLEAN FILL FOR GABIONS SHALL BE HAND TAMPED IN 6" LIFTS.
2. A 1" LAYER OF BACKFILL SHALL BE PLACED ON TOP OF THE ROW OF GABIONS AND RAKED. THE CUTTINGS SHALL BE PLACED ON THE BACKFILL MATERIAL AND ANOTHER 1" LAYER OF BACKFILL SHALL BE PLACED ON THE CUTTINGS BETWEEN THE GABIONS.
3. CLASS 2, TYPE B OR C, INTERMEDIATE EROSION CONTROL PRODUCT SHALL BE INSTALLED ON THE FRONT INSIDE FACE AND ANY OTHER EXPOSED VERTICAL SURFACE OF THE GABIONS.

ADAPTED FROM DETAILS PROVIDED BY: USDA - NRCS, NEW YORK STATE DEPARTMENT OF TRANSPORTATION, NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, NEW YORK STATE SOIL & WATER CONSERVATION COMMITTEE

VEGETATED ROCK GABIONS

STANDARD AND SPECIFICATIONS FOR VEGETATING SAND AND GRAVEL BORROW AREAS

Definition & Scope

Permanently vegetating inactive borrow areas with sustainable herbaceous perennial plants in order to stabilize the soil, thus preventing wind and water erosion; creating a more aesthetically pleasing view; and enhancing the wildlife habitat for greater diversity.

Condition Where Practice Applies

Sand and gravel borrow areas which have had EITHER the top portion of the soil profile replaced as 'topsoil' or overburden with greater than 15 percent fines included, OR the sand and gravel mined condition remains without 'topsoil' being replaced resulting in sand and gravel with less than 15 percent fines.

Design Criteria

1. Depending upon the type of unconsolidated material being mined, side slopes shall be graded in accordance with the New York State Mined Land Reclamation Law. Minimum requirements are: for fine sand, silt, clay the slope shall not exceed 2 horizontal to 1 vertical (26º); for coarse sand and gravel the slope shall not exceed 1.5 horizontal to 1 vertical (33º)

2. Rocks and other debris shall be removed from the site or buried during grading if allowed.

3. Surface soil layer shall be sampled from 0-6" in depth. Combine about 15 core samples to represent the site soil conditions. Analyze to determine pH, P and K.

4. Obtain a larger (5-10 lbs.) soil sample to represent the surface soil texture. Analyze for percent fines (particles less than .074 mm or 200 mesh sieve).

5. Apply soil amendments as indicated by soil chemical test. The surface to be seeded shall be limed to a pH of 6.0 using agricultural ground limestone. Fertilize to achieve a moderate level of available phosphorus (P_2O_5) and potassium (K_2O). If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply 50 pounds per acre of nitrogen. Incorporation will be accomplished following the seeding.

6. Select the appropriate seed mix based on percent fines and time of planting.

   A. **IF** 15 percent fines or less: use the warm season grass mix. If fall planting is necessary, use a temporary cover to allow planting of the warm season grasses in early spring. Two (2) bushels of oats per acre is suggested as this will winter kill and not be competitive when the permanent seeding is made. Another option is small grain straw at two (2) tons per acre. Do not use old hay.

   B. Warm Season Grass Table:

   C. **IF** greater than 15 percent fines: use a grass/ legume mixture, or the warm season grass mix.

Species	Variety	Certified Seed PLS*/Acre (lbs.)
Switchgrass	Blackwell, Shelter Pathfinder, or Trailblazer	2
Coastal panicgrass	Atlantic	2
Big bluestem	Niagara	4
Little bluestem	Aldous or Camper	4
Sand bluestem	Goldstrike	2
Sand lovegrass	Nebraska 27 or Bend	2
	Total mix (PLS/acre)	16 lbs.

*Pure Live Seed (PLS) = (% germination x %purity)/100

Pounds to be seeded = (100 x lbs. of 100% PLS required)/% PLS of commercial seed being used.

D. Grass/Legume Table:

Species	Variety	Pure Live Seed Per Acre (lbs.)
Creeping red fescue	Common	10
Smooth Bromegrass	Common	2
Perennial ryegrass	Pennfine/Linn	5
Red clover*	Empire plus Pardee	8**
* legume in seed mixture needs to be inoculated. ** 4 lbs. of each is best. 8 lbs. of either one is good.		

OR

Species	Variety	Pure Live Seed per Acre (lbs.)
Flatpea*	Lathco	10.0
Perennial pea*	Lancer	2.0
American vetch*	Common	10.0
Hard fescue	Common	10.0
	Total Mix (lbs./acre)	32.0
* legume in seed mixture needs to be inoculated.		

7. Planting instructions:

   A. Planting dates are very critical for warm season grasses. Very early spring (March/April) is best. The success rate decreases notably by the end of May. Fall seedings are not recommended. Grass/legume mixes may be reliably planted from early spring through June 15. Avoid June 16 through August 15. After August 15, seed anytime until ground freezes.

   B. A temporary cover of 2 bushels of oats may be seeded between August 15 and September 15 (oats will winter kill). This works well preparing for early spring seedings.

   C. Inoculate legume seed immediately prior to actual seeding. Use 4 times the standard agricultural rates.

   D. The seed mix must be uniformly broadcast. A hydroseeder works well or spread by hand if necessary. The use of spinner type seeders is difficult due to the lightweight and fluffy seed characteristics of some species.

   E. Incorporate the soil amendments and seed.

      i. "Tracking" an area is using a bulldozer having cleats at least 1 inch in depth. Operation of the dozer shall be perpendicular to the contour and such that the entire area is covered by the tracks.

      OR

      ii. Pulling a cultipacker over the entire site with the tines up or no deeper than 1 inch. This option only works if soil moisture is near field capacity.

8. Mulching is essential for immediate erosion control and uniform establishment of cool season grasses and legumes on sands and gravels. Use a heavier rate for the grass/legume seedings of 4000 lbs./ac. Use only small grain straw. Mulching of warm season grasses may not be necessary when runoff and sediment delivery is not an issue. If erosion control is necessary for warm season grass sites, mulch with 3000 lbs./ac. of small grain straw (not grass hay). On sites where mulch can be avoided, warm season grasses will respond favorably.

9. Anchor the mulch by using the bulldozer tracking technique. This may be done simultaneously with seed incorporation. Optional anchoring techniques and materials are available in the Mulching Standard.

10. Site protection is necessary to avoid wheel and tire damage.

STANDARD AND SPECIFICATIONS FOR VEGETATING SAND DUNES AND TIDAL BANKS

Definition & Scope

Establishing and maintaining **permanent** vegetative cover in order to provide coastal shoreline protection to stabilize sand dunes, provide for sand entrapment for dune building, and provide for protection of dune vegetation from foot traffic and vehicles. Also to stabilize tidal banks and provide for long term protection.

Condition Where Practice Applies

On any coastal shoreline, including shorelines of the Great Lakes, Lake Champlain, Long Island Sound and the Atlantic Ocean where vegetation can be expected to effectively stabilize a site.

Specifications

1. Sand dunes

   A. Where stabilization of existing sand dunes and/or re-establishment of beachgrass is needed.

      1) Long Island and NYC area, use Certified 'Cape' American Beachgrass. Planting of frontal dunes should be accomplished by April 30. Refer to American Beachgrass Information Sheet for specific instructions.

      2) Lake Champlain and Great Lakes, use the Lake Champlain strain or species if adequate planting material is available. Use American beachgrass guidelines for planting. 'Cape' will do well but is very aggressive compared with the Lake Champlain strain. Some people consider 'Cape' an invasive plant in these locations.

      3) 'Atlantic' coastal panicgrass is excellent for back dune areas. Seed at 10 pounds pure live seed per acre. Refer to Standard and Specifications for Vegetative Stabilization of Sand and Gravel Pits for determining the proper amount of pure live seed.

      4) Immediately after planting, a wooden sand fence (snow fence) will be built to protect the beachgrass from vehicle and foot traffic. The fence shall surround the planted area at a distance of 15 feet from the planted area. Passageways should be provided to allow pedestrians to cross the planted area at appropriate intervals. Elevated boardwalks, or dune cross-overs, are desirable and required by DEC on many stretches of coastline. .

   B. Where sand dunes are strengthened or reconstructed through sand entrapment, and shore conditions allow for sand deposition, appropriate permits for altering shorelines must be obtained prior to beginning work.

2. Building, Planting, and Maintaining Coastal Sand Dunes

Dune stabilization work should start as far landward as possible. Whenever feasible, leave room for two or more dune lines for a double layer of protection. Dunes grow toward the sand supply, which is the ocean or the lake.

   A. Building the dune:

      1) Vegetatively.

         Where blowing sand is available, a simple, relatively inexpensive and successful method exists for building dunes. It consists of planting American beachgrass strips parallel to the coastline. As the windblown sand moves off the beach landward, it drops its load of sand, beginning the natural cycle of dune growth. The plantings will trap most of the windblown sand, particularly during the growing season when the grass will continue to grow up through the newly trapped sand.

      2) Sand Fences (Snow Fence Material).

         The use of sand fence is effective and the material is readily available. It may be more expensive than building dunes vegetatively, but is less expensive than doing it with machinery. Normally it is also much faster than with

vegetation alone.

To form a barrier dune, erect the sand fences in parallel lines 30 or 40 feet apart. The fences should be roughly parallel to the water line and yet be as nearly as possible at a right angle to the prevailing winds. See Figure 4.21 on page 4.72. Where this is not possible, erect a single line of fence parallel with the water at least 140 feet from the MHT line and space 30 foot long perpendicular spurs 40 feet apart along the seaward side to trap lateral drift.

As the fences fill with sand, additional sets of fence can be placed over those filled until the barrier dune has reached a protective height.

To widen an old dune, the fencing should be set seaward at a distance of 15 feet from the old dune base.

Materials -

Use standard 4-foot sand (snow) fence. The fence should be sound and free of decay, broken wire, and missing or broken slats.

Wood posts for fence support should be black locust, red cedar, white cedar, or other wood of equal life and strength. They do not need to be treated. They should be a minimum of 6 ft. 6 in. long and a minimum diameter of 3 inches. Standard fence post length is usually 7 ft.- 8 ft. and should be used where possible.

Four (4) wire ties should be used to fasten the fence to the wood posts. Weave fence between posts so that every other post will have fence on ocean side of posts. Tie wires should be no smaller than 12 gauge galvanized wire.

The bottom of the fence should be set about 3 inches into the sand, or a mechanical grader could be used to push some sand against the bottom of fence.

3) Sand fence plus vegetation -

The combination of these two approaches is more effective than either one alone. The sand fence should be placed as discussed above. Bands of vegetation should then be planted parallel to the fence on the landward and seaward side. Each bank of vegetation should be about 20 feet wide and placed 10 to 15 feet from the sand fence. As the sand fills between the two fences, additional fence can be erected or the area between the fences can be planted. Such a combination can trap most of the wind blown sand crossing the dune area and produce a much broader based dune than either approach alone. See Figure 4.22.

3. Tidal Streams and Estuaries

The procedures to determine the effectiveness potential of stabilization of tidal streams and estuaries are found in Table 4.9 on page 4.73.

Plants to be used are as follows:

A. Certified 'Cape' American beachgrass

B. Certified 'Bayshore' smooth cordgrass

C. Certified 'Avalon' saltmeadow cordgrass

D. Certified 'Atlantic' coastal panicgrass

4. Coastal panicgrass is primarily used in freshwater tidal areas above high tide line. Frequently, it is seeded over top of saltmeadow cordgrass plantings.

5. Additional Reference

"Best of Beach Vegetation" by W. Curtis Sharp. Reprints from Parks and Recreation Resources. Volume 1, Nos. 1, 2, 4 & 5, 7 & 8. Published in January, February, May/June, July/August 1982.

Figure 4.21
Combination of Sand Fence and Vegetation for Dune Building

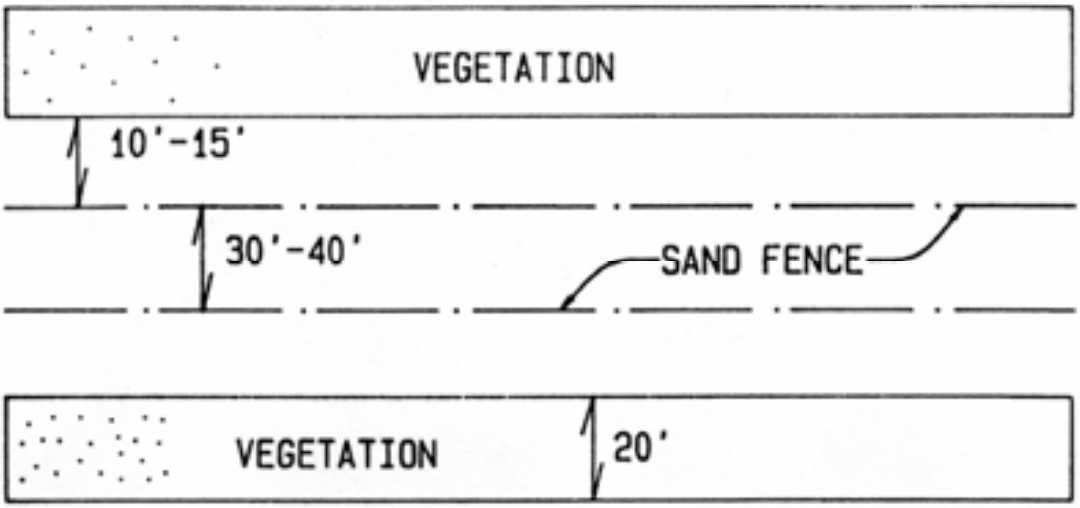


Figure 4.22
Typical Cross-Section Created by a Combination of Sand Fence and Vegetation

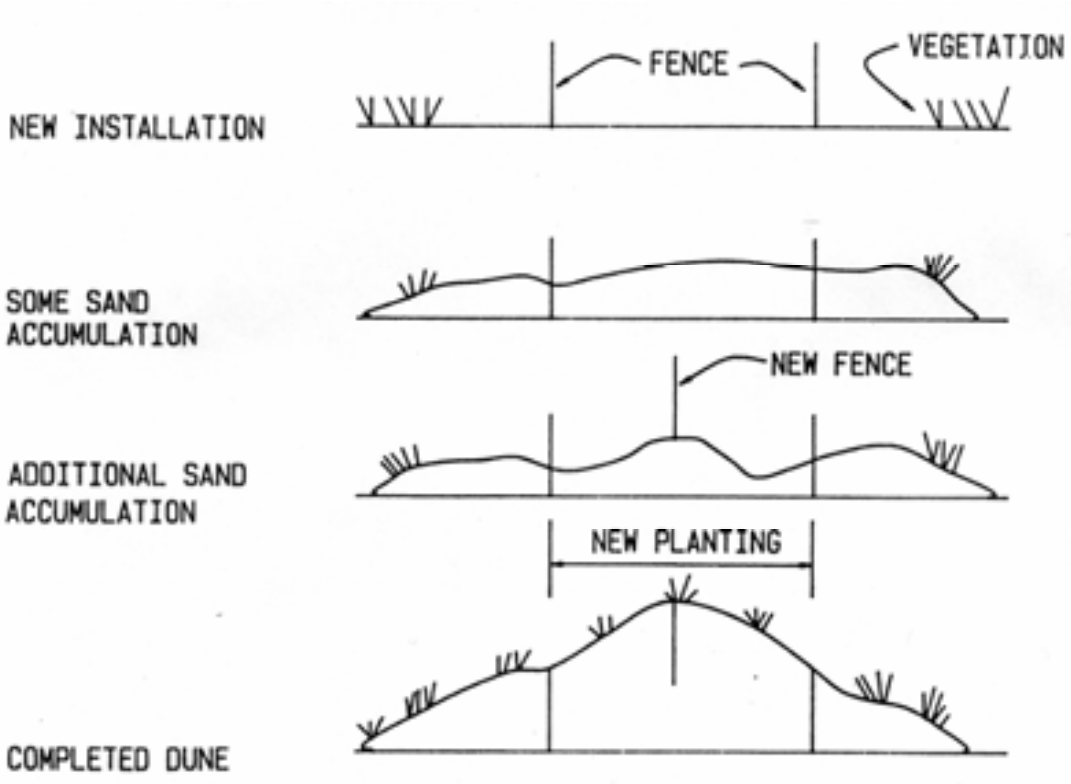


Table 4.9
Vegetative Treatment Potential for Eroding Tidal Shorelines

DIRECTIONS FOR USE

1. Evaluate each of the first four shoreline variables and match the site characteristics of the variable to the appropriate descriptive category.
2. Place the Vegetative Treatment Potential (VTP) assigned for each of the four variables in the right hand column.
3. Obtain the Cumulative Vegetative Treatment Potential for variables 1, 2, 3 & 4 by adding the VTP for each.
4. If it is 23 or more, the potential for the site to be stabilized with vegetative is very good and the rest of the table need not be used. If it is below 23, go to step 5.
5. Determine the VTP for shoreline variable 5 through 9 and obtain the cumulative VTP for variables 1-9.
6. Compare the cumulative VTP score with the Vegetative Treatment Potential Scale at the bottom of this page.

SHORELINE VARIABLES	DIRECTION FOR USE The Vegetative Treatment Potential (VTP) is located in bold type.					VTP
1. Fetch: Average distance in miles of open watermeasured perpendicular to the shore and 45 degrees either side of perpendicular to shore.	Less than 0.5 miles **8**	0.5 thru 1.4 miles **7**	1.5 thru 3.4 miles **4**	3.5 thru 4.9 miles **2**	over 5 miles[1] **0**	
2. General shape of shoreline for distance of 200 yards on each side of planting site.	Coves **8**	Irregular shoreline **3**		Headland or straight shoreline **0**		
3. Shoreline orientation: General geographic direction the shoreline faces.	Any less than 1/2 mile fetch **5**	West to North **3**	South to West **2**	South to East **1**	North to East **0**	
4. Boat traffic: Proximity of site torecreational & commercial boat traffic.	None **5**	1-10 per week within 1/2 mi. of shore. **3**	More than 10 per week within 1/2 mi. of shore. **2**	1-10 per week within 100 yds. of shore. **1**	More than 10 per week within 100 yds. of shore. **0**	

Cumulative Vegetative Treatment Potential for Variables 1, 2, 3 & 4 _____

If this score is 23 or above, the potential for the site is very good and the rest of the table need not be used. If it is below 23, go to step 5 below.

5. Width of beach above mean high tide in feet	Greater than 10 ft. **3**	10 ft. thru 7 ft. **2**	6 ft. thru. 3 ft. **1**	Less than 3 ft. **0**	
6. Potential width[2] of Planting area in feet	More than 20 ft. **3**	20 ft. thru 15 ft. **2**	14 ft. thru 10 ft. **1**	Less than 10 ft. **Do not plant**	
7. On shore gradient slope from MLW to toe of bank.	below 8% **6**	8% thru 14% **3**	15% thru 20% **1**	Over 20% **0**	
8. Beach Vegetation	Vegetation below toe of slope **3**		No vegetation below toe of slope **0**		
9. Depth of sand[3] at mean high tide in inches.	more than 10 in. **3**	10 in. thru 3 in. **2**	less than 3 in. **0**		

Cumulative Vegetative Treatment Potential for Variables 1-9 _____

1. Do not plant.
2. If tidal fluctuation is 2.5 feet or less, measure from MLW to toe of bank. If tidal fluctuation is over 2.5 feet, measure from MW to toe of bank.
3. Refers to depth of sand deposited by littoral drift over the substrata.

Vegetative Treatment Potential Scale

If the VTP is, Between	And	Potential of site to be Stabilized with Vegetation
40	33	Good
32	24	Fair
23	16	Poor

Figure 4.23
American Beachgrass Information Sheet
(*Ammophila breviligulata* Fern)

Adapted from USDA—NRCS Plant Guide[2]

Use: Major use is to stabilize moving sand along the Atlantic Sea coast and Great Lakes region. It is the best species for the initial stabilization of frontal dunes.

Useful as an erosion control plant on non-dune areas where soils are very sandy and the site conditions make establishment of seeded species very difficult. Also used on soils high in salinity such as industrial waste needing vegetative cover.

Description: American beachgrass is a leafy, spreading grass with many stems per clump. It may reach a height of two to three feet. The seed head is a spike-like panicle, about ten inches long, and appears in late July or August. Leaves are long and narrow, and may become rolled or folded as it matures.

One outstanding growth characteristic is the strong underground stems (rhizomes) that spread beneath the sand and give rise to many new plants. Its vigorous growth enables the plant to withstand heavy deposits of sand and the ability to grow up through deposits.

Adaptation: American beachgrass is native to the mid-Atlantic coastal region from Maine to North Carolina, and the Great Lakes region. It will grow on island sites, high in sand and/or saline content, provided adequate amounts of nitrogen and other nutrients are present.

Varieties: 'Cape' is the most recent variety and was developed by the Soil Conservation Service at the Cape May Plant Materials Center, Cape May Court House, N.J. 'Hatteras' developed by the Agricultural Experiment Station in North Carolina is a variety better adapted to southern climates.

Source: Both are commercially available vegetatively. Seed not available.

Establishment: The best time to plant beachgrass is from October 1 to April 30. If properly planted, good survival can be expected at any time during this period, except when soil is frozen. Summer plantings are not satisfactory. American beachgrass can be planted either by hand or by mechanical equipment designed for this work. The stems of plants called 'culms' are used for planting stock. Two or three culms are planted per hole. Space plants 18" by 18", unless wind erosion is severe, then reduce spacing to 12" by 12". Stagger the plantings in alternate rows to provide maximum erosion control. On very stable areas where wind is not a factor, a spacing of 24" x 24" is suitable. An 18" x 18" spacing requires 58,500 culms (3 culms/planting unit) per acre, or 1,350 culms per 1,000 square feet.

Beachgrass culms must be planted at least 8" deep. This prevents plants from drying out, as well as being blown out by the wind. A tiling or ditching spade is an excellent tool for opening the planting hole. A two person crew works best in planting on frontal dunes and loose sandy areas. The culms and roots must be kept cool and moist before and during planting. Success of planting will increase if the stock is dormant or has made very little growth.

AMERICAN BEACHGRASS

Fertilizer properly applied is the key to good vigorous growth, as coastal sands are rather infertile. Fertilize in March or April with 30 to 40 pounds of inorganic nitrogen per acre until desired density is obtained.

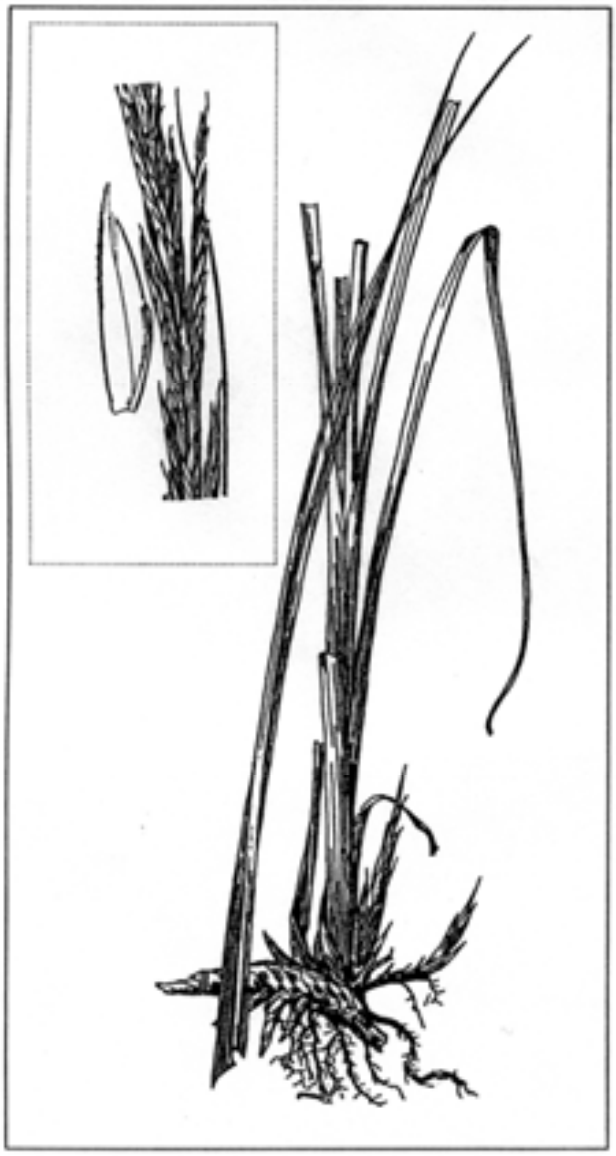
Management: Once the stand is well established, the rate of fertilizer applied can be reduced by half, or applied only when the stand appears to be weakening.

Exclude vehicular traffic if possible and provide elevated boardwalks for pedestrians. Pedestrian and vehicular traffic that bends or breaks the culms will seriously damage the plants and may kill them. Move boardwalks, or dune cross-overs, when beachgrass underneath begins to weaken and become open, exposing the sand for potential blowing. On frontal dunes, any area devoid of protective cover is subject to blowing and eventual ruin. Replanting of beachgrass stands that become open should be an annual operating procedure.

Figure 4.24
Cordgrass Information Sheet
Smooth Cordgrass (*Spartina alterniflora*)
and
Saltmeadow Cordgrass (*Spartina patens*)

Adapted from USDA—NRCS Plant Fact Sheets[2]

Description: Smooth cordgrass, a long life perennial, is the dominant, most productive marsh plant in the regularly flooded inter-tidal zone along the Atlantic and Gulf coast from Newfoundland to Florida and Texas. Smooth cordgrass grows three to seven feet tall with stems up to 1/2 inch in diameter. The leaves are twelve to twenty inches long, tapering to a point. The seed heads, produced in September and October, are ten to twelve inches long and hold twelve to fifteen spikelets, each two to three inches long. Its primary method of spreading is by vigorous, hollow rhizomes.



Spartina alterniflora

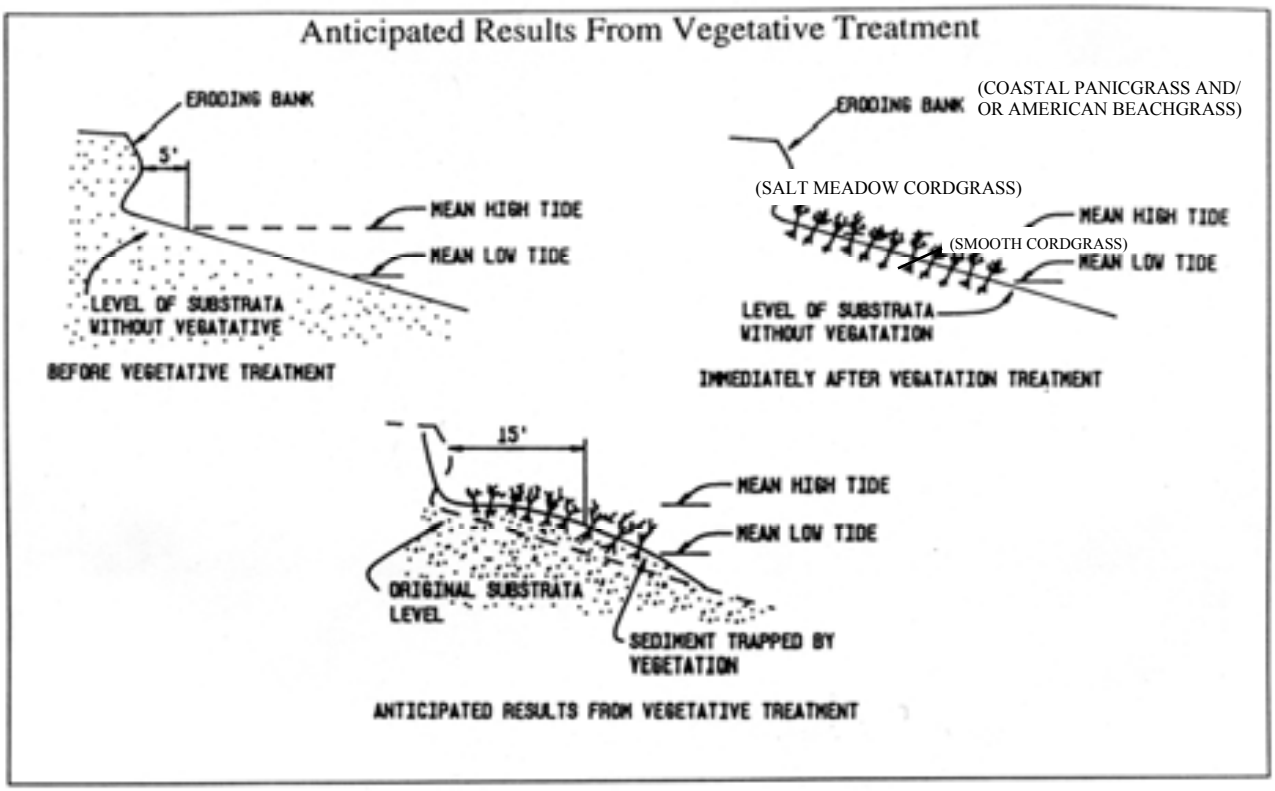
Saltmeadow cordgrass grows in salt marshes and sandy meadows along the Atlantic and Gulf coasts from Quebec to Florida and Texas. It occupies the area immediately above the inter-tidal zone. Mature plants are grayish green, usually one to three feet tall. The leaf sheath is round; the leaf blade is long and narrow, usually rolled inward giving a wiry appearance; the upper side of the leaf is rough. The seed heads produced in October have spikelets that grow almost at right angles to the rachis or main stem. Saltmeadow cordgrass reproduces rapidly by long, scaly, slender rhizomes.

Spartina patens

Both smooth and saltmeadow cordgrasses are used by waterfowl as a source of food. Saltmeadow cordgrass is also used by muskrats for housing materials.

Uses: Because of their adaptation to brackish water, smooth and saltmeadow cordgrasses occur naturally or can be planted to stabilize eroding shorelines. Planted along the shoreline, the cordgrasses absorb the wave energy and collect the sediment brought in by water. As the sediment is dropped, the band of vegetation expands, pushing the mean high tide away form the tow of the bank, thus reducing the potential for continuous erosion.

Establishment of Shoreline Plantings: Smooth cordgrass is planted between the mean low water level and the mean high water level. Saltmeadow cordgrass is planted above



the smooth cordgrass from mean high water to the toe of the slope. If the distance from the mean high water to the toe of the slope exceeds 10 feet, American beachgrass should also be planted in the upper part of the slope.

Establishment of Plants: There are three types of plant materials that can be used for planting along the shoreline. One type is seedlings grown in peat pots. Such plants should be about 12 inches tall with 3-5 stems per container before they are large enough for transplanting. The container is planted with the root mass.

A second method is to grow the plants in containers which allow the plants with the root mass to slip out at the time of planting. Their size, etc., are the same as above. The advantage of this method is that it eliminates the barrier occasionally created by the peat pots that may produce a slight turbulence around the plant and wash it out.

A third type is to harvest culms from natural or cultivated stands which are then planted directly to the shoreline. If the plants are to be taken from natural stands, they should be growing in sandy substrata. The stands should be open and developing rather than dense and mature. The culms will be ready for digging and transplanting when the top growth is six to ten inches tall. Each culm should have a well developed root.

Methods one, two and three are equally recommended for smooth cordgrass. Methods one and two are recommended for saltmeadow cordgrass. Although method three can be used, performance expectations will be less than with the other two methods. Coastal panicgrass can be planted using method one or be seeded.

Typical plantings consist of one row parallel to the shoreline. Transplants should be midway between the high and low tide elevations. Plant spacing within the row will vary according to the size of the transplant materials being used and the rate at which full coverage is desired. One gallon container stock are generally planted at 5’ to 8’ centers and plugs generally on 2’-3’ centers. Smooth cordgrass typically produces 8’-10’ rhizomes for lateral spread in one growing season. If two rows are planted, allow 5’ between rows. The spacing to be used is influenced by the severity of the site. On sites that have a potential of being washed away, the spacing should be closer. In protected areas where there is little danger of the planting being initially destroyed, the spacing can be wider. The hole made in the substrata should fully accommodate the plant roots. Be sure to seal the hole by pressing the soil around the roots with your heal.

Planting Method/Fertilization:

Planting Methods: When planting trade-gallons, transplants should be planted in a hole. Post-hole diggers, gas drills with modified bits, or any other methods of digging are satisfactory. The planting hole should be the same size or only slightly larger than the root-ball and deep enough so that the top of the root-ball is flush or slightly below ground. The top of the root-ball should not protrude above

nor be more than 2" below normal ground. The planting hole should be tightly closed around the plant to prevent the plant from wobbling and plants should remain erect after planting.

Planting sites where high wave energy is a problem may require the addition of a plant anchor. A plant anchor consists of ¼" steel re-bar bent into a hook (candy-cane shape) and pushed down into the soil so that the hook lays across the root-ball, pinning it to the ground. Anchors are generally about 30" in overall length and will add to the cost of the planting. However, anchors are generally necessary at unusually problematic sites to prevent plants from washing out.

When planting bare-root plugs, holes need only be approximately 3" in diameter and deep enough to cover the roots. Any style of tool that will punch a hole this size such as a dibble bar will work. Cupping the roots of the plug in hand and pushing down into the mud carefully will also work in more fluid soils. There are no plant anchors for plugs, and in practice, plugs should not be used at any site where wave energy is a factor.

Fertilization: There is no clear consensus on the effectiveness of fertilizer when used in saturated and/or anaerobic soils. However, the additional cost of fertilizer is a small investment given the overall cost involved in vegetative restoration.

Slow-release fertilizer tablets are commercially available in a range of weights and analyses. Recommended tablet weight should be between 15 and 25 grams and have a nitrogen content of not less than 15% and not more than 30%. When using tablets with trade-gallon plants, push the tablet into the top 3" of the root-ball immediately prior to or immediately after planting the transplant. The resulting hole should be pinched closed. When using tablets with bare-root plugs, drop the tablet in the planting hole prior to inserting the plug.

Planting should be made between mid Spring and July 1. The early Spring plantings are more hazardous because of storms and less favorable soil temperatures. Actual dates are influenced by location. Late Spring plantings are preferred.

Site Suitability: A high percentage of plantings made on tidal shorelines fail due to shoreline conditions, storms, etc. Most shoreline conditions can be identified and their likelihood of contributing to success or failure estimated. They are shown in Table 3.9.

While the procedure outline in Table 3.9 has been tested against actual plantings, there is no guarantee the outcome of the planting will be as the guideline suggests. For instance, unexpected storms could completely eliminate the value of these guidelines and destroy the planting.

Management of Established Plantings: Plantings should be monitored frequently each year. Plants destroyed or washed out should be replanted as quickly as possible. All debris washed onto the plantings should be immediately removed to prevent smothering the plants.

Sources: Smooth and saltmeadow cordgrasses are available commercially. Because commercial sources are subject to change, contact your local USDA Natural Resources Conservation Service office for sources closest to you. 'Bayshore' smooth cordgrass, 'Avalon' saltmeadow cordgrass, and 'Atlantic' coastal panicgrass are recommended varieties for Long Island.

STANDARD AND SPECIFICATIONS FOR VEGETATING WATERWAYS

Definition & Scope

Waterways are a **permanently** constructed conveyance channel, shaped or graded. They are vegetated for the safe transport of excess surface water from construction sites and urban areas without damage from erosion.

Conditions Where Practice Applies

This standard applies to vegetating waterways and similar water carrying structures.

Supplemental measures may be required with this practice. These may include: subsurface drainage to permit the growth of suitable vegetation and to eliminate wet spots; a section stabilized with asphalt, stone, or other suitable means; or additional storm drains to handle snowmelt or storm runoff.

Retardance factors for determining waterway dimensions are shown in Table 3.1 on page 3.10 and "Maximum Permissible Velocities for Selected Grass and Legume Mixtures" (See Table 4.10 on page 4.79).

Design Criteria

Waterways or outlets shall be protected against erosion by vegetative means as soon after construction as practical. Vegetation must be well established before diversions or other channels are outletted into them. Consideration should be given to the use of turf reinforcement mats, excelsior matting, other rolled erosion control products, or sodding of channels to provide erosion protection as soon after construction as possible. It is strongly recommended that the center line of the waterway be protected with one of the above materials to avoid center gullies and to protect seedlings from erosion before establishment.

1. Liming, fertilizing, and seedbed preparation.

   A. Lime to pH 6.5.

   B. **The soil should be tested to determine the amounts of amendments needed.** If the soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 1.0 lbs/1,000 sq. ft. of N, P_2O_5, and K_2O.

   C. Lime and fertilizer shall be mixed thoroughly into the seedbed during preparation.

   D. Channels, except for paved section, shall have at least 4 inches of topsoil.

   E. Remove stones and other obstructions that will hinder maintenance.

2. Timing of Seeding.

   A. Early spring and late August are best.

   B. Temporary cover to protect from erosion is recommended during periods when seedings may fail.

3. Seed Mixtures:

Mixtures	Rate per Acre (lbs)	Rate per 1,000 sq. ft. (lbs)
A. White clover or ladino clover[1]	8	0.20
Smooth bromegrass	20	0.45
Creeping red fescue[2]	2	0.05
Total	30	0.70
OR		
B. Smooth bromegass[3]	25	0.60
Creeping red fescue	20	0.50
Perennial ryegrass	10	0.20
Total	55	1.30

[1] Inoculate with appropriate inoculum immediately prior to seeding. Ladino or birdsfoot trefoil may be substituted for common white clover and seeded at the same rate.

[2] Perennial ryegrass may be substituted for the creeping red fescue but increase seeding rate to 5 lbs/acre (0.1 lb/1,000 sq. ft).

[3] Use this mixture in areas which are mowed frequently. Common white clover may be added if desired and seeded at 8 lbs/acre (0.2 lb/1,000 sq. ft.)

4. Seeding

Select the appropriate seed mixture and apply uniformly over the area. Rolling or cultipacking across the waterway is desirable.

Waterway centers or crucial areas may be sodded. Refer to the standard and specification for Stabilization with Sod. Be sure sod is securely anchored using staples or stakes.

5. Mulching

All seeded areas will be mulched. Channels more than 300 feet long, and/or where the slope is 5 percent or more, must have the mulch securely anchored. Refer to the standard and specifications for Mulching for details.

6. Maintenance

Fertilize, lime, and mow as needed to maintain dense protective vegetative cover.

Waterways shall not be used for roadways.

If rills develop in the centerline of a waterway, prompt attention is required to avoid the formation of gullies. Either stone and/or compacted soil fill with excelsior or filter fabric as necessary may be used during the establishment phase. See Figure 4.25, Rill Maintenance Measures. Spacing between rill maintenance barriers shall not exceed 100 feet.

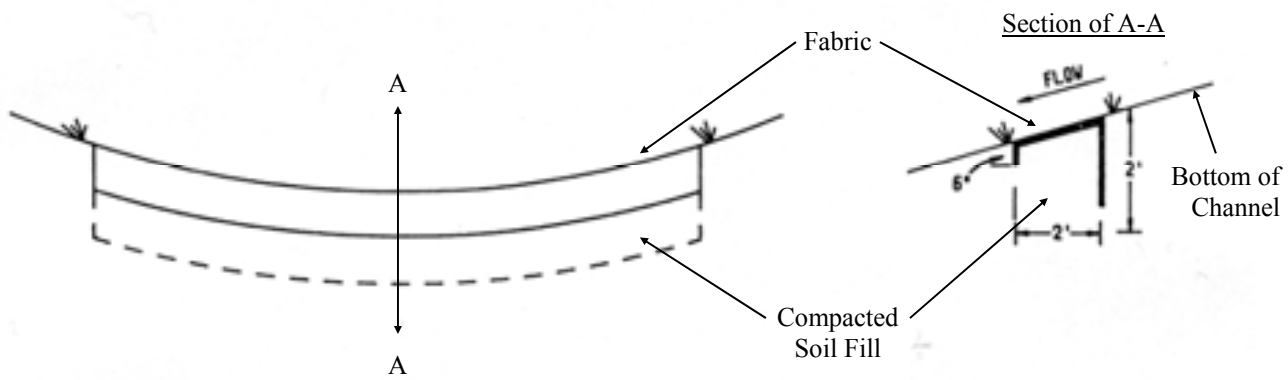
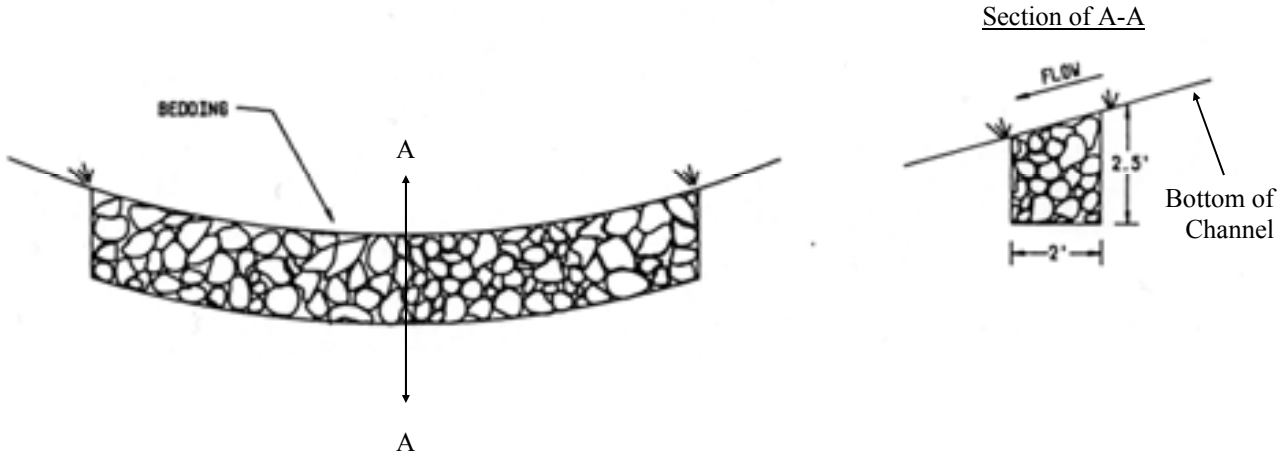
Table 4.10
Maximum Permissible Velocities for Selected Seed Mixtures

Cover	Slope Range [2] (%)	Permissible Velocity [1]	
		Erosion-resistant Soils (ft. per sec.) K=0.10 - 0.35 [3]	Easily Eroded Soils (ft. per sec.) K=0.36 - 0.80
Smooth Bromegrass Hard Fescue	0-5 5-10 Over 10	7 6 5	5 4 3
Grass Mixtures	[2] 0-5 5-10	5 4	4 3
White/Red Clover Alfalfa Red Fescue	[4] 0-5	3.5	2.5

[1] Use velocities exceeding 5 feet per second only where good covers and proper maintenance can be obtained.
[2] Do not use on slopes steeper than 10 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.
[3] K is the soil erodibility factor used in the Revised Universal Soil Loss Equation. Visit Appendix A or consult the appropriate USDA-NRCS technical guide for K values for New York State soils.
[4] Do not use on slopes steeper than 5 percent except for vegetated side slopes in combination with a stone, concrete, or highly resistant vegetative center section.
[5] Annuals - use on mild slopes or as temporary protection until permanent covers are established.
[6] Use on slopes steeper than 5 percent is not recommended.

Figure 4.25
Rill Maintenance Measures

Filter Fabric



Stone