Unit Three
VEGETATIVE STABILIZATION

Introduction

In most situations, vegetation is the most effective and economical means of stabilizing the site of an earth change and controlling wind or water erosion. In addition, vegetation is an effective means of preventing sediment transport and off-site sedimentation. This unit will explain how to successfully re-establish vegetation that has been removed during construction. While some vegetative cover must be removed during the construction process, remember that the best way to prevent erosion is to remove the very minimum amount of vegetation necessary, and to re-establish it as soon as possible.

The most effective vegetative erosion and sediment control is usually achieved with grass and the most commonly used means of reestablishing grass is with seeding. Grass has many fine fibrous roots that bind the soil together. The blades of grass have a higher stem density than other vegetation, creating a greater resistance to runoff and a fine "filter" to filter suspended sediment. The emphasis of this unit is, therefore, the proper selection and application of grass seed. Very steep slopes or areas exposed to high traffic or concentrated runoff may not be suitable for vegetative erosion control and may require structural treatments.

Native and Introduced (Non-Native) Species

Until recently, little consideration had been given to the natural distribution of species selected for revegetation; the only selection criterion was whether or not the species would function for its intended purpose. Over the past several years, the problems associated with the use and spread of non-native or introduced species and the benefits of planting native species have received much attention.

Many introduced species previously recommended for forage or erosion control have proved to be less beneficial for their intended purpose than native species and in some cases have become ***invasive*** or noxious, outgrowing and eventually displacing valuable native species. Native species are adapted to the local climate and soil, and have coevolved with other species to provide an important function in the ecosystem. If properly selected for site conditions, native species can dramatically reduce fertilizer, lime, and maintenance requirements. When revegetating natural areas, undertaking environmental restoration, or working in areas where introduced species may spread into adjacent natural areas, native seed should be used.

A result of the historic promotion of introduced species is that they are now economical to purchase and readily available. Conversely, native species are usually expensive and available from a limited number of suppliers. The increased awareness of the benefits of planting native species is beginning to reduce their price and increase availability.

Carefully selected introduced species can be planted in most SESC applications without threatening natural habitats. In addition to their inexpensive price and availability, in many – if not most – construction situations, introduced species are preferred because of their rapid growth rate and establishment; it may take several years for a stand of native grasses to mature to a condition that effectively reduces erosion or sedimentation. (See "Cool and Warm Season Grasses" on page 3-19.) Consequently, this unit deals primarily with the use of introduced species and provides limited information on native species. Selection criteria are included for a few of the most available native species.

Species that are widely recognized as invasive or noxious are not identified or recommended in this unit. Species that have been identified as potentially invasive in some situations are flagged in the tables with bold face type. These species can be used in most applications without the potential for environmental damage, but may not be appropriate in some situations. Be aware that as the science of ecology advances, species once considered harmless may be reclassified as noxious or invasive, or vice versa.

Site Assessment

The physical characteristics that will exist on a site following final grade should be assessed in the planning stage, long before it comes time to spend time and money on revegetation. The type of vegetation and means of vegetative establishment are based on such factors as available sunlight, slope, adjacent topography, local climate and microclimate, proximity to sensitive areas or natural plant communities, and soil characteristics such as natural drainage class, texture, fertility, and pH.

Climate

In addition to regional climatic conditions such as temperature and rainfall, the microclimate in the immediate area, which is affected by exposure to wind, shade, or sunlight, must be assessed. On dry sites, it is often more difficult to establish plants on slopes exposed to wind or that face south or west. Conversely, dense shade presents a challenge to establishing vegetation.

Soil Conditions

Consideration must be given to on-site soil conditions such as **fertility**, **pH**, and **moisture**. When soils are not suitable for vigorous plant growth, soil additives must be used to alter soil characteristics. A note of caution: it is important to remember that subsoils are usually lower in fertility and often more acidic than topsoil. It is, therefore, extremely important to save and reuse the topsoil when attempting to re-establish vegetation.

Soil Fertility

Fertility refers to the availability of plant nutrients in the soil. Fertile soils contain sufficient nutrients for successful plant growth. Infertile soil can be

improved by adding fertilizers. Fertilizers contain various proportions of the essential plant nutrients: nitrogen, which is labeled N on a fertilizer bag; phosphorus, labeled P; and potassium, labeled K. A fertilizer labeled "12-12-12" is a "well balanced" fertilizer. The number refers to the percentage of each primary nutrient (Figure 3-1). Fertilizer recommendations are usually given in weight of application per unit area (e.g., pounds per acre). To determine the amount of each primary nutrient by weight, multiply the total bag weight by the percent indicated. In a 50-pound bag of 12-12-12, there would be 6 pounds of each nutrient (50 pounds x 0.12 = 6 pounds).

Figure 3-1

Soil pH

The pH scale has a value range of 0-14; with a value of 7 considered neutral, values less than 7 acidic, (Figure 3-2), and values greater than 7 alkaline. The pH scale is logarithmic which means there is a 10-fold difference between each number on the pH scale. A soil with a pH of 5 is ten times more acidic than a soil with a pH of 6. Most plants grow best in circumneutral pH, about 6.5-7.5.

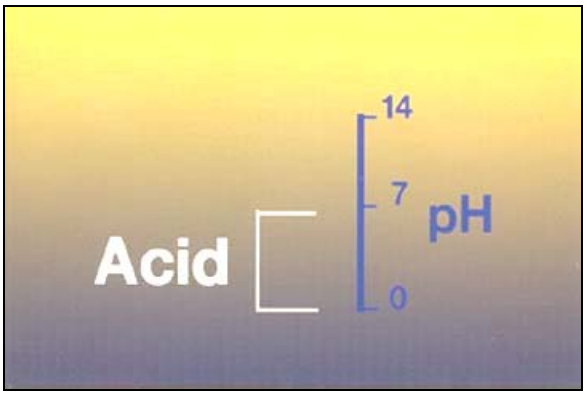

Figure 3-2
Source: John Warbach, Planning and Zoning Center, Inc

Soil pH can be adjusted by adding lime or sulfur. In Michigan, acidic soils are relatively common and it may be necessary to add lime to reduce acidity (increase alkalinity) to improve plant growth. Crushed limestone is generally used for lowering soil acidity rather than the application of pure lime. When

the acidity is lowered, the pH number actually increases. For example, a soil with a pH value of 6.5 is less acidic than a soil with a pH of 5.5 or 6.

Alkaline or basic soils have a pH of greater than 7. Although not often necessary in Michigan, the pH of alkaline or basic soils can be lowered (made more acidic) by adding sulfur or a sulfur compound to the soil.

Before adding soil amendments to adjust pH or increase fertility, soil testing is strongly recommended. Soil pH should be 6.5 to 7.0 if legumes are seeded and no lower than 5.5 if sowing only grass seed. Fertilizer should be avoided or used judiciously, in areas adjacent to lakes or streams because it may stimulate the growth of aquatic plants and algae. If fertilizer must be used near water, consider using a fertilizer with low levels of phosphorous. If soil testing is not performed, a standard application rate on low fertility sites not located near water is 150 pounds of 12-12-12, or equivalent fertilizer per acre. Properly selected native vegetation should not require fertilization; the establishment of fast growing introduced or other unwanted species may be promoted at the expense of the native seeding.

Soil Moisture

The water available to plants is determined by the moisture holding capacity of the soil and by the depth to the water table. Droughty soils – for example, sands with more than a few feet to the water table – are unable to maintain an adequate supply of water to sustain plant growth throughout the year. Wet soils, such as clays, silts, mucks, or even sands with a high water table, may retain too much water for growth of many plant species.

Soil with at least 25 to 35 percent silt and clay-sized particles generally will not be droughty in normal weather. The problem of droughty soil can be partially corrected by mixing silt and clay soil or organic material into the upper 3-4 inches of droughty soil and by selecting drought-resistant plant material.

The opposite of droughty soils are wet soils. Soils may stay saturated for prolonged periods of time due to high clay content, poor drainage, a high water table, or groundwater discharge (seepage). The problem of wet soil can be corrected by using plant materials tolerant of wet conditions, adding sand, or installing artificial surface or subsurface drainage (**Note:** drainage of wet areas may be regulated by law and require a permit).

Slope

When slopes are steeper than two to one (horizontal to vertical), structural controls or vegetation reinforced with structural treatments will be much more effective than vegetation alone (Figure 3-3). On slopes less than 2 to 1, vegetation can generally be used. However, establishing vegetation on slopes close to 2 to 1 may require special attention and careful management.

Figure 3-3

Site Use and Maintenance

Site use is important in selecting vegetation. This refers to whether plants will be subjected to foot and vehicular traffic, salt, or other chemicals.

Site maintenance will also influence the type of plant materials being used. Some sites are easy to maintain, such as those that are relatively flat. Grass cannot be safely mowed on slopes greater than 3 to 1. Other sites are nearly impossible to maintain because of difficult access or physical barriers. Grasses, legumes, or shrubs that do not require mowing should be selected for steep or inaccessible areas (Figure 3-4).

Figure 3-4

Critical, Non-Critical, and Sensitive Areas

Before starting any earth change, critical, non-critical, and sensitive areas should be identified on the site. A **critical area** is difficult to stabilize with vegetation once it is graded and the existing vegetation removed (Figure 3-5). Typical critical areas are characterized by highly erodible, infertile, or droughty soils, concentrated flow, heavy traffic, or long or steep slopes. Whenever possible, leave critical areas undisturbed.

Figure 3-5

Sensitive areas are located near lakes, streams, wetlands, adjacent properties, or other landscape features that are sensitive and vulnerable to damage by sediment (Figure 3-6). As with critical areas, make all reasonable efforts to leave sensitive areas undisturbed and, if possible, isolate from earth change activity with a well designed vegetative sediment filter (or filter strip). A dense cover of grass makes the best vegetative sediment filter; Appendix 3A provides more information on filter strips. If sensitive areas must be disturbed, isolate and stabilize them quickly after disturbance. In addition, many sensitive areas are protected by local, state, or federal law and cannot be disturbed without the appropriate permit.

A **non-critical area** is an area remote or well isolated from sensitive areas and on which a good cover of vegetation can be established and maintained without difficulty.

Figure 3-6

Site Preparation

Proper site preparation is essential to provide good contact between the soil and the seed, thereby assuring acceptable levels of germination. Site preparation includes the following activities:

Slope Preparation. Grade the site to a workable slope (remember, structural treatments are necessary for slopes steeper than 2H:1V, and maintenance becomes difficult or impossible on slopes steeper than 3H:1V). The toe of the slope must be protected from undercutting or slippage, and areas of concentrated flow must be

eliminated or armored prior to seeding. In some cases, temporary or permanent diversions or grade stabilization structures (downdrains) should be installed and functioning prior to seeding. If internal water movement may cause seeps or soil slippage, install subsurface drainage.

Topsoiling. Before seeding and mulching, topsoiling may be necessary. Topsoiling involves placing 3 to 4 inches of good quality topsoil, free of large clods and stones, on the final graded subsoil surface before preparing a seedbed (Figure 3-7). Native topsoil should be stockpiled and reapplied whenever possible (Figure 3-8). If necessary, import topsoil to achieve the required depth.

Figure 3-7

Figure 3-8

Topsoil slippage becomes a possibility when topsoiling steep slopes (Figure 3-9). There are three factors that can contribute to this problem.

The first is high moisture content. Because it contains organic material, topsoil is able to absorb and retain a large amount of water. By absorbing the water, the weight of the topsoil increases, and at the same time it becomes more fluid. When possible, divert water away from the slope until vegetation is established.

The second is slope steepness. The steeper the slope, the easier it is for a heavy, wet topsoil to slip down the slope (Figure 3-10).

Figure 3-9

Figure 3-10

The third is poor bonding, or a lack of a good bond between the topsoil and the underlying subsoil. To prevent slippage, the underlying soil must be roughened to a

depth of at least two inches before applying the topsoil (Figure 3-11). After the topsoil is spread, it should be compacted.

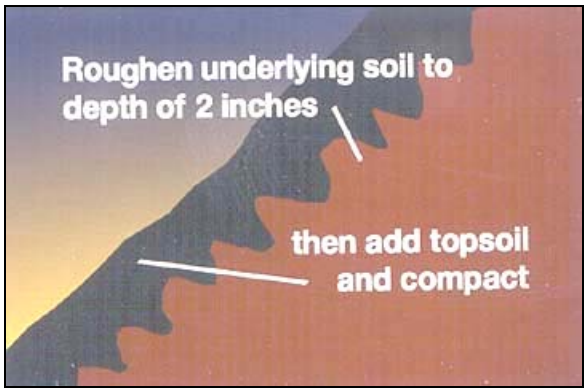

Figure 3-11
Source: John Warbach, Planning and Zoning Center, Inc.

Seedbed Preparation. During recommended seeding periods (Tables 1 and 2), seedbed preparation shall immediately follow construction activities. If seeding is delayed due to the season or other factors, then temporary erosion control measures such as anchored mulch or erosion control blankets shall be installed and maintained until seedbed preparation and seeding can commence.

If the topsoil was removed during construction, the first step in seedbed preparation is spreading 3-4 inches of topsoil and then, if deemed necessary, apply lime and fertilizer on the soil. The application rate should be determined by the soil testing.

Next, till to a depth of at least three inches with a disc or rototiller. Tilling should not be so deep that infertile subsoil is brought to the surface or that a roughened bonding surface is destroyed. Tilling mixes the lime and fertilizer into the soil, allows more air and moisture to penetrate the root zone, and breaks up clods of soil. Tilling should always be performed along the contour of the ground surface, not up and down the slope.

Establishing Vegetation

Seeding

The most common method of establishing vegetation is by means of seeding. The following sections describe some important considerations in the use of seed.

> **Seed Selection**. Use seed with acceptable purity and germination tests that are viable for the planned seeding date. Seed that has become wet or moldy is unacceptable. For most erosion control applications, readily available and economical seed mixtures are suitable; these mixtures are usually composed of introduced species. Use introduced seed mixtures only in places where they will not spread into an adjacent natural area. Invasive or noxious species should never be used.

Seed Mixtures and Rates - Recommended seeding rates should be written into contract specifications or the erosion and sedimentation control plan. Be advised that for any given species, recommended seeding rates from different reference sources may vary widely. Table 4 provides a list of introduced species and the minimum seeding rates for developing custom seed mixtures. Those rates, adapted from the Natural Resources Conservation Service (NRCS), are considerably lower than the rates recommended by MDOT in Table 8.

Seed mixtures that are suitable for most situations are readily available, off the shelf. A good, adaptable, and available mixture is composed of approximately 20-50% each of Kentucky bluegrass, creeping red fescue, and perennial rye. That mixture can be adjusted or supplemented as follows, depending on site conditions:

- If droughty, reduce or eliminate Kentucky bluegrass, increase red fescue and perennial rye, or in extremely dry conditions, add hard or sheep fescue.
- If soil is reasonably fertile and a more aesthetic appearance is desired, increase Kentucky bluegrass and decrease or eliminate perennial rye.
- If shady, increase the red fescue component and use one of the shade tolerant red fescue varieties, such as Chewings or Pennlawn.

Seed Mixtures - Native Species. Refer to Table 6 for example native seed mixtures. Seeding rates for native seed is given in pounds of pure live seed (PLS). This rate can be significantly different than the actual weight of bulk seed. The formula for converting PLS requirements to the required weight of bulk seed is found in the key to the tables on page 3-19.

Seeding Methods

Most grasses and legumes are established by seeding. Seeding is usually done after the lime and fertilizer have been worked into the soil. Seed should be applied as soon as possible, and no longer than five days after final grade has been established. One rainfall can destroy a prepared seedbed that is not mulched.

Herbicides should not be used for one year prior to or after seeding. If herbicides have been used more recently, ensure they are not persistent and will not damage the seeding. Most herbicides intended for use on broad-leaved weeds will also kill legumes.

Distribute seed evenly on a prepared seedbed. Consider making two passes at a lower seeding rate to ensure even coverage. Seed may be applied by hand (Fig. 3-12), mechanical spreader, seed drill, or by hydroseeding. In no case should seed be planted more than 1/4 inch deep. If the site is accessible, the ground should be lightly rolled after seeding to ensure good

seed and soil contact. Inaccessible areas can be limed, fertilized, and seeded with a hand spreader or hydroseeder.

Figure 3-12

Many different combinations of mulch, tackifier, fertilizer, and seed can be applied with a hydroseeder; refer to manufacturer's instructions and available technical literature for advice.

Seeding Dates. The date of seeding is critically important in determining if a seeding will succeed or fail. Tables 1 and 2 provide the dates for seeding permanent vegetation for a normal season. The seasonal window for successful seeding will vary from year to year based on moisture and temperature conditions. A successful seeding is more likely to result by planting in the middle of the suggested spring and fall seeding dates. If a project is completed outside the recommended dates for permanent seeding, the following options are available:

a) **Dormant Seeding.** When a project is completed after the fall permanent seeding date, a dormant seeding of introduced species may be applied for germination the following spring. The seeding must occur late enough to ensure that the seeds do not germinate in the fall, but before the ground freezes or is snow covered. Dormant seeding requires the use of anchored mulch or erosion control blankets to provide the necessary erosion protection during the winter and early spring until the seeds germinate and vegetation is established. Dormant seeding has a higher risk of failure and when successful often has a reduced germination rate. A seeding of a temporary crop with a follow-up planting of a permanent seed mixture the following spring is another option for late season situations.

b) **Frost Seeding.** Introduced permanent species may be seeded after thaw in early spring on seed beds which were prepared the previous fall or had a fall-planted temporary cover crop other than winter wheat or cereal rye (these two species persist over winter and must be destroyed to provide suitable conditions for a successful permanent seeding).

c) **Structural Controls**. If construction occurs too late in the year, one may have to rely on anchored mulch, erosion control blankets, and other temporary measures to protect the soil until the next growing season.

Temporary Cover Crop. Permanent vegetative stabilization is required when it is necessary to stabilize an area for more than one year so only perennial plants can be used.

Temporary vegetative stabilization is the use of fast growing plant materials to stabilize a site for a short time period (one year or less) or to provide stabilization outside the recommended planting season for permanent vegetation. These plants may be either annual or perennial plants. Temporary stabilization is used on soil storage or spoil piles and required when grading would otherwise leave an area without vegetative cover. See Table 3 for date and species selection for temporary vegetative cover. Temporary cover may have to be destroyed to eliminate competition and provide an acceptable seedbed prior to applying a permanent seeding.

Companion Crops. A fast growing annual crop is often included with permanent seed mixtures to provide rapid cover for more immediate erosion control and legumes are often added to provide available soil nitrogen.

a) **For Introduced Mixtures.** Small grain such as oats, barley, winter wheat, cereal rye (*Secale cereale*), or spring wheat may be seeded at 1.5 bushels/acre with a spring or fall permanent seeding. The use of small grains may present some problems for the permanent vegetation: cereal rye may inhibit the germination of other seeds, and any robust, rapidly growing annual may outcompete the slower growing perennial crop for light, nutrients, and water. The small grain companion crops must be mowed prior to seed production to eliminate competition and reseeding, and to allow adequate light penetration for the permanent crop. Mowing should be at a height of 8-10 inches to prevent damage to the permanent crop. A better option, if the season is appropriate, is to add 5-10 lbs/acre of annual ryegrass (*Lolium multiflorum*) to the perennial mixture.

b) **For Native Mixtures.** As a companion crop for native seeding, use Canada wild rye at 1-2 lbs/acre, annual ryegrass at 5-10 lbs/acre, or (in spring only) oats at 1/2 bushel/acre.

c) **Legumes.** Legumes are members of the pea family and have the capability of fixing atmospheric nitrogen into the soil for use by plants. It is often beneficial to include legumes in a seeding mix on low fertility sites. Legumes are slow to establish and usually should not be used as a pure stand for erosion control. They are also less resistant to damage from foot and vehicle traffic than most grasses. If legumes are included in a seeding mixture, they may need to be inoculated with

nitrogen fixing organisms. Follow manufacturer's instructions for both the seed and the inoculant.

Vegetative Treatments Other Than Seeding

Sod. On areas that require immediate vegetation or a high quality turf, sod may be considered as an alternative to seeding. Sod is expensive and prone to failure if irrigation is not available. If irrigation is available, sod may be laid from early May to mid-October. If sod must be used without irrigation, do not lay sod between early June and mid-September. Prepare the site as for seed application. Install the sod with staggered joints, with seams closely abutted but not overlapping, and stake sod in place if installed on a slope greater than 3H:1V or if in an area of concentrated runoff (Figure 3-13). The edge of sod at the top of a slope must be turned in to direct runoff over the sod rather than between the sod and substrate. Lightly roll or tamp sod to ensure good contact with the underlying soil.

Figure 3-13

Sprigging. On sand dunes or other areas of shifting or blowing sand, American beach grass (*Ammophila breviligulata*) is usually the best vegetative treatment for control of erosion. Beach grass is a native species that is established by sprigging - the planting of sprouted plants in the treated area (Figure 3-14). Plant beach grass during the cool portions of the growing season (spring or fall). The plants should be placed on a 12" x 12" grid (43,000 clumps/acre) for windy areas or a 24" x 24" grid (11,000 clumps/acre) for more protected areas. On steep or otherwise difficult sites, beach grass can be planted through erosion control blankets. When planting beach grass, place 2-3 plants in each hole and bury them deep enough to cover the roots and base of the stem. After beach grass is well established and sand movement is reduced or eliminated, other vegetation can be established if desired.

Figure 3-14

Trees and Shrubs. Although grasses, with or without legumes, are the best means to control erosion on most sites, occasionally a special situation arises that requires tall or deep-rooted vegetation or that has special aesthetic requirements. Trees are often used as windbreaks to control wind erosion and the deep roots of woody vegetation may provide soil stability in areas prone to slumping (Fig. 3-15). Table 7 provides information on other plants that may be used in erosion control.

Figure 3-15

Live Stakes and Fascines. Live willow branches, driven into the soil as stakes or bound together in bundles (fascines) and partially buried will sprout and provide rapid shrub establishment. Live willow stakes are most often used to stabilize stream banks. Fascines are used for stream bank stabilization or installed along the contour of slopes for slope stabilization. For live stakes or fascines to be successful, the soil must be moist or even saturated. For details of installation, refer to the substantial technical literature available for these and other "bioengineering" techniques.

Mulching Without Seeding. In situations where final grade is achieved with native organic soils (muck) and the site has low erosion potential, consider applying a clean mulch and allowing the native seed bank to germinate. This option should not be exercised if the organic soils had previously supported invasive species such as purple loosestrife, common reed (*Phragmites*), or reed canary grass.

Mulching

Mulching is essential when establishing grass or legumes from seed. Mulching involves placing material over the seed to protect the soil from erosion and to provide a proper environment for the germination and growth of vegetation. Mulch insulates the soil from intense heat and cold, and conserves moisture by limiting evaporation (Figures 3-16 and 17).

Figure 3-16

Figure 3-17

Immediately following seeding, evenly distribute a mulch of clean dry straw at the rate of 2 tons/acre or 2-3 bales (100 lbs.)/1000 square feet. Ensure that the mulch is derived from a crop that does not contain invasive or noxious species. Hay may contain seeds of undesirable species, and should not be used in most situations. For native plantings, only the cleanest straw mulch should be applied. Mulch can be applied by hand or with a mulch blower (Figure 3-18).

Figure 3-18

On slopes, windy sites, or areas adjacent to roads, mulch must be anchored using netting, a tackifier, or mulch-anchoring disk. On steep slopes or in areas of concentrated flow, erosion control blankets or turf reinforcement mats may be required to properly secure the seeding (Figure 3-19)**.** The blankets are generally made from straw, coconut fiber, excelsior, or a combination of straw and coconut fiber, and reinforced with netting (Figure 3-20). Refer to manufacturer specifications for the proper application of erosion control blankets. Netting and erosion control

blankets must be secured with special staples or stakes (Figure 3-21), and care must be taken to ensure that there is good contact between the blanket and soil. When selecting erosion control blankets, consider using biodegradable blankets and stakes wherever their application is appropriate. Permanent netting, blankets, and stakes often create hazards for wildlife and interfere with mowing operations.

Figure 3-19

Figure 3-20

Figure 3-21

Tackifiers or chemical binders are mixed with water and sprayed on the straw (Figure 3-22). Upon curing, the chemical binds the straw fibers together.

Figure 3-22

A mulch crimper is occasionally used to anchor straw on accessible areas. It consists of a gang of notched coulters, resembling a disc used for tilling. When pulled over the mulch, the revolving discs punch some of the straw into the soil (Figure 3-23).

A hydro-mulcher is often used to apply mulch. The mulch material, made of paper or a blend of wood and paper, is mixed with water to form a slurry and is then sprayed onto the area (Figure 3-24). Often, seed, fertilizer, and a tackifier is mixed with the slurry and applied with the mulch.

Figure 3-23

Figure 3-24

Monitoring Established Vegetation

Protection

All seeding must be protected from foot and vehicle traffic, concentrated runoff, animal grazing, or other potentially damaging uses during establishment. Use diversions, grade stabilization structures (downdrains), curbing, check dams, or other devices to reroute concentrated flow and install signage or barriers to route foot or vehicle traffic away from the establishing seeding.

Maintenance

Successful vegetative stabilization requires maintenance. There are two types of maintenance: follow-up and periodic. Follow-up maintenance is required when the initial seeding, sodding, or other vegetative practices do not achieve the desired degree of stabilization. Once vegetation is established, a long-term inspection routine should be established. Periodic maintenance is undertaken as necessary to maintain a complete and robust vegetative cover.

Inspect the site regularly to ensure that germination is adequate, coverage is complete, and erosion has not damaged the substrate, seed, or mulch. Materials planted in the spring should be inspected during the summer or early fall so that corrective action can be taken during the fall planting season. Areas planted in the fall should be inspected early in the spring so that maintenance can be performed during the spring planting season.

If the vegetative cover did not develop properly, re-evaluate the site to assess why the original seeding failed. Failure could be caused by selecting the wrong type of vegetation, pH problems, inadequate (or excessive) fertilization, lack of moisture, washouts due to storms, or seeding at the wrong time of the year. Reseed and mulch areas that did not germinate.

Plantings of introduced species should be mowed periodically to a height of 6-12 inches to promote dense growth and limit the establishment of undesirable species and woody vegetation. Native plantings may require a different maintenance regimen; contact your local NRCS or other authority for advice. Noxious or invasive species should be removed by spot treatment or hand pulling as soon as they are discovered to prevent their establishment.

Vegetation Specification Tables

Key for Information in the Tables

Abbreviations:

Soil Drainage Class Suitability (Tables 4 & 7): **WD** = Well Drained; **MWD** = Moderately Well Drained; **SPD** = Somewhat Poorly Drained;
PD = Poorly Drained; **VPD** =Very Poorly Drained

Suitable Uses (Table 4): **A** = sites maintained as a lawn or for aesthetic purposes; **C/F** = cut and fill, slopes, ditch banks; **WW** = areas subject to occasional storm water flow (not permanent or frequent inundation), such as grassed waterways, ditch bottoms, or diversions

Species shown in **bold face** may be invasive and should not be planted where they can escape into sensitive natural areas.

Pure Live Seed vs. Bulk Seed

Seeding rates for native species are usually given in pounds of "pure live seed" (PLS), which can be significantly different than the actual weight of bulk seed. Use the following formula to derive the required weight of bulk seed from the PLS rate. Germination, hard seed (a characteristic of legume seeds), and purity percentages are found on the information label attached to all commercially purchased seed.

$$\text{Pounds (lbs) of Bulk Seed} = \frac{\text{lbs PLS}}{(\text{purity}^* + \text{hard seed}^*)\,(\text{germination}^*)}$$

*express % purity, hard seed, and germination in hundredths; i.e. 97% = 0.97

For example, a seed label indicates a germination rate of 80%, 10% hard seed content, and a purity of 78%. If the PLS seeding rate is 25 pounds per acre, the bulk seeding rate is computed as follows:

$$\text{lbs of bulk seed} = \frac{25}{(0.78 + 0.10)\,(0.80)} = \frac{25}{0.704}$$

$$\text{lbs of bulk seed} = 35.5$$

Cool and Warm Season Grasses

Nearly all commonly available introduced or non-native grasses, including all the grass species listed in Table 4, are cool season grasses. These are grasses that put on most of their growth, are greenest, and germinate best in the cooler portions of the growing season; their favored season of growth is reflected in the dates in Table 1. Cool season grasses often go dormant during hot summer weather, putting on no growth, and even turning brown to the point of looking dead. Hot weather is not favorable to the germination of cool season grasses, and if they do germinate, the seedlings are prone to failure, particularly if not regularly watered. Cool season grasses tend to have shallower roots than warm season grasses.

Many of the native grasses are warm season species, which tend to germinate and grow best in the heat of the summer. Warm season grasses are often deep-rooted and slow to establish. Deep-rootedness has advantages for erosion and sediment control and for drought tolerance, but slow establishment – it may take several seasons to get a good cover of native warm season grasses – may be unacceptable for SESC purposes.

Mixing warm and cool season species together may seem a means of taking advantage of the best properties of each type of grass, but that is a strategy that rarely works. Either the cool season or warm season species (usually the rapidly establishing cool species) will out-compete the other, and eventually dominate the site.

Table 1. Preferred Seeding Dates for Permanent Introduced Grasses and Legumes

Zone	Spring Seeding Dates		Fall Seeding Dates
Lower Peninsula south of U.S. 10	April 1 - May 20	See note below regarding summer seeding	August 10 - October 1
North of U.S. 10 and Upper Peninsula	May 1 - June 10		August 1 - September 20

Summer seeding is more reliable if irrigation is available. If a project is completed in the summer and irrigation is not available, it is usually not feasible or advisable to delay seeding. Ensure that summer seeding is accompanied by an adequate thickness of properly anchored mulch. Even with the greatest care, follow-up maintenance of summer seeding is more likely than for spring or fall seeding.

Table 2. Preferred Seeding Dates for Native Grasses

Zone	Spring Seeding Dates	Fall Seeding Dates
Lower Peninsula south of U.S. 10	Thaw - June 30	November 1 - freeze/snow
North of U.S. 10 and Upper Peninsula	Thaw - July 15	October 15 - freeze/snow

The spring seeding dates are preferred for maximum germination. Seed planted in summer may not develop adequately to survive winter. Fall seeding mimics natural systems and is essentially a dormant seeding.

Table 3. Preferred Seeding Dates and Rates for Temporary Cover Crops

Common Name	Seeding Rates		Seeding Dates		
	rate/acre	rate/1000sq.ft.	Lower Peninsula south of U.S. 10	Lower Peninsula north of U.S. 10	Upper Peninsula
Oats	3 bushels	2 pounds	4/1 to 9/15	4/15 to 8/1	5/1 to 8/1
Barley	3 bushels	2 pounds	4/1 to 9/15	4/15 to 8/1	5/1 to 8/1
Annual Ryegrass	50 pounds	1.5 pounds	4/1 to 9/15	4/15 to 8/1	5/1 to 8/1
Winter Wheat	2 bushels	1.5 pounds	9/20 to 10/15	9/10 to 10/10	9/1 to 10/1
Cereal Rye	2 bushels	1.5 pounds	8/1 to 10/15	8/1 to 10/10	8/1 to 10/1

Temporary cover crops must usually be destroyed to properly prepare the seed bed and to eliminate competition for the permanent seed.

Table 4. Minimum Seeding Rates for Introduced Species

Common Name	Scientific Name	Plant Type	Seeding Rate lbs/acre	Drainage Class Suitability	Suitable Uses	Notes
Hard fescue, sheep fescue	*Festuca spp.*	grass	40	WD, MWD	C/F	1
Creeping red fescue	*Festuca rubra*	grass	40	WD, MWD, SPD	A, C/F	2
Chewings red fescue	*Festuca rubra var. falax*	grass	40	WD, MWD, SPD	A, C/F	2
Smooth bromegrass	***Bromus inermis***	grass	40	WD, MWD, SPD	C/F, WW	3
Perennial ryegrass	*Lolium perrene*	grass	25	WD, MWD, SPD	A, C/F, WW	4
Kentucky bluegrass	***Poa pratensis***	grass	30	MWD	A, C/F	2
Orchardgrass	*Dactylis glomerata*	grass	10	MWD, SPD	C/F, WW	3

Timothy	*Phleum pratense*	grass	10	MWD,SPD,PD	C/F, WW	3
Redtop	*Agrostis alba*	grass	8	SPD,PD,VPD	C/F, WW	5
Creeping bentgrass	***Agrostis stolonifera***	grass	8	SPD,PD,VPD	A	6
Alkali (Fults salt) grass	*Puccinellia distans*	grass	20	SPD,PD,VPD	C/F, WW	7
Alfalfa	*Medicago sativa*	legume	15	WD, MWD	C/F	
Red clover	*Trifolium pratense*	legume	15	WD, MWD, SPD	C/F	
White clover	*Trifolium repens*	legume	15	WD, MWD, SPD	C/F	
Birdfoot trefoil	***Lotus corniculata***	legume	15	SPD,PD,VPD	C/F, WW	
Alsike clover	*Trifolium hybridum*	legume	15	SPD,PD,VPD	C/F	

Notes

To provide quick cover, up to 5-10 pounds per acre of annual ryegrass (*Lolium multiflorum*) can be added to any mixture

1 - Drought tolerant species with reduced mowing requirements. Sheep and hard fescue have similar qualities and have been considered varieties of a single species.

2 - Species with shade tolerance. "Chewings" red fescue is most shade tolerant; Kentucky bluegrass is moderately shade tolerant.

3 - Not tolerant of heavy traffic or close mowing; best in low or no maintenance areas

4 - Perennial ryegrass should comprise no more than 50% of any mixture (approx. 12 lbs/acre) and no more than 20% if used in an aesthetic setting

5- Poor wear tolerance and poor turf quality; use for low or no maintenance wet sites

6 - Aggressive in mixtures and disease prone; tolerant of wet sites; produces "putting green" turf with high maintenance

7- Very high salt tolerance; use 10-25% in a seed mix; low wear tolerance; often short-lived

Refer to Table 5 for instructions to create a custom seed mixture.

Table 5. Creating a Custom Seed Mixture

The mixture must contain at least 50% grass seed. Select species based on the natural drainage class of the site. Multiply the pure stand seeding rate of each species by the percentage of the mixture composed of the respective species. Below is an example of a mixture of grasses and a legume selected for a well drained site.

Species	Pure Stand Rate lbs/acre		Percent in Seed Mixture	Rate per Species in Mixture lbs/acre
Creeping red fescue	40	X	40%	16
Kentucky bluegrass	30	X	30%	9
Perennial ryegrass	25	X	20%	5
White clover	15	X	10%	1.5

Total lbs/acre = 31.5

Table 6. Seed Selection Guide for Some Commonly Available Native Grasses

Common Name	Scientific Name	Seeding Rate lbs/acre	Drainage Class Suitability	Notes
American beachgrass	*Ammophila breviligulata*		Dunes, WD sands	1
"Tioga" deertongue	*Panicum clandestinum*	15	WD, MWD	2,3
Little bluestem	*Schizachyrium scoparius*	12	WD, MWD	2
Big bluestem	*Andropogon gerardii*	15	WD, MWD, SPD	2
Switch grass	*Panicum virgatum*	10	WD, MWD, SPD	2
Indian grass	*Sorghastrum nutans*	10	WD, MWD, SPD	2

Notes

1 - Beachgrass is planted vegetatively; see text.

2 - Warm season grasses.

3 - Suitable for sand and gravel pit and mine reclamation; tolerant of low pH.

A great variety of native species are available; consult suppliers for cultural information.

Table 7. Selected Trees and Shrubs for Erosion Control

Common Name	Scientific Name	Drainage Class Suitability	Notes
Evergreen Trees			
Jack pine	*Pinus banksiana*	WD, MWD, SPD	
Red pine	*Pinus resinosa*	WD, MWD	
White pine	*Pinus strobus*	MWD, SPD	
Norway spruce	*Picea abies*	WD, MWD	1
Deciduous Trees			
Quaking aspen	*Populus tremuloides*	WD, MWD, SPD	
Bigtooth aspen	*Populus grandidentata*	WD, MWD	
Hybrid poplar	*Populus spp.*	WD, MWD, SPD	1
Red maple	*Acer rubrum*	ADAPTABLE	
Silver maple	*Acer saccharinum*	MWD, SPD, PD	
Hawthorn	*Crataegus spp.*	varies by species	3
Black willow	*Salix nigra*	SPD, PD, VPD	
With the exception of hawthorn, the trees listed above are fast growing and selected for their potential use in windbreaks.			
Shrubs			
Northern bayberry	*Myrica pensylvanica*	WD, MWD	1,2
Fragrant sumac	*Rhus aromatica*	WD, MWD	2
Staghorn sumac	*Rhus typhina*	WD, MWD	
Gray dogwood	*Cornus foemina (racemosa)*	WD, MWD, SPD	
Red-osier dogwood	*Cornus stolonifera*	SPD, PD, VPD	
Cranberry-bush viburnum	*Viburnum opulus (trilobum)*	SPD, PD, VPD	
Shrub willows	*Salix spp.*	SPD, PD, VPD	
Blackberry/rasberry	*Rubus spp.*	varies by species	3
The shrubs listed above are selected for vigorous and extensive root growth. Willows are particularly useful for streambank stabilization; they will sprout from cuttings or branch bundles if moisture is adequate			
Notes -			
1 - These species are not native to Michigan (bayberry is native, but very rare).			
2 - These species may not be cold hardy in the Northern Lower or Upper Peninsula.			
3 - Thorny species useful for excluding humans where foot traffic may create erosion sites.			

Table 8. MDOT Seed Mixtures and Rates from *2003 Standards and Specifications for Construction*, *Tables 816-1 & 917-1*

Species	***Purity Min. %***	***Germination %***	***MDOT SEED MIXTURE (see explanation at bottom of chart)***								
			TDS	***THV***	***TUF***	***TGM***	***THM***	***CR***	***TSM 6-24***	***TSM 24+***	***ES***
			Mixture Proportions in **percent by weight** and *(pounds/acre)*[(a)]								*Rate,* [(b]) *lbs/acre*
Kentucky Blue Grass	98	85	**5** *(10)*	**15** *(35)*	**10** *(20)*	**10** *(20)*	**30** *(65)*				
Perennial Ryegrass	96	85	**25** *(55)*	**30** *(65)*	**20** *(45)*	**20** *(45)*	**20** *(45)*		**50** *(50)*	**50** *(100)*	*11*
Hard Fescue	97	85	**25** *(55)*		**20** *(45)*	**30** *(65)*					
Creeping Red Fescue	97	85	**45** *(100)*	**45** *(100)*	**40** *(90)*	**40** *(90)*	**50** *(110)*				
Fults Salt Grass	98	85		**10** *(20)*	**10** *(20)*						
Cereal Rye	85	85						**100** *(70)*			
Spring Oats	85	85							**50** *(50)*	**50** *(100)*	
Timothy	(b)	(b)									*24*
Little Blue Stem	(b)	(b)									*3*
Switchgrass	(b)	(b)									*4*
Indiangrass	(b)	(b)									*3*
Big Blue Stem	(b)	(b)									*9*
Total pounds per acre			*220*	*220*	*220*	*220*	*220*	*70*	*100*	*200*	*54*
Soil Type			*Dry sandy to sandy loam*	*Heavy*	*All*	*Medium to heavy*	*Loamy to heavy*	*All*	*All*	*All*	*All*
General Location			*Rural or urban*	*Rural*	*Urban*	*All*	*Resi-dential and business turf*	*All*	*All*	*All*	*Upland areas*
Salt Tolerance			*medium*	*high*	*high*	*low*	*medium*	*N/A*	*N/A*	*N/A*	*N/A*

(a) *(pounds/acre)* for the following mixtures are rounded to the nearest 5 pounds

TDS = Turf Dry Sandy	THM = Turf Loamy to Heavy
THV = Turf Heavy Soil	CR = Cereal Rye, less than 6 months
TUF = Turf Urban Freeway	TSM 6-24 = Temporary Seeding, 6-24 months
TGM = Turf Medium to Heavy Soil	TSM 24+ = Temporary Seeding, 24+ months

(b) Environmental Seeding (ES) mixture application rate is shown in pounds of pure live seed (PLS) per acre
PLS = (purity + hard seed) x germination x pounds of bulk seed; express % purity, hard seed, and germination in hundredths; for example, if 100 lbs. bulk seed with purity =85%, hard seed=10%, germ=85%, then PLS =(0.85+0.10) x 0.75 x 100 = 71.25 lbs.

UNIT THREE REVIEW

1. The best way to prevent erosion is to remove the minimum amount of _____ and re-establish it as soon as possible.

2. A critical area is _____ to stabilize with vegetation. Whenever possible, critical areas should not be _____.

3. A non-critical area is an area on which vegetation can be established without _____.

4. Sensitive areas are those areas next to _____, ____, ____, _____ _____, or other landscape features vulnerable to damage by sediment.

5. Permanent vegetative stabilization is required when it is necessary to stabilize an area for more than _____.

6. Legumes furnish _____ to the soil, an important plant nutrient.

7. When assessing a site prior to selecting plant materials, consideration should be given to:
   a. _____
   b. _____
   c. _____
   d. site _____ and _____

8. Consideration should be given to on-site soil conditions such as:
   a. _____
   b. _____
   c. soil _____ content

9. A 50 pound bag of 20-10-5 contains ____ pounds of phosphorous.

10. Topsoil should be _____at the beginning of grading operations for later use.

11. When slopes are steeper than ____:____ (horizontal/vertical), structures may be more effective to control erosion than vegetation.

12. It is necessary to add _____ to lower acidity (increase the pH).

13. Soil pH should be no lower than _____ for most grasses and no lower than _____ for legumes.

14. The amount of lime and/or fertilizer required for good vegetative growth can be determined through _____ _____.

15. Three factors that contribute to soil slippage are:
    a. high _____ _____
    b. slope _____
    c. poor _____

16. Droughty soil can be corrected by:
    a. selecting _____resistant plants
    b. _____ silt and clay soil or _____matter with the droughty soil

17. The problem of wet soil can be handled by:
    a. selecting plants _____ to wet conditions
    b. installing artificial _____ or subsurface _____

18. Four methods for establishing vegetation are:
    a. _____
    b. _____
    c. _____
    d. _____

19. Sprigging involves planting _____ plants in the treated area.

20. Sod must be closely _____ together and _____ in place on steep slopes or in areas of concentrated flow.

21. Immediately following seeding, a mulch of _____ _____ should be applied at ___ tons/acre.

22. _____ insulates the soil from intense heat and cold, and conserves _____.

23. On steep slopes or areas of concentrated flow, _____ or _____ may be required to properly secure the seeding.

24. The two types of maintenance required for vegetation stabilization are: _____ and _____.

25. Areas planted in the fall should be inspected in the _____.

ANSWERS TO UNIT THREE REVIEW

1. The best way to prevent erosion is to remove the minimum amount of **vegetation** and re-establish it as soon as possible.

2. A critical area is **difficult** to stabilize with vegetation. Whenever possible, critical areas should not be **disturbed**.

3. A non-critical area is an area on which vegetation can be established without **difficulty**.

4. Sensitive areas are those areas next to **lakes, streams, wetlands, adjacent properties,** or other landscape features that are vulnerable to damage by sediment.

5. Permanent vegetative stabilization is required when it is necessary to stabilize an area for more than **one year**.

6. Legumes furnish **nitrogen** to the soil, an important plant nutrient.

7. When assessing a site prior to selecting plant materials, consideration should be given to:
   a. **climate**
   b. **soil**
   c. **slopes**
   d. site **use** and **maintenance**

8. Consideration should be given to on-site soil conditions such as:
   a. **fertility**
   b. **acidity**
   c. soil **moisture** content

9. A 50 pound bag of 20-10-5 contains **five** pounds phosphorous.

10. Topsoil should be **saved** at the beginning of grading operations for later use.

11. When slopes are steeper than **2:1** (horizontal/vertical), structures may be more effective to control erosion than vegetation.

12. It is necessary to add **lime** to lower acidity (increase the pH).

13. Soil pH should be no lower than **5.5** for most grasses and no lower than **6.5** for legumes.

14. The amount of lime and/or fertilizer required for good vegetative growth can be determined through **soil testing**.

15. Three factors that contribute to soil slippage are:
    a. high **moisture content**
    b. slope **steepness**
    c. poor **bonding**

16. Droughty soil can be corrected by:
    a. selecting **drought** resistant plants
    b. **mix** silt and clay soil or **organic** matter with the droughty soil

17. The problem of wet soil can be handled by:
    a. selecting plants **tolerant** to wet conditions
    b. installing artificial **surface** or subsurface **drainage**

18. Four methods for establishing vegetation are:
    a. **seeding**
    b. **sprigging**
    c. **sodding**
    d. **planting a shrub or tree, live staking or fascines, mulching without seeding**

19. Sprigging involves planting **sprouted** plants in the treated area.

20. Sod must be closely **butted** together and **staked** in place on steep slopes or in areas of concentrated flow.

21. Immediately following seeding, a mulch of clean straw should be applied at **two** tons/acre.

22. **Mulch** insulates the soil from intense heat and cold, and conserves **moisture**.

23. On steep slopes or areas of concentrated flow, **mulch blankets** or **turf reinforcement mats** may be required to properly secure the seeding.

24. The two types of maintenance required for vegetation stabilization are: **follow-up** and **periodic**.

25. Areas planted in the fall should be inspected in the spring.

FILTER STRIP (ACRE) CODE 393A

DEFINITION

A strip of grass or other permanent vegetation used to reduce sediment, organics, nutrients, pesticides, and other contaminants.

PURPOSES

1. To remove sediment from runoff from cropland, grazing land, and disturbed areas.

2. To remove sediment in runoff from forestland.

3. To remove nitrogen, phosphorus, pesticides, and pathogens runoff from cropland, grazing land, and urban areas.

4. To remove sediment, organic material, and other pollutants from polluted water as part of an animal waste utilization plan.

5. To remove sediment from runoff and redirect flow toward a riparian forest buffer.

6. To provide wildlife habitat. **CONDITIONS**

WHERE PRACTICE APPLIES This practice

applies:

1. On cropland at the lower edge of a field or above conservation practices

2. On fields upgrade of intermittent or perennial streams, ponds, lakes, or sinkholes.

3. In areas requiring pollutant entrapment as part of an animal waste utilization plan.

4. When sediment entrapment is required on forestland.

5. As a riparian forest buffer component.

6. Where there is minimal concern for movement of leachate from the filter toward shallow ground water.

CRITERIA

General To All Purposes

Filter strips will be placed only in areas receiving overland laminar (sheet) flow.

The filter strip will be designed to encourage sheet flow and infiltration of run-on water. A method of spreading the effluent across the width of the filter strip will be established, if needed.

Infiltration will be promoted within all filter strip areas unless an immediate ground water concern is evident. Infiltration mechanisms such as detention basins, vegetative barriers, or stone and organic filled trenches can be placed within the filter area perpendicular to the flow gradient. If ground water contamination is a concern, contact the appropriate NRCS technical specialist for design guidance.

Adequate soil drainage, both surface and subsurface, is a necessary component to assure proper functioning of the soil biology and vegetation in the filter strip.

The flow length through the filter strip will be based on the slope, size, and land use of the contributing area; soil and average slope of the filter area; pollutants contained in the runoff, and presence of sensitive land features down gradient from the filter area.

Pollutant entrapment in filter strips is highly dependent on the conditions, particularly infiltration potential, in the filter area. Flow lengths given in the following tables for specific pollutants have been adjusted for the predominant hydrologic soil group in the filter area.

Landform of the filter area must allow equipment operation for mowing and harvesting the vegetation.

Comply with local, state, and federal regulations. Sections 401 and 404 of the Clean Water Act may apply to filter strips adjacent to water bodies. Local permits and regulation may supersede criteria in this standard.
Pesticide applications on or near filter strips must comply with label restrictions concerning buffer areas and setbacks.

Contaminant source control shall be considered for all purposes of a filter strip. Reducing the total volume and the concentrations of contaminants in the run-on will increase effectiveness of the filter strip.

Filter strips are part of a resource management system for the land being managed. Other conservation practices and management techniques to treat the resources of concern that must be in place before the filter strip can effectively reduce the pollutants in the runoff. These will include erosion control, nutrient and pest management, waste utilization and crop rotations.

VEGETATION CRITERIA

General For All Purposes

Filter strips will be established to suitable grasses and Forbes that are adapted to the soil and climate conditions.

Plants selected for filter strips should be actively growing during the expected run-on period.

Plant species must be selected according to the type and quantity of pollutant contained in the run-on and to the growth condition during the time of the year that the pollutant can be expected to move as overland flow.

Plant species should be selected that have stiff, upright growth characteristics for flow retardance and pollutant filtering. Plants must remain upright during flow events and be able to withstand sediment accumulation.

Vegetation will be mowed in the filter strip area. Mowing height criteria is given in Table 1 (see page 5).

Vigorous vegetation growth must be achieved under normal management situations.

The selected plant species must be compatible with other objectives of the landowner.

Vegetation in filter strip area will consist of a single species of grass or comprised of a mixture of grasses, legumes, or other Forbes.

Established grass vegetation must attain a minimum stem density per square foot. Legume and other forb density must also attain a minimum stem density per square foot. Stem density criteria for specific species is given in Table 1 (see page 5).

The recommended vegetation will be selected from Table 1, Planting Table for Grasses and Legumes (see page 5).

Vegetation establishment procedures, seeding, liming and fertilizing, will comply with practice standard for Critical Area Planting (342).

Shape and prepare a firm seedbed in a manner consistent with environmental concerns and proper functioning of the filter strip. If necessary, shape the site so conventional equipment can be used for preparing the seedbed, seeding, fertilizing, maintenance and harvesting.

CRITERIA FOR FILTER STRIPS TO REMOVE SEDIMENT FROM RUNOFF

Filter strips in cropland, grazing land, or disturbed areas will have a minimum length of flow as given in Table 2 (see page 6).

CRITERIA FOR FILTER STRIPS ON FORESTLAND

A forestland filter strip is part of a forestry operation to reduce delivery of sediment and related pollutants from forest harvest trails and landings toward water bodies. The minimum length of flow through undisturbed forest floor is given in Table 3 (see page 7).

Longer flow lengths should be used to accommodate high velocity runoff, large contributing areas, and partially concentrated flow situations.

If seeded, the recommended species and mixtures, seeding rate, and stem density will be the same as Table 1 (see page 5).

For filter strips that will be maintained in trees or shrubs refer to practice standard Riparian Forest Buffer (393) for design and maintenance guidance.

CRITERIA FOR VEGETATED (EITHER GRASS, LEGUME, OR FORB) FILTER STRIP COMPONENT (ZONE 3) OF A RIPARIAN FOREST BUFFER

Zone 3 will begin at the outer edge of Zone 2 and extend up gradient a minimum of 20 feet. Additional length may be necessary to accommodate land shaping and harvesting equipment.

Zone 3 is composed of grass, legumes, or forb or combinations of the three vegetation types.

Concentrated flow in Zone 3 will be transformed to sheet flow entering Zone 2 by use of mechanisms such as land shaping, vegetative barriers, or constructed water spreaders.

Zone 3 component of a riparian forest buffer will have the minimum length criteria given in Table 4 (see page 7).

CRITERIA FOR FILTER STRIPS TO REMOVE NITROGEN AND PESTICIDES FROM RUNON WATER

For filter strips with the purpose of removing nitrogen and pesticides contained in runoff water the following criteria will apply.

Filter strips or areas down gradient from animal waste spreading or crop fields with pesticide and fertilizer treatment where nitrogen and pesticides in runoff are a concern will have a minimum flow length as shown in Table 5 (see page 7).

Vegetation species will be selected that have high nutrient uptake and biomass production to remove the maximum amount of nitrogen in the harvested material. If legumes are selected as a part of the vegetation mixture, they will be restricted to only deep rooted (greater than 3 feet) species.

Vegetation selected for pesticide removal must have tolerance to the pesticide or be able to quickly recover from effects of the pesticide being entrapped in the filter strip.

CRITERIA FOR FILTER STRIPS TO REMOVE PHOSPHORUS FROM RUNOFF WATER

The filter strip will be designed and constructed to promote infiltration of the run-on water into the soil profile. Infiltration basins, filled trenches or vegetative barriers will be part of the design. Vegetation species will be selected that have high maximum amount of phosphorus in the harvested material.

Vegetation will be mowed and harvested in the filter strip area. Mowing height criteria is given in Table 1 (see page 6).

Filter strips or areas down gradient from animal waste spreading or crop fields with fertilizer treatment where phosphorus in runoff is a concern will have a minimum flow length as shown in Table 6 (see page 8).

CRITERIA FOR FILTER STRIPS TO REMOVE PATHOGENS (BACTERIA AND VIRUS) FROM RUNOFF WATER

Using filter strips and areas as sole treatment for pathogen removal may not reduce the pathogen counts to levels meeting water quality standards. Other management practices may need implementation.

The filter strip will be designed and constructed to promote infiltration of the run-on water into the soil profile. Infiltration basins, filled trenches and vegetative barriers will be part of the filter strip design.

Vegetation will be mowed and harvested in the filter strip area. Mowing height criteria is given in Table 1 (see page 5).

Filter strips or areas down gradient from animal waste spreading, pasture, or other organic waste material treatment where pathogens are a concern will have minimum flow lengths as shown in Table 7 (see page 8).

CRITERIA FOR WILDLIFE HABITAT

Select vegetation species that are compatible to desired wildlife species (see Wildlife Upland Habitat Management Standard 645)

If wildlife habitat is a secondary purpose, don’t compromise function or design of the primary purpose.

Multiple drill widths of various grass/forb species are desirable for habitat diversity and cover. For

example, a strip planted to orchardgrass, switchgrass, and garrison creeping foxtail.

CONSIDERATIONS

General For All Purposes

1. Consider the effects of seasonal weather variations such as frozen soils, snow cover, and varying ranges of soil moisture on the efficiency of the filter strip.

2. Consider the effects of vegetation on water use and retention with the soil profile.

3. Maintain a balance for the removal or accumulation of nutrients within the soil-plant system of the filter area.

4. Observe the effect on the visual quality onsite and down gradient from the vegetated filter strip.

5. Be sure the selection and management of the vegetation is consisent with the essential purpose of the vegetated filter strip.

6. Filter strip slopes between 2 and 6 percent are most effective. Steeper slopes require a greater area and length of flow. Shallow slopes cause ponding.

7. The filter should be maintained at the minimum flow length stated in the criteria. The length may be extended if changes occur in the contributing area of the watershed that would increase the amount of runoff or pollutants toward the filter strip.

8. Filter lengths (and widths) should be adjusted to accommodate harvest and maintenance equipment.

9. Provisions for preventing continuous or daily discharge to the vegetated filter strip should be made unless an adequate area for infiltration and soil storage of all applied effluent is provided. Temporary storage or alternate areas for application of the effluent should be considered.

10. For filter areas maintained in trees and shrubs refer to Practice Standard Riparian Forest Buffer (392).

PLANS AND SPECIFICATIONS

A plan and specifications are to be prepared for each specific field site where a filter strip will be implemented based on this standard. A plan includes information about the location, construction sequence, vegetation establishment, and management requirements. Specifications include size and slope of the filter area; amount and species of vegetation material to be used; as well as the operation and maintenance required assuring that the practice achieves its intended purpose.

OPERATION AND MAINTENANCE

A narrative will be prepared in the plan that will state the required operation and maintenance of the filter strip.

1. Concentrated flow within the filter strip area will be minimized. If concentrated flow occurs, repair and reconstruction will be made immediately to reestablish laminar (sheet) flow. Remove settled solids as much as practicable prior to directing flow to the filter strip.

2. Vegetation in the filter strip will be maintained in a vigorous growing condition. Supplemental application of nutrients will be applied if required by a soil test recommendation or other monitoring procedures. Establish fertilizer needs by soil test results. Apply N fertilizer after vegetation is established. Fertilize by observation and soil test when needed.

3. The filter strip area will be maintained in the vegetative species that supports the design criteria. Periodic removal or control of undesirable species will be performed by methods that do not hamper the overall performance of the filter strip.

4. The filter strip area shall be inspected on a seasonal basis and following major storm and runoff events. Any damages or sediment accumulation that would adversely impair the function of the filter must be corrected immediately.

5. Periodic tillage and reestablishment of some or all of the filter strip vegetation will be required as needed to remove accumulated sediment. An accumulation of sediment greater than 6 inches or any sediment accumulation that prevents the filter strip from performing as intended. This would be a criterion for removal and/or reestablishment of the affected filter strip area.

6. Vegetative plant density as required by the design criteria shall be maintained. It may require overseeding or other management methods such as clipping and harvesting to promote an adequate density of plant stems.

7. Nutrients that accumulate in the stems and leaves of the plant will be harvested and removed from the site. Periodic foliage harvest or intensive grazing as part of a planned prescribed haying and grazing system may accomplish this.

8. Grazing shall not be permitted in the filter strip unless a planned grazing system is being implemented. see (Prescribed Grazing Standard 528A) Grazing will be permitted under planned grazing system only when soil moisture conditions support animal traffic. Otherwise, livestock will be excluded by whatever means. Limit cattle access and control grazing.

9. Vegetation harvest must be performed on a regular basin to stimulate growth, maintain an upright growth habit, plus provide for removal of nutrients that are contained in the plant tissue.

10. The filter strip area and management will need to be adjusted if management changes occur in the contributing area.

11. Do not use filter strips as a travel way, cropland head land or lane for livestock or farm equipment.

REVIEW AND UPDATE OF THIS STANDARD

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

TABLE 1

Planting table for grasses and legumes. Recommended species of grasses, legumes, and other Forbes
(Select one of the species or seeding mixes below)

Species or Seeding Mixture	Cool/Warm Season	Seeding Rate (LB /Acre)	Established Density (Stems Per Ft^2)	Minimum Mowing Height (In.)	Sediment Trapping	Nutrient Trapping	Wildlife Value
Smooth Bromegrass	Cool	15-30	50	4	Y		
Garrison Creeping Foxtail	Cool	6-10	70	4		Y	
Orchardgrass	Cool	10-15	70	4	Y	Y	Y
Reed Canarygrass	Cool	10	50	4	Y	Y	
Tall Fescue**	Cool	15-25	60	4	Y		
Tall wheatgrass***	Cool	8-12		6	Y		Y
Prairie grasses							
Intermediate Wheatgrass	Cool	8-12	60	4	Y		Y
Big Bluestem	Warm	10-20*	40-50	12		Y	Y
Eastern Gamagrass	Warm	8*	40	12	Y	Y	Y
Indiangrass	Warm	10-15*	40-50	12		Y	Y
Switchgrass	Warm	5-10*	50	12	Y		Y

*Pounds of PLS- Pure Live Seed
**Do not include tall fescue if area is planned for grazing or forage.
***Do not include tall wheatgrass with filter strips for forestland applications

Planting table for grasses and legumes. Recommended species of grasses, legumes, and other Forbes **(Continued)**

Species or Seeding Mixtures	Cool/Warm Season	Seeding Rate (LB /Acre)	Established Density (Stems Per Ft^2)	Minimum Mowing Height (In.)	Sediment Trapping	Nutrient Trapping	Wildlife Value
Timothy	Cool;	5-10	60	4	Y	Y	Y
Alfalfa		6-10					
Bromegrass	Cool	6-12	60	4	Y	Y	Y
Alfalfa		6-10					
Orchardgrass	Cool	2-5	60	4	Y	Y	Y
Alfalfa		6-10					
Others			50	4			

TABLE 2

Filter Strip Length To Remove Sediment From Runof

Land Slope Percent of Contributing Area (%) Above Filter Strip	Length of Flow (Feet) Hydrologic Soil Group of Filter Area			
	A	B	C	D
0 –1	20	20	22	24
1 –3	20	25	28	30
3 –5	24	30	33	36
5 –8	28	35	40	42
8 –12	32	40	44	48
12 - 15	40	50	55	60
15 - 20	48	60	66	72
> 20	*	*	*	*

*For slopes that exceed 20% consult NRCS technical specialist for design guidance.

TABLE 3

Filter Strip Length through Undisturbed Forest Floor Forestland

Land Slope Percent of Contributing Area (%) Above Filter Strip	Length of Flow (Feet)
0 - 3	25
3 - 5	35
5 - 8	45
8 - 12	55
12 - 18	65
18 - 30	80
40 - 50	90
50 - 60	120
60 - 70	150
> 70	*

*For slopes that exceed 70% consult NRCS technical specialist for design guidance.

TABLE 4

Filter Width for Zone 3 Vegetation in A Riparian Forest Bufer

Land Slope Percent of Contributing Area (%) Above Filter Strip	Length of Flow (Feet)
0 - 8	20
9 - 15	30
> 15	40

TABLE 5

Filter Length for Areas Subject To Run-on of Nitrogen and Pesticides.

Land Slope Percent of Contributing Area (%) Above Filter Strip	Length of Flow (Feet) Hydrologic Soil Group of Filter Area			
	A	B	C	D
0 – 1	24	30	33	36
1 – 3	32	40	44	48
3 – 5	40	50	55	60
5 – 8	48	60	66	72
8 – 12	56	70	77	84
12 – 15	72	90	100	108
> 15	*	*	*	*

*For field slopes > 15% consult NRCS technical specialist.

TABLE 6

Filter Length for Areas Subject to Run-on of Phosphorus.

Land Slope Percent of Contributing Area (%) Above Filter Strip	Length of Flow (Feet) Hydrologic Soil Group of Filter Area			
	A	B	C	D
0 - 1	24	30	33	36
1 - 3	40	50	55	60
3 - 5	56	70	77	84
5 - 8	72	90	100	108
8 - 12	96	120	132	144
12 - 15	120	150	165	180
> 15	*	*	*	*

*For field slopes > 15% consult NRCS technical specialist.

TABLE 7

Filter Length for Areas Subject to Run-on of Pathogens (bacteria and virus).

Land Slope Percent of Contributing Area (%) Above Filter Strip	Length of Flow (Feet) Hydrologic Soil Group of Filter Area			
	A	B	C	D
0 – 1	20	25	28	30
1 – 3	24	30	33	36
3 – 5	32	40	44	48
5 – 8	48	60	66	72
8 – 12	100	125	137	150
12 – 15	144	180	198	216
> 15	*	*	*	*

*For field slopes > 15% consult NRCS technical specialist.