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Chapter 7: Vegetation for Erosion and Sediment Control

Introduction

The information in this chapter should be used in conjunction with Chapters 3, 4, and 5 guidance (erosion mechanisms and RUSLE, regional rainfall conditions and site hydrology, and channel and slope stability). These earlier chapters describe how site conditions and local rains can be used to identify suitable site controls to prevent erosion from a construction site. This chapter presents additional information on "vegetation controls" that can be used to meet these local needs, mostly summarized from the *Alabama Handbook for Erosion Control, Sediment Control, and Stormwater Management on Construction Sites and Urban Areas* (USDA 1993).

As stated in the *Alabama Handbook*, a dense, vigorous growing vegetative cover protects the soil surface from raindrop impact, a major force in causing erosion and sedimentation. Also, vegetation will shield the soil surface from the scouring effect of overland flow and decreases the erosive capacity of the flowing water by reducing its velocity. The shielding effect of a plant canopy is augmented by roots and rhizomes that hold the soil, improve its physical condition, and increase the rate of infiltration, further decreasing runoff. Plants also reduce the moisture content of the soil through transpiration, thus increasing its capacity to absorb water. Suitable vegetative cover offers excellent erosion protection and sedimentation control. Vegetative cover is essential to the design and stabilization of many structural erosion control practices. Vegetative cover is relatively inexpensive to achieve and maintain. Also, it is often the only practical, long-term solution to stabilization and erosion control on many disturbed sites.
Planning from the start for vegetative establishment reduces its cost, minimizes maintenance and repair, and makes structural erosion control measures more effective and less costly to maintain. Natural areas (those left undisturbed) can provide low-maintenance landscaping, shade, and screening.

Site Considerations

Species selection, establishment methods, and maintenance procedures should be based on site characteristics, including soils, slope, aspect, climate, and expected management.

The steeper the slope, the more essential is a vigorous vegetative cover. Good establishment practices, including seedbed preparation, proper planting, lime, fertilizer, mulching, and anchoring of mulch are critical. The degree of slope may limit the equipment that can be used in seedbed preparation, planting, and maintenance. Woody plants, shrubs, vines, and trees generally provide better erosion control on steep slopes. They may be more costly and slower to establish, but can provide substantial savings in maintenance. Also, they can be more desirable in the overall landscape plan.

Aspect affects soil temperature and available moisture. South and west facing slopes tend to be warmer and drier, and often require special treatment. For example, mulch may be essential to retain moisture. Also, warm-season species tend to do better on south and west facing slopes since they are usually more drought tolerant.

The regional climate must be considered in selecting well adapted plant species. Climatic differences determine the appropriate plant selections based on such factors as cold-hardiness, heat tolerance, and tolerance to a cool growing season.

When selecting plant species for erosion control and stabilization, the post-construction land use and the expected level of maintenance must be considered. In every case, future site management is an important factor in plant selection. When a site will receive heavy use such as a sports field, plant species should be selected that are wear resistant and have rapid wear recovery, such as bermudagrass. Bermudagrass also has a fast establishment rate and is adapted to many geographical areas. Where a neat appearance is desired, plants that respond to frequent mowing should be used. Likely choices for quality turf in north Alabama are bermudagrass or tall fescue, while in central or south Alabama bermudagrass, centipede, or zoysia are good choices. At sites where low maintenance is desired, low fertility requirements and vegetation persistence are particularly important. Sericea lespedeza and tall fescue are good choices in north Alabama, while bahiagrass and centipede do well in central and south Alabama.

Many soil characteristics, including acidity, moisture retention, drainage, texture, organic matter, fertility, and slope, influence the selection of plants and their establishment requirements. For example, bahiagrass and centipede are suited to droughty soils since they are more drought tolerant than most other grasses. Local county soils maps contain general descriptions of soils with respect to characteristics that affect stabilization of disturbed sites, including their erodible potential (k factor), nutrient and organic contents, and textures. In all cases, however, caution is warranted to ensure that the changing exposed soils are considered for the different construction phases. After site grading, the actual exposed soils may be substantially different from what was originally mapped as the surface soils. In addition, fill material will impart artificial soil characteristics, and the compaction associated with heavy construction equipment will modify many desirable soil characteristics.

Seasonal Considerations

Newly constructed slopes and other barren areas should be seeded or sodded as soon as possible after grading. Where feasible, grading operations should be planned around optimal seeding dates for the particular region. The most effective times for planting perennial grasses and legumes in Alabama generally extend from March through May and from late August through October. Outside these dates, the probability of failure is higher. If the time of year is not suitable for seeding permanent cover (perennial species) a temporary cover should be planted or the area may be stabilized with gravel or mulch, or a permanent sod can be used. Temporary seedings of annual species (small grains, ryegrass, millets etc.) often succeed at times of the year that are unsuitable for seeding permanent (perennial) species. Planting dates may differ for temporary species, depending on the geographical area.

Growing seasons must be considered when selecting species. Grasses and legumes are usually classified as warm or cool-season in reference to their season of growth. Cool-season species produce most of their growth during the spring and fall and are relatively inactive or dormant during the hot summer months. Therefore, fall is the most dependable time to plant them. Warm-season plants grow most activity during the summer, and go dormant at the first frost in the fall. Spring and early summer are the preferred planting times for warm-season species.

Selection of Vegetation

Plant selection should be considered early in the process of preparing the erosion and sedimentation control plan. A diversity of species can be grown in Alabama due to the variation in both soils and climate. However, for practical, economical stabilization and long-term protection of disturbed sites, plant selection should be made with care. Many plants are inappropriate for soil stabilization because they do not protect the soil effectively, or they can not be established quick and easy. Some plants may be very effective for soil stabilization, but are not aesthetically acceptable on some sites. Some plants may even become troublesome pests.

Kudzu

Initial stabilization of most disturbed sites requires grasses and legumes that grow together without gaps. This is true even where part or the entire site is planted to trees or shrubs. In landscape plantings, disturbed soil between trees and shrubs must also be protected either by mulching or by permanent grass, legumes, or mixtures.

Plant Hardiness Zones

The US Department of Agriculture has produced plant hardiness zone maps that are normally used to help determine the suitability of different plants for an area. These maps are based on the annual average low temperatures and are therefore most appropriate for permanent vegetation. Therefore, short-term vegetation use suitable for temporary erosion control at construction sites does not necessarily have to following the same selection guidelines needed for permanent vegetation. In all cases, it is important to contact the local NRCS office, or other erosion control specialists, for the most suitable vegetation to consider for a specific site. Figure 7-1a and Table 7-1a shows the current USDA hardiness zone map and selected cites associated with the different annual average minimum temperatures.

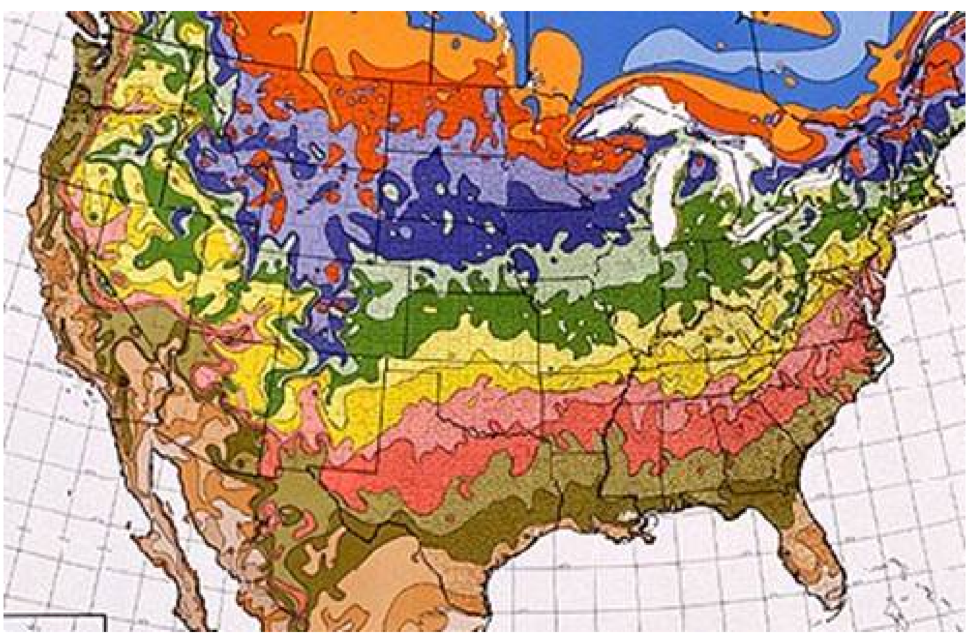

Figure 7–1a USDA Plant Hardiness Zone Map

Table 7-1a Annual Average Minimum Temperatures for Selected Cities

Fahrenheit	Celsius	Example Cities
Below -50 F	Below -45.6 C	Fairbanks, Alaska; Resolute, Northwest Territories (Canada)
-50 to -45 F	-42.8 to -45.5 C	Prudhoe Bay, Alaska; Flin Flon, Manitoba (Canada)
-45 to -40 F	-40.0 to -42.7 C	Unalakleet, Alaska; Pinecreek, Minnesota
-40 to -35 F	-37.3 to -39.9 C	International Falls, Minnesota; St. Michael, Alaska
-35 to -30 F	-34.5 to -37.2 C	Tomahawk, Wisconsin; Sidney, Montana
-30 to -25 F	-31.7 to -34.4 C	Minneapolis/St.Paul, Minnesota; Lewistown, Montana
-25 to -20 F	-28.9 to -31.6 C	Northwood, Iowa; Nebraska
-20 to -15 F	-26.2 to -28.8 C	Des Moines, Iowa; Illinois
-15 to -10 F	-23.4 to -26.1 C	Columbia, Missouri; Mansfield, Pennsylvania
-10 to -5 F	-20.6 to -23.3 C	St. Louis, Missouri; Lebanon, Pennsylvania
-5 to 0 F	-17.8 to -20.5 C	McMinnville, Tennessee; Branson, Missouri
0 to 5 F	-15.0 to -17.7 C	Oklahoma City, Oklahoma; South Boston, Virginia
5 to 10 F	-12.3 to -14.9 C	Little Rock, Arkansas; Griffin, Georgia
10 to 15 F	-9.5 to -12.2 C	Tifton, Georgia; Dallas, Texas
15 to 20 F	-6.7 to -9.4 C	Austin, Texas; Gainesville, Florida
20 to 25 F	-3.9 to -6.6 C	Houston, Texas; St. Augustine, Florida
25 to 30 F	-1.2 to -3.8 C	Brownsville, Texas; Fort Pierce, Florida
30 to 35 F	1.6 to -1.1 C	Naples, Florida; Victorville, California
35 to 40 F	4.4 to 1.7 C	Miami, Florida; Coral Gables, Florida
above 40 F	above 4.5 C	Honolulu, Hawaii; Mazatlan, Mexico

It may be suitable to simplify this map into smaller zones for some vegetation types. As an example, the Patten Seed company (http://www.pattenseed.com/info-chsel.html) simplified the map into five zones for the purpose of selecting permanent turfgrasses. This was possible because these grasses are generally adaptable to a broader range of temperatures than other plants, such as flowers, shrubs and trees. The following lists their recommendations for turfgrasses in each of these consolidated areas. Not all of these turfgrasses are suitable for erosion control applications, but this list does illustrate a simplified approach:

Area 1 - This area includes lower coastal North Carolina, coastal South Carolina, coastal and south Georgia, all of Florida, and lower and coastal sections of Alabama, Mississippi, Louisiana, and Texas. This area should use the Hot Climate Grasses which include Bermuda, Bahia, Centipede, Carpet, St. Augustine, and Zoysia.

Area 2 - This zone is north of Area 1 and includes north coastal North Carolina, much of central South Carolina, central Georgia, north and central Alabama, northern Louisiana, south west Tennessee, all except the most northern part of Arkansas, most of central Texas, and the southern portion of Oklahoma. This area should use a limited set of the Hot Climate Grasses including Bermuda, Centipede, and Zoysia.

Area 3 - This area covers much of the middle U.S. including parts of New Jersey, Maryland, Delaware, Virginia, western North Carolina, western Tennessee, western Kentucky, southern Indiana, southern Illinois, southern Missouri, southern Kansas, northern Oklahoma, northern Texas, most of New Mexico, southern Arizona, and most of coastal California. This area should use Cool Season Grasses including Tifway Bermuda, Meyer Zoysia, and Zenith Zoysia.

Area 4 - This area covers a band of the upper central U.S., including parts of Rhode Island and Connecticut, a small portion of southern New York, northern New Jersey, eastern Pennsylvania, eastern West Virginia, northern Virginia, east Tennessee, central Kentucky, most western Ohio, northern Indiana, southern Michigan, northern Illinois, southern Iowa, northern Missouri, southern Nebraska, northern Kansas, central Colorado, northwest New Mexico, northern Arizona, southeast Utah, the southern tip of Nevada, much of central California, coastal Oregon, and south coastal Washington. This zone should use Cool Season Grasses including Meyer Zoysia, and Zenith Zoysia.

Area 5 - This area covers the upper U.S., north of Area 4 and should use Cool Season Grasses.

Craig Edminster of Cebeco International Seeds (http://www.intlseed.com/index.html) provides an example of seed selection guidance for erosion control. This information is specifically for the Pacific Northwest, but many of these grass types are used in other areas of the country. The following is a description of introduced grass species commonly used for erosion control seed mixtures, excerpted from a summary paper by Edminster. This discussion illustrates the importance of proper seed selection and the assistance of an expert.

"Ryegrass has been used extensively as a short-lived component in erosion control mixtures. Their key attribute in erosion control is rapid seedling establishment, tolerance to slightly acidic soils and excellent spring, and fall forage growth when rainfall is abundant in the Pacific Northwest. In addition, they serve as an excellent nurse crop in low input plantings. Ryegrass is intolerant of droughty, nutrient deficient soils, and therefore may senescence and die during the early establishment period, which provides an excellent growing environment for long lived, grass species. *Lolium perenne* (Perennial ryegrass) tetraploid and diploid sources are commonly used in erosion control plantings. The diploid being more tolerant of grazing pressure (mowing) and more persistent than the larger leafed, more robust and less cold tolerant tetraploid. The use of very late maturing diploid perennials, such as Elka and Essence,® has been recommended to reduce reseeding potential and enhance long lived species establishment.

Annual ryegrass (*Lolium multiflorum*) is the most commonly used cool-season grass in conservation and erosion control in the Pacific Northwest. Annual ryegrass has the best seedling vigor and lowest cost per pound of all the cool season grass species. At low planting rates it can provide good to fair nurse or companion crop attributes. At extremely high seeding rates it can provide living mulch attributes. Annual ryegrass has excellent reseeding capability and seed can remain dormant in soil for up to five years. Therefore, its use is often discouraged where mixed species longevity is desired. Westerwold ryegrass and genetic mixtures containing high percentages of Westerwold germplasm, are readily available in the Pacific Northwest (cv Gulf, Oregon Common). Westerwold ryegrass require a very short floral induction period for plant vernalization and results in reseeding potential. Under these circumstances, annual ryegrass can become a weedy grass in erosion control mixtures. True Italian ryegrass cultivars (cv Sultan, Total) developed in Europe that require significantly more floral induction to induce seed production should be considered as an alternative if annual ryegrass is used.

There are six species of fine fescue recognized for their use in turf and forage production systems in the Pacific Northwest. They include, but are not limited to, chewings fescue *F. rubra* L. subsp. *commutata*, hard fescue *F. longifolia*, and sheeps or blue fescue *F. ovina*; and the rhizomatous type: slender creeping red fescue *F. rubra* L. subsp. *tricholphylla* and strong creeping red fescue *Festuca rubra* L. subsp. *rubra*. Strong creeping red fescue has been used extensively in conservation and erosion control mixtures primarily because of excellent seedling vigor, tolerance to acidic soils, good shade tolerance (understory), and rhizomatous growth habit. Strong creeping red fescue requires very little supplemental fertilization, once established, and grows well on shallow and rocky cut bank riparian and upland sites. Strong creeping red fescue is a moderately tall plant species and is highly compatible with many other tall and short serial species of introduced grass.

Timothy (*Phleum pratense*) has been used as a minor component in mixtures for wetland, bottomland and stream bank restoration where imperfect soil drainage may be a limiting factor. It is poorly adapted for erosion control mixtures because of its lack of seedling vigor. Therefore, mixtures containing rapid establishing species as a nurse crop are advised. Timothy is also intolerant of drought soils so its establishment on well drained sloped areas in riparian and upland sites is not recommended.

Orchardgrass (*Dactylis glomerata*) is a bunchgrass that has been used extensively in erosion control mixtures in West Coast Mountain Region. It has good seedling vigor, early spring forage growth, but requires well drained soil sites to persist. It is tolerant of mild soil acidity, and moderately shade tolerant, but requires supplemental fertilizer for proper growth. Orchardgrass cultivars are segregated into different maturity groups (early, medium and late) for their relative feed value when used in legume-based forage production systems. Early maturing short statured varieties such as Paiute, Palestine are often recommended because they enter dormancy during the summer when soil moisture is depleted in the Pacific Northwest. Upon dehydration in the fall, they regrow and persist.

Tall fescue (*Festuca arundinacea*) has been used on occasions in conservation and erosion control with mixed results. Tall fescue has poor seedling vigor, but exhibits good shade tolerance. Once established, it is a very dominate forage producer and may require aggressive management to constrain growth (mowing, burning). Tall fescue is tolerant of acidic, poorly drained, shallow soil sites, but prefers well drained sandy loam soil sites. In contrast to other cool-season grasses, tall fescue may not enter into summer induced dormancy or rest period. Its deep extensive root system facilitates deep soil profile water uptake during the summer, and tall fescue can dominate a riparian, upland or wetland site.

Kentucky bluegrass (*Poa pratensis*) has been used to a limited extent in the Pacific Northwest. Its most redeeming characteristic is the presence of rhizomes, which provides good soil and plant interface to reduce soil erosion potential. Its most limiting factors are that it has the poorest seedling vigor of all cool-season grasses and is intolerant of slightly acidic to acidic soils. To persist, it must be established in soils with excellent internal drainage. It also requires moderate to high soil nutrition and does best in a diurnal environment where summers are hot and winters cold.

Creeping bentgrass (*Agrostis palustris*) "the golf course greens grass" has been used to a very limited extent for erosion control in the Pacific Northwest. Bentgrass is very tolerant of acidic, poorly drained soils and exhibits fair to poor seedling vigor. If hydrated throughout the season, it can dominate a planting site because of its short, aggressive stoloniferous growth habit. It is therefore incompatible in grass seed mixtures. Established stands of creeping bentgrass will require burning or very short mowing to enhance persistence.

Highland bentgrass (*Agrostis castellana*) is very tolerant of acidic, poorly drained, or shallow soil sites and exhibits good to fair seedling vigor. It also exhibits better summer drought tolerance than creeping bentgrass. Highland bentgrass has larger more robust stolons than creeping bentgrass, and provides more forage for grazing animals and wildlife. Similar to creeping bentgrass, it can dominate a planting site because of its aggressive stoloniferous growth habit and is therefore considered incompatible in grass seed mixtures.

Little colonial bentgrass (*Agrostis tenuis*) has been used in conservation and erosion control projects in the Pacific Northwest. This is more the result of short seed supplies than a lack of its adaptation in conservation program. Colonial bentgrass is the only Agrostis species that is compatible in mixture with other cool-season grass species. This short, acid tolerant, fine leaved species has short prolific stolons that grow more upright than prostate. It exhibits excellent drought tolerance, requires only modest soil fertility and has good to fair seedling germination."

Selecting the Right Grasses and/or Legumes

Mixtures vs. Single Species Plantings
Single species plantings are desired in some cases, but most of the time a mixture is more desirable. Mixtures can be selected that may provide protective cover more quickly and can be more enduring than a single species. Mixtures need not be elaborate. The addition of a quick-growing annual or short lived perennial provides early protection and facilitates establishment of a slower growing and longer living perennial. It is important to evaluate the merits and weakness of each species in selecting the mixtures for the specific site to be treated.

Companion or "Nurse" Crop
The addition of a companion or "nurse" crop (quick-growing annual or weak perennial added to permanent mixtures) is a good practice on difficult sites, late seeding, or in situations where the development of permanent cover is likely to be slow. The companion crop germinates and grows rapidly, holding the soil until the perennial species becomes established. Seeding rate of the companion crop must be limited to avoid crowding, especially under optimum growing conditions.

Plant Species Selection
Detailed information on plant species adapted for soil stabilization use in Alabama is contained in the following discussions, and from the Internet sources listed at the end of this chapter. Most of these commercial suppliers of seeds and sod will help select the most appropriate species for local site conditions. Local USDA Agricultural Extension offices may also be able to provide updated guidance. Using this information makes plant selection more straight forward for most situations. Specific seeding rates and planting instructions are presented in specifications for local conditions by regulatory agencies.

Annuals
Annual plants grow rapidly, mature, and die in one growing season. They are useful for quick, temporary cover or as a companion crop for slower growing perennials. Rye (cereal) is usually superior to other small grains (wheat, oats, or barley) for temporary cover. It has more cold hardiness than other annuals and will germinate and grow at lower temperatures. It will provide more fall and early winter growth and matures earlier than other small grains. Rye germinates quickly and is tolerant of poor soils. Including rye in fall seeded perennial mixtures is particularly helpful on difficult soils and erodible slopes or when seeding is late. However, seeding rates of rye should be limited to the suggested rates because a thick stand will suppress the growth of the desired perennial seedlings. No more than 60 lb/acre should be planted when rye is used as a companion crop. Rye does grow fairly tall in the spring which may be undesirable. If this is a problem, some of the shorter growing varieties of wheat may be used.

Annual ryegrass is not recommended for use as a companion crop in perennial mixtures in Alabama. It is highly competitive and, if included in mixtures, crowds out most other species before it matures in late spring or early summer, leaving little or no lasting cover. It will provide dense cover rapidly, so it can be effective as a temporary seeding, but if allowed to mature, the seed volunteers and can seriously interfere with subsequent efforts to establish permanent cover.

Millets (Browntop, Foxtail) are warm-season annuals, useful for temporary seeding, or as a nurse crop. Browntop millet has early rapid growth, growing two to three feet in height. It is adapted to fine and medium textured soils of moderate productivity. Foxtail is a fine stemmed plant growing to a height of four to five feet. The leaves are broad and flat. Foxtail millets do best under fairly abundant moisture conditions. German millet is a type of foxtail millet. Sudangrass and sorghum-sudangrass hybrids, like the millets, are warm-season annuals which are useful for temporary vegetation. They are better adapted to medium to heavy textured soils. The small stemmed, shorter growing varieties are more satisfactory for temporary vegetation than the tall coarse-stemmed varieties.

Annual lespedeza is a warm-season reseeding annual legume growing to a height of six to twelve inches. It is tolerant of low fertility and is adapted to the climate and most soils throughout Alabama. It is not adapted to alkaline soils of the Black Belt or deep sands. It is a good companion crop for spring planted sericea lespedeza, filling in weak or spotty stands the first season without suppressing the sericea. Annual lespedeza can heal damaged areas in the perennial cover for several years after initial establishment. Two species of annual lespedeza are grown in Alabama. “Common” annual lespedeza volunteers in many parts of Alabama and is sold under the variety name Kobe. Korean lespedeza is a slightly larger, coarser and earlier-maturing plant sold under several variety names. Kobe is superior on sandy soils and generally preferable in south Alabama. Korean is better in north Alabama as the seeds mature earlier.

The preferred seeding dates for annual lespedeza are in the late winter to early spring. It can be mixed with fall seeding, in which case some seeds remain dormant over the winter and germinate the following spring.

Cool-Season Perennials
Perennial plants, once established, will live for more than one year. They may die back during a dormant period, but will grow back from their underground tubers or rhizomes in succeeding years. Stands of perennials will persist for a number of years under proper management and environmental conditions. They are the principal components of permanent vegetative covers. Cool-season perennials produce most of their growth during the spring and fall and are more cold-hardy than most warm-season species.

Tall fescue is the only cool-season perennial grass recommended for vegetating disturbed soils in Alabama. Tall fescue, a cool-season grass, is the most widely used species in north Alabama for erosion control. It is well adapted to all of north Alabama and all but the most droughty soils of central Alabama. Also it can be grown on the Black Belt soils of south Alabama. It thrives in full sun to partial shade and is fairly easy to establish. It will provide stabilization the year of establishment. Because tall fescue has a bunch growth habit, it is slow to fill in areas with poor stands. Therefore, some maintenance will be required on washed out areas or areas of spotty stands to prevent further damage. A number of new varieties of tall fescue are becoming available for lawn and other turf use and several offer definite improvements. However, their higher cost over the standard, Kentucky 31, is seldom justified solely for purposes of stabilization and erosion control. Also, fescue seed infected with a fungal endophyte are preferred since endophyte infected plants are more hardy and stands persist longer. Tall fescue is a fall planted grass. Liberal fertilization and proper liming are also essential for prompt establishment, but once established it can tolerate minimal maintenance almost indefinitely. White clover is sometimes planted with tall fescue.

Warm-Season Perennials
Warm-season perennials initiate growth later in the spring than cool-season species and experience their greatest growth during the hot summer months. Most species of warm-season perennials do better in the southern one-half of Alabama, but there are species or varieties that will grow in north Alabama. The following grasses have proven the most useful for soil stabilization:

• Bahiagrass is a warm-season perennial grass particularly well adapted for growing on sandy soils in the southern half of Alabama. It will tolerate acid and low fertility soils, grow in full sun to light shade, and persist almost indefinitely with little or no maintenance after it is established. However, bahiagrass seedlings are small and lack the vigor some species of warm-season grasses possess; it usually takes two years to establish a good sod. Bahiagrass is established with seed. Bahiagrass does produce a fairly dense sod suitable for low maintenance areas. It has a high resistance to wear and recovers fairly fast from wear. It produces rhizomes and will fill in small bare spots fairly fast. Bahiagrass will produce seedheads about one to two feet in height throughout the growing season and, where this is not a problem, it is probably the best choice for stabilizing soil in the southern one half of the state. Pensacola is the better variety of bahiagrass for soil stabilization. It is more tolerant to upland sites and is more cold tolerant than Argentine bahiagrass.

• Common Bermudagrass is a long lived perennial that spreads by creeping stolons and rhizomes that will extend outward several feet in a growing season. It will survive extreme heat and drought. It is not shade tolerant. Bermudagrass is best adapted to well drained fertile soils. It does poorly on extremely droughty sandy soils and will not grow on poorly drained soils. It responds well to fertilizer and will establish a dense sod quickly from seed. Common bermudagrass will grow in all areas of the state. Bermudagrass requires more maintenance than bahiagrass and, if a regular maintenance fertility program is not used, it will tend to slowly decline. It has a high resistance to wear and a fast recovery from wear which makes it a good choice for heavy use areas.

There are two types of bermudagrass which are important in soil stabilization. Common bermudagrass, which can be established with seed or sprigs, and turf-type bermudagrasses which must be established from vegetative material. Common bermudagrass has longer internodes and larger leaves than the turf-type hybrid bermudagrass. When common bermudagrass will be used for permanent vegetation, only seed that are 98% pure common bermudagrass should be planted. Common bermudagrass seed are often contaminated with giant-type bermudagrass seed. Giant-type bermudagrass is very competitive and fast growing, but is not cold hardy in Alabama. So when common bermudagrass seed contains even a small percent of giant type bermudagrass seed, they will be choked out by the giant-type bermudagrass. Since the giant-type bermudagrass is killed by the cold, a good sod the year of establishment becomes destroyed the second year.

The turf type hybrid bermudagrasses have fine leaves and short internodes which make them desirable for lawn, golf courses and other areas where a quality turf is desired. However, turf type hybrid bermudagrasses are more costly to establish because they must be planted from sprigs, plugs, or solid sodded. Tifway 419 is the most commonly used turf type hybrid bermudagrass. The agronomic varieties of hybrid bermudagrasses do not lend themselves to soil stabilization of construction areas. They too must be established with vegetative material which makes them costly to establish.

Perennial Legumes
Sericea lespedeza or sericea is a deep rooted, drought resistant perennial legume, adapted to all but the poorly drained and deep sandy soils of the state. It is long lived, tolerant of low fertility soils, pest free, and will fix nitrogen. It can be a valuable component in most low maintenance mixtures. Sericea is slow to establish and will not contribute much to prevention of erosion the first year; however, once established it persists indefinitely on suitable sites.

Plantings that include sericea require mulch and should include a companion crop such as browntop millet, annual lespedeza, or common bermudagrass. Sericea should be planted as early as possible within the planting date range so as to reduce as much weed competition as possible. Also, sericea may be planted in the late fall and winter months because many of the seeds will lie dormant until germination the following spring. Sericea does not tolerate frequent mowing and may be considered unsightly because the old top growth breaks down slowly.

Crownvetch is a deep rooted, perennial legume adapted only to north exposures in the northern tier of counties in Alabama. It is useful on steep slopes and rocky areas that are likely to be left unmoved. It can be seeded in the spring or fall. Crownvetch requires a specific inoculant.

Summary, Selection of Erosion Control Grasses

This section was excerpted from material prepared by Jason Kirby, a graduate student at the University of Alabama. Grass is an excellent choice for erosion control because it can form thick sods which will protect the soil from erosion, while making the area more aesthetically pleasing. All grasses are not the same however, and can vary in their ability to protect and survive in a given environment. Ryegrass is moderately dark green with good density (measured by the number of blades of grass per square inch) and a fine texture. This species is known to establish quickly and produce a stable/hearty turf. In addition to its low maintenance requirements, ryegrass has good tolerance to sun, shade, drought, temperature, and wear. Bluegrass displays a dark green color with dense uniform coverage. Bluegrass requires moderate maintenance (watering, mowing, etc.) and is less tolerant of changes in temperature, shade, drought than rye grass. Bluegrass can withstand more abuse (foot traffic, wear) than other similar grasses. Finally, Fescue has deep green blades and is known for its rapid germination and establishment. Fescue is quite tolerant to changes in temperature, wear, shade, and drought. Fescue can be maintained with limited effort. Unfortunately, all of these above listed grasses are considered cool-season grasses and have limited application in the Southeast.

Bermuda, Centipede, and Zoysia share characteristics similar to the above listed grass, but are better suited to the hotter conditions in the Southeast. Commercial grass suppliers (S&S seeds, for example, at www.ssseeds.com) are able to recommend grass types/blends based on site location and other characteristics (slope, watering, etc). These recommendations will identify the appropriate species and the suggested method of application, such as by seed or sod.

The decision to use seed or sod to establish a specified grass type is a crucial one. While most grasses can be established either way the initial costs and characteristics can be significantly different. The following table is a general comparison between seeding and sodding.

	Seeding	**Sod**
Planting Season	Fall, and perhaps Spring	Anytime
Water Requirements	Very High for Germination/Establishment	Low (6” initially then limited for next 3 weeks)
Soil Preparation	Tillage, fertilization, etc.	Same as for seeding
Weed control	Requires Herbicide	Minimal, if any
Uniformity	Varies based on weeds, washouts, etc.	99-100%
Usability (Traffic)	None for 2 months, then limited up to 6 months	Normal to high within 2 weeks
Erosion Control	None until established, Rain will necessitate repair	Good control after installation
Cost	\$0.01 to \$0.04 per ft^2	\$0.14 to \$0.60 per ft^2

Sod, as a rule of thumb, cost about 20 times more than seeding to install, however, this cost is usually offset by sod’s ability to be planted year round, uniform establishment, and instant erosion protection. Sod is available throughout the country form various national and local sod farms. These farms carry numerous species with varying levels of quality.

High quality sod is expensive (up to \$0.60 per ft^2) but will contain fewer weeds and have a better appearance. Lower quality sods have more weeds/pests but save money and will still establish a good ground cover. Laying sod can cost up to \$15,000 an acre, so while it has enhanced erosion control properties, it needs to be used as a permanent control or on a small scale temporary basis to be cost effective.

Seeding an area is much less expensive than using sod (\$250 an acre) and can provide adequate erosion protection given time. Germination can take up to a month, and up to six months for grass establishment, depending on the grass type and planting conditions. Until full grass development, constant maintenance (watering, replanting, etc.) will be required. In addition to seeding a site for grass creation, annual species can be used to supplement established grasses that may go seasonally dormant. The extra attention seeding requires may make sod a more attractive option, depending on the site. The decision basically comes down to a decision between excellent initial erosion protection at high cost, or low initial cost with less erosion control.

Sod sizing will depend on the farm and grass type selected. Sod pieces can range from 12”x24” (residential) to 8’x 32’ (commercial applications, especially golf courses). Staples may be required to anchor the sod into place until the root system is established.

Once grass has been established (seed or sod) their physical characteristics become indistinguishable (Sod will have better erosion resistance initially, but once the seeds develop the differences are minimal). Typically, grass can withstand a maximum permissible velocity of around 5 ft/s with an absolute maximum of 8 ft/s. The following table (USDA 1954) lists the permissible velocities for several grasses:

Cover	Slope Range	Erosion Resistant Soils maximum permissible velocity (ft/s)	Easily Eroded Soils maximum permissible velocity (ft/s)
Bermudagrass	0-5	8	6
	5.-10	7	5
	over 10	6	4
Kentucky Bluegrass	0-5	7	5
	5.-10	6	4
	over 10	5	3
Grass Mixture (Rye, Fescue)	0-5	5	4
	5.-10	4	3
Crabgrass	0-5	3.5	2.5
Common Lespedeza	0-5	3.5	2.5

USDA. *Handbook of Channel Design for Soil and Water Conservation*. Technical Paper TP-61. 1954.

Establishing Vegetation


SCS photo


SCS photo

Topsoiling

The surface layer of an undisturbed soil is often enriched in organic matter and has physical, chemical, and biological properties that make it a desirable planting and growth medium. These qualities are particularly beneficial to plant establishment. Consequently, where practical, topsoil should be stripped off prior to construction and stockpiled for use in final vegetation of the site. Stockpiling topsoil may eliminate costly amendments and repair measures later. Topsoil may not be required for the establishment of less demanding, lower maintenance plants, but it is essential on sites having shallow soils or soils with other severe limitations. It is essential for establishing fine turf and ornamentals.

The need for topsoil should be evaluated, taking into account the amount and quantity of available topsoil and weighing this against the difficulty of preparing a good seedbed on the existing subsoil. Where a limited amount of topsoil is available, it should be reserved for use on the most critical areas.

Soil Amendments

Lime is almost always required on disturbed sites to decrease soil acidly. Lime raises the pH, reduces exchangeable aluminum, and supplies calcium and magnesium for vigorous plant growth. Only the alkaline soils of the Black Belt and north Alabama do not require lime. A soil test should be used to determine the need for liming materials.

Plant nutrients (fertilizer materials) will usually be required even on the best soils. Plant nutrient application rates for a particular species of vegetative cover should be applied according to a soil test report. Soil amendments should be applied uniformly and well mixed with the top 6 inches of soil during seedbed preparation.

Site Preparation

The soil on a disturbed site must be modified to provide an optimum environment for germination and growth. Addition of topsoil, soil amendments, and tillage are used to prepare a good seedbed. At planting, the soil must be loose enough for water infiltration and root penetration, but firm enough to retain moisture for seedling growth. Tillage generally involves disking, harrowing, chiseling, or some similar method of land preparation. Tillage should be done on the contour where feasible to reduce runoff and erosion. Lime and fertilizer should be incorporated during the tillage.

Planting Methods

Seeding is by far the fastest and most economical method that can be used with most species. However, some grasses do not produce seed and must be planted vegetatively. Seedbed preparation, liming, and fertilization are essentially the same regardless of the method chosen.

Uniform seed distribution is essential. This is best obtained using a cyclone seeder, conventional grain drill, cultipacker seeder, or hydraulic seeder. The grain drill and cultipacker seeder are pulled by a tractor and require a fairly clean, smooth seedbed. On steep slopes where equipment can not safely work, hydroseeding may be the most effective seeding method. A rough surface is particularly important when preparing slopes for hydroseeding. In contrast to other seeding methods, a rugged and even trashy seedbed gives the best results. Because uniform distribution is difficult to achieve with hand broadcasting, it should be considered only as a last resort. When hand broadcasting of seed is necessary, uneven distribution may be minimized by applying half the seed in one direction and the other half at right angles to the first. Small seed should be mixed with sand for better distribution. A sod seeder (no-till planter) can plant seed into an existing cover or mulch or be used to restore or repair a weak stand. It can be used on moderately uneven, rough surfaces. It is designed to penetrate the sod, open narrow slits, and deposit seed with a minimum of surface disturbance. Seeding rates recommended in the *Alabama Handbook* have taken into account the "insurance" effect of extra seed. Rates exceeding those given are not recommended because over dense stands are more subject to drought and competitive interference.

Sprigging refers to planting stem fragments consisting of runners (stolons) or lateral, below-ground stems (rhizomes), which are sold by the bushel. Sprigs can be broadcast or planted in furrows using a transplanter. This method works well with bermudagrass. Also sprigs may be broadcast and covered with soil by light disking, or cultipacking. Broadcasting is easier but requires more planting material. Common and forage type hybrid bermudagrass will cover over much more quickly than the lawn type bermudagrass. Plugging differs from sprigging only in the use of plugs cut from established sod, in place of sprigs. It requires more planting stock, but usually produces a complete cover more quickly than sprigging. It is usually used to introduce a superior grass into an old lawn.

In sodding, the soil surface is completely covered by laying cut sections of turf. It is limited primarily to lawns, steep slopes, and sod waterways in Alabama. Turf-type bermudas, centipede, and zoysia are usually the types of turf used for sodding. Plantings must be wet down immediately after planting, and kept well watered for a week or two thereafter. Sodding, though quite expensive, is warranted where immediate establishment is required, as in stabilizing drainage ways and steep slopes, or in the establishment of high quality turf. If properly done, it is the most dependable method and the most flexible in seasonal requirements. Sodding can be done almost anytime of the year in Alabama.

Inoculation of legumes

Legumes have a bacteria called rhizobia which invade the root hairs and form gall like "nodules." The host plant supplies carbohydrates to the bacteria, which supply the plant with nitrogen compounds fixed from the atmosphere. A healthy stand of legumes, therefore, does not require nitrogen fertilizer. *Rhizobium* species are host specific in that a given species will inoculate some legumes but not others. Therefore, successful establishment of legumes requires the presence of specific strains of nodule forming, nitrogen fixing bacteria on their roots. In areas where a legume has been growing, sufficient bacteria may be present in the soil to inoculate seeded plants, but in other areas the natural *Rhizobium* population may be too low.

In acid subsoil material, if the specific *Rhizobium* is not already present, it must be supplied by mixing it with the seed at planting. Cultures for inoculating various legume seed are usually available through seed dealers.
Among the legumes listed for use in the *Alabama Handbook*, crown vetch is the only one generally requiring inoculation. Lespedeza nodule bacteria are widely distributed in the soils of Alabama, unless the site has had all surface soil removed.

Irrigation

Irrigation, though not usually required, can extend seeding dates into the summer and insure seedling establishment. Damage can be caused by both under and over irrigating. If the amount of water applied penetrates only the first few inches of soil, plants may develop shallow root systems that are prone to desiccation during droughts. If supplementary water is used to get seedlings up, it must be continued until plants become completely established.

Mulching

Mulch is essential to the vegetation of most disturbed sites, especially on difficult sites such as southern exposures, channels, and excessively dry soils. The steeper the slope and the poorer the soil, the more valuable mulch becomes.

Mulch protects the site from erosion until the vegetation is established. In addition, mulch aids seed germination and seedling growth by reducing evaporation, preventing soil crusting, and insulating the soil against rapid temperature changes. Mulch may also protect surfaces that cannot be seeded. Mulch prevents erosion in the same manner as vegetation, by protecting the surface from raindrop impact and by reducing the velocity of overland flow.

Small grain straw (wheat, oats, barley or rye) is the most widely used and one of the best mulch materials. However, there are other materials that work well but may be only locally available. Mulching materials have their respective advantages and appropriate applications, and a material should not be selected on the basis of cost alone.

Maintenance

Satisfactory stabilization and erosion control requires a complete vegetative cover. Even small breaches in vegetative cover can expand rapidly and, if not repaired, can result is excessive soil loss from an otherwise stable site. A single heavy rain will enlarge rills and bare spots and, the longer repairs are delayed, the more costly they become. Prompt action will keep soil loss, sedimentation damage, and repair cost down. New plantings should be inspected frequently and maintenance performed as needed. If rills and eroded areas develop, they must be repaired, seeded, and mulched as soon as possible.

Maintenance requirements extend beyond the seeding phase. Damage to vegetation from disease, insects, traffic, etc., can occur at any time. Pest control (weed or insect) may be needed at any time. Weak or damaged spots must be fertilized, seeded and mulched as promptly as possible.

Vegetation established on disturbed soils often requires additional fertilization. Frequency and amount of fertilizer to apply can best be determined through periodic soil testing. A fertilization program is required for the maintenance of turf and sod that is mowed frequently. Maintenance requirements should always be considered when selecting plant species for vegetation.

Vegetation Controls for Construction Sites

The *Alabama Handbook*, along with other erosion control manuals, contains descriptions of many “vegetation” practices that can be used on construction sites to prevent erosion, or to capture sediment that has already eroded. The following excerpts from the *Alabama Handbook* are only a few that are usually included, but are the most basic controls that should be considered: buffer zones, mulching, temporary seeding, permanent seeding, and sodding. These sections contain recommendations for the use of these controls for Alabama conditions. As noted previously, this handbook is currently being revised, and local USDA extension offices should be consulted for updated recommendations.

Buffer Zones

A buffer zone is a strip of undisturbed, original vegetation or established vegetation surrounding the land-disturbing site, or bordering streams, lakes, and wetlands. Its purpose is to provide a buffer zone to reduce storm runoff velocities, filter sediment in runoff water, act as a visual screen for, reduce construction noise, and improve aesthetics on the land disturbed. Buffers only provide water quality benefits if the water is allowed to flow through them as sheetflows. Concentrated or channelized flows (or storm drainage pipes) passing through buffers effectively bypass these direct water quality benefits. Buffers along waterways will improve the riparian habitat and general stream aesthetics.

The most effective buffers are well-established natural vegetated areas, with dense undergrowth. Research in silviculture areas has show that buffers need to be several decades old to be most effective for water quality considerations. This long period is needed for the planted trees to establish a thick layer of organic debris which is an effective water filter. However, it may be possible to obtain an effective newly planted buffer more rapidly through the use of a wide variety of plants, especially emphasizing shade tolerant thickly growing groundcovers, and using a thick layer of organic mulch. In most cases, leaving a buffer of natural vegetation is likely more effective than trying to plant a new buffer. Visual screens, however, can be effectively planted.

The steps in creating a buffer zone include:

1. Preserve a strip of natural vegetation along permanent and intermittent streams and lakes for bank stabilization and sediment trapping. Minimum width of a buffer zone of natural vegetation for shore line or stream bank protection should be at least 35 feet. However; depending on the size of stream or lake, soil type, existing vegetation, and bank height, the width may be increased up to 100 feet. Also, with narrow buffer zones, additional supporting practices will usually be needed.

2. Preserve a strip of natural vegetation between residences, businesses, roads or other areas needing screening from the construction site. Natural vegetation can be supplemented with trees and/or shrubs to improve the screening or effectiveness of the buffer zone. The width should be adequate to permit the buffer zone to serve as an effective screen or its intend purpose. Table BZ-1 list some fast growing trees and large shrubs for use in establishing or supplementing buffer zones or vegetative screens.

Table BZ-1. Fast Growing Trees and Large Shrubs for Screens and Buffer Zones in Alabama

Common Name	Mature Height	Remarks
Green Ash	60-80 ft.	Does best in moist sites and well suited for alkaline soils
Loblolly Pine	50-85 ft.	Adaptable to more sites and soils than most pine
Yellow Poplar	70-100 ft.	Does best in moist sites but has some insect and disease problems
Bradford pear	30-60 ft.	Pest resistant, has flowers and good fall color
Slash Pine	60-100	Best adapted to coastal areas and wet, sandy soils. Limited to south Alabama
Wax Myrtle	8-15 ft.	Evergreen shrub adapted to coastal plain soils
Shrub Lespedeza	8-12 ft.	Best adapted to coastal plain soils. Wildlife plant
Willow	30-50 ft.	Must have a moist site. Good for buffer zones along streams

3. Establish a strip of fast growing trees between residences, businesses, roads, churches or other areas needing screening from the construction site. Large shrubs may be added to make the buffer zone more effective. The established buffer zone should be a part of the overall landscape plan. Also, planting the buffer zone as soon as possible before construction begins will improve its effectiveness. If sufficient time is lacking for trees to grow, larger plant materials and irrigation can be used. Table BZ-1 list some fast growing trees and large shrubs for use in establishing buffer zones or vegetative screens.

Mulching
Mulching is an application of a protective layer of straw, other plant residues, stone, or synthetic materials to the soil surface. Its purpose is to protect the soil surface from the forces of raindrop impact and overland flow. Mulch encourages the growth of vegetation, reduces evaporation, insulates the soil, and suppresses weed growth. Mulch is frequently used to accent landscape plantings. If incorporated into the soil, mulch also improves many soil properties that have been altered by the construction activities.

Pitt, *et al*. (1999) described the effects of construction activities on soil structure and the use of amendments to improve soil characteristics. Land construction activities typically significantly compact soil, increasing the soil density with decreased rainwater infiltration and reduced plant viability. The use of organic amendments to the soil, and surface mulches, can be used to dramatically improve the sol texture, allowing better plant growth under these typically stressful conditions.

Conditions Where Practice Applies
Mulch temporary or permanent seedings immediately after planting. Mulch around plantings of trees, shrubs, or ground covers to stabilize the soil between plants. Areas that cannot be seeded because of the season should be

mulched to provide temporary protection of the soil surface. In these conditions, use an organic mulch that can be incorporated into the soil during seedbed preparation.

Planning Considerations
1. A surface mulch is the most effective, practical means of controlling runoff and erosion on disturbed land prior to vegetation establishment. Mulch reduces evaporative moisture losses, prevents crusting and sealing of the soil surface, moderates soil temperatures, provides a suitable microclimate for seed germination, and increases the amount of infiltration into the soil.

2. Organic mulches, such as straw, wood chips, and shredded bark, have been found to be the most effective mulch materials. Materials containing weed and grass seeds which may compete with establishing vegetation should not be used. Also, decomposition of some wood products can tie up significant amounts of soil nitrogen, making it necessary to modify fertilization rates, or add fertilizer with the mulch.

3. A variety of erosion control blankets have been developed in recent years for use as mulches, particularly in critical areas such as waterways and channels. Various types of netting materials are also available to anchor organic mulches.

4. Chemical soil stabilizers, or soil binders, when used alone, are less effective than other types of mulches. These products are primarily useful for tacking wood fiber or straw mulches.

5. The choice of materials for mulching should be based on soil conditions, season, type of vegetation, and size of the area. A properly applied and tacked mulch is always beneficial. It is especially important when conditions of germination are not optimum, such as midsummer and early winter, and on difficult sites such as cut slopes and drought soils.

6. Organic Mulches

A. Straw is the most commonly used material in conjunction with seeding. Wheat straw is the most commonly used straw, and can be spread by hand or with a mulch blower. If the site is susceptible to blowing wind, the straw needs to be tacked down to prevent loss.

B. Wood chips are suitable for areas that will not be closely mowed, and around ornamental plantings. Chips do not require tacking. Because they decompose slowly they must be treated with 12 pounds of nitrogen per ton to prevent nutrient deficiency in plants. They can be an inexpensive mulch if the chips are obtained from trees cleared on the site.

C. Wood fiber refers to short cellulose fibers applied as a slurry in hydroseeding operations. Wood fiber hydroseeder slurries may be used to tack straw mulch on steep slopes, critical areas, and where harsh climatic conditions exist. Wood fiber mulch does not provide sufficient erosion protection when used alone.

D. Peanut hulls, cotton burs, and pine straw are organic materials that make excellent mulches but may only be available locally or seasonally. Creative use of these materials can reduce costs.

7. Erosion Control Blankets and Netting

A. Jute mesh, or other types of netting, is very effective in holding mulch in place on waterways and slopes before grasses become established.

B. Erosion control blankets promote seedling growth in the same way as organic mulches. They are very useful in establishing grass in channels and waterways. A wide variety of synthetic and organic materials are available such as wood excelsior, small grain straw, coconut fiber, or mixtures of these materials. When installing erosion control blankets, it is critical to obtain a firm, continuous contact between the material and the soil. Without such contact, the material is useless and erosion will occur underneath.

Specifications

1. Select a mulch material based on the site and practice requirements, availability of material, and availability of labor and equipment. Table MU-1 lists commonly used mulches and their application rates.

Table MU-1. Typical Mulching Materials and Application Rates

Material	Rate Per Acre	Notes
Straw	1-1/2 to 2 tons	Spread by hand or machine; tack down when subject to blowing.
Wood chips	5 to 6 tons	Treat with 12 lbs nitrogen/ton.
Bark	35 cu yds	Can apply with mulch blower. Do not use asphalt tack.
Pine straw	1 to 2 tons	Spread by hand or machine; will not blow like straw.
Peanut hulls	10 to 20 tons	Will wash off slopes. Treat with 12 lbs nitrogen/ton.

2. Before mulching, complete the required grading, install sediment control practices, and prepare the seedbed. Also, plant and cover seed before mulching, except when seed is applied as part of a hydroseeder slurry containing wood fiber mulch.

3. Uniformly spread organic mulches by hand or with a mulch blower at a rate which provides about 75% ground cover. When spreading straw mulch by hand, divide the area to be mulched into sections of approximately 1,000 sq. ft. and place 70-90 pounds of straw (1-1/2 to 2 bales) in each section to facilitate uniform distribution. This will result in 1-1/2 to 2 tons of straw per acre. In hydroseeding operations, a green dye may be added to the slurry, to assure a uniform application.

4. Anchoring Straw Mulch

A. When straw mulch is subject to be blown away by wind, it must be anchored immediately after spreading. It can be anchored with a mulch anchoring tool or a regular farm disk, with added weight and the disk set to run straight. The disk should not be sharp enough to cut the straw, but to punch it into the ground

B. Liquid mulch binders can also be used to tack mulch subject to being blown away by wind. Applications of liquid mulch binders and tackifiers should be heaviest at the edges of areas and at crests of ridges and banks, to resist the wind. Binders should be applied uniformly to the rest of the area. Binders may be applied after mulch is spread or may be sprayed into the mulch as it is being blown onto the soil. Applying straw and binder together is the most effective method. Liquid binders include an array of commercially available synthetic binders. Asphalt-based binders have been used in the past, but runoff toxicity is a potential problem.

C. Straw mulch may also be anchored with lightweight plastic, cotton, jute, wire or paper netting which are stapled over the mulch. The manufacturer's recommendations on stapling netting should be followed.

5. Installation of Erosion Control Blankets

A. All smoothing, seedbed preparation, and vegetation operations must be completed prior to placing the erosion control blanket. Any rocks, clods, sticks, or other debris which would prevent the blanket form making close contact with the soil should be removed. The erosion control blanket should be placed immediately after planting seed. Some special erosion control blankets are also available with the seed incorporated in the blanket, allowing much more uniform seeding.

B. Unroll the erosion control blanket from the top down, parallel to the direction of flow, in flumes and ditches and perpendicular to the direction of flow on slopes. Allow the blankets to lay loosely on the soil but without wrinkles, and do not stretch.

C. To secure the blanket, bury the upslope end in a slot or trench- no less than 6 inches deep, cover with soil, and tamp firmly. Staple the blanket every 12 inches across the top end and every 3 feet around the edges and bottom. Where erosion control blankets are laid side by side, the adjacent edges should be overlapped, with the uphill blanket on top, and stapled together. Each blanket should also be stapled down the center, every 3 feet. Do not stretch the erosion control blanket when applying staples. Most manufactures provide specific installation and stapling instructions for their products and for specific situations. Manufactures of erosion control blankets also frequently specify a specific stable pattern that must be followed when using their products in order to obtain the specified level of performance.

Maintenance
Inspect all mulches periodically, and after rainstorms to check for rill erosion, dislocation, or failure. Where erosion is observed, apply additional mulch. If washout occurs, repair the slope grade, reseed, and reinstall mulch. Continue inspections until vegetation is firmly established.

Topsoil (TS)

Definition
Removing the more fertile topsoil, storing it and replacing it after final grading to enhance permanent site stabilization with vegetation.

Purpose
To provide a better soil medium for establishing and sustaining permanent vegetation so as to provide better soil cover and minimize future erosion.

Conditions Where Practice Applies
1. Sites where a sufficient quantity of suitable quality topsoil is available.

2. Where the excavated subsoil is not suitable for establishing and sustaining adequate permanent vegetation.

3. Where final graded slopes are 3:1, or flatter, and topsoil can be reasonably replaced.

4. Where topsoil replacement is the most economical or expeditious method of providing the proper plant medium to minimize future erosion, or to present the desired landscape appearance.

Planning Considerations
Topsoil is the surface layer of the soil profile, generally characterized as darker than the subsoil due to enrichment with organic matter. It is the major zone of root development and biological activity. Microorganisms that enhance plant growth thrive in this layer. Topsoil can usually be differentiated from subsoil by texture as well as color. Clay content usually increases in the subsoil. The depth of topsoil may be quite variable. On severely eroded sites, it may be non-existent.

Benefits of topsoil include its high organic-matter content and friable consistency (soil aggregates can be crushed with only moderate pressure), and its high water-holding capacity and nutrient content. The texture and friability of topsoil are usually much more conducive to seedling emergence and root growth than exposed subsoil. In addition to being a better growth medium, topsoil is often less erodible than subsoils, and the coarse texture of topsoil increases infiltration capacity and reduces runoff.

Although topsoil provides an excellent growth medium, there are disadvantages to its use. Stripping, stockpiling, and reapplying topsoil, or importing topsoil, may not always be cost-effective. Topsoiling can delay seeding or sodding operations, increasing the exposure time of denuded areas. Most topsoil contains weed seeds, and weeds may compete with desirable species.

In site planning, the option of topsoiling should be compared with that of preparing a seedbed in subsoil. The clay content of most subsoils provides high moisture availability and deters leaching of nutrients. When properly limed and fertilized, subsoils may provide a good growth medium, especially if there is adequate rainfall or irrigation water to allow root development in otherwise high density material.

Topsoiling is strongly recommended where ornamental plants or high-maintenance turf will be grown. Topsoiling is a required procedure when establishing vegetation on shallow soils, soils containing potentially toxic materials, and soils of critically low pH (high acid) levels.

If topsoiling is to be done, the following items should be considered:

1. An adequate volume of topsoil should exist on the site. Topsoil needs to be spread at a compacted depth of 2-4 inches.

2. The topsoil stockpile should be located so that it meets specifications and does not interfere with work on the site, block drainage or release appreciable amounts of sediment.

3. Allow sufficient time in scheduling for topsoil to be spread and bonded prior to seeding, sodding, or planting.

4. Care must be taken not to apply topsoil to subsoil if the two soils have contrasting textures. Clayey topsoil over sandy subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough.

5. If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation.

Design Criteria
Materials. Field exploration of the site shall be made to determine if there is sufficient surface soil of good quality to justify stripping. Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). It shall be free of debris, trash, stumps, rocks, roots and weeds, and shall give evidence of being able to support healthy vegetation. It shall contain no substance potentially toxic to plant growth.

Potential topsoil should be tested by a recognized laboratory. It should meet the following criteria:

- Organic matter content shall be not less than 1.0% by weight.
- pH range shall be from 6.0-7.5. If pH is less than 6.0, lime shall be added in accordance with soil test results, or in accordance with the recommendations of the vegetative establishment practice being used.
- Soluble salts shall not exceed 500 ppm.

If additional off-site topsoil is needed, it must meet standards stated above.

The depth of material meeting the above qualifications should be at least 2 inches. Soil factors such as rock fragments, slope, depth to water table, and layer thickness affect the ease of excavation and spreading of topsoil. Generally, the upper part of the soil, which is richest in organic matter, is most desirable; however, material excavated from deeper layers may be worth storing if it meets the other criteria listed above.

Stripping. Strip only those areas that will be affected by construction or development. A normal stripping depth is 4-6 inches, but deeper depths may be satisfactory if the soil is suitable and undercutting is allowable in locations such as buildings, water impoundment structures, roadways, etc. Temporary sediment control measures such as silt fences, sediment basins, diversions hay bale barriers, etc., should be in place before the topsoil is stripped.

Stockpiling. The stockpile location should be out of drainageways and traffic routes. Stockpiles should not be placed on steep slopes where undue erosion will take place. Measures should be taken to prevent erosion of the stockpiles. The 14 day exposed ground criterion should also be applied to stockpiles. These control measures would include:

1. Mulching the stockpile when it is left inactive for an appreciable period of time.

2. Planting temporary vegetation when the stockpile is to be inactive over winter or periods of expected heavy rainfall.

3. Covering the stockpile with plastic whenever the piles are small or any soil loss would damage existing buildings or facilities.

4. Planting permanent vegetation when the stockpile use will be inactive over 12 months.

5. Sediment barrier protection should be in place before the stockpile is started.

Site Preparation. Areas to be covered with topsoil shall be excavated, graded, filled and shaped to the proper lines, grades, and elevations before topsoil placement is started.

The subgrades should be checked for pH and limed if less than 6.0. Liming shall be done in accordance with soil tests and in relation to the seeding mixture to be planted. Incorporate lime to a depth of at least 2 inches by discing.

Applying Topsoil. The subsoil should be disced, or scarified, to a depth of 4 inches to enhance bonding of the subsoil and topsoil, immediately before placement of topsoil. Topsoil should be uniformly spread to 2 inches on 3:1 slopes and 4 inches on flatter slopes. Required volumes of topsoil may be determined by use of Table TS-1. Topsoil should not be spread when it, or the subgrade, is frozen or muddy. Precautions should be taken to prevent layering of the topsoil over the subsoil. Mixing and bonding of the two soils should be enhanced.

Table TS-1. Cubic Yards of Topsoil Required for Application to Various Depths

Depth (inches)	Per 1,000 Sq. Ft.	Per Acre
1	3.1	134
2	6.2	268
3	9.3	403
4	12.4	537
5	15.5	672
6	18.6	806

Settling of the topsoil is necessary to bond the soils together, but undue compaction should be prevented. Light compaction is necessary to increase soil strength, reduce erosion and enhance vegetation establishment. Excessive compaction should be prohibited as it increases runoff and inhibits seed germination and root development.

Surface irregularities that would impede drainage, increase erosion, or otherwise damage the site, should be removed in final grading. Areas that will not be maintained by mowing may be left rough.

Maintenance
Repair any compacted, eroded or otherwise damaged areas before starting seeding operations.

Construction Specifications for Topsoil
l. The materials to be used as topsoil shall be salvaged from the areas designated on the site drawings or as approved by the engineer.

2. Any material that is found not suitable for topsoil shall be disposed of as directed by the engineer.

3. Any topsoil brought to the site shall be approved before delivery.

4. Remove topsoil to a depth of 4” from the designated area. Provide erosion control measures on borrow areas to prohibit off-site sediment damage.

5. Install any needed sediment control or erosion prevention measures before removing soil from borrow areas or moving soil into the stockpile area.

6. Place the topsoil in the stockpile area shown on the drawings or at a location mutually agreeable to by all parties.

7. Protect any inactive stockpiles as follows:

    a) Mulching when the stockpile will be inactive over 30 days.
    b) Establishing temporary vegetation when the stockpile will be inactive over winter or spring or 120 days.
    c) Establishing permanent vegetation when the stockpile will be inactive over 12 months.

8. Prepare the site in accordance with notes on the drawings or as follows:

    a) Check the pH of the site after grading.
    b) If the pH is below 6.0, take soil samples for liming recommendations.
    c) Apply lime in accordance with soil samples with recommendations for the specified seeding mixture.
    d) Incorporate the lime to a depth of 2 inches.

9. Disc or scarify the subsoil to a depth of 4 inches immediately before topsoiling.

10. Apply topsoil 2 inches deep on 3:1 slopes and 4 inches deep on flatter slopes.

11. Do not apply topsoil when subsoil is frozen or muddy.

12. Lightly compact the placed material to settle the topsoil.

13. Final grade to remove irregularities, taking care to preserve the depth of the topsoil.

14. Proper steps to establish vegetation shall be taken immediately after topsoiling.

Temporary Vegetation - Seeding (TV)

	

Definition
Planting rapid growing annual grasses, small grains, or legumes to provide initial, temporary cover for erosion control on disturbed areas.

Purpose
To temporarily stabilize bare areas that will not be brought to final grade for a period of more than 30 working days. Temporary seedling controls runoff and erosion until permanent vegetation or other erosion control measures can be established. In addition, it provides residue for soil protection and seedbed preparation and reduces problems of mud and dust production from bare soil surfaces during construction.

Conditions Where Practice Applies
On any cleared, bare, or sparsely vegetated soil surface where vegetative cover is needed for less than one year. Application of this practice include diversions, dams, temporary sediment basins, temporary road banks, and soil stockpiles.

Planning Considerations
1. Temporary vegetative cover can provide short term protection before establishing perennial vegetation. It can control rills and excessive erosion on earthen sediment control structures such as diversions, dams, and sediment basins.

2. Temporary vegetation will reduce the amount of maintenance associated with sediment basins. The frequency of sediment basin cleanups will be reduced if watershed areas outside the active construction zone are stabilized.

3. Certain plant species used for temporary vegetation will produce large quantities of residue which can provide mulch for establishment of permanent vegetation.

4. Proper seedbed preparation and selection of appropriate species are important with this practice. Failure to follow establishment guidelines and recommendations carefully may result in an inadequate or short-lived stand of vegetation that will not control erosion.

5. Temporary vegetation is used to provide cover for no more than one year. Permanent vegetation should be established at the proper planting time for permanent vegetative cover.

Specifications
1. Grading and shaping - Minor grading and shaping may be needed to provide a surface on which equipment can safely and efficiently be used for seedbed preparation and seeding.

2. Plant Selection - Plant selection for temporary vegetation should be based on plant characteristics, site and soil conditions, time of year of planting, method of planting, and the needed use of the vegetative cover. Plant species commonly used for temporary cover are contained in Table TV-1.

Table TV-1. Commonly Used Plants for Temporary Cover in Alabama

		Seeding Dates		
Species	**Seeding Rate/Ac**	**North Alabama**	**Central Alabama**	**South Alabama**
Millet, Browntop or German	40 lbs	May 1-Aug 1	Apr 1-Aug 15	Apr 1-Aug 15
Rye	3 bu	Sep 1-Nov 15	Sep 15-Nov 15	Sep 15-Nov 15
Ryegrass	30 lbs	Aug 1-Sep 15	Sep 1-Oct 15	Sep 1 -Oct 15
Sorghum-Sudan Hybrids	40 lbs	May 1-Aug 1	Apr 15-Aug 1	Apr 1-Aug 15
Sudangrass	40 lbs	May 1-Aug 1	Apr 15-Aug 1	Apr 1-Aug 15
Wheat	3 bu	Sep 1-Nov 1	Sep 15-Nov 15	Sep 15-Nov 15

3. Soil Amendments

A. Apply lime according to soil test recommendations. If the pH of the soil in not known, use 2 tons of agricultural limestone or equivalent per acre on coarse textured soils and 3 tons per acre on fine textured soils. Do not apply lime to alkaline soils or to areas which have been limed during the preceding 2 years.

B. Fertilizer application rates should be based on soil test results. When soil test are not possible, apply 500 to 700 pounds of 10-10-10 grade fertilizer.

4. Seedbed Preparation - Complete grading before preparing seedbeds and install all necessary erosion control practices, such as sediment basins. If soils become compacted during grading, loosen them to a depth of 6 to 8 inches using a ripper or chisel plow. Good seedbed preparation is essential to successful plant establishment. A good seedbed is well pulverized, loose, and smooth. Incorporate lime and fertilizer into the top 6 inches of soil during seedbed preparation. If rainfall has caused the surface to become sealed or crusted, loosen it just prior to seeding by disking, raking, harrowing, or other suitable methods. When hydroseeding methods are used, the surface should be left with a more irregular surface of clods.

5. Planting - Evenly apply seed using a cyclone seeder (broadcast), drill, cultipacker seeder, or hydroseeder. Use seeding rates given in Table TV-1. Broadcast seeding and hydroseeding are appropriate for steep slopes where equipment cannot operate safely.

Small grains should be planted no more than 1 inch deep, and grasses and legumes no more than 1/2 inch deep. Broadcast seed must be covered by raking or chain dragging, and then lightly firmed with a roller or cultipacker, Hydroseeding mixtures should include a wood fiber mulch which is dyed an appropriate color to facilitate uniform application of the seed.

6. Mulching - The use of an appropriate mulch will help ensure establishment of vegetative cover under normal conditions and is essential to seeding success under harsh site conditions. Harsh site conditions include:

- seeding in late fall for winter cover (wood fiber mulches are not considered adequate for this use),
- slopes steeper than 3:1, and
- adverse soils (shallow, rocky, or high in clay or sand).

If the area to be mulched is subject to concentrated water flow, as in channels, anchor mulch with netting, or preferably use sod or an erosion control mat. See Chapter 5 for determining channel stability requirements.

7. Irrigation - Use irrigation when available and needed to insure establishment. Apply irrigation at a rate that will not cause runoff.

8. Maintenance - Reseed and mulch areas where seedlings emergence is poor, or where erosion occurs, as soon as possible. Do not mow. Protect from traffic as much as possible.

Permanent Seeding - (PS)

	
	

Definition
Controlling runoff and erosion on disturbed areas by establishing perennial vegetative cover with seed.

Purpose
To reduce erosion and decrease sediment yield from disturbed areas, and to permanently stabilize such areas in a manner that is economical, adapts to site conditions, and allows selection of the most appropriate plant materials.

Conditions Where Practice Applies
Disturbed areas where permanent, long-lived vegetative cover is needed or the most effective method of stabilizing the soil. Permanent seeding may also be used on rough-graded areas that will not be brought to final grade for a year or more.

Planning Considerations
l. The most common and economical means of stabilizing disturbed soils is by seeding grasses and legumes. The advantages of seeding over other means of establishing plants include the smaller initial cost, lower labor input, and greater flexibility of method. Disadvantages of seeding include potential for erosion during the establishment stage, seasonal limitations on suitable seeding dates, and weather related problems such as droughts etc.

2. The probability of successful plant establishment can be maximized through good planning. The selection of plants for permanent vegetation must be site specific. Factors that should be considered are type of soils, climate, establishment rate, and management requirements of the vegetation. Other factors that may be important are wear, mowing tolerance, and salt tolerance of vegetation.

3. The use of irrigation (temporary or permanent) will greatly improve the success of vegetation establishment.

4. Endophyte infected tall fescue appears to establish quicker and have better survival under adverse conditions than endophyte free tall fescue.

5. The operation of equipment is restricted on slopes steeper than 3:1, severely limiting the quality of the seedbed that can be prepared. Provisions for establishment of vegetation on steep slopes can be made during final grading. In construction of fill slopes, for example, the last 4-6 inches might not be compacted. A loose, rough seedbed with irregularities that hold seeds and fertilizer is essential for hydroseeding. Cut slopes should be roughened.

6. Good mulching practices are critical to protect against erosion on steep slopes. When using straw, anchor with netting or asphalt. On slopes steeper than 2:1, jute, excelsior, or synthetic matting may be required to protect the slope.

Specifications
1. Grading and shaping - Minor grading and shaping may be needed to provide a surface on which equipment can safely and efficiently be used for seedbed preparation and seeding.

2. Plant Selection - Plant selection for permanent vegetation should be based on plant characteristics, site and soil conditions, time of year of planting, method of planting, and the intended use of the vegetated area. Climate factors can vary widely in Alabama and the three basic climatic zones were indicated previously.

Plant selection may include companion plants to provide quick cover on difficult sites, late seedings, or in situations where the desired permanent cover may be slow to establishment. Annuals are usually used for companion plants. The plants used for temporary vegetation may be used for companion plants provided the seeding rate is reduced by one half. Ryegrass or other highly competitive plants should not be used as a companion plant. Table PS-1 lists suitable perennial plants, along with the seeding rates and dates.

Table PS-1. Perennial Grasses, Legumes and Mixtures; Seeding Rates; and Planting Dates for Disturbed Areas in Alabama

		Seeding Dates & Adapted Area		
Species	**Seeding Rates/Ac**	**North Alabama**	**Central Alabama**	**South Alabama**
Bahiagrass, Pensacola	40 1bs	---	Mar l-July 1	Feb 1-Nov 1*
Bermudagrass, Common	10 lbs	Apr 1-July 1	Mar 15-July 15	Mar 1-July 15
Bahiagrass, Pensacola Common Bermudagrass	30 lbs 5 lbs	---	Mar 1-July l	Mar 1-July 15
Bermudagrass, Hybrid (Lawn Types)	Solid Sod	Anytime	Anytime	Anytime
Bermudagrass, Hybrid (Lawn Types)	Sprigs 1/sq ft	Mar 1-Aug 1	Mar 1-Aug 1	Feb 15-Sep 1
Fescue, Tall	40-50 lbs	Sep 1-Nov 1	Sep 1-Nov 1	---
Sericea	40-601bs	Mar 15-July 15	Mar 1-July 15	Feb 15-July 15
Sericea & Common Bermudagrass	40-60 lbs 10 lbs	Mar 15-July 15	Mar 1-July 15	Feb 15-July 15

* Fall planting of bahia should contain 45 pounds of smallgrain to provide cover during winter months.

3. Seedbed Requirements - Establishment of vegetation should not be attempted on sites that are unsuitable due to inappropriate soil texture, poor drainage, concentrated overland flow, or steepness of slope, until measures have been taken to correct these problems.

To maintain a good stand of vegetation, the soil must meet certain minimum requirements as a growth medium. A good growth medium should have these criteria:

- Enough fine-grained (silt and clay) soil material to maintain adequate moisture and nutrient supply.
- Sufficient pore space to permit root penetration.
- Sufficient depth of soil to provide an adequate root zone. The depth to rock or impermeable layers such as hardpans should be 12 inches or more, except on slopes steeper than 2:1 where the addition of soil is not feasible.
- A favorable pH range for plant growth, usually 6.0 - 6.5.
- Freedom from large roots, branches, stones, or large clods. Clods and stones may be left on slopes steeper than 3:1 if they are to be hydroseeded.

If any of the above criteria are not met - i.e., if the existing soil is too coarse, dense, shallow or acidic to foster vegetation - special amendments or topsoil should be used to improve soil conditions. The soil conditioners described below may be beneficial or, preferably, topsoil may be applied.

4. Soil Conditioners - In order to improve the structure or drainage characteristics of a soil, the following materials may be added. These amendments should only be necessary where soils have limitations that make them poor for plant growth or for turf establishment.

A. Peat - Appropriate types are sphagnum moss peat, reed-sedge peat, or peat humus, all from freshwater sources. Peat should be shredded and conditioned in storage piles for at least 6 months after excavation.
B. Sand - Clean and free of toxic materials.
C. Vermiculite - Horticultural grade and free of toxic substances.
D. Rotted manure - Stable or cattle manure not containing undue amounts of straw or other bedding materials.
E. Thoroughly rotted sawdust - Free of stones and debris. All 6 lbs of nitrogen to each cubic yard.

5. Soil Amendments

A. Liming Materials - Lime (Agricultural limestone) should have a neutralizing value of not less than 90 percent calcium carbonate equivalent and 90 percent will pass through a 10 mesh sieve and 50 percent will pass through a 60 mesh sieve. Selma chalk should have a neutralizing value of not less than 80 percent calcium carbonate equivalent and 90 percent will pass through a 10 mesh sieve.

B. Plant Nutrients - Commercial grade fertilizers that comply with current state fertilizer laws should be used to supply nutrients required to establish vegetation.

C. Rates of Soil Amendments - Lime and fertilizer needs should be determined by soil tests. Soil testing can be performed by university soil testing laboratories. The local county Cooperative Extension Service can provide information on obtaining soil tests. Commercial laboratories that make recommendations based on soil analysis may be used.

When soil tests are not available, use the following rates for application of soil amendments.

Lime (Agricultural limestone or equivalent) :
- Light-textured, sandy soils: 2 tons/acre
- Heavy-textured, clayey soils: 3 tons/acre (Do not apply lime to alkaline soils)

Fertilizer
- Grasses alone: 800 to 1200 lbs/acre of 10-10-10 or equivalent.
- Grass-legume mixtures: 800 to 1200 lbs/acre of 5-10-10 or equivalent.
- Legumes alone: 800 to 1200 lbs/acre of 0-10-10 or equivalent.

D. Application of Soil Amendments - Apply lime and fertilizer evenly and incorporate into the top 6 inches of soil by disking, chiseling or other suitable means during seedbed preparation. Operate machinery on the contour.

6. Seedbed Preparation - Install necessary mechanical erosion and sedimentation control practices before seedbed preparation, and complete grading according to the approved plan.

Complete the seedbed preparation, which began with incorporation of soil amendments with tillage as a minimum, that will adequately loosen the soil to a depth of at least 6 inches. Break up large clods, alleviate compaction, and smooth and firm the soil into a uniform surface. Fill in or level depressions that can collect water.

7. Planting Methods

A. Seeding - Use certified seed for permanent seeding whenever possible. All seed sold in Alabama is required by law to be tagged indicating it has been inspected, for example. Seed tags contain important information on seed purity, germination, and presence of weed seeds. Seed must meet State standards for content of noxious weeds. Do not accept seed containing prohibited noxious weed seed.

Seeding dates are given in Table PS-1. Seeding properly carried out within the optimum dates have a higher probability of success. It is also possible to have satisfactory establishment when seeding outside these dates. However, if plantings are conducted outside of the optimum dates, the probability of failure increases rapidly. Seeding, dates should be taken into account in scheduling land-disturbing activates.

Inoculate legume seed with the Rhzobium bacteria appropriate to the species of legume.

Plant seed uniformly with a cyclone seeder, drill, cultipacker seeder, or by hand on a fresh, firm, friable seedbed. If the seedbed has been sealed by rainfall, it should be disked so the seed will be sown in freshly prepared seedbed.

When using broadcast-seeding methods, subdivide the area into workable sections and determine the amount of seed needed for each section. Apply one-half the seed while moving back and forth across the area, making a, uniform pattern; then apply the second half in the same way, but moving at right angles to the first pass.

Cover broadcast seed by raking or chain dragging; then firm the surface with a roller or cultipacker to provide good seed contact. Small grains should be planted no more than 1 inch deep and grasses and legume seed no more than 1/2 inch deep.

B. Hydroseeding - Surface roughening is particularly important when hydroseeding, as roughened slopes will provide some natural coverage for lime, fertilizer, and seed. The surface should not be compacted or smooth. Fine seedbed preparation is not necessary for hydroseeding operations; large clods, stones, and irregularities provide cavities in which seeds can lodge.

Mix seed, inoculant if required, and a seed carrier with water and apply as a slurry uniformly over the area to be treated. The seed carrier should be a cellulose fiber, natural wood fiber, or cane fiber mulch material which is dyed an appropriate color to facilitate uniform application of seed. Use the correct legume inoculant at four times the recommended rate when adding inoculant to a hydroseeder slurry. The mixture should be applied within one hour after mixing to reduce damage to seed.

Fertilizer should be not be mixed with the seed inoculant mixture because fertilizer salts may damage seed and reduce germination and seedling vigor. Fertilizer may be applied with a hydroseeder as a separate operation after seedlings are established.

Lime is not normally applied with a hydraulic seeder because it is abrasive, but if necessary, it can be added to the seed slurry and applied at seeding or it may be applied with the fertilizer mixture. Also lime can be blown onto steeper slopes in dry form.

C. Sprigging - Hybrid bermudagrass cannot be grown from seed and must be planted vegetatively. Vegetative methods of establishing common and hybrid bermudagrass, centipedegrass, and zoysia include sodding, plugging and sprigging. Sprigs are fragments of horizontal stems which include at least one node (joint). They are normally sold by the bushel and can either be broadcast or planted in furrows using a tractor-drawn transplanter.

Furrows should be 4-6 inches deep and 2 feet apart. Place sprigs about 2 feet apart in the row with one end at or above ground level.

Broadcast sprigs at the specified rate. Press into the top 1/2 to 2 inches of soil with a cultipacker or with a disk set nearly straight so that the sprigs are not brought back to the surface. A mulch tacking machine may be used to press sprigs into the soil.

8. Mulching - The use of a mulch will help ensure establishment of vegetation under normal conditions and is essential to seeding success under harsh site conditions. Harsh site conditions include:

- Seeding in late fall (wood fiber mulches are not adequate for this use),
- Slopes steeper than 3:1, and
- Adverse soils (shallow, rocky, or high in clay or sand),

9. Irrigation - Moisture is essential for seed germination and vegetation establishment. Supplemental irrigation can be very helpful in assuring adequate stands in dry seasons or to speed development of full cover. It is a requirement for establishment of vegetation from sprigs and should be used elsewhere when feasible. However; irrigation is rarely critical for low-maintenance vegetation planted at the appropriate time of the year. Water application rates must be carefully controlled to prevent runoff. Inadequate or excessive amounts of water can be more harmful than no supplemental water.

10. Maintenance - Generally, a stand of vegetation cannot be determined to be fully established until soil cover has been maintained for one full year from planting. Inspect vegetated areas for failure and make necessary repairs and vegetate as soon as possible.

If stand has inadequate cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand after seedbed preparation or over-seed the stand. Consider seeding temporary cover if the time of year is not appropriate for establishment of permanent vegetation.

If vegetation fails to grow, soil must be tested to determine if acidity or nutrient imbalance is responsible.

Fertilization - On the typical disturbed site, full establishment usually requires application of fertilizer in the second growing season. Turf grasses require annual maintenance fertilization. Use soil tests if possible or follow the guidelines given for the specific seeding mixtures.

Protect establishing vegetation from traffic that will be harmful. Use either temporary fences or barriers to protect areas that may be damaged by excessive traffic.

Sodding (SD)

Definition
Permanently stabilizing areas by laying a continuous cover of grass sod.

Purpose
To prevent erosion and damage from sediment and runoff by stabilizing the soil surface with permanent vegetation; to provide immediate vegetative cover of critical areas; to stabilize disturbed areas with a suitable plant material that cannot be established by seed; and to stabilize drainage ways and channels and other areas of concentrated flow where flow velocities will not exceed that specified for a vegetated waterway.

Conditions Where Practice Applies
Disturbed areas which require immediate and permanent vegetative cover, or where sodding is preferred to other means of grass establishment such as waterways or sod flumes carrying intermittent flow at acceptable velocities, areas around drop inlets, and steep critical areas needing immediately cover.

Planning Considerations
1. Advantages of properly installed sod include immediate erosion control, nearly year-round establishment capability, less chance of failure than with seeding, and rapid stabilization of surfaces for traffic areas, channel linings, or critical areas.

2. Initially, it is more costly to install sod than to plant seed; however, the higher cost may be justified for specific situations where sod performs better than seed.

3. Sodding for soil stabilization eliminates the seeding and mulching operations, but the same site preparation is required. Sodding is a more reliable method of producing adequate cover and erosion control than seeding.

4. Sod can be laid during the times of the year when seeded grasses may fail, provided there is adequate water available for irrigation in the early establishment period. Irrigation is essential, at all times of the year, when installing sod.

5. In waterways and sod flumes that carry concentrated flow, properly pegged sod provides immediate protection and is preferable to seeding.

6. Sod placed around drop inlets can protect them from sediment and help maintain the necessary grade around the inlet.

7. The site should be prepared and ready for laying of sod when it is delivered. Leaving sod stacked or rolled can cause severe damage and loss of plant material.

Specifications

1. Selection of appropriate types of sod - The type of sod selected should be adapted to both the site and the intended purpose. In Alabama, these are limited to bermuda, zoysia, centipede, St. Augustine, tall fescue, and bahiagrass. Tall fescue and bahiagrass is not readily available but can be obtained from some growers. Species selection is primarily determined by region, availability, and intended use (Tables SD-1 and SD-2).

Table SD-1. Types of Sod Available in Alabama

Warm-season Grasses:	Varieties	Adaptable Region
Bermudagrass	Tifway, Tifgreen Tiflawn, common	North Alabama Central Alabama South Alabama
Bahiagrass	Pensacola	Central Alabama South Alabama
Centipede	No improved varieties	Central Alabama South Alabama
St. Augustine	Bitterblue, Raleigh, common	South Alabama
Zoysia	Emerald, Meyer	Central Alabama South Alabama
Cool-season Grasses:		
Tall Fescue	Kentucky 31	North Alabama

Table SD-2. Characteristics of Grasses Used as Sod in Alabama

	Adaptation					Maintenance	
Grass	**Shade**	**Heat**	**Cold**	**Drought**	**Wear**	**Mowing Height**	**Mowing Frequency**
Bermudagrass	no	good	poor	excel.	excel.	1 in.	high
Bahiagrass	fair	good	poor	excel.	good	2-3 in.	high
Centipede	fair	good	poor	good	poor	1-1/2 in.	low
Tall fescue	good	fair	good	good	good	3 in.	high
St. Augustine	good	good	poor	poor	poor	2-3 in.	med.
Zoysia	fair	good	fair	excel.	good	1 in.	high

2. Sod Quality - Sod should be machine cut at a uniform depth of 1/2 to 2 inches (excluding shoot growth and thatch). The sections of sod should be strong enough to support their own weight and retain their size and shape when lifted

by one end. Sod should be placed within 36 hours of harvest.

3. Site preparation - Test soil to determine the exact requirements for lime and fertilizer. Soil test may be conducted by university soil testing laboratories (available through local agricultural extension offices for a nominal fee) or other laboratories that make recommendations based on soil analysis. When soil test recommendations are unavailable, the following soil amendments may be sufficient:

- Agricultural limestone at a rate of 2 tons per acre (100 lbs per 1000 sq. ft.)
- Fertilizer at a rate of 1000 lbs per acre (25 lbs per 1000 sq. ft.) of 10-10-10.

Equivalent nutrients may be applied with other fertilizer formulations. The soil amendments should be spread evenly over the treatment area and incorporated into the top 6 inches of soil by disking, chiseling or other effective, means.

Prior to laying sod, clear the soil surface of trash, debris, roots, branches, stones, and clods larger than 2 inches in diameter. Fill or level low spots in order to avoid standing water. Rake or harrow the site to achieve a smooth and level final grade.

Complete soil preparation by rolling or cultipacking to firm the soil. Avoid using heavy equipment on the area, particularly when the soil is wet, as this may cause excessive compaction and make it difficult for the sod to take root.

4. Sod installation - A step-by-step procedure for installing sod is described below:

A. Moistening the sod after it is unrolled helps maintain its viability. Store it in the shade during installation.

B. Rake the soil surface to break the crust just before laying sod. During the summer, lightly irrigate the soil, immediately before laying the sod to cool the soil and reduce root burning and dieback.

C. Do not lay sod on gravel, frozen soils, or soils that have been recently sterilized or treated with herbicides.

D. Lay the first row of sod in a straight line with subsequent rows placed parallel to and butting tightly against each other. Stagger strips in a brick-like pattern. Be sure that the sod is not stretched or overlapped and that all joints are butted tightly to prevent voids. Use a knife or sharp spade to trim and fit irregularly shaped areas.

E. Install strips of sod with their longest dimension perpendicular to the slope. On slopes 3:1 or greater, or wherever erosion may be a problem, secure sod with pegs or staples.

F. As sodding of clearly defined areas is completed, roll sod to provide firm contact between roots and soil.

G. After rolling, irrigate until the soil is wet at least 6 inches below the sod.

H. Keep sodded areas moist to a depth of 4 inches until the grass takes root. This can be determined by gently tugging on the sod. Resistance indicates that rooting has occurred.

I. Mowing should not be attempted until the sod is firmly rooted, usually 2 to 3 weeks.

5. Sodded waterways - Sod provides a resilient channel lining, providing immediate protection from concentrated flow and eliminating the need for installing mats or mulch. The following points apply to the use of sod in waterways:

A. Prepare the soil as needed for good channel design. The sod type must be able to withstand the velocity of flow specified in the channel design.

B. Lay sod strips perpendicular to the direction of flow, with the lateral joints staggered in a brick-like pattern. Edges should butt tightly together.

C. After rolling or tamping to create a firm contact, peg or staple individual sod strips to resist washout during establishment. Jute or other netting material may be pegged over the sod for extra protection on critical areas.

Maintenance

1. After the first week, water as necessary to maintain adequate moisture in the root zone and prevent dormancy of the sod.

2. Do not remove more than one-third of the shoot during any one mowing. Grass height should be maintained between 2 and 3 inches, unless otherwise specified (see Table SD-2).

3. After the first growing season, established sod requires fertilization, and may also require lime.

Summary Application of Vegetation Controls at Construction Sites

Grasses are important components of erosion control programs at construction sites. Chapter 5 previously presented methods to design channels, using different types of liners, and to examine problems associated with unprotected slopes. This chapter presents further information, specific to the selection of different grasses.

Selection of Channel Lining and Grass Systems based on Expected Roughness Conditions

The value of Manning's "n" in grasses is a function of grass type, and the product of velocity and hydraulic radius (VR). Grasses are divided into retardance classes based on their physical characteristics (height, width, density, etc.). Most sod forming grasses are classified as type C. These grasses can have "n" values ranging from 0.03 - 0.3 depending on VR, with a typical value of 0.03 in open channels. Figure 7-1 is an example of a VR-n curve based on data from the Stillwater, OK, USDA field tests and from Chow (1959). This diagram has long been used to design stable channels that are grass lined. The basic design procedure, incorporating a turf-reinforcing mat along with grass, is illustrated in the following example. This example shows how liners can substantially decrease the needed right-of-way area needed in channel construction, compared to the typically broad and shallow channels needed if only grass lined (illustrated in Chapter 5).

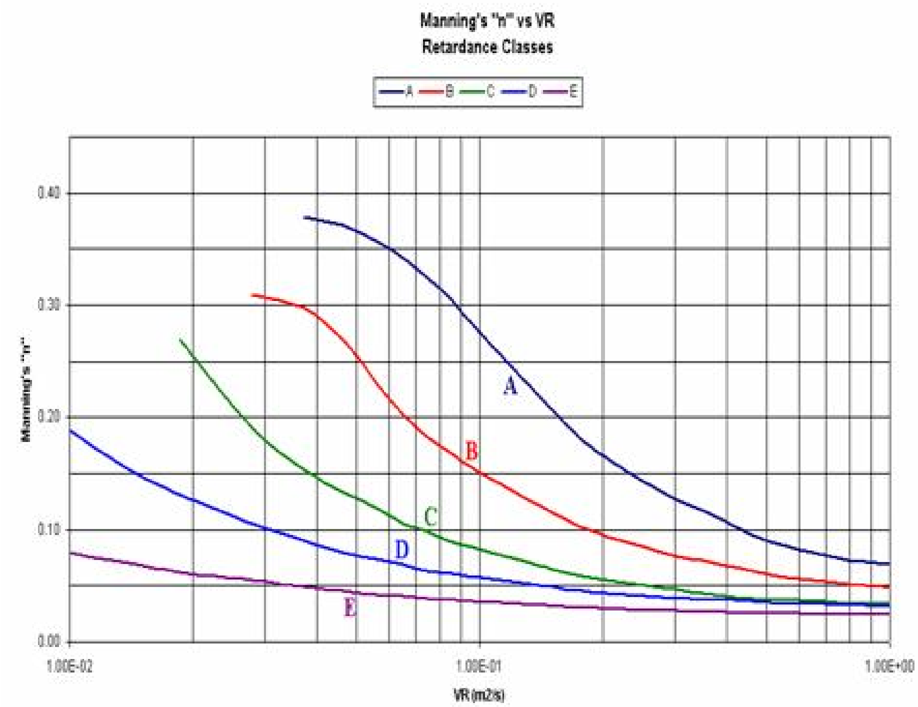

Figure 7-1. VR-n curve for different grasses (J. Kirby).

Example Problem

The appropriate Manning's "n" to use varies on the time frame: bare soil retention and vegetation establishment (short-term) and for fully grassed conditions (long-term) (Chow 1959). The "n" values for commercial products can vary significantly with material type and flow depth, but they typically range from 0.02 to 0.04 and are usually provided by the manufacturer. If not available, Sprague (1999) presents the following example illustrating how VR-n curves can be used from proper selection of a channel liner system:

> "Determine if a turf-reinforced mat (TRM) lined drainage channel will be stable for a long-term peak flow (10-year design storm) of 70 cfs (2 cms) down a 20:1 slope (S=0.05) with a 4 foot (1.2 m) bottom width and 1:1 side slopes. The duration of flow is 50 hours for long-term and one hour for short-term design. The grass cover is expected to be in retardance group D. Short-term stability can be checked using the two-year design storm, which produces a short-term peak flow of 45 cfs (1.27 cms)."

Long-term design, based on vegetated channel stability:

- use $Q_{peak} = Q_{10year} = 70\ ft^3/s\ (2\ m^3/s)$
- from Figure 7-2, the limiting shear stress is 6 lb/ft^2 (300 N/m^2) [TRM reinforced grass and 50 hours duration]
- assume that $n_{vegetated} = 0.05$

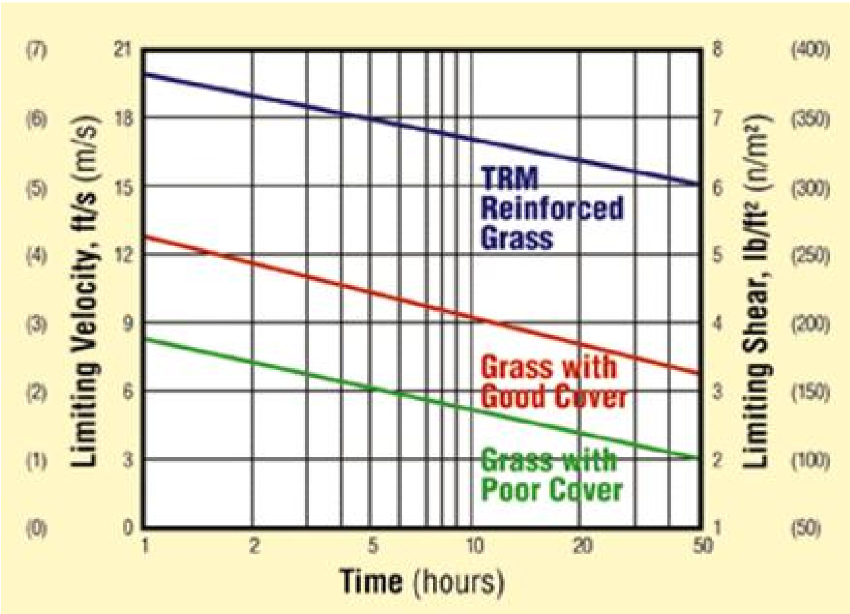

Figure 7-2. Limiting values for plain and TRM reinforced grass (long-term design) (Sprague 1999).

Determine the normal depth of flow, using procedures given in Chapter 5 (Figure 5-8, from Chow 1959, and repeated below as Figure 7-3):

$$AR^{\frac{2}{3}} = \frac{nQ}{1.49S^{0.5}} = \frac{0.05(70cfs)}{1.49(0.05)^{0.5}} = 10.51$$

and $b^{8/3} = (4\ \text{ft})^{8/3} = 40.32$

therefore $AR^{2/3}/b^{8/3} = 10.51/40.32 = 0.26$

With a 1:1 side slope trapezoidal channel, the ratio of y/b from Figure 7-3 is 0.43, and the depth is therefore: 4(0.43) = 1.7 ft.

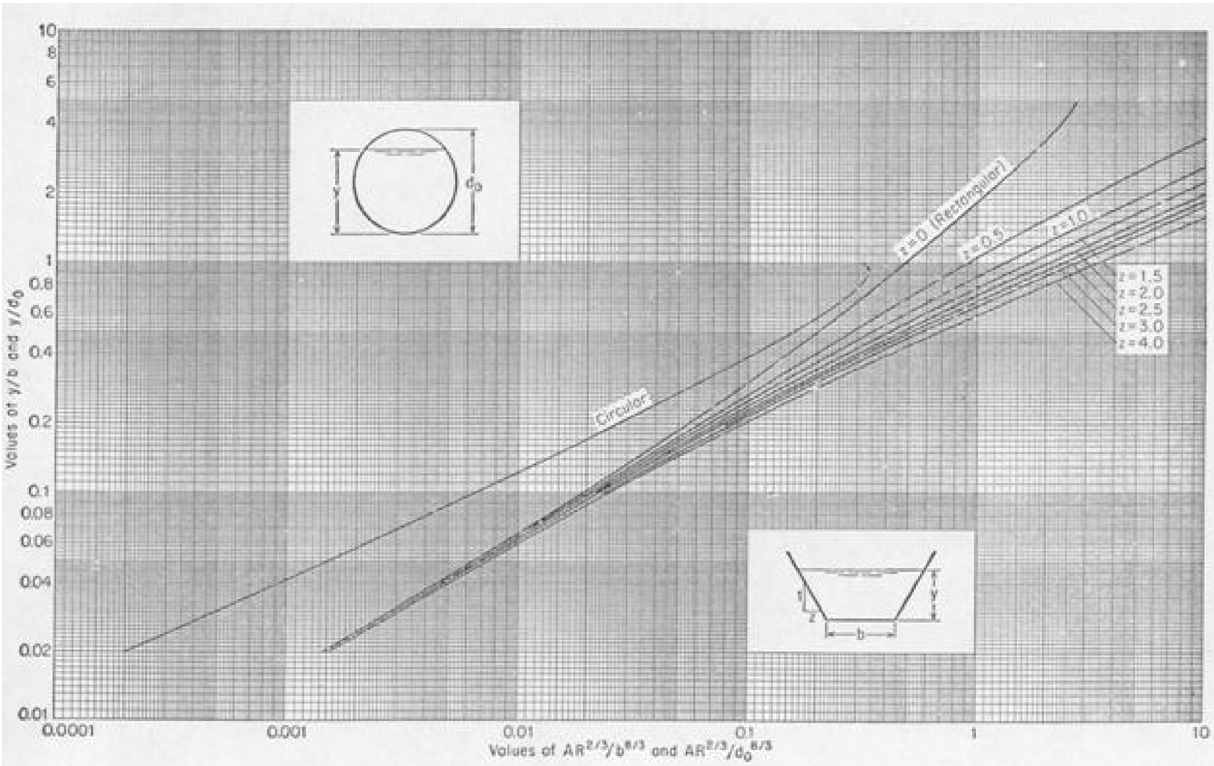

Figure 7-3. Chow (1959) curves for determining normal depth for various channel geometries.

From geometry, the area is therefore 9.7 ft^2, the velocity is (70 ft^3/sec)/(9.7 ft^2) = 7.2 ft/sec, P is 8.8 ft, and R is 9.7/8.8 = 1.1 ft. VR is therefore (7.2 ft/sec)(1.1) = 7.9 ft/sec. From Figure 7-4, the estimated new value for n is therefore 0.032, using a retardance class of D. The depth must therefore be recalculated, using this new value for n:

$$AR^{\frac{2}{3}} = \frac{nQ}{1.49S^{0.5}} = \frac{0.032(70cfs)}{1.49(0.05)^{0.5}} = 6.72$$

and $b^{8/3} = (4\text{ ft})^{8/3} = 40.32$

therefore $AR^{2/3}/b^{8/3} = 6.72/40.32 = 0.17$

With a 1:1 side slope trapezoidal channel, the ratio of y/b from Figure 7-3 is 0.34, and the depth is therefore: 4(0.34) = 1.4 ft.

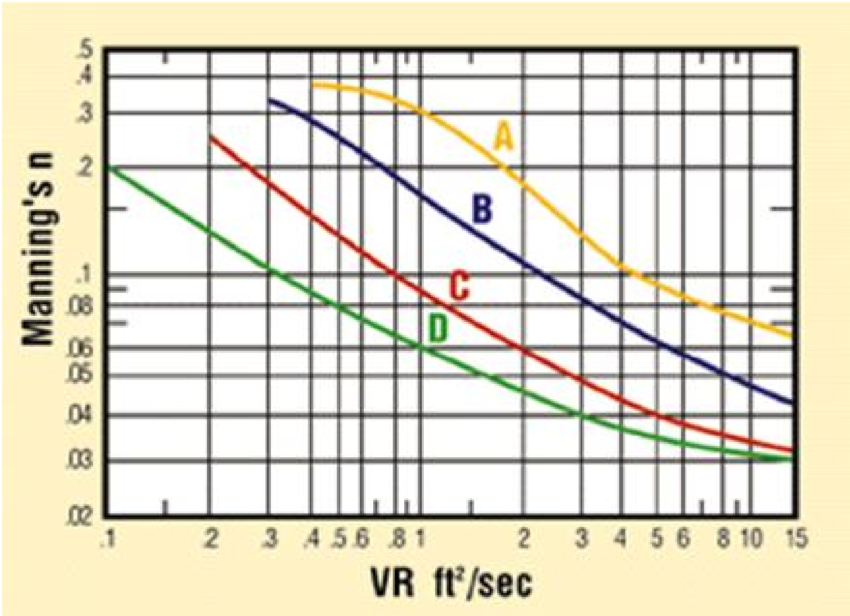

Figure 7-4. Hydraulic roughness of grass (Sprague 1999).

From geometry, the area is 7.6 ft^2, the velocity is 70/7.6 = 9.2 ft/sec, P is 8.0 ft, and R is 7.6/8.0 = 0.95 ft. The revised VR is therefore (9.2)(0.95) = 8.7 ft/sec. Re-examining Figure 7-4, the revised value of n is still close to 0.032.

The shear stress is therefore:

$\gamma yS= (62.4\ lb/ft^3)\ (1.4\ ft)\ 0.05\ ft/ft) = 4.4\ lb/ft^2$

This calculated shear stress is less than the critical value of 6 lb/ft^2 and the long-term channel stability is assumed to be satisfactory.

Short-term design, based on bare soil channel stability:

- Use $Q_{peak} = Q_{2year}$ = 45 ft^3/sec (1.27 m^3/sec)
- from Figure 7-5, the limiting shear stress is 4.5 lb/ft^2 (250 N/m^2) [bare soil and 1 hour duration]
- for a mat on bare soil, assume n = 0.03

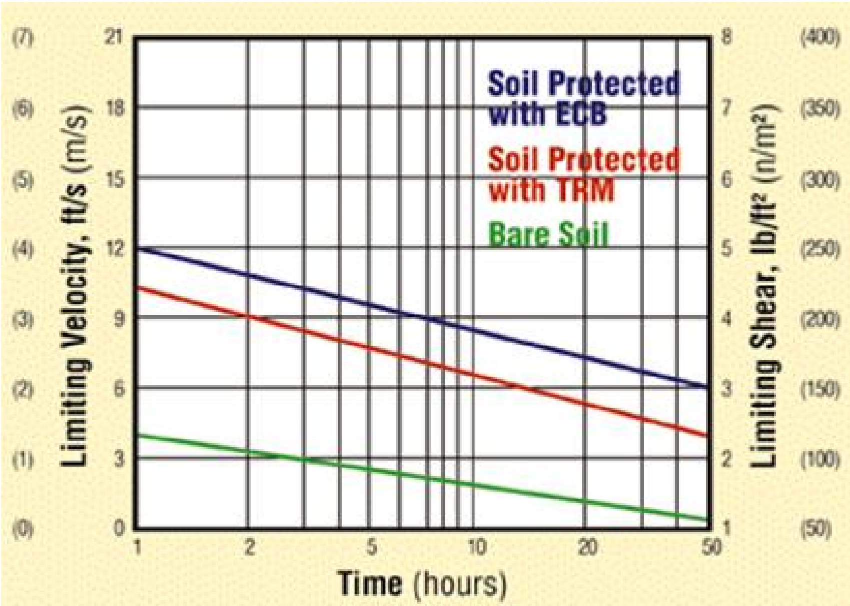

Figure 7-5. Limiting values for bare and turf reinforcing mat (TRM) or erosion control blanket (ECB) protected soils (short-term design) (Sprague 1999).

Determine the depth of flow, using procedures given in Chapter 5 (Figure 7-3, from Chow 1959):

$$AR^{\frac{2}{3}} = \frac{nQ}{1.49S^{0.5}} = \frac{0.03(45cfs)}{1.49(0.05)^{0.5}} = 4.05$$

and $b^{8/3} = (4\text{ ft})^{8/3} = 40.32$

therefore $AR^{2/3}/b^{8/3} = 4.05/40.32 = 0.10$

With a 1:1 side slope trapezoidal channel, the ratio of y/b from Figure 7-3 is 0.25, and the depth is therefore: 4(0.25) = 1.0 ft.

The shear stress is therefore:

γyS= (62.4 lb/ft^3) (1.0 ft) 0.05 ft/ft) = 3.1 lb/ft^2

This calculated shear stress is less than the critical value of 4.5 lb/ft^2 and the short-term channel stability under bare soil conditions protected with an erosion control mat, but before establishment of vegetation, is assumed to be satisfactory.

RUSLE Cover Factors (C) for Grasses

Table 7-1 lists reported RUSLE cover (C) factors for different grass-covered slopes, having varying mulch rates, for different periods. The use of erosion control mats and blankets significantly increase the immediate protection available, compared to seeding, under most conditions. The use of mulch rates of 2 tons per acre and for slopes less than 20% may result in comparable initial performance and only slightly less protection for longer periods, assuming the mulch is securely anchored. With mulches or protective mats or blankets, grasses can provide 85 to 98% erosion control during the initial year, increasing to 99+% control the second year. Without mulches or other protection, the level of erosion control is much less before establishment. In fact, it many cases, grasses planted without protection on slopes would likely be so severely damaged that successful grass stands would never occur.

Table 7-1. RUSLE Cover C-Factors for Different Grass Growing Periods and Mulch Rates (Sprague 1999)

			C-Factor for Growing Period for Humid Climates				
Treatment	**Mulch rate (tons/acre)**	**Slope (%)**	**<6 weeks**	**1.5 to 6 months**	**6-12 months**	**First year weighted total C factor**	**Second year grass and fully vegetated mats**
No mulching or seeding	--	all	1.00	1.00	1.00	1.00	1.00
Seeded grass	none	all	0.70	0.10	0.05	0.15	0.01
	1	<10	0.20	0.07	0.03	0.07	0.01
	1.5	<10	0.12	0.05	0.02	0.05	0.01
	2	<10	0.06	0.05	0.02	0.04	0.01
	2	11 – 15	0.07	0.05	0.02	0.04	0.01
	2	16 – 20	0.11	0.05	0.02	0.04	0.01
	2	22 – 25	0.14	0.05	0.02	0.05	0.01
	2	26 – 33	0.17	0.05	0.02	0.05	0.01
	2	34 – 50	0.20	0.05	0.02	0.05	0.01
Organic and synthetic blankets and composite mats	--	all	0.07	0.07	0.005	0.02	0.005
Synthetic mats	--	all	0.14	0.14	0.005	0.03	0.005

Important Internet Links (Sources of Commercial Seeds and Plants for Erosion Control)

Sod

- www.Gardnerturf.com
- www.Motzturffarms.com
- www.turfgrasssod.com
- www.usaturf.com

Hydroseeding

- www.htpa.org

Seeded Blankets

- www.sureturf.com

Seed Suppliers

- www.sylvanative.com
- www.sroseed.com
- www.turf-seed.com
- www.seedland.com
- www.erosionseed.com
- www.seedswest.com
- www.albrightseed.com

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