4.4 Soil Stabilization

General Information

A variety of soil stabilization BMPs are available. All practices discussed in this section seek to vegetate or otherwise cover bare soil areas with grass, mulch, sod, or other material for the purpose of reducing raindrop erosion, muddy runoff, gullying, and dust problems. Note that for all sites with a disturbed area of one acre or more, Kentucky requires that bare areas that have not been actively worked for 14 consecutive days be temporarily or permanently stabilized. In practice, this means that seed, mulch, or other cover must be in place after 21 days if no clearing or grading has occurred in an area. Also, note that the use of erosion control blankets and turf reinforcement mats—which are specified for some bare areas, slopes, and ditches—are discussed in the Slope Protection section.

Hydraulically Applied Products

Note that hydraulically applied (i.e., spray-on) seed and mulch products have undergone rapid development and improvement during the past 10 years and now provide seed establishment and soil protection performance equivalent (or superior) to conventional seeding and mulching practices. The key benefits of hydraulically applied products are realized on large sites with steep (3H:1V to 1H:1V), long slopes or other areas where installation of erosion control blankets or turf reinforcement mats is difficult. A nearby source of water—or water tank—to mix the slurry is also necessary for large sites.

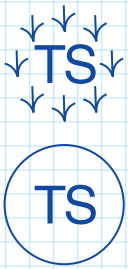
Typical hydraulic soil cover applications include a slurry-like mix of seed, fertilizer, and mulch. Also available for inclusion are other amendments such as tackifier and a variety of fibrous materials that dry to form a flexible *net* or crust that provides excellent protection for bare soil before seed germination.

Application equipment ranges from small, hand-pulled polyethylene units with electric sprayers and tanks that hold up to 15 pounds of seed, fertilizer, and mulch to large, towed or truck-mounted machines with tanks of 100–2,000 gallons. Mixing ratios will vary significantly by application, but in general a standard turf application for one acre will include 100–150 pounds of seed (or more, depending on seed variety and site conditions), 300–400 pounds of fertilizer, 140 pounds of binder, and 1,500–2,000 pounds of fiber mulch mixed with 4,000 or more gallons of water.

Soils on flatter areas are stabilized by temporary/permanent seeding and mulching. On slopes, tracking with a bulldozer or other equipment creates indentations perpendicular to runoff flow that effectively increase overall slope length and trap seed and sediment. Long, steep slopes typically require erosion control blankets or turf reinforcement mats (see Slope Protection section). Another key planning consideration for slopes is how to get upslope drainage down to the bottom, which is also covered in the Slope Protection section.

4.4.1 Temporary Seeding

Temporary seeding and/or mulching is necessary for bare areas that will not be worked for 3 or more consecutive weeks, according to state and local regulations.



Definition

Temporary seeding uses rapidly growing grass to stabilize disturbed areas that have not reached final grade. Areas that will be inactive for 21 days or more must be seeded and mulched within 14 days of reaching temporary grade.

Purpose

Temporary seeding serves to reduce problems associated with muddy runoff or dust from bare soil surfaces during construction and to maintain sheet flow, protect the soil surface, and promote infiltration into the soil; to protect the soil and prepare it for permanent seeding at a later date; and to reduce aesthetic and other concerns regarding water quality and visual impacts associated with construction areas.

Design Criteria

The area must be protected from excess run-on from upgradient areas as necessary with diversions or berms. Plant species must be selected on the basis of quick germination, growth, and time of year to be seeded. Fertilizer, lime, seedbed preparation, seed coverage, mulch, and irrigation must be used as necessary to promote quick plant growth.

Mulch should be specified for sites with slopes greater than five percent (20H:1V) and slope lengths greater than 100 feet.

Construction Specifications

Site Preparation

Grade as needed and feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulch application, and anchoring.

Install the needed erosion control practices before seeding such as diversions ditches and berms.

Do not apply fertilizer, lime, or seed before heavy rain storms (e.g., predicted to be one-half inch or more in one hour or less).

Seedbed Preparation

Mix seed, mulch, and other material for application via hydraulic spray equipment or follow the procedure below.

Spread lime (in lieu of a soil test recommendation) on acid soil (pH 5.5 or lower) and subsoil at a rate of one ton per acre of agricultural ground limestone. For best results, test

soil pH and fertility—this can reduce the expense of unneeded lime and fertilizer and potential excess nutrient loss through runoff and leaching.

Fertilizer (in lieu of a soil test recommendation) must be applied at a rate of no more than 800 pounds per acre of 10-10-10 analysis or equivalent.

Work the lime and fertilizer into the soil with a disk harrow, springtooth harrow, or similar tools to a depth of two inches. On sloping areas, the final operation must be on the contour.

Seeding Rates for Temporary Site Protection

March 1 to October 31	Per 1,000 Square Feet	Per Acre
1. Oats	3 lbs.	120 lbs.
2. Perennial Ryegrass	1 lbs.	40 lbs.
3. Tall Fescue	1 lbs.	40 lbs.
4. Wheat	3 lbs.	120 lbs.
5. Annual Rye	3 lbs.	120 lbs.
November 1 to February 28	**Per 1,000 Square Feet**	**Per Acre**
1. Annual Rye	3 lbs.	120 lbs.
2. Wheat	3 lbs.	120 lbs.
3. Perennial Ryegrass	1 lb.	40 lbs.
4. Tall Fescue	3 lbs.	120 lbs.

Apply the seed uniformly with a cyclone seeder, drill, or hydroseeder (slurry can include seed and fertilizer) preferably on a firm, moist seedbed. Seed no deeper than one-fourth inch to one-half inch.

When feasible, except where a cyclone type seeder is used, the seedbed should be firmed following seeding operations with a cyclone, roller, or light drag. On sloping land, seeding operations should be on the contour wherever possible.

Triple the seeding rate for all ditches that will carry flowing water; cover seed with erosion control blanket or turf reinforcement mat if needed to prevent ditch erosion.

Inspection and Maintenance

Water the soil until the grass is firmly established. This is especially needed when seedings are made late in the planting season, in abnormally dry and hot seasons, or on sites with steep slopes or other adverse conditions.

Prepare spot repairs by working soil where seed establishment is poor, applying additional seed, and covering with mulch or erosion control blanket. Water area during dry conditions.

Designate haul roads and material storage areas on large sites, and seed or mulch the rest to minimize the amount of bare areas exposed to the weather.

4.4.2 Permanent Seeding

Establishing grass through broadcast or hydro-seeding reduces erosion and sediment loss by more than 90 percent. Use mulch on short flatter slopes and erosion control blankets or hydro-mulch on long steep slopes.

PS

PS

Definition

Permanent seeding is the establishment of permanent, perennial vegetative cover—usually grass—on disturbed areas. Permanent seeding must be applied to disturbed areas within 14 days of reaching final grade if no temporary cover is applied.

Purpose

Permanent seeding is intended to maintain sheet flow, promote infiltration, and reduce problems associated with muddy runoff or dust from bare soil surfaces during construction; to reduce sediment runoff to downstream areas and improve the visual aesthetics of the construction area; and to provide permanent site stabilization in preparation for completion of the project.

Design Criteria

The area must be protected from excess runoff as necessary with upgradient diversion berms or ditches. Plant species must be selected on the basis of quick germination, growth, and time of year to be seeded. Fertilizer, lime, seedbed preparation, seed coverage, mulch, and irrigation must be applied as necessary to promote quick plant growth.

Construction Specifications

Site Preparation

Soil should be capable of supporting permanent vegetation and have at least 25 percent silt and clay to provide an adequate amount of moisture holding capacity. An excessive amount of porous sand will not consistently provide sufficient moisture for good growth regardless of other soil factors.

- Plan to seed all areas as soon as final grade is reached, to take advantage of soil seedbed conditions and to minimize erosion potential.
- Where compacted soils occur, they should be broken up sufficiently to create a favorable rooting depth of 6–8 inches.
- Stockpile topsoil to apply to sites that are otherwise unsuited for establishing vegetation. Approximately 400 cubic yards of topsoil per acre are needed for application depths of 3 inches (~9.3 cubic yards per 1,000 square feet).
- Grade as needed and feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulch application and anchoring, and maintenance. After the grading operation, spread topsoil where needed.
- Install the needed erosion control practices, such as diversion berms and ditches.

Seedbed Preparation

Spread lime (in lieu of a soil test recommendation) on acid soil and subsoil, at a rate of one ton per acre of agricultural ground limestone. For best results, test the soil—this can reduce the expense of unneeded lime and fertilizer and potential excess nutrient loss through runoff and leaching.

Fertilizer (in lieu of a soil test recommendation) should be applied at a rate of no more than 800 pounds per acre of 10-10-10 analysis. For best results, test the soil to determine fertilizer requirements. In limestone areas with streams and rivers impacted by high algae concentrations, use 10-0-10 fertilizer.

Work the lime and fertilizer into the soil with a disk harrow, springtooth harrow, or other suitable field equipment to a depth of 4 inches. On sloping land, the final operation must be on the contour.

Kentucky Transportation Cabinet Seed Mixes

Mixture Type	Seed Mixture
Mixture No. I	75% Kentucky 31 Tall Fescue 10% Red Top 5% White Dutch Clover 10% Ryegrass (perennial)
Mixture No. III	30% Kentucky 31 Tall Fescue 15% Red Top 15% Partridge Pea 20% Sericea Lespedeza 10% Sweet Clover – Yellow 10% Ryegrass

KYTC does not specify the seeding rate but requires that sufficient seed be applied to ensure a "dense, uniform vegetative cover."

Recommended Seeding Rates and Other Information for Various Species and Seed Mixtures

Seed species & mixtures	Seeding rate/ acre	Per 1000 sq. ft	Soil pH	Other Information
Seed and seed mixtures for relatively flat or slightly sloping areas				
Perennial ryegrass	25 to 35 lbs	1 lb	5.6 to 7.0	Apply lime at 2 tons per acre if soil pH is below 5.5; use 400-800 lb fertilizer (10-10-10) on poor soils. Use wildflower mixes to save on mowing and watering costs.
+ tall fescue	15 to 30 lbs	1 lb	5.5 to 7.5	
Tall fescue	40 to 50 lbs	1.5 lb		
+ ladino or white clover	1 to 2 lbs	2 oz		
Steep slopes, banks, cuts, and other low maintenance areas (not mowed)				
Smooth bromegrass	25 to 35 lbs	1 lb	5.5 to 7.5	Track steep slopes with dozer up and down hill before seeding. Mulch slopes after seeding with 2 to 3 tons of straw or 6 tons of wood chips per acre. Use tackifier on mulch, disk it in, or punch in with sheep-foot roller. Disk or sheep-foot on the contour (across slope, on the level). For extremely steep slopes, use erosion control blankets after seeding. Use 20" spacing on blanket staples
+ red clover	10 to 20 lbs	0.5 lb		
Tall fescue	40 to 50 lbs	1 lb	5.5 to 7.5	
+ white or ladino clover	1 to 2 lbs	2 oz		
Orchardgrass	20 to 30 lbs	1 lb	5.6 to 7.0	
+ red clover	10 to 20 lbs	0.5 lb		
+ ladino clover	1 to 2 lbs	2 oz		
Crownvetch	10 to 12 lbs	0.25 lb	5.6 to 7.0	
+ tall fescue	20 to 30 lbs	1 lb		

Seed species & mixtures	Seeding rate/ acre	Per 1000 sq. ft	Soil pH	Other Information
Lawns and other high traffic or high maintenance areas (mowed)				
Bluegrass	105 to 140 lbs	3 lb	5.5 to 7.0	Use wildflower mixes to save on mowing and watering costs. Do not establish grassed lawns near streams or wetlands—leave a 15 to 30 ft buffer of natural vegetation.
Perennial ryegrass (turf)	45 to 60 lbs	2 lb	5.6 to 7.0	
+ bluegrass	79 to 90 lbs	2.5 lb		
Tall fescue (turf type)	130 to 170 lbs	4 lb	5.6 to 7.5	
+ bluegrass	20 to 30 lbs	1 lb		
Channels and other areas of concentrated water flows				
Perennial ryegrass	100 to 150 lbs	3 lb	5.6 to 7.0	Seed ditches and channels thickly. Do not use fertilizer near ditch or channel bottom. Use erosion control blankets or turf reinforcement mats when channel bottom slopes exceed 3%.
+ white or ladino clover	1 to 2 lbs	2 oz		
Kentucky bluegrass	20 lbs	0.5 lb	5.5 to 7.5	
+ smooth bromegrass	10 lbs	.25 lb		
+ switchgrass	3 lbs	2 oz		
+ timothy	4 lbs	.25 lb		
+ perennial ryegrass	10 lbs	.25 lb		Silt check dams are needed when channel slopes exceed 5% or when channels begin downcutting (gullying) on the bottom. Do not use silt fencing or straw bales as silt check dams in channels with slopes greater than 3%; use rock or brush instead.
+ white or ladino clover	1 to 2 lbs	2 oz		
Tall fescue	100 to 150 lbs	3 lb	5.5 to 7.5	
+ ladino or white clover	1 to 2 lbs	2 oz		
Tall fescue	100 to 150 lbs	3 lb	5.5 to 7.5	
+ perennial ryegrass	15 to 20 lbs	0.5 lb		
+ Kentucky bluegrass	15 to 20 lbs	0.5 lb		

Inspection and Maintenance

Water the soil until the grass is firmly established. This is especially needed when seedings are made late in the planting season, in abnormally dry and hot season, or on sites with steep slopes or other adverse conditions.

Inspect all seeded areas for failures and make necessary repairs, replacements, reseedings, and remulching within the planting season.

If stand is inadequate, (less than 85 percent groundcover) seed over the site and fertilize, using half of the seeding rate originally applied, and apply mulch.

If stand is more than 60 percent damaged, reestablish the stand. Follow the original seedbed preparation methods, seeding and mulching recommendations, and apply lime and fertilizer as needed according to a soil test.

Hydraulically applied seed, mulch, tackifier, and soil amendments (e.g., lime, fertilizer) offer excellent results at a reasonable price on large sites, especially those with long, steep slopes. Follow manufacturer's recommendation regarding materials mixing and application rates.

Seed ditches immediately after construction. Use mulch, netting, or erosion control blankets to protect newly seeded areas.

4.4.3 Mulching

Mulch can be hand-scattered or blown straw or other material used on temporary or final grades. Use chemical tackifiers, netting, or blankets if wind is a concern. Mulch alone can reduce erosive forces by more than 90 percent; with seeding, the reductions approach 99 percent.

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M

Definition

Mulching is the application of a protective layer of straw, cellulose, or other suitable material to the soil surface. Straw mulch and/or hydromulch are also used in conjunction with seeding and hydroseeding of critical areas for the establishment of temporary or permanent vegetation.

Purpose

Multching serves to temporarily stabilize seeded or unseeded bare soil areas, to protect the soil surface from raindrop impact, to increase infiltration, to conserve moisture, to prevent soil compaction or crusting, and to decrease runoff. Mulching also fosters growth of vegetation by protecting the seeds from predators, reducing evaporation, and insulating the soil. Mulching with straw or fiber mulches is commonly used as a temporary measure to protect bare or disturbed soil areas that have not been seeded.

Design Criteria

Mulch can be applied to any site where soil has been disturbed and the protective vegetation has been removed. The most common use of a mulch is to provide temporary stabilization of soil, usually until permanent stabilizing vegetation is established. Where mulches are used to complement vegetation establishment, they should be designed to last as long as it takes to establish effective vegetative erosion control.

Where mulches are used as surface cover only (i.e. bark, wood chips, or straw mulch cover) the serviceable duration of the application and maintenance requirements, including augmentation or replication should be specified.

On steep slopes, greater than 2.5H:1V, or where the mulch is susceptible to movement by wind or water, the mulch material should be hydraulically applied or the straw mulch should be appropriately anchored. Hydraulic fiber mulches or tackifying agents are used effectively to bind the straw together and prevent displacement by wind or rain. Straw can also be covered by degradable netting or secured by crimping (see below).

NOTE: For steep slopes—especially long ones—specify erosion control blankets (see Section 3) or hydraulically applied mulches with sufficient tackifier to protect seedbed. Nets can be used with straw mulch if properly staked down.

Summary of Mulch Design and Application Considerations

Mulch product	Application rate	Benefits	Limitations
Straw or hay	1½ to 2½ tons per acre	Readily available and inexpensive; very effective in controlling erosion; can be applied on large sites via blower	Can carry unwanted seeds; might need tackifier or anchoring, especially on steep slopes
Wood chips, bark, sawdust	5 to 8 tons per acre	Very low cost in some locations; chips effective on slopes up to 35%	High nitrogen demand when decomposing; can float away or blow away during rain storms
Rock	200 to 500 tons or more per acre	Could be inexpensive and readily available in some localities; might be suitable for smaller sites	Inhibits plant growth; adds no nutrients to the soil; can be costly to apply on slopes and large sites; adds "hardened" look to slopes
Hydraulic mulches and soil binders	1½ to 2 tons per acre	Easily and rapidly applied with sprayer equipment; can include seed, fertilizer, flexible/fibrous mulches, and soil binders	Could be too expensive for small or very remote sites; must dry for at least 24 hours before rainfall

Construction Specifications

Straw

Straw is an excellent mulch material. Because of its length and bulk, it is highly effective in reducing the impact of raindrops and in moderating the microclimate of the soil surface. Straw mulch can be applied by hand on small sites and blown on by machine on large sites. Straw blowers have a range of about 50 feet. Some commercial models advertise a range up to 85 feet and a capacity of 15 tons per hour.

- Mulch should not be applied more than 2 inches deep on seeded sites, unless it is incorporated into the soil by tracking, disking (crimping), or other *punching in* techniques. If the straw is applied at rates higher than 3 tons per acre, the mulch could be too dense for the sunlight and seedlings to penetrate.

- Before mulching, install any needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, dikes, grass-lined channels and sediment basins.

- Obtain clean wheat, barley, oat, or rice straw to prevent the spread of noxious weeds. Avoid moldy, compacted straw because it tends to clump and is not distributed evenly.

- The straw must be evenly distributed by hand or machine to the desired depth of 2–4 inches and should cover the exposed area to a uniform depth. One bale (approximately 80 lbs) of straw covers about 1000 square feet adequately. The soil surface should be barely visible through the straw mulch. On steep or high-wind sites, straw must be anchored to keep it from blowing away.

- For seeded sites, apply 1.5–2 tons per acre, 1–2 inches deep, covering 80 percent of the soil surface. For unseeded sites, use 1.5–2.5 tons per acre, apply 2–4 inches deep, covering 90 percent of the soil surface.

- Mulch must be anchored immediately to minimize loss by wind or water. Straw mulch is commonly anchored by crimping, tracking, disking, or punching into the soil; covering with a netting material; spraying with asphaltic or organic tackifier; or tacking with cellulose fiber mulch at a rate of 750 pounds per acre.

- On small sites where straw has been distributed by hand, it can be anchored by hand punching it into the soil every 1–2 feet with a dull, round-nosed shovel. A sharp shovel will merely cut the straw and not anchor it. A mulch anchoring tool is a tractor-drawn implement designed to punch and anchor mulch into the top 2–8

inches of soil. This practice affords maximum erosion control but is limited to flatter slopes where equipment can operate safely. A set of disk harrows can be used for this purpose if the disks are straightened (not angled) so they cut the straw into the soil. Tracking is the process of cutting straw into the soil using a bulldozer or other equipment that runs on cleated tracks. Tracking is used primarily on slopes 3:1 or flatter where this type of equipment can safely operate. This is an effective way to crimp straw on fill slopes. Tracking equipment must operate up and down the slope so the cleat tracks are perpendicular to flow.

- Netting material made of biodegradable paper, plastic or cotton netting can be used to cover straw mulch. Netting should be specified judiciously since birds, snakes and other wildlife can get trapped in the nettings.
- Polymer tackifiers are generally applied at rates of 40–60 pounds per acre, however manufacturers recommendations vary. Organic tackifiers are generally applied at rates of 80–120 pounds per acre, however manufacturer's recommendations vary. Applications of liquid mulch binders should be heavier at edges, in valleys, and at crests of banks and other areas where the mulch could be moved by wind or water. All other areas must have a uniform application of the tackifier.

Wood Chips or Bark

Apply at a rate of 5–8 tons per acre.

The mulch should be evenly distributed across the soil surface to a depth of 2–3 inches.

If decomposition, soil building and revegetation are desired, increase the application rate of nitrogen fertilizer by 20 pounds of nitrogen per acre, to compensate for the temporary diversion (loss) of available nitrogen to the soil microbes.

Hydraulic Mulches

Hydraulic mulches can be made of recycled newsprint, magazines, wood or other wood/paper waste sources. This type of mulch is to be mixed in a hydraulic application machine (hydroseeder) and applied as a liquid slurry that contains the recommended rates of seed and fertilizer for the site. It can be specified with or without a tackifier.

Apply at rate of 1.5 to 2 tons per acre—mixed with seed and fertilizer at recommended rates—to achieve uniform, effective coverage.

Paper mulch used to tack and bind straw mulch can be specified at a lower rate (i.e., about 750 pounds per acre).

Hydraulic mulches from wood and paper fiber are combination mulches generally composed of 70 percent wood fiber and 30 percent paper fiber, manufactured from lumber mill waste, virgin wood chips, recycled newsprint, office paper and other waste paper. The mulch is mixed in a hydraulic application machine (hydroseeder) and applied as a slurry in combination with the recommended seed and fertilizer. The mulch can be specified with or without a tackifier.

Wood, paper or combination fiber mulches are typically applied with a hydraulic applicator (hydroseeder) at a minimum rate of 1.5 tons per acre. A typical construction specification and application for this type of mulch is as follows:

- Moisture content (total weight basis) not to exceed 12 percent +/- 3 percent.
- Organic matter content (oven dry weight basis) is 98 percent minimum.
- Inorganic matter (ash) content (oven dried basis) 2 percent maximum.
- pH at 3 percent consistently in water should be 4.9.
- Fiber must be dyed to aid in visual metering during application. The dye must be biodegradable and must not inhibit plant growth.
- Water holding capacity (oven dried basis) minimum 1.0 gallons per pound of fiber.

- The mulch must be mixed with seed and fertilizer as specified and applied at a rate recommended by the manufacturer to achieve uniform, effective coverage and provide adequate distribution of seed.

Rock

Use rock only for slopes of 2H:1V or flatter. Install non-woven geotextile on graded slope, place rock of mixed sizes on geotextile, starting at bottom and working uphill. Generally rock is not suitable for residential or other areas where aesthetics are a design consideration.

Inspection and Maintenance

Inspect weekly and repair or replace any bare areas promptly. If properly applied and anchored, little additional maintenance is required during the first few months. After high winds or significant rainstorms, mulched areas should be checked for adequate cover and re-mulched if necessary. Mulch needs to last until vegetation develops to provide permanent erosion resistant cover. Straw mulch can last from 6 months to 3 years.

Visually inspect mulched areas to ensure uniform, sufficient coverage. Application must cover all bare areas, with less than 5 percent soil showing through mulch cover.

Good use of straw mulch and grass seed in relatively flat and fairly wide swale. For more concentrated flows, triple seed the ditch and use erosion control blankets.

Use netting to secure loose straw on steep or long slopes. Above: Good coverage with straw mulch. Mulch alone can reduce erosion by more than 90 percent. Apply temporary or permanent mulch as soon as final grade is established.

4.4.4 Sodding

Sod reduces erosion potential to near zero. Make sure the surface is properly prepared with appropriate soil amendments; use fresh sod and keep well watered during the first 2 weeks after application.

SO

Definition

Sod consists of rectangular strips of live turf grass held together by matted roots laced through an organic, growing medium.

Purpose

The purpose of sodding is to immediately establish a permanent turf grass cover over bare soil and improve visual aesthetics, during almost any time of year; to prevent erosion and damage from sediment and runoff by stabilizing the soil surface, and to promote the infiltration of precipitation and reduction of stormwater runoff; to reduce the production of dust and mud associated with bare soil surfaces; to stabilize swales, ditches, and channels where concentrated flows will occur; and to protect areas around drop inlets from muddy inflows.

Design Criteria

- Sod should be machine-cut and contain one-half inch to 1 inch of soil, not including roots or shoots or thatch.
- Specify that sod will be installed within 36 hours of digging and removal from the field.
- Avoid planting when subject to frost heave or hot weather if irrigation is not available.
- Sod should not be used on slopes steeper than 2H:1V. If it is to be mowed, installation should be on slopes no greater than 3H:1V.

Construction Specifications

Cutting and Handling Sod

The sod should consist of strips of live, vigorously growing grasses. The sod should be free of noxious and secondary noxious weeds and should be obtained from good, solid, thick-growing stands. The sod should be cut and transferred to the job in the largest continuous pieces that will hold together and that are practical to handle.

- The sod must be cut with smooth, clean edges and square ends to facilitate laying and fitting. The sod must be cut to a uniform thickness of not less than three-fourths of an inch measured from the crown of the plants to the bottom of the sod strips for all grasses except bluegrass. Bluegrass sod must be cut to a uniform thickness of not less than 1.5 inches.

- The sod must be mowed to a height of not less than 2 inches and no more than 4 inches before cutting.
- The sod must be kept moist and covered during hauling and preparation for placement on the sod bed.

Site Preparation

Soils in areas to be sodded must be capable of supporting permanent vegetation and must consist of at least 25 percent silt and clay to provide an adequate amount of moisture-holding capacity. An excessive amount of porous sand will not consistently provide sufficient moisture for the sod regardless of other soil factors.

- Compacted soils must be broken up sufficiently to create a favorable rooting depth of 6–8 inches.
- Stockpile topsoil to apply to sites that are otherwise unsuited for establishing vegetation.
- Grade as needed and feasible to permit the use of conventional equipment for the sod bed preparation. After the grading operation, spread topsoil where needed.

Sod Bed Preparation

Apply lime (in lieu of a soil test) on acid soil and subsoil at a rate of one ton per acre. The lime should be agricultural ground limestone or equivalent. For best results, conduct a soil test. This can reduce expense of unneeded lime and fertilizer and potential excess nutrient loss through runoff and leaching.

- Apply fertilizer (in lieu of a soil test) at 1,000 pounds per acre of 10-10-10 analysis. For best results, conduct a soil test.
- Work lime and fertilizer into the soil with a disk harrow, springtooth harrow, or other suitable field equipment to a depth of 4 inches.
- Before sodding, the soil surface must be cleared of all trash, debris, and stones larger than 1.5 inches in diameter, and of all roots, brush, wire, and other objects that would interfere with the placing of the sod.
- After the lime and fertilizer have been applied and just before laying the sod, the soil in the area to be sodded must be loosened to a depth of one inch. The soil must be thoroughly dampened immediately after the sod is laid if it is not already in a moist condition.

Placing Sod

No sod should be placed when the temperature is below 32° F. No frozen sod must be placed nor should any sod be placed on frozen soil.

- Sod should be carefully placed and pressed together so it will be continuous without any voids between the pieces. Stagger the joints between the ends of strips in a brick-like pattern. Ensure that the edge of the sod at the outer edges of all gutters is sufficiently deep so that the surface water will flow over onto the top of the sod.
- On gutter and channel sodding, carefully place the sod on rows or strips at right angles to the centerline of the channel (i.e., at right angles to the direction of flow). On steep, graded channels, stake each strip of sod with at least two stakes not more than 18 inches apart. The stakes should be wooden and approximately 1/2" × 3/4" × 12". Drive nthe stakes flush with the top of the sod and with the flat side against the slope.

- On slopes 3:1, or steeper, and where drainage into a sod gutter or channel is one-half acre or larger, roll or tamp the sod and then peg chicken wire, jute, or other netting over the sod for protection in the critical areas. Stake the netting and sod with at least two stakes not more than 18 inches apart. The stakes should be wooden and approximately 1/2" × 3/4" × 12". Drive the stakes with the flat side against the slope and on an angle toward the slope. Staple the netting on the side of each stake within 2 inches of the top of the stake, then drive the stake flush with the top of the sod.

- The sod should be tamped or rolled after placing and then watered. Watering must consist of a thorough soaking of the sod and of the sod bed to a depth of at least 4 inches. Maintain the sod in a moist condition by watering for a period of 30 days.

Inspection and Maintenance

Inspect sod twice a week after installation to check on moisture conditions and grass viability. Irrigate sod immediately after installation and every few days afterwards if no significant rainfall occurs during the first 2 weeks. Soak the area thoroughly to a depth of 3 inches during irrigation.

- Where sodding does not establish properly, remove the old sod and resod the area as soon as possible. Identify the cause of the failure and correct it as soon as possible.

- Once established, initiate a regular maintenance program for fertilization (if needed) and mowing.

Use sod in ditches and around drop inlets for superior protection against scouring flows. Sod slows down concentrated flows and promotes filtration and settling of sediment-laden runoff.

Rolled sod should be moist, flexible, green, and fresh. For best results, install as soon as possible after final grade is established.

4.4.5 Polyacrylamides

Long, bare slopes need to be stabilized. Polyacrylamide offers excellent temporary protection for slopes that will not be seeded or mulched immediately. Do not use near creeks, rivers, or wetlands. Follow manufacturer's instructions.

PAM

Definition

The land application or stormwater application of products containing anionic polyacrylamide (PAM), a chemical agent that binds soil particles together, which reduces erosion in the field and promotes coagulation and rapid settling in sedimentation basins.

Purpose

Land application of PAM is performed to reduce soil surface erosion due to wind or water forces. Stormwater applications of PAM promote settling of fine soil particles in sediment basins. Polyacrylamides are applied directly—via liquid spray or hand or mechanical spreader for the dry product—to bare soil areas where the timely establishment of vegetation might not be feasible or where vegetative cover is absent or inadequate. Such areas can include construction sites where land-disturbing activities prevent the establishment or maintenance of a vegetative cover. For stormwater treatment, PAM can be applied to stormwater as it enters sediment basins. This will cause soil particles to bind together and settle within the pond.

This temporary practice is not intended for application to surface waters or ditches that lead directly to surface waters. It is intended for application within construction stormwater drainage systems that feed into pre-constructed sedimentation (detention or retention) ponds or basins.

Design Criteria

Only the anionic form of PAM should be used. Cationic PAM is toxic and should NOT be used. PAM and PAM mixtures should be environmentally benign, harmless to fish, wildlife, and plants. PAM and PAM mixtures should be noncombustible.

PAM is typically applied at construction sites with temporary seeding or mulching on areas where the timely establishment of temporary erosion control is so critical that seedings and mulching need additional reinforcement. It can be used alone on sites where no disturbances will occur until site work is continued and channel erosion is not a significant potential problem. Permanent grassing applications can be better established using PAM as a tackifier and soil conditioner.

Anionic PAM is available in emulsions, powders, and gel bars or logs. Other BMPs must be used in conjunction or combination with anionic PAM, such as mulch, sediment basins, and eventually seed or other cover. The use of seed and mulch for additional erosion protection beyond the life of the anionic PAM is recommended. Repeat

application if disturbance occurs to the target area. The following recommendations relating to design can enhance PAM use and help prevent problems:

- Use 25-foot setbacks when applying anionic PAM near natural water bodies, such as creeks, ponds, lakes, wetlands, and rivers.
- Consider that performance of PAM decreases with time and exposure to ultraviolet light.
- In concentrated flow channels, the effectiveness of PAM decreases.
- Mulch to protect seed if seed is applied with anionic PAM.
- Never add water to PAM; add PAM slowly to water. If water is added to PAM, clumping can form, which can clog dispensers. This signifies incomplete dissolving of the PAM and increases the risk of under-application.
- Using PAM logs or block formulations is effective in removing colloidal clay, nutrients, and metals in sediment basins. Passive addition of PAM to incoming basin flows must be managed carefully by monitoring logs, blocks, or other application methods. Basin or pond systems featuring baffles or grids that slow stormwater movement through the detention area provides extended treatment or settling times and better performance. Level spreader applications provide a similar level of contact and treatment time.

Construction Specifications

Application rates should be uniform and conform to manufacturer's guidelines for application. Anionic PAM, in pure form, should have less than or equal to 0.05 percent acrylamide monomer by weight, as established by the Food and Drug Administration and EPA. To maintain less than or equal to 0.05 percent of acrylamide monomer, the maximum application rate of PAM, in pure form, should not exceed 200 pounds per acre per year. Do not over-apply PAM. Excessive application of PAM can lower the infiltration rate or suspend solids in water rather than promoting settling.

- Users of anionic PAM should obtain and follow all Material Safety Data Sheet requirements and manufacturer's recommendations. Additives to PAM such as fertilizers, solubility promoters, or inhibitors, should be nontoxic. The manufacturer or supplier should provide written application methods of PAM and PAM mixtures. The application method should ensure uniform coverage to the target and avoid drift to non-target areas including waters of the state. The manufacturer or supplier should also provide written instructions to ensure proper safety, storage, and mixing of the product.
- Gel bars or logs of anionic PAM mixtures can be used in ditch systems. This application should meet the same testing requirement as anionic PAM emulsions and powders. Effectiveness is reduced in steeply sloping ditches.
- To prevent exceeding the acrylamide monomer limit in the event of a spill, the anionic PAM in pure form should not exceed 200 pounds/batch at 0.05 percent acrylamide monomer or 400 pounds per batch at 0.025 percent acrylamide monomer.

Inspection and Maintenance

Inspect the area before anticipated storm events (or series of storm events such as intermittent showers over one or more days), within 24 hours after the end of a rainfall event of one-half inch or more, and at least once every 14 calendar days. Maintenance needs that are identified in inspections or by other means must be accomplished before the next storm event if possible, but in no case more than 7 days after the need is identified. Maintenance consists of reapplying anionic PAM to disturbed areas including high-use traffic areas that interfere with the performance of this practice.

4.4.6 Dust Control

Apply water, polyacrylamide, or other stabilizers to bare areas if windblown dust will be a problem. Heavy dust blowing toward downwind homes can result in complaints to regulatory authorities.

DC

Definition

Dust control is the reduction of windborne sediment and dust movement during land clearing, grading, excavation, fill placement, demolition, and other construction activities.

Purpose

The purpose of dust control is to prevent the airborne movement of sediments to off-site areas or on-site areas without sediment control where they could subsequently be washed into surface waters. Dust control should be planned in association with earthmoving or site grading activities and areas with frequent construction traffic.

Design Criteria

Construction activities must be phased to minimize the total exposed soil area and the length of time bare areas are exposed, thereby reducing erosion due to air and water movement.

- Existing trees, shrubs, and ground cover must be retained as long as possible during construction. Initial land clearing should be conducted only in those areas to be regraded or where construction is to occur. Areas to be cleared only for new vegetation or landscaping must be stabilized with seed and/or mulch immediately following clearing.
- Vegetative cover is the most effective means of dust and erosion control, when appropriate. See sections on Temporary Seed, Permanent Seed, Mulch, and Sod in this manual.
- When areas have been regraded or brought to final grade, stabilize them using temporary or permanent seed and mulch or other measures.
- Use mulch with mulch binders as an interim dust control measure in areas where vegetation might not be appropriate.
- Anionic polyacrylamide (PAM) is an effective dust control agent for undisturbed areas (see Section 4.4.5). Calcium chloride has proven effective in controlling dust on roadways, but repeat applications are necessary and the product could restrict establishment of vegetation on treated areas. A permit might be needed for using calcium chloride.
- Salt solutions such as magnesium chloride, calcium chloride, and natural brines are popular and effective dust control products for roads. Organic, nonpetroleum-based chemicals such as calcium lignosulfonate and sodium lignosulfonate are also

effective. All these chemicals work best on unpaved roadways with fines in the 10 percent to 30 percent range. Petroleum-based products are not recommended because of their adverse effects on plants and water resources.

Construction Specifications

Construction roads should be watered as needed to minimize dust. Repeat applications will be necessary during dry weather.

- Roughening the soil to create ridges perpendicular to the prevailing wind direction can reduce surface wind velocities and sediment loss significantly. However, if winds shift to become parallel to the ridges, blown sediment will increase.
- Silt fences or board fencing that is perpendicular to the prevailing wind direction can also be used to lower surface wind velocities and reduce airborne sediment problems. Fences do not have to be trenched in, but may need to be 50–100 feet apart to appreciably reduce wind velocities.
- See sections on Temporary Seed, Permanent Seed, Sod, Mulch, and Construction Entrance.

Dust Control BMPs for Various Site Conditions

Site condition	Grass/ seeding	Mulching	Watering	Chemical application	Gravel or asphalt surfacing	Silt or sand fencing	Rock pad or wash-down
Disturbed areas—no traffic	●	●	●	●	●	●	
Disturbed areas—with traffic			●	●	●		
Soil stockpiles	●	●	●	●		●	
Demolition			●				●
Clearing/ Excavation	●	●	●	●		●	
Unsurfaced roads			●	●	●		
Site exit to paved road					●		●

Inspection and Maintenance

Observe the site daily for evidence of windblown dust and take reasonable steps to reduce dust whenever possible.

- When construction on a site is inactive for a period, stabilize the site with mulch or temporary vegetation, and inspect it at least weekly for evidence of dust emissions or previously windblown sediments.
- Implement dust control measures or upgrade them if the site inspection shows evidence of wind erosion.
- Heavy rains will wash away chemical dust control products. This will require reapplication after the site dries out.