Planning Considerations

Water which is pumped from a construction site usually contains a large amount of sediment. A dewatering structure is designed to remove the sediment before water is released off-site.

This practice includes several types of dewatering structures which have different applications dependent upon site conditions and types of operation. Other innovative techniques for accomplishing the same purpose are encouraged, but only after specific plans and details are submitted to and approved by the Plan-Approving Authority.

A dewatering structure may not be needed if there is a well- stabilized, vegetated area on-site to which water may be discharged. The area must be stabilized so that it can filter sediment and at the same time withstand the velocity of the discharged water without eroding. A minimum filtering length of 75 feet must be available in order for such a method to be feasible.

Design Criteria

1. A dewatering structure must be sized (and operated) to allow pumped water to flow through the filtering device without overtopping the structure.

2. Material from any required excavation shall be stored in an area and protected in a manner that will prevent sediments from eroding and moving off-site.

3. An excavated basin (applicable to "Straw Bale/Silt Fence Pit") may be lined with filter fabric to help reduce scour and to prevent the inclusion of soil from within the structure.

4. Design criteria more specific to each particular dewatering device can be found in Plates 3.26-1 through 3.26-3.

Construction Specifications

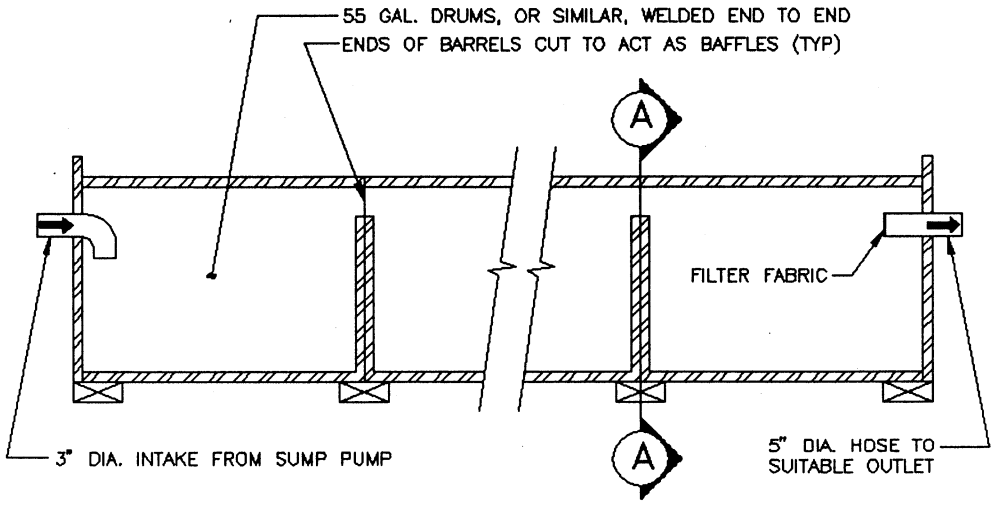
1. Portable Sediment Tank (see Plate 3.26-1)

   a. The structure may be constructed with steel drums, sturdy wood or other material suitable for handling the pressure exerted by the volume of water.

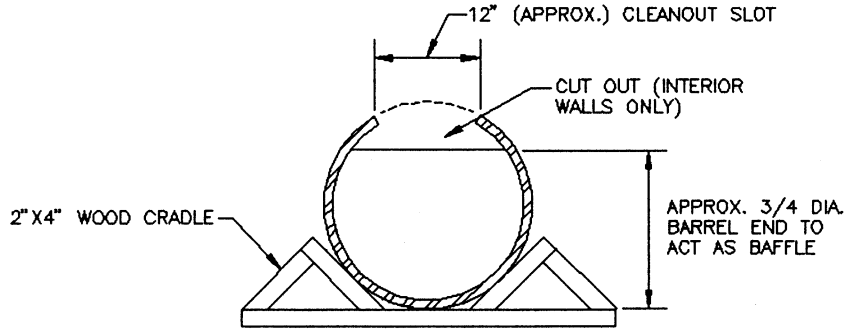
   b. Sediment tanks will have a minimum depth of two feet.

   c. The sediment tank shall be located for easy clean-out and disposal of the trapped sediment and to minimize the interference with construction activities.

PORTABLE SEDIMENT TANK



ELEVATION



CROSS-SECTION A-A

Source: USDA-SCS Plate 3.26-1

d. The following formula shall be used to determine the storage volume of the sediment tank:

Pump discharge (g.p.m.) x 16 = cubic feet of storage required

e. Once the water level nears the top of the tank, the pump must be shut off while the tank drains and additional capacity is made available.

f. The tank shall be designed to allow for emergency flow over top of the tank.

g. Clean-out of the tank is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.

2. Filter Box (see Plate 3.26-2)

a. The box selected should be made of steel, sturdy wood or other materials suitable to handle the pressure requirements imposed by the volume of water. Fifty-five gallon drums welded top to bottom are normally readily available and, in most cases, will suffice.

b. Bottom of the box shall be made porous by drilling holes (or some other method).

c. VDOT #3 Coarse Aggregate shall be placed over the holes at a minimum depth of 12 inches (metal "hardware" cloth may need to be placed between the aggregate and the holes if holes are drilled larger than the majority of the stone).

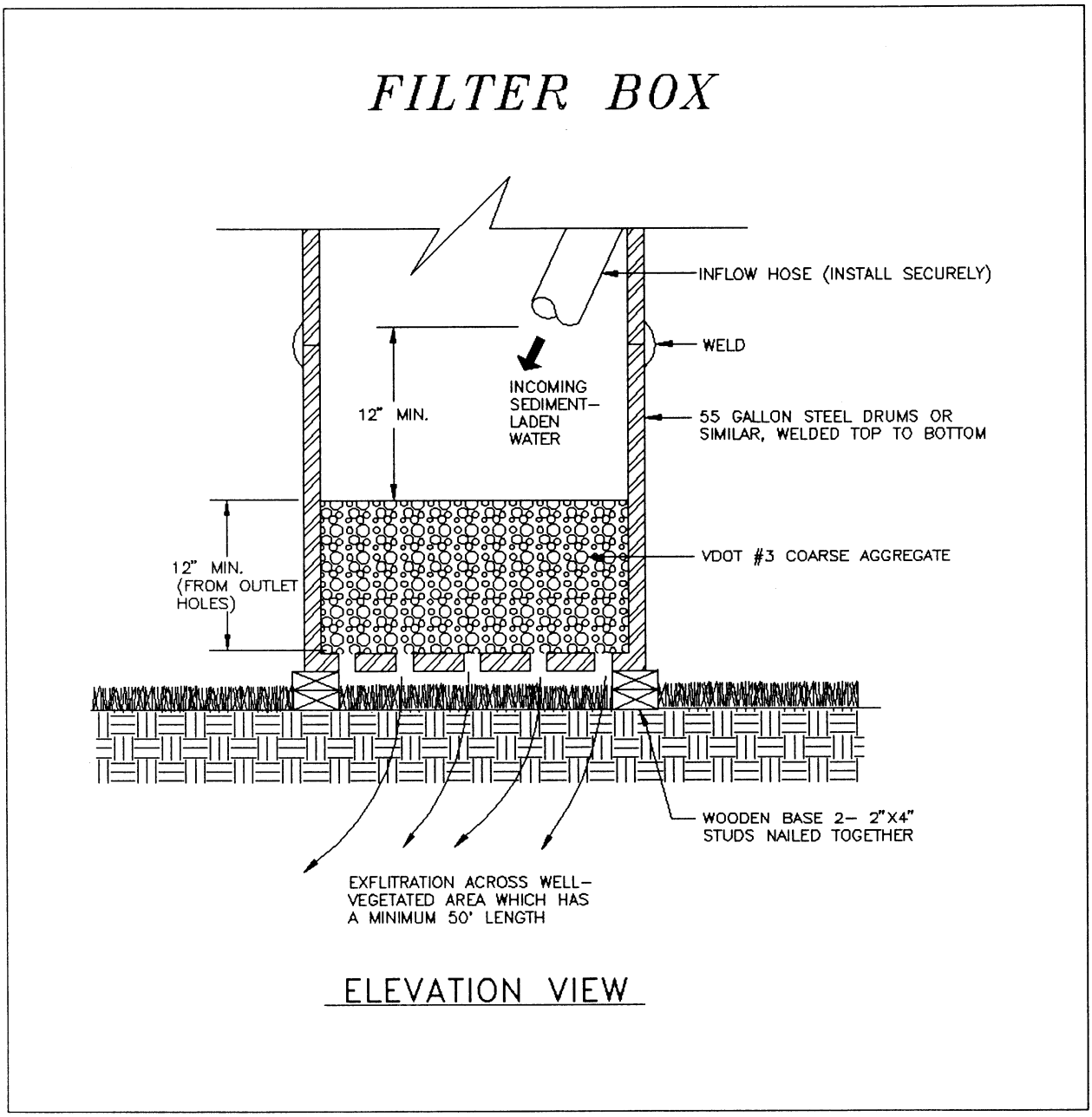
d. As a result of the fast rate of flow of sediment-laden water through the aggregate, the effluent must be directed over a well-vegetated strip of at least 50 feet after leaving the base of the filter box.

e. The box shall be sized as follows:

Pump discharge (g.p.m.) x 16 = cubic feet of storage required

f. Once the water level nears the top of the box, the pump must be shut off while the box drains and additional capacity is made available.

g. The box shall be designed/constructed to allow for emergency flow over the top of this box.



Source: Va. DSWC Plate 3.26-2

h. Clean-out of the box is required once one-third of the original capacity is depleted due to sediment accumulation. The tank shall be clearly marked showing the clean-out point.

i. If the stone filter does become clogged with sediment so that it no longer adequately performs its function, the stones must be pulled away from the inlet, cleaned and replaced.

Note: Using a filter box only allows for minimal settling time for sediment particles; therefore, it should only be used when site conditions restrict the use of the other methods.

3. Straw Bale/Silt Fence Pit (see Plate 3.26-3)

a. Measure shall consist of straw bales, silt fence, a stone outlet (a combination of VDOT Class AI Riprap and VDOT #25 or #26 Aggregate) and a wet storage pit oriented as shown in Plate 3.26-3.

b. The structure must have a capacity which is dictated by the following formula:

Pump discharge (g.p.m.) x 16 = *cubic feet of storage required*

In calculating the capacity, one should include the volume available from the floor of the excavation to the crest of the stone weir.

c. In any case, the excavated area should be a minimum of 3 feet below the base of the perimeter measures (straw bales or silt fence).

d. The perimeter measures must be installed as per the guidelines found in Std. & Spec. 3.04, STRAW BALE BARRIER and Std. & Spec. 3.05, SILT FENCE.

e. Once the water level nears the crest of the stone weir (emergency overflow), the pump must be shut off while the structure drains down to the elevation of the wet storage.

f. The wet storage pit may be dewatered only after a minimum of 6 hours of sediment settling time. This effluent should be pumped across a well-vegetated area or through a silt fence prior to entering a watercourse.

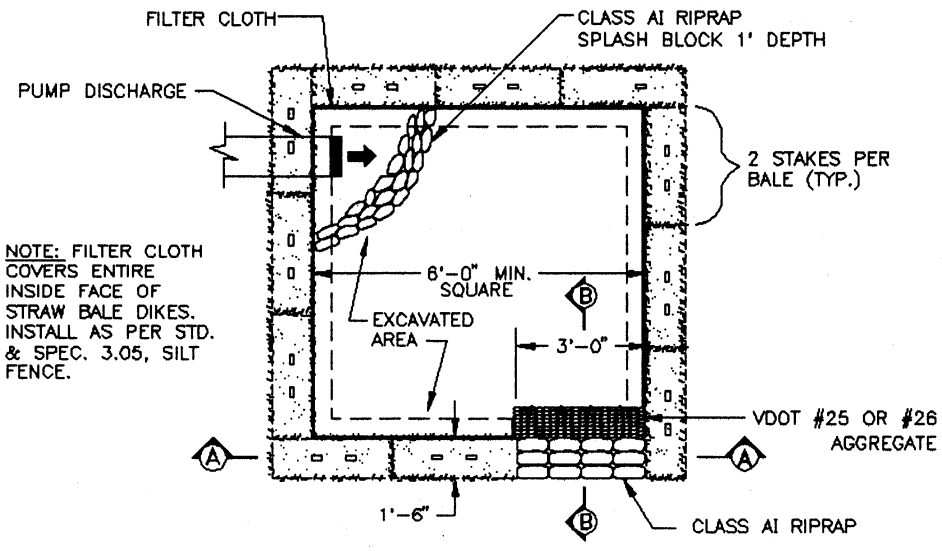
g. Once the wet storage area becomes filled to one-half of the excavated depth, accumulated sediment shall be removed and properly disposed of.

h. Once the device has been removed, ground contours will be returned to original condition.

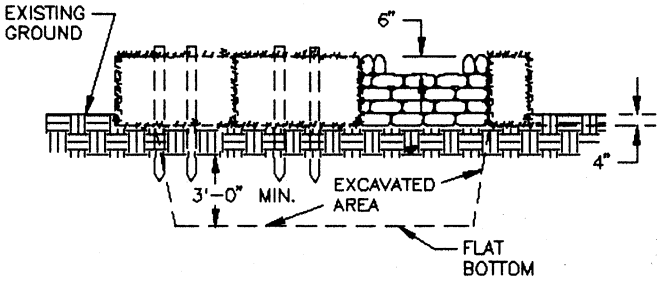
Maintenance
(All dewatering structures)

1. The filtering devices must be inspected frequently and repaired or replaced once the sediment build-up prevents the structure from functioning as designed.

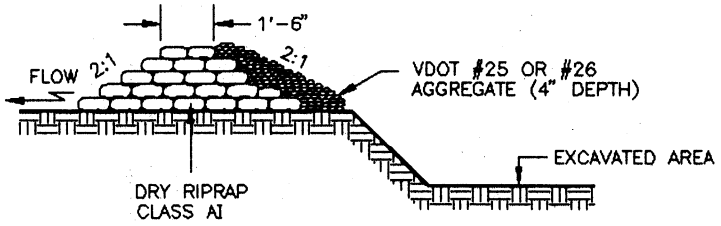
STRAW BALE/SILT FENCE PIT



PLAN VIEW



CROSS-SECTION A-A



CROSS-SECTION B-B

Source: Va. DSWC

Plate 3.26-3

2. The accumulated sediment which is removed from a dewatering device must be spread on-site and stabilized or disposed of at an approved disposal site as per approved plan.

STD & SPEC 3.27

TURBIDITY CURTAIN

TC

Definition

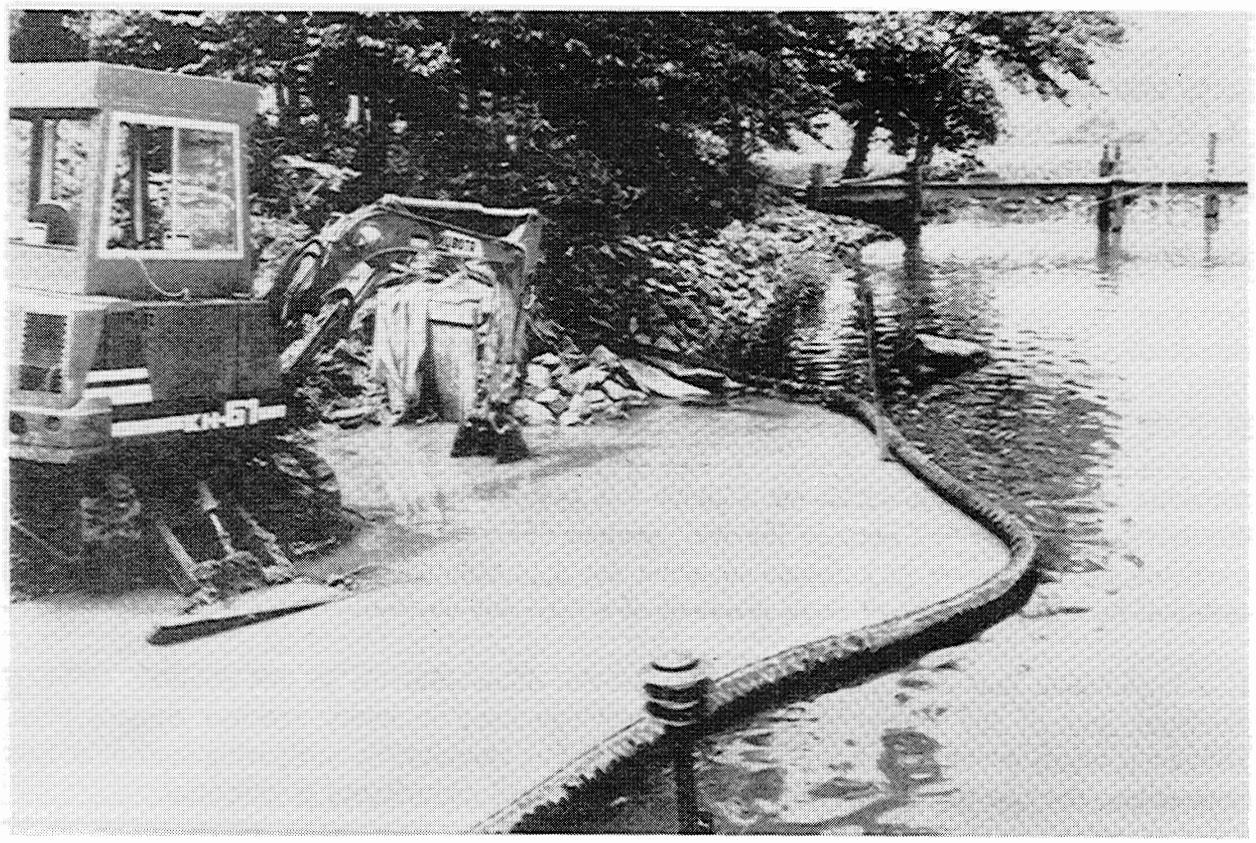
A floating geotextile material which minimizes sediment transport from a disturbed area adjacent to or within a body of water.

Purpose

To provide sedimentation protection for a watercourse from up-slope land disturbance or from dredging or filling within the watercourse.

Conditions Where Practice Applies

Applicable to non-tidal and tidal watercourses where intrusion into the watercourse by construction activities and subsequent sediment movement is unavoidable.



Planning Considerations

Soil loss into a watercourse results in long-term suspension of sediment. In time, the suspended sediment may travel large distances and affect wide-spread areas. A turbidity curtain is designed to deflect and contain sediment within a limited area and provide enough residence time so that soil particles will fall out of suspension and not travel to other areas.

Turbidity curtain types must be selected based on the flow conditions within the water body - whether it be a flowing channel, lake, pond, or a tidal watercourse. The specifications contained within this practice pertain to minimal and moderate flow conditions where the velocity of flow may reach 5 feet per second (or a current of approximately 3 knots). For situations where there are greater flow velocities or currents, a qualified engineer and product manufacturer should be consulted.

Consideration must also be given to the direction of water movement in channel flow situations. Turbidity curtains are not designed to act as water impoundment dams and can not be expected to stop the flow of a significant volume of water. They are designed and installed to trap sediment, not to halt the movement of the water itself. In most situations, turbidity curtains should not be installed across channel flows.

In tidal or moving water conditions, provisions must be made to allow the volume of water contained within the curtain to change. Since the bottom of the curtain is weighted and external anchors are frequently added, the volume of water contained within the curtain will be much greater at high tide verses low tide and measures must be taken to prevent the curtain from submerging. In addition to allowing for slack in the curtain to rise and fall, water must be allowed to flow through the curtain if the curtain is to remain in roughly the same spot and to maintain the same shape. Normally, this is achieved by constructing part of the curtain from a heavy woven filter fabric. The fabric allows the water to pass through the curtain, but retains the sediment pollutants. Consideration should be given to the volume of water that must pass through the fabric and sediment particle size when specifying fabric permeability.

Sediment which has been deflected and settled out by the curtain may be removed if so directed by the on-site inspector or the Plan-Approving Authority. However, consideration must be given to the probable outcome of the procedure - will it create more of a sediment problem by resuspension of particles and by accidental dumping of the material by the equipment involved? It is, therefore, recommended that the soil particles trapped by a turbidity curtain only be removed if there has been a significant change in the original contours of the affected area in the watercourse. Regardless of the decision made, soil particles should always be allowed to settle for a minimum of 6-12 hours prior to their removal by equipment or prior to removal of a turbidity curtain.

It is imperative that the intended function of the other controls in this chapter, to keep sediment out of the watercourse, be the strategy used in every erosion control plan. However, when proximity to the watercourse makes successfully mitigating sediment loss impossible, the use of the turbidity curtain during land disturbance is essential.

Design Criteria

1. Type I configuration (see Plate 3.27-1) should be used in protected areas where there is no current and the area is sheltered from wind and waves.

2. Type II configuration (see Plate 3.27-1) should be used in areas where there may be small to moderate current running (up to 2 knots or 3.5 feet per second) and/or wind and wave action can effect the curtain.

3. Type III configuration (see Plate 3.27-2) should be used in areas where considerable current (up to 3 knots or 5 feet per second) may be present, where tidal action may be present and/or where the curtain is potentially subject to wind and wave action.

4. Turbidity curtains should extend the entire depth of the watercourse whenever the watercourse in question is not subject to tidal action and/or significant wind and wave forces.

5. In tidal and/or wind and wave action situations, the curtain should never be so long as to touch the bottom. A minimum 1-foot "gap" should exist between the weighted lower end of the skirt and the bottom at "mean" low water. Movement of the lower skirt over the bottom due to tidal reverses or wind and wave action on the flotation system may fan and stir sediments already settled out.

6. In tidal and/or wind and wave action situations, it is seldom practical to extend a turbidity curtain depth lower than 10 to 12 feet below the surface, even in deep water. Curtains which are installed deeper than this will be subject to very large loads with consequent strain on curtain materials and the mooring system. In addition, a curtain installed in such a manner can "billow up" towards the surface under the pressure of the moving water, which will result in an effective depth which is significantly less than the skirt depth.

7. Turbidity curtains should be located parallel to the direction of flow of a moving body of water. Turbidity Curtain should not be placed across the main flow of a significant body of moving water.

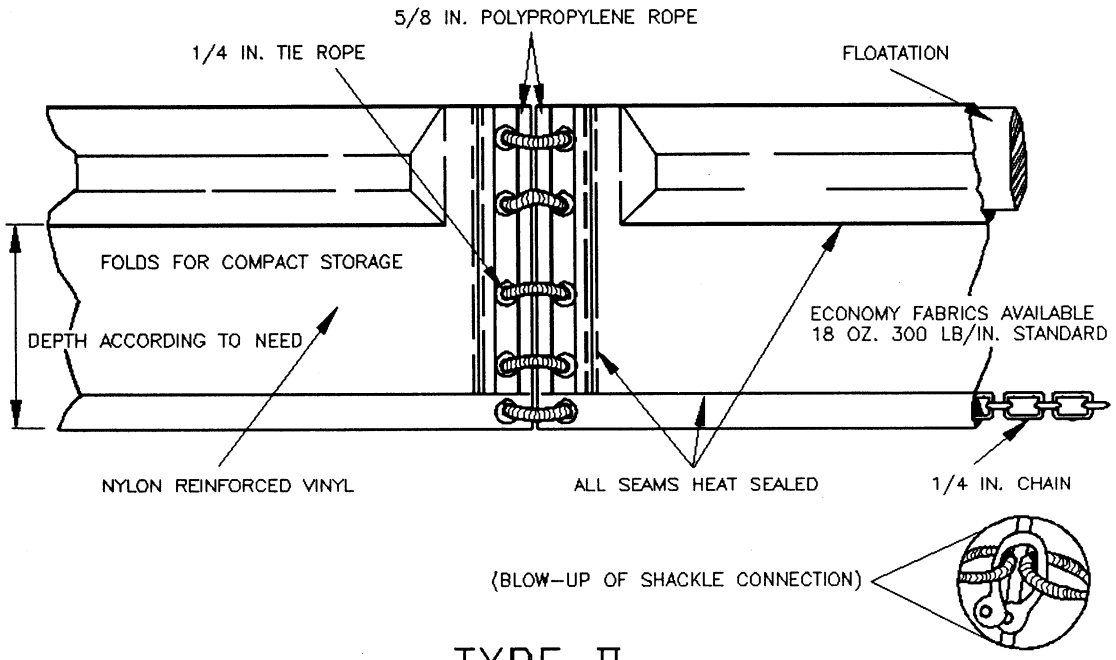
8. When sizing the length of the floating curtain, allow an additional 10-20% variance in the straight line measurements. This will allow for measuring errors, make installing easier and reduce stress from potential wave action during high winds.

9. An attempt should be made to avoid an excessive amount of joints in the curtain; a minimum continuous span of 50 feet between joints is a good "rule of thumb."

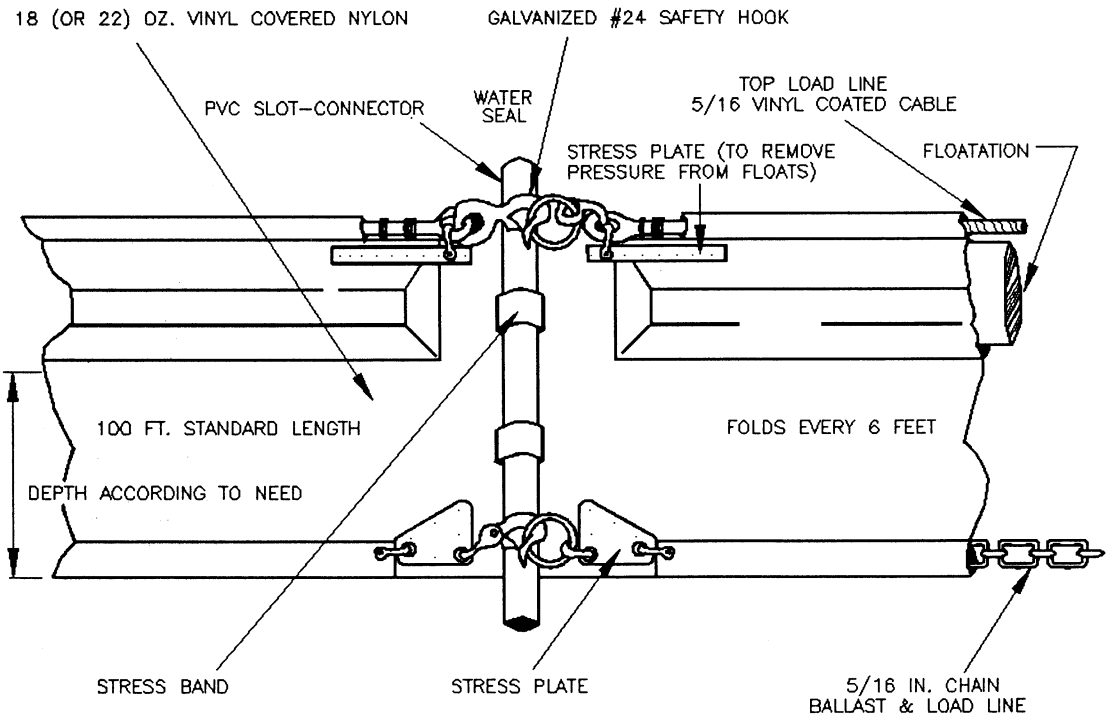
10. For stability reasons, a maximum span of 100 feet between joints (anchor or stake locations) is also a good rule to follow.

TURBIDITY CURTAIN

TYPE I



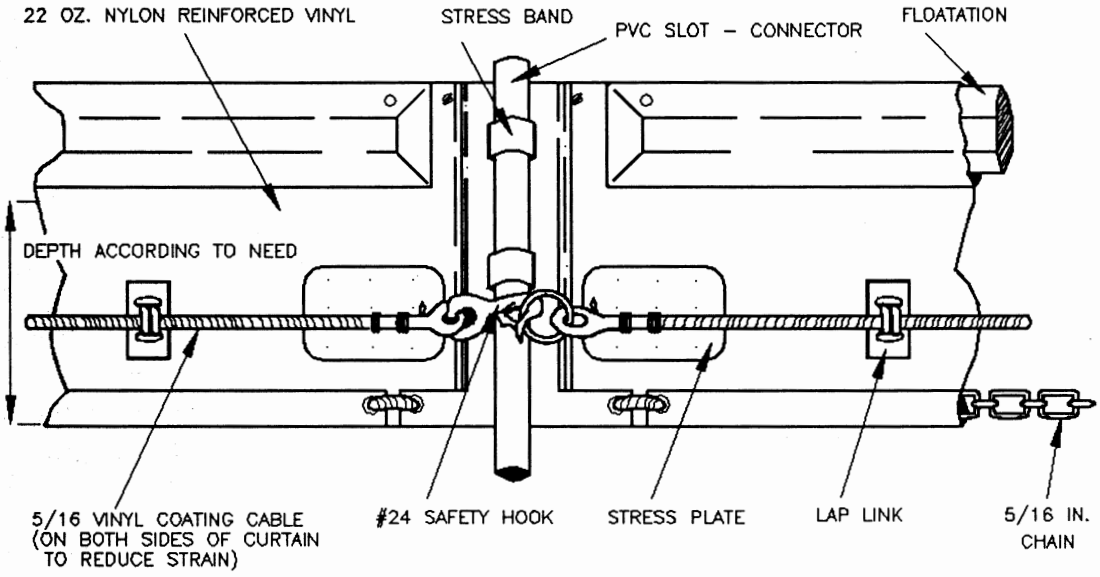
TYPE II



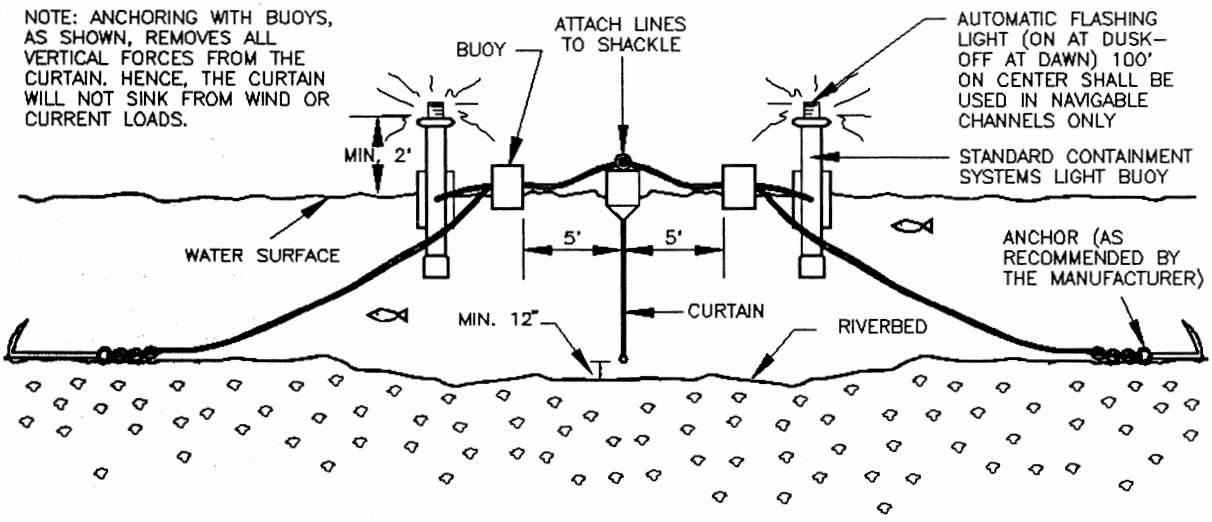
Source: American Boom and Barrier Corp. product literature Plate 3.27-1

TURBIDITY CURTAIN

TYPE III



ORIENTATION WHEN INSTALLED (TIDAL SITUATION – TYPE III)



Source: Adapted from American Boom and Barrier Corp. and VDOT Standard Sheets

Plate 3.27-2

11. The ends of the curtain, both floating upper and weighted lower, should extend well up into the shoreline, especially if high water conditions are expected. The ends should be secured firmly to the shoreline (preferably to rigid bodies such as trees or piles) to fully enclose the area where sediment may enter the water.

12. When there is a specific need to extend the curtain to the bottom of the watercourse in tidal or moving water conditions, a heavy woven pervious filter fabric may be substituted for the normally recommended impervious geotextile. This creates a "flow-through" medium which significantly reduces the pressure on the curtain and will help to keep it in the same relative location and shape during the rise and fall of tidal waters.

13. Typical alignments of turbidity curtains can be seen in Plate 3.27-3. The number and spacing of external anchors may vary depending on current velocities and potential wind and wave action; manufacturer's recommendations should be followed.

Construction Specifications

Materials

1. Barriers should be a bright color (yellow or "international" orange are recommended) that will attract the attention of nearby boaters.

2. The curtain fabric must meet the minimum requirements noted in Table 3.27-A.

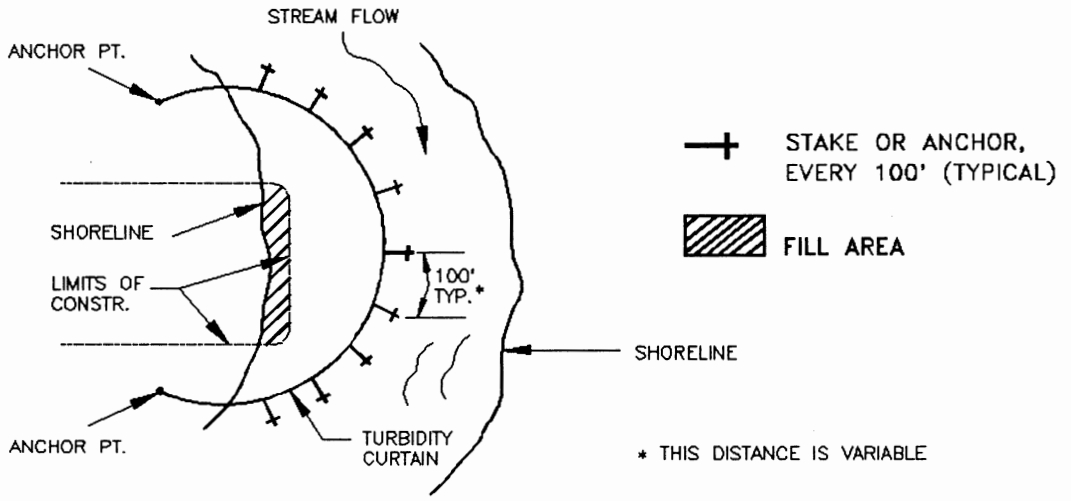
3. Seams in the fabric shall be either vulcanized welded or sewn, and shall develop the full strength of the fabric.

4. Floatation devices shall be flexible, buoyant units contained in an individual floatation sleeve or collar attached to the curtain. Buoyancy provided by the floatation units shall be sufficient to support the weight of the curtain and maintain a freeboard of at least 3 inches above the water surface level (see Plate 3.27-2).

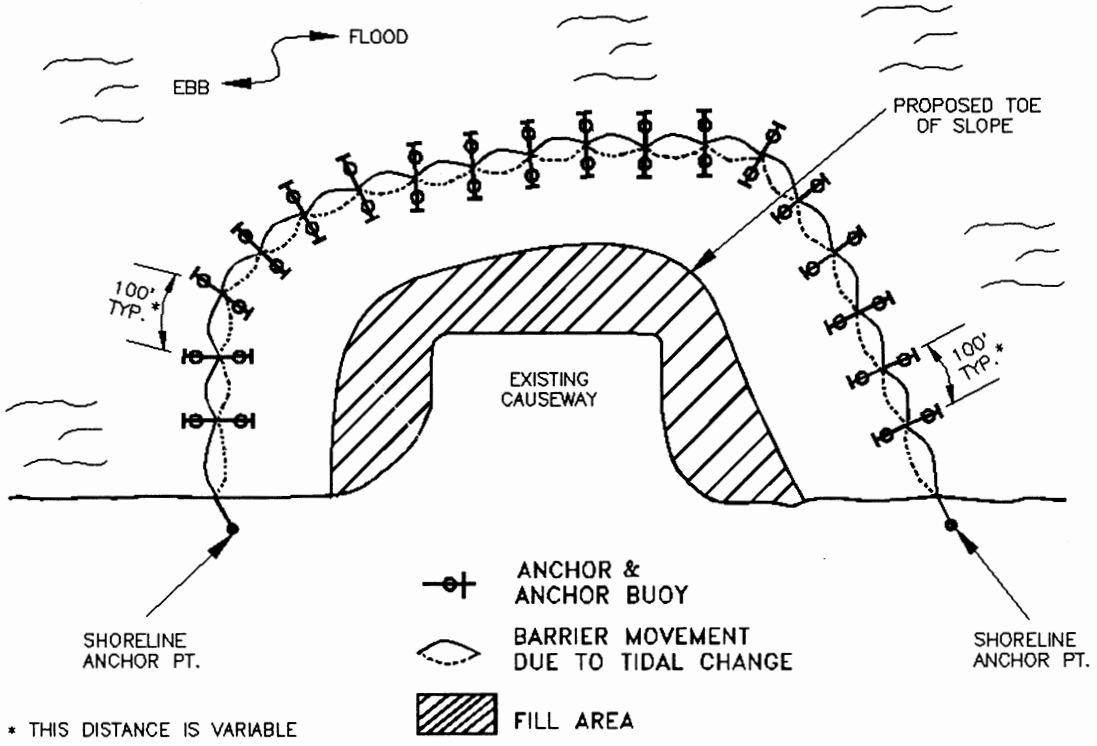
5. Load lines must be fabricated into the bottom of all floating turbidity curtains. Type II and Type III must have load lines also fabricated into the top of the fabric. The top load line shall consist of woven webbing or vinyl-sheathed steel cable and shall have a break strength in excess of 10,000 pounds. The supplemental (bottom) load-line shall consist of a chain incorporated into the bottom hem of the curtain of sufficient weight to serve as ballast to hold the curtain in a vertical position. Additional anchorage shall be provided as necessary. The load lines shall have suitable connecting devices which develop the full breaking strength for connecting to load lines in adjacent sections (see Plates 3.27-1 and 3.27-2 which portray this orientation).

TURBIDITY CURTAIN

TYPICAL LAYOUTS:
STREAMS, PONDS & LAKES (PROTECTED & NON-TIDAL)



TIDAL WATERS AND/OR HEAVY WIND & WAVE ACTION



Source: Adapted from Florida Department of Transportation Road and Design Specifications

Plate 3.27-3

TABLE 3.27-A

PHYSICAL PROPERTIES OF TURBIDITY CURTAIN FABRIC

Physical Property	Requirement
Thickness, mils	45
Weight/oz./sq. yd.:	
Type I	18
Type II	18 or 22
Type III	22
Grab Tensile Strength, lbs.	300
UV Inhibitor	Must be included

Source: Adapted from The Ralph Lemon Company product literature

6. External anchors may consist of wooden or metal stakes (2- x 4-inch or 2½-inch minimum diameter wood or 1.33 pounds/linear foot steel) when Type I installation is used; when Type II or Type III installations are used, bottom anchors should be used.

7. Bottom anchors must be sufficient to hold the curtain in the same position relative to the bottom of the watercourse without interfering with the action of the curtain. The anchor may dig into the bottom (grappling hook, plow or fluke-type) or may be weighted (mushroom type) and should be attached to a floating anchor buoy via an anchor line. The anchor line would then run from the buoy to the top load line of the curtain. When used with Type III installations, these lines must contain enough slack to allow the buoy and curtain to float freely with tidal changes without pulling the buoy or curtain down and must be checked regularly to make sure they do not become entangled with debris. As previously noted, anchor spacing will vary with current velocity and potential wind and wave action; manufacturer's recommendations should be followed. See orientation of external anchors and anchor buoys for tidal installation in Plate 3.27-2.

Installation

1. In the calm water of lakes or ponds (Type I installation) it is usually sufficient to merely set the curtain end stakes or anchor points (using anchor buoys if bottom anchors are employed), then tow the curtain in the furled condition out and attach it to these stakes or anchor points. Following this, any additional stakes or buoyed anchors required to maintain the desired location of the curtain may be set and these anchor points made fast to the curtain. Only then, the furling lines should be cut to let the curtain skirt drop.

2. In rivers or in other moving water (Type II and Type III installations) it is important to set all the curtain anchor points. Care must be taken to ensure that anchor points are of sufficient holding power to retain the curtain under the existing current conditions, prior to putting the furled curtain into the water. Again, anchor buoys should be employed on all anchors to prevent the current from submerging the flotation at the anchor points. If the moving water into which the curtain is being installed is tidal and will subject the curtain to currents in both directions as the tide changes, it is important to provide anchors on both sides of the curtain for two reasons:

   a) Curtain movement will be minimized during tidal current reversals.

   b) The curtain will not overrun the anchors and pull them out when the tide reverses.

   When the anchors are secure, the furled curtain should be secured to the upstream anchor point and then sequentially attached to each next downstream anchor point until the entire curtain is in position. At this point, and before unfurling, the "lay" of the curtain should be assessed and any necessary adjustments made to the anchors. Finally, when the location is ascertained to be as desired, the furling lines should be cut to allow the skirt to drop.

3. Always attach anchor lines to the flotation device, not to the bottom of the curtain. The anchoring line attached to the floatation device on the downstream side will provide support for the curtain. Attaching the anchors to the bottom of the curtain could cause premature failure of the curtain due to the stresses imparted on the middle section of the curtain.

4. There is an exception to the rule that turbidity curtains should not be installed across channel flows; it occurs when there is a danger of creating a silt build-up in the middle of a watercourse, thereby blocking access or creating a sand bar. Curtains have been used effectively in large areas of moving water by forming a very long-sided, sharp "V" to deflect clean water around a work site, confine a large part of the silt-laden water to the work area inside the "V" and direct much of the silt toward the shoreline. Care must be taken, however, not to install the curtain perpendicular to the water current.

5. See Plate 3.27-3 for typical installation layouts.

Removal

1. Care should be taken to protect the skirt from damage as the turbidity curtain is dragged from the water.

2. The site selected to bring the curtain ashore should be free of sharp rocks, broken cement, debris, etc. so as to minimize damage when hauling the curtain over the area.

3. If the curtain has a deep skirt, it can be further protected by running a small boat along its length with a crew installing furling lines before attempting to remove the curtain from the water.

Maintenance

1. The developer/owner shall be responsible for maintenance of the filter curtain for the duration of the project in order to ensure the continuous protection of the watercourse.

2. Should repairs to the geotextile fabric become necessary, there are normally repair kits available from the manufacturers; manufacturer's instructions must be followed to ensure the adequacy of the repair.

3. When the curtain is no longer required as determined by the inspector, the curtain and related components shall be removed in such a manner as to minimize turbidity. Remaining sediment shall be sufficiently settled before removing the curtain. Sediment may be removed and the original depth (or plan elevation) restored. Any spoils must be taken to upland area and be stabilized.

STD & SPEC 3.28

SUBSURFACE DRAIN

SD

Definition

A perforated conduit such as pipe, tubing or tile installed beneath the ground to intercept and convey ground water.

Purposes

1. To prevent sloping soils from becoming excessively wet and subject to sloughing.

2. To improve the quality of the growth medium in excessively wet areas by lowering the water table.

3. To drain stormwater detention areas or structures.

Conditions Where Practice Applies

Wherever excess water must be removed from the soil. The soil must be deep and permeable enough to allow an effective system to be installed. Either a gravity outlet must be available or pumping must be provided. These standards do no apply to foundation drains.

Planning Considerations

Subsurface drainage systems are of two types, relief drains and interceptor drains. Relief drains are used either to lower the water table in order to improve the growth of vegetation, or to remove surface water. They are installed along a slope and drain in the direction of the slope. They can be installed in a gridiron pattern, a herringbone pattern, or a random pattern (see Plate 3.28-1).

Interceptor drains are used to remove water as it seeps down a slope to prevent the soil from becoming saturated and subject to slippage. They are installed across a slope and drain to the side of the slope. They usually consist of a single pipe or series of single pipes instead of a patterned layout (see Plate 3.28-2).

Design Criteria

Location

Tree roots can often clog subsurface drain systems. Consequently, sub-surface drains should be located such that there are no trees within 50 feet of the drain.

Relief Drains - Relief drains should be located through the center of wet areas. They should drain in the same direction as the slope.

Interceptor drains - Interceptor drains should be located on the uphill side of wet areas . They should be installed across the slope and drain to the side of the slope.

Capacity of Drains

The required capacity of a subsurface drain depends upon its use.

Relief drains- Relief drains installed in a uniform pattern should remove a minimum of 1 inch of groundwater in 24 hours (0.042 cfs/acre). The design capacity must be increased accordingly to accommodate any surface water which enters directly into the system (see Plate 3.28-4).

Interceptor drains or relief drains in a random pattern- Interceptor drains or relief drains installed in a random pattern should remove a minimum of 1.5 cfs/1000 feet of length. This

value should be increased for sloping land according to the values in Table 3.28-A. In addition, if a flowing spring or surface water enters directly into the system, this flow must be accommodated and the design capacity must be increased accordingly to take care of this flow (see Plate 3.28-4).

TABLE 3.28-A

WATER REMOVAL RATES FOR SLOPING LAND*

Land Slope	Water Removal Rates
2 - 5%	1.65 cfs/1000 ft.
6 - 12%	1.80 cfs/1000 ft.
> 12%	1.95 cfs/1000 ft.

* These rates depend on the soil types where the drains are installed. Heavier soils may result in slower water removal rates.

Source: Va. DSWC

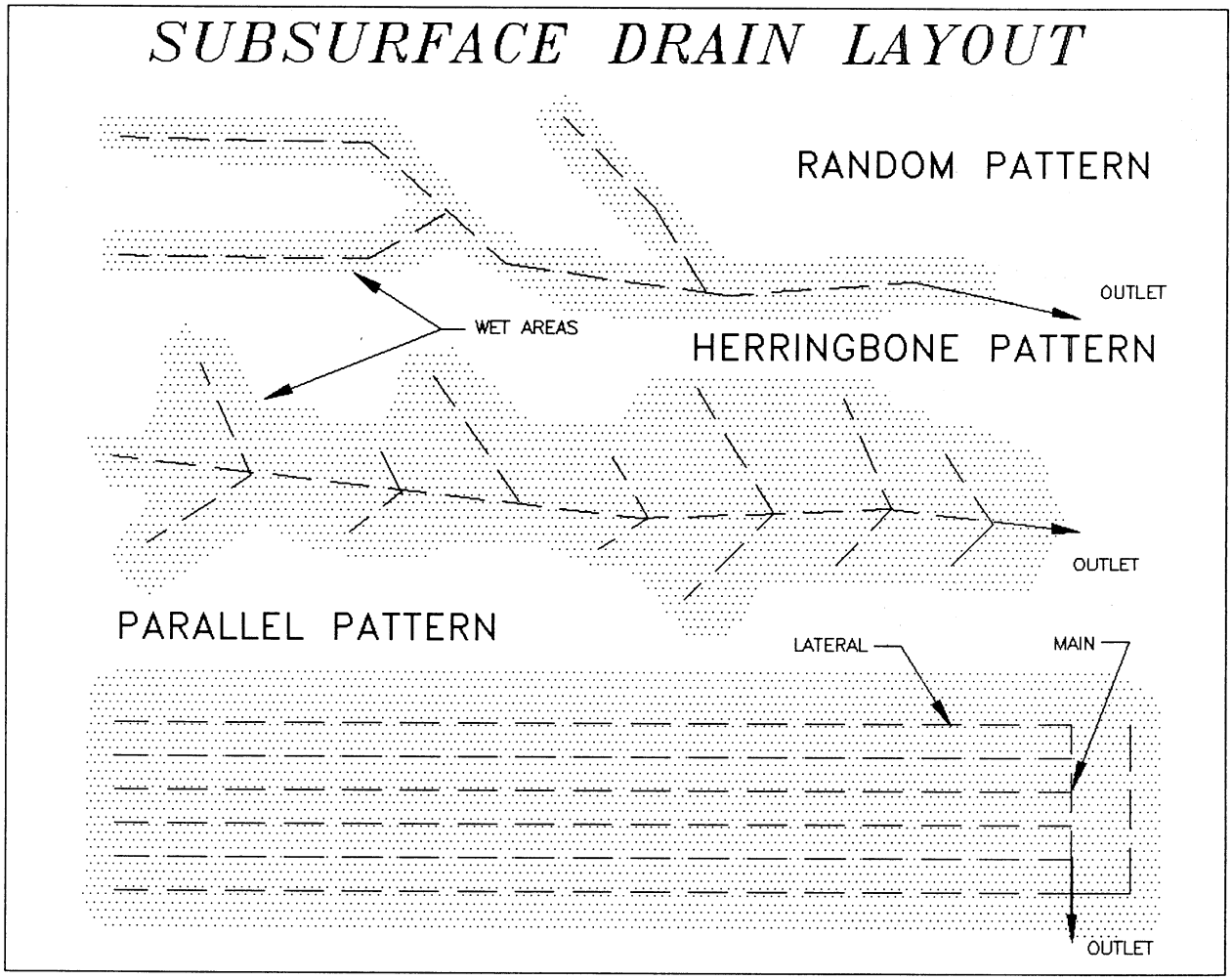
Size of Drains

Subsurface drains should be sized for the required capacity using Plates 3.28-6 and 3.28-7 in Appendix 3.28-a. The minimum diameter for a subsurface drain shall be 4 inches.

Depth and Spacing

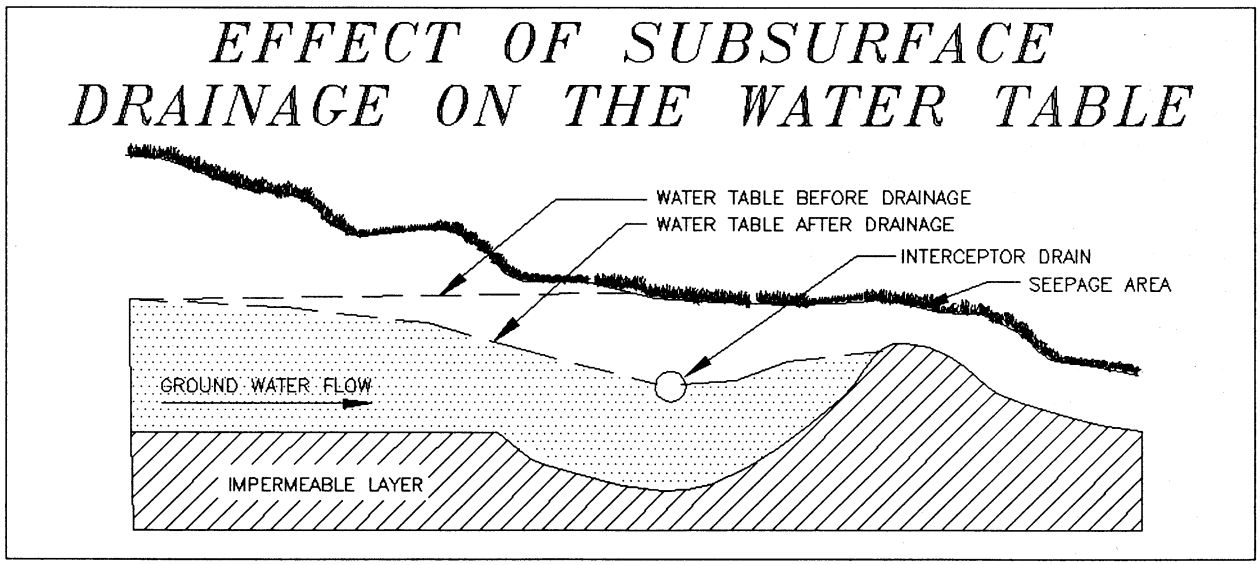
Relief Drains - Relief drains installed in a uniform pattern should have equal spacing between drains and the drains should be at the same depth. Maximum depth is limited by the allowable load on the pipe, depth to impermeable layers in the soil, and outlet requirements. The minimum depth is 24 inches under normal conditions. Twelve inches is acceptable where the drain will not be subject to equipment loading or frost action. Spacing between drains is dependent on soil permeability and the depth of the drain. In general, however, a depth of 3 feet and a spacing of 50 feet will be adequate. A more economical system may be designed., if the necessary information is available, by using the equations found in Appendix 3.28-a.

Interceptor drain - The depth of installation of an interceptor drain is influenced mainly by the depth to which the water table is to be lowered. The maximum depth is limited by the allowable load on the pipe and the depth to an impermeable layer. Minimum depth should be the same as for relief drains.



Source: USDA-SCS

Plate 3.28-1



Source: USDA-SCS

Plate 3.28-2

One interceptor drain is usually sufficient. However, if multiple drains are to be used, determining the required spacing can be difficult. The best approach is to install the first drain - then if seepage or high water table problems occur downslope, install an additional drain a suitable distance downslope. This distance can be calculated from equations found in Appendix 3.28-a.

Velocity and Grade

The minimum velocity required to prevent silting is 1.4 ft./sec. The line should be graded to achieve at least this velocity. Steep grades should be avoided, however. Table 3.28-B lists maximum velocities for various soil textures.

TABLE 3.28-B

MAXIMUM VELOCITIES FOR VARIOUS SOIL TEXTURES

Soil Texture	Maximum Velocity (ft./sec.)
Sandy and Sandy Loam	3.5
Silt and Silt Loam	5.0
Silty Clay Loam	6.0
Clay and Clay Loam	7.0
Coarse Sand or Gravel	9.0

Source: Va. DSWC

Envelopes

Envelopes shall be used around all drains for proper bedding and improved flow of groundwater into the drain. The envelope shall consist of 3 inches of VDOT #68 aggregate placed completely around the drain. The stone shall be encompassed by a filter cloth separator in order to prevent the migration of surrounding soil particles into the drain (see Plate 3.28-3). Filter cloth must meet the physical requirements noted in Std. & Spec. 3.19, RIPRAP.

Surface Water

Plate 3.28-4 shows two types of surface water inlets. The grated inlet should not be used where excessive sedimentation might be a problem.

Outlet

The outlet of the subsurface drain shall empty into a channel or some other watercourse which will remove the water from the outlet. It shall be above the mean water level in the receiving channel. It shall be protected from erosion, undermining, damage from periods of submergence, and the entry of small animals into the drain.

The outlet shall consist of a 10-foot section of corrugated metal, cast iron, steel or schedule 40 PVC pipe without perforations. No envelope material shall be used around the pipe. At least two-thirds of the outlet pipe length shall be buried.

Materials

Acceptable materials for subsurface drains include perforated, continuous closed-joint conduits of corrugated plastic, concrete, corrugated metal, asbestos cement, and bituminous fiber. The strength and durability of the pipe shall meet the requirements of the site in accordance with the manufacturer's specifications.

Construction Specifications

1. The trench shall be constructed on a continuous grade with no reverse grades or low spots.

2. Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.

3. Deformed, warped, or otherwise unsuitable pipe shall not be used.

4. Envelopes or filter material shall be placed as specified with at least 3 inches of material on all sides of the pipe.

5. Backfilling shall be done immediately after placement of the pipe. No sections of pipe should remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drain pipe is not displaced or damaged.

6. The outlet section of the drain shall consist of at least 10 feet of non-perforated corrugated metal, cast iron, steel or schedule 40 PVC pipe. At least two-thirds of its length shall be buried.

Maintenance

1. Subsurface drains should be checked periodically to ensure that they are free-flowing and not clogged with sediment.

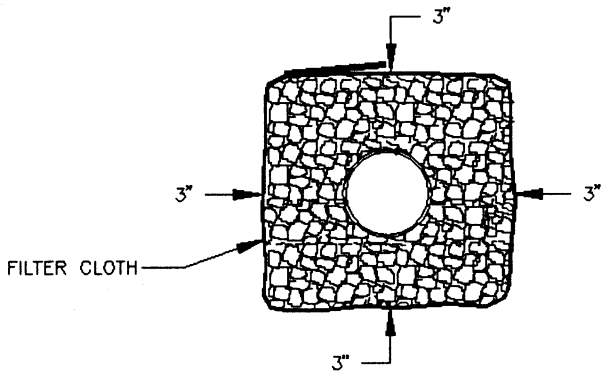
2. The outlet should be kept clean and free of debris.

3. Surface inlets should be kept open and free of sediment and other debris.

4. Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees.

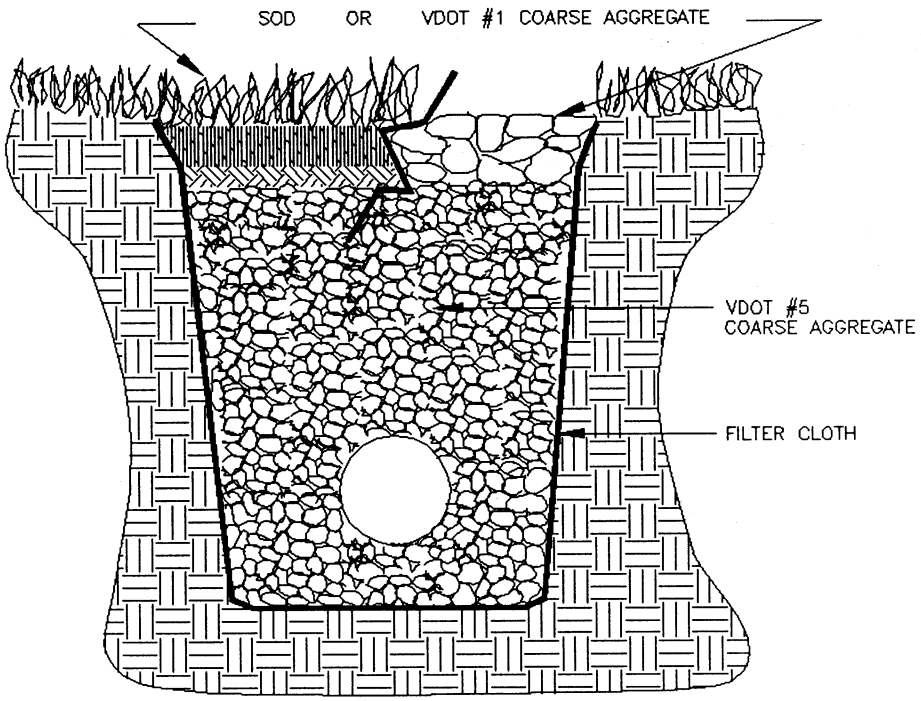
5. Where drains are crossed by heavy vehicles, the line should be checked to ensure that it is not crushed.

DRAINAGE ENVELOPE

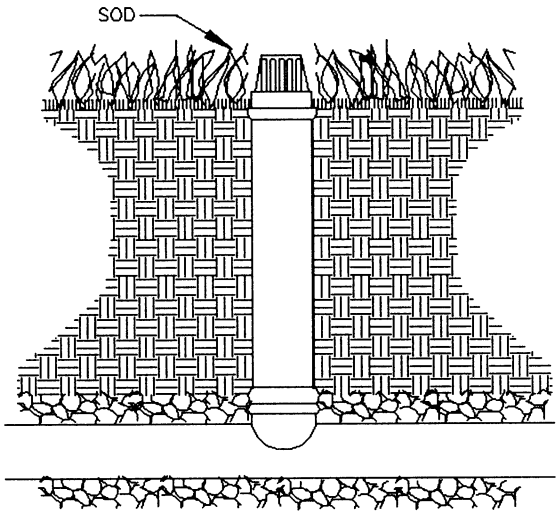


Source: USDA-SCS Plate 3.28-3

SURFACE INLETS



NATURAL INLET



GRATED INLET

Source: USDA-SCS

Plate 3.28-4

APPENDIX 3.28-a

Subsurface drains are not generally designed to flow under pressure and the hydraulic gradient is parallel with the grade line. Consequently, the flow is considered to be open channel and Manning's Equation can be used. The required drain size can be determined by the following procedure:

1. Determine the flow the drain must carry.

2. Determine the gradient of the drain

3. From Table 3.28-C, determine "n" for the type of drain pipe to be used. Choose the correct Plate (3.28-5 through 3.28-7) for the "n" just determined.

4. Enter the appropriate plate with the gradient of the pipe and the flow in the pipe. The intersection of the two lines must be to the right of the line for 1.4 ft./sec. If it is not, increase the gradient or flow capacity or both.

Example 1

Given:

A random subsurface drain is to be installed on a 1.0% grade, 700 feet in length, and using corrugated plastic pipe.

Calculate:

The required size of the drain pipe.

Solution:

From the Std. & Spec., the required capacity of the pipe is:

$$1.5\ ft.^3/\text{sec.}/1000\ ft.$$

$$Capacity = \frac{700}{1000} \times 1.5\ ft.^3/\text{sec.} = 1.05\ ft.^3/\text{sec.}$$

* From Table 3.28-C, n = 0.015 for corrugated plastic pipe.

* From Plate 3.28-6, choose an 8-inch pipe.

Example 2

Given:

A relief drain installed in a gridiron pattern of 8 laterals, 500 feet long, 0.5% grade, and 50 feet on centers. A main 400 feet in length on a 0.5% grade will connect to the laterals. Use bituminized fiber pipe for the main and laterals.

Calculate:

The required size of the drain pipe.

Solution:

The drainage area for each lateral is 25 feet on either side of the pipe times the length. Therefore:

$$\frac{50\ ft.\ \times\ 500\ ft.}{43{,}560\ ft.^2/acre} = 0.57\ acre$$

From the Std. & Spec., the drains must remove 1 inch of water in 24 hours or 0.042 $ft.^3$/sec./acre.

$$0.042\ ft.^3/sec./acre\ \times\ 0.57\ acre = 0.02\ ft.^3/sec.$$

From Table 3.28-C, n = 0.013 for bituminized fiber pipe.

From Plate 3.28-5, a 4-inch pipe must be used for the laterals.

The first 25 feet of the main will drain 25 feet on either side of the pipe. The remaining 375 feet will drain only 25 feet on the side opposite from the laterals. In addition, the main will drain the laterals.

Drainage from main:

$$\frac{25\ ft.\ \times\ 50\ ft.}{43{,}560\ ft.^2/acre} + \frac{375\ ft.\ \times\ 25\ ft.}{43{,}560\ ft.^2/acre} = 0.24\ acre$$

Drainage from laterals:

$$8 \quad x \quad 0.57 \text{ acre} \quad = \quad 4.56 \text{ acre}$$

$$\text{Total} \quad = \quad 0.24 \quad + \quad 4.56 \quad = \quad 4.8 \text{ acre}$$

Required capacity:

$$0.042 \text{ ft.}^3\text{/sec./acre} \quad x \quad 4.8 \text{ acre} \quad = \quad 0.20 \text{ ft.}^3\text{/sec.}$$

From Plate 3.28-5, choose a 5-inch pipe for the main.

TABLE 3.28-C

"n" VALUES FOR SUBSURFACE DRAIN PIPES

Composition of Pipe or Tubing	"n" Values
Asbestos Cement	0.013
Bituminized Fiber	0.013
Concrete	0.015
Corrugated Plastic	0.015
Corrugated Metal	0.025

Source: Va. DSWC

Spacing of Relief Drains

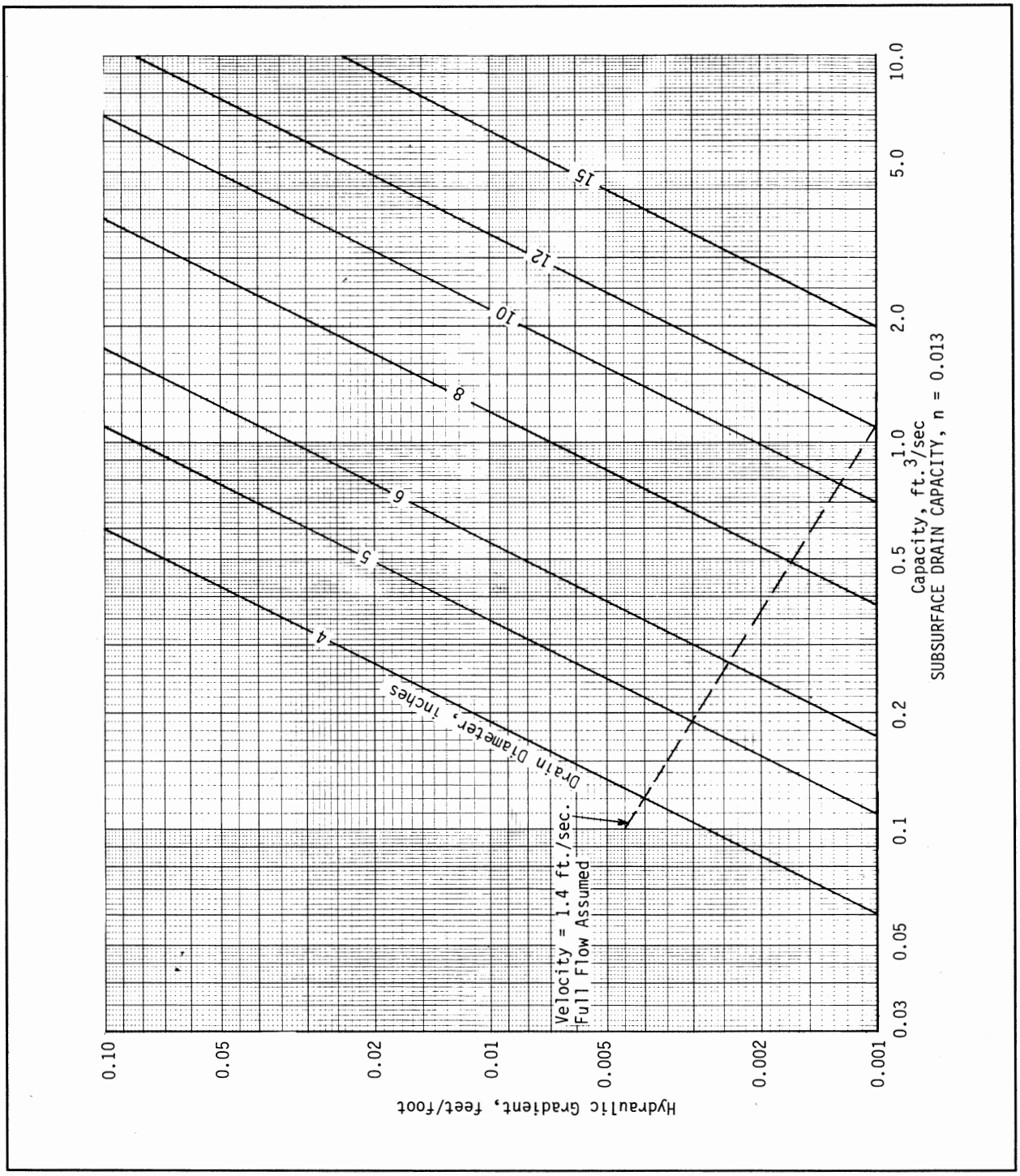
If the necessary information is known, the following equation can be used to calculate drain spacing in lieu of the recommended standard:

$$S = \sqrt{\frac{4k\,(M^2 + 2\,AM)}{q}}$$

Where,

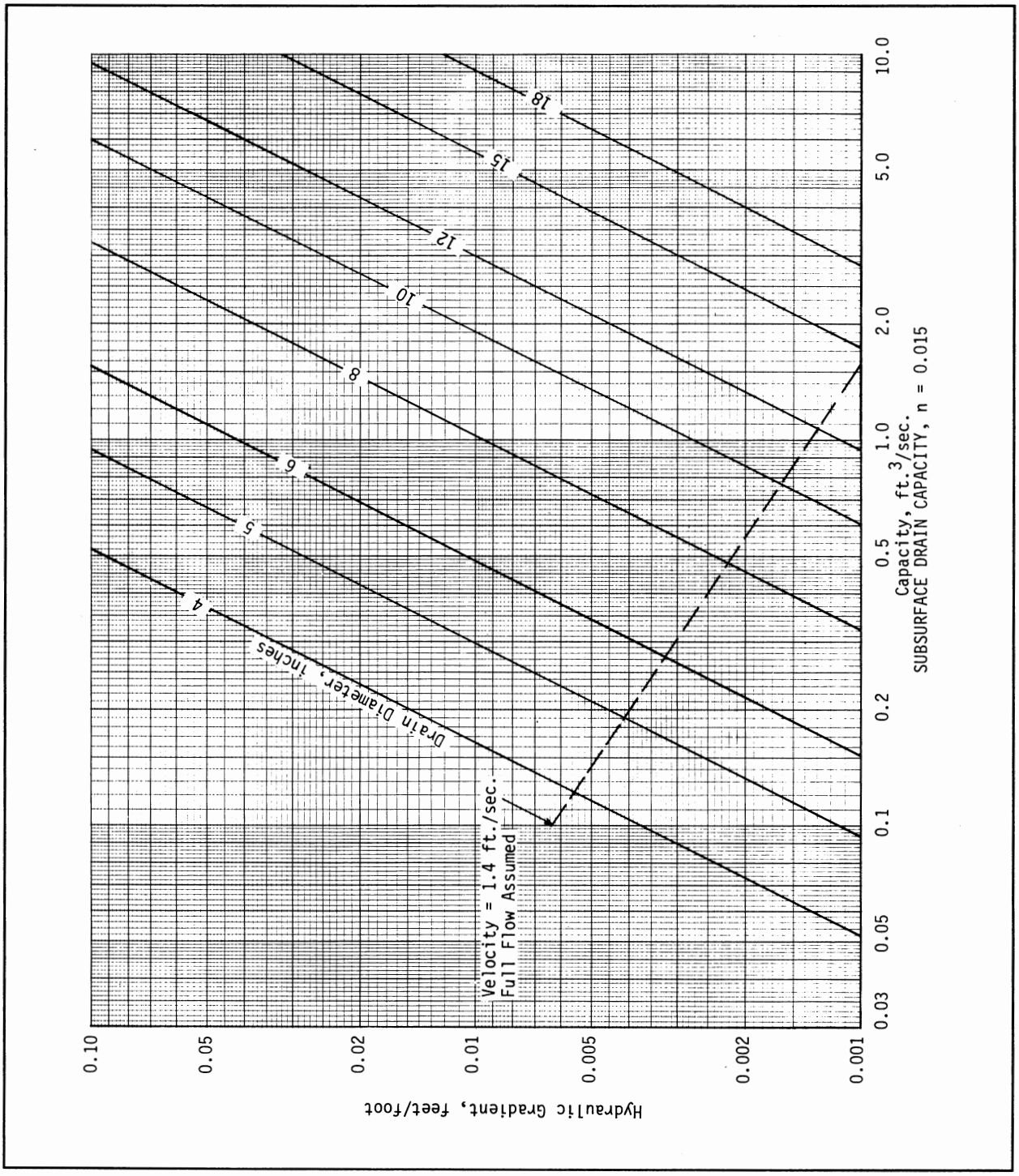
S = drain spacing, feet

k = average hydraulic conductivity, in./hr. (for practical purposes, hydraulic conductivity is equal to permeability).



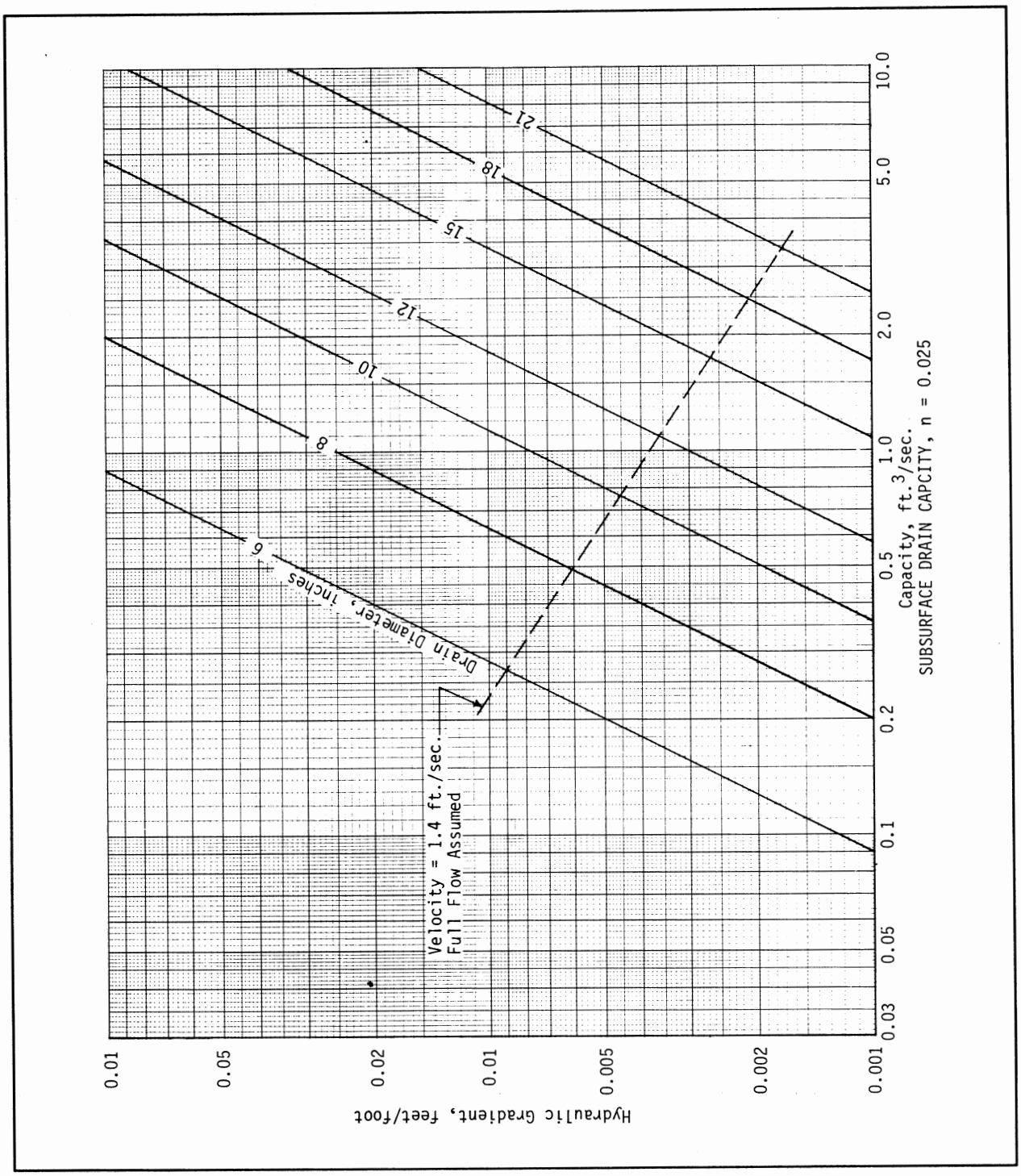
Source: USDA-SCS

Plate 3.28-5



Source: USDA-SCS

Plate 3.28-6



Source: USDA-SCS

Plate 3.28-7

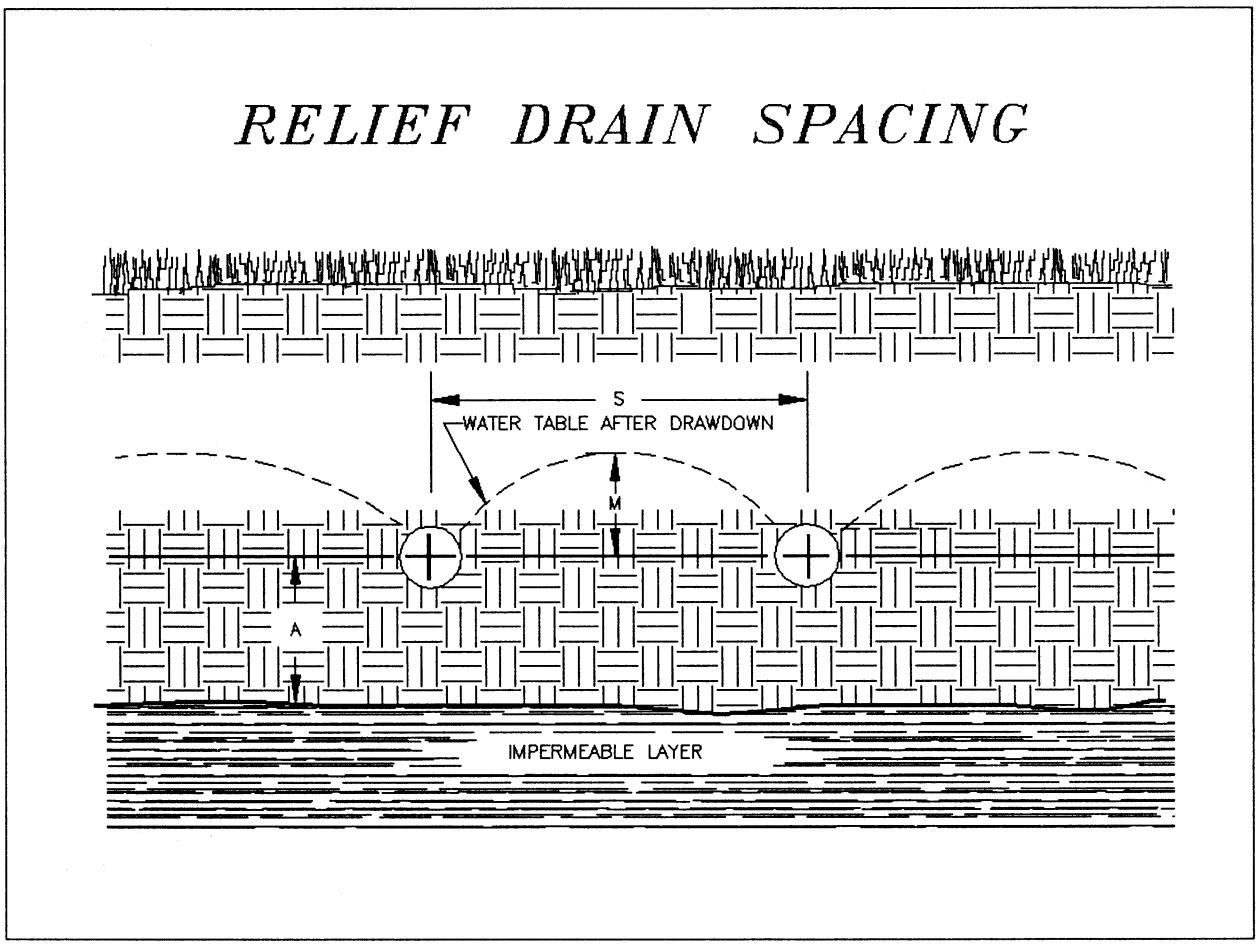
M = vertical distance, after drawdown, of water table above drain at mid-point between lines, feet.

A = depth of barrier below drain, feet.

q = drainage coefficient, rate of water removal, inch/hr.

Also, see Plate 3.28-8.

This equation is applicable to most areas in Virginia. Limitations of the equation are listed in the SCS National Engineering Handbook, Section 16, Drainage of Agricultural Land (66).



Source: USDA-SCS Plate 3.28-8

Spacing of Interceptor Drains

If one interceptor drain is not sufficient, the spacing of multiple drains can be calculated by the following equation:

$$Le = \frac{k\,i}{q}\,(de - dw + W_2)$$

Where,

Le = the distance downslope from the drain to the point where the water table is at the desired depth after drainage, feet. The second drain should be located at this point.

k = the average hydraulic conductivity of the subsurface profile to the depth of the drain, in./hr.

q = drainage coefficient, rate of water removal, in./hr.

i = the hydraulic gradient of the water table before drainage, feet/foot.

de = the effective depth of the drain, feet.

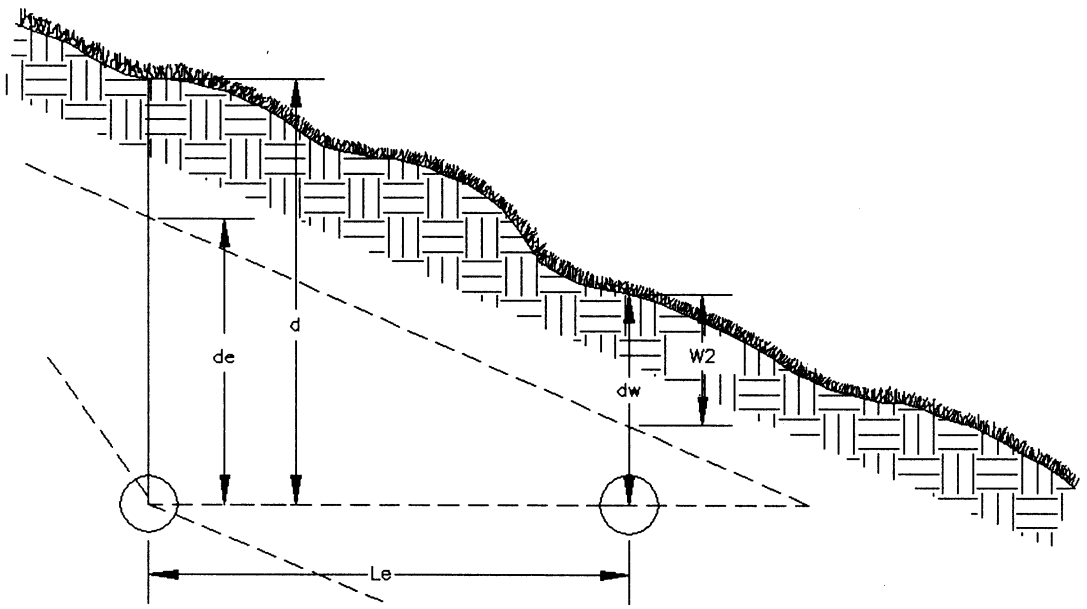
dw = the desired minimum depth to water table after drainage, feet.

W_2 = the distance from the ground surface to the water table, before drainage, at the distance (Le) downslope from the drain, feet.

Also, see Plate 3.28-9.

Further information on the equation can be obtained from the SCS National Engineering Handbook, Section 16, Drainage of Agricultural Land (66).

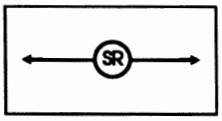
INTERCEPTOR DRAIN SPACING



Source: USDA-SCS

Plate 3.28-9

STD & SPEC 3.29



SURFACE ROUGHENING

SR

Definition

Providing a rough soil surface with horizontal depressions created by operating a tillage or other suitable implement on the contour, or by leaving slopes in a roughened condition by not fine-grading them.

Purposes

1. To aid in establishment of vegetative cover with seed.
2. To reduce runoff velocity and increase infiltration.
3. To reduce erosion and provide for sediment trapping.

Conditions Where Practice Applies

1. All slopes steeper than 3:1 require surface roughening, either stair-step grading, grooving, furrowing, or tracking if they are to be stabilized with vegetation.

2. Areas with grades less steep than 3:1 should have the soil surface lightly roughened and loose to a depth of 2 to 4 inches prior to seeding.

3. Areas which have been graded and will not be stabilized immediately may be roughened to reduce runoff velocity until seeding takes place.

4. Slopes with a stable rock face do not require roughening or stabilization.

Planning Considerations

Graded areas with smooth, hard surfaces give a false impression of "finished grading" and a job well done. It is difficult to establish vegetation on such surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and rocks left in place may appear unattractive or unfinished at first, but encourage water infiltration, speed the establishment of vegetation, and decrease runoff velocity.

Rough loose soil surfaces give lime, fertilizer and seed some natural coverage. Niches in the surface provide microclimates which generally provide a cooler and more favorable moisture level than hard flat surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving, and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

1. Disturbed areas which will not require mowing may be stair-step graded, grooved, or left rough after filling.

2. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material which sloughs from above, and provides a level site where vegetation can become established.

3. Areas which will be mowed (these areas should have slopes less steep than 3:1) may have small furrows left by discing, harrowing, raking, or seed-planting machinery operated on the contour.

4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as

effective as other forms of roughening, as the soil surface is severely compacted and runoff is increased.

Specifications

Cut Slope Applications For Areas Which Will Not Be Mowed

Cut slopes with a gradient steeper than 3:1 shall be stair-step graded or grooved (Plates 3.29-1 and 3.29-2).

1. Stair-step grading may be carried out on any material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

   The ratio of the vertical cut distance to the horizontal distance shall be less than 1:1 and the horizontal portion of the "step" shall slope toward the vertical wall.

   Individual vertical cuts shall not be more than 30 inches on soft soil materials and not more than 40 inches in rocky materials.

2. Grooving consists of using machinery to create a series of ridges and depressions which run perpendicular to the slope (on the contour).

   Grooves may be made with any appropriate implement which can be safely operated on the slope and which will not cause undue compaction. Suggested implements include discs, tillers, spring harrows, and the teeth on a front-end loader bucket. Such grooves shall not be less than 3 inches deep nor further than 15 inches apart.

Fill Slope Applications For Areas Which Will Not Be Mowed

Fill slopes with a gradient steeper than 3:1 shall be grooved or allowed to remain rough as they are constructed. Method (1) or (2) below may be used.

1. Groove according to #2 above.

2. As lifts of the fill are constructed, soil and rock materials may be allowed to fall naturally onto the slope surface (see Plate 3.29-3).

Colluvial materials (soil deposits at the base of slopes or from old stream beds) shall not be used in fills as they flow when saturated.

At no time shall slopes be bladed or scraped to produce a smooth, hard surface.

Cuts, Fills, and Graded Areas Which Will Be Mowed

Mowed slopes should not be steeper than 3:1. Excessive roughness is undesirable where mowing is planned. These areas may be roughened with shallow grooves such as remain after tilling, discing, harrowing, raking, or use of a cultipacker-seeder. The final pass of any such tillage implement shall be on the contour (perpendicular to the slope).

Grooves formed by such implements shall be not less than 1-inch deep and not further than 12-inches apart. Fill slopes which are left rough as constructed may be smoothed with a dragline or pickchain to facilitate mowing.

Roughening With Tracked Machinery (see Plate 3.29-4)

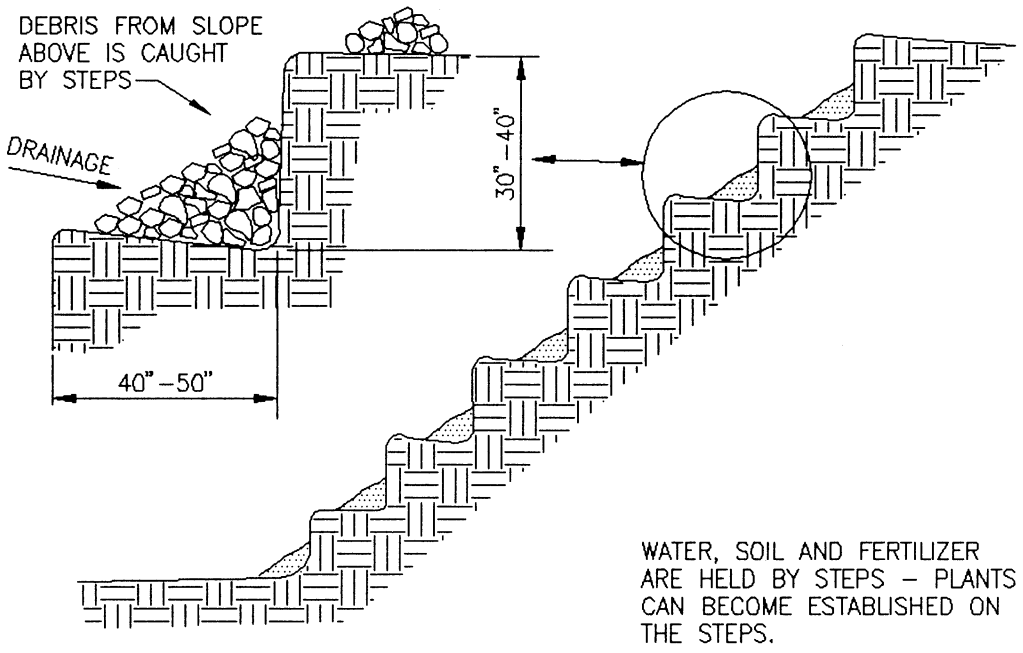
Roughening with tracked machinery on clayey soils is not recommended unless no alternatives are available. Undue compaction of surface soil results from this practice. Sandy soils do not compact severely, and may be tracked. In no case is tracking as effective as the other roughening methods described.

When tracking is the chosen surface roughening technique, it shall be done by operating tracked machinery up and down the slope to leave horizontal depressions in the soil. As few passes of the machinery should be made as possible to minimize compaction.

Seeding

Roughened areas shall be seeded and mulched as soon as possible to obtain optimum seed germination and seedling growth.

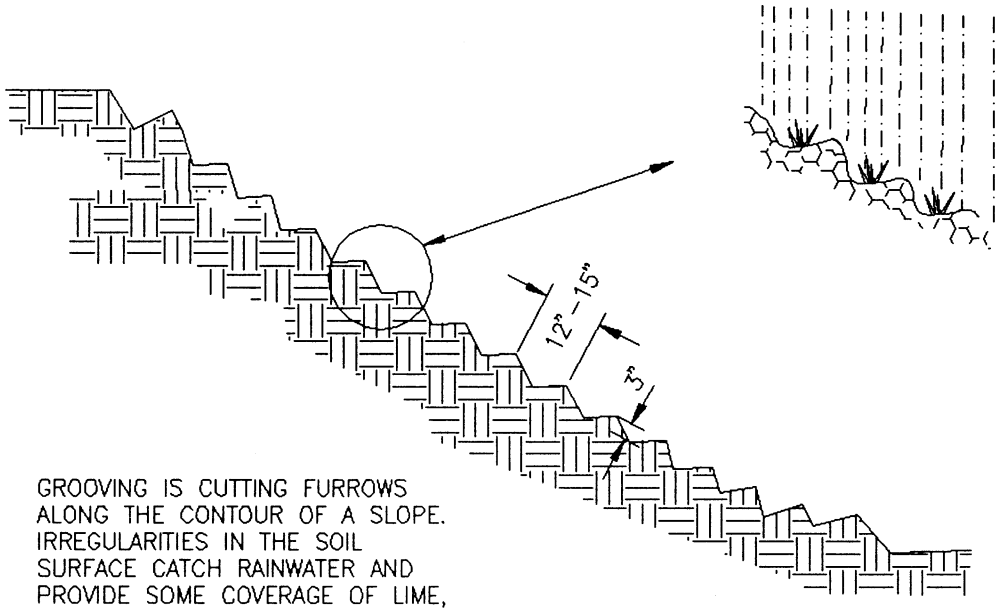
STAIR STEPPING CUT SLOPES



Source: Va. DSWC

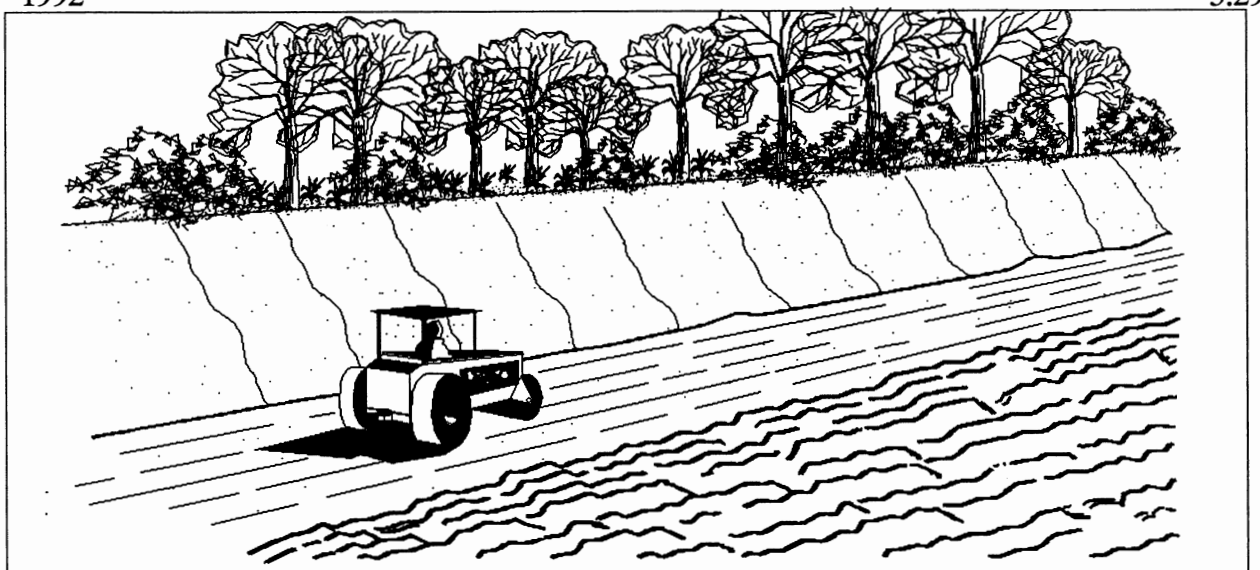
Plate 3.29-1

GROOVING SLOPES



Source: Va. DSWC

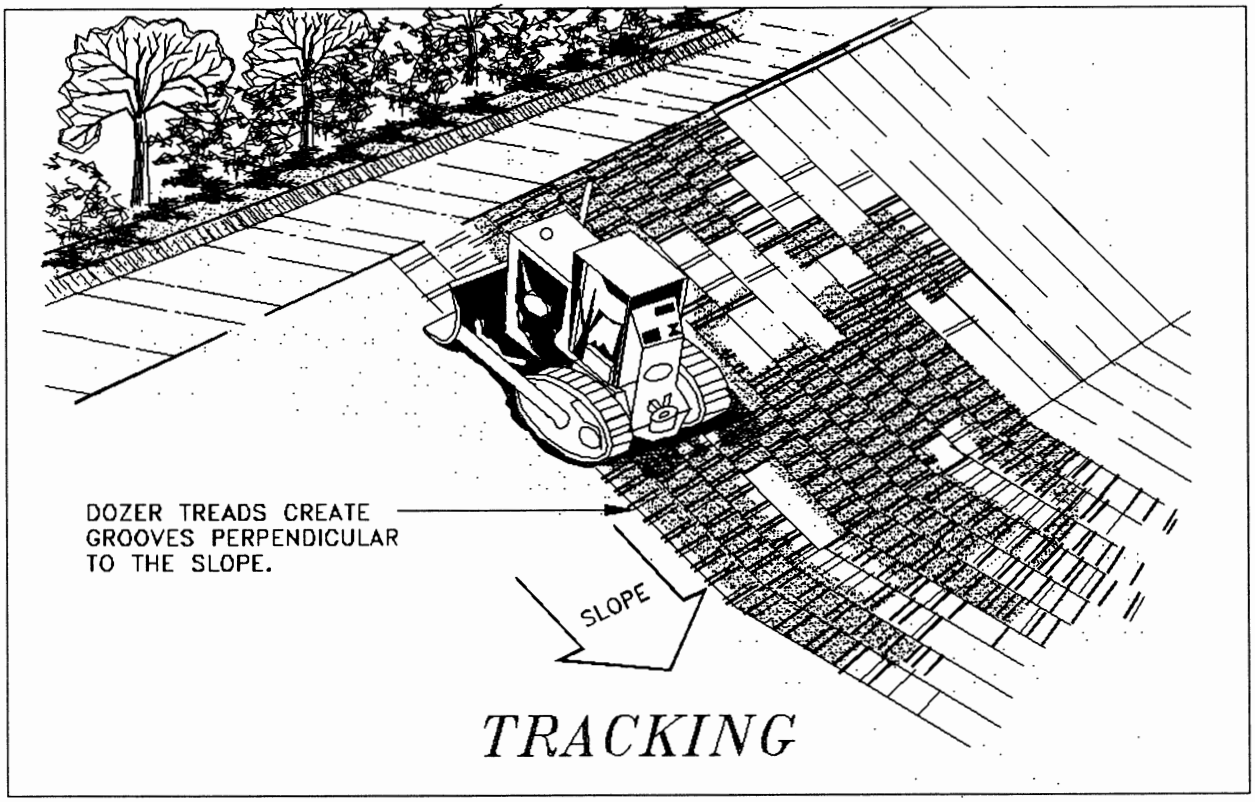
Plate 3.29-2



EACH LIFT OF THE FILL IS COMPACTED, BUT THE OUTER FACE OF THE SLOPE IS ALLOWED TO REMAIN LOOSE SO THAT THE ROCKS, CLODS, ETC. REACH THE NATURAL ANGLE OF REPOSE.

FILL SLOPE TREATMENT

Source: Va. DSWC Plate 3.29-3



TRACKING

Source: Michigan Soil Erosion and Sedimentation Guide Plate 3.29-4

STD & SPEC 3.30

TOPSOILING

Definition

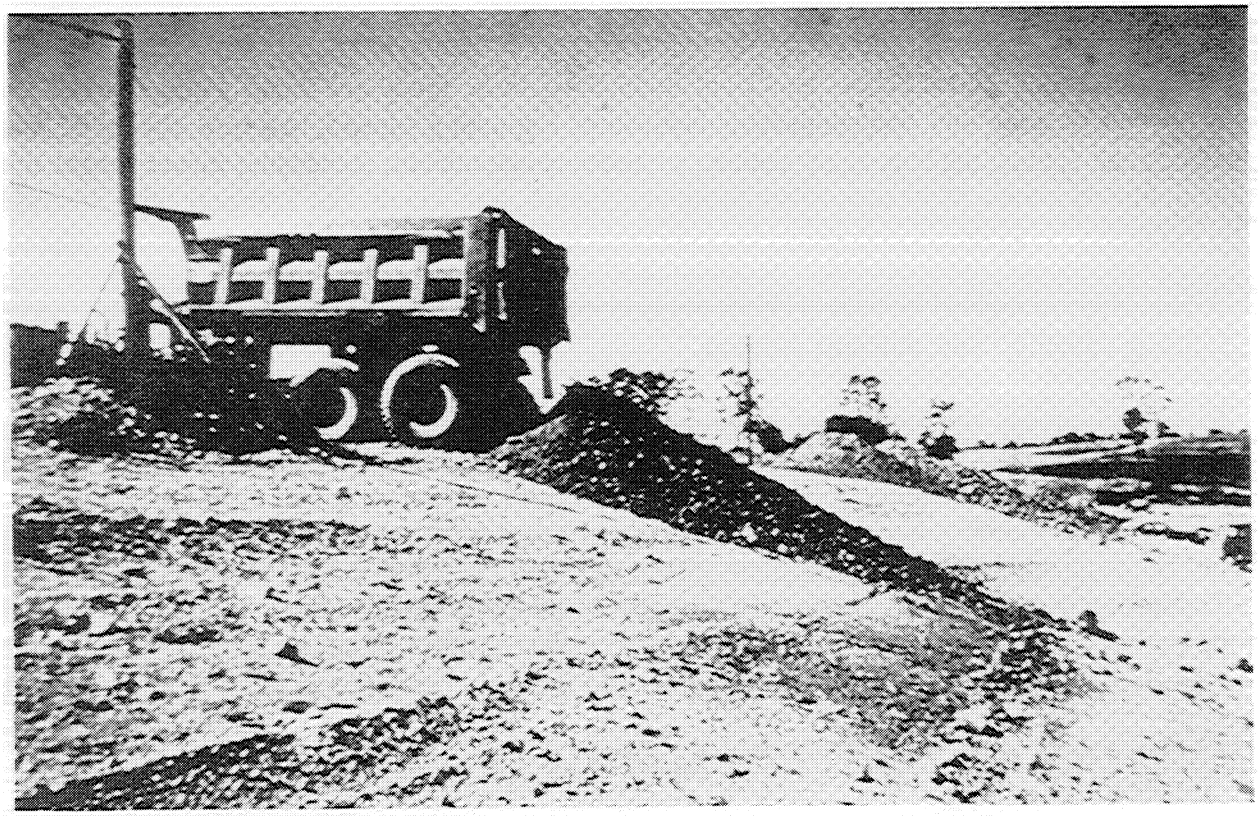
Methods of preserving and using the surface layer of undisturbed soil, often enriched in organic matter, in order to obtain a more desirable planting and growth medium.

Purpose

To provide a suitable growth medium for final site stabilization with vegetation.

Conditions Where Practice Applies

1. Where the preservation or importation of topsoil is determined to be the most effective method of providing a suitable growth medium.



2. Where the subsoil or existing soil presents the following problems:

   a. The texture, pH, or nutrient balance of the available soil cannot be modified by reasonable means to provide an adequate growth medium.

   b. The soil material is too shallow to provide an adequate root zone and to supply necessary moisture and nutrients for plant growth.

   c. The soil contains substances potentially toxic to plant growth.

3. Where high-quality turf is desirable to withstand intense use or meet aesthetic requirements.

4. Where ornamental plants will be established.

5. Only on slopes that are 2:1 or flatter unless other measures are taken to prevent erosion and sloughing.

Planning Considerations

Topsoil is the surface layer of the soil profile, generally characterized as being darker than the subsoil due to the presence of organic matter. It is the major zone of root development, carrying much of the nutrients available to plants, and supplying a large share of the water used by plants.

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.

Advantages of topsoil include its high organic matter content and friable consistence, water-holding capacity, and nutrient content.

In site planning, the option of topsoiling should be compared with that of preparing a seedbed in subsoil. The clay content of subsoils does provide high moisture availability and deter leaching of nutrients and, when properly limed and fertilized, subsoils may provide a good growth medium which is generally free of weed seeds. In many cases topsoiling may not be required for the establishment of less demanding, lower maintenance plant 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. Whether an adequate volume of topsoil exists on the site. Topsoil will be spread at a compacted depth of 2 to 4 inches (depths closer to 4 inches are preferred).

2. Location of the topsoil stockpile so that it meets specifications and does not interfere with work on the site.

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 may creep along the junction between the soil layers, causing the topsoil to slough. Sandy topsoil over a clay subsoil is equally as likely to fail.

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. Topsoiling of steep slopes should be discouraged unless good bonding of soils can be achieved.

Specifications

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 noxious weeds, and shall give evidence of being able to support healthy vegetation. It shall contain no substance that is potentially toxic to plant growth.

All topsoil shall be tested by a recognized laboratory for the following criteria:

Organic matter content shall be not less than 1.5% 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 the standards stated above.

Stripping

Topsoil operations should not be performed when the soil is wet or frozen. Stripping shall be confined to the immediate construction area. A 4-to 6-inch stripping depth is common,

but depth may vary depending on the particular soil. All perimeter dikes, basins, and other sediment controls shall be in place prior to stripping.

Stockpiling

Topsoil shall be stockpiled in such a manner that natural drainage is not obstructed and no off-site sediment damage shall result. Stabilize or protect stockpiles in accordance with MS #2.

Side slopes of the stockpile shall not exceed 2:1.

Perimeter controls must be placed around the stockpile immediately; seeding of stockpiles shall be completed within 7 days of the formation of the stockpile, in accordance with Std. & Spec. 3.31, TEMPORARY SEEDING if it is to remain dormant for longer than 30 days (refer to MS #1 and MS #2).

Site Preparation Prior to and Maintenance During Topsoiling

Before topsoiling, establish needed erosion and sediment control practices such as diversions, grade stabilization structures, berms, dikes, level spreaders, waterways, sediment basins, etc. These practices must be maintained during topsoiling.

Grading: Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan.

Liming: Where the pH of the subsoil is 6.0 or less, or the soil is composed of heavy clays, agricultural limestone shall be spread in accordance with the soil test or the vegetative establishment practice being used.

Bonding: After the areas to be topsoiled have been brought to grade, and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or scarifying to a depth of at least 2 inches to ensure bonding of the topsoil and subsoil.

Applying Topsoil

Topsoil shall not be placed while in a frozen or muddy condition, when topsoil or subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed sodding or seeding. The topsoil shall be uniformly distributed to a minimum compacted depth of 2 inches on 3:1 or steeper slopes and 4 inches on flatter slopes. (See Table 3.30-A to determine volume of topsoil required for application to various depths). Any irregularities in the surface, resulting from topsoiling or other operations, shall be corrected in order to prevent the formation of depressions or water pockets.

It is necessary to compact the topsoil enough to ensure good contact with the underlying soil and to obtain a level seedbed for the establishment of high maintenance turf. However, undue compaction is to be avoided as it increases runoff velocity and volume, and deters

seed germination. Special consideration should be given to the types of equipment used to place topsoil in areas to receive fine turf. Avoid unnecessary compaction by heavy machinery whenever possible. In areas which are not going to be mowed, the surface should be left rough in accordance with SURFACE ROUGHENING (Std. & Spec. 3.29).

Soil Sterilants

No sod or seed shall be placed on soil which has been treated with soil sterilants until sufficient time has elapsed to permit dissipation of toxic materials.

TABLE 3.30-A

CUBIC YARDS OF TOPSOIL REQUIRED FOR APPLICATION TO VARIOUS DEPTHS

Depth (inches)	Per 1,000 Square Feet	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

Source: Va. DSWC

STD & SPEC 3.31

TEMPORARY SEEDING

TS

Definition

The establishment of a temporary vegetative cover on disturbed areas by seeding with appropriate rapidly growing annual plants.

Purposes

1. To reduce erosion and sedimentation by stabilizing disturbed areas that will not be brought to final grade for a period of more than ~~30~~ 14 days. RWE; DEQ-OTS 3-12-14

2. To reduce damage from sediment and runoff to downstream or off-site areas, and to provide protection to bare soils exposed during construction until permanent vegetation or other erosion control measures can be established.

Conditions Where Practice Applies

Where exposed soil surfaces ~~are not to be fine-graded for periods longer than 30~~ will not be at final grade for more than 14 days. Such areas include denuded areas, soil stockpiles, dikes, dams, sides of sediment basins, temporary roadbanks, etc. (see MS #1 and MS #2). A permanent vegetative cover shall be applied to areas that will be left dormant for a period of more than 1 year.

Planning Considerations

Sheet erosion, caused by the impact of rain on bare soil, is the source of most fine particles in sediment. To reduce this sediment load in runoff, the soil surface itself should be protected. The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover. Annual plants which sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover. Temporary seeding is encouraged whenever possible to aid in "controlling" construction sites.

Temporary seeding also prevents costly maintenance operations on other erosion control systems. For example, sediment basin clean-outs will be reduced if the drainage area of the basin is seeded where grading and construction are not taking place. Perimeter dikes will be more effective if not choked with sediment.

Temporary seeding is essential to preserve the integrity of earthen structures used to control sediment, such as dikes, diversions, and the banks and dams of sediment basins.

Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Specifications

Prior to seeding, install necessary erosion control practices such as dikes, waterways, and basins.

Plant Selection

Select plants appropriate to the season and site conditions from Tables 3.31-B and 3.31-C. Note that Table 3.31-B presents plants which can be used without extensive evaluation of site conditions; Table 3.31-C presents more in-depth information on the plant materials.

Seedbed Preparation

To control erosion on bare soil surfaces, plants must be able to germinate and grow. Seedbed preparation is essential.

1. Liming: An evaluation should be conducted to determine if lime is necessary for temporary seeding. In most soils, it takes up to 6 months for a pH adjustment to occur following the application of lime. Therefore, it may be difficult to justify the cost of liming a temporary site, especially when the soil will later be moved and regraded. The following table may be used to determine the actual need along with suggested application rates.

TABLE 3.31-A

LIMING REQUIREMENTS FOR TEMPORARY SITES

pH Test	Recommended Application of Agricultural Limestone
below 4.2	3 tons per acre
4.2 to 5.2	2 tons per acre
5.2 to 6	1 ton per acre

Source: Va. DSWC

2. Fertilizer: Shall be applied as 600 lbs./acre of 10-20-10 (14 lbs./1,000 sq. ft.) or equivalent nutrients. Lime and fertilizer shall be incorporated into the top 2 to 4 inches of the soil if possible.

3. Surface Roughening: If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted, or hardened, the soil surface shall be loosened by discing, raking, harrowing, or other acceptable means (see SURFACE ROUGHENING, Std. & Spec. 3.29).

4. Tracking: Tracking with bulldozer cleats is most effective on sandy soils. This practice often causes undue compaction of the soil surface, especially in clayey soils, and does not aid plant growth as effectively as other methods of surface roughening.

Seeding

Seed shall be evenly applied with a broadcast seeder, drill, cultipacker seeder or hydroseeder. Small grains shall be planted no more than 1½ inches deep. Small seeds, such as Kentucky Bluegrass, should be planted no more than 1/4 inch deep. Other Grasses and Legumes should be planted from 1/4 inch to 1/2 inch deep.

Mulching

1. Seedings made in fall for winter cover and during hot and dry summer months shall be mulched according to MULCHING, Std. & Spec. 3.35, except that hydromulches (fiber mulch) will not be considered adequate. Straw mulch should be used during these periods.

2. Temporary seedings made under favorable soil and site conditions during optimum spring and fall seeding dates may not require mulch.

Re-seeding

Areas which fail to establish vegetative cover adequate to prevent rill erosion will be re-seeded as soon as such areas are identified.

TABLE 3.31-B

ACCEPTABLE TEMPORARY SEEDING PLANT MATERIALS

"QUICK REFERENCE FOR ALL REGIONS"

Planting Dates	Species	Rate (lbs./acre)
Sept. 1 - Feb. 15	50/50 Mix of Annual Ryegrass (Lolium multi-florum) & Cereal (Winter) Rye (Secale cereale)	50 - 100
Feb. 16 - Apr. 30	Annual Ryegrass (Lolium multi-florum)	60 - 100
May 1 - Aug 31	German Millet (Setaria italica)	50

Source: Va. DSWC

TABLE 3.31-C

TEMPORARY SEEDING PLANT MATERIALS, SEEDING RATES, AND DATES

SPECIES	SEEDING RATE		NORTH[a]			SOUTH[b]			PLANT CHARACTERISTICS
	Acre	1000 ft^2	3/1 to 4/30	5/1 to 8/15	8/15 to 11/1	2/15 to 4/30	5/1 to 9/1	9/1 to 11/15	
OATS (Avena sativa)	3 bu. (up to 100 lbs., not less than 50 lbs.)	2 lbs.	X	-	-	X	-	-	Use spring varieties (e.g., Noble).
RYE[d] (Secale cereale)	2 bu. (up to 110 lbs., not less than 50 lbs.)	2.5 lbs.	X	-	X	X	-	X	Use for late fall seedings, winter cover. Tolerates cold and low moisture.
GERMAN MILLET (Setaria italica)	50 lbs.	approx. 1 lb.	-	X	-	-	X	-	Warm-season annual. Dies at first frost. May be added to summer mixes.
ANNUAL RYEGRASS[c] (Lolium multi-florum)	60 lbs.	1½ lbs.	X	-	X	X	-	X	May be added in mixes. Will mow out of most stands.
WEEPING LOVEGRASS (Eragrostis curvula)	15 lbs.	5½ ozs.	-	X	-	-	X	-	Warm-season perennial. May bunch. Tolerates hot, dry slopes and acid, infertile soils. May be added to mixes.
KOREAN LESPEDEZA[c] (Lespedeza stipulacea)	25 lbs.	approx. 1½ lbs.	X	X	-	X	X	-	Warm season annual legume. Tolerates acid soils. May be added to mixes.

[a] Northern Piedmont and Mountain region. See Plates 3.22-1 and 3.22-2.
[b] Southern Piedmont and Coastal Plain.
[c] May be used as a cover crop with spring seeding.
[d] May be used as a cover crop with fall seeding.
X May be planted between these dates.
- May not be planted between these dates.

STD & SPEC 3.32

PERMANENT SEEDING

PS

Definition

The establishment of perennial vegetative cover on disturbed areas by planting seed.

Purposes

1. To reduce erosion and decrease sediment yield from disturbed areas.

2. To permanently stabilize disturbed areas in a manner that is economical, adaptable to site conditions, and allows selection of the most appropriate plant materials.

3. To improve wildlife habitat.

4. To enhance natural beauty.

Conditions Where Practice Applies

1. Disturbed areas where permanent, long-lived vegetative cover is needed to stabilize the soil.

2. Rough-graded areas which will not be brought to final grade for a year or more.

Planning Considerations

Vegetation controls erosion by reducing the velocity and the volume of overland flow and protecting the bare soil surface from raindrop impact.

Areas which must be stabilized after the land has been disturbed require vegetative cover. The most common and economical means of establishing this cover is by seeding grasses and legumes. Permanent vegetative covers must meet the requirements of Minimum Standard #3.

Advantages of seeding over other means of establishing plants include the small initial establishment cost, the wide variety of grasses and legumes available, low labor requirement, and ease of establishment in difficult areas.

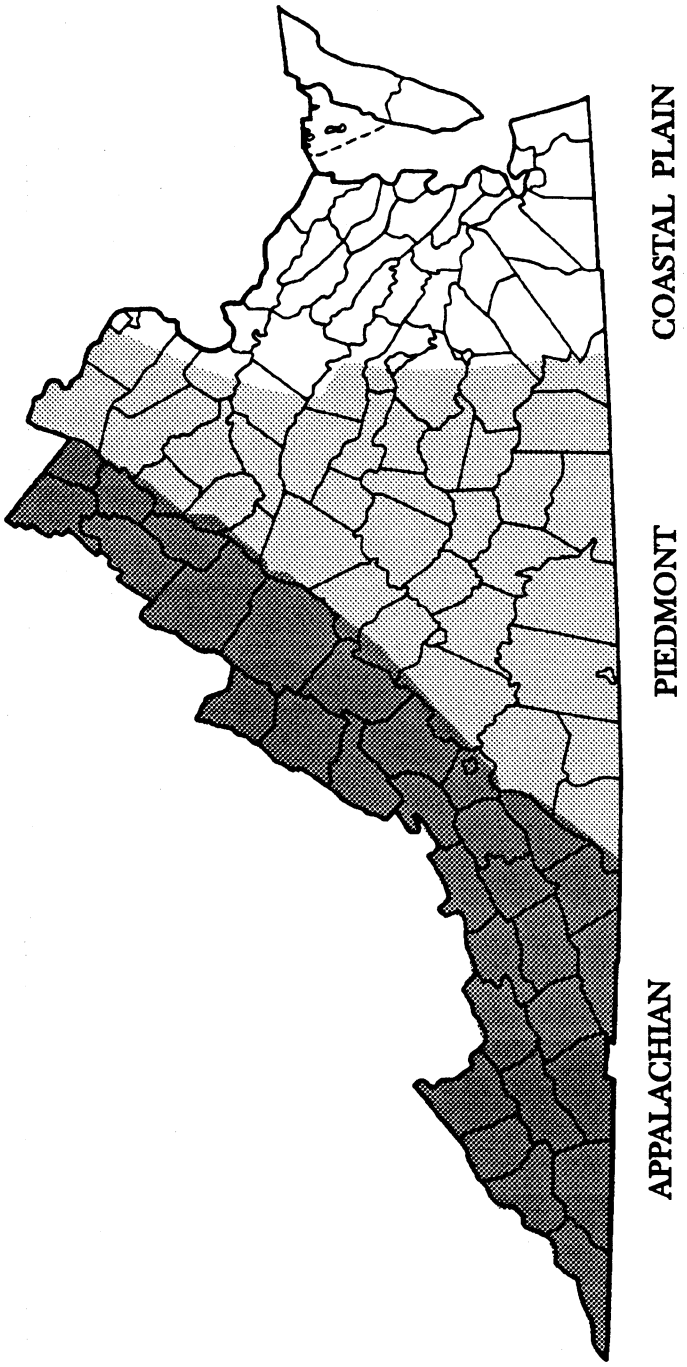
Disadvantages which must be dealt with are the potential for erosion during the establishment stage, a need to reseed areas that fail to establish, limited periods during the year suitable for seeding, the potential need for weed control during the establishment phase, and a need for water and appropriate climatic conditions during germination.

There are so many variables in plant growth that an end product cannot be guaranteed. Much can be done in the planning stages to increase the chances for successful seeding. Selection of the right plant materials for the site, good seedbed preparation, and conscientious maintenance are important.

SELECTING PLANT MATERIALS: The factors affecting plant growth are climate, soils, and topography. In Virginia, there are three major physiographic regions that reflect changes in soil and topography. In selecting appropriate plant materials, one should take into account the characteristics of the physiographic region in which the project is located (see Plate 3.32-1).

PHYSIOGRAPHIC REGIONS:

Coastal Plain - Soils on the Coastal Plain are deeply weathered, stratified deposits of sand and clay. They are generally acidic and low in plant nutrients. The sandy soils are hot and droughty in summer. This region receives more rain and is warmer than the other regions of the state. The land is fairly level, and many areas are poorly drained. Warm season grasses traditionally perform well in these areas.



PHYSIOGRAPHIC PROVINCES IN VIRGINIA

Source: Va. DSWC

Plate 3.32-1

Piedmont - Soils on the Piedmont plateau are highly variable. They tend to be shallow, with clayey subsoils. Piedmont soils are low in phosphorus. Soils derived from mica schist are highly erodible. Topography is rolling and hilly. The southern Piedmont has much the same climate as the Coastal Plain. Often referred to as the "transition zone" in planting. Contains areas that will support both warm or cool season grasses.

Appalachian and Blue Ridge Region - This region is divided into plateaus, mountains, and narrow valleys. Soils tend to be shallow and acid, and may erode rapidly on steep slopes. Shaley slopes are often unstable and droughty. This area is colder and drier than the rest of the State. The rugged topography makes plant establishment difficult. Cool season grasses are normally specified in this region.

SOILS: On the whole, soils in Virginia always require some nitrogen (N) fertilization to establish plants. Phosphorus (P) and potassium (K) are usually needed. Except for some small pockets of shallow limestone soils, lime is universally needed.

Soils can be modified with lime and fertilizer, but climate cannot be controlled. For this reason, the State has been divided into two major climatic regions, referred to as the Northern Piedmont and Mountain Region and the Southern Piedmont and Coastal Plain Region, for grass and legume selection (see map, Plate 3.32-2).

Microclimate, or localized climate conditions, can affect plant growth. A south-facing slope is drier and hotter than a north-facing slope, and may require drought-tolerant plants. Shaded areas require shade-tolerant plants; the windward side of a ridge will be drier than the leeward, etc.

LAND USE: A prime consideration in selecting which plants to establish is the intended use of the land. All of these uses - residential, industrial, commercial, recreational - can be separated into two major categories: high-maintenance and low-maintenance.

High-maintenance areas will be mowed frequently, limed and fertilized regularly, and will either receive intense use (e.g., athletics) or require maintaining to an aesthetic standard (home lawns). Grasses used for these situations must be fine-leaved and attractive in appearance, able to form tight sod, and be long-lived perennials. They must be well-adapted to the geographic area where they are planted, because constant mowing puts turf under great stress. Sites where high-maintenance vegetative cover is desirable include homes, industrial parks, schools, churches, athletic playing surfaces as well as some recreational areas.

Low-maintenance areas will be mowed infrequently or not at all; lime and fertilizer may not be applied on a regular basis; the areas will not be subjected to intense use, nor required to have a uniform appearance. These plants must be able to persist with little maintenance over long periods of time. Grass and legume mixtures are favored for these sites because legumes are capable of fixing nitrogen from the air for their own use, and the use of the plants around them. Such mixed stands are better able to withstand adverse conditions.

Sites that would be suitable for low-maintenance vegetation include steep slopes, stream or channel banks, some commercial properties, and "utility turf" areas such as roadbanks.

Seedbed Preparation - The soil on a disturbed site must be modified to provide an optimum environment for seed germination and seedling growth. The surface soil must be loose enough for water infiltration and root penetration. The pH (acidity and alkalinity) of the soil must be such that it is not toxic and nutrients are available, usually between pH 6.0-7.0. Sufficient nutrients (added as fertilizer) must be present. After seed is in place, it must be protected with a mulch to hold moisture and modify temperature extremes, and to prevent erosion while seedlings are growing.

The addition of lime is equally as important as applying fertilizer. Lime is best known as a pH, or acidity, modifier, but it also supplies calcium and magnesium which are plant nutrients. Its effect on pH makes other nutrients more available to the plant. It can also prevent aluminum toxicity by making aluminum less soluble in the soil. Many soils in Virginia are high in aluminum, which stunts the growth of plant roots.

MAINTENANCE: Even with careful, well-planned seeding operations, failures can occur. When it is clear that plants have not germinated on an area or have died, these areas must be reseeded immediately to prevent erosion damage. However, it is extremely important to determine for what reason germination did not take place and make any corrective action necessary prior to reseeding the area. Healthy vegetation is the most effective erosion control available.

Specifications

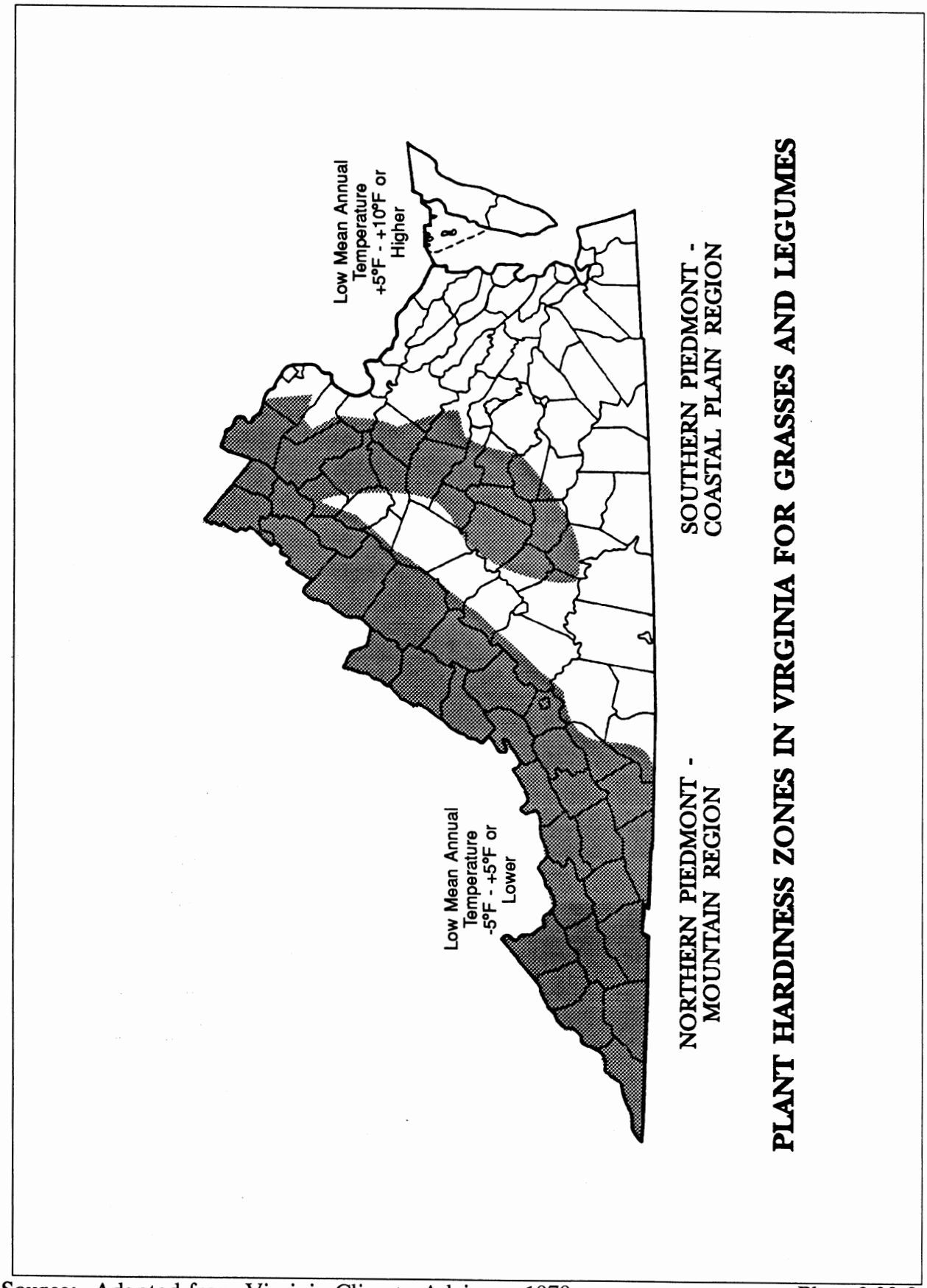
Selection of Plant Materials

1. Selection of plant materials is based on climate, topography, soils, land use, and planting season. To determine which plant materials are best adapted to a specific site, use Tables 3.32-A and 3.22-B which describe plant characteristics and list recommended varieties.

2. Appropriate seeding mixtures for various site conditions in Virginia are given in Tables 3.32-C, 3.32-D and 3.32-E. These mixtures are designed for general use, and are known to perform well on the sites described. Check Tables 3.32-A and 3.32-B for recommended varieties.

3. A more extensive description of plant materials (grasses and legumes), their usage and pictorial representation can be found in Appendix 3.32-c.

4. When using some varieties of turfgrasses, the Virginia Crop Improvement Association (VCIA) recommended turfgrass mixtures may also be used. Consumer protection programs have been devised to identify quality seed of the varieties recommended by the Virginia Cooperative Extension Service. These will bear a label indicating



Source: Adapted from Virginia Climate Advisory, 1979.

Plate 3.32-2

that they are approved by the Association. Mixtures may be designed for a specific physiographic region or based on intended use. Special consideration is given to plant characteristics, performance, etc.

TABLE 3.32-A
CHARACTERISTICS OF COMMONLY SELECTED GRASSES

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
TALL FESCUE (Festuca arundinacea)	P	C	5.5-6.2	10-14	60-85	F	F	M	SPD	225K	Low when used for erosion control; high when used in lawn	Better suited for erosion control and rough turf application.	Ky 31
TALL FESCUES (Improved)	P	C	5.5-6.2	10-14	60-85	F	G	M	SPD	220K	Responds well to high maintenance.	Excellent for lawn and fine turf.	See current VCIA list.
KENTUCKY BLUEGRASS (Poa pratense)	P	C	6.0-6.5	14	60-75	G	P	M	SPD	2.2m	Needs fertile soil, favorable moisture. Requires several years to become well established.	Excellent for fine turfs-takes traffic, mowing. Poor drought/heat tolerance.	See current VCIA list.
PERENNIAL RYEGRASS (Lolium perenne)	P	C	5.8-6.2	7-10	60-75	F	F	M-H	SPD	227K	Will tolerate traffic.	May be added to mixes. * Improved varieties will perform well all year.	See current VCIA list.

KEY

A = Annual P = Perennial C = Cool Season Plant W = Warm Season Plant G = Good F = Fair P = Poor VP = Very Poor H = High
M = Medium L = Low SPD = Somewhat Poorly Drained MPD = Moderately Poorly Drained PD = Poorly Drained VPD = Very Poorly Drained

TABLE 3.32-A (Continued)
CHARACTERISTICS OF COMMONLY SELECTED GRASSES

COMMON NAME (Botanical Name)		Life Cycle	Season	pH Range	Germination Time, In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
FINE FESCUES	HARD FESCUE (Festuca Longifolia)	P	C	5.0-6.2	10-14	60-80	VG	G	L	MWD	400K	Grows well in sun or shade and will tolerate infertile soils; improved disease resistance.	Exceeds all fine fescues in most tests. Excellent for low-maintenance situations.	Reliant, Spartan, Aurora
	CHEWINGS FESCUE	P	C	5.0-6.2	10-14	60-80	VG	G	L	MWD	400K	Tolerates shade, dry infertile soils.	Poor traffic tolerance, less thatch than other fine fescues.	Flyer
	RED FESCUE (Festuca Rubra)	P	C	5.0-6.2	10-14	60-80	VG	G	L	MWD	400K	Low to medium fertility requirements. Requires well-drained soil.	Spreads by rhizomes, tillers and stolons. Will not take traffic - very shade tolerant.	Long-fellow, Victory
REED CANARYGRASS (Phalaris arundinacea)		P	C	5.8-6.2	21	70-85	G	G	M-H	VPD	530K	Do not mow closely or often.	Conservation cover in wet areas.	No named varieties

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TABLE 3.32-A (Continued)
CHARACTERISTICS OF COMMONLY SELECTED GRASSES

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time, In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
REDTOP (Agrostis alba)	P	C	5.8-6.2	10	65-85	G	F	L	PD	5m	Will tolerate poor, infertile soils; deep rooted.	Does well in erosion control mixes - not for lawns.	No named varieties.
WEEPING LOVEGRASS (Evagrostis curvula)	P	W	4.5-6.2	14	65-85	F-P	G	L-M	SPD	1.5m	Low-fertility requirements; excellent drought tolerance.	Fast-growing, warm-season bunch grass. Excellent cover for erosion control.	No named varieties.
BERMUDAGRASS (Cynodon dactylon)	P	W	5.8-6.2	21	70-95	P	G	M-H	SPD	1.8m hulled	High nitrogen utilization, excellent drought tolerance. Some varieties adapted to western VA.	Common varieties used for erosion control. Hybrids used for fine turf.	See current VCIA list.
ORCHARDGRASS (Dactylis glomerata)	P	C	5.8-6.2	18	60-75	F	F	M	SPD	625K	Does best on well-drained, loamy soil.	Good pasture selection - may be grazed.	Virginia origin or Potomac

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TABLE 3.32-A (Continued)
CHARACTERISTICS OF COMMONLY SELECTED GRASSES

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
ANNUAL RYEGRASS (Lolium multiflorum)	A	C	5.8-6.2	7	60-70	G	P	M-H	SPD	227K	Will grow on most Virginia Soils. Do not use in fine-turf areas.	May be added into mixes or established alone as temporary cover in spring and fall.	No named varieties.
RYE (Secale cereale)	A	C	5.8-6.2	7	55-70	VG	G	L-M	SPD	18K	Will establish in most all Virginia soils. Do not use in fine-turf areas.	May be added into mixes or established alone for late fall/winter cover.	Abruzzi, Balboa
FOXTAIL MILLET (Setaria italica)	A	W	5.8-6.2	10	65-85	VP	G	M	MWD	220K	Establishes well during summer. Very low moisture requirements.	May be added to erosion-control mixes or established alone.	Common, German

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TABLE 3.32-B
CHARACTERISTICS OF LEGUMES APPROPRIATE FOR EROSION CONTROL

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
CROWNVETCH (Coronilla varia)	P	C	6.0-6.5	14-21	70	G	VG	M	MWD	110K	Does best on well-drained soils. Minimum maintenance when established. May need phosphorus. Inoculation is essential.	Excellent for steep, rocky slopes. Produces colorful blooms in May/June. Slow to establish. Does best when seeded in spring.	Penngift Chemung Emerald
SERICEA LESPEDEZA (Lespedeza cuneata)	P	W	5.8-6.2	21-28	70-85	F	VG	L	MWD	335K	Grows in most well-drained soils. Low fertility requirements. Inoculation is essential.	Use hulled seed in spring; unhulled in fall. Very deep-rooted legume. Excellent choice for eastern Va.	Serecia Interstate
FLATPEA (Lathyrus silvestrus)	P	C	5.0-7.0	14-28	65-75	G	G	L	PD	15K	Needs lime and high phosphorus. Good shade tolerance.	Tolerates acidic and wetter soils better than other legumes.	Lathco
BIRDSFOOT TREFOIL (Lotus corniculatus)	P	C	6.0-6.5	7	65-70	G	F	M	SPD	375K	Inoculation is essential. Grows in medium-fertile, slightly acid soils.	Grows better on poorly drained soils than most legumes. Poor drought/heat tolerance.	No named varieties.

KEY

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TABLE 3.32-B (Continued)
CHARACTERISTICS OF LEGUMES APPROPRIATE FOR EROSION CONTROL

COMMON NAME (Botanical Name)	Life Cycle	Season	pH Range	Germination Time In Days	Optimum Germination Temperature (°F)	Winter Hardiness	Drought Tolerance	Fertility	Soil Drainage Tolerance	Seeds Per Pound	MAINTENANCE REQUIREMENTS	REMARKS	Suggested Varieties for Virginia
ANNUAL LESPEDEZAS (Lespedeza striata, L. stipulacea)	A	W	5.8-6.2	14	70-85	F	VG	L	MWD	200K	Will grow on almost any well-drained soil.	Choose Kobe for southeastern Va.; needs almost no nitrogen to survive.	Kobe, Korean
RED CLOVER (Trifolium pratense)	P	C	6.0-6.5	7-14	70	G	F	M	SPD	275K	Needs high levels of phosphorus and potassium.	Acts as a biennial. Can be added to low-maintenance mixes.	Kenstar, Kenland
WHITE CLOVER (Trifolium repens)	P	C	6.0-6.5	10	70	G	P	M	PD	700K	Requires favorable moisture, fertile soils, high pH.	Spreads by soil surface stolons, white flowers.	Common, White Dutch

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TABLE 3.32-C
SITE SPECIFIC SEEDING MIXTURES
FOR APPALACHIAN/MOUNTAIN AREA

Minimum Care Lawn	Total Lbs. Per Acre
- Commercial or Residential	200-250 lbs.
- Kentucky 31 or Turf-Type Tall Fescue	90-100%
- Improved Perennial Ryegrass *	0-10%
- Kentucky Bluegrass	0-10%
High-Maintenance Lawn	
Minimum of three (3) up to five (5) varieties of bluegrass from approved list for use in Virginia.	125 lbs.
General Slope (3:1 or less)	
- Kentucky 31 Fescue	128 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop **	20 lbs.
	150 lbs.
Low-Maintenance Slope (Steeper than 3:1)	
- Kentucky 31 Fescue	108 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop **	20 lbs.
- Crownvetch ***	20 lbs.
	150 lbs.

* Perennial Ryegrass will germinate faster and at lower soil temperatures than fescue, thereby providing cover and erosion resistance for seedbed.

** Use seasonal nurse crop in accordance with seeding dates as stated below:

March, April through May 15th	Annual Rye
May 16th through August 15th	Foxtail Millet
August 16th through September, October	Annual Rye
November through February	Winter Rye

*** If Flatpea is used, increase to 30 lbs./acre. All legume seed must be properly inoculated. Weeping Lovegrass may also be included in any slope or low-maintenance mixture during warmer seeding periods; add 10-20 lbs/acre in mixes.

TABLE 3.32-D
SITE SPECIFIC SEEDING MIXTURES FOR PIEDMONT AREA

	Total Lbs. Per Acre
Minimum Care Lawn	
- Commercial or Residential	175-200 lbs.
- Kentucky 31 or Turf-Type Tall Fescue	95-100%
- Improved Perennial Ryegrass	0-5%
- Kentucky Bluegrass	0-5%
High-Maintenance Lawn	200-250 lbs.
- Kentucky 31 or Turf-Type Tall Fescue	100%
General Slope (3:1 or less)	
- Kentucky 31 Fescue	128 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop *	20 lbs.
	150 lbs.
Low-Maintenance Slope (Steeper than 3:1)	
- Kentucky 31 Fescue	108 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop *	20 lbs.
- Crownvetch **	20 lbs.
	150 lbs.

* Use seasonal nurse crop in accordance with seeding dates as stated below:
February 16th through April ..... Annual Rye
May 1st through August 15th ..... Foxtail Millet
August 16th through October ..... Annual Rye
November through February 15th ..... Winter Rye

** Substitute Sericea lespedeza for Crownvetch east of Farmville, Va. (May through September use hulled Sericea, all other periods, use unhulled Sericea). If Flatpea is used in lieu of Crownvetch, increase rate to 30 lbs./acre. All legume seed must be properly inoculated. Weeping Lovegrass may be added to any slope or low-maintenance mix during warmer seeding periods; add 10-20 lbs./acre in mixes.

TABLE 3.32-D

SITE SPECIFIC SEEDING MIXTURES FOR COASTAL PLAIN AREA

	Total Lbs. Per Acre
Minimum Care Lawn	
- Commercial or Residential	
- Kentucky 31 or Turf-Type Tall Fescue	175-200 lbs.
or	
- Common Bermudagrass **	75 lbs.
High-Maintenance Lawn	
- Kentucky 31 or Turf-Type Tall Fescue	200-250 lbs.
or	
- Hybrid Bermudagrass (seed) **	40 lbs. (unhulled)
or	30 lbs. (hulled)
- Hybrid Bermudagrass (by other vegetative establishment method, see Std. & Spec. 3.34)	
General Slope (3:1 or less)	
- Kentucky 31 Fescue	128 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop *	20 lbs.
	150 lbs.
Low Maintenance Slope (Steeper than 3:1)	
- Kentucky 31 Tall Fescue	93-108 lbs.
- Common Bermudagrass **	0-15 lbs.
- Red Top Grass	2 lbs.
- Seasonal Nurse Crop *	20 lbs.
- Sericea Lespedeza **	20 lbs.
	150 lbs.

* Use seasonal nurse crop in accordance with seeding dates as stated below:

February, March through April	Annual Rye
May 1st through August	Foxtail Millet
September, October through November 15th	Annual Rye
November 16th through January	Winter Rye

** May through October, use hulled seed. All other seeding periods, use unhulled seed. Weeping Lovegrass may be added to any slope or low-maintenance mix during warmer seeding periods; add 10-20 lbs./acre in mixes.

Seedbed Requirements

Vegetation should not be established on slopes that are unsuitable due to inappropriate soil texture, poor internal structure or internal drainage, volume of overland flow, or excessive steepness, 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. The existing soil must have these characteristics:

1. Enough fine-grained material to maintain adequate moisture and nutrient supply.

2. Sufficient pore space to permit root penetration. A bulk density of 1.2 to 1.5 indicates that sufficient pore space is present. A fine granular or crumb-like structure is also favorable.

3. Sufficient depth of soil to provide an adequate root zone. The depth to rock or impermeable layers such as hardpans shall be 12 inches or more, except on slopes steeper than 2:1 where the addition of soil is not feasible.

4. A favorable pH range for plant growth. If the soil is so acidic that a pH range of 6.0-7.0 cannot be attained by addition of pH-modifying materials, then the soil is considered an unsuitable environment for plant roots and further soil modification would be required.

5. Freedom from toxic amounts of materials harmful to plant growth.

6. Freedom from excessive quantities of roots, branches, large stones, large clods of earth, or trash of any kind. Clods and stones may be left on slopes steeper than 3:1 if they do not significantly impede good seed soil contact.

If any of the above criteria cannot be met, i.e., if the existing soil is too coarse, dense, shallow, acidic, or contaminated to foster vegetation, then topsoil shall be applied in accordance with TOPSOILING, Std. & Spec. 3.30.

Necessary structural erosion and sediment control practices will be installed prior to seeding. Grading will be carried out according to the approved plan.

Surfaces will be roughened in accordance with SURFACE ROUGHENING, Std. & Spec. 3.29.

Soil Conditioners

In order to modify the texture, structure, or drainage characteristics of a soil, the following materials may be added to the soil:

1. Peat is a very costly conditioner, but works well. If added, it shall be sphagnum moss peat, hypnum moss peat, reed-sedge peat or peat humus, from fresh-water sources. Peat shall be shredded and conditioned in storage piles for at least six months after excavation.

2. Sand shall be clean and free of toxic materials. Sand modification is ineffective unless you are adding 80 to 90% sand on a volume basis. This is extremely difficult to do on-site. If this practice is considered, consult a professional authority to ensure that it is done properly.

3. Vermiculite shall be horticultural grade and free of toxic substances. It is an impractical modifier for larger acreage due to expense.

4. Raw manure is more commonly used in agricultural applications. However, when stored properly and allowed to compost, it will stabilize nitrogen and other nutrients. Manure, in its composted form, is a viable soil conditioner; however, its use should be based on site-specific recommendations offered by a professional in this field.

5. Thoroughly rotted sawdust shall have 6 pounds of nitrogen added to each cubic yard and shall be free of stones, sticks, and toxic substances.

6. The use of treated sewage sludge has benefitted from continuing advancements in its applications in the agricultural community. When composted, it offers an alternative soil amendment. Limitations include a potentially undesirable pH (because of lime added during the treatment process) and the possible presence of heavy metals. This practice should be thoroughly evaluated by a professional and be used in accordance with any local, state, and federal regulations.

Lime and Fertilizer

Lime and fertilizer needs should be determined by soil tests. Soil tests may be performed by the Cooperative Extension Service Soil Testing Laboratory at VPI&SU, or by a reputable commercial laboratory. Information concerning the State Soil Testing Laboratory is available from county extension agents. Reference Appendix 3.32-d for liming applications (in lbs.) needed to correct undesirable pH for various soil types.

Under unusual conditions where it is not possible to obtain a soil test, the following soil amendments will be applied:

Lime

Coastal Plain: 2 tons/acre pulverized agricultural grade limestone (90 lbs./1000 ft.^{2}).

Piedmont and Appalachian Region: 2 tons/acre pulverized agricultural grade limestone (90 lbs./1000 ft.^{2}).

Note: An agricultural grade of limestone should always be used.

Fertilizer

Mixed grasses and legumes: 1000 lbs./acre 10-20-10 or equivalent nutrients (23 lbs./1000 ft.^{2}).

Legume stands only: 1000 lbs./acre 5-20-10 (23 lbs./ 1000 ft.^{2}) is preferred; however, 1000 lbs./acre of 10-20-10 or equivalent may be used.

Grass stands only: 1000 lbs./acre 10-20-10 or equivalent nutrients, (23 lbs./1000 ft.^{2}).

Other fertilizer formulations, including slow-release sources of nitrogen (preferred from a water quality standpoint), may be used provided they can supply the same amounts and proportions of plant nutrients.

Incorporation - Lime and fertilizer shall be incorporated into the top 4-6 inches of the soil by discing or other means whenever possible. For erosion control, when applying lime and fertilizer with a hydroseeder, apply to a rough, loose surface.

Seeding

1. Certified seed will be used for all permanent seeding whenever possible. Certified seed is inspected by the Virginia Crop Improvement Association or the certifying agency in other states. The seed must meet published state standards and bear an official "Certified Seed" label (see Appendix 3.32-a).

2. Legume seed should be inoculated with the inoculant appropriate to the species. Seed of the Lespedezas, the Clovers and Crownvetch should be scarified to promote uniform germination.

3. Apply seed uniformly with a broadcast seeder, drill, culti-packer seeder, or hydroseeder on a firm, friable seedbed. Seeding depth should be 1/4 to 1/2 inch.

4. To avoid poor germination rates as a result of seed damage during hydroseeding, it is recommended that if a machinery breakdown of 30 minutes to 2 hours occurs, 50% more seed be added to the tank, based on the proportion of the slurry remaining in the tank. Beyond 2 hours, a full rate of new seed may be necessary.

   Often hydroseeding contractors prefer not to apply lime in their rigs as it is abrasive. In inaccessible areas, lime may have to be applied separately in pelletized or liquid form. Surface roughening is particularly important when hydroseeding, as a roughened slope will provide some natural coverage of lime, fertilizer and seed.

   Legume inoculants should be applied at five times the recommended rate when inoculant is included in the hydroseeder slurry.

   Mulching

   All permanent seeding must be mulched immediately upon completion of seed application. Refer to MULCHING, Std. & Spec. 3.35.

   Maintenance of New Seedings

   In general, a stand of vegetation cannot be determined to be fully established until it has been maintained for one full year after planting.

   Irrigation: New seedings should be supplied with adequate moisture. Supply water as needed, especially late in the season, in abnormally hot or dry weather, or on adverse sites. Water application rates should be controlled to prevent excessive runoff. Inadequate amounts of water may be more harmful than no water.

   Re-seeding: Inspect seeded areas for failure and make necessary repairs and re-seedings within the same season, if possible.

   a. If vegetative cover is inadequate to prevent rill erosion, over-seed and fertilize in accordance with soil test results.

   b. If a stand has less than 40% cover, re-evaluate choice of plant materials and quantities of lime and fertilizer. The soil must be tested to determine if acidity or nutrient imbalances are responsible. Re-establish the stand following seedbed preparation and seeding recommendations.

Fertilization: Cool season grasses should begin to be fertilized 90 days after planting to ensure proper stand and density. Warm season fertilization should begin at 30 days after planting.

Apply maintenance levels of fertilizer as determined by soil test. In the absence of a soil test, fertilization should be as follows:

Cool Season Grasses

4 lbs. nitrogen (N)

1 lb. phosphorus (P) } Per 1000 ft.^{2} per year

2 lbs. potash (K)

Seventy-five percent of the total requirements should be applied between September 1 and December 31st. The balance should be applied during the remainder of the year. **More than 1 lb. of soluble nitrogen per 1000 ft.^{2} should not be applied at any one time.**

Warm Season Grasses

Apply 4-5 lbs. nitrogen (N) between May 1 and August 15th per 1000 ft.^{2} per year.

Phosphorus (P) and Potash (K) should only be applied according to soil test.

Note: The use of slow-release fertilizer formulations for maintenance of turf is encouraged to reduce the number of applications and the impact on groundwater.

Additional Information on the Successful Establishment of Grasses and Legumes

See Appendix 3.32-b for "helpful hints" in achieving high success rates in grass or legume plantings.

APPENDIX 3.32-a

SEED QUALITY CRITERIA

Where certified seed is not available, the minimum requirements for grass and legume seed used in vegetative establishment are as follows:

a. All tags on containers of seed shall be labeled to meet the requirements of the State Seed Law.

b. All seed shall be subject to re-testing by a recognized seed laboratory that employs a registered seed technologist or by a state seed lab.

c. All seed used shall have been tested within twelve (12) months.

d. Inoculant - the inoculant added to legume seed in the seed mixtures shall be a pure culture of nitrogen-fixing bacteria prepared for the species. Inoculants shall not be used later than the date indicated on the container. Twice the supplier's recommended rate of inoculant will be used on dry seedings; five times the recommended rate if hydroseeded.

e. The quality of the seed used shall be shown on the bag tags to conform to the guidelines in Table 3.32-E.

TABLE 3.32-E

QUALITY OF SEED*

	Minimum Seed Purity (%)	Minimum Germination (%)
Legumes		
Crownvetch	98	65**
Lespedeza, Korean	97	85**
Lespedeza, Sericea	98	85**
Grasses		
Bluegrass, Kentucky	97	85
Fescue, Tall (Improved, Turf-Type Cultivars)	98	85
Fescue, Tall (Ky-31)	97	85
Fescue, Red	98	85
Redtop	94	80
Reed Canarygrass	98	80
Perennial Ryegrass	98	90
Weeping Lovegrass	98	87
Annuals		
Annual Ryegrass	97	90
German Millet	98	85
Oats	98	80
Cereal Rye	98	85

* Seed containing prohibited or restricted noxious weeds should not be accepted. Seed should not contain in excess of 0.5% weed seed. To calculate percent pure, live seed, multiply germination times purity and divide by 100.

Example: Ky-31 Tall Fescue with a germination of 85 percent and a purity of 97 percent.

97 x 85 = 8245. 8245 ÷ 100 = 82.45 percent pure live seed.

** Includes "hard seed"

APPENDIX 3.32-b

KEYS TO SUCCESSFUL ESTABLISHMENT OF GRASSES AND LEGUMES

Planning

Where feasible, grading operations should be planned around optimal seeding dates for the particular region. The most effective times for establishing perennial grass in Virginia generally extend from March through May and from August through October. Outside these dates, the probability of failure is much higher. If the time of year is not suitable for seeding a permanent cover (perennial species), a temporary cover crop should be planted. Temporary seeding of annual species (small grains, ryegrasses or millets) often succeeds during periods of the year that are unsuitable for seeding permanent (perennial) species.

Variations in weather and local site conditions can modify the effects of regional climate on seeding success. For this reason, mixtures including both cool and warm season species are preferred for low-maintenance cover, particularly in the Coastal Plain. Such mixtures promote cover which can adapt to a range of conditions. Many of these mixtures are not desirable, however, for high quality lawns, where variation in texture of the turf is inappropriate. It is important to note that in Virginia the establishment of 100% warm season grasses in a high quality lawn is limited to the extreme eastern portions of the Coastal Plain.

Selection

Species selection should be considered early in the process of preparing an erosion and sediment control plan. A variety of vegetation can be established in Virginia due to the diversity in both soils and climate. However, for practical, economical stabilization and long-term protection of disturbed sites, species selection should be made judiciously.

Seasonality 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 plants realize 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 favorable time to plant them. Warm season plants "green-up" late in the spring, grow most actively during the summer, and go dormant at the time of the first frost in fall. Spring and early summer are preferred planting times for warm season plants.

Seed Mixtures

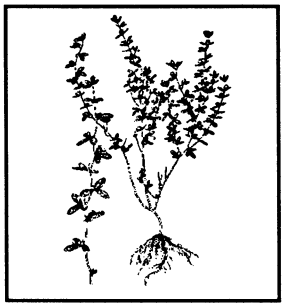
As previously noted, the establishment of high quality turf frequently involves planting one single species. However, in seedings for erosion control purposes, the inclusion of more than one species should always be considered. Mixtures need not be excessive in poundage or seed count. The addition of a quick-growing annual provides early protection and facilitates establishment of one or two perennials in a mix. More complex mixtures might include a quick-growing annual, one or two legumes and more than one perennial grass.

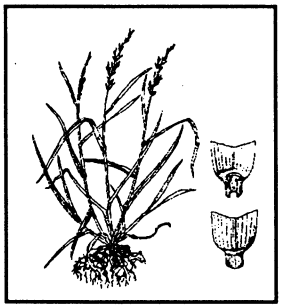
The addition of a "nurse" crop (quick-growing annuals added to permanent mixtures) is a sound practice for soil stabilization, particularly on difficult sites - those with steep slopes; poor, rocky, erosive soils; those seeded out the optimum seeding periods; or in any situation where the development of permanent cover is likely to be slow. The nurse crop germinates and grows rapidly, holding the soil until the slower-growing perennial seedlings become established.

APPENDIX 3.32-c

PLANT INFORMATION SHEETS

Contents:





ANNUAL GRASSES AND GRAINS

Small grains are cool season annual grasses primarily grown for animal feed and human consumption. In Virginia, the grains used for soil stabilization are primarily Rye and Oats. Foxtail Millet, which is sometimes considered a small grain, is becoming a very popular and successful planting for soil stabilization.

1. Oats (Avenasativa): A cool season annual grass primarily grown for animal feed and human consumption, but also used for soil stabilization. Oats are seeded in early spring in the western part of the state (winter oats may be sown in the Coastal Plain). Seeding rates are 3 bushels (100 lbs.) per acre bare ground or 2-1/2 lbs. per 1000 square feet.

2. Rye (Secale cereale): Often referred to as Winter Rye because of its winter hardiness, Rye is the most common small grain used for soil stabilization. It is also the most productive grain on dry, infertile, acid or sandy soils. It may be seeded in the fall for winter ground cover. By maturing early, it offers less competition during the late spring period, a critical time in the establishment of perennial species. Rye grain germinates quickly and is tolerant of poor soils. Including Rye grain in fall-seeded mixtures is almost always advantageous, but it is particularly helpful on difficult and erodible soils, erodible slopes or when seeding is late. Rates up to 100 lbs. for bare ground. Overly thick stands of Rye grain will suppress the growth of perennial seedlings. Approximately 50 lbs. per acre is the maximum for this purpose and, where lush growth is

Rye (Secale cereale)

expected, that rate should either be cut in half, or Rye grain should be totally eliminated from the mixture.

3. Foxtail Millet (Setaria italica): A warm season annual grass which may be used for temporary cover. German Millet (variety commonly used in Virginia) germinates quickly and goes to seed quickly. These features make it an excellent companion grass for summer seedlings. It dies at first frost. Seeding rates are up to 50 lbs. per acre for temporary cover. Use 10 to 20 lbs. per acre in mixes.

4. Annual Rye (Lolium multiflorum): A cool season annual grass used for temporary cover or as a nurse grass to allow for germination of permanent stands. Most commonly used in mixes for erosion control. Performs well throughout the state in neutral to slightly acid soils. Rates up to 100 lbs. per acre for temporary cover. Use 10 to 20 lbs. per acre in mixes.

Foxtail Millet (Setaria italica)

Annual Rye (Lolium multiflorum)

ANNUAL LEGUMES

1. Annual Lespedezas (Lespedeza striata)

Uses: Pasture, hay, erosion control, soil improvement, wildlife food.

Description: Annual warm season legumes. Korean Lespedeza is larger and coarser than Common Lespedeza and grows to about 12 inches. Seed of Korean is shiny and black, while seed of Common is stippled. Kobe is the most desirable variety of Common Lespedeza.

Adaptation: Throughout Virginia. Optimum pH range is 6.0 to 6.5; will grow from 5.5 to 7.0. Will grow in soil textures ranging from sands to clays and through a wide range of fertility conditions.

Establishment: Seed should always be inoculated. May be seeded alone or mixed with grasses or small grains. Requires a firm seedbed; may be broadcast or drilled. Should be seeded in early spring at 25 to 40 lbs. per acre or one-half to 1 lb. per 1000 square feet, depending on use. (Use lower figure as half the seeding rate of any spring seeding with grass or grain.) Should not be mowed at less than three inches. Lespedeza will not make a large contribution in sod grasses like Bluegrass; they do best in open sod grasses like tall fescue.

Sources: Seed of common variety (Kobe) and Korean varieties (Climax, Harbin and Rowan) are commercially available.

Annual Lespedezas (Lespedeza striata)

PERENNIALS

1. Tall Fescue (Festuca arundinacea)

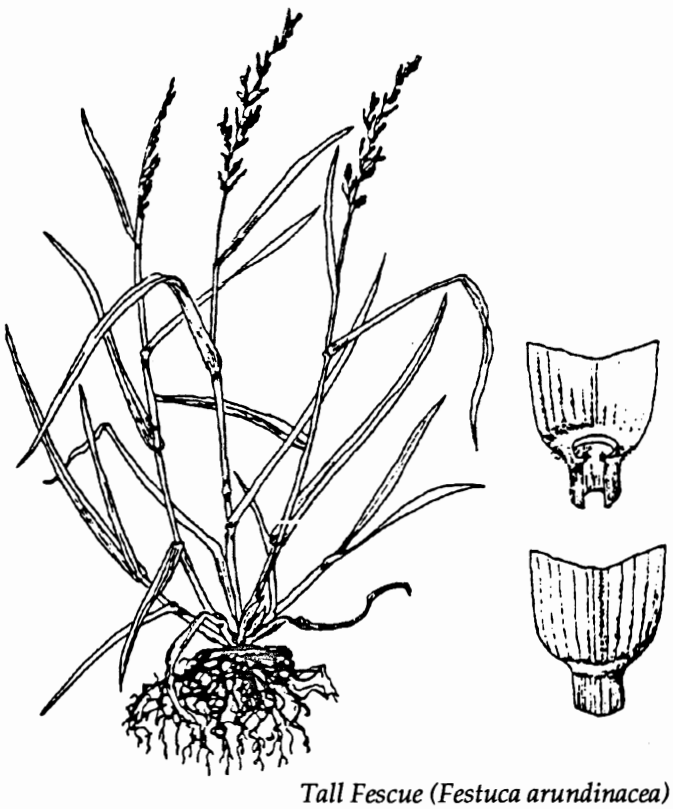
Uses: Pasture, hay, recreation areas, lawns and stabilization of waterways, banks, slopes, cuts, fills, and spoils. It is the most widely used grass at this time for stabilizing large disturbed areas.

Description: A robust, cool season, long-lived, deep-rooted bunchy grass which may have short rhizomes (underground stems). Kentucky 31 is the best-known variety. A number of new varieties of Tall Fescue are becoming available for lawn and other fine-turf uses, and several offer definite improvements. However, their higher cost over the old standby, KY 31, is seldom justified when used for purposes of stabilization and erosion control. Tall Fescue tolerates a wide range of seeding dates; however, with the possible exception of high mountain elevation, it is most dependable when planted in fall.

Adaptation: Adapts well to both high and low maintenance uses throughout Virginia. Adapted to a wide range of climatic conditions. Optimum pH range is 6.0 to 7.0; will tolerate from 3.0 to 8.0. Will grow on shallow and claypan soils if they are moist. Growth is limited more by moisture than by temperature extremes, but it will tolerate drought, infertile soils and moderate shade.

Establishment: Requires a firm seedbed. Hydroseeding is successful. Seeding rates vary from 100 lbs. per acre for erosion control to 250 lbs. per acre for lawns. Plant in early spring or from the middle of August through September. Legumes may not thrive in fescue stands due to the aggressive growth habits of this grass. Mowing is desirable on critical areas at least once every two years; lack of periodic mowing will encourage clumpiness.

Sources: Readily available as seed and sod.



Tall Fescue (Festuca arundinacea)

2. Kentucky Bluegrass (Poa pratense)

Uses: Pasture, turf for lawns, athletic fields, golf courses, and playgrounds. Also used to stabilize waterways, slopes, cuts and fills. Choice food for grouse, turkeys, deer and rabbits.

Description: Long-lived, cool season perennial grass which forms a dense sod. Becomes dormant in the heat of summer since its growing season is spring and fall.

Adaptation: Best adapted to well-drained, fertile soils of limestone origin and the climate of northern and western Virginia. Optimum pH range is 6.0 to 7.0. Bluegrasses are better suited to high maintenance situations in the transition zone. Essentially dormant during dry or hot weather; however, it will normally survive severe drought.

Establishment: Requires a firm, weed-free seedbed and adequate fertilization (liberal phosphorus) and lime are important. Can be used with Tall Fescues at low rates. Minimum mowing height is 1-1/2 inches. Critical erosion areas may be mowed only once per year, if desired. This grass is usually seeded with a mixture of other grasses or legumes; several varieties of Bluegrass should be used together to ensure good stand survival. Bare ground rates are 120 lbs. per acre. Overseed 1 to 1-1/2 per 1000 square feet.

Sources: Readily available as seed and sod.

Kentucky Bluegrass (Poa pratense)

3. Perennial Ryegrass (Lolium perrenne)

Uses: Erosion control, soil improvement, lawns, pasture, and hay; newer varieties are excellent for high-traffic areas.

Description: Perennial Ryegrasses are an excellent selection where rapid establishment is desired. Cool season. Ryegrasses cross-pollinate freely so "Common Ryegrass" may be a mixture of annual and perennial species. Certified seed of Perennial Ryegrass varieties is produced: Blaser, Palmer, Goalie, Fiesta II, Ranger, Regal and Pennfine may be used in Virginia.

Perennial Ryegrass (Lolium perrenne)

Adaptation: Throughout Virginia. Grows best on dark, rich soils in mild climates. Newer varieties have good drought tolerance but may require irrigation if under drought stress or heavy traffic. Will tolerate wet soils with good surface drainage.

Establishment: A firm, mellow surface over compact subsoils gives good results. Seed in fall or spring. Perennial Ryegrass may also be seeded in mid-August to early September. For turf, use a rate of 5 to 8 lbs. per 1000 square feet, if seeded alone; lesser amounts are suitable in mixtures, depending on the characteristics of the companion species. Generally not seeded alone except on athletic fields with intensive use. Perennial Ryegrass does best when used with bluegrass as 20 percent or less of the mixture. Ryegrasses germinate rapidly which makes them particularly suited to disturbed-area stabilization and temporary

seeding. They will, however, tend to dominate stands in mixtures if percentage is too high.

Sources: Readily available commercially. Care should be taken to buy seed appropriate to the needs of the project.

4. Fine Fescues

* Red Fescue
* Hard Fescue
* Chewings Fescue

Uses: Excellent for shady, low maintenance areas and north-facing slopes. May be used to stabilize waterways, slopes, banks, cuts, fills, and as a cover crop in orchards.

Description: Red Fescue is a cool season perennial that occurs in two forms: bunch-type and creeping. Creeping Red Fescue forms a tight sod. The leaves of Red Fescue are narrow and wiry. Hard Fescues are slow-growing with excellent shade tolerance.

Adaptation: Shade tolerant and somewhat drought-resistant once established. Grows well in sandy and acidic soils. Optimum pH range is 4.5 to 6.0. Prefers well-drained soils but requires adequate moisture for establishment. In areas of high temperature and humidity (such as southeastern Virginia), some Fine Fescues may turn brown or deteriorate during the summer. Newer varieties of Hard Fescue are more drought tolerant.

Establishment: Rarely seeded in pure stands. Seedbed preparation and fertility adjustments are usually dictated by the other grasses in the mixture. Red Fescues may comprise 25 to 60% by weight of a seeding mixture. In shaded areas red fescue may be the key grass in the mixture. Mowing consistently below 1-1/2 is not recommended.

Sources: Readily available commercially. New Hard Fescues may be in short supply.

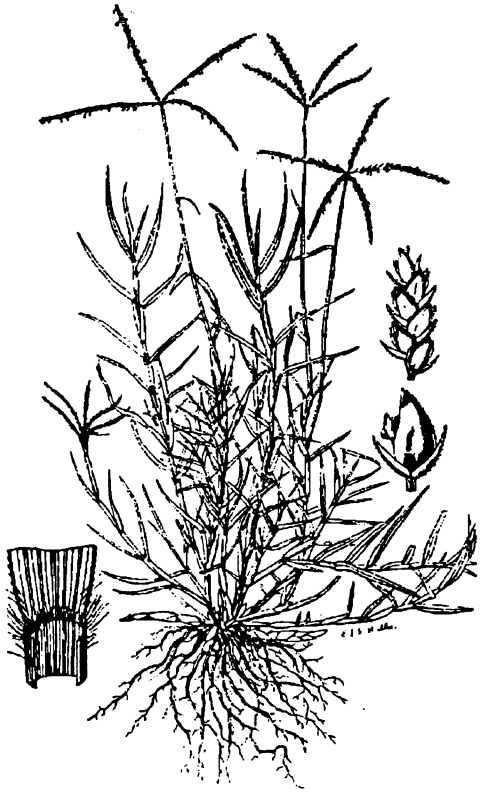
Red Fescue (Festuca rubra)

5. Bermudagrass (Cynodon dactylion)

Uses: Soil and water conservation, pasture, hay, silage, lawns, both high maintenance and general purpose turf, and stabilization of grassed waterways.

Description: A long-lived, warm season perennial that spreads by stolons and rhizomes (runners and underground stems). Height of stems of Common Bermudagrass may be 12 inches. The stems are short-jointed and the leaves flat and spreading. Common Bermudagrass may be established vegetatively with sprigs (sections of stems) or from seeds; however, it has the potential to develop into a weed problem because it spreads vigorously. Cold-tolerant hybrids are usually specified. These are traditionally established from sprigs or sod, but seed is now available.

Adaptation: Southern Piedmont and Coastal Plain in Virginia and some southern appalachian ridges and valleys. Check Std. & Spec. 3.34 for regional adaptations of varieties. Makes its best growth when average daily temperatures are above 75 degrees. Grows on a wide range of soils from heavy clays to deep sands. Optimum pH is 6.0 to 6.5. It is drought-resistant and salt-tolerant. Tolerates floods of short duration but will not thrive on waterlogged soils; does not persist under heavy shade. For rough areas, the varieties Midland (a forage hybrid) and Coastal are recommended. For fine-turf areas, Tufcote (a fine-leaved turf hybrid), Midiron, Tifway, and Vamont are used in Virginia.



Bermudagrass (Cynodon dactylion)

Establishment: By sodding or planting sprigs. Sprigs should be planted (by hand or machine) when soil is warm in a well-prepared, moist seedbed. One end of the sprig should extend above ground, and the other should be covered by firmly packed soil.

Sources: Readily available as seed, sprigs, and sod.

6. Reed Canarygrass (Phalaris arundinacea)

Uses: Pasture, hay silage, and erosion control. An excellent grass for stabilizing waterways, healing and controlling gullies, and protecting shorelines of ponds and reservoirs from wave action. Also provides good cover for shooting preserves. Can be used in deep gullies and drainage ditches where streamflow is rapid. Vigorous growth may impede flow in small, low velocity channels.

Description: A long-lived, cool season, clumpy perennial with coarse rhizomes (underground stems). Grows 4 to 7 feet tall. Most widely used variety is Ioreed.

Adaptation: Throughout Virginia. Does best in a cool, moist climate. Makes best growth on fertile, moist, medium to fine soils; but will grow in a wide range of soil moisture conditions. Will also grow well on swampy or floodplain soils consisting of peat, muck or sand. Will withstand flooding, yet is quite drought-tolerant when mature. Optimum pH range 5.0 to 7.5.

Reed Canarygrass (Phalaris arundinacea)

Establishment: Requires a well-prepared seedbed that is firm and weed free. Seed in spring or late summer; drill seed alone or with a legume. Seed must be fresh - it should be labeled as having at least 70% germination tested within the last 6 months. Normally, pure stands should be established because this grass is not very compatible with other plants. Mowing should not occur more than twice a year on stabilized critical erosion areas or waterway as this will result in reduced stands.

Sources: Available commercially.

MISCELLANEOUS EROSION CONTROL GRASSES

1. Weeping Lovegrass (Eragrostis curvula)

Uses: Fast-growing cover for erosion control. In the northeast, weeping lovegrass acts as a summer annual. The normal life of 3 to 5 years may be foreshortened by low winter temperatures. May provide permanent cover on southern exposure.

Description: A rapid-growing, warm season bunch grass introduced from East Africa. The long, narrow leaves are numerous, very fine, and droop over to the ground, hence the name. Leaf height is rarely above 12 inches.

Adaptation: Prefers light-textured, well-drained soil; will thrive on soil of low fertility. Low winter temperatures may deplete stand.

Establishment: Easy to establish by seed; germinates rapidly and grows quickly. Lime and fertilizer needs are similar to those of Tall Fescue and Ryegrass. Requires pH of 5.5 or higher. May be planted any time after danger of frost and throughout the summer. Very fine seed, commonly added to erosion control seed mixtures. Use of hydroseeders is successful if the seeding rate is increased to compensate for the lack of a firm seedbed. Normal seeding rates are 5 to 20 lbs. per acre in mixes.

Sources: Readily available from large seed companies.

Weeping Lovegrass (Eragrostis curvula)

2. Redtop (Agrostis alba)

Uses: Erosion control, pasture, companion grass in turf seedings and stabilizing ditch and channel banks, grassed waterways, and other disturbed areas.

Description: A coarse, cool season perennial grass with rhizomes (underground stems). Grows to 30 to 40 inches.

Adaptation: Throughout Virginia; does better in the cool, humid areas. Will grow under a wide variety of soil and moisture conditions. Grows on very acid soils (pH 4.0 to 7.5) and poor, clay soils of low fertility. While drought-resistant, it is also a useful wetland grass.

Establishment: Has very small seed and requires a compact seedbed. May be sown in early spring or late summer. Seldom seeded alone except as temporary turf. Adequate fertilization is essential on critical areas to obtain good cover rapidly. Most commonly added to mixes, usually 2 to 3 lbs. per acre. Redtop will disappear from a stand under frequent low mowing.

Sources: Available from commercial sources.

Redtop (Agrostis alba)

LEGUMES

1. Crownvetch (Coronilla varia)

Uses: For erosion control of critical areas such as steep roadbanks, surface mine spoil and industrial waste areas. It is also useful as a residential ground cover. It provides high-quality forage for ruminant animals and serves as a wildlife food and cover plant.

Description: A deep-rooted, cool season, perennial, herbaceous legume with a semi-reclining growth habit. It reaches 2 to 3 feet in height, and does not climb or twine. It fixes nitrogen in the soil and makes a dense mat of vegetative cover.

Crownvetch (Coronilla varia)

Adaptation: Best adapted to the northern Piedmont and Mountain regions of Virginia. It grows best on well-drained soils with a pH range of 5.5 to 8.3. It will persist on more acid soils for a prolonged period once established. It is not adapted to soils with poor drainage. Crownvetch is winter-hardy and drought-tolerant. Varieties commonly used are Chemung, Penngift and Emerald.

Establishment: Only inoculated seed should be used. Requires at least 500 lbs. per acre of 5-10-10 fertilizer (or the area should be fertilized according to soil test results). Soil acidity must be raised above a pH of 5.5. Crownvetch requires mulch and can be hydroseeded successfully. Seeding in the spring is most successful. Frost-seeding may be used on steep or stony sites (seed in late winter, and allow frost action to work the seed into soil). Crownvetch often takes 2 to 3 years to establish a dense stand. A companion grass such as Perennial Ryegrass or Redtop needs to be mixed into the initial planting, but the Crownvetch will eventually crowd out the companion plants. It will not persist under frequent mowing.

Sources: Available commercially.

2. Flatpea (Lathyrus sylvestris)

Uses: Flatpea is an erosion control plant that provides a thick mat of vegetative cover, fixes nitrogen in the soil, and can be maintained with a minimum of management. It is useful on roadbanks, dams, borrow area, gravel pits, surface mine spoil, and industrial waste areas. It is an ideal plant for stabilizing logging roads and utility right-of-ways since it will restrict the invasion of many woody species. It also provides good wildlife cover and food.

Description: A cool season perennial legume. It will climb to a height of 6 to 7 feet if support is available, but the normal height is 2 to 3 feet.

Flatpea (Lathyrus sylvestris)

Adaptation: Flatpea is adaptable to a wide variety of soil conditions. It is drought-tolerant, cold-hardy, and does well on low-fertility sites such as sands, gravels, and soils from acid sandstones. It is not adapted to wet sites, but it will grow on somewhat poorly drained soils. It will tolerate minor shade and a minor degree of flooding. The optimum pH range is from 6.0 to 6.5. The only available variety is Lathco, developed by the USDA-Soil Conservation Service.

Establishment: Use only inoculated seed. The seedbed should be scarified, if possible. The seed is normally drilled or band seeded, but on rough sites or steep slopes, it can be broadcast and then worked into the soil by light dragging. Where possible, a light application of mulch, properly anchored, will assure a good stand. Lime is essential if the soil is below a pH of 5.0. Fertilize according to a soil test or apply 400 lbs. per acre of 10-20-10. Work lime and fertilizer into soil when preparing

the seedbed. For a primary stand, use a seeding rate of 30 to 40 lbs. in a mixture with 8 to 10 lbs. of Perennial Ryegrass or 10 to 15 lbs. of Tall Fescue. Flatpea is slow to germinate, so grasses are needed to provide quick cover. Early spring seedings in April or May are best; June seedings are less desirable. Grass seedings may be overseeded with Flatpea from November through March. Flatpea is usually not winter-hardy if seeded in mid or late summer; therefore, dormant seedings are recommended. Mulch with straw at a minimum rate of 1-1/2 tons per acre on all critical sites, and anchor. Little management is required. Remove woody vegetation if the site is invaded. Mowing is acceptable once the stand is established. Mow after full bloom at a 6-inch minimum height.

Sources: Lathco is commercially available.

3. Sericea Lespedeza (Lespedeza cuneata)

Uses: Hay, pasture, erosion control, cover crop, wildlife food.

Description: Warm season perennial legume with upright woody stems 12 to 18 inches tall. Roots widely branched penetrating soil 3 feet or more.

Adaptation: Well adapted to all parts of Virginia. Best on well-drained, deep soils of medium texture. Will also grow on sandy, rather acidic, infertile soils. Most often the legume of choice for eastern Virginia. Optimum pH range is 6.0 to 6.5, but will tolerate a range of 5.0 to 7.0. It is drought-tolerant. Common varieties in Virginia are Serala and Interstate.

Sericea Lespedeza (Lespedeza cuneata)

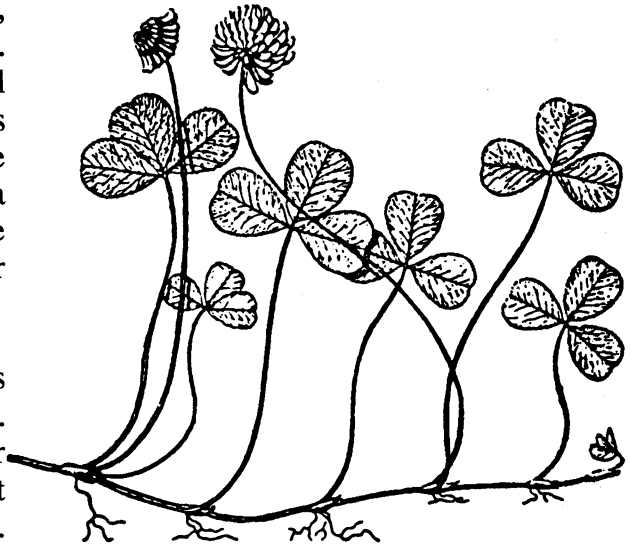
Establishment: Seed from April to June. Requires a firm seedbed. Use only inoculated seed. Rates vary from 20 to 30 lbs. of unhulled seed per acre. Requires phosphate and potash. Will not persist under frequent mowing (once a year recommended).

Sources: Seed of common varieties is commercially available.

4. White Clover (Trifolium repens)

Uses: Common White Clover is used mostly for pastures. Ladino clover, a giant white clover, is also used for hay and silage in mixtures with a grass. The thick-growing, spreading characteristics of the common type make it ideal for erosion control.

Description: A cool season perennial legume. The common type has a prostrate type of growth, while the Ladino is more upright. Both spread by stolons (horizontal branches along ground) and by roots at the nodes. Representative common varieties used in Virginia are Tillman, Common and White Dutch. Ladino is the only cultivar for the large type.



White Clover (Trifolium repens)

Adaptation: Thrives in cool climates and on moist, rich soils with full sun. Will not tolerate extremes of cold or drought. Where soil moisture is not adequate, Ladino is short-lived. Optimum soil pH is 6.5, but it will grow in a range of 5.0 to 7.5. Common White Clover volunteers readily in Bluegrass mixtures where moderate to high fertility is maintained. Stands are persistent.

Establishment: Ladino Clover requires inoculation, fertilizing, and liming for successful growth. Phosphorus and potash are the key fertilizer elements required. Ladino makes a good companion crop with grasses such as Orchardgrass, Bromegrass, Tall Fescue and Timothy. These grasses will normally crowd out the Ladino after 2 to 3 years. Seed should be planted (drilled or broadcast) at shallow depths, and a firm seedbed is desirable.

Sources: Available commercially.

APPENDIX 3.32-d

TABLE 3.32-F

LBS. OF GROUND AGRICULTURAL LIMESTONE* PER THOUSAND SQUARE FEET NEEDED TO CORRECT pH LEVEL OF ACID SOILS TO 6.5

Existing pH	Soil Texture		
	Sandy Loam	Loam	Clay Loam
6.2	20	35	40
6.0	40	55	70
5.8	55	65	85
5.6	70	80	105
5.4	90	100	125
5.2	105	120	140
5.0	120	140	160
4.8	125	180	205
4.6	155	210	230
4.0	200	250	300

* Lime should always be applied in accordance with the results of a soil test, such as may be obtained through the soil testing laboratory at VPI&SU or through a reputable commercial laboratory.

Source: DSWC's Basic Urban E&S in Virginia

STD & SPEC 3.35

MULCHING

Definition

Application of plant residues or other suitable materials to the soil surface.

Purposes

1. To prevent erosion by protecting the soil surface from raindrop impact and reducing the velocity of overland flow.

2. To foster the growth of vegetation by increasing available moisture and providing insulation against extreme heat and cold.

Conditions Where Practice Applies

1. Areas which have been permanently seeded (see Std. & Spec. 3.32, PERMANENT SEEDING) should be mulched immediately following seeding.

2. Areas which cannot be seeded because of the season should be mulched to provide some protection to the soil surface. An organic mulch should be used, and the area then seeded as soon weather or seasonal conditions permit. It is not recommended that fiber mulch be used alone for this practice; at normal application rates it just simply does not provide the protection that is achieved using other types of mulch.

3. Mulch may be used together with plantings of trees, shrubs, or certain ground covers which do not provide adequate soil stabilization by themselves.

4. Mulch shall be used in conjunction with temporary seeding operations as specified in TEMPORARY SEEDING, Std. & Spec. 3.31.

Planning Considerations

Mulches are applied to the soil surface to conserve a desirable soil property or to promote plant growth. A surface mulch is one of the most effective means of controlling runoff and erosion on disturbed land.

Mulches can increase the infiltration rate of the soil, reduce soil moisture loss by evaporation, prevent crusting and sealing of the soil surface, modify soil temperatures, and provide a suitable microclimate for seed germination.

Organic mulch materials, such as straw, wood chips, bark, and fiber mulch have been found to be the most effective.

Chemical soil stabilizers or soil binders should not be used alone for mulch. These materials are useful to bind organic mulches together to prevent displacement.

A variety of manufactured SOIL STABILIZATION BLANKETS AND MATTING (see Std. & Spec. 3.36) have been developed for erosion control in recent years. Some of these products can be used as mulches, particularly in critical areas such as waterways. They also may be used to hold other mulches to the soil surface.

The choice of materials for mulching will be based on the type of soil to be protected, site conditions, season and economics. It is especially important to mulch liberally in mid-summer and prior to winter, and on cut slopes and southern slope exposures.

Organic Mulches

Straw - The mulch most commonly used in conjunction with seeding. The straw should come from wheat or oats (free of troublesome weed seeds) and may be spread by hand or machine. Straw can be windblown and must be anchored down by an acceptable method.

Hay - May be used in lieu of straw where volunteers will not present a problem, and may be spread by hand or machine. Hay can be windblown and must also be anchored or tacked down.

Corn Stalks - These should be shredded into 4- to 6-inch lengths. Stalks decompose slowly and are resistant to displacement.

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

Bark Chips, Shredded Bark - These are by-products of timber processing which are used in landscaped plantings. Bark is also a suitable mulch for areas planted to grasses and not closely mowed. It may be applied by hand or mechanically and is not usually toxic to grasses or legumes; additional nitrogen fertilizer is not required.

Fiber Mulch - Used in hydroseeding operations and applied as part of the slurry. It creates the best seed-soil contact when applied over top of (as a separate operation) newly seeded areas. These fibers do not require tacking, although tacking agents or binders are sometimes used in conjunction with the application of fiber mulch. This form of mulch does not provide sufficient protection to highly erodible soils. Additionally, fiber mulch will not be considered adequate mulch when used during the dry summer months or when used for late fall mulch cover. Use straw mulch during these periods. Fiber mulch may be used to tack (anchor) straw mulch. This treatment is well suited for steep slopes, critical areas, and areas susceptible to displacement.

There are other organic materials which make excellent mulches but are only available locally or seasonally. Creative use of these materials can reduce costs.

Chemical Mulches and Soil Binders

A wide range of synthetic, spray-on materials are marketed to stabilize and protect the soil surface. These are emulsions or dispersions of vinyl compounds, rubber or other substances which are mixed with water and applied to the soil. They may be used alone in some cases as temporary stabilizers, or in conjunction with fiber mulches or straw.

When used alone, chemical mulches do not have the capability to insulate the soil or retain soil moisture that organic mulches have. This soil protection is also easily damaged by traffic. Application of these mulches is usually more expensive than organic mulching, and the mulches decompose in 60-90 days.

Blankets and Matting

Field experience has shown that plastic netting, when used alone, does not retain soil moisture or modify soil temperature. In some cases it may stabilize the soil surface while

grasses are being established, but is primarily used in grassed waterways and on slopes to hold straw or similar mulch in place.

Jute mesh and other soil stabilization blankets are good choices for mulching on difficult slopes and in minor drainage swales. Most of the soil stabilization mattings (used to create a permanent matrix for root growth within the soil) must receive mulching in order to properly stabilize an area. Notably, some manufacturers have recently developed permanent mattings which include self-contained, temporary mulching materials; however, these measures will have to meet the requirements noted in Std. & Spec. 3.36, SOIL STABILIZATION BLANKETS AND MATTING, before they can be recommended for use on steep slopes and in channel flow situations.

The most critical aspect of installing blankets and mats is obtaining firm, continuous contact between the material and the soil. Without such contact, the material may fail and thereby allow erosion to occur. It is important to use an adequate number of staples and make sure the material is installed properly in order to maximize soil protection. These products are discussed in more detail in Std. & Spec. 3.36, SOIL STABILIZATION BLANKETS & MATTING.

Specifications

Organic Mulches

Organic mulches may be used in any area where mulch is required, subject to the restrictions noted in Table 3.35-A.

Materials: Select mulch material based on site requirements, availability of materials, and availability of labor and equipment. Table 3.35-A lists the most commonly used organic mulches. Other materials, such as peanut hulls and cotton burs, may be used with the permission of the local Plan-Approving Authority.

Prior to mulching: Complete the required grading and install needed sediment control practices.

Lime and fertilizer should be incorporated and surface roughening accomplished as needed. Seed should be applied prior to mulching except in the following cases:

a. Where seed is to be applied as part of a hydroseeder slurry containing fiber mulch.

b. Where seed is to be applied following a straw mulch spread during winter months.

TABLE 3.35-A

ORGANIC MULCH MATERIALS AND APPLICATION RATES

MULCHES:	RATES:		NOTES:
	Per Acre	Per 1000 sq. ft.	
Straw or Hay	1½ - 2 tons (Minimum 2 tons for winter cover)	70 - 90 lbs.	Free from weeds and coarse matter. Must be anchored. Spread with mulch blower or by hand.
Fiber Mulch	Minimum 1500 lbs.	35 lbs.	Do not use as mulch for winter cover or during hot, dry periods.* Apply as slurry.
Corn Stalks	4 - 6 tons	185 - 275 lbs.	Cut or shredded in 4-6" lengths. Air-dried. Do not use in fine turf areas. Apply with mulch blower or by hand.
Wood Chips	4 - 6 tons	185 - 275 lbs.	Free of coarse matter. Air-dried. Treat with 12 lbs nitrogen per ton. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand.
Bark Chips or Shredded Bark	50 - 70 cu. yds.	1-2 cu. yds.	Free of coarse matter. Air-dried. Do not use in fine turf areas. Apply with mulch blower, chip handler, or by hand.

* When fiber mulch is the only available mulch during periods when straw should be used, apply at a minimum rate of 2000 lbs./ac. or 45 lbs./1000 sq. ft.

Source: Va. DSWC

Application: Mulch materials shall be spread uniformly, by hand or machine.

When spreading straw mulch by hand, divide the area to be mulched into approximately 1,000 sq. ft. sections and place 70-90 lbs. (1½ to 2 bales) of straw in each section to facilitate uniform distribution.

Mulch Anchoring: Straw mulch must be anchored immediately after spreading to prevent displacement. Other organic mulches listed in Table 3.35-A do not require anchoring. The following methods of anchoring straw may be used:

1. Mulch anchoring tool (often referred to as a Krimper or Krimper Tool): This is a tractor-drawn implement designed to punch mulch into the soil surface. This method provides good erosion control with straw. It is limited to use on slopes no steeper than 3:1, where equipment can operate safely. Machinery shall be operated on the contour.

2. Fiber Mulch: A very common practice with widespread use today. Apply fiber mulch by means of a hydroseeder at a rate of 500-750 lbs./acre over top of straw mulch or hay. It has an added benefit of providing additional mulch to the newly seeded area.

3. Liquid mulch binders: Application of liquid mulch binders and tackifiers should be heaviest at edges of areas and at crests of ridges and banks, to prevent displacement. The remainder of the area should have binder applied uniformly. Binders may be applied after mulch is spread or may be sprayed into the mulch as it is being blown onto the soil.

   The following types of binders may be used:

   a. Synthetic binders - Formulated binders or organically formulated products may be used as recommended by the manufacturer to anchor mulch.

   * b. Asphalt - Any type of asphalt thin enough to be blown from spray equipment is satisfactory. Recommended for use are rapid curing (RC-70, RC-250, RC-800), medium curing (MC-250, MC-800) and emulsified asphalt (SS-1, CSS-1, CMS-2, MS-2, RS-1, RS-2, CRS-1, and CRS-2).

      Apply asphalt at 0.10 gallon per square yard (10 gal./1000 sq. ft. or 430 gal./acre). Do not use heavier applications as it may cause the straw to "perch" over rills. All asphalt designations are from the Asphalt Institute Specifications.

* Note: This particular method is not used as commonly today as it once was in the past. The development of hydraulic seeding equipment promoted the industry

to turn to synthetic or organically based binders and tackifiers. When this method is used, environmental concerns should be addressed to ensure that petroleum-based products do not enter valuable water supplies. Avoid applications into waterways or channels.

4. Mulch nettings: Lightweight plastic, cotton, or paper nets may be stapled over the mulch according to manufacturer's recommendations.

5. Peg and twine: Because it is labor-intensive, this method is feasible only in small areas where other methods cannot be used. Drive 8- to 10-inch wooden pegs to within 3 inches of the soil surface, every 4 feet in all directions. Stakes may be driven before or after straw is spread. Secure mulch by stretching twine between pegs in a criss-cross-within-a square pattern. Turn twine 2 or more times around each peg.

Chemical Mulches

Chemical mulches* may be used alone only in the following situations:

a. Where no other mulching material is available.

b. In conjunction with temporary seeding during the times when mulch is not required for that practice.

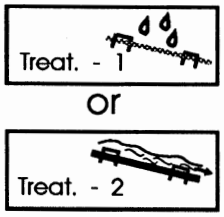
c. From March 15 to May 1 and August 15 to September 30, provided that they are used on areas with slopes no steeper than 4:1, which have been roughened in accordance with SURFACE ROUGHENING, Std. & Spec. 3.29. If rill erosion occurs, another mulch material shall be applied immediately.

* Note: Chemical mulches may be used to bind other mulches or with fiber mulch in a hydroseeded slurry at any time. Manufacturer's recommendations for application of chemical mulches shall be followed.

Maintenance

All mulches and soil coverings should be inspected periodically (particularly after rainstorms) to check for erosion. Where erosion is observed in mulched areas, additional mulch should be applied. Nets and mats should be inspected after rainstorms for dislocation or failure. If washouts or breakage occur, re-install netting or matting as necessary after repairing damage to the slope or ditch. Inspections should take place up until grasses are firmly established. Where mulch is used in conjunction with ornamental plantings, inspect periodically throughout the year to determine if mulch is maintaining coverage of the soil surface; repair as needed.

STD & SPEC 3.36



SOIL STABILIZATION BLANKETS & MATTING

B/M

Definition

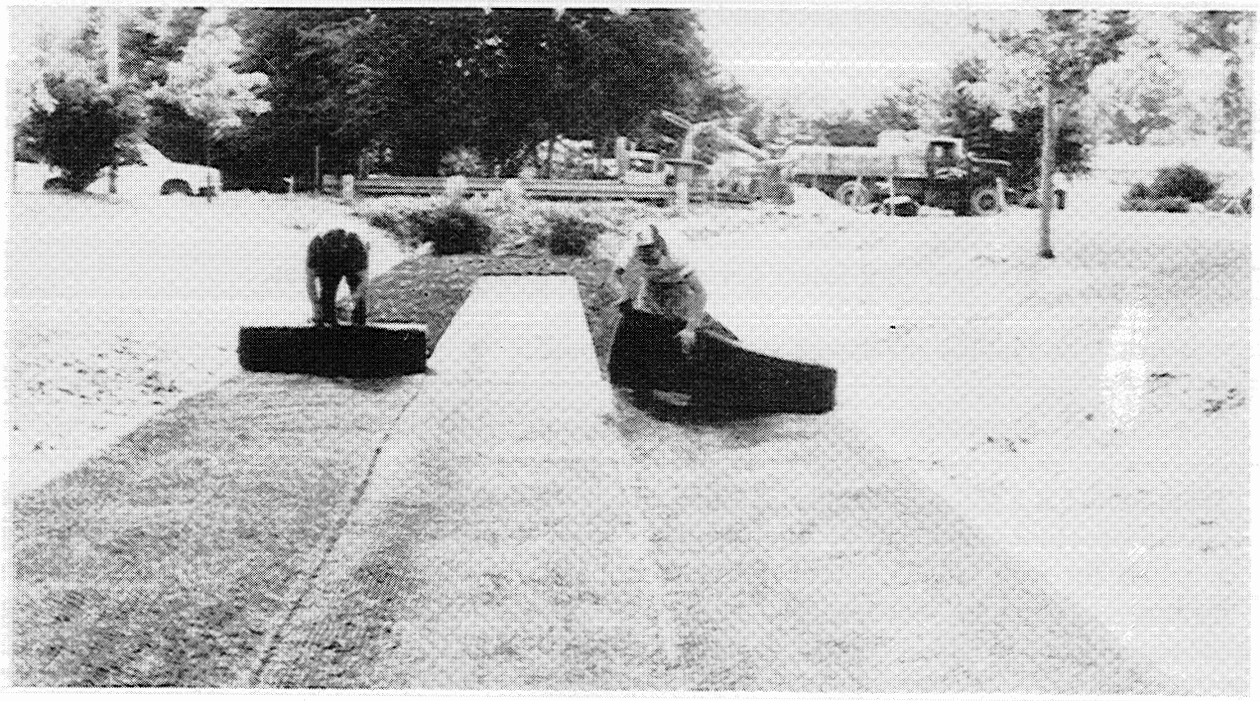
The installation of a protective covering (blanket) or a soil stabilization mat on a prepared planting area of a steep slope, channel or shoreline.

Purpose

To aid in controlling erosion on critical areas by providing a microclimate which protects young vegetation and promotes its establishment. In addition, some types of soil stabilization mats are also used to raise the maximum permissible velocity of turf grass stands in channelized areas by "reinforcing the turf" to resist the forces of erosion during storm events.

Conditions Where Practice Applies

On short, steep slopes where erosion hazard is high and planting is likely to be too slow in providing adequate protective cover; in vegetated channels where the velocity of design flow exceeds "allowable" velocity; on streambanks or tidal shorelines where moving water is likely to wash out new plantings; or in areas where the forces of wind prevent standard mulching practices from remaining in place until vegetation becomes established.



Planning Considerations

Soil stabilization blankets and mats can be applied to problem areas to supplement nature's erosion control system (vegetation) in its initial establishment and in providing a safe and "natural" conveyance for high velocity stormwater runoff. They are being used today in many applications were previously a structural lining would have been required. Care must be taken to choose the type of blanket or matting which is most appropriate for the specific needs of a project. Two general types of blankets and mats are discussed within this specification. However, with the abundance of soil stabilization products available today, it is impossible to cover all the advantages, disadvantages and specifications of all manufactured blankets and mats. Therefore, as with many erosion control-type products, there is no substitute for a thorough understanding of the manufacturer's instructions and recommendations and a site visit by a designer or plan reviewer to verify a product's appropriateness.

Treatment-1 is a degradable soil stabilization blanket which includes "combination" blankets consisting of a plastic netting which covers and is intertwined with a natural organic or man-made mulch; or, a jute mesh which is typically homogeneous in design and can act alone as a soil stabilization blanket.

It should be used to help establish vegetation on previously disturbed slopes - normally problem slopes of 3:1 or greater. Since the materials which compose the soil stabilization blankets will deteriorate over time, they should be used in permanent conveyance channels with the realization that the system's resistance to erosion is based on the type of vegetation planted and the existing soil characteristics. During the establishment of vegetation, **Treatment-1** should not be subjected to shallow or deep concentrated flows moving at greater than 4 feet/second.

Treatment-1 provides the following benefits in the achievement of vegetative stabilization when properly applied over seed and required amendments:

1. Protection of the seed and soil from raindrop impact and subsequent displacement.

2. Thermal consistency and moisture retention for seedbed area.

3. Stronger and faster germination of grasses and legumes.

4. Planing off excess stormwater runoff.

5. Prevention of sloughing of topsoil added to steeper slopes.

Treatment-2 is a soil stabilization matting which consists of a non-degradable, 3-dimensional plastic structure which can be filled with soil prior to planting. This configuration provides a matrix for root growth where the matting becomes entangled and penetrated by roots, forming continuous anchorage for surface growth and promoting enhanced energy

dissipation. **Treatment-2** can be used on problem slopes (normally 3:1 or greater), and in stormwater conveyance channels.

In addition to those benefits noted for **Treatment-1**, **Treatment-2** provides the following benefits in the achievement of vegetative stabilization and in the replacement of more traditional channel linings such as concrete and riprap:

1. Causes soil to drop out of stormwater and fill matrix with fine soils which become the growth medium for the development of roots.

2. When embedded in the soil within stormwater channels, it acts with the vegetative root system to form an erosion resistant cover which resists hydraulic lift and shear forces.

Since **Treatment-2** is non-degradable, it can be used in permanent conveyance channels and can withstand higher velocities of flow than the vegetation and soil would normally allow. However, a 10 feet/second velocity of flow should be the maximum allowed in a conveyance system which utilizes **Treatment-2**.

VDOT Nomenclature and Product Information

The Virginia Department of Transportation has its own nomenclature for many of the standards and specifications found in this handbook; this is true in the case of soil stabilization blankets and matting. The following relationship exists between the two methods of naming the practice:

Va. E&S-C Handbook		VDOT Specifications
Treatment-1	(is equivalent to)	EC-2
Treatment-2	(is equivalent to)	EC-3

It is recommended that most current VDOT "Approved Products List" for these products be consulted prior to installation of a particular blanket or mat. Importantly, the list names those products approved for a certain range of flow velocities when **Treatment-2** (VDOT's EC-3) installation is contemplated.

TREATMENT-1: SOIL STABILIZATION BLANKET

(Allowable Velocity Range During Vegetation Establishment: 0 - 4 f.p.s.)

Materials

1. Combination Blankets - They shall consist of a photo-degradable plastic netting which covers and is entwined in a natural organic or man-made mulching material.

The mulching material shall consist of wood fibers, wood excelsior, straw, coconut fiber, or man-made fibers, or a combination of the same. The blanket shall be of consistent thickness with the mulching material/fibers evenly distributed over its entire length. The mulching material/fibers must interlock or entwine to form a dense layer which not only resists raindrop impact, but will allow vegetation to penetrate the blanket.

The blanket shall be nontoxic to vegetation and to the germination of seed and shall not be injurious to the unprotected skin of humans. At a minimum, the plastic netting must cover the top side of the blanket and possess a high web strength. The netting shall be entwined with the mulching material/fiber to maximize strength and provide for ease of handling.

2. Jute Mesh - It shall be of a uniform, open, plain weave, of undyed and unbleached single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than one half of its normal diameter. Jute mesh shall be new and shall conform to the following:

   a. Length of jute mesh shall be marked on each roll.

   b. There shall be 0.60-inch openings (± 25%) between strands, lengthwise.

   c. There shall be 0.90-inch openings (± 25%) between strands, lengthwise.

   d. Weight shall average 0.90 lbs./square yard with a tolerance of 5%.

   As previously noted, jute mesh provides such good coverage (large surface area of strands) and contains such small openings that it can be used alone as a blanket.

3. Other **Treatment-1** Products - These shall conform to manufacturer's specifications and be approved by the Plan-Approving Authority prior to being specified for a particular application. These products should be installed in accordance with manufacturer's recommendations, provided those recommendations are at least as stringent as this specification. Again, it is recommended that VDOT's "Approved Products List" be consulted. In no case shall these products cover less than 30% of the soil surface.

4. Staples - Staples for anchoring Treatment-1 shall be No. 11-gauge wire or heavier. Their length shall be a minimum of 6 inches. A larger staple with a length of up to 12 inches should be used on loose, sandy, or unstable soils.

Installation Requirements

Site Preparation - After site has been shaped and graded to approved design, prepare a friable seedbed relatively free from clods and rocks more than 1½ inches in diameter and any foreign material that will prevent uniform contact of the protective covering with the soil surface.

Planting - Lime, fertilize, and seed in accordance with seeding or other type of planting plan. When using jute mesh on a seeded area, apply approximately one-half the seed after laying the mat. The protective covering can be laid over sprigged areas where small grass plants have been inserted into the soil. Where ground covers are to be planted, lay the protective covering first and then plant through the material as per planting design.

When open-weave nets are used, lime, fertilizer, seed and mulch should be applied before laying the net. When a combination blanket (such as an "excelsior" blanket) is used, seed and soil amendments must also be applied before the blanket is laid.

Orientation - See Plate 3.36-1 for orientation of **Treatment-1** for different topographic conditions.

Laying and Stapling (see Plate 3.36-2) - If instructions have been followed, all needed check slots will have been installed, and the protective covering will be laid on a friable seedbed free from clods, rocks, roots, etc. that might impede good contact.

1. Start laying the protective covering from the top of the channel or top of slope and unroll down-grade.

2. Allow to lay loosely on soil - do not stretch.

3. Upslope ends of the protective covering should be buried in a anchor slot no less than 6-inches deep. Tamp earth firmly over the material. Staple the material at a minimum of every 12 inches across the top end.

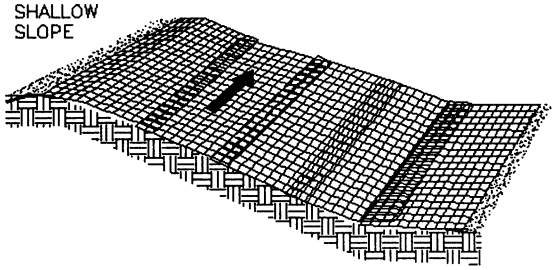
4. Edges of the material shall be stapled every 3 feet. Where multiple widths are laid side by side, the adjacent edges shall be overlapped a minimum of 2 inches and stapled together.

5. Staples shall be placed down the center, staggered with the edges at 3 foot intervals.

Check slots - On highly erodible soils and on slopes steeper than 4:1, erosion check slots should be made every 50 feet (see Plate 3.36-2). Insert a fold of the material (separate piece) into a 6-inch trench and tamp firmly. Staple fold to "main" blanket at minimum 12-inch intervals across the upstream and downstream portion of the blanket.

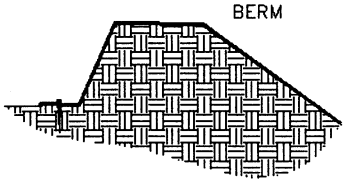
TYPICAL ORIENTATION OF TREATMENT – 1 (SOIL STABILIZATION BLANKET)

SHALLOW SLOPE

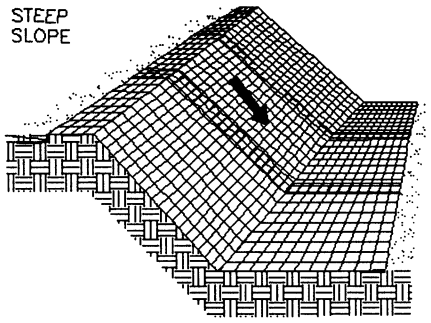


ON SHALLOW SLOPES, STRIPS OF NETTING PROTECTIVE COVERINGS MAY BE APPLIED ACROSS THE SLOPE.

WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE MATERIAL OVER THE BERM AND ANCHOR IT BEHIND THE BERM.

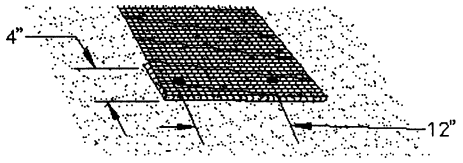


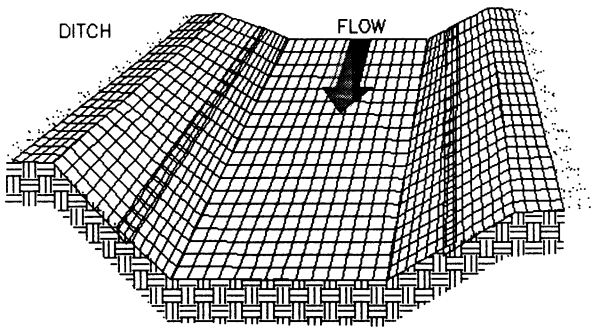
STEEP SLOPE



ON STEEP SLOPES, APPLY PROTECTIVE COVERING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY.

BRING MATERIAL DOWN TO A LEVEL AREA BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 4" AND STAPLE AT 12" INTERVALS.

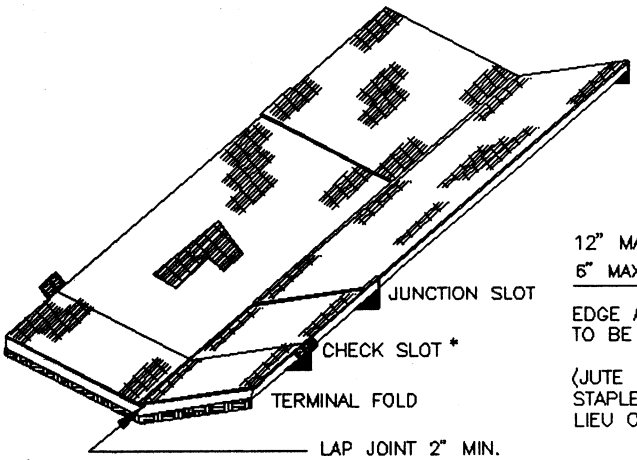




IN DITCHES, APPLY PROTECTIVE COVERING PARALLEL TO THE DIRECTION OF FLOW. USE CHECK SLOTS AS REQUIRED. AVOID JOINING MATERIAL IN THE CENTER OF THE DITCH IF AT ALL POSSIBLE.

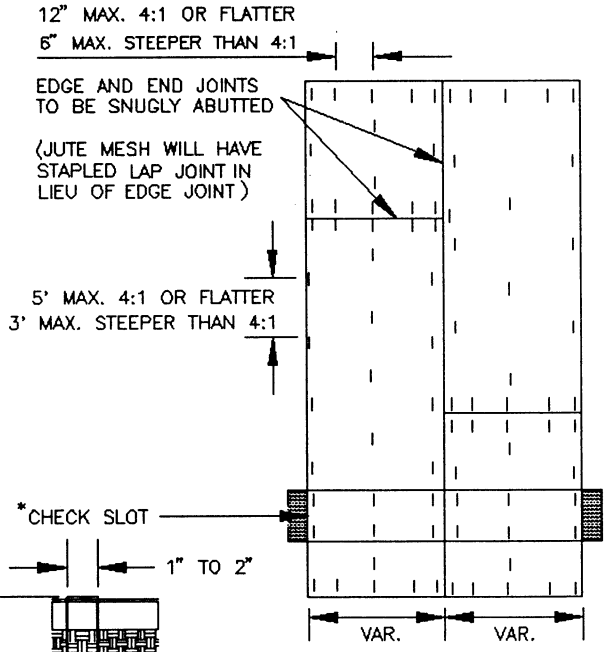
Source: Adapted from Ludlow Products Brochure Plate 3.36-1

TYPICAL TREATMENT – 1
(SOIL STABILIZATION BLANKET)
INSTALLATION CRITERIA

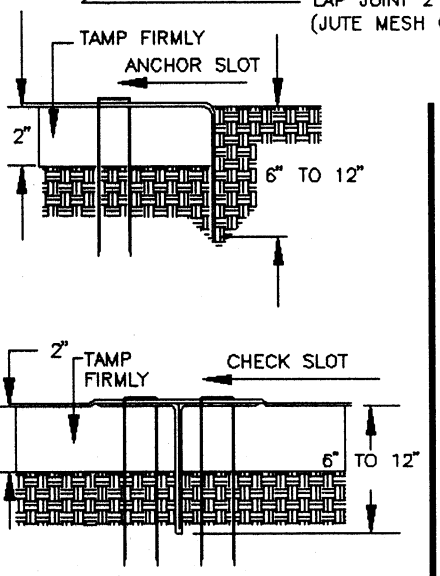


NOTES

APPROXIMATELY 200 STAPLES REQUIRED PER 100 SQ. YDS. OF MATERIAL ROLL. ANCHOR SLOTS, JUNCTION SLOTS & CHECK SLOTS TO BE BURIED 6" TO 12".

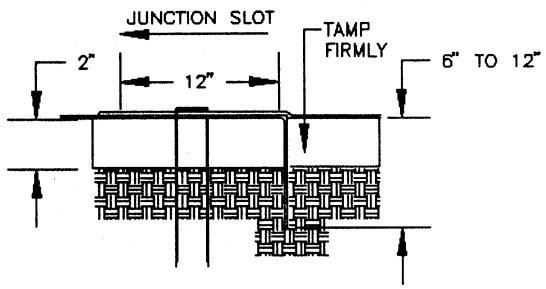


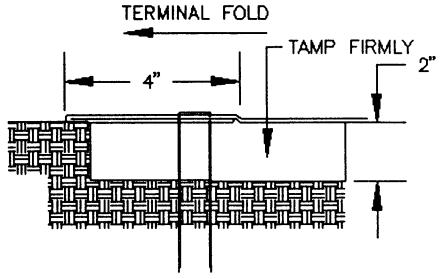
PLAN VIEW
STAPLING DIAGRAM



STAPLE FORMED FROM NO.11 STEEL WIRE.
8" STAPLE MIN. LENGTH FOR SANDY SOIL.
6" STAPLE MIN. LENGTH FOR OTHER SOIL.

*CHECK SLOTS AT MIN. 50' C–C INTERVALS; NOT REQ.'D WITH ALL "COMBINATION" BLANKETS





Source: VDOT Road and Bridge Standards

Plate 3.36-2

Note: Many combination blankets are designed and manufactured to resist movement and uplift to a point which check slots may not be required. Plan designers and review authorities are urged to study manufacturers' recommendations and site conditions.

Joining Protective Coverings - Insert a new roll of material into an anchor slot, as with upslope ends. Overlap the end of the previous roll a minimum of 12 inches, and staple across the end of the roll just below the anchor slot and across the material every 12 inches.

Terminal End - At the point at which the material is discontinued, or at which time the protective covering meets a structure of some type, fold 4 inches of the material underneath and staple every 12 inches (minimum).

At bottom of slopes - Lead net out onto a level area before anchoring. Turn ends under 4 inches, and staple across end every 12 inches.

Final Check - These installation techniques must be adhered to:

1. Protective blanket is in uniform contact with the soil.
2. All lap joints are secure.
3. All staples are driven flush with the ground.
4. All disturbed areas have been seeded.

TREATMENT-2: SOIL STABILIZATION MATTING

(Allowable velocity range after vegetative establishment: 0 - 10 f.p.s.)

Materials

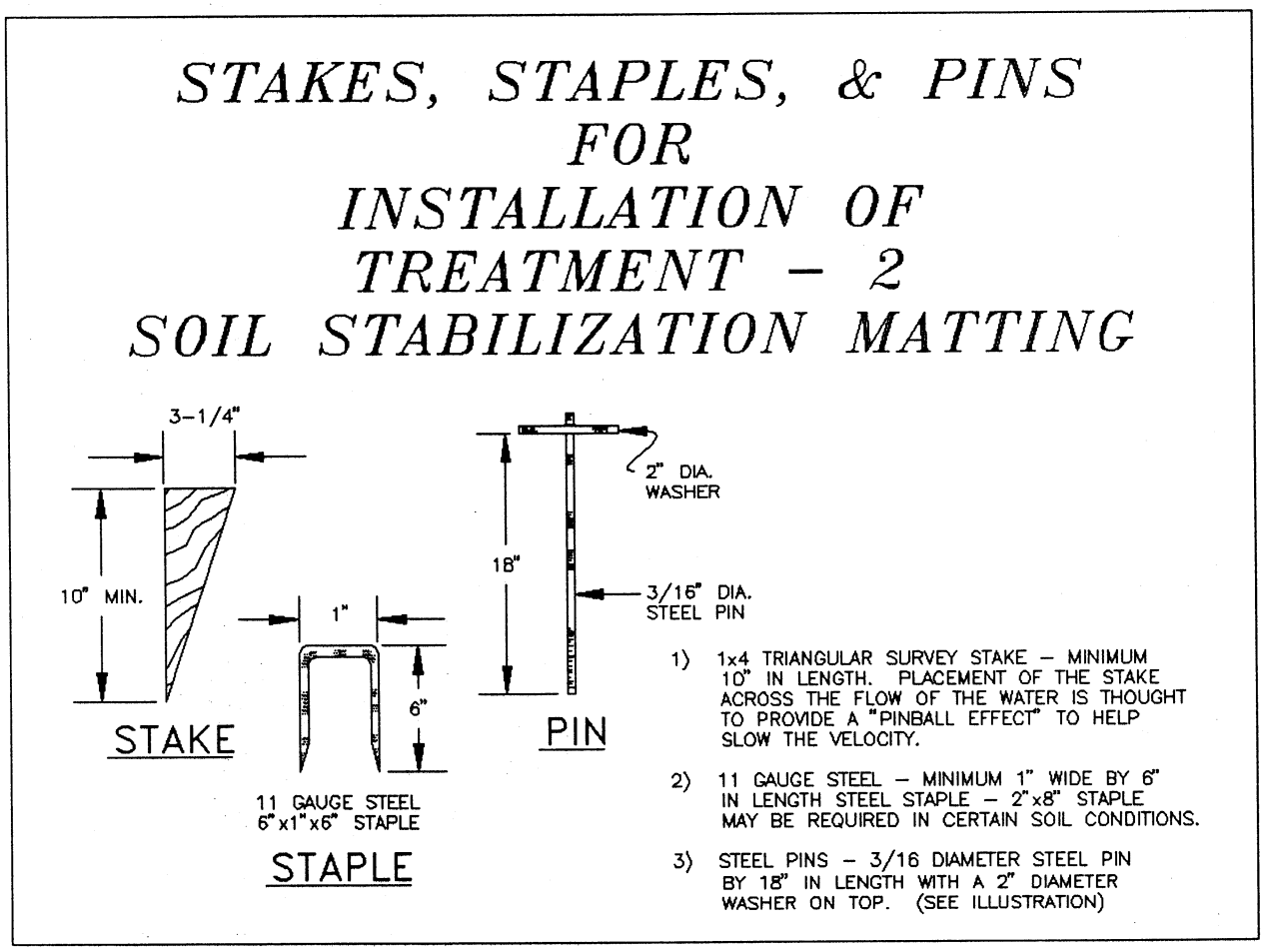
Matting - The majority of these products provide a three dimensional geomatrix of nylon, polyethylene, or randomly oriented monofilaments, forming a mat. These products contain ultra violet (UV) inhibiting stabilizers, added to the compounds to ensure endurance and provide "permanent root reinforcement."

The three dimensional feature creates an open space which is allowed to fill with soil. The roots of the grass plant become established within the mat itself, forming a synergistic root and mat system. As the grass becomes established, the two actually "reinforce" each other, preventing movement or damage to the soil. Allowable velocities are increased considerably over natural turf stands.

Selection of the appropriate matting materials along with proper installation become critical factors in the success of this practice. VDOT's "Approved Products List" can be a real asset in the selection process. Consultation with the supplier or the manufacturer and thorough

evaluation of performance data to ensure proper selection of a soil stabilization matting are also essential. Although many manufacturers claim their products may inhibit erosion associated with channel velocities of up to 20 ft./sec., it is recommended that any velocities that exceed 10 ft./sec. be properly protected with some form of structural lining (see Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL).

Staples - Staples or anchoring methods and recommendations vary by manufacturers. The expectation of high velocities should dictate the use of more substantial anchoring. Some of the typically recommended stakes, staples and pins are depicted in Plate 3.36-3



Source: Product literature from Greenstreak, Inc. Plate 3.36-3

Installation Requirements

Site Preparation - After site has been shaped and graded to approved design, prepare a friable seedbed relatively free from clods and rocks more than 1 inch in diameter, and any foreign material that will prevent contact of the soil stabilization mat with the soil surface. If necessary, redirect any runoff away from the ditch or slope during installation.

Planting - Lime, fertilize and seed in accordance with MS #1 and the approved plan, paying special attention to the plant selection that may have been chosen for the matted area. If the area has been seeded prior to installing the mat, make sure and reseed all areas disturbed during installation.

Mulching - Mulch (normally straw) should be applied following installation of **Treatment-2** at rates noted in Std. & Spec. 3.35, MULCHING.

Laying and Securing - See Plates 3.36-4, 3.36-5 and 3.36-6. Similar to installing **Treatment-1**, but Plan Approving Authority's requirements or manufacturer's recommendations must be followed as detailed. The key to achieving desired performance is dependent upon proper installation.

Check Slots - See Plate 3.36-4. Matting manufacturers vary significantly in their check slot requirements. Similar to the installation of **Treatment-1**, a check slot may be required when laying **Treatment-2** to "correct" the flow of water if it has the potential to undermine the matting. Most authorities (including VDOT) require that the sides of the matting also be entrenched, creating a slope shelf for the material to rest on, preventing water from entering under the mat on the sides.

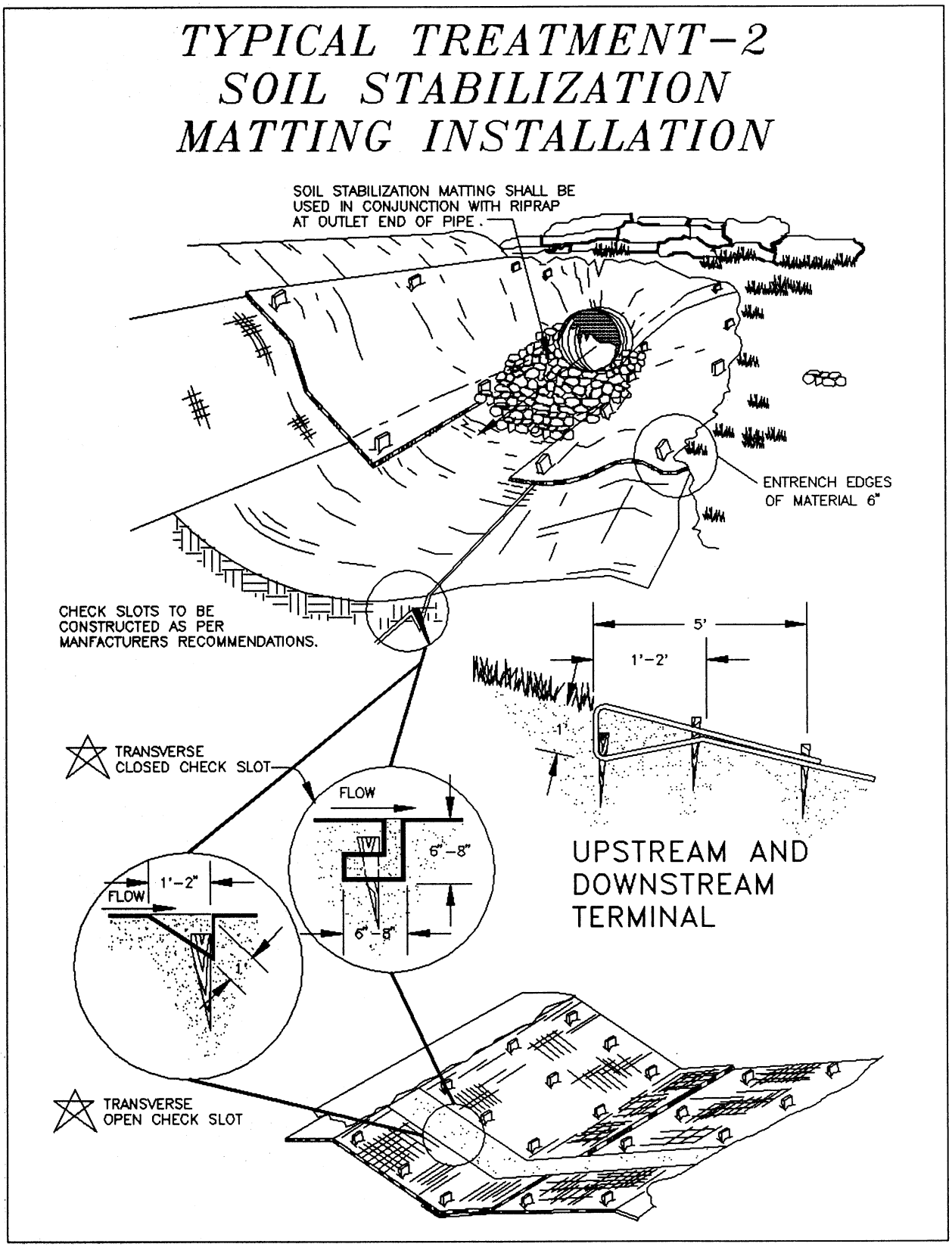
Securing the Material and Joining Mats - Again, product specifications vary - upstream and downstream terminal slots, new roll overlaps and multiple width installations differ by various products and manufacturers.

Final Check - These installation techniques must be adhered to:

1. Soil stabilization mat is in uniform contact with the soil.
2. All required slots and lapped joints are in place.
3. The material is properly anchored.
4. All disturbed areas are seeded.

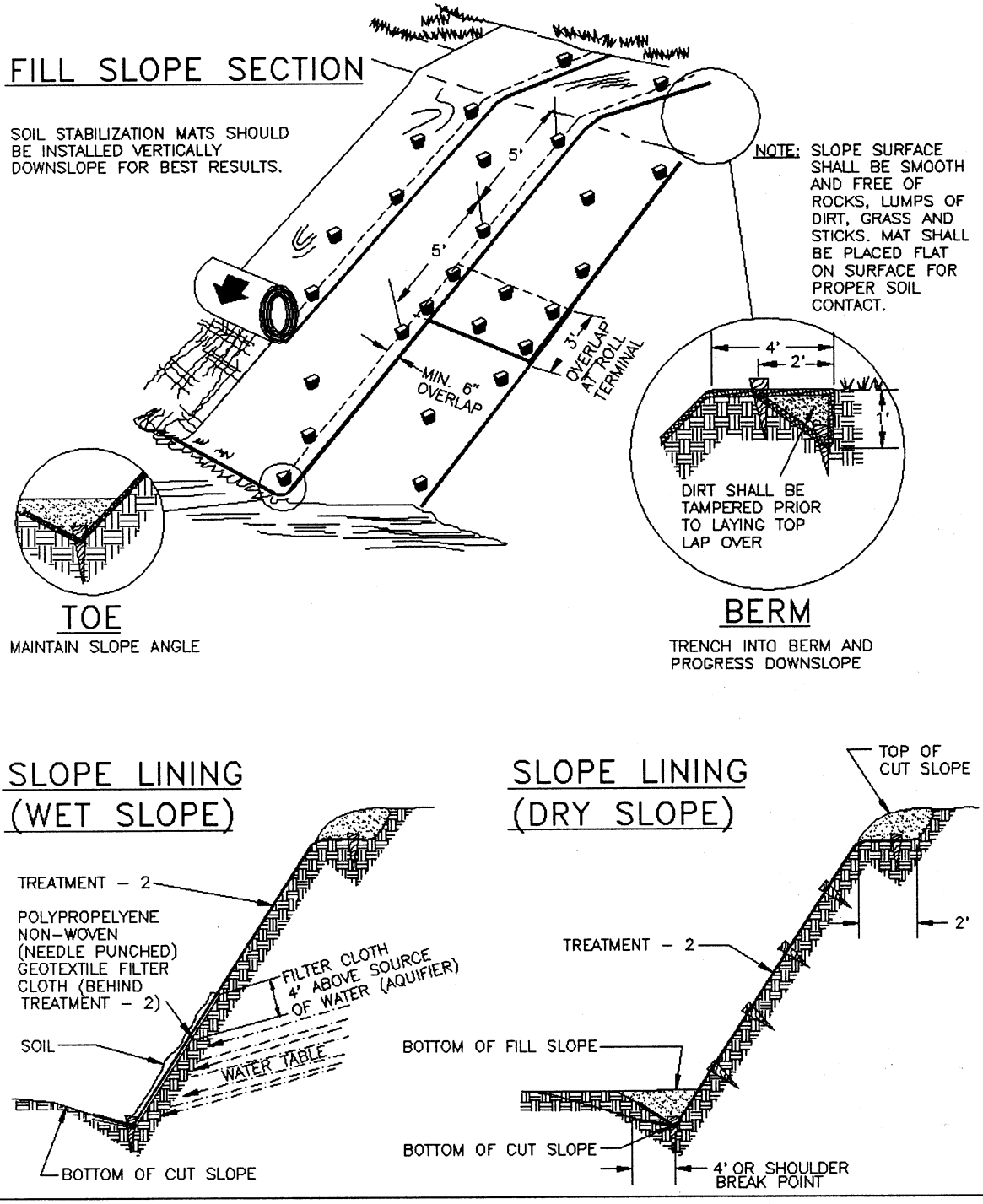
Maintenance

All soil stabilization blankets and matting should be inspected periodically following installation, particularly after rainstorms to check for erosion and undermining. Any dislocation or failure should be repaired immediately. If washouts or breakage occurs, re-install the material after repairing damage to the slope or ditch. Continue to monitor these areas until which time they become permanently stabilized; at that time an annual inspection should be adequate.



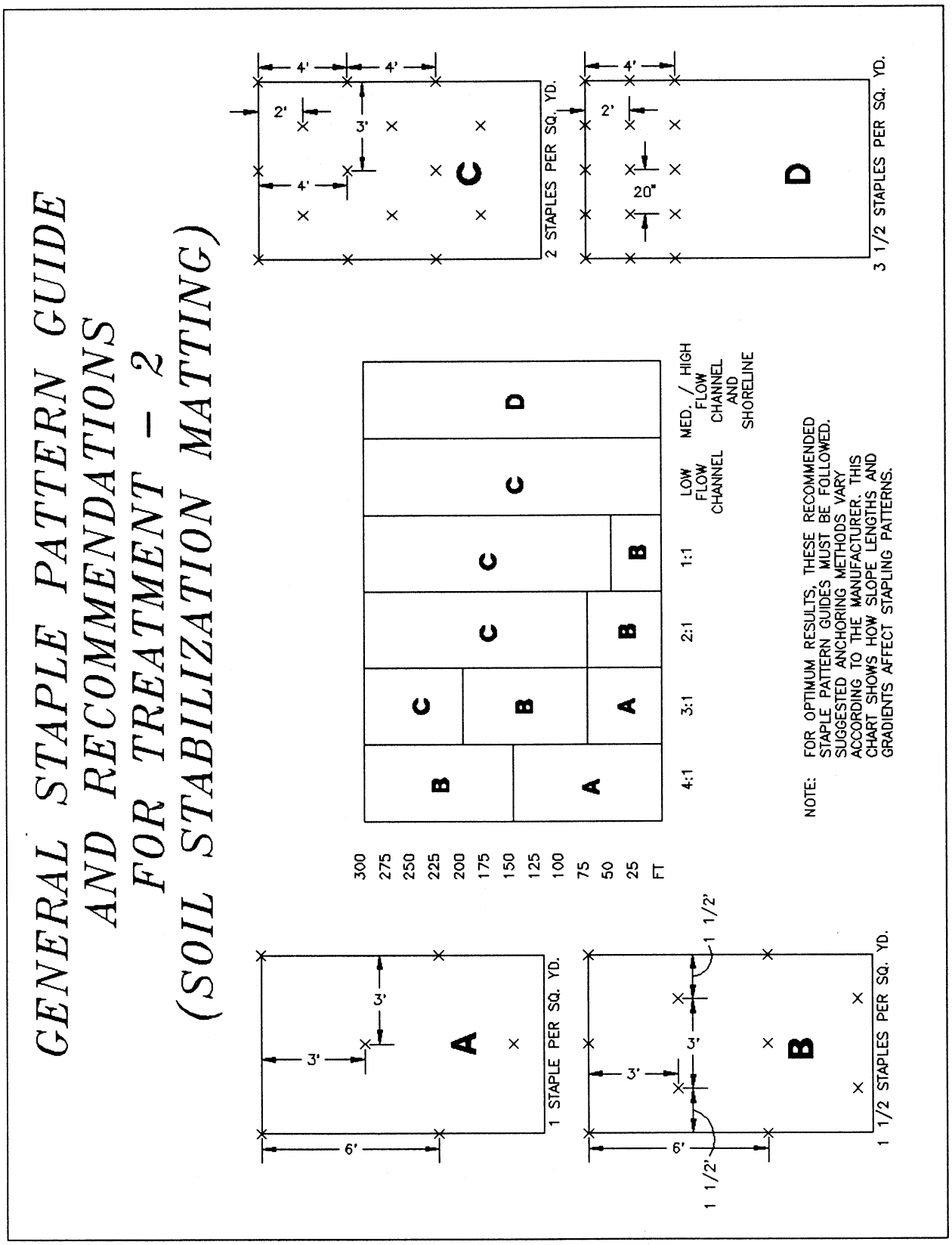
Source: VDOT Road and Bridge Standards Plate 3.36-4

TYPICAL TREATMENT – 2
SOIL STABILIZATION MATTING
SLOPE INSTALLATION



Source: VDOT Road and Bridge Standards

Plate 3.36-5



Source: Product literature from North American Green Plate 3.36-6

STD & SPEC 3.37

TREES, SHRUBS, VINES & GROUND COVERS

Definition

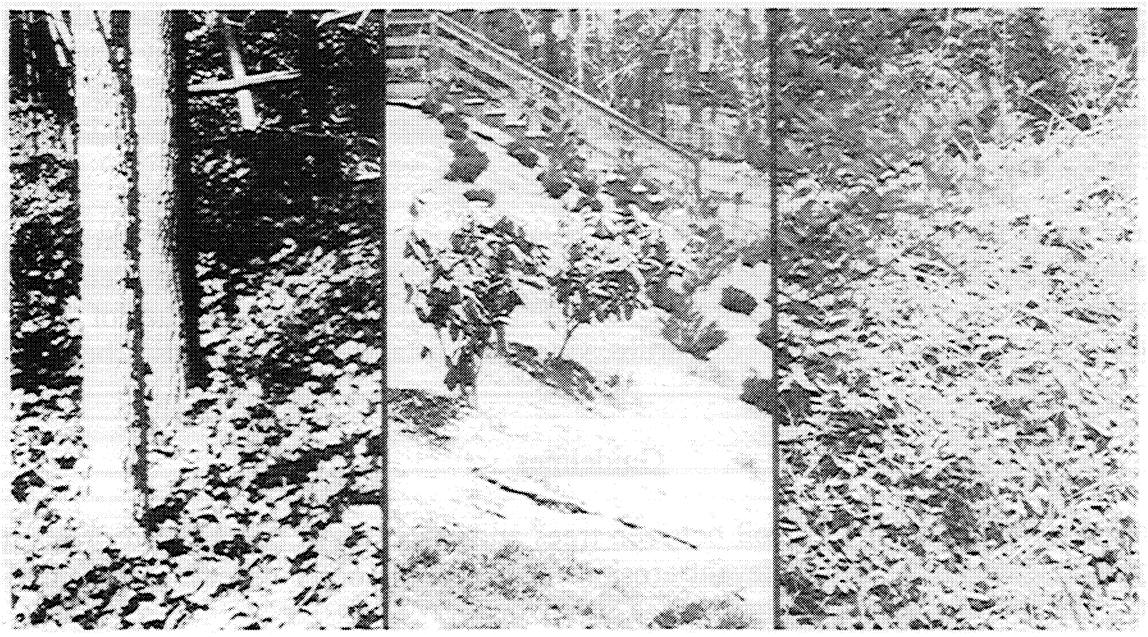
Stabilizing disturbed areas by establishing vegetative cover with trees, shrubs, vines, or ground covers.

Purposes

1. To aid in stabilizing soil in areas where vegetation other than turf is preferred.
2. To provide food and shelter for wildlife where wildlife habitat is desirable.

Conditions Where Practice Applies

1. In areas where turf establishment is difficult.
2. On steep or rocky slopes, where mowing is not feasible.



3. Where ornamentals are desirable for landscaping purposes.

4. Where woody plants are desirable for soil conservation, or to establish wildlife habitat.

Planning Considerations

Disturbed areas may be stabilized in many different ways. Most frequently, a permanent vegetative cover of grasses and legumes is established. There are locations, however, where other types of vegetation are preferred. The following situations are examples of ways in which trees, shrubs, vines, and ground covers may be used:

1. On cut and fill slopes adjacent to paved areas of shopping centers, schools, industrial parks, or other non-residential projects: woody plants and ground covers can be used on these slopes to control erosion. They will also help to control foot traffic, will not require as much maintenance as mowed lawns, and will be more attractive than unmowed grass cover.

2. In residential areas, slopes too steep to be mowed and areas along rights-of-way or easements may be planted in trees, shrubs, vines or ground covers to reduce maintenance and improve appearance.

3. The interested homeowner or small project developer may choose to use ornamental plants in problem areas - shade, steep slopes, inaccessible places - as alternatives to grass. Ground covers may be used to reduce or eliminate the need for mowing grass on level areas.

There are vast numbers of plants that may be used for these purposes. The plants discussed in this practice are those which are known to be adapted to Virginia, fairly easy to grow, and commonly available from commercial nurseries. Many plants suitable for use are not mentioned here. Information on such plants can be obtained from nurserymen, landscape architects, and extension agents.

Because many types of woody plants and ground covers are discussed, and because site conditions and land use vary so widely, it is not practical to give specific requirements for the establishment of every plant mentioned. This practice consists, instead, of a set of general guidelines for growing trees, shrubs, vines, and ground covers on disturbed land.

Guidelines

As noted in MS #1, disturbed soil between trees and shrubs must be mulched or planted with permanent vegetation to prevent erosion. Refer to the other vegetative practices to select a method for stabilizing these areas.

Trees

Selecting the Right Trees - In the urban and suburban environment, trees may be exposed to insufficient light and water; high velocity winds; salt from highway ice control programs; heat radiation from roads and buildings; pollutants from cars and industry; root amputation for water, sewer, and gas lines; topping to prevent interference with power lines; and covering of roots by pavement. New species and varieties of trees are being selected for the modern environment on the basis of their ability to withstand those difficult conditions and still provide the benefits associated with having trees (see Plate 3.37-1).

Selection of trees depends on the desired function of the tree, whether it be shade, privacy screening, noise screening, appearance, enhancement of wildlife habitat, or a combination of these. The following characteristics of the tree should be considered when making choices:

1. Hardiness - "Hardiness zones" are based on average annual minimum temperature. Virginia contains 3 such zones (Plate 3.37-2) to which different trees are adapted.

2. Mature height and spread - The eventual height of a tree must be considered in relation to planting location to avoid future problems with power lines and buildings (see Plate 3.37-3).

3. Growth rate - Some trees attain mature height at an early age, others take many years. If "instant shade" is desired, rapid growth is needed. Slow-growing trees are usually less brittle and live longer.

4. Root system - Some trees obstruct underground pipelines with fibrous roots.

5. Cleanliness - Maintenance problems can be avoided by not selecting trees that drop seedpods, flowers, or twigs in large amounts.

6. Moisture and fertility requirements - If good soil and drainage are not available, trees tolerant of poor growing conditions must be planted.

7. Ornamental effects - If a tree is unusually attractive in appearance, some other shortcomings may be overlooked.

8. Evergreen vs. deciduous - Evergreens retain their leaves throughout the year, and so are useful for privacy screens and noise screens. Deciduous trees drop their leaves in fall. They are preferable for shade trees.

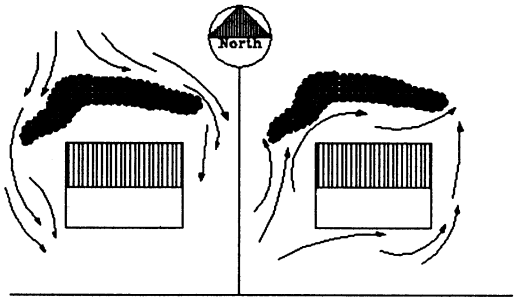
Some of these characteristics are given in Table 3.37-B for trees commonly grown in Virginia.

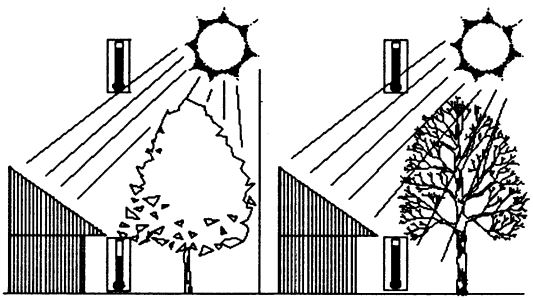
At the same time as trees are being selected, the site where they will be planted should be evaluated. Consider the prior use of the land; adverse soil conditions, such as poor drainage

BENEFITS OF TREES

TEMPERATURE MODIFICATION

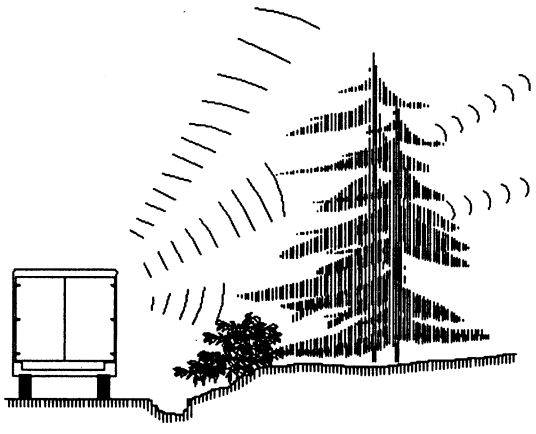
TREES AFFECT WIND SPEED AND DIRECTION, AND THUS TEMPERATURE. FOR EXAMPLE, AN EVERGREEN PLANTING ON THE NORTHWEST SIDE OF A BUILDING WILL REDUCE THE EFFECTS OF HARSH WINTER WINDS AND DIRECT COOL SUMMER BREEZES THROUGH THE AREA. TREES PROTECT THE SOIL FROM DRYING SUN AND WIND, REDUCING EVAPORATION AND MAINTAINING COOLER TEMPERATURES UNDER TREES. WHEN PROPERLY PLACED NEAR BUILDINGS, TREES OF PROPER SIZE WILL INSULATE BUILDINGS FROM EXTREME TEMPERATURE CHANGES IN WINTER AND SUMMER, HELPING REDUCE COSTS OF HEATING AND COOLING. DECIDUOUS TREES BLOCK OUT THE HOT SUMMER SUN, KEEPING THE HOME COOLER, AND ALLOW WARMTH OF WINTER SUN TO PASS THROUGH.





SOUND CONTROL

NOISES FROM NEARBY SOURCES CAN BE REDUCED THROUGH PROPER PLACEMENT OF TREES. THE DEGREE OF CONTROL DEPENDS ON THE DENSITY OF THE PLANTING AND INTENSITY AND DIRECTION OF SOUND WAVES. BOTH DECIDUOUS AND EVERGREEN TREES SHOULD BE USED FOR BEST EFFECT.

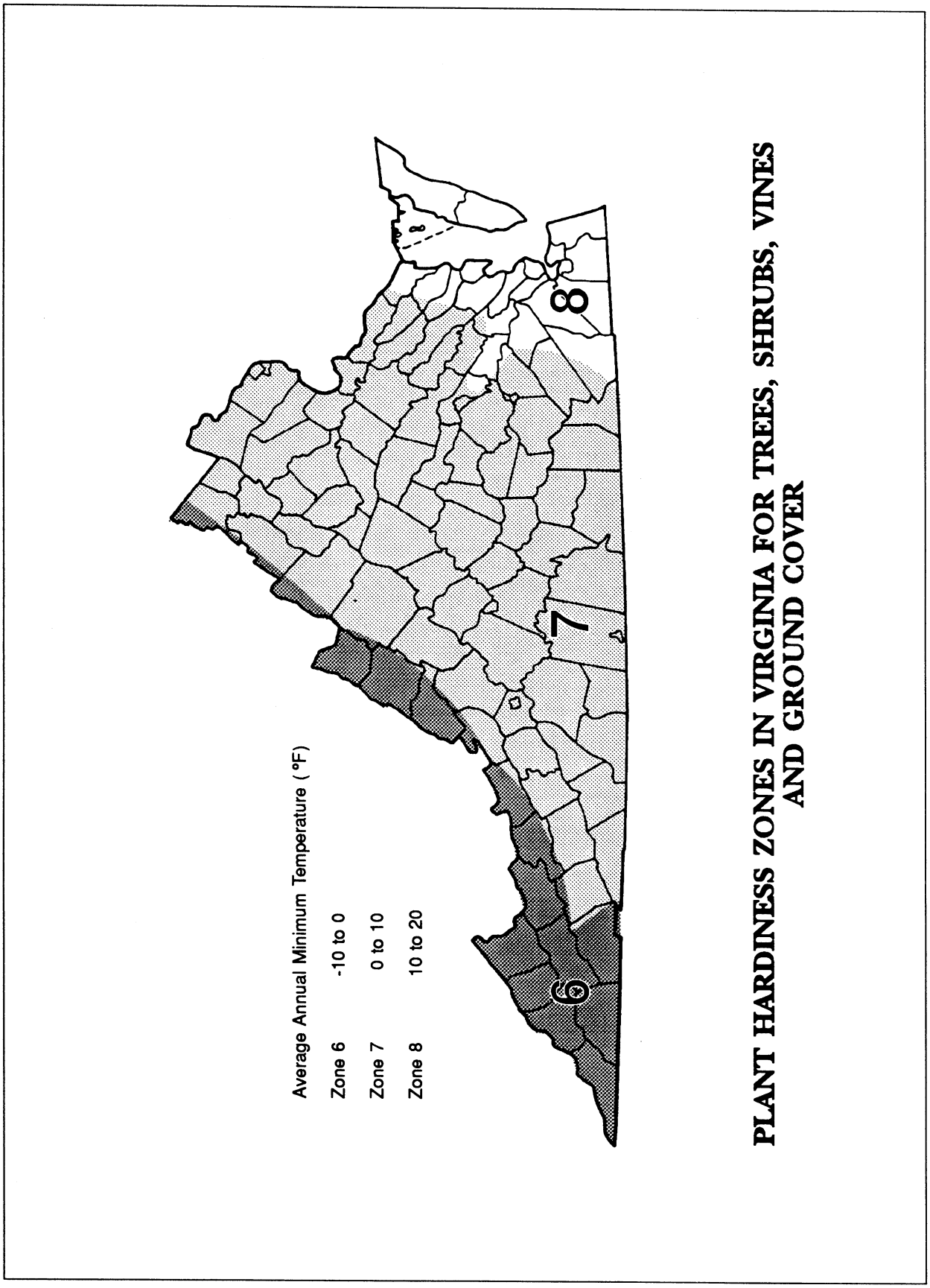


EROSION CONTROL

COARSE LEAF TEXTURES, HORIZONTAL BRANCHING HABITS, FIBROUS ROOT STSTEMS, AND ROUGH BARK ARE TREE CHARACTERISTICS MOST EFFECTIVE IN SLOWING WATER MOVEMENT AND WIND SPEED, THUS REDUCING EROSION PROBLEMS.

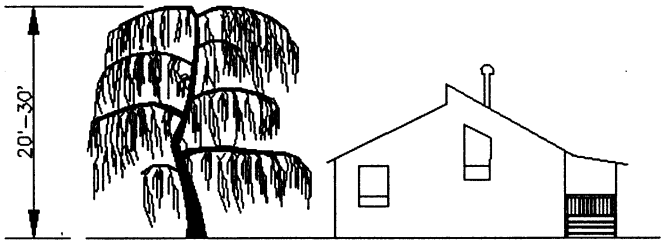
Source: Va. DSWC

Plate 3.37-1



Source: Conservation Plants for the Northeast, USDA-SCS Plate 3.37-2

SPACING TREES FOR SAFETY AND EFFECTIVE LANDSCAPING

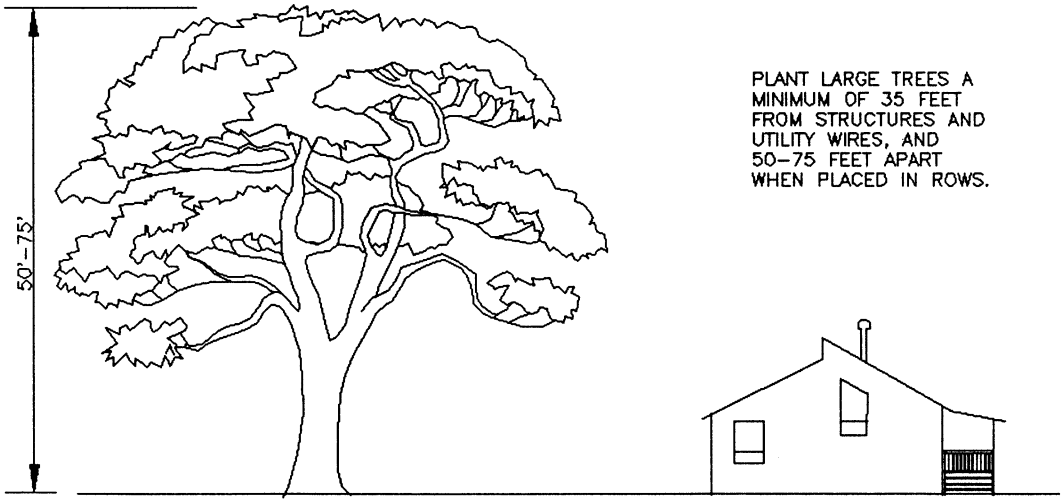


PLANT SMALL TREES A MINIMUM OF 12 FEET FROM STRUCTURES OR UTILITY WIRES. IN ROWS, PLANT THEM 25 FEET APART.

SMALL TREES

PLANT MEDIUM TREES A MINIMUM OF 25 FEET FROM STRUCTURES AND UTILITY WIRES, AND 30–50 FEET APART IN ROWS.

MEDIUM TREES



PLANT LARGE TREES A MINIMUM OF 35 FEET FROM STRUCTURES AND UTILITY WIRES, AND 50–75 FEET APART WHEN PLACED IN ROWS.

LARGE TREES

Source: Va. DSWC

Plate 3.37-3

or acidity, exposure to wind; temperature extremes; location of utilities, paved areas, and security lighting; and traffic patterns.

Sources of trees and how they may be bought - The trees listed in Table 3.37-A are usually available at commercial nurseries as container-grown trees or as balled and burlapped trees. Container-grown trees can be planted at any time of year that the ground is not frozen, if sufficient water is provided. They should be purchased and planted when quite young (less than 2" diameter trunk) to avoid dealing with root-bound plants.

Balled and burlapped trees are usually larger; check to be sure that soil around roots was dug with the tree and not just packed around bare roots. The soil should have been kept moist.

Tree seedlings are available commercially and are also sold in lots of 50, 100, 500, or 1000 by the state forest nurseries. State nurseries are located in New Kent, Augusta, and Cumberland. About 20 species of trees are usually available during the height of the planting season, at nominal prices. These seedlings are not to be used as ornamentals or for fine landscaping; they are intended to be used as conservation plantings for erosion control, reforestation, and development of wildlife habitat. Since 50 seedlings will only plant an area of 3000 square feet, it is permissible to plant fairly small areas as long as the purpose is conservation. More information about this program is available through the Virginia Department of Forestry.

Planting Bare-Rooted Tree Seedlings

When - Trees to be planted as bare-rooted seedlings should be handled only while dormant in spring, or after leaf fall in autumn. Refer to Plate 3.37-4 for planting instructions.

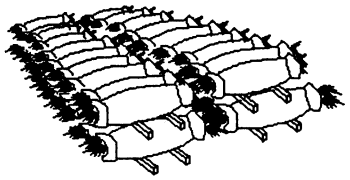
When stabilizing the disturbed area between tree plantings, do not use grasses or legumes which will overshade the new seedlings. Where possible, a circle of mulch around seedlings will help them to compete successfully with herbaceous plants.

Transplanting Trees (Planting Balled-and-Burlapped and Container-Grown Trees)

When - Hardwoods should be transplanted in the late fall following their leaf drop. There is a single exception to this rule: "Willow" Oaks seem to survive at a greater rate when they are transplanted in the spring. Evergreens may be transplanted beginning with the fall cool-down period (normally September) and may continue into spring prior to elongation of the new growth.

Tree preparation - Proper digging of a tree includes the conservation of as much of the root system as possible, particularly the fine roots. Soil adhering to the roots should be damp when tree is dug, and kept moist until planting. The soil (or "root") ball should be 12 inches in diameter for each inch of diameter of the trunk. The tree should be carefully excavated and the soil ball wrapped in burlap and tied with rope. Use of a mechanical tree spade is also acceptable.

PLANTING BARE-ROOTED SEEDLINGS



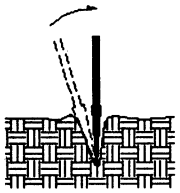
CARE OF SEEDLINGS UNTIL PLANTED

SEEDLINGS SHOULD BE PLANTED IMMEDIATELY. IF IT IS NECESSARY TO STORE MOSS-PACKED SEEDLINGS FOR MORE THAN 2 WEEKS, ONE PINT OF WATER PER PKG. SHOULD BE ADDED. IF CLAY-TREATED, DO NOT ADD WATER TO PKG. PACKAGES MUST BE SEPERATED TO PROVIDE VENTILATION TO PREVENT "HEATING". SEPARATE PACKAGES WITH WOOD STRIPS AND STORE OUT OF THE WIND IN A SHADED, COOL (NOT FREEZING) LOCATION.

CARE OF SEEDLINGS DURING PLANTING

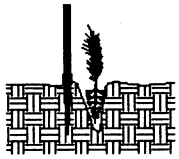
WHEN PLANTING, ROOTS MUST BE KEPT MOIST UNTIL TREES ARE IN THE GROUND. DO NOT CARRY SEEDLINGS IN YOUR HAND EXPOSED TO THE AIR AND SUN. KEEP MOSS-PACKED SEEDLINGS IN A CONTAINER PACKED WITH WET MOSS OR FILLED WITH THICK MUDDY WATER. COVER CLAY-TREATED SEEDLINGS WITH WET BURLAP ONLY.

HAND PLANTING

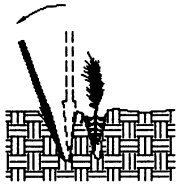


INSERT BAR AT ANGLE SHOWN AND PUSH FORWARD TO UPRIGHT POSITION.

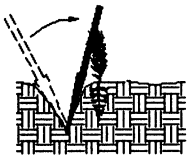
REMOVE BAR AND PLACE SEEDLING AT CORRECT DEPTH.



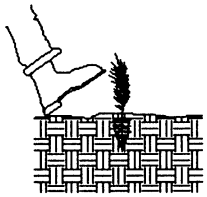
INSERT BAR TWO INCHES TOWARD PLANTER FROM SEEDLING.



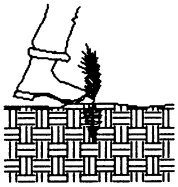
PULL BAR TOWARD PLANTER FIRMING SOIL AT BOTTOM OF ROOTS.



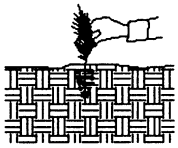
PUSH BAR FORWARD FROM PLANTER FIRMING SOIL AT TOP OF ROOTS.



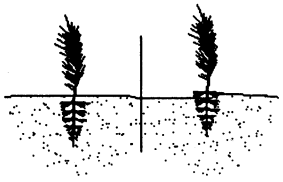
FILL IN LAST HOLE BY STAMPING WITH HEEL.



FIRM SOIL AROUND SEED-LING WITH FEET.



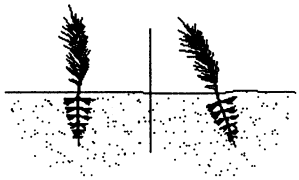
TEST PLANTING BY PULLING LIGHTLY ON SEEDLING.



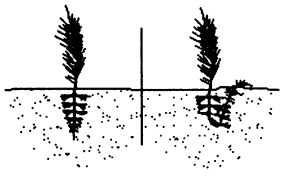
RIGHT WRONG

DON'T EXPOSE ROOTS TO AIR DURING FREEZE OR PLANT IN FROZEN GROUND.

PLANT SEEDLINGS UPRIGHT - NOT AT AN ANGLE.

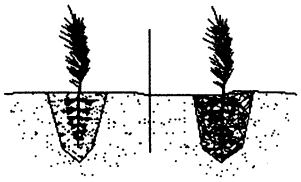


RIGHT WRONG



DO NOT BEND ROOTS SO THAT THEY GROW UPWARDS OUT OF THE GROUND.

ALWAYS PLANT IN SOIL - NEVER LOOSE LEAVES OR DEBRIS. PACK SOIL TIGHTLY.



Source: Va. Department of Forestry Plate 3.37-4

Evergreens, or any trees which are to be transported for a distance, should have the branches bound with soft rope to prevent damage.

Site Preparation - Rather than digging a planting hole, rototill or loosen with a shovel, a shallow area the depth (height) of the soil ball and the width of five times the diameter of the soil ball or container. Organic material can be added to the loosened soil as long as the new material is used uniformly throughout the area.

Heavy or poorly drained soils are not good growth media for trees. When it is necessary to transplant trees into such soils, extra care should be taken. Properly installed drain tile will improve drainage.

Setting the tree - At the center of the prepared area, dig a shallow hole to set the tree. The hole should allow the root ball to sit on solid ground rather than loose soil. The upper surface of the root ball should be level with the existing soil. The tree may be set just a few inches higher than its former location, especially if soil is poorly drained. Do not set the tree lower than it was previously positioned. Soil to be placed around the root ball should be moist but not wet (see Plate 3.37-5).

Set the tree in the hole and remove the rope which holds the burlap. Cut away the burlap or, at a minimum, push it back into the bottom of the excavation. Do not break the soil of the root ball. Fill the hole with soil half-way, and tamp firmly around the root ball. Add water to settle the soil and eliminate air pockets. When the water has drained off, fill the hole the remainder of the way and tamp as before.

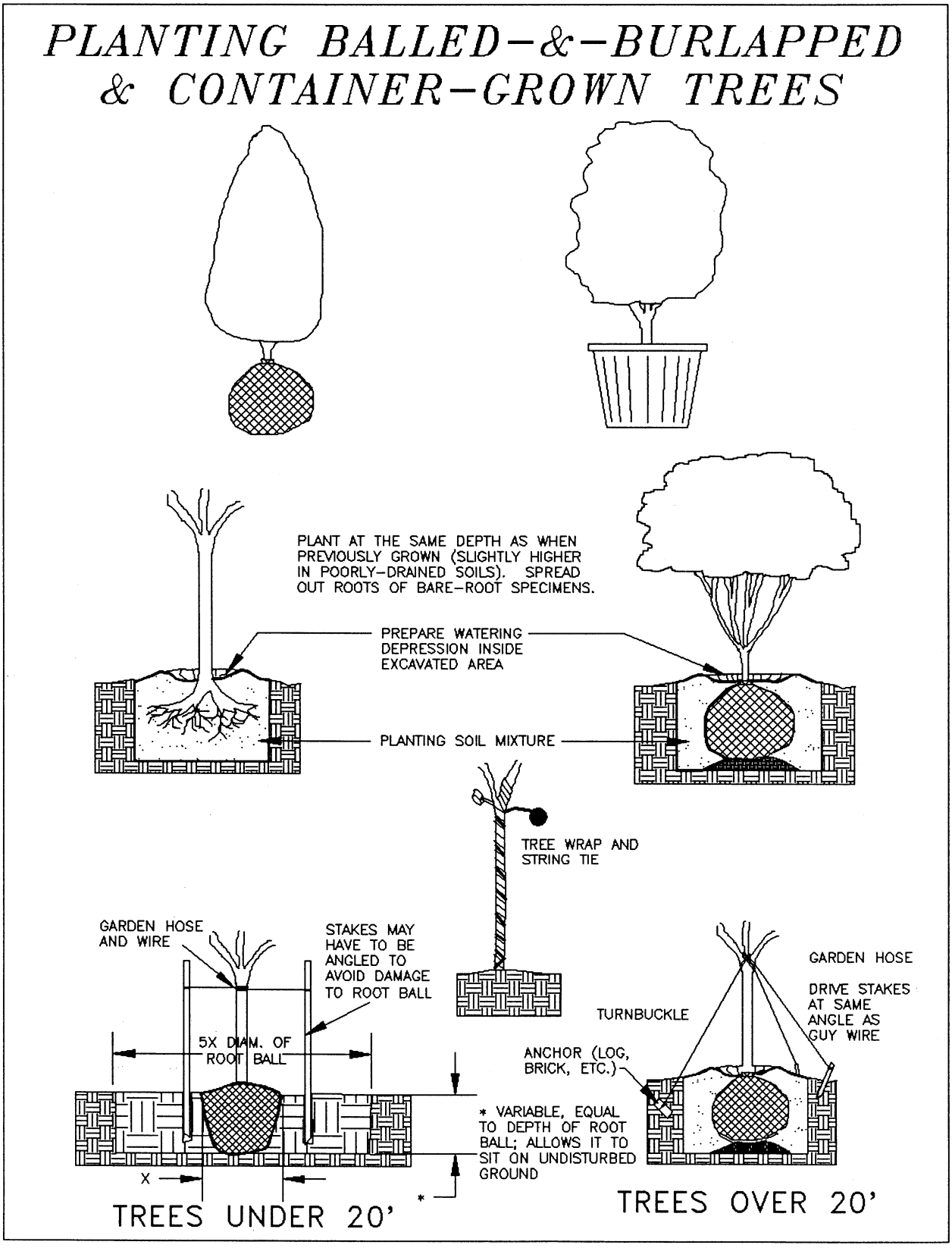
Use extra soil to form a shallow basin around the tree, somewhat smaller than the diameter of the root ball (Plate 3.37-5). This will be for holding water when the tree is irrigated.

Note: Level the ground and eliminate these basins when winter sets in, as ice forming in the basin might injure the trunk.

Supporting the tree - Newly planted trees may need artificial support, especially in windy areas, to prevent excessive swaying. Stakes or guy wires may be used (see Plate 3.37-4). Use rubber hose and allow some slack in the guy to encourage strengthening of the plant. Remove all supports within six months of planting.

Watering - Soil around the tree should be thoroughly watered after the tree is set in place. When the soil becomes dry, the tree should be watered deeply but not too often. Mulching around the base of the tree is helpful in preventing roots from drying out.

Maintenance of Tree Plantings - Like all plants, trees require water and fertilizer to grow. Ideally, young trees should receive an inch of water each week for the first two years after planting. When rain does not supply this need, the tree should be watered deeply but not any more frequent than once per week.



Source: Va. Department of Forestry

Plate 3.37-5

Transplanted trees should be fertilized one year or so after planting. There are many sophisticated ways to supply fertilizer to trees, but some simple methods are adequate. The best material for small trees is well-rotted stable manure, if it can be obtained. Add it as a 2-inch layer of mulch around the tree annually. If chemical fertilizers are to be used, a formulation such as 10-8-6 or 10-6-4 is preferred. Use about 2 lbs. per inch of trunk diameter measured 4 feet from the ground. Thus, if the trunk diameter at 4 feet was 5 inches, 10 lbs. of fertilizer would be applied.

Note: Evergreens - use one-half the recommended amount of chemical fertilizer or use only organic fertilizers such as cottonseed meal, bone meal, or manure.

Fertilizer must come in contact with the roots to benefit the tree. A simple way to insure this is to make holes in the tree's root area with a punchbar, crowbar, or augur. Holes should be 18-inches deep, spaced about 2 feet apart, and located around the drip line of the tree. Distribute the necessary fertilizer evenly into these holes, and close the holes with the heel of the shoe or by filling with topsoil or peat moss.

Fertilize trees in late fall or in early spring, before leaves emerge.

Shrubs

Much of what has been said about trees also applies to shrubs. A shrub is an erect, woody plant less than 15 feet tall, usually with several trunks rising from a common base. Some have the appearance of small trees, and some lie close to the ground.

Selecting appropriate shrubs - There are so many ornamental shrubs available that advising on the choice of any one is difficult. Table 3.37-B gives the basic characteristics of shrubs commonly available at commercial nurseries in Virginia, which are recommended for conservation planting because they enrich or hold the soil or encourage development of wildlife habitat. Information on other shrubs is available from nurserymen and extension agents.

Follow the general procedure for tree planting when planting shrubs.

Maintenance

Proper pruning, watering, and application of fertilizer every three years or so will keep shrubs, healthy. Maintain the mulch cover or turf cover surrounding the shrubs. A heavy layer of mulch reduces weeds and retains moisture.

VINES AND GROUND COVERS

Low-growing plants that sprawl, trail, spread, or send out runners come in many leaf types, colors and growth habits. Some are suitable only as part of a maintained landscape, and some can stabilize large areas with little care.

In addition to stabilizing disturbed soil, vines and ground covers can perform the following functions:

1. Maintain cover in areas where turf will not thrive.

2. Provide attractive cover that does not need mowing.

3. Help to define traffic areas and control pedestrian movement. People are more likely to walk on the grass than to walk on a thick bed of ivy or a prickly planting of juniper.

Table 3.37-C gives the characteristics of some commonly used vines and ground covers suitable for Virginia. Information on others is available from nurserymen.

Most all ground covers perform best when planted in the spring. Container-grown plants can be planted throughout the growing season if adequate water is provided.

Site preparation - Ground covers are plants that naturally grow very close together, causing severe competition for space, nutrients, and water. Soil for ground covers should be well-prepared. A well-drained soil high in organic matter is best.

If the area to be planted is so large that adding amendments to the soil as a whole would be impractical, organic matter may be added only to each planting hole.

Lime and fertilize according to soil test, or add 5 lbs. or 10-10-10 and 10 lbs. of ground agricultural limestone to every 100 square feet. Incorporate into the top 4 to 6 inches of the soil. Add organic matter up to one-third of the total soil volume, either over the whole area (a layer 2 inches deep mixed into the top 6 inches) or in each planting hole, if the area is large.

Plants such as ivy, pachysandra, and periwinkle should be planted on 1-foot centers; large plants such as juniper can be spaced on 3-foot centers.

Mulching - The soil between trees and shrubs must be planted with cover vegetation or must be mulched. When establishing ground covers, it is not desirable to plant species that will compete strongly with the ground cover or will make maintenance difficult. A thick, durable mulch such as shredded bark or wood chips is recommended to prevent erosion and reduce weed problems. Pre-emergent herbicides may be necessary where weeding is not practical.

On slopes where erosion may be a problem, jute mesh or excelsior blankets may be installed prior to planting, and plants tucked into the soil through slits in the net. Such plants should be put in a staggered pattern to minimize erosion.

Maintenance

Trim old growth as needed to improve the appearance of ground covers. Most covers need once-a-year trimming to promote growth. Maintain mulch cover with additions of mulch where needed. Fertilize as described above, every 3 to 4 years.

TABLE 3.37-A
TREES FOR LANDSCAPING, EROSION CONTROL AND SOIL CONSERVATION IN VIRGINIA

COMMON NAME (Botanical Name)	Leaf Type	Zones in Va.	Mature Size (in feet)	SOIL MOISTURE PREFERRED			pH Range	USES			Disease/Pest Resistance	Salt Tolerance	POLLUTION TOLERANCE			REMARKS (Suggested Varieties)
				Dry	Med	Wet		Lawns	Street	Seashore			O_3	SO_2	F	
BEECH (Fagus grandifolia)	D	6 7 8	70 - 120		X		6.5 - 7.5	X			fair	S	-	S	-	Long-lived. Has edible nuts. Needs lots of space.
BIRCH, RIVER (Betula nigra)	D	7 8	50 - 80	X	X		4.0 - 5.0	X			good	-	S	S	-	Prefers deep, moist soils such as streambanks. Graceful form.
CEDAR, EASTERN RED (Juniperus virginiana)	E	7 8	20 - 50	X	X	X	6.0 - 6.5	x			good	-	T	T	T	Long-lived.
CHERRY, JAPANESE (Prunus serrulata)	D	6 7 8	15 - 20		X		6.5 - 7.5	X	X		good	-	-	-	T	Very showy pink or white flowers. Usually grafted on 6-7 foot stem. (Kwanzan)
CRABAPPLE (Malus spp.)	D	6 7 8	15 - 20		X		6.5 - 7.5	X	X	X	fair	I	S	S	-	White or pink flowers. Many varieties, some with edible fruit.
CUCUMBER TREE (Magnolia acuminata)	D	6 7	50 - 80	X	X		4.0 - 7.0	X			good	-	-	-	-	Grows rapidly. Green flowers; scarlet fruits in fall.
DOGWOOD, FLOWERING (Cornus florida)	D	6 7 8	30 - 40		X		5.0 - 6.5	X	X		good	-	T	T	T	Ideal street tree. White or pink flowers. Has poor drought resistance.
GINKGO (Ginkgo biloba)	D	6 7 8	to 100		X	X	6.0 - 6.5	x	x		very good	-	T	T	T	Plant male trees only - fruit has an offensive odor.

TABLE 3.37-A (continued)
TREES FOR LANDSCAPING, EROSION CONTROL AND SOIL CONSERVATION IN VIRGINIA

COMMON NAME (Botanical Name)	Leaf Type	Zones in Va.	Mature Size (in feet)	SOIL MOISTURE PREFERRED			pH Range	USES			Disease/Pest Resistance	Salt Tolerance	POLLUTION TOLERANCE			REMARKS (Suggested Varieties)
				Dry	Med	Wet		Lawns	Street	Seashore			O_3	SO_2	F	
GOLDEN RAIN TREE (Koelreutaria paniculata)	D	6 7 8	20 - 30		X	X	6.0 - 6.5	X	X		good	-	-	-	-	Clusters of yellow flowers. Tolerant of parking lot conditions.
HACKBERRY, SOUTHERN (Celtis Mississippiensis)	D	6 7 8	80 - 90	X	X	X	6.5 - 7.5	X	X		good	T	T	T	-	Resembles elm in appearance. European hackberry also a good street tree. Tolerant of parking lot conditions.
HAWTHORNE (Crataegus spp.)	D	6 7 8	15 - 25		X		6.0 - 7.5	X	X		good	I	-	S	-	Thorny, Washington, and Lavalle types are good ornamentals. Tolerant of parking lot conditions.
HOLLY (Ilex opaca)	E	6 7 8	40 - 50	X	X	X	4.0 - 6.0	X	X	X	good	I	-	T	T	Slow-growing. Shade tolerant. Red berries appear only on female trees.
HORNBEAM (IRONWOOD) (Carpinus spp.)	D	6 7 8	10 - 30	X	X	X	6.5 - 7.5	X	X		good	S	-	T	I	Prefers low, moist bottomlands. Will tolerate shade. Yeddo hornbeam and European hornbeam preferred.
LINDEN, LITTLE LEAF (Tilia cordata)	D	6 7 8	40 - 50		X		6.5 - 7.5	X	X	X	fair	S	S	I	T	Best streetside linden. (Rancho, Greenspire, Chancellor)
LOCUST, BLACK (Robinia pseudo-acacia)	D	6 7 8	30 - 50		X	X	5.0 - 7.5			X	fair	I	S	T	I	Suited only to erosion control on seriously disturbed areas.

TABLE 3.37-A (continued)
TREES FOR LANDSCAPING, EROSION CONTROL AND SOIL CONSERVATION IN VIRGINIA

COMMON NAME (Botanical Name)	Leaf Type	Zones in Va.	Mature Size (in feet)	SOIL MOISTURE PREFERRED			pH Range	USES			Disease/Pest Resistance	Salt Tolerance	POLLUTION TOLERANCE			REMARKS (Suggested Varieties)
				Dry	Med	Wet		Lawns	Street	Seashore			O_3	SO_2	F	
LOCUST, HONEY (Gleditsia triacanthos inermis)	D	6 7	50 - 75	X	X	X	6.5 - 7.5	X	X	X	good	T	S	-	-	Sturdy, wind-firm tree. (Moraine, Sunburst, Shademaster)
MAGNOLIA, SOUTHERN (Magnolia grandiflora)	E	7 8	60 - 80	X	X		4.0 - 7.0	X		X	good	-	-	-	-	Prefers moist, rich soil. Large, glossy leaves and 6-8" white flowers. Tolerant of parking lot conditions.
MAPLE, HEDGE (Acer campestre)	D	6 7 8	20 - 30		X	X	6.5 - 7.5	X	X		good	-	T	T	I	Prefers well-drained, deep, fertile soil. May be used in clipped hedges.
MAPLE, NORWAY (Acer platanoides)	D	6 7 8	50 - 60		X	X	6.5 - 7.5	X	X	X	good	T	I	T	I	Rapid growing. Provides extremely dense shade (kills grass). (Cavalier, Summer Shade)
MAPLE, RED (Acer rubrum)	D	6 7 8	50 - 80	X	X		4.5 - 7.5	X	X	X	good	S	T	T	-	Grows rapidly when young. Good tree for suburbs, but not city. (Gerling, Tilford)
MAPLE, SUGAR (Acer saccharum)	D	6	50 - 70	X	X	X	6.5 - 7.5	X			fair	I	T	T	-	Outstanding fall foliage. Suburban, but not city, tree. Slow-growing and shapely. (Green Mountain)
OAK, CHESTNUT (Quercus montana)	D	6	60 - 70		X	X	6.0 - 6.5	X			good	T	S	T	I	Grows well in sandy, gravelly or rocky soils.

TABLE 3.37-A (continued)
TREES FOR LANDSCAPING, EROSION CONTROL AND SOIL CONSERVATION IN VIRGINIA

COMMON NAME (Botanical Name)	Leaf Type	Zones in Va.	Mature Size (in feet)	SOIL MOISTURE PREFERRED			pH Range	USES			Disease/Pest Resistance	Salt Tolerance	POLLUTION TOLERANCE			REMARKS (Suggested Varieties)
				Dry	Med	Wet		Lawns	Street	Seashore			O_3	SO_2	F	
OAK, PIN (Quercus palustris)	D	6 7 8	60 - 80	X	X	X	5.5 - 6.5	X	X		good	T	S	S	I	Most easily transplanted of the oaks. (Sovereign)
OAK, RED, NORTHERN (Quercus rubra borealis)	D	6 7 8	70 - 90		X	X	4.5 - 6.0	X	X	X	good	T	T	T	I	Most rapid-growing oak. Needs plenty of space.
OAK, RED, SOUTHERN (Quercus falcata)	D	7 8	70 - 80			X	4.0 - 5.0			X	good	-	T	T	I	Characteristically an upland tree. Prefers dry, infertile soils.
OAK, SCARLET (Quercus coccinea)	D	6 7	60 - 80			X	6.0 - 6.5	X	X		good	T	S	T	I	Prefers sandy or gravelly soils.
OAK, WHITE (Quercus alba)	D	6 7 8	60 - 80		X	X	6.5 - 7.5	X	X	X	fair	T	S	S	I	Long-lived, stately tree. Grows slowly.
OAK, WILLOW (Quercus phellos)	D	7 8	40 - 50	X	X	X	4.0 - 6.5	X			good	T	S	T	I	Long-lived, but grows quickly. Easy to transplant. Prefers fertile, acid soil.
PAGODATREE, JAPANESE (Sophora japonica)	D	7 8	30 - 40		X	X	6.0 - 7.5	X	X		good	-	-	-	-	Tolerates parking lot conditions. White flowers.

TABLE 3.37-A (continued)
TREES FOR LANDSCAPING, EROSION CONTROL AND SOIL CONSERVATION IN VIRGINIA

COMMON NAME (Botanical Name)	Leaf Type	Zones in Va.	Mature Size (in feet)	SOIL MOISTURE PREFERRED			pH Range	USES			Disease/Pest Resistance	Salt Tolerance	POLLUTION TOLERANCE			REMARKS (Suggested Varieties)
				Dry	Med	Wet		Lawns	Street	Seashore			O_3	SO_2	F	
PEAR, CALLERY (Pyrus Calleryana)	D	6 7 8	40 - 50		X	X	6.5 - 7.5	X	X		good	I	-	S	-	Tolerates parking lot conditions. White flowers. (Bradford, Chanticleer)
PINE, AUSTRIAN (Pinus nigra)	E	6 7 8	30 - 50		X	X	4.0 - 6.5	X		X	good	T	-	-	-	Very hardy and rapid-growing. Will tolerate shallow soil and drought.
PINE, JAPANESE BLACK (Pinus thunbergi)	E	7 8	30 - 50		X	X	4.0 - 6.5	X		X	good	T	-	-	-	Popular ornamental selection for Virginia.
PINE, LOBLOLLY (Pinus taeda)	E	7 8	90 - 120	X	X		4.0 - 6.5			X	good	-	-	S	S	Use only for conservation plantings, not as an ornamental.
PINE, SHORTLEAF (Pinus echinata Miller)	E	6 7 8	80 - 100		X	X	4.0 - 6.5	X			good	-	-	-	-	Attractive shape. Prefers well-drained, sandy or gravelly soil.
PINE, SCOTCH (Pinus sylvestris)	E	6 7	60 - 90			X	4.0 - 6.5	X			good	I	S	S	S	Moderate growth. Very hardy and disease resistant.
PINE, VIRGINIA (Pinus virginiana)	E	6 7	30 - 40		X	X	4.0 - 6.5	X			good	I	S	S	-	Tolerates poor soil. Use for conservation plantings, not as an ornamental. Shallow-rooted.

TABLE 3.37-A (continued)
TREES FOR LANDSCAPING, EROSION CONTROL AND SOIL CONSERVATION IN VIRGINIA

COMMON NAME (Botanical Name)	Leaf Type	Zones in Va.	Mature Size (in feet)	SOIL MOISTURE PREFERRED			pH Range	USES			Disease/Pest Resistance	Salt Tolerance	POLLUTION TOLERANCE			REMARKS (Suggested Varieties)
				Dry	Med	Wet		Lawns	Street	Seashore			O_3	SO_2	F	
PINE, WHITE (Pinus strobus)	E	6	80 - 100			X	4.0 - 6.5	X			fair	S	S	S	S	Very attractive, rapid-growing tree. Prefers deep, sandy loam. Subject to white pine blister rust.
PLANE-TREE, LONDON (Platanus acerifolia)	D	6 7 8	50 - 70		X		6.5 - 7.5	X	X	X	good	-	-	T	T	Good city tree. Does shed bark.
SWEETGUM (Liquidambar styraciflua)	D	7 8	80 - 120	X	X	X	6.0 - 7.5	X	X		good	-	S	S	T	Disease-prone in Washington, D.C. area. Splendid fall color. Needs deep soil and full sunlight. (Festival, Burgundy)
TUPELO (BLACKGUM) (Nyssa sylvatica)	D	6 7 8	60 - 80	X	X		5.0 - 6.0	X		X	good	I	T	T	-	Scarlet fall foliage. Suitable for swampy areas.
YEW, JAPANESE (Taxus cuspidata)	E	6 7 8	15 - 20		X		6.0 - 6.5	X			good	-	T	-	I	Can be used as an ornamental.
ZELKOVA (Zelkova serrata)	D	6 7 8	70 - 80		X		6.0 - 6.5	X	X		good	-	-	-	-	Recommended as replacement for American Elm. Hardy, fast-growing. Tolerates parking lot conditions.

Note: 1. For hardiness zones in Virginia, see Plate 3.37-2.

2. "E" - Evergreen
   "D" - Deciduous

3. Pollution tolerance: "S" - sensitive. Will show physical damage.
   "T" - tolerant.
   "I" - intermediate. Damage depends on growing conditions.
   "-" - no information at this time.

TABLE 3.37-B
SHRUBS FOR VEGETATING DISTURBED AREAS

COMMON NAME (Botanical Name)	Leaf Type	DRAINAGE TOLERANCE					Shade Tolerance	pH Range	Mature Height (in feet)	Flowers	FRUIT	USES
		Droughty	Well-Drained	Moderately Well-Drained	Somewhat Poorly Drained	Poorly Drained						
AMERICAN CRANBERRY BUSH (Viburnum trilobum)	D			X	X	X	fair	6.5 - 7.5	6 - 7	--*	red berries	Hedges and borders. Winter food for birds. Fruits in 4 - 5 years.
AMUR HONEYSUCKLE "Rem Red" (Lonicera maackii)	D	X	X	X	X		good	6.5 - 8.0	8 -12	white	red berries	Erect shrubs for borders and hedges. Fall and winter food for birds.
CALIFORNIA PRIVET (Ligustrum ovalifolium)	E		X	X			fair	6.0 - 7.0	12 -18	--	--	Hedges and wind-breaks. Grows rapidly. Do not use in Mountain Region.
AUTUMN OLIVE (Eleagnus umbrellata)	D	X	X	X			poor	4.5 - 7.0	12	fragrant	red berries	Reclaiming mined land, screening; abundant food for wildlife. Fixes nitrogen. Attractive silvery foliage.
BAYBERRY (Myrica pennsylvanica)	E	X	X	X			poor	5.0 - 6.0	6 - 8	--	waxy, gray berries	Revegetating sand dunes; ornamental for droughty areas; fixes nitrogen in soil.
BEACH PLUM (Prunus maritima)	D	X	X	X			fair	6.0 - 8.0	7	white	edible, purple plum-like fruits	Revegetating sand dunes/droughty areas. Fruit used for jelly and baking, also favored by wildlife.
BICOLOR LESPEDEZA "Natob" (Lespedeza bicolor)	D	X	X	X			fair	4.5 - 6.5	12	purple	--	Rapid-growing shrub, provides food and cover for quail and wild turkey. Fixes nitrogen. Holds soil on slopes.

E = Evergreen D = Deciduous * Where no comment is made, fruit or flowers are inconspicuous.

TABLE 3.37-B (continued)
SHRUBS FOR VEGETATING DISTURBED AREAS

COMMON NAME (Botanical Name)	Leaf Type	DRAINAGE TOLERANCE					Shade Tolerance	pH Range	Mature Height (in feet)	Flowers	FRUIT	USES
		Droughty	Well-Drained	Moderately Well-Drained	Somewhat Poorly Drained	Poorly Drained						
BRISTLY LOCUST "Arnot" (Robinia fertilis)	D	X	X	X			fair	5.0 - 7.5	6	pink	pods	Steep slopes, gravelly infertile areas. Fixes nitrogen. Spreads by sprouting from roots.
ELDERBERRY (Sambucus canadensis)	D		X	X	X	X	fair	6.0 - 7.5	12	white	edible purple berries	Provides food for birds and deer. Fruit in 4-5 yrs.
FIRETHORN (Pyracantha coccinea)	E	X	X	X			fair	6.0 - 8.0	10 - 15	white	orange or red berries	Screens, barriers. Food for songbirds. Low-growing and upright types available.
HORIZONTAL JUNIPER (Juniperus spp.)	E	X	X				poor	5.0 - 6.0	1 - 2	--	--	Used as ground cover or ornamental. Set plants 2 feet apart for cover in 2-3 years.
JAPANESE YEW (Taxus cuspidata)	E			X	X		good	6.0 - 7.0	12 - 16	--	--	Used for hedges and screens.
RUGOSA ROSE (Rosa rugosa)	D	X	X	X			fair	6.0 - 7.0	3 - 5	white, pink	red hips in 1-2 yrs.	Stabilizing sand dunes and landscaping. Food and cover for songbirds and rabbits. Sprawling growth habit, but not aggressive.
SHORE JUNIPER "Emerald Sea" (Juniperus conferta)	E	X	X				fair	5.0 - 6.0	1	--	--	Stabilizing sand dunes and sandy road banks.

E = Evergreen D = Deciduous * Where no comment is made, fruit or flowers are inconspicuous.

TABLE 3.37-B (continued)
SHRUBS FOR VEGETATING DISTURBED AREAS

COMMON NAME (Botanical Name)	Leaf Type	DRAINAGE TOLERANCE					Shade Tolerance	pH Range	Mature Height (in feet)	Flowers	FRUIT	USES
		Droughty	Well-Drained	Moderately Well-Drained	Somewhat Poorly Drained	Poorly Drained						
SWEET FERN (Comptonia peregrina)	D	X	X				poor	5.0 - 6.0	2 - 4	--	--	Pleasantly scented. Fixes nitrogen. Spreads by underground stems. Stabilizes droughty areas. Do not use in Coastal Plain.
TATARIAN HONEYSUCKLE (Lonicera tatarica)	D		X	X			fair	6.5 - 8.0	6 - 9	pink, showy	red berries in 3-4 yrs	Erect shrub; hedges, borders, summer food for birds.
WINTERBERRY (Ilex verticillata)	D		X	X	X	X	fair	5.0 - 6.0	10	--	red berries in 3-4 years	Ornamental screens. Winter food for songbirds.

E = Evergreen D = Deciduous * Where no comment is made, fruit or flowers are inconspicuous.

TABLE 3.37-C
GROUND COVERS AND VINES FOR EROSION CONTROL

COMMON NAME (Botanical Name)	Leaf Type	DRAINAGE TOLERANCE					Shade Tolerance	pH Range	FLOWERS	CHARACTERISTICS
		Droughty	Well-Drained	Moderately Well-Drained	Somewhat Poorly Drained	Poorly Drained				
BEARBERRY (Arctostaphylos uva-ursi)	E	X	X				good	4.5 - 6.0	--*	Trailing shrub. Low-fertility sandy areas, dunes. Set plants 18 in. apart for cover in 2-4 yrs.
BUGLEWEED (Ajuga reptans)	E		X	X			excellent	6.0 - 7.5	blue, white or red spikes	Small, low-growing herbaceous plants, in bronze or green. Set plants 1 ft. apart for cover in 1 year.
DAYLILY (Hemerocallis spp.)	D	X	X	X	X	X	fair	6.0 - 8.0	various/showy	Grass-like foliage. Unusually adaptable and free of pests and disease.
DUSTY MILLER "Beach Wormwood" (Artemisia stelleriana)	D	X	X	X			poor	6.0 - 7.5	--	Silvery foliage, 1-2 ft. tall. Spreads by underground stems. Stabilizing groundcover on coastal dunes. Set plants 2 ft. apart for cover in 2 years.
ENGLISH IVY (Hedera helix)	E	X	X	X			good	6.0 - 8.0	--	Low-maintenance vine for large areas. Will climb on trees, walls, etc. Set plants or rooted cutting 1 ft. apart for cover in 2 yrs.
HALL'S JAPANESE HONEYSUCKLE (Lonicera japonica halliana)	sE	X	X	X	X		good	6.0 - 7.5	white, fading to yellow; fragrant	Aggressively spreading vine. Excellent cover for large sloping areas such as road banks. Set clumps or plants 18 in. apart for cover in 2 years.

E = Evergreen D = Deciduous sE = Semi-evergreen * Where no comment is made, flowers are inconspicuous.

TABLE 3.37-C (continued)
GROUND COVERS AND VINES FOR EROSION CONTROL

COMMON NAME (Botanical Name)	Leaf Type	DRAINAGE TOLERANCE					Shade Tolerance	pH Range	FLOWERS	CHARACTERISTICS
		Droughty	Well-Drained	Moderately Well-Drained	Somewhat Poorly Drained	Poorly Drained				
JAPANESE SPURGE "Pachysandra" (Pachysandra terminalis)	E		X	X			excellent	4.5 - 5.5	small white spikes	Low-growing, attractive cover for borders and as lawn substitute under trees and other shady areas. Set plants 1 ft. apart for cover in 2 years.
LILY-OF-THE-VALLEY (Convallaria majalis)	E	X	X	X	X		excellent	4.5 - 6.0	fragrant white bells on short stalks	Low-maintenance cover for partial or full shade. Set plants 1 ft. apart for cover in 2-3 years.
LILY-TURF (Liriope spp.)	E	X	X	X	X		good	4.5 - 6.0	white, lavender, or purple spikes	Grass-like, low-maintenance cover for droughty, infertile soils. Spreads by underground stems. Available in variegated form. Set plants 6-12 inches apart for cover in 2 years.
PERIWINKLE "Vinca" (Vinca Minor)	E		X	X			excellent	6.0 - 7.5	small, blue flowers	Lawn substitute for shady areas. Spreads by stolons; not aggressive. Grows in full sun as well as shade. Set plants 1 ft. apart for cover in 1-2 years.
SMALL-LEAVED COTONEASTER (Cotoneaster microphylla)	E		X	X			fair	6.0 - 7.0	tiny, white flowers	Prostrate shrub. Informal cover for large areas. Set plants 2 ft. apart for cover in 2 years.
VIRGINIA CREEPER (Quinquefolia parthenocissus)	D	X	X				fair	5.0 - 7.5	--*	Ground cover for dunes and other dry areas; will climb trees. Attractive crimson foliage in fall. Berries eaten by songbirds. Set plants 18 in. apart for cover in 1-2 years.

E = Evergreen D = Deciduous * Where no comment is made, flowers are inconspicuous.

STD & SPEC 3.38

TREE PRESERVATION & PROTECTION

TP

Definition

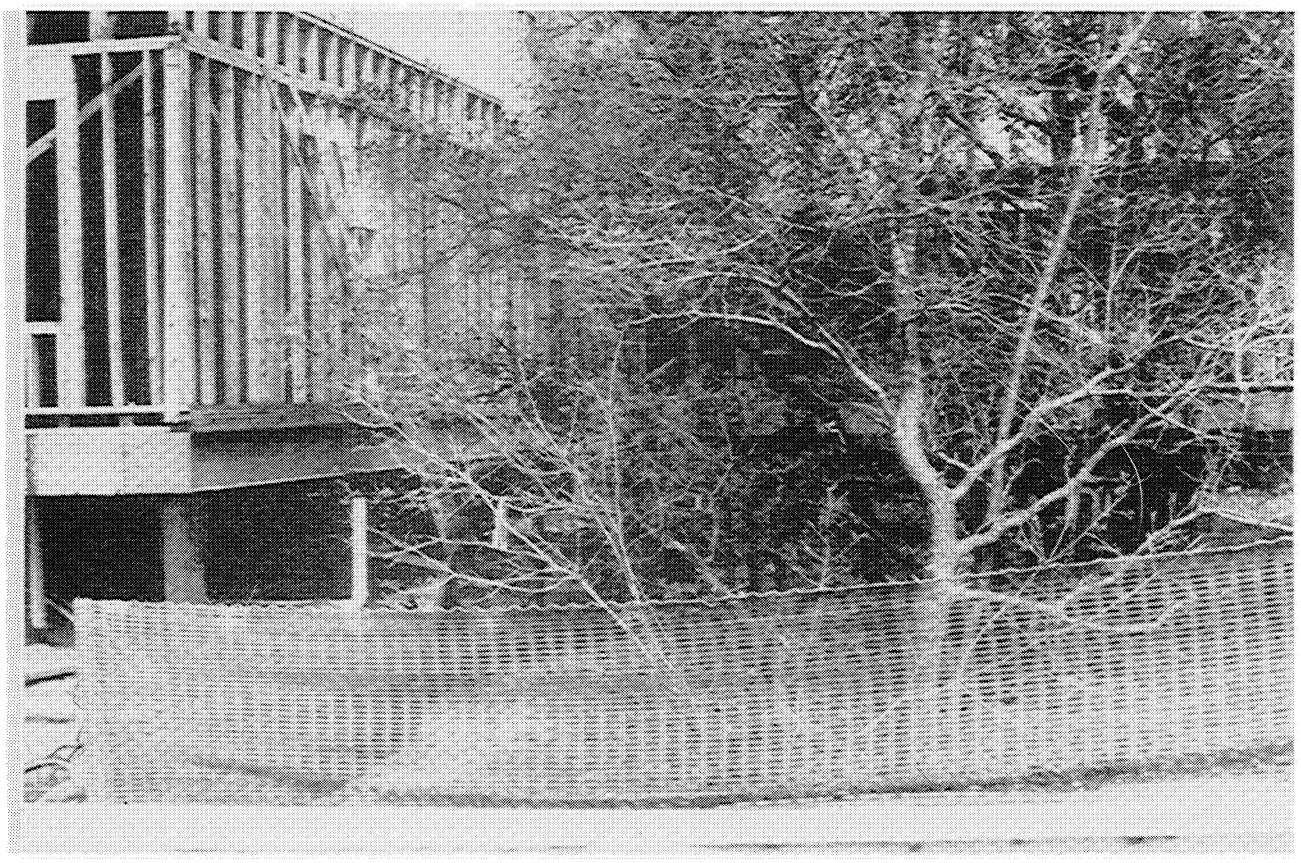
Protection of desirable trees from mechanical and other injury during land disturbing and construction activity.

Purpose

To ensure the survival of desirable trees where they will be effective for erosion and sediment control, watershed protection, landscape beautification, dust and pollution control, noise reduction, shade and other environmental benefits while the land is being converted from forest to urban-type uses.

Conditions Where Practice Applies

Tree-inhabited areas subject to land disturbing activities.



Planning Considerations

New development often takes place on tracts of forested land. In fact, building sites are often selected because of the presence of mature trees. However, unless sufficient care is taken and planning done in the interval between buying the property and completing construction, much of this resource is likely to be destroyed. The property owner is ultimately responsible for protecting as many trees as possible, with their understory and ground cover. This responsibility is usually exercised by agents-the planners, designers and contractors. It takes 20 to 30 years for newly planted trees to provide the benefits for which we value trees so highly. Trees perform the following functions on a site:

1. Assist in stabilizing the soil and preventing erosion.

2. Help to decrease stormwater runoff through canopy interception and root zone absorption.

3. Moderate temperature changes and provide shade.

4. Moderate the effects of sun and wind.

5. Provide buffers and screens against noise.

6. Filter pollutants from the air.

7. Help to remove carbon dioxide from the air and release oxygen.

8. Provide a haven for animals and birds, which help to control insect populations.

9. Conserve and increase property values.

10. Provide psychological and aesthetic counterpoints to the man-made urban setting.

Stresses of Construction

Trees may appear to be inanimate objects, but they are living organisms that are constantly involved in the process of respiration, food processing, and growth. Construction activities expose trees to a variety of stresses resulting in injury ranging from superficial wounds to death. An understanding of these stresses is helpful in planning for tree protection.

1. Surface Impacts: Natural and man-related forces exerted on the tree above the ground can cause significant damage to trees.

   a. Wind damage - Removal of some trees from groups will expose those remaining to greater wind velocities. Trees tend to develop anchorage where

it is most needed. Isolated trees develop anchorage rather equally all around, with stronger root development on the side of the prevailing winds. The more a tree is protected from the wind, the less secure is its anchorage. The result of improper thinning is often wind-thrown trees. Selective removal in favor of a single tall tree may also create a lightning hazard.

b. Excessive pruning - Unprotected trees are often "topped" or carelessly pruned to prevent interference with utility wires or buildings. If too many branches are cut, the tree may not be able to sustain itself. If the pruning is done without considering the growth habit, the tree may lose all visual appeal. If the branches are not pruned correctly, decay may set in.

c. Trunk damage - Tree trunks are often nicked or scarred by trucks and construction equipment. Such superficial wounds provide access to insects and disease.

2. Root Zone Impacts: Disturbing and delicate relationship between soil, roots, and the rest of the tree can damage or kill a tree. The roots of an existing tree are established in an area where essential materials (water, oxygen, and nutrients) are present. The mass of the root system is the correct size to balance the intake of water from the soil with the transpiration of water from the leaves.

a. Raising the grade as little as 6 inches can retard the normal exchange of air and gases. Roots may suffocate due to lack of oxygen, or be damaged by toxic gases and chemicals released by soil bacteria.

b. Raising the grade may also elevate the water table. This can cause drowning of the deeper roots.

c. Lowering the grade is not usually as damaging as raising it. However, even shallow cuts of 6 to 8 inches will remove most of the topsoil, removing some feeder roots and exposing the rest to drying and freezing.

d. Deep cuts may sever a large portion of the root system, depriving the tree of water and increasing the chance of wind-throw.

e. Lowering the grade may lower the water table, inducing drought. This is a problem in large roadway cuts or underdrain installations.

f. Trenching or excavating through a tree's root zone can eliminate as much as 40 percent of the root system. Trees suffering such damage usually die within 2 to 5 years.

g. Compaction of the soil within the drip line (even a few feet beyond the drip line) of a tree by equipment operation, materials storage, or paving can block off air and water from roots.

h. Construction chemicals or refuse disposed of in the soil can change soil chemistry or be toxic to trees. Most damage to trees from construction activities is due to the invisible root zone stresses.

Design Criteria

No formal design is required. However, in planning for the development of a wooded site where some trees will be preserved, a number of criteria must be considered.

Selecting Trees to be Retained

The proper development of a wooded site requires completion of a plan for tree preservation before clearing and construction begins. Trees should be identified by species, and located on a topographical map, either as stands or as individuals, depending on the density and value of the trees. Base decisions on which trees to save on the following considerations:

1. Life expectancy and present age: Preference should be given to trees with a long life span, such as white oak, beech, and maple. Long-lived specimens that are past their prime may succumb to the stresses of construction, so smaller, younger trees of desirable species are preferred; they are more resilient and will last longer. However, if the cost of preservation is greater than the cost of replacement with a specimen of the same age and size, replacement may be preferred.

2. Health and disease susceptibility: Check for scarring caused by fire or lightning, insect or disease damage, and rotted or broken trunks or limbs. Pest- and pollution-resistant trees are preferred.

3. Structure: Check for structural defects that indicate weakness or reduce the aesthetic value of a tree: trees growing from old stumps, large trees with overhanging limbs that endanger property, trees with brittle wood (such as silver maple), misshapen trunks or crowns, and small crowns at the top of tall trunks. Open grown trees often have better form than those grown in the woods. Trees with strong tap or fibrous root systems are preferred to trees with weak rooting habits.

4. Cleanliness: Some trees such as elm and black locust are notoriously "dirty", dropping twigs, bark, fruit, or plant exudates. A clean tree is worth more than a dirty one. Trees which seed prolifically or sucker profusely are generally less desirable in urban areas. Thornless varieties are preferred.

5. Aesthetic values: Handsome bark and leaves, neat growth habit, fine fall color, and attractive flowers and fruit are desirable characteristics. Trees that

provide interest during several seasons of the year enhance the value of the site.

6. Comfort: Trees help relieve the heat of summer and buffer strong winds throughout the year. Summer temperatures may be 10 degrees cooler under hardwoods than under conifers. Deciduous trees drop their leaves in winter, allowing the sun to warm buildings and soil. Evergreens are more effective wind buffers.

7. Wildlife: Preference should be given to trees that provide food, cover, and nesting sites for birds and game.

8. Adaptability to the proposed development:

   a. Consider the mature height and spread of trees; they may interfere with proposed structures and overhead utilities. Roots may interfere with walls, walks, driveways, patios, and other paved surfaces; or water lines, septic tanks, and underground drainage.

   b. Trees must be appropriate to the proposed use of the development; select trees which are pollution-tolerant for high-traffic and industrial areas, screen and buffer trees for noise or objectionable views, salt-tolerant species for areas exposed to deicing salts or ocean spray.

   c. Consider location of landfills. Gases generated in them can travel long distances underground, to injure distant trees. Choose species tolerant of anaerobic soil conditions.

   d. Determine the effect of proposed grading on the water table. Grading should not take place within the drip line of any tree to be saved.

9. Survival needs of the tree: Chosen trees must have enough room to develop naturally. They will be subject to injury from increased exposure to sunlight, heat radiated from buildings and pavement, and wind. It is best to retain groups of trees rather than individuals. As trees mature, they can be thinned gradually.

10. Relationship to other trees: Individual species should be evaluated in relation to other species on the site. A species with low value when growing among hardwoods will increase in value if it is the only species present. Trees standing alone generally have higher landscape value than those in a wooded situation. However, tree groups are much more effective in preventing erosion and excess stormwater runoff.

Site Planning for Tree Protection

1. If lot size allows, select trees to be saved before siting the building. No tree should be destroyed or altered until the design of buildings and utility systems is final.

2. Critical areas, such as flood plains, steep slopes, and wetlands, should be left in their natural condition or only partially developed as open space.

3. Locate roadways to cause the least damage to valuable stands. Follow original contours, where feasible, to minimize cuts and fills.

4. Minimize trenching by locating several utilities in the same trench. Excavations for basements and utilities should be kept away from the drip line of trees.

5. Construction material storage areas and worker parking should be noted on the site plan, and located where they will not cause compaction over roots.

6. When retaining existing trees in parking areas, leave enough ground ungraded beyond the drip line of the tree to allow for its survival.

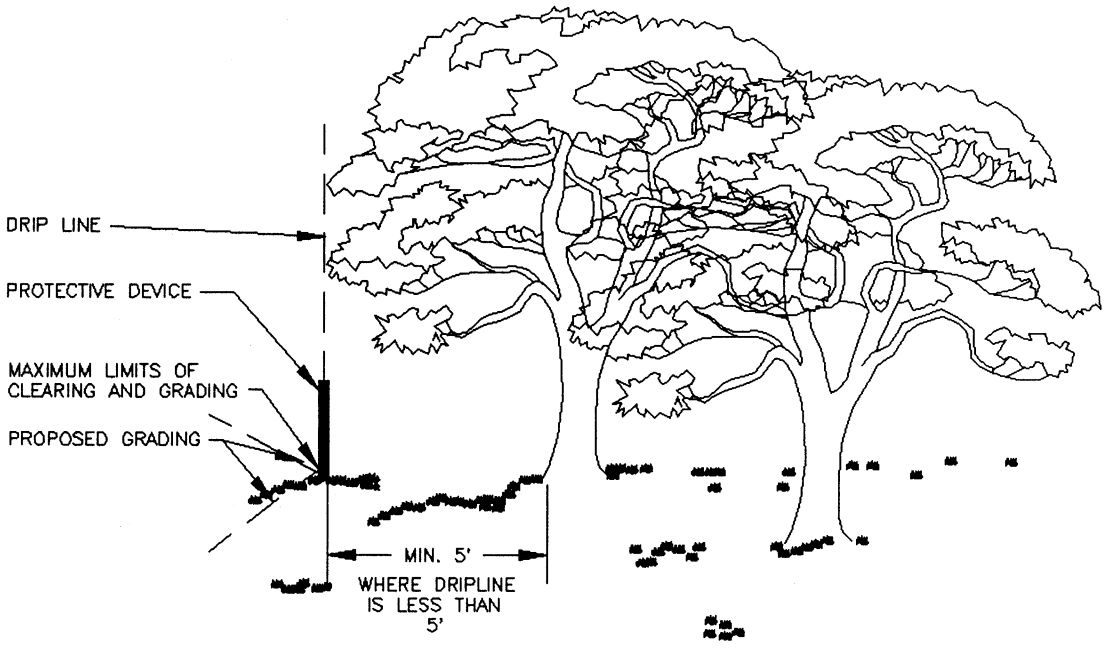
7. Locate erosion and sediment control measures at the limits of clearing and not in wooded areas, to prevent deposition of sediment within the drip line of trees being preserved. Sediment basins should be constructed in the natural terrain, if possible, rather than in locations where extensive grading and tree removal will be required.

Specifications

1. Groups of trees and individual trees selected for retention shall be accurately located on the plan and designated as "tree(s) to be saved." Individual specimens that are not part of a tree group shall also have their species and diameter noted on the plan.

2. At a minimum, the limits of clearing shall be located outside the drip line of any tree to be retained and, in no case, closer than 5 feet to the trunk of any tree (Plate 3.38-1).

3. Marking: Prior to construction and before the preconstruction conference, individual trees and stands of trees to be retained within the limits of clearing shall be marked at a height visible to equipment operators. According to the Virginia Department of Forestry, a diagonal slash of brightly colored paint approximately 8 to 10 inches in length is a common practice in areas where an accidental or purposeful alteration of the proper markings is a concern. In most situations, such as an area which is supposed to receive formal landscaping, a surveyor's ribbon or a similar material applied at a reasonable height encircling the tree will suffice.



CONSTRUCTION OPERATIONS RELATIVE TO THE LOCATION OF PROTECTED TREES

Source: Public Facilities Manual, Vol. III, Fairfax Co., Va., 1976 Plate 3.38-1

4. Pre-Construction Conference: During any preconstruction conference, tree preservation and protection measures should be reviewed with the contractor as they apply to that specific project.

5. Equipment Operation and Storage: Heavy equipment, vehicular traffic, or stockpiles of any construction materials (including topsoil) shall not be permitted within the drip line of any tree to be retained. Trees being removed shall not be felled, pushed or pulled into trees being retained. Equipment operators shall not clean any part of their equipment by slamming it against the trunks of trees to be retained.

6. Fires: Fires shall not be permitted within 100 feet from the drip line of any trees to be retained. Fires shall be limited in size to prevent adverse effects on trees, and kept under surveillance.

7. Storage and Disposal of Toxic Materials: No toxic materials shall be stored closer than 100 feet to the drip line of any trees to be retained. Paint, acid, nails, gypsum board, wire, chemicals, fuels, and lubricants shall not be disposed of in such a way as to injure vegetation.

8. Fencing and Armoring (Plate 3.38-2): Any device may be used which will effectively protect the roots, trunk and tops of trees retained on the site. However, trees to be retained within 40 feet of a proposed building or excavation shall be protected by fencing. Personnel must be instructed to honor protective devices. The devices described are suggested only, and are not intended to exclude the use of other devices which will protect the trees to be retained.

   a. Snow Fence - Standard 40-inch high snow fence shall be placed at the limits of clearing on standard steel posts set 6 feet apart.

   b. Board Fence - Board fencing consisting of 4-inch square posts set securely in the ground and protruding at least 4 feet above the ground shall be placed at the limits of clearing with a minimum of two horizontal boards between posts. If it is not practical to erect a fence at the drip line, construct a triangular fence nearer the trunk. The limits of clearing will still be located at the drip line, since the root zone within the drip line will still require protection.

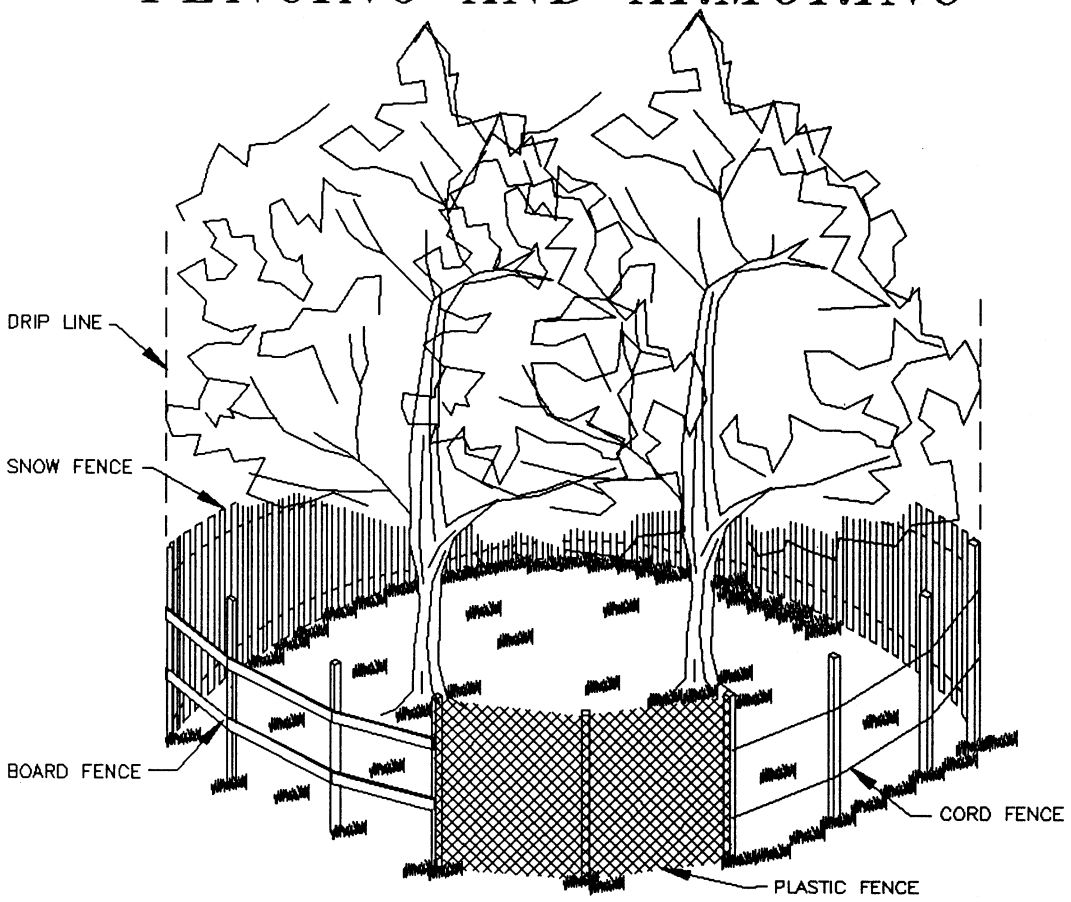
   c. Cord Fence - Posts with a minimum size of 2 inches square or 2 inches in diameter set securely in the ground and protruding at least 4 feet above the ground shall be placed at the limits of clearing with two rows of cord 1/4-inch or thicker at least 2 feet apart running between posts with strips of colored surveyor's flagging tied securely to the string at intervals no greater than 3 feet.

   d. Plastic Fencing - 40-inch high "international orange" plastic (polyethylene) web fencing secured to conventional metal "T" or "U" posts driven to a minimum depth of 18 inches on 6-foot minimum centers shall be installed at the limits of clearing. The fence should have the following minimum physical qualities:

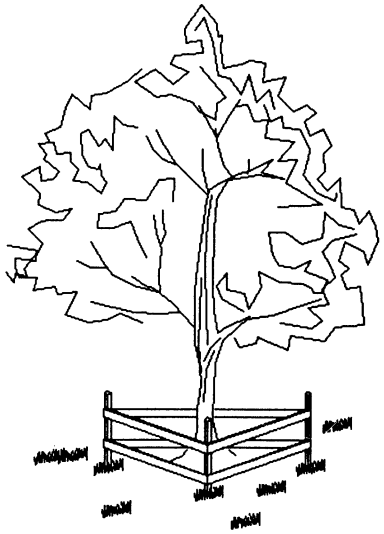
Tensile yield:	Average 2,000 lbs. per 4-foot width (ASTM D638)
Ultimate tensile yield:	Average 2,900 lbs. per 4-foot width (ASTM D638)
Elongation at break (%):	Greater than 1000% (ASTM D638)
Chemical resistance:	Inert to most chemicals and acids

   e. Earth Berms - Temporary earth berms shall be constructed according to specifications for a TEMPORARY DIVERSION DIKE (Std. & Spec. 3.9) with the base of the berm on the tree side located along the limits of clearing. Earth berms may not be used for this purpose if their presence will conflict with drainage patterns.

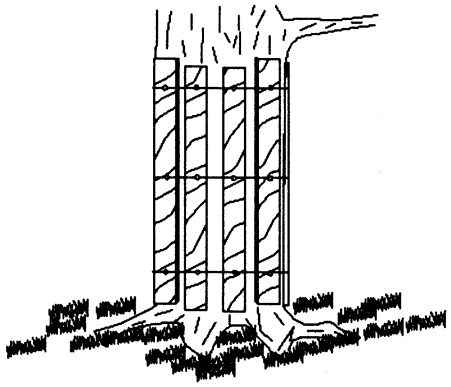
FENCING AND ARMORING



CORRECT METHODS OF TREE FENCING



TRIANGULAR BOARD FENCE



CORRECT TRUNK ARMORING

Source: Va. DSWC

Plate 3.38-2

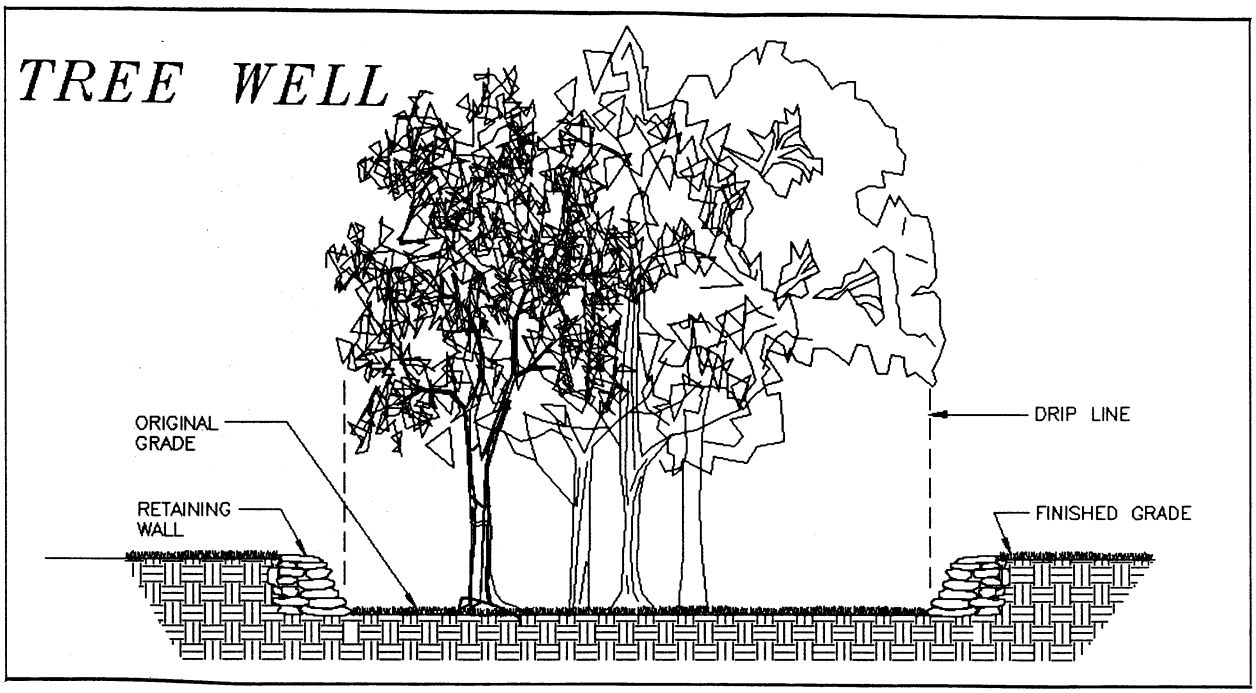
f. Additional Trees - Additional trees may be left standing as protection between the trunks of the trees to be retained and the limits of clearing. However, in order for this alternative to be used, the trunks of the trees in the buffer must be no more than 6 feet apart to prevent passage of equipment and material through the buffer. These additional trees shall be reexamined prior to the completion of construction and either be given sufficient treatment to ensure survival or be removed.

g. Trunk Armoring - As a last resort, a tree trunk can be armored with burlap wrapping and 2-inch studs wired vertically no more than 2 inches apart to a height of 5 feet encircling the trunk. If this alternative is used, the root zone within the drip line will still require protection. Nothing should ever be nailed to a tree.

Fencing and armoring devices shall be in place before any excavation or grading is begun, shall be kept in good repair for the duration of construction activities, and shall be the last items removed during the final cleanup after the completion of the project.

9. Raising the grade: When the ground level must be raised around an existing tree or tree group, the following considerations shall be made and steps taken to adequately care for the affected tree.

a. A well may be created around the tree(s) slightly beyond the drip line to retain the natural soil in the area of the feeder roots (Plate 3.38-3).



Source: Va. DSWC Plate 3.38-3

b. In the case of an individual tree, when the above alternative is not practical or desirable, the following method is recommended to ensure survival of the tree (Plate 3.38-4).

1) Before making the fill, remove the green vegetation, sod, leaf litter, and other organic matter from beneath the tree or trees to a distance of 3 feet beyond the drip line and loosen the surface soil to a depth of approximately 3 inches without damaging the roots.

2) Apply fertilizer in the root area of the tree to be retained. Fertilizer formulations and application rates and methods shall conform to the guidelines provided in Table 3.38-A.

3) The dry well shall be constructed so as to allow for tree trunk diameter growth. A space of at least 1 foot between the tree trunk and the well wall is adequate for large, old, slow-growing trees. Clearance for younger trees shall be at least 2 feet.

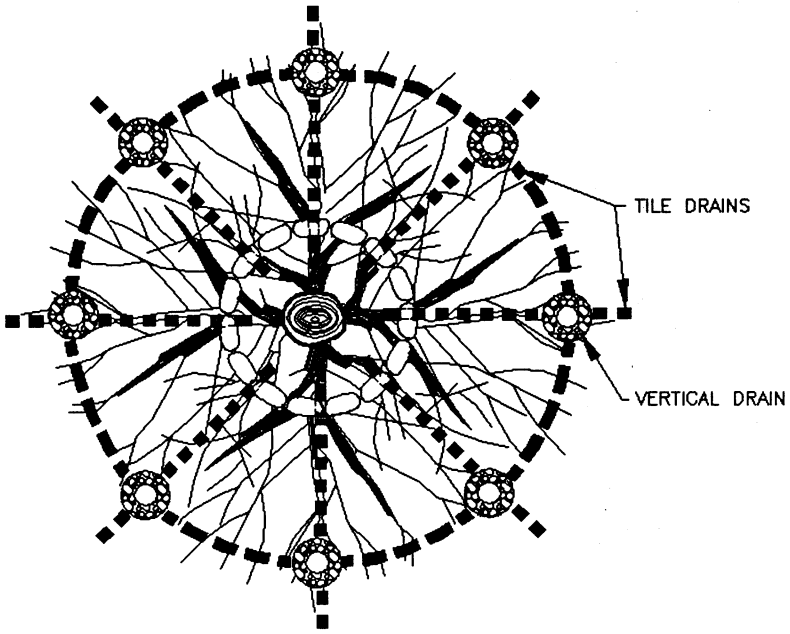
4) The well shall be high enough to bring the top just above the level of the proposed fill. The well wall shall taper slightly away from the tree trunk at a rate of 1 inch per foot of wall height.

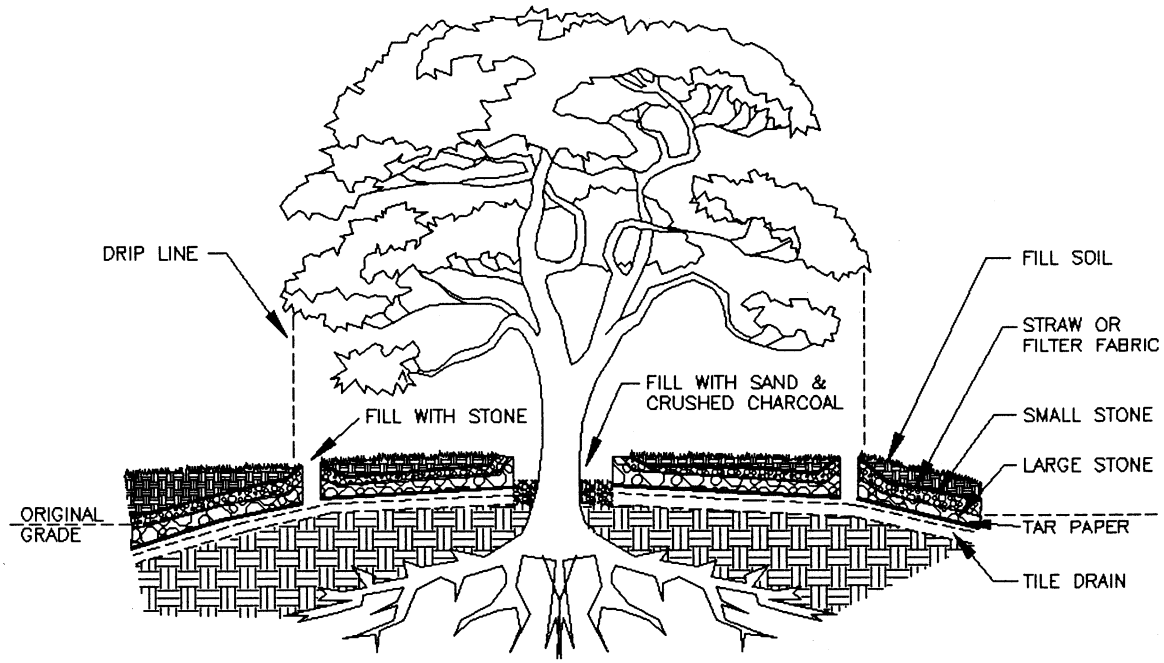
5) The well wall shall be constructed of large stones, brick, building tile, concrete blocks, or cinder blocks with care being taken to ensure that ample openings are left through the wall of the well to allow for free movement of air and water. Mortar shall only be used near the top of the well and only above the porous fill.

6) Drain lines composed of 4-inch, high-quality drain tiles shall begin at the lowest point inside the well and extend outward from the tree trunk in a wheel-and-spoke pattern with the trunk as the hub. These radial drain lines shall slope away from the well at a rate of 1/8 inch per foot. The circumferential line of tiles should be located beneath the drip line of the tree. Vertical tiles or pipes shall be placed over the intersections of the two tile systems if a fill of more than 2 feet is contemplated. These vertical tiles shall be held in place with stone fill. Tile joints shall be tight. A few radial tiles shall extend beyond each intersection and shall slope sharply downward to ensure good drainage.

7) Tar paper or its approved equivalent shall be placed over the tile and/or pipe joints to prevent clogging, and large stone shall be placed around and over drain tiles and/or pipes for protection.

TREE WELL DETAIL





Source: Adapted from Tree Maintenance, 5th ed., Pirone, 1978. Plate 3.38-4

TABLE 3.38-A
TREE FERTILIZATION FOR PROTECTION FROM CONSTRUCTION ACTIVITY

TREE TYPE	SPECIAL CONDITIONS	APPLICATION RATE & METHOD		FORMULATION
Broad-Leaf Deciduous	Greater than 6 inches dbh* except American Beeches and Crabapples	Normal	2-4 lbs. per inch dbh; broadcast	Commercial 10-8-6 or 10-6-4
		Grade Change	4-5 lbs. per inch dbh; broadcast	Commercial 10-6-4
	Smaller than 6 inches dbh, including all American Beeches and Crabapples	Normal	1-2 lbs. per inch dbh; broadcast	Commercial 10-8-6 or 10-6-4
		Grade Change	2-3 lbs. per inch dbh; broadcast	Commercial 10-6-4
Narrow-Leaf Evergreen	Greater than 6 inches dbh, located in groups	2-4 lbs per 100 sq. ft. of bed area; broadcast		Commercial 10-6-4
	Greater than 6 inches dbh, single specimens in open area	2 lbs. per inch dbh; broadcast		Commercial 10-6-4
	Smaller than 6 inches dbh	5 lbs. per 100 sq. ft. of bed area; incorporated into soil		Tankage or Cottonseed Meal
Broad-leaf Evergreen	Where nitrogen in soil is sufficient	Liberal quantities incorporated into soil and applied as mulch		Acid Peat Moss or Rotted Oak Leaf Mold
	Where additional nitrogen is necessary	Also add 5 lbs. per 100 sq. ft. of bed area incorporated into soil		Tankage or Cottonseed Meal

* dbh : Diameter at breast height (4.5 feet above ground level).

Source: Information taken from Tree Maintenance, P. P. Pirone, 1978.

8) A layer of 2- to 6-inches of stone shall be placed over the entire area under the tree from the well outward at least as far as the drip line. For fills up to 2-feet deep, a layer of stone 8- to 12-inches thick should be adequate. A thicker layer of this stone, not to exceed 30 inches, will be needed for deeper fills.

9) A layer of 3/4-inch to 1-inch stone covered by straw, fiber-glass mat or a manufactured filter fabric shall be used to prevent soil from clogging the space between stones. Cinders shall not be used as fill material.

10) Filling shall be completed with porous soil such as topsoil until the desired grade is reached. This soil shall be suitable to sustain specified vegetation.

11) To prevent clogging of the drain lines, crushed stone shall be placed inside the dry well over the openings of the radial tiles. Vertical tiles shall also be filled with crushed rock and may also be covered with a screen.

12) To prevent anyone from falling into the dry well and leaves and debris from accumulating there, the area between the trunk and the well wall shall either be covered by an iron grate or filled with a 50-50 mixture of crushed charcoal and sand. (This will also prevent rodent infestation and mosquito breeding.)

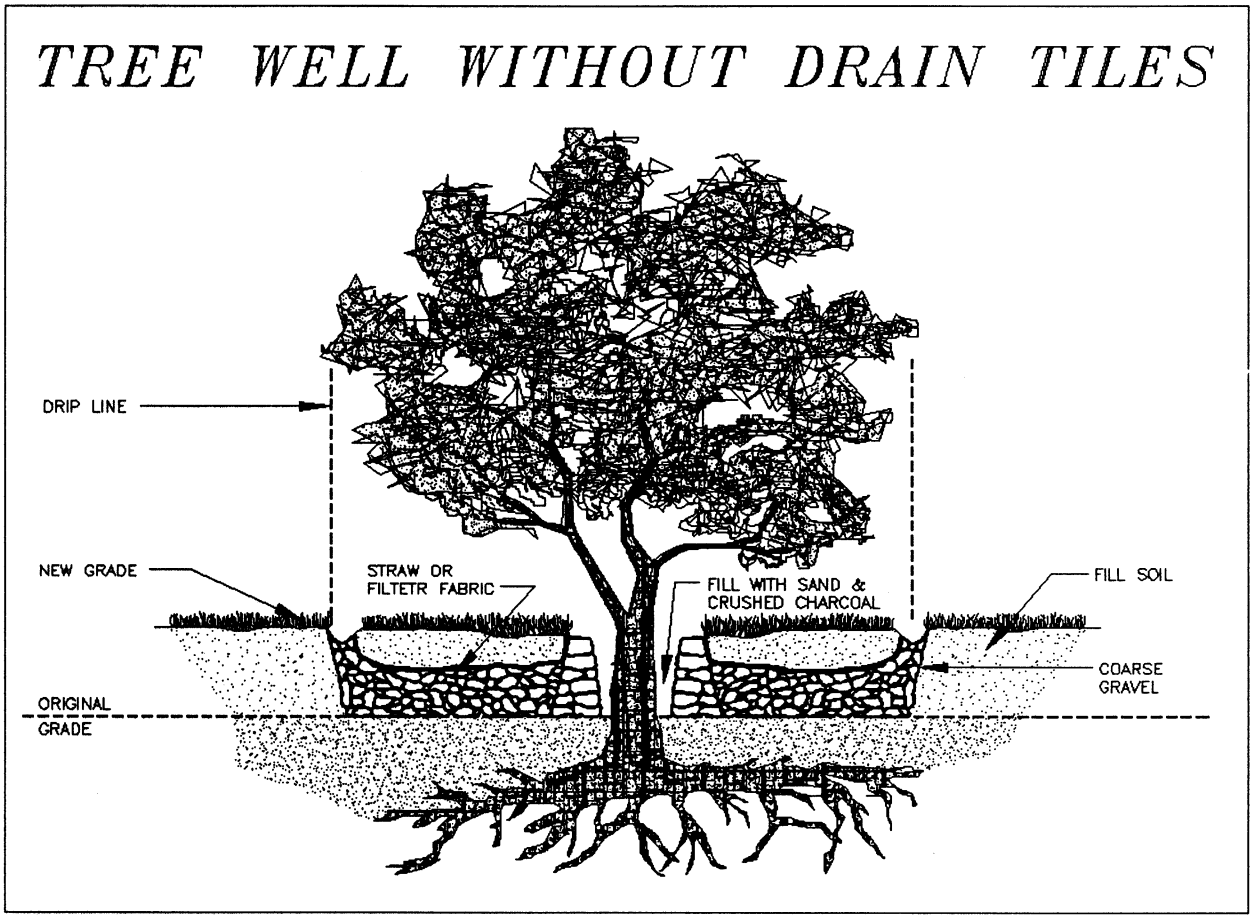
c. Where water drainage through the soil is not a problem, coarse gravel in the fill may be substituted for the tile. This material has sufficient porosity to ensure air drainage. Instead of the vertical tiles or pipes in the system, stones, crushed rock, and gravel may be added so that the upper level of these porous materials slants toward the surface in the vicinity below the drip line (Plate 3.38-5).

d. Raising the grade on only one side of a tree or group of trees may be accomplished by constructing only half of one of these systems.

10. Lowering the grade: Trees shall be protected from harmful grade cuts by the construction of a tree wall (Plate 3.38-6).

a. Following excavation, all tree roots that are exposed and/or damaged shall be trimmed cleanly, painted with tree paint, and covered with moist peat moss, burlap, or other suitable material to keep them from drying out.

b. The wall shall be constructed of large stones, brick, building tile, or concrete block or cinder block in accordance with the detail in Plate 3.38-6.



Source: Va. DSWC Plate 3.38-5

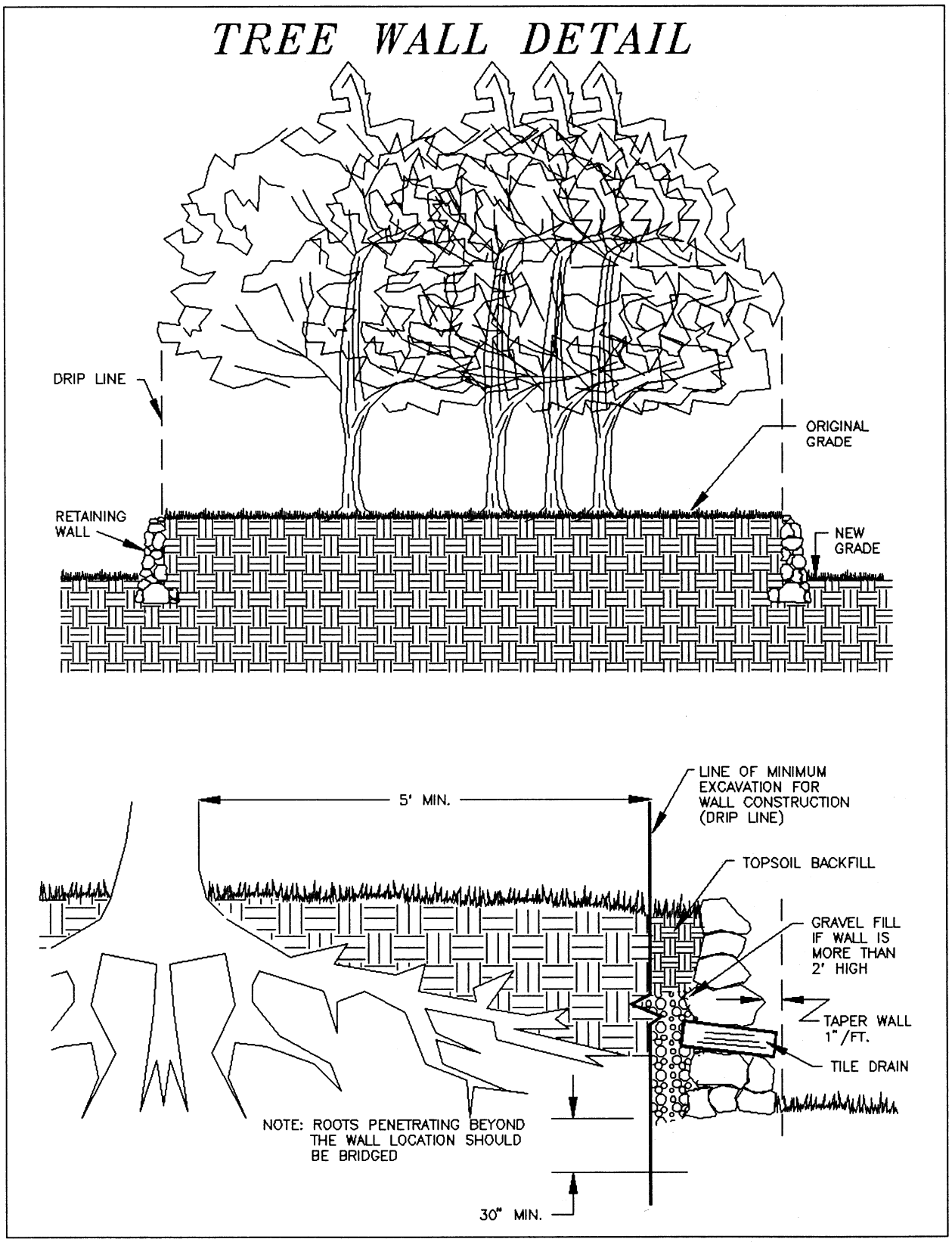
c. Backfill with peat moss or other organic material or with topsoil to retain moisture and aid in root development.

d. Apply fertilizer and water thoroughly. Fertilizer formulations and application rates and methods shall conform to the guidelines provided in Table 3.38-A.

e. Prune the tree crown, reducing the leaf surface in proportion to the amount of root loss.

f. Provide drainage through the wall so water will not accumulate behind the wall.

g. Lowering the grade on only one side of a tree or group of trees may be accomplished by constructing only half of this system.



Source: Adapted from Trees for Architecture and the Landscape, Zion, 1968.

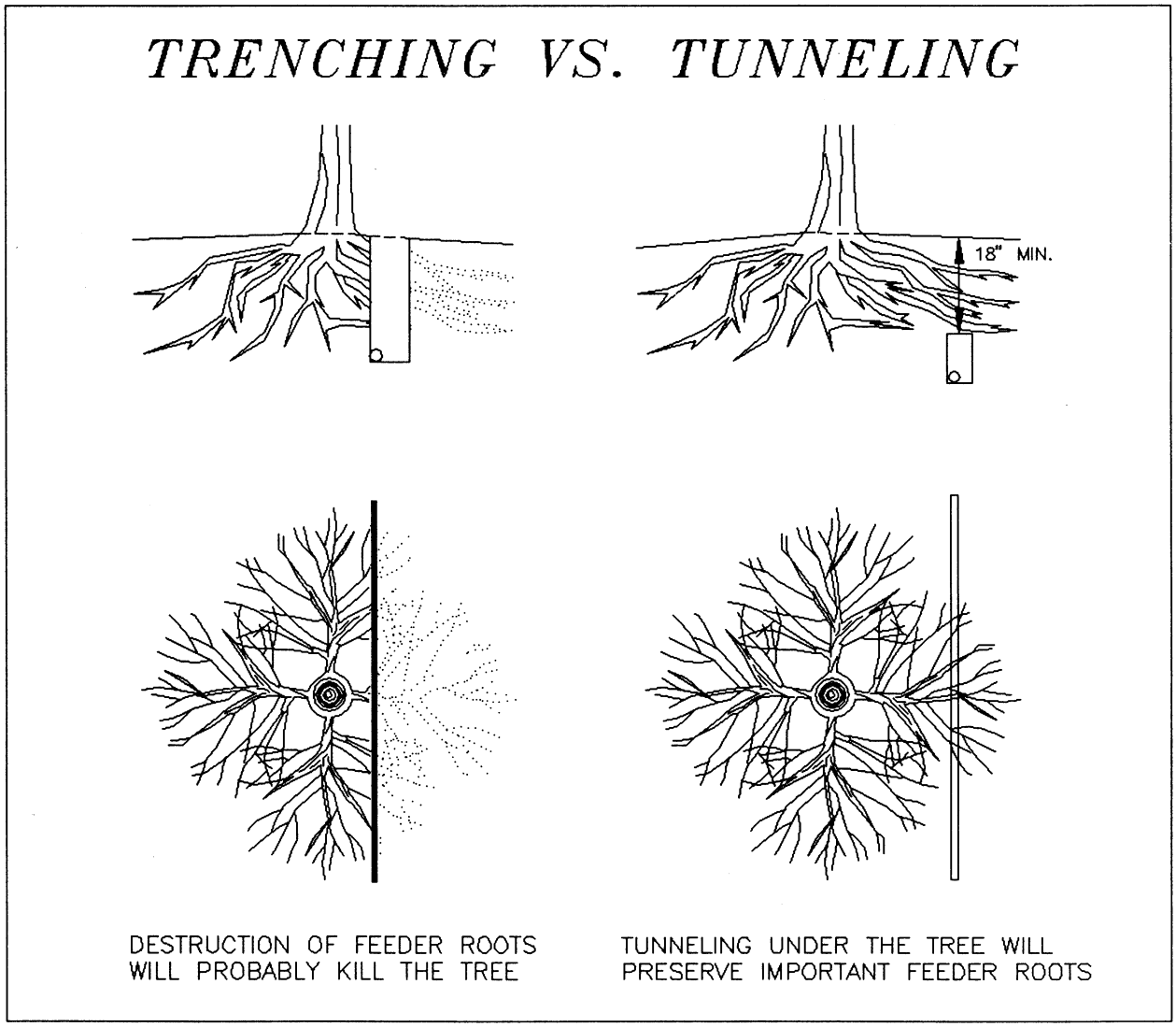
Plate 3.38-6

11. Trenching and Tunnelling:

a. Trenching shall be done as far away from the trunks of trees as possible, preferably outside the branches or crown spreads of trees, to reduce the amount of root area damaged, or killed by trenching activities.

b. Wherever possible, trenches should avoid large roots or root concentrations. This can be accomplished by curving the trench or by tunnelling under large roots and areas of heavy root concentration.

c. Tunnelling is more expensive initially, but it usually causes less soil disturbance and physiological impact on the root system (Plate 3.38-7). The extra cost may offset the potential cost of tree removal and replacement should the tree die.



Source: Tree Maintenance, Pirone, 1979. Plate 3.38-7

Tunnelling is almost always preferred over the trenching method. The tunnel should be 18 inches or greater below the ground surface and should not be located under the center of the tree (an off-center tunnel has the least impact on the roots).

d. Roots shall not be left exposed to the air. They shall be covered with soil as soon as possible or protected and kept moistened with wet burlap or peat moss until the trench or tunnel can be filled.

e. The ends of damaged and cut roots shall be cut off smoothly and protected by painting promptly with a tree-wound dressing.

f. Trenches and tunnels shall be filled as soon as possible. Air spaces in the soil shall be avoided by careful filling and tamping.

g. Peat moss or other suitable material shall be added to the fill material as an aid to inducing and developing new root growth.

h. The tree shall be mulched and fertilized to conserve moisture, stimulate new root growth, and enhance general tree vigor.

i. If a large amount of the root system has been damaged and killed, the crown leaf surface shall be proportionately reduced to balance the reduced root system. This may be accomplished by pruning 20 to 30 percent of the crown foliage. If roots are cut during the winter, pruning shall be accomplished before the next growing season. If roots are cut during the growing season, pruning shall be done immediately.

12. Removal and Replacement of Damaged Trees: Should a tree intended and marked to be retained be damaged seriously enough that survival and normal growth are not possible, the tree shall be removed. If replacement is desirable and/or required, the replacement tree shall be of the same or similar species, 2-inch to 2½-inch (minimum) caliper balled and burlapped nursery stock. However, today, with the aid of a "tree spade," the same caliper tree may be required as a replacement.

13. Clean-Up: Clean-up after a construction project can be a critical time for tree damage. Trees protected throughout the development operation are often destroyed by carelessness during the final clean-up and landscaping. Fences and barriers shall be removed last, after everything else is cleaned-up and carried away.

14. Maintenance: In spite of precautions, some damage to protected trees may occur. In such cases, the following maintenance guidelines should be followed:

a. Soil Aeration - If the soil has become compacted over the root zone of any tree, the ground shall be aerated by punching holes with an iron bar. The bar shall be driven 1-foot deep and then moved back and forth until the soil is

loosened. This procedure shall be repeated every 18 inches until all of the compacted soil beneath the crown of the tree has been loosened.

b. Repair of Damage

1) Any damage to the crown, trunk, or root system of any tree retained on the site shall be repaired immediately.

2) Whenever major root or bark damage occurs, remove some foliage to reduce the demand for water and nutrients.

3) Damaged roots shall immediately be cut off cleanly inside the exposed or damaged area. Cut surfaces shall be painted with approved tree paint, and moist peat moss, burlap, or top-soil shall be spread over the exposed area.

4) To treat bark damage, carefully cut away all loosened bark back into the undamaged area, taper the cut at the top and bottom, and provide drainage at the base of the wound (Plate 3.38-8).

5) All tree limbs damaged during construction or removed for any other reason shall be cut off above the collar at the preceding branch junction (Plate 3.38-8).

6) Care for serious injuries shall be prescribed by a forester or a tree specialist.

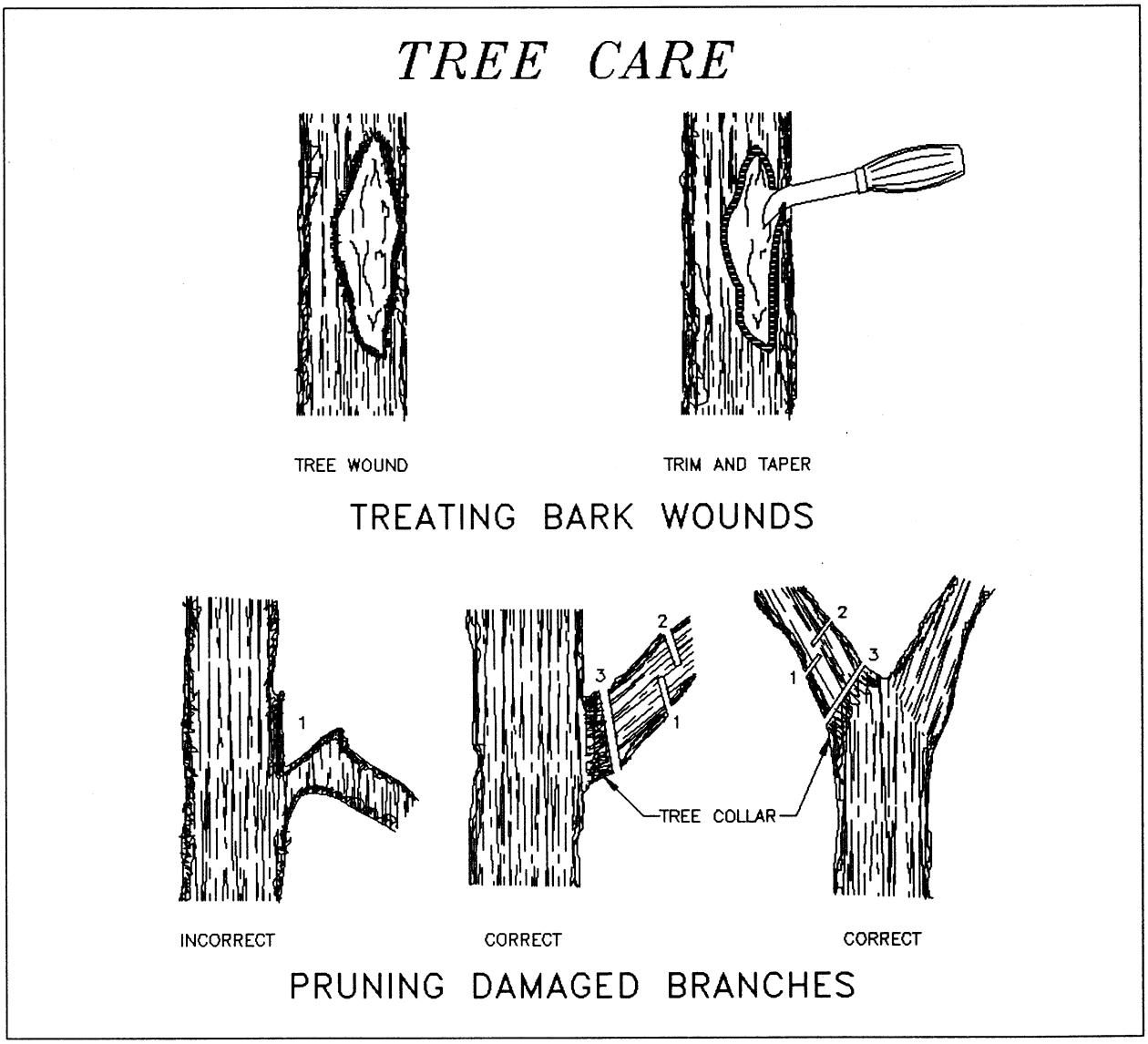
c. Fertilization: Broadleaf trees that have been stressed or damaged shall receive a heavy application of fertilizer to aid their recovery.

1) Trees shall be fertilized in the late fall (after October 1) or the early spring (from the time frost is out of the ground until May 1). Fall applications are preferred, as the nutrients will be made available over a longer period of time.

2) Fertilizer shall be applied to the soil over the feeder roots (see Plate 3.38-9). In no case should it be applied closer than 3 feet to the trunk.

The root system of conifers extends some distance beyond the drip line. Increase the area to be fertilized by one fourth the area of the crown.

3) Fertilizer shall be applied using approved fertilization methods and equipment.

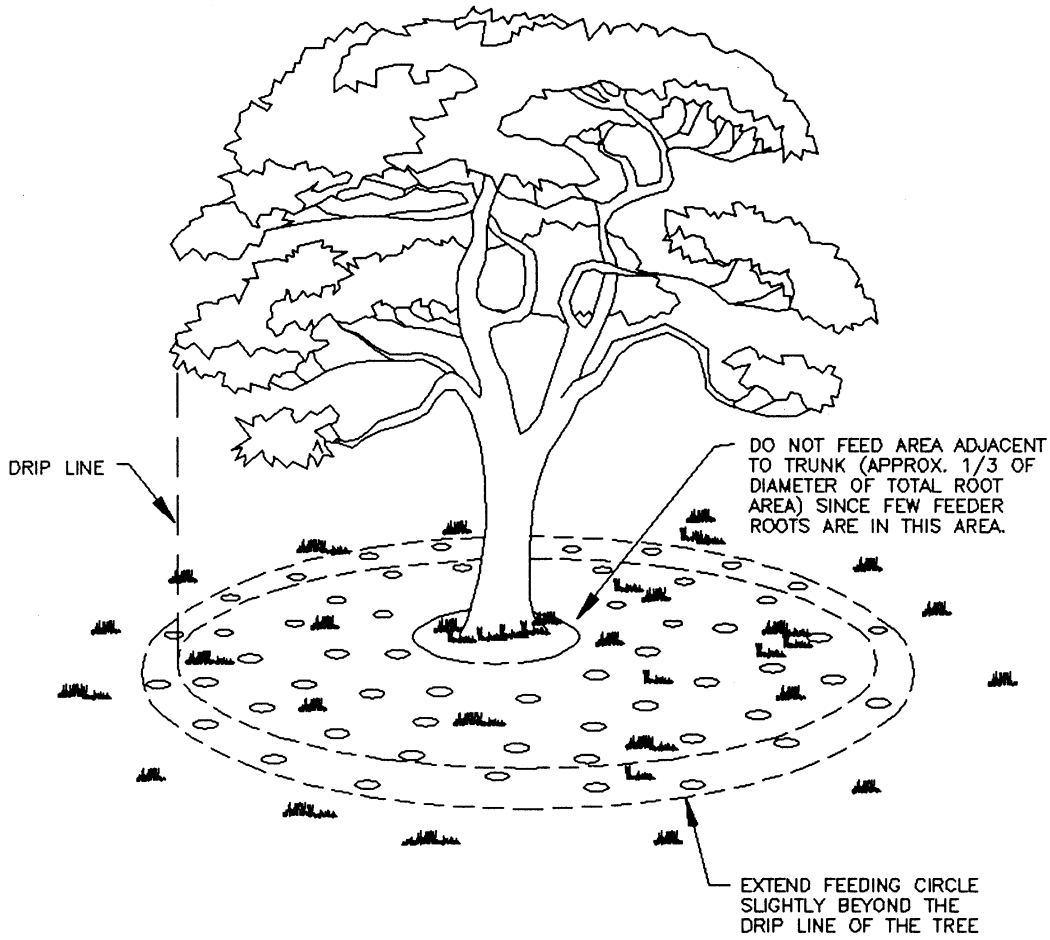


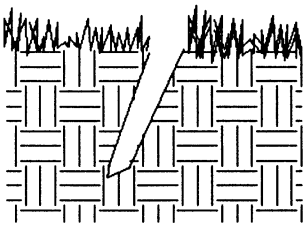
Source: Public Facilities Manual, Vol. III, Fairfax Co., Va., 1976. Plate 3.38-8

4) Formulations and application rates shall conform to the guidelines given in Table 3.38-A.

Maintain a ground cover of organic mulch around trees that is adequate to prevent erosion, protect roots, and hold water.

TREE FERTILIZATION





HOLES SHOULD BE APPROXIMATELY 18" DEEP AND 2' APART, AND THEY SHOULD SLANT TOWARD THE TRUNK.

Source: Tree Maintenance, Pirone, 1979.

Plate 3.38-9

STD & SPEC 3.39

DUST CONTROL

DC

Definition

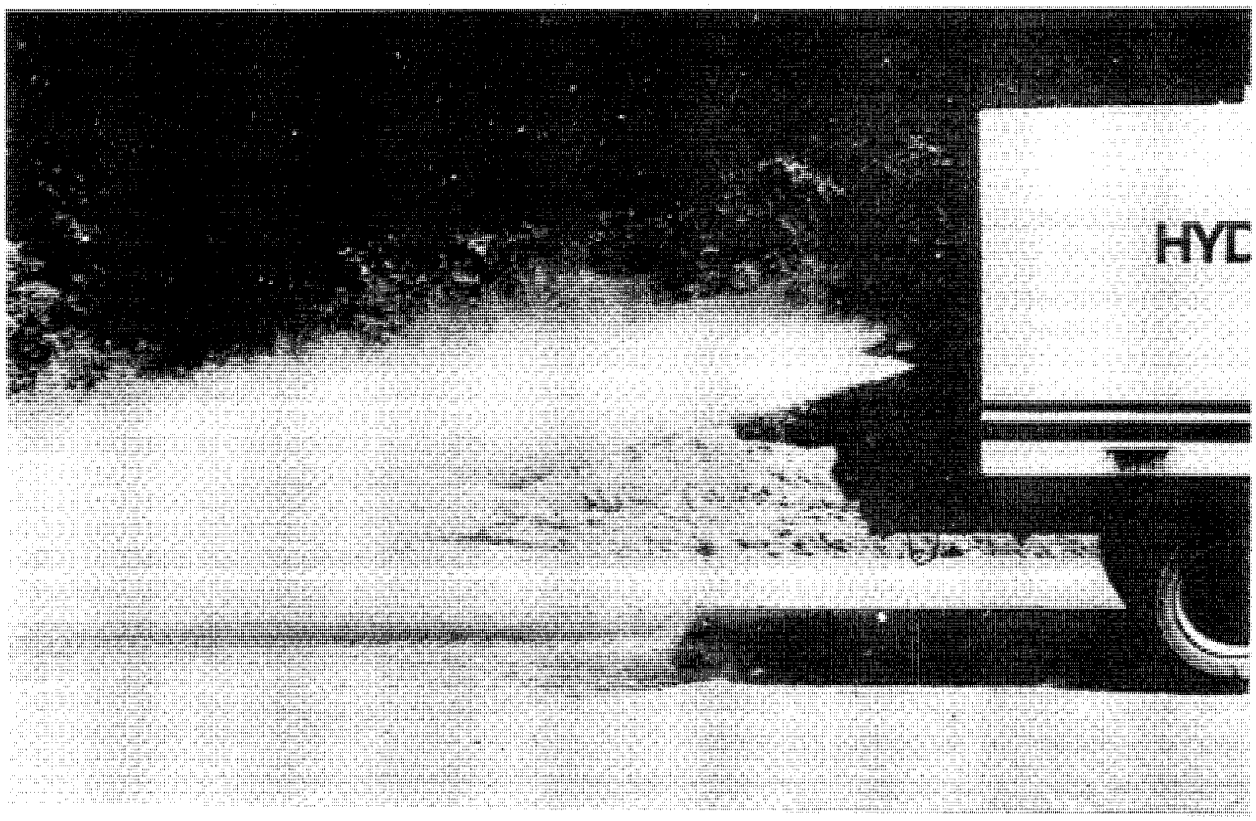
Reducing surface and air movement of dust during land disturbing, demolition and construction activities.

Purpose

To prevent surface and air movement of dust from exposed soil surfaces and reduce the presence of airborne substances which may present health hazards, traffic safety problems or harm animal or plant life.

Conditions Where Practice Applies

In areas subject to surface and air movement of dust where on-site and off-site damage is likely to occur if preventive measures are not taken.



Planning Considerations

Construction activities inevitably result in the exposure and disturbance of soil. Fugitive dust is emitted both during the activities (i.e., excavation, demolition, vehicle traffic, human activity) and as a result of wind erosion over the exposed earth surfaces. Large quantities of dust are typically generated in "heavy" construction activities, such as road and street construction and subdivision, commercial or industrial development, which involve disturbance of significant areas of the soil surface. Research of construction sites has established an average dust emission rate of 1.2 tons/acre/month for active construction. Earth-moving activities comprise the major source of construction dust emissions, but traffic and general disturbance of the soil also generate significant dust emissions.

In planning for dust control, limiting the amount of soil disturbance at any one time should be a key objective. Therefore, phased clearing and grading operations and the utilization of temporary stabilization in accordance with MS #1 can significantly reduce dust emissions. Undisturbed vegetative buffers (minimum 50-foot widths) left between graded areas and protected areas can also be very helpful in dust control.

Temporary Measures Used During Construction

1. Vegetative Cover - In areas subject to little or no construction traffic, a vegetatively stabilized surface will reduce dust emissions (see TEMPORARY SEEDING, Std. & Spec. 3.31).

2. Mulch - When properly applied, mulch offers a fast, effective means of controlling dust. Not recommended for areas within heavy traffic pathways. Binders or tackifiers should be used to tack organic mulches (see MULCHING, Std. & Spec. 3.35).

3. Tillage - This practice is designed to roughen and bring clods to the surface. It is an emergency measure which should be used before wind erosion starts. Begin plowing on windward side of site. Chisel-type plows spaced about 12 inches apart, spring-toothed harrows, and similar plows are examples of equipment which may produce the desired effect.

4. Irrigation - This is the most commonly used dust control practice. Site is sprinkled with water until the surface is wet. Repeat as needed. It offers fast protection for haul roads and other heavy traffic routes.

5. Spray-On Adhesives - Tremendous progress has been made in recent years in the development of products of this type. Most are effective on "mineral" soils and are ineffective on "muck" soils. These coherics are derived from a variety of compounds, both organic and synthetic based. Many of the adhesives will withstand heavy traffic loads. The organics include derivatives from pine tar and vegetable gum; synthetics may be acrylic or petroleum based.

The following table list various adhesives and provides corresponding information on mixing and application:

TABLE 3.39-A

ADHESIVES USED FOR DUST CONTROL

Adhesive	Water Dilution (Adhesive: Water)	Type of Nozzle	Application Rate Gallons/Acre
Anionic Asphalt Emulsion	7:1	Coarse Spray	1,200
Latex Emulsion	12.5:1	Fine Spray	235
Resin in Water	4:1	Fine Spray	300
Acrylic Emulsion (Non-Traffic)	7:1	Coarse Spray	450
Acrylic Emulsion (Traffic)	3.5:1	Coarse Spray	350

Source: Va. DSWC

6. Stone - Stone can be used to stabilize roads or other areas during construction using crushed stone or coarse gravel (see CONSTRUCTION ROAD STABILIZATION, Std. & Spec. 3.3).

7. Barriers - A board fence, wind fence, sediment fence, or similar barrier can help to control air currents and blowing soil. Place barriers perpendicular to prevailing air currents at intervals of about 15 times the barrier height. Where dust is a known problem, existing windbreak vegetation should be preserved.

8. Calcium Chloride - This chemical may be applied by mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage. Application rates should be strictly in accordance with suppliers' specified rates.

Permanent Methods

1. Permanent Vegetation - The application of PERMANENT SEEDING (see Std. & Spec. 3.32) and saving existing trees and large shrubs can help reduce soil and air movement from construction sites.

2. Stone - Crushed stone or coarse gravel can be used as a permanent cover which will provide control of soil emissions.