DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2100 CLEARING AND SITE PREPARATION

Approved and Adopted this __ day of 20__

KANSAS CITY METROPOLITAN CHAPTER
OF THEAMERICAN PUBLIC WORKS ASSOCIATION

FIGURES

SECTION 2101 CLEARING

Referenced Standards: The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM
D638 – Standards Test Method for Tensile Properties of Plastics
D4318 – Method of Test for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

2101.1 CLEARING, GRUBBING, AND DEMOLITION

A. **Description**:

1. **Clearing**: Clearing shall consist of removing all vegetative matter such as trees, brush, downed timber, and other objectionable materials found on or above the surface of the site. It shall include: removing buildings, fences, and lumber; waste dumps and trash; salvaging of such materials as may be specified; and disposing of the debris as per public entity requirements. Scalping shall include the removal of material such as sod, grass, residue or agricultural crops, and decayed vegetative matter from the surface of the ground without removing more earth than is necessary. Perimeter erosion and sediment controls must be in place before clearing activities occur.

2. **Grubbing**: Grubbing shall consist of removing and disposing of all vegetative matter such as stumps, roots, buried trees, and brush encountered below the surface of the ground of subgrade, whichever is lower, that has not been included in the description of clearing.

   In all cases of grubbing, the vegetative matter shall be removed to a minimum depth of 12 inches below ground line or subgrade, whichever is lower, except as provided in the description of demolition and removal.

   When deleterious materials are encountered below the ground line which may be detrimental to the proposed improvement, they shall be removed to a depth necessary to provide adequate support for the proposed improvement.

3. **Demolition and Removal:** This work shall consist of demolishing, removing and disposing of all structures and improvements within the construction limits unless included in other items of work as shown on the plans or in the Special Provisions. This work shall apply to all structures and improvements, whether on, above or below the surface of the ground or subgrade.

   Demolition and removal shall include but not be limited to items such as buildings, drainage structures, pipes, pavements, fences, retaining walls, guard rails and signs.

   Items such as fences and guard rails shall be salvaged and relinquished to the appropriate owner or relocated, where indicated on the plans.

Relocation of signs, fences, guardrails, etc. shall be considered incidental to removal work except where such relocation is listed separately in the Itemized Proposal of the Special Provisions.

All pipes which are to be abandoned shall be removed unless otherwise shown on the plans or approved by the Engineer.

4. **Trees:** Vegetable growth 6 inches (15.24 cm) in diameter and larger, measured 3 feet (91.44 cm) above ground shall be classified as a tree.

5. **Brush:** Vegetable growth less than 6 inches (15.24 cm) in diameter, measured 3 feet (91.44 cm) above ground shall be classified as brush.

B. **Construction Specifications**:

1. **Limits of Work**: The limits of clearing, grubbing, and demolition shall extend to the construction limits unless otherwise shown on the plans. Clearing should only occur in those areas required for construction within a six month period. Where possible, large projects should be cleared and grubbed as construction progresses. Mass clearing and grubbing should be avoided. An undisturbed strip of not less than 25 feet in width of existing grass or other vegetation should be kept in place around the perimeter of the construction site, where possible, and protected from damage. The Contractor shall scalp only those excavation and embankment areas necessary for construction of the project.

   Existing structures within or adjacent to the construction limits which are not to be removed or demolished shall be protected by the Contractor during construction. Any private facilities, such as house sewer laterals, that are disturbed or damaged by the Contractor's work shall be repaired by the Contractor prior to the close of the workday. This repair shall be made in a manner sufficient to restore utility service to that property.

   Perimeter Erosion and Sediment Controls: Perimeter controls will be put in place prior to the start of clearing and grubbing of the site. It is possible some clearing and grubbing will need to be done to accommodate the installation of some perimeter controls.

2. **Embankment Areas**: Where undisturbed stamps and roots are encountered where the fill depth will exceed 3 feet, the stumps and roots may be left in place provided they do not extend more than 3 inches above the original ground line.

3. **Borrow Areas**: All stumps, roots, and other objectionable matter shall be removed from the borrow material used for embankment or fill. The borrow area shall be left in a well drained and smooth condition.

4. **Backfilling the Site**: All trenches, holes, pits, and basement areas resulting from clearing, grubbing, demolition, or removal on the site shall be backfilled with suitable material placed and compacted in conformance with Section 2101.2.

5. **Disposal of Materials**: All materials, with the exception of those that are designated for salvage or embankment, shall become the Contractor's property and shall be disposed of by the Contractor, outside the project limits.

6. **Items to be Left in Place**: In removing concrete pavements, curbs, curb and gutter, sidewalks and similar objects where portions of these objects are to be left in place, they shall be removed to an existing or new joint and saved to a minimum depth of 2 inches or ¼ the slab thickness, whichever is greater. The joint shall be to true line and vertical face. Sufficient portions of these items shall be removed to provide the proper grade and connection to the new work.

2101.2 TREE PROTECTION

A. **Description**: Tree protection is the protection of trees from mechanical or other injury during land disturbance and construction activity. These trees are to be left in place and undisturbed during construction.

B. **Application**: Tree protection 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.

C. **Construction Specifications**:

1. **Existing Structures and Private Facilities**: The plans will designate trees, shrubs, or other plants to remain, and the Contractor will take necessary steps to protect this vegetation. Trees may be pruned upon prior approval of the Engineer but only in accordance with the best practices of arboriculture with respect to the individual species' natural form and growth characteristics.

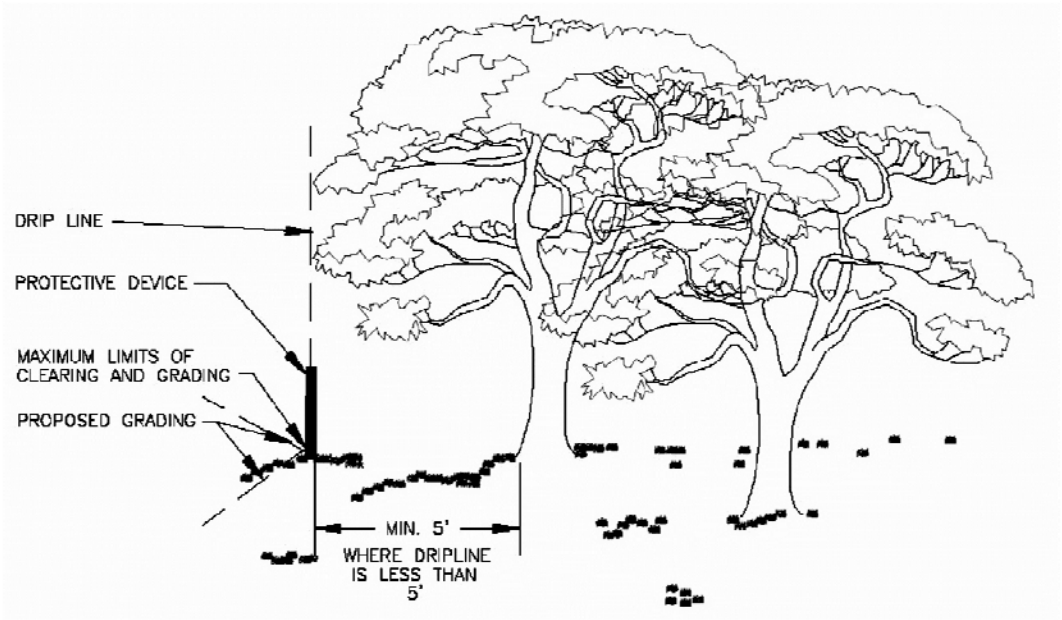
   Groups of trees and individual trees selected to remain will be accurately located on the plan and designated as "tree(s) to remain." Individual specimen that are not part of a tree group will also have their species and diameter noted on the plan.

   At a minimum the limits of clearing must be located outside the drip line of any tree to remain and in no case closer then 5 feet to the trunk of any tree (Figure 2101-1).

2. **Marking**: Prior to construction, individual trees and stands of trees to remain within the limits of clearing must be marked at a height visible to equipment operators. 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 to receive formal landscaping, a surveyor's ribbon or a similar material applied at a reasonable height encircling the tree will suffice.

3. **Pre-Construction Conference**: During any pre-construction conference, three preservation and protection measures should be reviewed with the Contractor.

Figure 2101-1: Construction Operations Relative to the Location of Protected Trees



Source: VA. DCR, 1992.

4. **Equipment Operation and Storage**: Heavy equipment, vehicular traffic, and stockpiles of any construction materials (including topsoil) will not be permitted within the drip line of any tree to remain on 5 feet of its trunk, whichever is greater. Trees removed will not be felled, pushed, or pulled into trees being retained. Equipment operators must not clean any part of their equipment by slamming it against the trunks of trees to remain.

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

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

7. **Fencing and Armoring**: Any device may be used which will effectively protect the roots, trunk, and tops of trees to remain on the site (Figure 2101-2). All trees to remain shall be protected by fencing placed at least 5 feet from trunks if drip line is less than 5 feet wide. Personnel must be instructed to honor protective devices. The devices described are suggested only and are not intended to exclude the use of other comparable devices that will protect trees to remain.

a. **Snow Fence**: Standard 40-inch high snow fence will 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 general 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, a triangular fence shall be constructed nearer the trunk. Regardless of fence location, the limits of clearing shall not extend within the drip line.

c. **Cord Fence**: Posts with a minimum size of 2 inches set securely in the ground and protruding at least 4 feet above the ground shall be placed at the limits of clearing. Two rows of cord ¼-inch or thicker at least 2 feet apart shall run between posts with surveyor's ribbon tired 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" pots driven 18 inches on 6-foot centers shall be installed at the limits of clearing. The fencing 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)

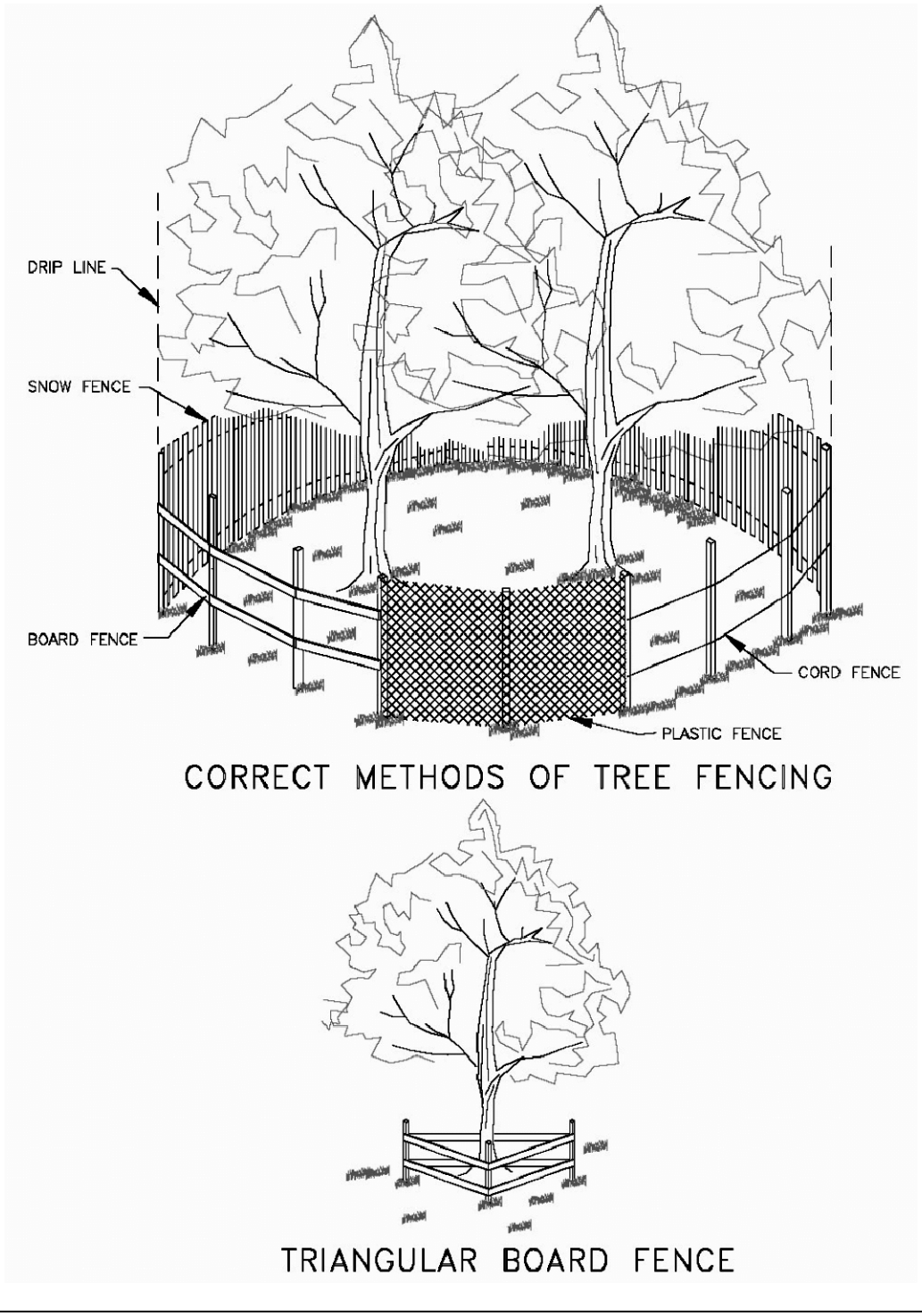
   Elongation at break (%): Greater than 1000% (ASTM D638)

   Chemical resistance: Inert to most chemicals and acids

e. **Earth Berms**: Temporary earth berms shall be constructed according to specifications, with the base of the berm on the tree side located along the limits of clearing. Earth berms may not be used to protect trees if their presence will conflict with drainage patterns.

f. **Additional Trees**: Additional trees may be left standing as protection between the trunks of the trees to remain and the limits of the clearing. However, 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 shall be given sufficient treatment to ensure survival or removed.

Figure 2101-2: Fencing and Armoring

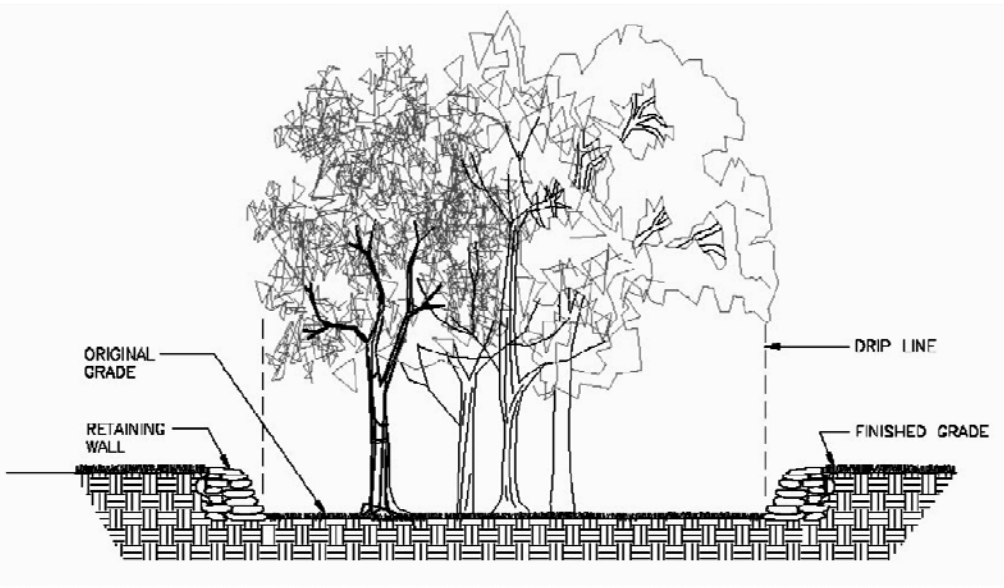


Source: VA. DCR, 1992.

8. **Raising the grade:** When the ground level must be raised around an existing tree or tree group the following steps shall be taken to adequately care for the effected 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 (Figure 2101-3).

Figure 2101-3: Tree Well



Source: VA, DCR, 1992.

    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 (Figure 2101-4).

        1) Before filling, remove the green vegetation, sod, leaf litter, and other organic matter from beneath the tree 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. Fertilizer formulations and application rates and methods shall conform to the guidelines provided in Table 2101-1.

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.

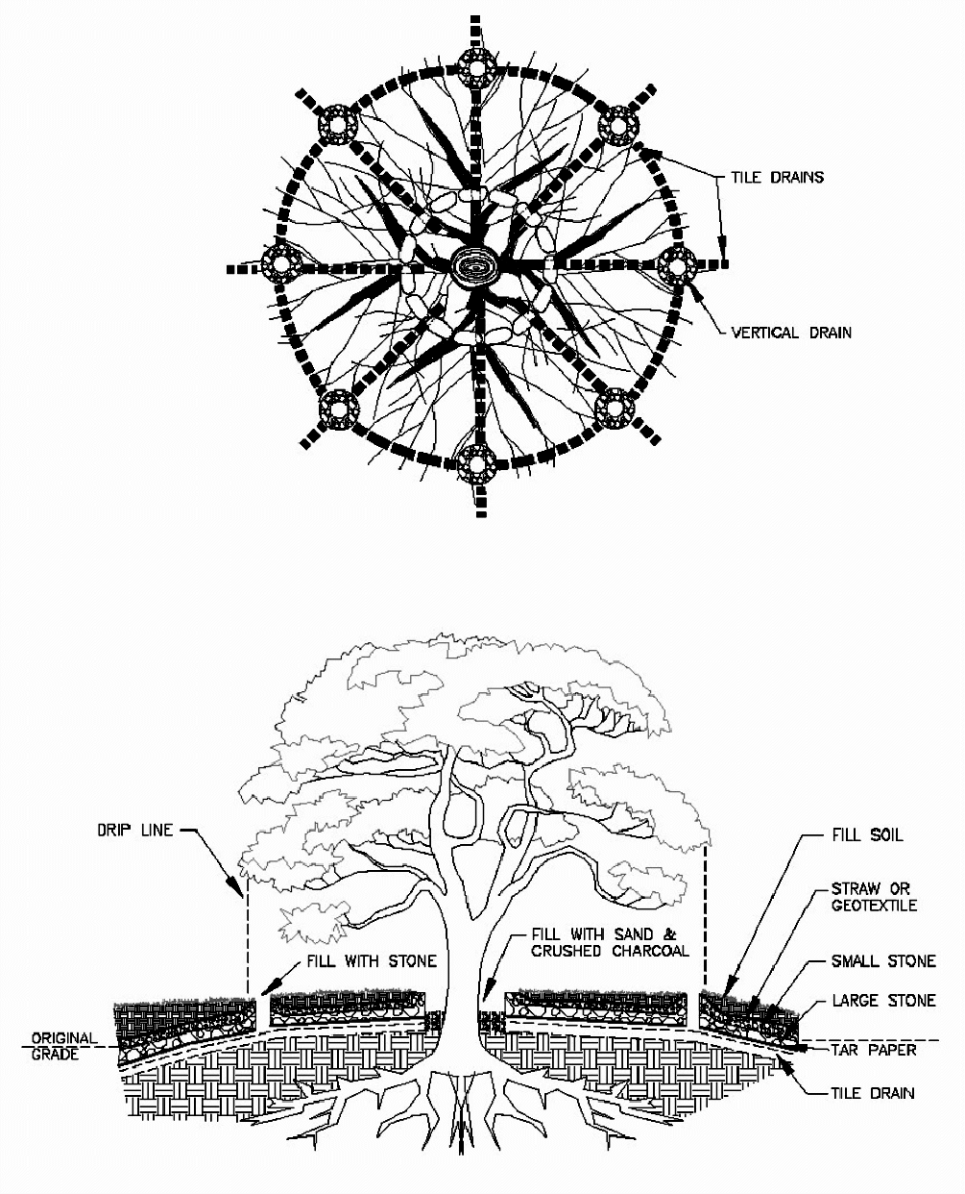
5) The well wall shall be constructed of large stones, brick, building tile, concrete blocks, or cinder blocks with care being taken to ensure that ample openings are left through the wall of the well to allow for free movement of air and water. Mortar shall only be used near the top of the well and 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, non-woven geotextile, or its approved equivalent shall be placed over the tile or pipe joints to prevent clogging, and large stone shall be placed around and over drain tiles or pipes for protection.

8) A layer of 2 to 6 inches of stone shall be placed over the entire area under the tree from the dry 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.

Figure 2101-4: Tree Well Detail



Source: VA, DCR, 1992.

TABLE 2101-1: 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 DHB; 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 INCHS 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: VA, DCR, 1992.

9) A layer of 3/4-inch to 1-inch stone covered by straw or a non-woven geotextile 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.

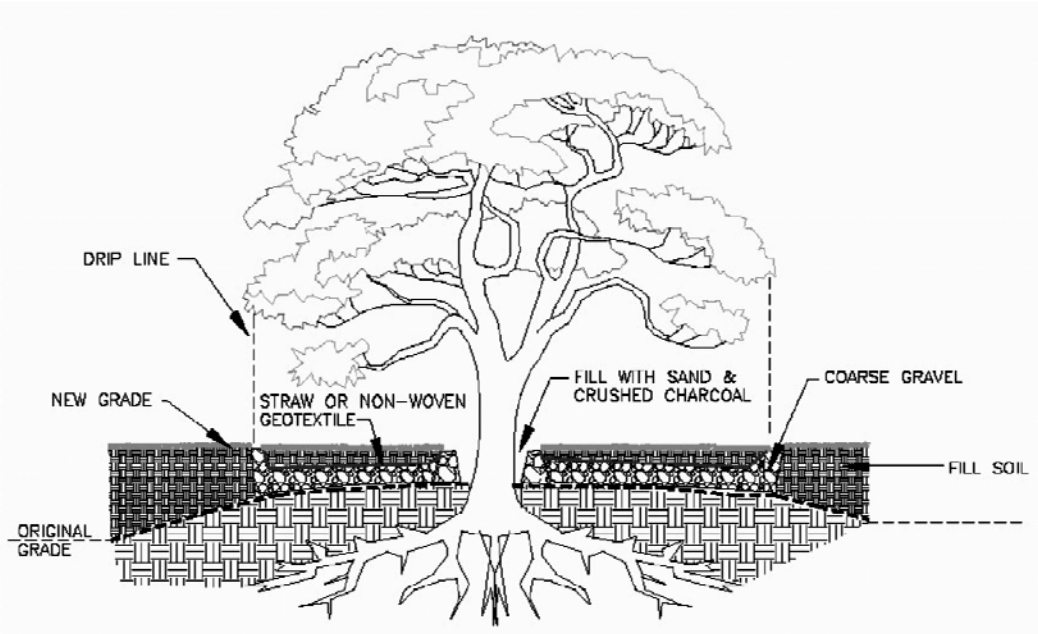
11) To prevent clogging of the drain lines crushed stone shall be placed inside the dry well over the openings of the radial tiles. Vertical tiles shall also be filled with crushed rock and may also be covered with a screen.

12) To prevent anyone from falling into the dry well and to prevent leaves and debris from accumulating, the dry well shall 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.

    a. 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 (Figure 2101-5).

    b. 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.

Figure 2101-5: Tree Well Without Drain Tiles



Source: VA. DCR, 1992.

9. **Lowering the grade:** Trees shall be protected from harmful grade cuts by constructing of a tree wall (Figure 2101-6).

    a. Following excavation, all tree roots that are exposed 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, concrete block, or cinder block as indicated.

    c. The wall shall be backfilled with peat moss or other organic material or with topsoil to retain moisture and aid in root development.

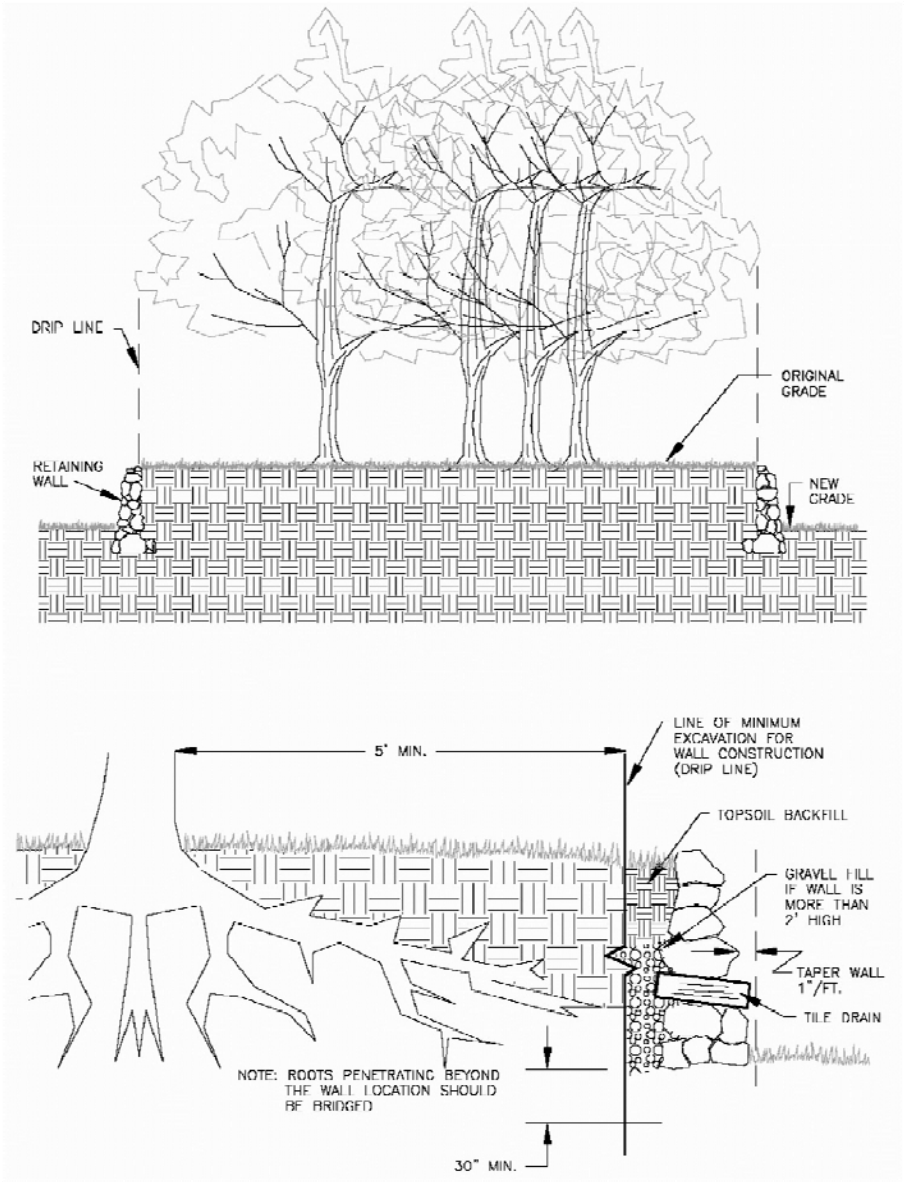
    d. Apply fertilizer and water thoroughly. Fertilizer formulations and application rates and methods shall conform to the guidelines in Table 2101-1.

    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.

Figure 2101-6: Tree Wall Detail



Source: VA. DCR, 1992.

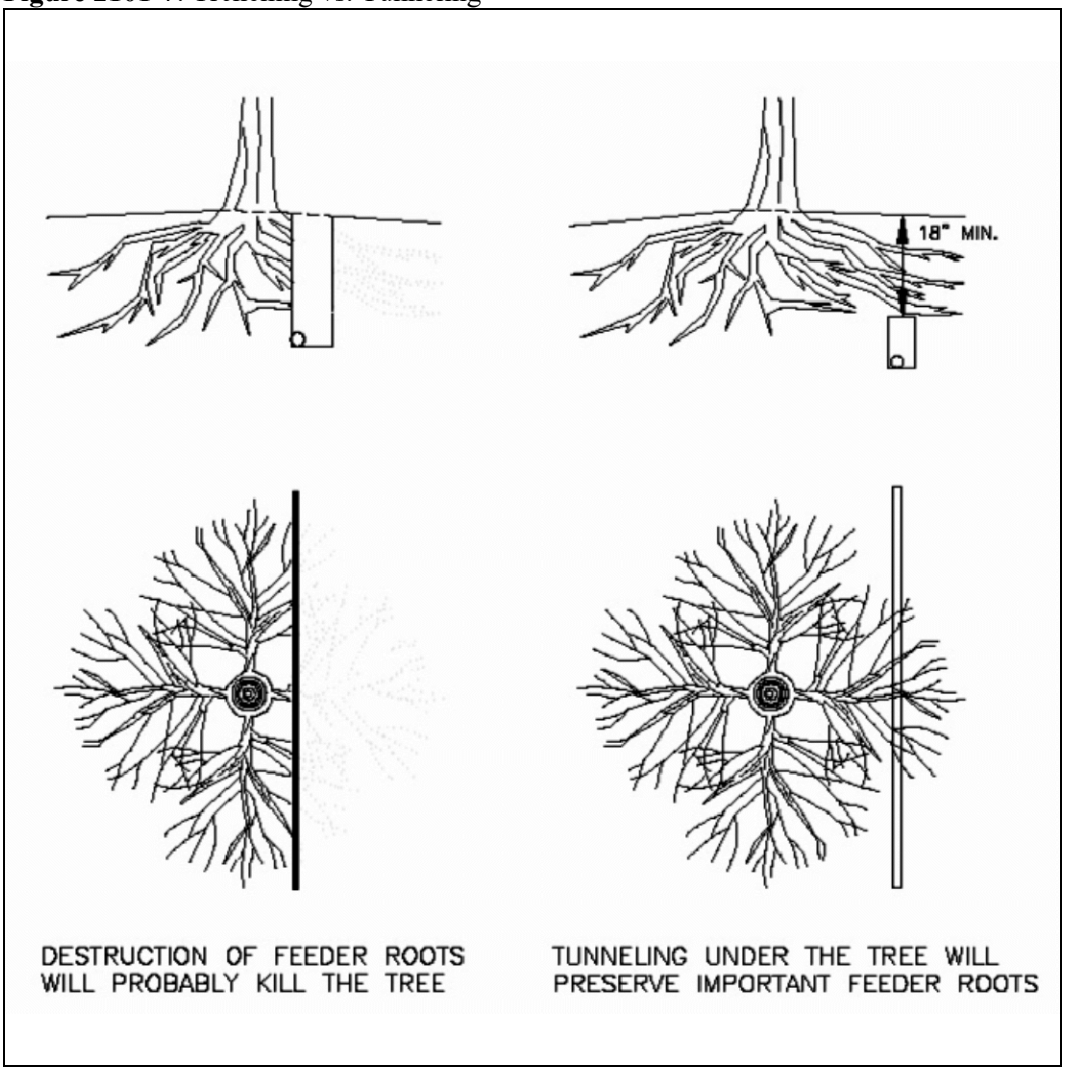
10. **Trenching and Tunneling:**

    a. Trenching shall be done as far away from the trunks of trees as possible, preferably outside the crown spreads, 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 tunneling under large roots and areas of heavy root concentration.

    c. Tunneling is more expensive initially, but it usually causes less soil disturbance and physiological impact on the root system. The extra cost may offset the potential cost of tree removal and replacement should the tree die (Figure 2101-7).

Figure 2101-7: Trenching vs. Tunneling



Source: VA. DCR, 1992.

d. Tunneling is almost always preferred over trenching. 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).

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

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

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

h. Peat moss or other suitable material shall be added to the fill material to aid new root growth.

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

j. 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 completed before the next growing season. If roots are cut during the growing season, pruning shall be completed immediately.

11. **Removal and Replacement of Damaged Trees:** Should a tree intended to remain be damaged seriously enough that survival and normal growth are not possible, the tree shall be removed. If replacement is desirable or required, the replacement tree shall be of the same or similar species and 2- inch to 2 ½ -inch (minimum) caliper, balled and burlapped nursery stock.

12. **Clean-Up:** Tree damage often occurs during construction. Fences and barriers shall be removed as a last order of work.

D. **Troubleshooting:** All trees to remain and protective fencing shall be inspected weekly. Fencing shall be repaired or replaced as necessary. Damage to trees shall be repaired as dictated below.

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

1. **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 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.

2. **Repair of Damage:**

    a. Any damage to the crown, trunk, or root system of any tree to remain shall be repaired immediately.

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

    c. Damaged roots shall immediately be cut 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.

    d. To treat bark damage, carefully cut all loosened bark back to the undamaged area, taper the cut at the top and bottom, and provide drainage at the base of the wound.

    e. All tree limbs damaged during construction, or removed for any other reason, shall be cut off above the collar at the preceding branch junction.

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

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

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

    b. Fertilizer shall be applied to the soil over the feeder roots. 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.

    c. Fertilizer shall be applied using approved fertilization methods and equipment.

    d. Formulation and application rates shall conform to the guidelines given in Table 2101-1.

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

2101.3 VEGETATIVE BUFFERS (FILTER STRIPS)

A. **Description:** Vegetative buffers are wide belts of vegetation designed to provide infiltration, intercept sediment and other pollutants, and reduce stormwater flow and velocity. Vegetative buffers are designed to accept only overland sheet flow. They cannot treat high velocity flows. Surface runoff must be evenly distributed across the filter strip. Once a channel forms in the filter strip, it is no longer effective.

B. **Application:** Vegetative buffers can consist of grass, woody vegetation, or other erosion resistant plants. They can be used as a perimeter control or in conjunction with infiltration basins, infiltration trenches, or alongside streams to slow flow velocities so sediment settles out.

C. **Construction Specifications:**

1. **Site Preparation:** Natural wooded strips or existing densely covered grass strips. At the start of development, fence off any undisturbed vegetation to be preserved. Avoid storing debris from clearing and grubbing and other construction waste material in these areas during construction.

2. **Grading:** If the adjacent area does not have a level edge, grade a level swale adjacent to the top edge of the filter strip. The swale should discharge to the filter strip along a level edge. The swale will serve as a level spreader to distribute runoff evenly to the filter strip (Figure 2101-8).

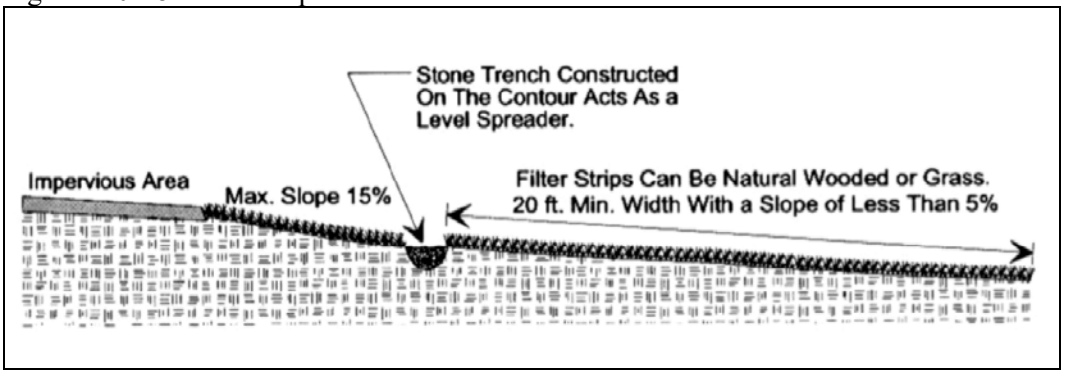
    a. Line the swale with rock, turf reinforcing mat, or other erosion resistance material.

    b. Sod or seed, mulch, and fertilize the filter strip area.

    c. See Section 5106.6 for minimum width of filter strips and constructing a vegetative buffer for perimeter control.

    d. If the filter strip is used to trap sediment during construction, the top edge should be regraded and reseeded following construction. This will remove sediment trapped during construction and prolong the effective use of the filter strip.

Figure 2101-8: Filter Strip



Source: MDNR Protecting Water Quality, 1998

3. **Erosion Control:** Minimize the size of all disturbed areas and stabilize as soon as each phase of construction is complete.

    a. Use temporary diversions to prevent surface runoff from being transported to the filter strip unless it is used to trap sediment during construction.

    b. Direct all overland flow to the filter strip or the level spreading swale at low velocities.

4. **Safety:**

    a. Store all construction materials and waste material well away from the filter strip.

    b. If utility lines are buried beneath the filter strip, do not perform final grading until all trench settlement has taken place. Follow all local, state, and federal guidelines in constructing utility trenches. Overhead utility lines should be located at least 20 feet from the top edge of the filter strip.

    c. Provide temporary fencing and warning signs until vegetation is established.

D. **Troubleshooting:** Consult with a design professional if any of the following occur:

1. Variations in topography on the site indicate filter strip will not function as intended.

2. Design specifications for fill, rock, sod, seed, mulch, or fertilizer cannot be met; substitution may be required. Unapproved substitutions could lead to the filter strip not operating as designed.

E. **Inspection and Maintenance:**

1. Check for eroded channels in the filter strip after every storm event of ½-inch or greater. Fill with topsoil, prepare seed bed in eroded areas, and reseed, mulch, and fertilize the affected area.

2. For long-term construction projects, apply a complete fertilizer annually to maintain the desired density of vegetation. After construction, apply fertilizer in accordance with soil test recommendations.

3. Protect new plantings from livestock or wildlife.

4. Mow grass strips to a height of 6 to 12 inches, two to three times a year to suppress weeds and woody vegetation unless natural, woody vegetation is planned.

5. Repair foot paths and traffic ruts.

2101.4 VEGETATED STREAM BUFFERS

A. **Description:** Vegetated stream buffers limit both vegetation removal and grading of the riparian area along flowing waters. They are intended to protect the banks of natural streams from damage due to development, lessen the risk of flooding in developed areas, and provide a buffer between the developed area and the stream. A properly maintained streambank setback will help maintain channel capacity and stability, reduce the sediment load in the channel, and reduce the movement of pollutants into the stream.

B. **Application:** Vegetated stream buffers are setbacks that help preserve natural channel meander and protect homes and other buildings from damage due to bank erosion. They can also be used adjacent to excavated open channels, drainageways, and watercourses that route runoff to streams.

C. **Construction Specifications:**

1. **Site Preparation:** Follow all federal, state, and local regulations for channel improvements required to increase stream capacity due to development. Open channel cross sections should not be reduced to increase streambank setback. Locate all underground utilities.

2. **Natural channels:** Natural channel side slopes should not be disturbed. When disturbance is necessary to develop a site, reestablish vegetation on channel side slopes as soon as possible after excavation or improvement. Consider the natural zones of a streambank community when placing vegetation. Use native plant materials for establishment and long term success. Lists of suitable species may be obtained from the Missouri

3. **Department of Conservation (MDC) or NRCS**. Existing woody vegetation adjacent to the stream should not be disturbed. Leave any rights-of-way in the best condition feasible consistent with the project purposes and adjacent land uses. Preserve or plant adapted trees to provide shade, prevent thermal pollution in the stream, help stabilize banks, and provide wildlife habitat in those areas of perennial flow or where woody cover exists.

4. **Erosion Control:** Minimize the size of all disturbed areas and stabilize as soon as each phase of construction is complete. Establish vegetation on all disturbed areas immediately after construction. The streambank setback area should be used as a filter strip during construction. Use temporary diversions to prevent lateral surface water from running onto the streambank setback area. After construction, direct all overland flow through the streambank setback area at velocities of 5 feet per second or less.

5. **Safety:** At the completion of each work day, move all construction equipment away from the streambank setback area in anticipation of flooding. Construction materials and waste material should not be stored in the stream channel or streambank setback area. Provide temporary fencing and post warning signs until vegetation is established in areas that are disturbed. Provide site drainage. Vehicle traffic through the setback areas should be avoided. Temporary stream

crossings should be used by construction equipment to prevent destruction of the streambank setback areas. See Details ESC-39 and ESC-40 in Division III in this manual.

6. **Construction Verification:** The alignment and width of the setback should be maintained during all construction activities. The final grades and elevations of the setback area should be checked to ensure compliance with plans and specifications.

D. **Troubleshooting:** Consult with a qualified design professional if any of the following occur:

1. Variation in topography on the site indicate setback or channel is inadequate or will not function as intended; changes in the plans may be needed.

2. Design specifications for seed variety, trees, mulch and fertilizer cannot be met; substitution may be required. Unapproved substitutions could result in additional flooding and erosion of the streambank.

E. **Maintenance:** Check the streambank setback area after every storm event of ½-inch or greater. Fix gaps in the vegetative cover by seeding and mulching or with new plants. Protect new plantings in the streambank setback area from livestock or wildlife. Mulch, spray with a herbicide approved for aquatic use, or chop out undesirable vegetation periodically to prevent its growth. Keep inlets to side drainage structures open. Keep subsurface drain outlet pipes open and protected.

SECTION 2102 SITE PREPARATION

2102.1 CONSTRUCTION SEQUENCE SCHEDULE

A. **Description:** A construction sequence schedule is a specified work schedule that coordinates the timing of land-disturbing activities and the installation of erosion and sediment control measures.

B. **Application:** A construction sequence schedule reduces on-site erosion and off-site sedimentation by performing land-disturbing activities and installing erosion and sediment control practices in accordance with a planned schedule.

C. **Construction Specifications:** Many timely construction techniques can reduce the erosion potential of a site such as shaping earthen fills daily to prevent overflows and constructing temporary diversions ahead of anticipated storms. These types of activities cannot be put on the construction sequence schedule but should be used whenever possible.

D. Following a planned construction sequence schedule to reduce erosion should help keep field personnel aware of the possibilities of erosion prevention through construction management and reduction in the total area disturbed at any one time.

E. **Inspection and Maintenance:** Follow the construction sequence throughout project development. When changes in construction activities are needed, amend the sequence schedule in advance to maintain management control.

2102.2 LAND GRADING

A. **Description:**

1. **Grading:** Grading, as used herein, shall mean the performance of all excavation, embankment, and backfill in connection with the construction of all improvements. Mass grading should be avoided. An undisturbed strip of existing grass or other vegetation should be kept in place around the perimeter of the construction site where possible. The Contractor shall scalp only those excavation and embankment areas necessary for construction of the project.

2. **Excavation:** Excavation is defined as the removal of materials from the construction area to the lines and grades shown on the plans.

    a. **Unclassified Excavation:** Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation unless the Special Provisions specify Classified Materials.

    b. **Rock Excavation:** Rock excavation is defined as the removal of all rock ledges 6 inches or more in thickness, detached rock or boulders having a volume of more than 1 ½ cubic yards, and shale occurring in its natural state, hard and unweathered. A rock ledge is defined as a continuous body of rock

that may not include thin interbedded seams of shale or other soft materials less than 12 inches thick. The vertical limit of each ledge shall be defined by interbedded seams of soft materials 12 inches or more in thickness. The beds of soft interbedded material 12 inches or more in thickness shall not be included in the measurement for Rock Excavation but shall be included in the measurement for Earth Excavation.

c. **Earth Excavation**: Earth excavation is defined as the removal of all material not defined as rock.

3. **Embankment or Backfill:** Embankment or backfill is defined as the placing and compacting of material in the construction area to the lines and grades as shown on the plans.

a. **Unsuitable Material:** Unsuitable material is defined as muck, frozen material, organic material, top soil, rubbish, and rock with a maximum dimension greater than 24 inches.

b. **Suitable Material:** Suitable material is defined as entirely imperishable with that portion passing the No. 40 sieve having a liquid limit not exceeding 40 and a plastic index not exceeding 25 when tested in accordance with ASTM D-4318.

1) **Rock Embankment:** Material for rock embankment shall be free of unsuitable material and shall contain, by volume, greater than 10 percent rock or gravel having a maximum dimension greater than 3 inches, but not greater than 24 inches.

2) **Earth Embankment:** Material for earth embankment shall be free of unsuitable material and shall contain, by volume, less than 10 percent rock or gravel having a maximum dimension greater than 3 inches.

3) **Borrow:** Borrow is defined as approved material excavated from an area outside of the project limits and required for construction of embankments.

4) **Waste:** Waste is defined as excavation material that is not used in embankments and is disposed of outside of the embankment areas.

5) **Structures:** Structures, as used herein, refers to bridges, culverts, storm sewer and sanitary appurtenances, retaining walls, and similar construction.

A. **Application:** This practice is applicable where grading to a planned elevation is necessary and practical for the proposed development of a site and for proper operation of sediment control practices.

B. **Construction Specifications:**

1. Construct and maintain all erosion and sediment control practices and measures in accordance with the approved erosion and sediment control plan and construction schedule.

2. Remove good topsoil from areas to be graded and filled and preserve it for use in the final grading of all critical areas.

3. Scarify areas to be topsoiled to a minimum depth of 2 inches before placing topsoil.

4. Clear and grub areas to be filled to remove trees, vegetation, roots, or other objectionable material that would affect the planned stability of the fill.

5. Ensure that fill material is free of brush, rubbish, rocks, logs, stumps, building debris, and other materials inappropriate for constructing stable fills.

6. Place all fill in layers not to exceed ***specified thicknesses***, and compact the layers as required to reduce erosion, slippage, settlement, or other related problems.

7. Do not incorporate frozen or soft, mucky, or highly compressible materials into fill slopes.

8. Do not place fill on a frozen foundation due to possible subsidence and slippage.

9. Keep diversions and other water conveyance measures free of sediment during all phases of development.

10. Handle seeps or springs encountered during construction in accordance with State Agency-approved methods.

11. Permanently stabilize all graded areas immediately after final grading is completed on each area in the grading plan. Apply temporary stabilization measures within 14 days on all graded areas when work is to be interrupted or delayed for 30 calendar days or longer.

12. Show topsoil stockpiles, borrow areas, and spoil areas on the plans, and make sure they are adequately protected from erosion. Include final stabilization of these areas in the plan.

C. **Inspection and Maintenance:** Periodically check all graded areas and their associated erosion and sediment control practices, especially after rainfall events of ½-inch or greater. Promptly remove all sediment from diversions and other control devices. If washouts or breaks occur, repair them immediately.

2102.3 SURFACE ROUGHENING

A. **Description:** Surface roughening provides a rough soil surface with horizontal depressions created by operating a tiller or other suitable implement on the contour or by leaving the slopes in a roughened condition by not fine-grading them. This will aid in establishment of seeded vegetative cover, reduce runoff velocity, increase infiltration, reduce erosion, and provide for sediment trapping. This technique should not be used on slopes intended for erosion control blankets or other rolled products.

B. **Application:**

1. To be stabilized with vegetation, all slopes steeper than 3H:1V require surface roughening by stair-step grading, grooving, furrowing, or tracking.

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

3. Areas that 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.

C. **Construction Specifications:** Cut slope applications for areas that will not be mowed: Cut slopes with a gradient steeper than 3H:1V shall be stair-step graded or grooved.

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 in 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 that run perpendicular to the slope (on the contour).

   Grooves may be made with any appropriate implement that can be safely operated on the slope and that 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 spaced more than 15 inches apart.

   Fill slope applications for areas that will not be mowed: Fill slopes with a gradient steeper than 3H:1V shall be grooved or allowed to remain rough as they are constructed.

   a. Groove according to #2 under the “Cut Slope” section.

b. As lifts of the fill are constructed, soil and rock materials may be allowed to fall naturally onto the slope surface.

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

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

Roughening with tracked machinery: 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 as possible shall be made to minimize compaction.

D. **Seeding:** Roughened areas shall be seeded and mulched as soon as possible to obtain optimum seed germination and seedling growth. (See Section 2151 of this manual).

E. **Inspection and Maintenance:** Periodically check the seeded slopes for rills and washes. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

2102.4 TOPSOILING

A. **Description:** Topsoiling is a method of preserving and reusing the surface layer of undisturbed soil, which is often enriched in organic matter, to obtain a more desirable planting and growth medium.

B. **Application:** Topsoiling provides a suitable growth medium for final site vegetative stabilization.

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 2H:1V or flatter unless other measures are taken to prevent erosion and sloughing.

C. **Construction Specifications:**

1. **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, or clay loam. It shall be free of debris, trash, stumps, rocks, root, 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.

2. **Stripping:** Topsoil operations should not be performed when the soil is wet or frozen. Stripping shall be confined to the immediate construction area. Stripping depth may vary depending on the particular soil. All perimeter dikes, basins, and other sediment controls shall be in place prior to stripping.

3. **Stockpiling:** Topsoil shall be stockpiled in such a manner that natural drainage is not obstructed and no off-site sediment damage results. Side slopes of the stockpile shall not exceed 2H:1V. Stabilize stockpiles as per Section 2151. Perimeter controls must be placed around the stockpile immediately.

4. **Site Preparation:** 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.

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

5. **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 4 inches. It is necessary to compact the topsoil enough to ensure good contact with the underlying soil and to obtain a level seed bed 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.

2102.5 TEMPORARY CONSTRUCTION ENTRANCE

A. **Description:** A temporary construction entrance is a stabilized layer of large aggregate that is located at any point where traffic leaves a construction site and move directly onto a public road or other paved area. See Detail ESC-01 (Temporary Construction Entrance) in Division III of this manual.

B. **Application:** A temporary construction entrance provides a buffer area where construction vehicles can drop their mud to avoid transporting it onto public roads.

   For single family residential lots less than ½ acre in size, use specifications in the *Single Family Residential Standard Booklet*.

2102.6 Construction Details - General: The Contractor shall adhere to any and all statutes regarding the notification of utilities prior to beginning any work within public right-of-way. Relocation or protection of any existing utilities located in street right-of-way shall be governed by Section 1510 and 1511 of the General Provisions and Covenants. The relocation and/or protection of any utility that is shown on the plans, that lies within a utility easement and is endangered by this construction shall be the responsibility of the Contractor.

The Contractor shall make every reasonable effort to protect private facilities. These facilities may not be shown on the plans. When these facilities are disturbed or damaged by the work, the Contractor shall make necessary arrangements for repairs to the facilities for continuous service prior to the close of that work day.

It shall be the responsibility of the Contractor to protect all property lot corners and control monumentation. Should it be necessary to disturb any such monument, whether stake, pin, bar, disk, box, or other, it remains the responsibility of the Contractor to reference such markers prior to removal, reset, them, and file such relocations or monumentation documents as the law may require. Any such references, removal, replacement and certification of monuments shall be performed by a registered licensed surveyor. A copy of all such certification documents shall be provided to the Engineer prior to final payment. Any monument destroyed or improperly reset by the Contractor may be replaced by the Engineer to the standards required by law at the expense of the Contractor.

Grading, excavation and backfilling for all improvements shall be made to the lines, grades and cross sections indicated by the plans.

In addition, to any erosion control measures shown on the plans, the Contractor shall schedule and conduct his operations in such a manner and shall provide any necessary control facilities to protect downstream and adjacent properties from pollution, sedimentation or erosion caused by the grading operations. Any pollution or damage occurring shall be the responsibility of the Contractor.

During construction, the graded area shall be maintained by the Contractor in such condition that it will be well drained at all times. Roadway ditches, channel changes, inlet and outlet ditches and other ditches in connection with the roadway shall be cut and maintained to the required cross section. All drainage work shall be performed in proper sequence with other operations. All ditches and channels shall be kept free of debris or obstructions.

2102.7 Excavation: This section governs the excavation for all improvements.

All suitable material removed by excavation shall be used as far as practicable in the formation of embankment as required to complete the work. The Contractor shall sort all excavated material and stockpile when necessary, so as to provide suitable materials for embankments.

After removal of the roadway excavation material to the required section, all material between lines 1 foot (30.48 cm) outside of the curbs and within the top 6 inches (15.24 cm) of the subgrade shall be compacted to 95 percent of maximum density for the material as defined in Section 2102.

Rock encountered within the full width of the roadway, toe of slope to toe of slope, shall be undergraded to an elevation of 6 inches (15.24 cm) below the finished subgrade elevation. Care shall be taken to avoid overshooting when blasting. Rock shall be removed in such a manner as to leave no excessive water pockets in the surface.

Areas of undergrading or overbreak in rock between lines 1 foot (30.48 cm) outside of the curbs shall be backfilled with spalls, rock fragments or a granular type material. Backfill materials shall have a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the No. 4 (4.75 mm) Sieve.

2102.8 Undergrading: Where materials are encountered which are deemed as unsuitable by the Engineer for use in the work, they shall be removed to the depth and limits as ordered by the Engineer. Areas undergraded shall be backfilled with one of the following materials:

A. Rock fragments or spalls.

B. A granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the No.4 (4.75 mm) Sieve and not more than 40 percent will pass the No. 10 (2.00 mm) Sieve.

C. A material meeting the requirements of Section 2102.2.

2102.9 Embankment: This section governs embankment for all improvements. The embankments shall be constructed using suitable materials, as herein defined, procured from excavations made on the project site or from borrow areas as required to complete the grading work.

A. Starting the Embankment: Where embankments, regardless of height, are placed against hillsides or existing embankments, either of which have a slope steeper than 1 vertical to 4 horizontal, the existing slope shall be benched or stepped in approximately 24 inch (60.96 cm) rises as the new fill is brought up in 12 inch maximum (30.48 cm) layers or lifts. The material bladed out, the bottom of the area cut into, and the embankment material being placed, shall be compacted to the required density. Material cut out, bladed into place and compacted shall not be measured and paid for directly but will be considered as incidental work.

The existing surface upon which embankment material is to be placed shall have all unstable and unsuitable material removed before starting the embankment work.

Where embankments 2 feet (60.96 cm) or less in depth are to be placed on areas covered by existing pavement, the existing pavement shall be removed and the cleared ground surface shall be compacted to the specified density. Where embankments greater than 2 feet (60.96 cm) in depth are to be placed on areas coveted by existing pavement, the existing pavement shall be broken into pieces not larger than 24 inches (60.96 cm) maximum dimension, left in place and the embankment started thereon.

B. Placing Earth Embankment: Earth shall be placed in successive horizontal layers, wetted or dried as necessary to be within the required moisture range and distributed uniformly over the full width of the embankment area. Each layer of material shall not exceed 12 inches maximum (30.48 cm) in thickness (loose state) and shall be compacted to not less than the required density before the next layer is placed thereon. Compaction equipment shall be approved by the Engineer prior to use. As the compaction of each layer progresses, continuous blading, or dozing will be required to level the surface and to insure uniform compaction. Embankment construction shall not be performed when material contains frost, is frozen or is snow covered.

C. Placing Earth and Rock Embankment: When earth and stone or rock fragments are mixed in the embankment, all stones or rock fragments exceeding the thickness of the compacted lift shall be disposed of by being incorporated into the embankment outside the limits of the proposed surfaced areas. The thickness of the layer in these areas may be increased if necessary to accommodate the rocks, but shall not exceed 24 inches (60.96 cm) in thickness (loose state). The stones or rock fragments are to be placed so there will be no nesting. Compaction equipment shall be approved as required on Section 2102.9.B.

D. Consolidated Rock Embankment: When the excavated material consists predominantly of stone or rock fragments of such size that the material cannot be placed in layers of the thickness prescribed, such material shall be placed in the embankment in layers having a thickness of the approximate average size of the larger rocks but not to exceed 24 inches (60.96 cm). Rocks or boulders too large to permit placing in a 24 inch (60.96 cm) layer shall be reduced in size as necessary to permit placement. Rock shall not be dumped in place but shall be distributed by blading or dozing in a manner to insure proper placement in final position in the embankment. The spalls and smaller stone fragments shall be left on the surface of each layer as formed. Each layer shall be thoroughly consolidated before the next layer is placed.

The top 12 inches (30.48 cm) of the embankment shall not contain material having a maximum dimension greater than 3 inches (7.62 cm). The rock fragments or crushed stone shall be well graded to form a dense mass when compacted.

E. Compacting the Embankment: Before placing any embankment, the surface of the existing ground shall be prepared as heretofore specified, moistened as required, and the top 6 inches (15.24 cm) compacted to a density of 90 percent as prescribed by the following paragraph.

All embankment shall be compacted to a density of at least 90 percent of the maximum density for the material used as determined by ASTM D-698 and within a tolerance of minus 3 percent and plus 2 percent of the optimum moisture at maximum density as determined by the Moisture Density Curve obtained. In addition to the above required compaction, the subgrade between lines 1 foot (30.48 cm) outside of the curbs and within the top 6 inches (15.24 cm) of the subgrade shall be compacted to a density of at least 95 percent of the maximum density for material used as determined by ASTM D-698 and with a tolerance of minus 3 percent and plus 2 percent of the optimum moisture at maximum density as determined by the Moisture Density Curve obtained.

All the work involved in either adding moisture to or removing moisture from embankment materials to within these moisture limits shall be considered incidental to the completion of the grading operation.

F. Moisture - Density Determination: In-place density and moisture content of the embankment will be determined by the Standard Method of Test for Density of Soil in Place by the Sand-Cone Method, ASTM D- 1556; or by the Rubber Balloon Method, ASTM D-2167; or by Nuclear Methods, ASTM D-2922.

2102.10 Finishing: In areas where sodding or seeding is proposed, the upper 12 inches (30.48 cm) of the surface area shall be earth material. The top 6 inches (15.24 cm) shall be suitable for sustaining grass. Except where other permit or utility work is in progress, the graded surface shall be made free of rock, concrete, and brick, or fragments thereof, or rubbish and shall be finished to the lines, grades, and cross-section indicated on the plans, including shoulder, berm and sidewalk spaces.

The Contractor shall repair any damaged surface, and shall not use any finishing equipment that will leave a marred surface. When the subgrade preparation is included as a part of the finishing, the work shall be accomplished according to the requirements of Section 2201 entitled "Subgrade Preparation", and shall be considered incidental to finishing the grading work.

2102.11 Cleanup: Cleanup shall follow the work progressively and final cleanup shall follow immediately behind the finishing. The contractor shall remove from the site of the work all equipment, tools and discarded materials, and other construction items. The entire right-of-way or easement shall be left in a finished and neat condition. Cleanup shall be considered as incidental to the completion of the grading work.

2102.12 Construction Details:

A. Trench Excavation: Prior to excavation of the trench in fill areas, fill shall be compacted to a minimum 90% of maximum density (as determined by ASTM D 698) *up* to a minimum *height* of 18 inches above the top of *the proposed* pipe. Trenches shall be excavated to the width and depth as necessary to lay the pipe to the grade line as indicated on the Contract Drawings. Deviation *from the* indicated alignment will not be permitted except under special circumstances, subject to approval of the Engineer. Excavated materials are to be deposited beside trenches and excavations, beyond the reach of slides, transported to the spoil banks, or used for backfilling.

The length of trench excavation opened at one time shall be limited depending on the nature of the soil or other safety considerations. Trenches shall be excavated to a width that will provide adequate working space and pipe clearances for proper pipe installation, jointing, and embedment. However, the limiting trench widths must comply with *the* bedding class requirements *set forth in Section 2102.12.D*. Over-excavation shall be replaced with granular bedding material*, or CLSM*.

1. **Unclassified Excavation:** Unclassified excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation unless the Special Provisions specify Classified Materials.

2. **Rock Excavation:** Rock excavation is defined as the removal of all rock ledges 6 inches or more in thickness, detached rock or boulders having a volume of more than 1-1/2 cubic yards, and shale occurring in its natural state, hard and unweathered.

   A rock ledge is defined as a continuous body of rock; which may include

interbedded seams of shale or other soft materials. Such interbedded soft material seams less than 12 inches in thickness will be included in the measurement of rock excavation. Such seams 12 inches or greater in thickness will be included only in the measurement of earth excavation.

No soft or disintegrated rock which can be removed with a pick or digging machine, no loose, shaken or previously blasted rock, no broken stones, and no rock which may fall into the trench from outside the limits of excavation will be considered as rock excavation. When solid rock is *unexpectedly discovered* in the trench, it shall be stripped of earth, and the Engineer notified.

When blasting is permitted by the Engineer, the Contractor shall use the utmost care to protect life and property. The Contractor shall comply with all laws, ordinances, and applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property and shall be responsible for all damage thereto caused by *them* or *their* subcontractor's operations.

The Contractor shall provide insurance as required by the General Provisions and Covenants and Special Provisions before performing any blasting. The governing agency shall be notified at least 24 hours before blasting operations begin.

3. **Earth Excavation:** Earth excavation is defined as the removal of all material not defined as rock.

4. **De-watering:** The Contractor shall remove any water that may accumulate, or be found in the trenches and other excavations made under the Contract.

   The Contractor shall form all dams, flumes or other works necessary to keep them clear of water while the sewers and their foundations, and other foundation works, are being constructed. All water shall be removed from such excavation in a manner to avoid damage to property.

5. **Cribbing and Sheeting:** The Contractor shall furnish, install, and maintain such sheeting, bracing, and other components, as may be required to support any excavation and to prevent any movement which could in any way injure or delay the work or endanger adjacent pavement, building, or other structures. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed they shall be immediately filled and consolidated.

   For the purpose of preventing injury or property damage, contractor may leave in place all sheeting or bracing, and other items to be embedded in the backfill of the trench. No sheeting or bracing, however, shall be left in place within 5 feet of the surface without the written permission of the Engineer.

6. **Unstable Foundation:** Where materials encountered in the bottom of the trench are deemed as unsuitable by the Engineer to afford a sufficiently stable pipe foundation, the materials shall be removed to the depth and limits as ordered by the Engineer. Areas undergraded shall be backfilled with approved granular material or materials meeting the requirements of Section 2102.8 entitled "Undergrading."

B. Granular Bedding Material: Granular bedding material shall be crushed *clean limestone aggregate meeting one of the following gradations:*

Bedding Material Gradation Limits, % Passing

Sieve Size	*3/4"*	*1/2"*	*3/8"*
1"	*100*		
3/4"	*90-100*	*100*	
1/2"		*80-100*	
3/8″	*20-55*	*40-70*	*100*
No. 4	*0-10*	*0-15*	*30-40*
No. 8	*0-5*	*0-5*	*0-4*

In areas where the pipe trench is below the potential high point of the water table, only three-eighths (3/8″) inch bedding may be used.

C. Flowable Backfill: Controlled Low Strength Material (CLSM):

1. **Description:** This item shall govern the backfilling of *storm sewer* structures and pipe trenches. *When crossing existing utilities, the bedding requirements of the affected Utility shall apply.*

2. **Materials:**

a. CLSM Control and Quality:

1. Proposed Materials: *No material shall be used until it has been checked or tested for compliance with the specifications of this Section and approved by the Engineer. Representative samples of all materials proposed for use in the CLSM shall be submitted to a private laboratory by and at the expense of the Contractor for compliance testing to these Specifications. All tests shall be performed and all materials shall fully comply. A determination of compliance with these Specifications shall be ascertained by a private laboratory prior to submitting a request for approval to the Engineer for the use of the materials and proposed mix design. Acceptable materials proposed for use shall have test results that accompany the request for approval of the proposed mix design.*

2. ***Mix Design Strength Testing:*** *Compressive strength shall be tested at 7 and 28 days in accordance with ASTM C- 39. The test cylinders shall be 3″ in diameter by 6″ in height.*

   Flowable backfill shall have a maximum and minimum 28-day design compressive strength of 125 psi and 50 psi, respectively. The final set shall be a maximum of 2 hours when tested in accordance with ASTM C 266.

3. ***Cost of Testing:*** *All tests necessary for determining conformance with the requirements specified herein will be at the Contractor's expense.*

b. CLSM Materials Requirements: *The CLSM materials proposed for use in construction shall conform to the following requirements:*

1. Cement shall *conform to ASTM C 150*, Type I or Type II.

2. Fly Ash shall conform to ASTM C 618, Class C.

3. Fine Aggregate shall *conform to ASTM C 33.*

4. Mixing water shall *conform to ASTM C 94*.

5. Admixtures shall only be used when specified by the Engineer.

The CLSM *Flowable Backfill* shall be transit mix*, or from a mobile mixer. The elapsed time from when the water is added for batching until the CLSM is placed shall not exceed* ***two*** *hours.*

The slurry mixture shall be mixed between 70 to 100 revolutions of the ready-mixed truck. To minimize segregation, all flowable fill material shall be re-mixed at the project site at mixing speed in the ready-mix truck for approximately two (2) minutes immediately prior to discharge of the slurry mixture.

4. Construction:

The CLSM shall be constructed to the configuration and the lines and grades shown on the Contract Drawings, or as directed by the Engineer.

No CLSM shall be placed on frozen ground. When the ambient temperature either falls or is forecasted to fall below 35 degrees F within 24 hours of its proposed placement time, a set accelerator shall be used.

D. **Backfill of Trenches:**

General: All trenches and excavations shall be backfilled with suitable material placed and compacted in conformance with this Section and Section 2102.9 entitled "Embankment."

The bedding material area identified as Zone "A" in Figures "1" through "3" in this Section shall consist of approved granular material for all storm sewer conduits. The bedding rock shall be consolidated by vibratory or manual "chinking" action to provide uniform support – beneath and up to the Springline of the conduit.

In the areas above Zone "A", the placement, consolidation, compaction, and moisture content of all backfill materials shall be done in accordance with the following specifications and cross-section details of Figures "1 thru 4." Controlled low strength material (CLSM), or flowable fill as it is commonly known, ***shall be used*** *for all trenches under street or alley pavements up to the level of the pavement subgrade unless heavy compaction equipment is utilized or* ***unless otherwise approved by Engineer****. The pavement subgrade is a six to twelve-inch thick layer that consists of uniformly compacted material (as specified in Section 5200 and the Standard Drawings).* ***Compaction tests shall be performed, at the Contractors expense, by an approved testing laboratory to ensure the compaction requirements are met. One compaction test will be done for every 20', or part thereof, of trench under pavement and one set of tests will be done for every three feet, or part thereof, of backfill placed. A copy of the compaction test results shall be provided to the City prior to final inspection. Compaction testing is not required on flowable fill.***

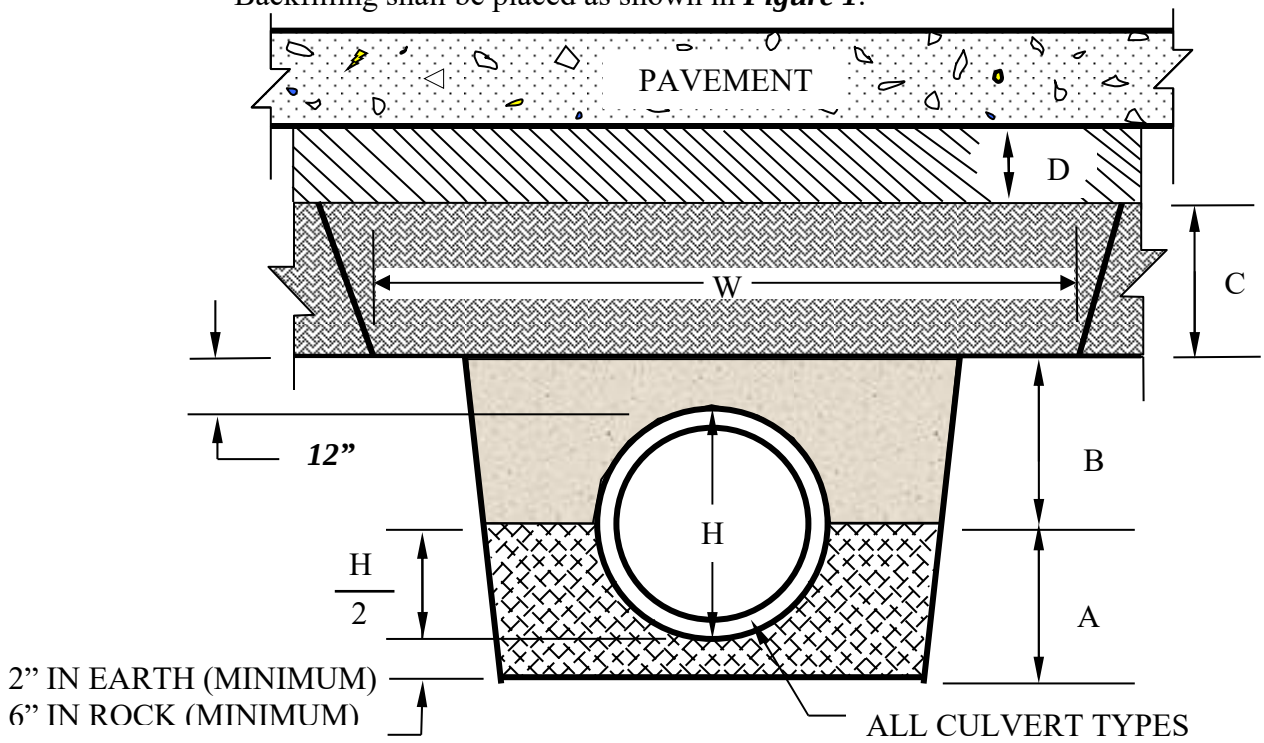
Figure 1: The cross-sectional details in Figure "1" describe the minimum requirements for trench backfilling in areas within street and alley pavements ***where heavy compaction equipment is utilized****. The backfill shall be placed in accordance with section 2102.9.*

Figure 2: The cross-sectional details in Figure "2" describe the minimum requirements for trench backfilling in areas within street and alley pavements that do not allow for placement of the backfill material in accordance with 2102.9.

Figure 3: The cross-sectional detail of Figure "3" prescribes the minimum requirements for trench backfilling in areas that are outside of street and alley pavements.

1. Backfilling under street and alley pavements where heavy compaction equipment is utilized.

Backfilling shall be placed as shown in ***Figure 1***.



A – *Consolidated* granular bedding material **or flowable fill. This zone may be extended up to a maximum of 12" above the top of the pipe if compacted in accordance with Section 2102.9 and tested as previously described.**

B – Flowable Fill (CLSM). ***If zone A is extended to encompass zone B then no flowable fill will be required.***

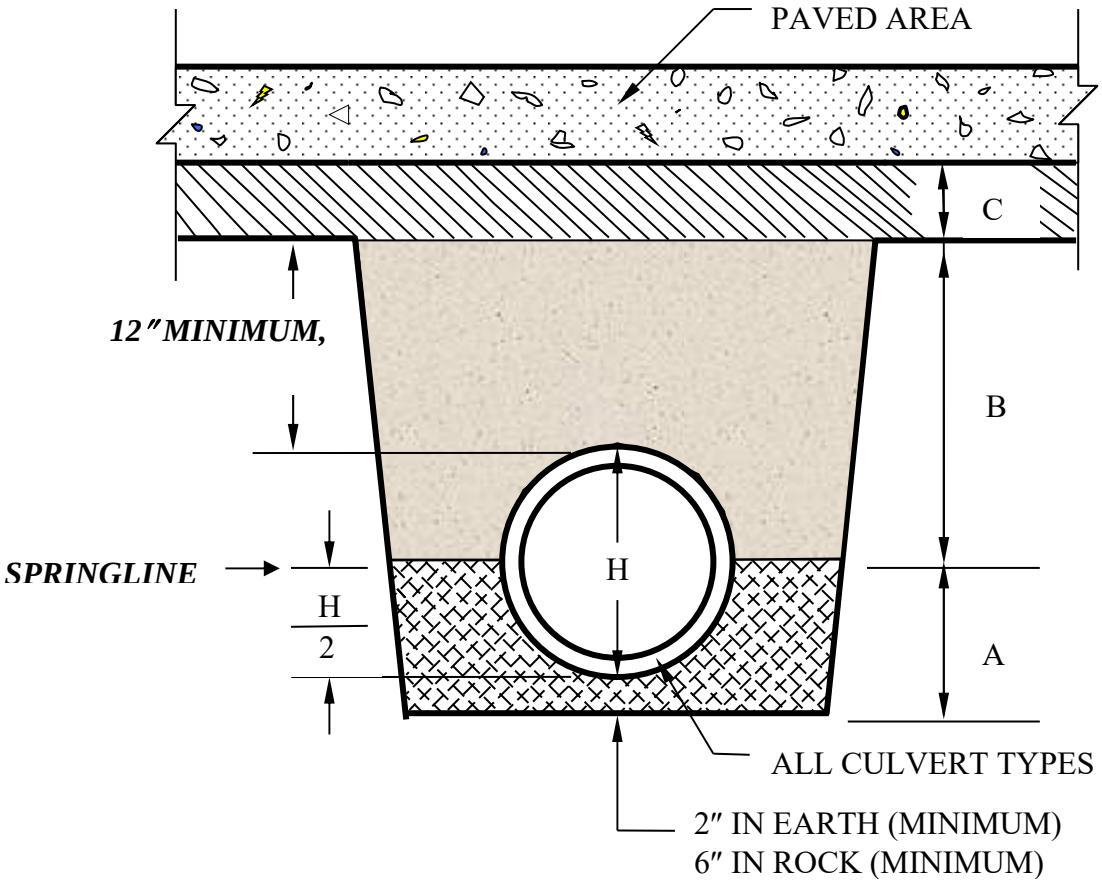
C – ***Compacted Embankment*** *- Shall be constructed in accordance with Section **2102.9**. Lift thickness shall not exceed the capability of the equipment being utilized to achieve the proper density and consolidation, and in no case shall a lift exceed twelve inches for soil. The minimum width, W, shall be two feet wider than the width of the required compaction device.*

D – Compacted Subgrade *- Subgrade thickness shall be as specified in Table 1 of Section 5206 and as directed by the engineer. Subgrade preparation shall be done in accordance with Section 2201 and shall consist of untreated compacted aggregate, stabilized aggregate base, or compacted soil – in accordance with the associated Sections 2201, 2202, and 2203.*

FIGURE 1
(Trench Lines Using Earth Compaction Equipment)

2. ***The following cross-sectional view of typical trench construction under street and alley pavements, Figure 2, shall apply to all backfill areas where trenches are not widened to allow heavy roadway compaction equipment.:***

Backfilling shall be placed as shown in ***Figure 2***.



A – *Consolidated* granular bedding material.

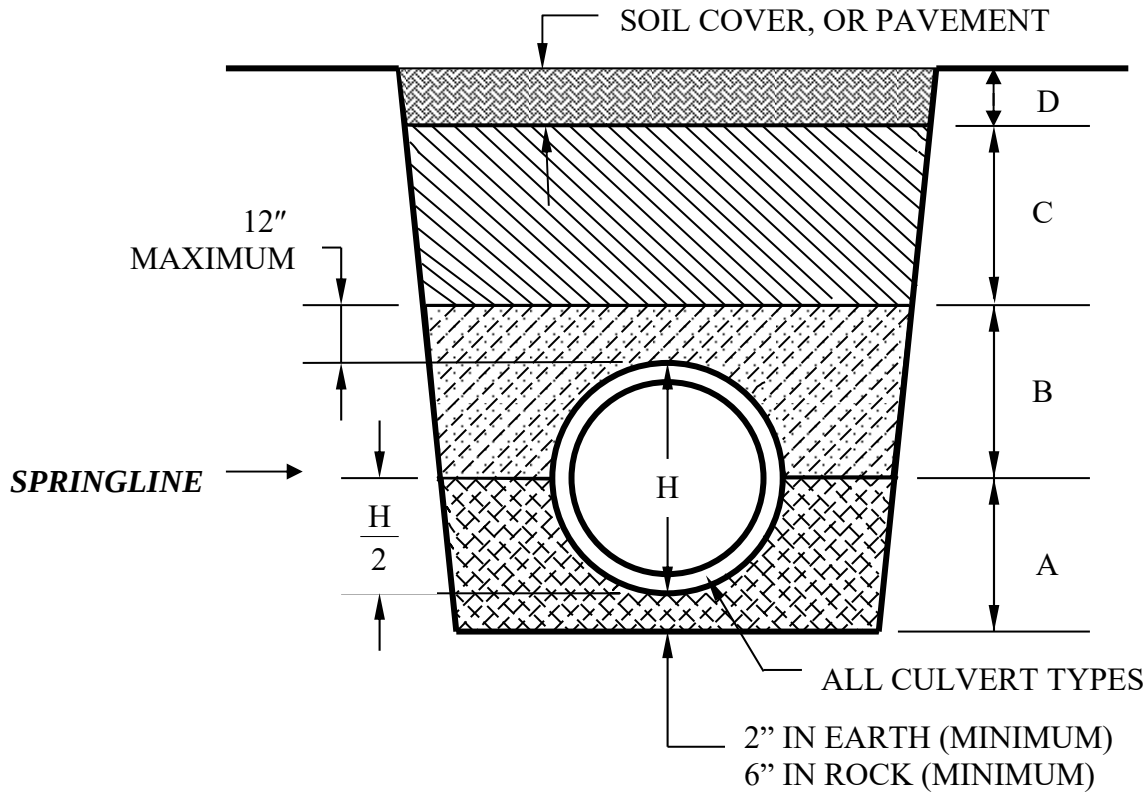
B – Flowable Fill (CLSM).

C – ***Compacted Subgrade*** *- Subgrade thickness shall be as specified in Table 1 of Section 5206 and as directed by the engineer. Subgrade preparation shall be done in accordance with Section 2201, and shall consist of untreated compacted aggregate, stabilized aggregate base, or compacted soil – in accordance with the associated Sections 2201, 2202, and 2203.*

FIGURE 2

(For Trenches Without Roadway Compaction Equipment)

3. Trench backfilling in areas other than street and alley pavements where the near edge of trench is behind the back of curb:
Backfilling shall be placed as shown in ***Figure 3.***



A – *Consolidated* granular bedding material.

B – *Consolidated* granular bedding material, *flowable fill (CLSM),* or compacted soil – *compacted to* 90% of maximum density using ASTM D 698. Maximum lift thickness *for the granular or soil materials shall be* six inches.

C –***Untreated compacted aggregate***, ***flowable fill (CLSM),*** or compacted soil – compact to approximate density of adjacent soil but not less than 90% of maximum density using ASTM D 698***.*** *Lift thickness shall not exceed the capability of the equipment being utilized to achieve the proper density and consolidation; however, in no case shall it exceed twenty-four inches for soil.*

D – Soil Cover – *Soil cover shall be as specified in Section 2102.7. The top twelve inches shall be consolidated soil; the top six inches shall be topsoil suitable for sustaining grass.*

FIGURE 3
(Trenches Outside of Street Pavements)

SECTION 2103 MEASUREMENT AND PAYMENT

2103.1 SCOPE

This section covers the methods of measurement and the basis of payment for the furnishing of all labor, equipment, tools, and materials and for the performance of all related work necessary to complete any construction covered in Section 2100.

2103.2 GENERAL

Unless specifically altered by the Contract Special Provisions, the methods of measurement and payment will be as specified herein.

2103.3 ITEMS NOT LISTED IN THE PROPOSAL

There will be no measurement or separate payment for any items of work not specifically identified and listed in the Proposal, and all costs pertaining thereto will be included in the contract unit prices for other items listed in the Proposal.

2103.4 METHODS OF MEASUREMENT

The quantities of accepted work will be measured and determined as follows:

A. **Clearing, Grubbing, and Demolition:**

1. Clearing may be listed in the Proposal and measured per acre or hundredth part thereof.

2. Grubbing may be listed in the Proposal and measured per acre or hundredth part thereof.

3. Demolition may be included as clearing or may be listed in the Proposal as a separate item and measured per each, and as such shall include all work as defined in Section 2101.2C.

4. Tree removal may be included in clearing or may be listed as a separate item in the Proposal and measured as per each.

B. **Tree Protection:**

    1. Protection fence may be listed in the Proposal and measured per linear foot.

    2. Fertilizer may be listed in the Proposal and measured per 100 pounds.

    3. Concrete block, brick, or stone for tree wells or walls may be listed in the Proposal and measured per piece.

C. **Buffers:** There will be no measurement of payment for buffers or construction sequence schedule.

D. **Grading:**

1. Unclassified Excavation may be listed in the Proposal and measured to determine the quantity in cubic yards or tenth part thereof.

2. Rock excavation may be included as Unclassified Excavation or may be listed in the Proposal as a separate item and measured to determine the quantity in cubic yards or tenth part thereof. No measurement will be made for rock overbreak in excess of 12 inches below the subgrade elevation.

3. Earth Excavation may be included as Unclassified Excavation or may be listed in the Proposal as a separate item and measured to determine the quantity in cubic yards or tenth part thereof. No measurement will be made for embankment performed in rock overbreak areas where the overbreak is in excess of 12 inches below the subgrade elevation.

4. Embankment may be listed in the Proposal and measured to determine the quantity in cubic yards or tenth part thereof.

5. Undergrading may be listed in the Proposal and measured to determine the quantity in cubic yards or tenth part thereof.

E. **Topsoiling:**

1. Topsoiling may be listed in the Proposal and measured in cubic yards.

F. **Construction Entrance:**

1. Rock may be listed in the Proposal and measured in cubic yards or ton.

2. Geotextile may be listed in the Proposal and measured in square yards.

2103.5 BASIS OF PAYMENT

Payment for the quantities of accepted work will be made as follows:

A. **Clearing, Grubbing, and Demolition:**

1. Clearing, grubbing, or clearing and grubbing may be included in the Proposal as separate items or as one item and will be paid for by one of the following:

   a. Payment will be made at the contract unit bid price.

   b. Payment will be made at the contract lump sum bid price.

2. Demolition, if listed as a separate item in the Proposal and not included as a part of Clearing or Clearing and Grubbing, will be paid for by one of the following:

   a. Payment will be made at the contract unit bid price.

b. Payment will be made at the contract lump sum bid price.

3. Tree Removal, if listed in the Proposal as a separate item and not included as a part of Clearing or Clearing and Grubbing, will be paid for by one of the following:

a. Payment will be made at the contract unit bid price.

c. Payment will be made at the contract lump sum bid price.

B. **Tree Protection:**

1. Payment will be made at the contract unit bid price.

2. Payment will be made at the contract lump sum bid price.

C. **Grading:**

1. Unclassified Excavation, Rock Excavation, or Earth Excavation may be included in the Proposal as separate items or as one item and will be paid for by one of the following:

a. Payment will be made at the contract unit bid price.

b. Payment will be made at the contract lump sum bid price.

2. Embankment may be included in the Proposal and will be paid for by one of the following:

a. Payment will be made at the contract unit bid price.

b. Payment will be made at the contract lump sum bid price.

3. Undergrading may be listed in the Proposal and will be paid for at the contract unit bid price.

D. **Topsoiling:**

1. Payment will be made at the contract unit bid price.

2. Payment will be made at the contract lump sum bid price.

E. **Temporary Construction Entrance:**

1. Payment will be made at the contract unit bid price.

2. Payment will be made at the contract lump sum bid price.

SECTION 2150 EROSION AND SEDIMENT CONTROL

SECTION 2151 GENERAL REQUIREMENTS

2151.1 CONTRACTOR'S RESPONSIBILITIES & QUALIFICATIONS

Contractors must take all measures necessary to reduce erosion and sedimentation from occurring on the project. Contracts should include the installation, inspection, and maintenance of erosion and sediment control measures. Contractors should have the proper education, training, and qualifications necessary as stated in Section 5102 of these standards to properly install and maintain all temporary erosion and sediment control measures.

2151.2 COMPLIANCE WITH PERMITS

All construction projects disturbing one or more acres will have obtained a National Pollutant Discharge Elimination System (NPDES) permit from the state. Other Federal, State, or local permits may also need to be obtained for the project. The Contractor is required to conform to and comply with all permits and follow the Storm Water Pollution Prevention Plan (SWPPP) developed for the site.

2151.3 STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

The Storm Water Pollution Prevention Plan will be developed as a requirement of the NPDES permit and local municipal ordinance and permit. Before any construction activities begin on the project, the Contractor and any Subcontractor, who will implement any measures identified in the SWPPP, must verify that they understand the terms and conditions of the permits and plan. The name Erosion and Sediment Control Plan can be substituted for Storm Water Pollution Prevention Plan (SWPPP).

2151.4 INSPECTION AND MAINTENANCE OF PLAN

The Contractor and Subcontractors must maintain the integrity of the temporary erosion and sediment control measures as long as they are in place and necessary. The devices should be inspected immediately after each rainfall of ½ inch or greater and as often as the permits require. Devices should be maintained as dictated in the SWPPP and devices that are not functioning properly should be corrected or replaced. A troubleshooting matrix is included in Table 2151-1 to guide the Contractor to the information necessary to keep the devices working in order to reduce sediment pollution. All pipes that are to be abandoned shall be removed unless otherwise shown on the plans or approved by the Engineer.

Table 2151-1: Troubleshooting Matirx for Erosion, Sediment, and Stormwater Runoff Control in Developing Areas

Problem:	Solution:	Types of Protection:	Control Practice:	Section:
Soil Erosion Sediment (off-site) Dust Dying Grass Unstable Slopes	Soil Protection & Stabilization	Vegetative	Tree Protection	2101.2
			Temporary Seeding	2151.1.1
			Permanent Seeding	2151.1.2
			Sodding	2151.1.3
		Non-Vegetative & Combined Vegetative and Non-Vegetative	Land Grading	2102.2
			Surface Roughening	2102.3
			Topsoiling	2102.4
			Temporary Construction Entrance	2102.5
			Mulching	2151.2
			Tackifiers, Soil Binders, and Bounded Fiber Matrix	2151.3
			Rolled Erosion Control Products	2151.4
			Dust Control	2153.1
Sediment Flowing into Drains Sediment (off-site)	Sediment Control	Storm Drain Inlet Protection	Drop and Curb Storm Inlet Protection	2152.10.1
			Culvert Inlet Protection	2152.10.2
		Sediment Barriers	Vegetated Buffer (Filter Strip)	2101.3
			Sediment Fence	2151.1
			Super Sediment Fence	2152.3
			Straw Bale Barrier	2152.4
			Log or Wattle Products	2152.6
			Rock Check Dam	2152.7
			Triangular Silt Dyke™	2152.8
			GeoRidge®	2152.9
			Turbidity Curtain	2152.20
Sediment (on or off-site) Erosion on Slopes Erosion Channels Localized Flooding Wet, Soft Ground Erosion at Outlets	Stormwater Runoff Control	Surface Runoff Control	Temporary Fill Diversion	2152.12.1
			Temporary Diversion Dike	2152.12.2
			Right-of-Way Division	2152.12.3
		Runoff Conveyance	Grass-lined Channel	2152.13.1
			Temporary Slope Drain	2152.14
			Dewatering	2152.19
		Outlet Protection	Outlet Protection (Energy Dissipation)	2152.11
Sediment (on or off-site) Flooding (on or off-site) Erosion (on or off-site) Stream Erosion Pollutants in Runoff	Stormwater Management	Sediment & Stormwater Traps	Temporary Sediment Trap	2152.15
			Temporary Sediment Basis	2152.16
		Infiltration	Vegetated Stream Buffers	2104.4
			Compost Berm or Tubes	2152.5
			Infiltration Trench	2152.13.2
			Detention/Infiltration Basin	2152.17

SECTION 2152 EROSION CONTROLS (C)

2152.1 SEEDING AND SODDING

A. **Description:** The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover. Seeding and sodding are two methods to provide for vegetative cover. Depending on the type of seed chosen, the vegetative cover can be either temporary, lasting approximately one season, or permanent.

Seeds: Seeds for cover crops shall comply with the requirements of the applicable state seed laws and shall be the mixture of seeds specified in the Erosion and Sediment Control Plan. Seeds shall be free of prohibited weed seeds and shall not have more than 1 percent of noxious weed seeds. Seeds shall be delivered to the site in convenient containers, each fully labeled, bearing the name trade name, or trade mark, warranty of the producer, and a certificate of the percentage of the purity and germination of each kind of seed specified.

Pure Live Seed: The following formula shall be used to determine the amount of commercial seed required to provide each kind of seed for the specified quantities of pure live seeds:

$$\text{Pounds of Commercial Seed Required} = \frac{10{,}000 \times \text{Pure Live Seed (lbs per acre)}}{\text{Purity (percent)} \times \text{Germination (percent)}}$$

B. **Fertilizer:** Fertilizer shall be inorganic 12-12-12, 13-13-13, or 10-20-5 grade; uniform in composition; free flowing and suitable for application with approved equipment; and delivered to the site in convenient containers, each fully labeled and conforming to the applicable state fertilizer laws, bearing the name, trademark or trade name, and a warranty of the producer.

1. **Temporary Seeding:**

A. **Description:** Temporary Seeding is the establishment of fast growing annual vegetation to provide economical erosion control for up to 12 months. Annual plants, which sprout rapidly and survive for only one growing season, are suitable for establishing temporary vegetative cover.

B. **Application:** Temporary Seeding applies where short-lived vegetation can be established before final grading or in a season not suitable for permanent seeding. It helps reduce costly maintenance operations on other erosion and sediment control systems such as sediment basin clean-out. Temporary or permanent seeding is necessary to protect earthen structures such as dikes, diversions, and dams of sediment basins.

C. **Installation:**

1) **Planting Seeds:** Apply seed evenly with a broadcast seeder, drill, cultipacker seeder, or hydroseeder. Plant small grains such oats, rye, and wheat no more than 1½ inch deep. Plant grasses and legumes no more than ½ inch deep. Prior to mulching, harrow, rake, or drag a chain to lightly incorporate broadcast seed and enhance germination. Cover

broadcast or drilled seed with mulch (See *Mulching),* on bare soils, firm lightly with a roller or a cultipacker.

2) **Planting Dates:** Plant according to the design plan. In absence of a plan, choose a recommended temporary species or mixture appropriate for the season from Table 2152-1.

Table 2152-1: Temporary Seeding Plant Materials and Minimum Seeding Rates *

Species	Seeding Rate		Plant Characteristics
	lbs. per Acre	lbs. per 1,000 sq.ft.	
Oats	80 lbs.	2 lbs.	Not cold tolerant, height uop to 2 feet
Cereals: Rye/Wheat	90 / 120	2.0 / 2.5	Cold tolerant, height up to 2 feet, low pH tolerant
Millets, Sundangrass	45 / 60	1.0 / 1.5	Warm season annual, aggressive growth, height up to 5 feet
Annual Ryegrass	75	2	May be added to mix, not heat tolerant, height up to 16 inches
Annual Lespedeza** Pluse Tall Fescue	15 plus 45	0.5 plus 1.0	Warm season annual legume, makes own nitrogen, tolerates low pH

Source: MDNR, 1998.

* If site may not be developed for more than one year consider using permanent species in Table 2152-7.

** If there is any possibility that the seeding will be required to control erosion for more than one year, then consider the addition of fescue or another permanent species as part of a mixture when seeding.

Plant during optimum seeding dates from Table 2152-2 if possible. Use mulch as a cover after planting. Roll and cultipack broadcast seed for good soil-to-seed contact. Use high quality seed. For best results use certified seed. When using uncertified seed, use the highest recommended seeding rate.

3) **Compaction:** Immediately following the completion of seeding operations, the entire area should be compacted by a roller weighing between 60 and 90 pounds per linear foot.

Table 2152-2: Seeding Dates for Temporary Seeding

Species	Seeding Dates Optimum & Acceptable											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Oats												
Cereals: Rye/Wheat												
Millets, Sudangrass												
Annual Ryegrass												
Annual Lespedeza plus Tall Fescue												

Source: MDNR, 1998.

Optimum Seeding Dates

Acceptable Seeding Dates

D. **Troubleshooting:** Consult with a qualified design professional if: design specifications for seed variety, seeding dates, or mulching cannot be met;

substitutions may be required. Unapproved substitutions could lead to failure of vegetation establishment.

E. **Inspection & Maintenance:** Check temporary seedings within 2 to 4 weeks of planting to ensure stands cover more than 50% of the ground surface. Stands should be uniform and dense for best results. Fertilize, reseed, and mulch bare and sparse areas immediately to reduce erosion potential.

Water area of temporary seeding if rainfall is inadequate for proper germination or growth. Mowing is not recommended for cereals seeded alone. Cereals seeded with grass can be mowed when height is greater than 12 inches. However, to prevent damage to grasses, do not mow shorter than 4 inches.

Millets and sudangrass should be mowed before height is greater than 6 inches to allow regrowth and continued erosion protection. Annual lespedeza and tall fescue may be mowed after height exceeds 8 inches. Do not mow shorter than 4 inches.

Replant temporary or permanent vegetation within 12 months as annual plants die off and no longer provide erosion control. Consider no-till planting where possible.

2. **Permanent Seeding:**

A. **Description:** Permanent seeding is the establishment of perennial vegetation on disturbed areas for periods longer than 12 months. Permanent vegetation provides economical, long-term erosion control.

B. **Application:** Permanent seeding is used when vegetation is desired to permanently stabilize the soil. It is necessary to protect earthen structures such as dikes, channels, and embankments. Particular care is required to establish a good, thick cover of permanent grass.

C. **Installation:** During final grading, take soil samples from the top 6 inches in each area to be seeded. Submit sample to a soil testing laboratory for liming and fertilizer recommendations.

1) **Seedbed Preparation:** Seedbed preparation is essential for the seed to germinate and grow. For broadcast seeding and drilling, loosen the soil to a depth of approximately 3 inches. For no-till drilling, the soil surface does not need to be loosened unless it has been compacted. Loosen compacted, hard or crusted soil surfaces with a disk, ripper, chisel, harrow, or other tillage equipment. Avoid preparing the seedbed under excessively wet conditions.

2) **Liming:** Follow the design plan. Apply ground agricultural limestone unless a soil test shows a pH of 6.0 or greater. If a soil test or plan is not available, use 2 tons of ground agricultural lime per acre. Incorporate lime into the top 3 to 6 inches of soil.

3) **Fertilizer:** For establishment and long-term growth, apply a complete fertilizer at rates recommended by soil tests or as specified in the design plan. In the absence of soil tests, use the following as a guide:

   a. **Cool Season Grasses:** Apply 90 pounds (lbs.) each of actual Nitrogen, Phosphorus, and Potassium per acre.

   b. **Cool Season Grass/Legume Mixtures:** Apply 60 lbs. actual Nitrogen, 90 lbs. actual Phosphorus, and 90 lbs. actual Potassium per acre.

   c. **Warm Season Grasses:** Apply 20 lbs. actual Nitrogen, 60 lbs. actual Phosphorus, and 30 lbs. actual Potassium per acre.

   d. **Cool/Warm Season Grass Mixtures:** Apply 30 lbs. actual Nitrogen, 60 lbs. actual Phosphorus, and 30 lbs. actual Potassium per acre.

Note: Fertilizer can be blended to meet exact fertilizer recommendations. Take soil test recommendations to local fertilizer dealer for bulk fertilizer blends. This may be more economical than bagged fertilizer.

Incorporate lime and fertilizer to a depth of 3 to 6 inches by disking or chiseling on slopes of 3H:1V or flatter.

Grade the soil to a smooth, firm surface to enhance rooting of seedlings and reduce rill erosion.

4) **Plant Selection:** If not specified in the design plan, choose a suitable species of grass or a grass/legume mixture from Tables 2151-3 and 2151-4 appropriate for the season that planting will occur. Consider site conditions including soils, plant characteristics, region of the state, and desired level of maintenance. The species shown are adapted for lawns and erosion control. If there are questions about species selection and how they may be adapted in wildlife habitat or wetland applications, contact your local NRCS or County Extension office.

5) **Developing a Mixture:** A pure stand of grass provides the best erosion control. The advantage of a grass/legume mix is that the legume provides nitrogen for the grass and often grows during hotter and drier months when a cool season grass is usually dormant. Usually one or two grasses and one legume is sufficient in a mixture. Refer to Tables 2151-3 and 2151-4 for information about each grass and legume to determine the correct species for your site.

6) **Nurse Crops:** Nurse crops such as wheat, rye, and oats are sometimes used in a seeding mixture. These winter annuals can reduce weeds, control erosion, and provide winter protection to young seedlings. Nurse crops should be planted about 1 inch deep, however, nurse seed can be mixed with permanent seed mix and planted shallower. Most permanent

grasses and legumes are sown ¼ inch deep. Permanent seedings should not be planted deeper than ½ inch.

7) **Aesthetic Plantings:** A wide variety of native forbs and grasses are available that add diversity and beauty to permanent plantings (e.g. switchgrass as an accent). Contact your local NRCS office for species selection and seeding rates.

Table 2152-3: Plant Characteristics

Species		Kansas Adaptation[1]	Missouri Adaptation[2]	Maintenance L – M – H[3]	Fertility Needs L – M – H[3]	Establishment Ease P – M – G[4]
Cool Season Grasses	Perennial ryegrass	E, C, W *	N, S	L	M	M
	Canada wild rye	E, C, W	N, S	M	L	G
	Tall fescue	E, C, W *	N, S	M	L – H	G
	Crested wheatgrass	E, C, W	N	M	L	M – G
	Kentucky bluegrass	E, C, W *	N, S	H	M – H[5]	M – G
	Bromegrass	E, C, W *	N, S	M	M – H[5]	M – G
	Rice Cutgrass	E, C, W *	N, S	L	L	M
	Bluejoint Reedgrass	E, C, W	N, S,	L	L	G
	Redtop	S1/2 E	N, S	L	L	M
Warm Season Grasses	Common Bermuda	S1/2 E, C	S	L	L – M	M
	Hybrid Bermuda	S1/2 E, C	-	L	L – M	M
	Buffalograss[6]	E, C, W	N, S	L	L	M
	Blue grama	E, C, W	N, S	L	L	M
	Zoysia[7]	S1/2 E, C	-	M	M – H	M
	Sideoats grama	E, C, W	N, S	M	L	G
	Little bluestem	E, C, W	N, S	M	L	M
	Big bluestem	E, C, W	N, S	M	L	M
	Indiangrass	E, C, W	N, S	M	L	M
	Switchgrass	E, C, W	N, S	M	L	M
Legumes[8]	Birdsfoot trefoil	E, C*, W*	N, S	L	M	P – M
	Annual lespedeza[9]	E, C, W*	N, S	M	M	P – M
	Red clover	E, C*, W*	N, S	M	M	G
	White clover	E, C*, W*	N, S	L	L	M – G
	Alfalfa	E, C*, W*	N, S	M	M	P
Companion Crops/Cereal Grains	Wheat				M	M
	Rye (cereal)				M	M
	Oats				M	M

Source: MDNR, 1998.

*Adaptation limited to areas in western Kansas which receive additional moisture enhancement by irrigation, subirrigation or overland flow.

[1] E=East, C=Central, W=West

[2] N=North, S=South (Separation is the Missouri River)

[3] L=low, M=moderate, H=high

[4] P=poor, M=moderate, G=good in a mixture.

[5] Will be high maintenance in lawn-type or low rainfall (<30") settings.

[6] Usually seeded, but can be sprigged.

[7] Usually sprigged, plugged or sodded.

[8] Legumes alone will not provide adequate erosion protection: use with a grass

[9] Will reseed each year if not mowed until after seed shatter in September.

Table 2152-4: Species Tolerance for Environmental Conditions

Species		Tolerance				
		Shade	Drought	Flooding	Traffic	Soil Wetness
		L - M - H				P - M - G
Cool Season Grasses	Perenial Ryegrass	L	L	M	M	M
	Canada Wildrye	M	M	L	M	P
	Tall Fescue	M	M	M	M	P
	Crested Wheatgrass	L	H	M	M	G
	Kentucky Bluegrass	L	L	M	H	G
	Bromegrass	L	M	L	H	M
	Redtop	L	L	M	H	G
	Rice Cutgrass	L	L	H	L	G
	Bluejoint Reedgrass	L	L	H	L	G
Warm Season Grasses	Common Bermuda	L	H	H	H	M
	Hybrid Bermuda	L	H	H	H	M
	Buffalograss	L	H	H	H	G
	Blue Gama	L	H	L	M	P
	Zoysia	L	H	M	H	P
	Sideoats Gama	L	H	M	H	M
	Little Bluestem	L	H	L	L	P
	Big Bluestem	L	H	M	L	M
	Indiangrass	L	M	L	M	P
	Switchgrass	L	M	M	M	G
Legumes[1]	Birdsfoot Trefoil	L	H	L	M	G
	Annual Lespedeza®	L	L	M	L	M
	Red Clover	L	L	M	L	M
	White Clover	L	L	L	H	M
	Alfalfa	L	L	L	L	P

Source: MDNR, 1998.

Key: P = poor, L = low, M = moderate, G = good, H = high

[1]Legumes alone will not provide adequate erosion protection: use with grass in a mixture

8) **Planting Dates:** If seeding dates are not specified in the design plan, use the seeding calendar shown in Table 2151-5.

Plant during optimum seeding dates if possible. Use mulch if planting during acceptable or dormant seeding dates. For dormant seeding dates, broadcast seed and immediately roll and cultipack for good soil-to-seed contact.

If unable to seed according to schedule, use temporary seeding until preferred date for permanent seeding.

Table 2152-5: Optimum and Acceptable* Planting Dates

Species	Seeding Dates Optimum & Acceptable											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Turf Fescue												
Tall Fescue												
Kentucky Bluegrass												
Perennial Ryegrass												
Rice Cutgrass												
Redtop												
Bermuda - Common												
Bermuda - Hybrid												
Buffalograss[1]												
Zoysia[2]												
Birdsfoot Trefoil												
Common Lespedeza												
Red Clover												
White Clover												
Wheat/Rye[3]												
Oats[3],$												

Source: MDNR, 1998.

Optimum Seeding Date

Acceptable/Dormant Seeding date (*with mulch over)

[1]Can also be sprigged

[2]Usually sprigged. Space plugs every 6, 8, 12 inches; with 4,000, 2,250 or 1,000 springs/100 sq.ft. respectively

[3]Nurse crop only

$Provides a quick temporary cover or nurse crop even if planted in the fall

9) **Seeding Rates:** If seeding rates are not specified in the design plan, use rates in Table 2152-6 for grasses alone. Use rates in Table 2152-7 for a grass/legume mixture. These rates are based on the poor growing conditions that typically exist on a development site, a need for dense growth, and high germination rates.

For best results use certified seed. When using uncertified seed, use the highest recommended seeding rate. Higher seeding rates will not compensate for seedbed preparation.

Table: 2152-6: Seeding Rates

Species		Kansas: Full Seeding Rate[1] lbs/acre (PLS)[2]	Missouri: Full Seeding Rate[2] lbs/acre (PLS)[2]
Cool Season Grasses	Perenial Ryegrass	80	80
	Canada Wildrye	21	24
	Tall Fescue	80	80
	Crested Wheatgrass	20	16
	Kentucky Bluegrass	50	50
	Bromegrass	100	100
	Redtop	8	8
	Rice Cutgrass	8	8
	Bluejoint Reedgrass	4	4
Warm Season Grasses	Common Bermuda	2	4
	Hybrid Bermuda	20 bu*/acre	-
	Buffalograss	8 (grain)	8 (grain)
	Blue Gama	3	6
	Zoysia	20 bu/acre	-
	Sideoats Gama	15	15
	Little Bluestem	9	13
	Big Bluestem	17	16
	Indiangrass	12.5	16
	Switchgrass	8	9
Legumes[1]	Birdsfoot Trefoil	5	10
	Annual Lespedeza	14	16
	Red Clover	8	12
	White Clover	3	4
	Alfalfa	9	9
Nurse Crops	Wheat	1 bu/acre	1 bu/acre
	Rye (cereal)	1 bu/acre	1 bu/acre
	Oats	1½ bu/acre	1½ bu/acre

Source: MDNR, 1998.

[1]Note: Rates based on typical construction site conditions where seedbed is normally less than ideal. Planned future use or specific site conditions may dictate an increase or a decrease in rates. Contact your local NRCS office or consulting agronomist for specific seeding rates within your county.

[2]PLS or Pure Live Seed = the amount of seed guaranteed to grow.

[3]Legumes alone will not provide adequate erosion protection: use with a grass in a mixture.

*Bu = bushel

Table 2152-7: Seeding Mixtures for Critical Areas

Grass-Legume Mixture	Seeding Rate (PLS*)	
	lbs/1000 ft²***	lbs/acre
Rice Cutgrass/Bluejoint Reedgrass	-	8 + 4
Tall Fescue**/Birdsfoot Trefoil	10 + ¼	80 + 2
Tall Fescue**/White Clover	10 + 0.1	80 + 1
Tall Fescue**/Lespedeza	10 + ½	80 + 4
Tall Fescue**Lespedeza/White Clover	10 + ½ + 0.1	80 + 4 + 1
Tall Fescue**/Red Clover	10 + ¼	80 + 2
Tall Fescue**/Red Clover/White Clover	10 + ¼ + 0.1	80 + 2 + 1
Kentucky Bluegrass/White Clover	3 + 0.1	25 + 1
Kentucky Bluegrass/Red Clover	3 + ¼	25 + 2
Kentucky Bluegrass/Birdsfoot Trefoil	3 + ¼	25 + 2
Kentucky Bluegrass/Lespedeza	3 + ½	25 + 4
Perennial Ryegrass/Red Clover	8 + 1	70 + 10
Perennial Ryegrass/Birdsfoot Trefoil	8 + ½	70 + 5
Perennial Ryegrass/Lespedeza	8 + 3	70 + 25
Big Bluestem/Indiangrass/ Switchgrass/Sideoats Grama/Western Wheatgrass	-	3.4 + 2.5 + 2 + 3 + 4
Wheat/Rye (as nursery crop)	1.5	60
Oats (as nursery crop)	0.75	30

Source: MDNR, 1998

*PLS or Pure Live Seed = the amount of seed guaranteed to grow. To calculate amount of bulk seed needed: Read seed tag and multiply % purity X% germination = % PLS; then divide lbs of PLS recommended by % PLS.

**Turf Fescue may be substituted for fescue at the same rates.

***Note: Use lbs/1000 ft2 rate to establish dense vegetation for lawns.

10) **Seeding:** Apply seed uniformly using a cyclone seeder, drop-type spreader, drill, cultipacker seeder, or hydroseeder. When using a drill seeder, plant rye or other grains about 1 inch deep; plant grasses and legumes no more than ½ inch deep. Calibrate equipment in the field. Cover seed by raking or dragging a chain, brush, or mat. Then firm the soil lightly with a roller. Seed can also be covered with hydro mulched wood fiber and tackifier.

11) **Legumes:** Legumes require inoculation with nitrogen-fixing bacteria to ensure good growth. Purchase inoculum from seed dealer and mix with seed prior to planting.

12) **Mulching:** Mulching is recommended to conserve moisture and reduce erosion. Cover at least 75% of the area with approved mulch materials. Crimp, tack, or tie down mulch with netting or use a rolled erosion control product instead of mulching. Mulching is extremely important for successful seeding. See Section 2152.2 for mulch rates.

13) **Watering:** The seeded area must be watered if adequate rainfall does not occur for germination or vegetation establishment.

14) **Construction Verification:** Check materials and installation for compliance with specifications.

D. **Troubleshooting:** Consult with design professional if: design specifications for seed variety, seeding dates, or mulching cannot be met; substitutions may be required. Unapproved substitutions could lead to failure of vegetative establishment.

1) **Common Problems:**

a. Inadequate seedbed preparation results in poor stand Prepare well-tilled, limed, and fertilized seedbed and reseed.

b. Unsuitable choice of plant materials (e.g. seeding Bermuda grass in the north or in the fall) results in stand failure. Select an appropriate species based on plant characteristics in Tables 2152-3 and 2152-4 and time of seeding in Table 2152-5.

c. Nurse crop rate too high in mixture results in perennial being out-competed. Limit rates to those shown in Table 2152-7; eliminate old nurse crop, prepare seedbed, and reseed.

d. Seeding at the wrong time of the year results in inadequate stand. Consult Table 2152-5 and reseed. If timing is not right, use temporary seeding to stabilize soil until preferred seeding dates.

e. Inadequate mulching results in inadequate stand, bare spots, or eroded areas. Prepare seedbed, reseed, cover seed evenly, and tack or tie down mulch, especially on slopes, ridges, and in channels (see Section 2152.4).

E. **Maintenance & Inspection:** Expect emergence of grasses within 4 to 28 days and legumes 5 to 28 days after seeding, with legumes following grasses.

1) **Check permanent seedings within 4 to 6 weeks after planting to ensure:**

a. Vigorous seedlings;

b. Uniform density with at least 75% of the ground surface covered;

c. Uniformity with nurse plants, legumes, and grasses well intermixed; and

d. Green, not yellow, leaves. At a minimum, perennial plant bases should remain green throughout the summer.

2) **Reseeding:** Inspect seedings for erosion or die-out for a minimum of one year. To repair bare and sparse areas, fill gullies, re-fertilize, reseed, and mulch. Consider no-till planting where possible.

   If stand is inadequate or plant cover is patchy, identify the cause of failure and take corrective action. Possible causes of failure include choice of plant materials, lime or fertilizer quantities, poor seedbed preparation, and weather. If vegetation fails to grow, have the soil tested to determine whether pH is in the correct range or if nutrient deficiency is a problem. Depending on stand conditions, repair with complete seedbed preparation, then over-seed or reseed. If seasonal constraints prohibit planting the desired species, use temporary seeding or over-seed with cereal grain or millets to thicken the stand until the desired perennials may be planted.

3) **Fertilization:** Satisfactory establishment may require re-fertilizing the stand in the second growing season.

   a. Do not fertilize cool season grasses from late May through July.

   b. Grass that looks yellow may be nitrogen deficient. An application of 50 lbs of N-P-K per acre in early spring will help cool season grasses compete against weeds or grow more successfully. Remember to convert actual pounds of nutrient needed when determining how many pounds of commercial fertilizer to buy.

   c. Do not use nitrogen fertilizer if stand contains more than 20% legumes.

4) **Mowing:** Consider mowing after plants reach a height of 6 to 8 inches. Mow grasses to not less than 3 inches in height and minimize compaction during mowing process. Monitor the late winter and early spring growth of nurse crops to be sure that they do not smother the permanent seeding. Mowing in April may reduce the competitiveness of the nurse crop and open the canopy to allow more sunlight to permanent seedlings that are beginning to grow. Vegetation of elements such as embankments and grass-lined channels needs to be mowed only to prevent woody plants from invading.

2. **Sodding**

A. **Description:** Sodding is established turfgrass grown to be cut in strips of some leaf, crown, root mass, and soil then transported to a new site and reestablished to provide vegetative cover and protect the soil from erosion. See Detail ESC-02, Sodding, in Division III of this manual.

B. **Application:** Sodding is well suited for stabilizing erodible areas such as grass-lined channels, stormwater detention basins, diversions, swales, slopes and filter strips. Disturbed areas which require immediate and permanent vegetative cover, or where sodding is preferred to other means of grass establishment. Locations particularly suited to stabilization with sod include:

1) Waterways and channels carrying intermittent flow at acceptable velocities. See Detail ESC-03, Sodded Waterways in Division III of this manual,

2) Areas around drop inlets, when the drainage area has been stabilized,

3) Residential or commercial lawns and golf courses where prompt use and aesthetics are important, and

4) Steep critical areas.

2152.2 MULCHING

A. **Description:** Mulching is the application of plant residues such as straw, hay, wood cellulose, or other suitable materials to the soil surface. Mulch protects the soil surface from the erosive force of raindrop impact and reduces the velocity of overland flow. It helps seedlings germinate and grow by conserving moisture, protecting against temperature extremes, and controlling weeds. Mulch also maintains the infiltration capacity of the soil.

B. **Application:** Mulch can be applied to seeded areas to help establish plant cover. It can also be used in unseeded areas to protect against erosion over the winter or until final grading and shaping can be accomplished.

   1. Areas which have been permanently seeded 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 as weather or seasonal conditions permit. It is not recommended that fiber mulch be used alone for this practice; at normal application rates it 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.

   5. Mulch can be used for dust control if adequately anchored.

C. **Construction Specifications:** Prior to start of construction, mulch requirements should be designed by a qualified professional. Plans and specifications should be referred to by field personnel throughout the construction process.

   1. **Material:** As specified in the approved site plan. If not specified, select from mulch materials listed in Table 2152-8. The choice should be based upon soils, slope steepness and length, flow conditions, and time of year.

   2. **Coverage:** At least 75% of the soil surface.

   3. **Anchoring:** Light materials such as hay and straw should be anchored mechanically, or with tackifiers or netting. Heavy material mulches such as wood chips will not require anchoring unless installed on a slope steeper than 2H:1V.

Table 2152-8: Typical Organic Mulching Materials and Application Rates

Material	Rate per Acre	Requirements	Installation/Uses
Straw	2 – 3 tons	Dry, unchopped, unweathered; free of weed, seeds and rot;	Spread by hand or machine 1.5 to 2.5 inches deep; must be tacked or tied down.
Wood fiber, wood cellulose, recycled newsprint, bonded fiber matrix	1 – 2 tons	Double the application rate for erosion control on critical mass.	Use with power mulcher or hydroseeder; may be used to tack straw on steep slopes. Do not use in hot, dry weather.
Wood chips	10 – 20 tons	Air dry. Add Nitrogen fertilizer. 20 to 25 lbs. of actual Nitrogen per ton of mulch.	Apply with blower, chip handler or by hand. Not for fine turn areas. Most effective around trees and shrubs. Not recommended for mowed areas.
Bark	35 yd^2	Air dry, shredded or hammermilled or chips. Add Nitrogen fertilizer, 20 to 25 lbs. of actual Nitrogen per ton of mulch.	Apply with mulch blower, chip handler or by hand. Do not use asphalt tack. Resistant to wind blowing. Most effective around trees and shrubs. Not recommended for mowed areas.

Source: MDNR, 1998

D. **Installation:**

1. **Site Preparation:** Divert runoff water from areas above the site that will be mulched. Remove stumps, roots, and other debris from the construction area. Grade area as needed to permit the use of equipment for seeding, mulching, and maintenance. Shape area so that it is relatively smooth. If the area will be seeded, follow seeding specifications in the design plan and apply mulch immediately after seeding.

2. **Mulching:** Spread straw or cereal grain mulch uniformly over the area with a power blower or by hand. Not more than 25% of the ground surface should be visible after spreading.

   Apply at the rates shown in Table 2152-8. Use higher rates for steep slopes, channels, and other erosive areas.

   Anchor straw or wood cellulose mulch by one of the following methods:

   a. Crimp with a weighted, straight, notched disc or use a mulch anchoring tool to punch the straw into the soil.

b. Tack with a liquid tackifier designed to hold mulch in place. Use suitable spray equipment and follow manufacturer's recommendations.

c. Cover with netting, using a degradable natural or synthetic mesh to hold mulch materials in place in more erosive areas. The netting should be anchored according to manufacturer's specifications.

d. Use heavy natural nets without additional mulch, synthetic netting with additional mulch, or rolled erosion control products (Section 2152.4) to control erosion on steep slopes and in areas needing a higher degree of protection such as waterways, swales, and diversion channels. These commercial materials vary greatly in longevity, strength, weight, and tolerable shear stress.

E. **Construction Verification:** Check materials and installation for compliance with specifications.

F. **Troubleshooting:** Consult with a qualified design professional if any of the following occur:

1. Variations in topography on the site indicate the mulching materials will not function as intended; changes in plan may be needed.

2. Design specifications for mulching materials or seeding requirements cannot be met; substitutions could result in erosion or seeding failure.

G. **Maintenance & Inspection:** All mulches and soil coverings should be inspected periodically and after rainstorms of ½-inch or greater to check for erosion. Where erosion is observed in mulched areas, additional mulch should be applied after any damage is repaired. Nets should be inspected after rainstorms for dislocation or failure. If washouts or breakage occur, re-install netting as necessary after repairing damage to the slope or ditch. Inspections should take place 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.

2152.3 TACKIFIERS, SOIL BINDERS, AND BONDED FIBER MARIX

A. **Description:**

1. **Tackifiers** - The tackifier for straw, paper, and wood mulch cover shall consist of a guar gum, plantago, starch, or other organic substance. It shall be mixed with water and distributed over the mulch at the manufacturer's recommended rate for that substance and site condition. Application of mulches is found in Section 2152.2.

2. **Soil Binders** - Soil binders are chemical soil stabilizers used for temporary soil stabilization. There are many soil binder products available. Anionic

Polyacrylamide (PAM) is a product that is land-applied as a temporary soil binding agent to reduce erosion.

a. This temporary practice is not intended for direct application to surface waters of the state.

b. Never add water to PAM, add PAM slowly to water.

c. Not all polymers are PAM. Only the anionic form of PAM shall be used. Cationic PAM is toxic and shall not be used.

d. Anionic PAM in pure form shall have less than or equal to 0.05 percent acrylamide monomer by weight, as established by the Food and Drug Administration and the Environmental Protection Agency.

e. To maintain less than or equal to 0.05 percent of acrylamide monomer, the maximum application rate of PAM, in pure form, shall not exceed 200 pounds/acre/year. Do not over apply PAM. Excessive application of PAM can lower infiltration rate or suspend solids in water, rather than promote settling.

f. Users of anionic PAM shall obtain and follow all Material Safety Data Sheets and manufacturer's recommendations.

g. The manufacturer or supplier shall provide written application methods for PAM and PAM mixtures. The application method shall ensure uniform coverage of the target and avoid drift to non-target areas including waters of the State. The manufacturer or supplier shall also provide written instructions to ensure proper safety, storage, and mixing of the product.

4. **Bonded Fiber Matrix (BFM)** – BMF is a classification of erosion control products designed to stay in place on steep slopes. It is a continuous layer of elongated fiber strands held together by a water-resistant bonding agent. BFMs eliminate direct raindrop impact on soil. Once dry, the BFM forms a water-absorbent protective cover that is porous and breathable and secures soil and seed to enhance establishment of vegetation.

B. **Application:** Follow manufacturer's specifications for mixing and application rates of each product. These products should be installed by a Contractor certified by the manufacturer and trained in the proper procedures for mixing and application of the product. Product should be applied as a uniform blanket on 100 percent of the soil surface to ensure the integrity of the material bonding together. It should not be applied if air temperature is below 40°F, if rain is expected within 24 hours of application, or in high wind situations.

C. **Inspection and Maintenance:** The site where these products are used should be inspected within 48 hours of application to check for 100 percent coverage of the product and proper bonding of the material to the soil. The area should also be inspected periodically and after every rain event to ensure effective performance.

Additional product should be applied to areas that require additional stabilization or where bare soil is visible.

2152.4 ROLLED EROSION CONTROL PRODUCTS

A. **Description:** The rolled erosion control products in this manual are broken up into two distinct groups: erosion control blankets and turf reinforcement mats. Erosion control blankets are temporary protection blankets made of organic materials such as straw, wood, coir, or coconut fibers and held together with single or double netting of cotton string or polypropylene. Turf Reinforcement Mat (TRM) is a permanent protection blanket made of polypropylene woven blanket and netting, which may have additional organic fibers woven between the top and bottom netting.

B. **Application:** Erosion control blankets should be used on bare soils with slopes flatter than 2H:1V; in areas that need erosion control for between 8 months and 1 year; in areas where winds prevent standard mulching practices from remaining in place until vegetation becomes established; and in concentrated flow areas where shear stress is within the manufacturer's recommended limits for the specific product. TRMs should be used on slopes steeper than 2H:1V where erosion hazard is high and planting is likely to be too slow to provide adequate protective cover; in vegetated channels; and on stream banks where moving water is likely to wash out new plantings. The shear stress must be calculated and within the limits of manufacturer's recommendations for the specific product used.

    1. Rolled erosion control products provide a protective covering or additional soil stabilization on a prepared planting area with slopes greater than 8 percent, in channels, and along shorelines. They aid in controlling erosion on critical areas. They may also raise the maximum permissible velocity and shear stress on turfgrass stands in channelized areas by reinforcing the vegetation.

    2. Before installation of these products, the area should be final graded to a smooth and uniform surface free of debris. Topsoil should be incorporated as needed. Seed and fertilize as shown on the plan. The erosion control blankets and TRMs should be installed in accordance with the manufacturer's recommendations and specifications. All products should be anchored firmly with continuous contact to the soil surface. The product should be anchored following the manufacturer's recommended stapling pattern for that specific application. Details for these products are found in Division III, Details ESC-04 through ESC-09.

SECTION 2153 SEDIMENT CONTROLS

2153.1 SEDIMENT FENCE

A. **Description:** Sediment fence is a temporary sediment barrier consisting of synthetic fabric stretched across and attached to supporting posts and entrenched or sliced in place. See Detail ESC-10, Sediment Fence, in Division III of this manual.

B. **Application:**

1. Sediment fence intercepts and detains small amounts of sediment from disturbed areas during construction operations in order to prevent sediment from leaving the site.

2. Sediment fence decreases the velocity of sheet flows and low-to-moderate channel flows.

2153.2 SEDIMENT FENCE INSTALLATION MACHINES

A. **Description:** Sediment fence installation machines insert a narrow custom-shaped blade at least 10 inches into the ground while simultaneously pulling sediment fence fabric into the opening created as the blade is pulled through the ground. See Detail ESC-11, Sediment Fence Installation Slicing Method, in Division III of this manual.

B. **Application:** Sediment fence installation machines install sediment fence by inserting sediment fence fabric while slicing the ground. No trenching is required and there is little soil disturbance.

2153.3 SUPER SEDIMENT FENCE

A. **Description:** Super sediment fence is a temporary barrier of geotextile over wire fence used to intercept sediment-laden runoff from small drainage areas. See Detail ESC-12, Super Sediment Fence, in Division III of this manual.

B. **Application:** Super sediment fence reduces runoff velocity and allows the deposition of transported sediment to occur.

1. Super sediment fence provides a barrier that can collect and hold debris and soil preventing the material from entering sensitive areas, streams, streets, etc.

2. Super sediment fence can be used where the installation of a dike would destroy sensitive areas, woods, wetlands, etc.

3. Super sediment fence should be placed as close to the contour as possible. No section of sediment fence should exceed a grade of 5% for a distance of more than 50 feet.

2153.4 STRAW BALE BARRIER

A. **Description:** Straw bale barriers are temporary sediment barriers consisting of a row of entrenched and anchored straw bales. See Detail ESC-13, Straw Bale Barrier, in Division III of this manual.

B. **Application:**

1. Straw bale barriers intercept and detain small amounts of sediment from disturbed areas of less than one acre in order to prevent sediment from leaving the site.

2. Straw bale barriers decrease the velocity of sheet flows.

2153.5 COMPOST BERM AND TUBES

A. **Description:** Compost berms and tubes consist of finely chipped wood blown in place or blown into tubular mesh material. See Detail ESC-14, Compost Berm, in Division III of this manual.

B. **Application:** Compost berms and tubes can function as a perimeter control for areas of surface runoff less than one-quarter acre. They can also be used as diversions above a construction site to direct stormwater that does not need to be treated with a Best Management Practice around the site in order to reduce the total volume of stormwater flowing across the disturbed site.

2153.6 LOG OR WATTLE PRODUCTS

A. **Description:** Log or wattle products are tubes of open weave containment material filled with straw, rice or wheat, excelsior, coir, or coconut. They come in a variety of diameters and lengths.

B. **Application:** Logs or wattles can be used as perimeter control for disturbed areas less than one-quarter acre, along contours as slope breaks, and for inlet protection, ditch checks, and streambank protection.

C. **Installation:**

1. Logs or wattles should be installed in shallow trenches 2-4 inches deep depending on soil type and slope steepness. Dig a deeper trench for soft, loamy soils and steep slopes. Dig a shallower trench for hard, rocky soils and gentler slopes.

2. Lay the log or wattle in the trench and stake with 1” x 1” x 18” or 24” wood stakes depending on soil type. Use one at each end and every four feet. Logs or wattles should be butted firmly and staked securely together to prevent leakage. Do not overlap.

D. **Inspection and Maintenance:** Logs or wattles should be inspected after every rain event of ½ inch or greater. Accumulated sediment should be removed behind the logs or wattles. If they have been displaced or damaged they should be reinstalled or replaced as necessary.

2153.7 ROCK CHECK DAMS

A. **Description:** Rock check dams are small temporary stone dams constructed across a swale or drainage ditch. See Detail ESC-15, Rock Check Dam, in Division III of this manual.

B. **Application:** Rock check dams reduce the velocity of concentrated stormwater flows thereby allowing sediment to settle out. Rock dams perform more effectively than sediment fence or straw bales in stabilizing "wet-weather" ditches.

2153.8 TRIANGULAR SILT DIKE ™

A. **Description:** Triangular Silt Dike™ shall be triangular shaped having a height of at least eight to ten inches. The triangular shaped inner material shall be urethane foam. The outer cover shall be a woven geotextile fabric placed around the inner material and allowed to extend beyond both sides of the triangle by two or three feet. See Detail ESC-16, Triangular Silt Dike™, in Division III of this manual.

B. **Application:** Triangular Silt Dike™ should be used to contain sediment along a perimeter or as a ditch check to minimize sediment movement through the waterway.

2153.9 GEO-RIDGE®

A. **Description:** Geo-Ridge® is a light-weight, durable alternative to straw bales and sediment fence as a ditch check in stormwater channels. It attenuates flows rather than blocking them completely, allowing a smoother and less damaging release of water through the berm as opposed to cascading over it.

B. **Application:** Geo-Ridge® can be used in swales, ditches, or other channels as a treatment for stormwater that travels through a channel. It reduces stormwater velocity thereby allowing sediment to settle out within the channel before the stormwater leaves the site. See Detail ESC-17, Geo-Ridge®, in Division III of this manual.

2153.10 INLET PROTECTION

A. **Description:** Inlet protection is accomplished by gravel, sediment-impounding area constructed around a storm drain drop inlet, curb inlet, or culvert inlet.

B. **Application:** Inlet protection reduces the amount of sediment entering a storm drainage system prior to permanent stabilization of the disturbed area.

1. **Drop and Curb Inlet Protection**

a. **Description:** Drop and curb inlet protection consists of a sediment impounding area around a drop inlet or curb inlet to slow the velocity of the stormwater and settle out sediment before the stormwater enters the storm drain system.

b. **Application:** Drop and curb inlet protection reduces the amount of sediment entering storm drainage systems prior to permanent stabilization of the disturbed area. There are many types of inlet protection for different applications.

c. **Silt Saver®** - This product is a manufactured frame and geotextile installed over a round or square inlet. It has an additional safety feature in that the top of the cloth is orange or green for easy visual identification of the inlets. The woven, high-visibility top also provides a more open weave for higher flow volumes during unexpected flash flood events. See Detail ESC-18, Silt Saver®, in Division III of this manual.

d. **Sediment Fence Drop Inlet Protection** – This is applicable where an inlet drains an area sloping no more than 5% and where inlet flows less than 1 cfs are typical. This method shall not apply to inlets receiving concentrated flows such as those in street or highway medians. See Detail ESC-19, Sediment Fence Drop Inlet Protection, in Division III of this manual.

e. **Gravel and Wire Mesh Drop Inlet Sediment Trap** – This method is applicable where heavy concentrated flows are expected but not where ponding around the structure might cause excessive inconvenience or damage to adjacent structures and unprotected areas. See Detail ESC-20, Gravel and Wire Mesh Drop Inlet Sediment Trap, in Division III of this manual.

f. **Block and Gravel Drop Inlet Sediment Trap** – This method is applicable where heavy flows are expected and where an overflow capacity is necessary to prevent excessive ponding around the structure. See Detail ESC-21, Block and Gravel Drop Inlet Sediment Trap, in Division III of this manual.

g. **Excavated Drop Inlet Sediment Trap** – This method is applicable where heavy flows are expected and where an overflow capability and ease of maintenance are desirable. See Detail ESC-22, Excavated Drop Inlet Sediment Trap, in Division III of this manual.

h. **Sod Drop Inlet Sediment Trap** – This method is applicable only at the time of permanent seeding to protect the inlet from sediment and mulch material until permanent vegetation has become established. See Detail ESC-23, Sod Drop Inlet Sediment Trap, in Division III of this manual.

i. **GUTTERBUDDY™** - This product prevents sediment, debris, and other pollutants from entering the stormwater system. The product allows water to freely flow through the fibrous material while stopping sediment and debris. The GUTTERBUDDY™ is installed in front of the curb inlet at a length so that there is approximately a 12-inch overlap at each end of the curb opening.

The GUTTERBUDDY™ is reusable. Once construction is complete and it is no longer needed for sediment control, remove, clean, and store it out of the sunlight until reuse is desired. The GUTTERBUDDY™ must be inspected regularly and after each rain event. It must be cleaned when sediment and debris build up around it. Ponding is likely if sediment is not removed.

j. **Gravel Curb Inlet Sediment Trap** – This method is applicable at curb inlets where ponding in front of the structure is not likely to cause inconvenience or damage to adjacent structures and unprotected areas. See Detail ESC-24, Gravel Curb Inlet Sediment Trap, in Division III of this manual.

k. **Wooden Weir Curb Inlet Protection** – This method is applicable to curb inlets where a sturdy, compact installation is desired. Emergency overflow capabilities are minimal so significant ponding may occur. See Detail ESC-25, Wooden Weir Curb Inlet Protection, in Division III of this manual.

l. **Block and Gravel Curb Inlet Protection** – This method is applicable at curb inlets where an overflow capability is necessary to prevent excessive ponding in front of the structure. See Detail ESC-26, Block and Gravel Curb Inlet Protection, in Division III.

m. **Beaver Dam® or True Dam® -** These products allow suspended solids to settle out of the slowed flow and be captured prior to entering the inlet. These products shall be installed as per manufacturer's recommendations. Maintenance should occur after each rain event. Remove all accumulated sediment and debris from surface and vicinity of unit. These products are reusable.

2. **Culvert Inlet Protection**

a. **Description:** Culvert inlet protection reduces flow at culvert inlets and allows sediment to settle out of stormwater runoff. There are two types of culvert inlet protection details in Division III: Detail ESC-27, Culvert Inlet Sediment Trap and Detail ESC-28, Sediment Fence Culvert Inlet Protection device.

b. **Application:**

1) Culvert inlet protection prevents sediment from entering, accumulating in, and being transferred by a culvert and associated drainage system prior to permanent stabilization of a disturbed project area.

2) Culvert inlet protection provides sediment control at culvert inlets when elevation and drainage patterns may change causing original control measures to be ineffective or in need of removal.

2153.11 OUTLET PROTECTION (ENERGY DISSIPATION)

A. **Description:** Outlet protection is designed to prevent erosion and scour at the outlet of a channel or conduit dissipating the flow energy. Energy dissipaters usually consist of a riprap-lined apron, a reinforced concrete flume with concrete baffles, or a reinforced concrete box with chambers or baffles.

B. **Application:** Outlet protection shall be used when the discharge velocity of a pipe, box culvert, diversion, open channel, or other water conveyance structure exceeds the permissible velocity of the receiving channel or disposal area.

C. **Inspection and Maintenance:** Inspect riprap outlet structures, after heavy rains, to ensure no erosion around or below the riprap has taken place or stones have been dislodged. Immediately make all needed repairs to prevent further damage.

2153.12 DIVERSION

A. **Description:** A diversion is a channel constructed perpendicular to a slope with a supporting earthen ridge on the lower side. See Detail ESC-29, Diversions, in Division III of this manual for many types of diversions.

B. **Application:** Diversions reduce slope length and intercept and divert stormwater runoff to stabilized outlets at non-erosive velocities. Diversions may be used in the following locations:

1) Where runoff from areas of higher elevation may damage property, cause erosion, or interfere with the establishment of vegetation on lower areas.

2) Where surface or shallow subsurface flow is damaging sloping upland.

3) Where the slope length needs to be reduced to minimize soil loss.

1. **Temporary Fill Diversion**

a. **Description:** A temporary fill diversion is a channel with a supporting ridge of soil on the lower side constructed along the top of an active earth fill.

b. **Application:** Temporary fill diversions divert storm runoff away from the unprotected slope of the fill to a stabilized outlet or sediment-trapping facility.

c. **Inspection and Maintenance:** Since these channels are temporary and under most situations will be filled the next workday, the maintenance required should be low. If the diversion is to remain in use for more than one day, an inspection will be made at the end of each workday and repairs made if needed. The Contractor should avoid the placement of any material over the diversion while it is in use. Construction traffic should not be permitted to cross the diversion.

2. **Temporary Diversion Dike**

   a. **Description:** A temporary diversion dike is a temporary ridge of compacted soil constructed at the top or base of a sloping disturbed area.

   b. **Application:**

      1) Temporary diversion dikes divert storm runoff from upslope drainage areas away from unprotected disturbed areas and slopes to a stabilized outlet.

      2) Temporary diversion dikes divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin.

   c. **Inspection and Maintenance:** Facilities shall be inspected after every storm and repairs made to the dike, flow channel, outlet, or sediment trapping facility, as necessary. Once every two weeks, whether a storm event has occurred or not, the facility shall be inspected and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

3. **Right-of-Way Diversion**

   a. **Description:** A right-of-way diversion is a ridge of compacted soil or loose rock or gravel constructed across disturbed rights-of-way and similar sloping areas.

   b. **Application:** Right-of way diversions shorten the flow length within a sloping right-of-way, thereby reducing the erosion potential by diverting storm runoff to a stabilized outlet.

   c. **Inspection and Maintenance:** Diversions shall be inspected after every rainfall and repairs made if necessary. At least once every two weeks, whether a storm has occurred or not, they shall be inspected and repairs made if needed. Right-of-way diversions, which are subject to damage by vehicular traffic, should be reshaped at the end of each workday.

2153.13 RUNOFF CONVEYANCE

A. **Description:** Runoff conveyance is any ditch, swale, or channel constructed to collect overland stormwater flow and direct it to a specific containment device or offsite waterway.

B. **Application:** Runoff conveyance facilities collect stormwater and reduces the flow volume and velocity to settle out sediment and other pollutants before the stormwater leaves the site.

   1. **Grass-Lined Channels**

a. **Description:** A grass-lined channel is a channel with vegetative lining constructed to design cross sections and grades for conveyance of runoff. These channels convey and dispose of concentrated surface runoff without damage from erosion, deposition, or flooding. See Detail ESC-30, Trapezoidal Grass-Lined Channel, in Division III of this manual.

b. **Application:** Grass-lined channels can be applied to construction sites where:

1) Concentrated runoff will cause damage from erosion or flooding;

2) A vegetative lining can provide sufficient stability for the channel cross section and grade;

3) Slopes are generally less than 5%;

4) Space is available for a relatively large cross section. Typical uses include roadside ditches, channels at property boundaries, outlets for diversions and other channels, and drainage of low areas. Turf Reinforcement Mats (TRMs) can be used with a specified vegetation to increase the permissible velocity and shear stress of the grass-lined channel. Permissible velocities and shear stresses of TRMs range from 10-20 feet per second and 6-10 pounds per square foot respectively.

2. **Infiltration Trench**

a. **Description:** An infiltration trench is a shallow excavated trench that has been backfilled with stone designed to filter pollutants from stormwater runoff and allow runoff to infiltrate back into the groundwater. Infiltration trenches are effective in removing pollutants from stormwater runoff in urban settings. Sediments must be screened before runoff enters the trench to prevent the trench from becoming clogged. Infiltration trenches provide for groundwater recharge in areas with permeable soils and bedrock well below the bottom of the trench. They require careful construction and regular maintenance.

Infiltration trenches are normally constructed 3 to 8 feet deep, lined with filter fabric or a sand filter, and backfilled with clean stone or gravel. Grass filter strips or inlets can be designed to filter sediments before entering the trench.

b. **Application:** Infiltration trenches cut off the flow of subsurface drainage and work well in areas where there is not sufficient land available for infiltration basins. See Detail ESC-31, Infiltration Trench, in Division III of this manual.

2153.14 TEMPORARY SLOPE DRAIN

A. **Description:** A temporary slope drain is a flexible tubing or conduit extending from the top to the bottom of a cut or fill slope. See Detail ESC-32, Temporary Slope Drain, in Division III of this manual.

B. **Application:** Temporary slope drains temporarily convey concentrated stormwater runoff safely down the face of a cut or fill slope without causing erosion on or below the slope. On cut or fill slopes where there is a potential for upslope flows to move over the face of the slope causing erosion and preventing adequate stabilization.

2153.15 TEMPORARY SEDIMENT TRAP

A. **Description:** A temporary sediment trap is a temporary ponding area formed by constructing an earthen embankment with a stone outlet. See Detail ESC-33, Temporary Sediment Trap, in Division III of this manual.

B. **Application:** Temporary sediment traps detain sediment-laden runoff from small, disturbed areas long enough to allow the majority of the sediment to settle out.

1. Below disturbed areas where the total contributing drainage area is less than 3 acres.

2. Where the sediment trap will be used no longer than 18 months. The maximum useful life is 18 months.

3. The sediment trap may be constructed either independently or in conjunction with a temporary diversion dike.

2153.16 TEMPORARY SEDIMENT BASIN

A. **Description:** A temporary sediment basin is a temporary barrier or dam constructed across a drainageway or at other suitable locations to intercept sediment-laden runoff. This barrier may be combined with excavation to achieve the required storage.

B. **Application:** Sediment basins protect downstream properties and drainageways by trapping sediment and controlling the release of stormwater runoff.

Sediment basins detain sediment-laden runoff from disturbed areas in “wet” and “dry” storage long enough for the majority of the sediment to settle out. Sediment basins shall be located below disturbed areas where the total contributing drainage area is equal to or greater than three (3) acres. There must be sufficient space and appropriate topography for the construction of a temporary impoundment. It is recommended that these measures, by virtue of their potential to impound large volumes of water, be designed by a qualified professional.

C. **Construction Specifications:**

1. **Site Preparation:** Areas under the embankment or any structural works related to the basin shall be cleared, grubbed, and stripped of topsoil to remove trees,

vegetation, roots, or other objectionable material. In order to facilitate cleanout and restoration, the area of most frequent inundation, measured from the top of the principal spillway, will be cleared of all brush and trees.

2. **Cutoff Trench:** For earth embankments, a cutoff trench shall be excavated along the centerline of the dam. The trench must extend at least 1 foot into a stable, impervious layer of soil and have a minimum depth of 2 feet. The cutoff trench shall extend up both abutments to the riser crest elevation. The minimum bottom width shall be 4 feet, but also must be wide enough to permit operation of compaction equipment. The side slopes shall be no steeper than 1H:1V. Compaction requirements shall be the same as those for the embankment. The trench shall be drained during the backfilling/compacting operations.

3. **Embankment:** The fill material shall be taken from approved borrow areas. It shall be clean mineral soil, free of roots, woody vegetation, stumps, sod, oversized stones, rocks, or other perishable or objectionable material. The material selected must have enough strength for the dam to remain stable and be tight enough, when properly compacted, to prevent excessive percolation of water through the dam. Fill containing particles ranging from small gravel or coarse sand to fine sand and clay in desired proportion is appropriate. Using the Unified Soil Classification System, SC (clayey sand), GC (clayey gravel) and CL ("low liquid limit" clay) are among the preferred types of embankment soils. Areas on which fill is to be placed shall be scarified prior to placement of fill. The fill material should contain the proper amount of moisture to ensure that 95% compaction will be achieved. Fill material will be placed in 6-inch continuous layers over the entire length of the fill. Compaction shall be obtained by routing the hauling equipment over the fill so that the entire surface of the fill is transversed by at least one wheel or tread track of the equipment, or by using a compactor. Special care shall be taken in compacting around the anti-seep collars to avoid damage and achieve desired compaction. The detail for anti-seep collars is Detail ESC-34, Anti-Seep Collar, located in Division III of this manual. The embankment shall be constructed to an elevation 10% higher than the design height to allow for settlement if compaction is obtained with hauling equipment. If compactors are used for compaction the overbuild may be reduced to not less than 5%.

4. **Principal Spillway:** The riser of the principal spillway shall be securely attached to the barrel by a watertight connection. The barrel and riser shall be placed on a firmly compacted soil foundation. The base of the riser shall be firmly anchored according to design criteria to prevent its floating. Pervious materials such as sand, gravel, or crushed stone shall not be used as backfill around the barrel or anti-seep collars. Special care shall be taken in compacting around the anti-seep collars. Fill material shall be placed around the pipe in 4-inch layers and compacted until 95% compaction is achieved. A minimum of 2 feet of fill shall be hand-compacted over the barrel before crossing it with construction equipment.

5. **Emergency Spillway:** Vegetative emergency spillways shall not be constructed over fill material. Design elevations, widths, and entrance and exit channel slopes are critical to the successful operation of the spillway and should be adhered to

closely during construction.

6. **Vegetative Stabilization:** The embankment and emergency spillway of the sediment basin shall be stabilized with temporary or permanent vegetation immediately after installation of the basin.

7. **Erosion and Sediment Control:** The construction of the sediment basin shall be carried out in a manner such that it does not result in sediment problems downstream.

8. **Safety:** All state and local requirements shall be met concerning fencing and signs warning the public of the hazards of soft, saturated sediment and flood waters.

D. **Inspection and Maintenance:**

1. Inspect the sediment basin after each storm event.

2. Remove and properly dispose of sediment when it accumulates to one-half the design volume.

3. Periodically check the embankment, emergency spillway and outlet for erosion damage, piping, settling, seepage, or slumping along the toe or around the barrel and repair immediately.

4. Remove trash and other debris from the riser, emergency spillway and pool area.

5. Clean or replace the gravel around the riser if the sediment pool does not drain properly.

6. Remove the basin after the drainage area has been permanently stabilized, inspected, and approved. Do so by draining any water, removing the sediment to a designated disposal area, and smoothing the site to blend with the surrounding area; then stabilize.

2153.17 DETENTION/INFILTRATION BASIN

A. **Description:** An infiltration basin is a dam designed to detain stormwater allowing it to slowly filter through the soil. Infiltration basins can be constructed to reduce the peak flow rate from the design storm, recharge groundwater in the vicinity of the basin, filter contaminants, and increase flows during low-stream flow conditions. The basins are effective in removing pollutants from stormwater runoff in urban settings. Their usage is best suited to larger, more intensively developed sites. See Detail ESC-35, Detention/Infiltration Basin, in Division III of this manual.

B. **Application:** Infiltration basins should be considered at sites where the soil is permeable and the groundwater elevation is well below the soil surface. Disadvantages of infiltration basins include standing water, mosquitoes in summer, frequent maintenance, and the possibility of transporting soluble pollutants to the groundwater.

2153.18 TEMPORARY WATERWAY CROSSING (UTIITY AND VEHICULAR)

A. **Description:** A temporary waterway crossing is a strategy for crossing small waterways when in-stream utility construction is involved or a temporary structural span is installed across a flowing watercourse for use by construction vehicles.

B. **Application:** Temporary waterway crossings are generally applicable to flowing streams with drainage areas less than one square mile. Structures or methodology for crossing streams with larger drainage areas should be designed by methods which more accurately define the actual hydrologic and hydraulic parameters which will affect the functioning of the structure.

1. To help protect sediment from entering the stream from construction within approach areas.

2. To minimize the amount of disturbance within the stream itself.

3. To provide a means for construction traffic to cross flowing streams without damaging the channel or bank.

   For utility crossings through a waterway see the following Details in Division III of this manual: ESC-36, Diversion Channel Crossing; ESC-37, Flume Pipe Crossing; and ESC-38, Cofferdam Crossing. For vehicular crossings, see Details ESC-39, Temporary Culvert Crossing, and ESC-40, Temporary Bridge Crossing.

2153.19 DEWATERING

A. **Description:** Dewatering is a temporary settling and filtering device for water which is discharged from dewatering activities.

B. **Application:** Dewatering allows sediment-laden water to be filtered prior to being discharged off-site. Wherever sediment-laden water must be removed from a construction site by means of pumping. Methods include a straw bale/sediment fence pit as shown in Detail ESC-41, a dewatering box as shown in Detail ESC-42, or a Dirtbag® as shown in Detail ESC-43 in Division III of this manual.

2153.20 TURBIDITY CURTAIN

A. **Description:** Turbidity curtains are floating barriers of synthetic fabric suspended in the water from a floatation section and held in a vertical position by a weighted chain on the lower edge. Turbidity curtains work by slowing, containing, and directing the flow of runoff from disturbed earth and allowing the sediment to settle out before spreading into surrounding water courses. See Details ESC-44 and ESC-45 in Division III of this manual.

B. **Application:** Turbidity curtains are applicable to rivers, streams, lakes, and ponds where intrusion into the watercourse by construction activities and sediment movement is unavoidable. They are not designed to act as dams and should not be placed across channel flows. In general, they should not be extended to the bottom of

the watercourse. They are installed to trap sediment, not to significantly impede the flow of water. A special type of barrier in which sections of the geotextile are replaced with filter fabric can be used when the volume of water within the curtain must be allowed to change with current flow. Staked barriers are a type of turbidity curtain which are installed above grade or in very shallow water and are used only in calm, protected areas having bottoms with a high rate of performability. Details for the types and installation of turbidity curtains can be found in Details ESC-45 and ESC-46 in Division III of this manual.

SECTION 2154 OTHER CONTROLS

2154.1 DUST CONTROL

A. **Description:** Dust control reduces surface and air movement of dust during land disturbing, demolition, and construction activities.

B. **Application:** Dust control prevents surface and air movement of dust from exposed soil surfaces and reduces the presence of airborne substances which may present health hazards, traffic safety problems, or harm animal or plant life. In Missouri, the Contractor is required by State law to control fugitive dust blown from the site. Kansas does not have specific regulations for fugitive dust emissions; however, the Kansas Department of Health and Environment (KDHE) encourage Contractors to implement measures to reduce such emissions. Dust can be minimized by stabilizing areas with mulch as soon as possible. Watering should be provided in unstabilized areas. Contact MDNR Air Pollution Control Program at (573) 751-4817 or KDHE Bureau of Air and Radiation at (785) 296-1550 for guidance.

C. **Construction Specifications:**

1. **Vegetative Cover:** For disturbed areas not subject to traffic, vegetation provides the most practical method of dust control.

2. **Mulch (including gravel 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.

3. **Spray-On Adhesive:** 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 derivates from pine tar and vegetable gum; synthetics may be acrylic or petroleum based. Examples of spray-on adhesives for use on mineral soils are present in Table 2154-1.

Table 2154-1: Spray-on Adhesive for Dust Control

	Water Dilution	Type of Nozzle	Apply 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 DCR, 1992.

4. **Calcium Chloride:** This chemical may be applied by a 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.

5. **Watering:** The site may be sprinkled until the surface is wet. Sprinkling is especially effective for dust control on haul roads and other traffic routes.

6. **Stone:** Stone can be used to stabilize roads or other areas during construction by using crushed stone or coarse gravel.

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 about 15 times the barrier height. Where dust is a known problem, existing windbreak vegetation should be preserved.

8. **Tillage:** Deep plow large open disturbed areas and bring clods to the surface. This is a temporary emergency measure that can be used as soon as soil blowing starts. Begin plowing on the windward edge of the site.

D. **Troubleshooting:** Reapply material if dust is not adequately controlled.

E. **Inspection and Maintenance:** Maintain dust control measures through dry weather periods until all disturbed areas have been stabilized.

2154.2 SOLID WASTE DISPOSAL

The General Contractor is responsible for disposing all solid waste from the site in accordance with State laws. Dumpsters or other collection facilities must be provided as needed. Solid waste may not be buried on the site.

2154.3 SANITARY WASTE DISPOSAL

The General Contractor is responsible for providing sanitary facilities on the site. Sanitary waste may be disposed of only in locations having a State permit.

2154.4 SPILL PREVENTION AND MATERIAL MANAGEMENT PRACTICES

A. **Petroleum Products:** All vehicles kept on the site need to be monitored for leaks and receive regular preventive maintenance to reduce the chance of leakage. Petroleum products should be stored in tightly-sealed containers which are clearly labeled. Any asphalt substances used on site should be applied according to the manufacturer's recommendations.

B. **Fueling & Servicing:** No fueling, servicing, maintenance, or repair of equipment or machinery should be done within 50 feet of a stream or within 100 feet of a classified stream, losing stream, or sinkhole.

C. **Concrete Trucks:** Concrete trucks should be allowed to wash only in locations where discharge is directed to a permitted sediment basin. It is not permissible to discharge concrete wash directly to streams or storm drains. Alkalinity and chemical additives could be harmful to fish, stream bottom macro invertebrates, and wildlife.

D. **Disposal of Oil:** No fuels, oils, lubricants, solvents, or other hazardous materials can be disposed of on the site. All hazardous material must be properly disposed of in accordance with State laws. For guidance contact 1-800-361-4827 in Missouri or 1-785-296-1667 in Kansas.

E. **Spill Controls:** An Erosion & Sediment Control Officer will be designated as the spill prevention and cleanup coordinator. In addition to the good housekeeping practices and material management practices listed previously, the following practices need to be followed for spill prevention and clean-up:

1. Manufacturer's recommended methods for spill cleanup need to be clearly posted and site personnel need to be made aware of the procedures and the location of the information and cleanup supplies. Refer to Material Safety Data Sheets (MSDS).

2. Materials and equipment necessary for spill cleanup need to be kept in the secured material storage area on site. Equipment and materials include but are not limited to: brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.

3. All spills need to be cleaned up immediately after discovery and properly containerized for proper disposal. Burial is not acceptable.

4. The spill area must be kept well ventilated and personnel need to wear appropriate protective clothing to prevent injury from contact with a hazardous substance.

5. Spills of toxic or hazardous material must be reported immediately to the appropriate State or local government agency regardless of the size. Each county should have a Local Emergency Planning Committee (LEPC). If you are unable to access your local LEPC directly, contact your local fire department, city hall, or county courthouse. When permits are applicable, the permittee or his authorized representative is required to notify the MDNR or KDHE Environmental Emergency Response in accordance with 40CFR117 and CFR302 as soon as he has knowledge of the discharge of any hazardous substance or petroleum product in excess of the reportable quantity. In Missouri, contact the MDNR emergency spills hotline at 1-573-634-2436. In Kansas, contact the KDHE 24-hour spill hotline at 1-785-296-1679.

7. The spill prevention plan needs to be adjusted to include measures to prevent this type of spill from being repeated, and the plan needs to show how to clean up the spill if another one does occur.

F. **Hazardous Products:**

1. Products must be kept in their original containers unless they are not resealable. If a product is transferred to a new container, it must be properly labeled.

2. Original labels and MSDS should be retained.

3. If surplus product must be disposed of, disposal must be done in accordance with State law. For local disposal information contact your solid waste district or EPC. In Missouri call 1-800-361-4827 or in Kansas call 1-785-296-1667.

G. **Other Good Housekeeping Practices:** In addition to the foregoing, the following good housekeeping practices need to be followed during the construction of the project:

1. An effort should be made to store only enough product to do the job.

2. All materials stored on site should be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other secured enclosure.

3. Products should be kept in their original containers with the original manufacturer's label.

4. Whenever possible, all of the product should be used before disposing of the container.

5. Manufacturer's recommendations for proper use and disposal must be followed See the MSDS.

6. The site superintendent should inspect daily to ensure proper usage, storage, security of storage area, and disposal of materials.

7. Fertilizers need to be applied only in the minimum amounts recommended by the manufacturer.

8. All paint containers need to be tightly sealed and stored when not required for use. Excess paint should not be dumped into the storm sewer system but should be properly disposed of according to manufacturer's instructions and State regulations.

SECTION 2155 MEASUREMENT AND PAYMENT

2155.1 SCOPE

This section covers the methods of measurement and the basis of payment for the furnishing of all labor, equipment, tools, and materials and for the performance of all related work necessary to complete any construction covered in Section 2150.

2155.2 GENERAL

Unless specifically altered by the contract Special Provisions, the methods of measurement and payment will be as specified herein.

2155.3 ITEMS NOT LISTED IN THE PROPOSAL

There will be no measurement or separate payment for any items of work not specifically identified and listed in the Proposal, and all costs pertaining thereto will be included in the contract unit prices for other items listed in the Proposal.

2155.4 METHODS OF MEASUREMENT

The quantities of accepted work will be measured and determined as follows:

Table 2155-1: Measurement and Payment Units

Measurement Item	Measurement Unit
Seeding	Acres covered
Sodding	Square yard
Lime	Ton
Fertilizer	Pound
Mulch – Straw	Ton
Mulch – Hydro	Bag/Ton
Compost Berms or Tubes	Linear foot
Log or Wattle Products	Linear foot
Tackifiers, Soil Binders, BFM	Bag/Case
Rolled Erosion Control Products	Square yard
Sediment Fence	Linear foot
Diversion Ditch	Linear foot
Triangular Silt Dike™	Linear foot
Rock Ditch Checks	Cubic yard/ton
Straw Bale Ditch Checks	Bale
Rock	Ton
Sediment Basin (installation, clean-out, or removal)	Cubic yard
Pipe	Linear foot
Geotextiles	Square foot
GUTTERBUDDY®	Linear foot
Silt Saver®	Per device
Geo-Ridge®	Per device
Dirtbag®	Per device
Siltsack	Per device
Turbidity Curtain	Per device
Beaver Dam® or True Dam®	Per device

2155.5 BASIS OF PAYMENT

Payment for the quantities of accepted work will be made as follows: the activity completed, accepted, and measured as provided above will be paid for at the contract unit price bid for the material. Said price shall be full compensation for soil preparation, furnishing the material, hauling, applying, building or installing the product, and for all labor equipment, tools, and incidentals necessary to complete the work. Payment will be made under the units in Table 2155-1.