Tennessee Department of Transportation

Statewide Storm Water Management Program

Manual for Management of Storm Water Discharges Associated with Construction Activities

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It has been a pleasure for RBF team to work with TDOT in developing the State Wide Storm Water Management Plan (SSWMP) and this manual. We believe it will provide a valuable source of information to help TDOT minimize or prevent water quality impacts from construction activities, and ensure that TDOT is in compliance with applicable Federal, State, and local storm water regulatory requirements.

We wish to express special thanks to Jody Knox and Barry Brown for taking their time to assist in providing photographs and offering timely guidance in developing the content of the manual. We also wish to acknowledge Ali Hangul for his assistance in helping us match the content to current standard drawings and keeping us abreast of changes in Design Division documents which were also under development and Angie Duncan of the Construction Division for her review of Chapter 7.

RBF Team

About This Manual

This manual has been prepared as part of the TDOT Statewide Storm Water Management Plan (SSWMP). It is directed to TDOT personnel, general contractors and other personnel charged with implementing and maintaining Storm Water Pollution Prevention Plans (SWPPPs) and Aquatic Resources Alteration Permits (ARAPs) in the field.

The manual is part of the Department's plan implementation strategy and intended to supplement other department publications including but not limited to:

- Design Division, Drainage Manual
- Standard Drawings
- Standard Specifications
- Circular Letters, and
- Qualified Products List (QPL)

The manual is intended to support training efforts and to provide a handy reference for field personnel for TDOT inspectors and others charged with ensuring compliance with the General NPDES Permit for Storm Water Discharges Associated with Construction Activities (CGP). For this reason the manual does not included any detailed design information. The focus is on those activities that begin with the pre-construction meetings and continue through the entire period of construction.

Inspectors and contractors alike should find the information included in the manual useful in managing day to day activities whether it be questions about what is required by the Tennessee Department of Environment and Conservation (TDEC) or TDOT.

1 Regulatory Overview

1 - 1. Clean Water Act

The national law governing water quality is the Clean Water Act, (CWA)

The national law governing surface waters is the Federal Water Pollution Control Act, or Clean Water Act (CWA). Although it was originally passed in 1948, it was totally revised in 1972 and remains in essentially the same form today. The 1972 legislation mandated ambitious programs for water quality improvement. The programs have been expanded and are still being implemented by states, municipal jurisdictions and the private sector.

The CWA is divided into two parts. First are the provisions that authorize federal financial assistance for municipal sewage treatment plant construction. The second part establishes regulatory requirements that apply to all forms of dischargers into waters of the U.S. Early in the rulemaking process that followed enactment, emphasis was placed on regulating discharges of conventional pollutants, such as suspended solids or bacteria. More recently, the focus of water quality programs has been the control of potentially toxic pollutant discharges.

Figure: 1-1 The goal of the Clean Water Act is to: *"Restore and maintain the chemical, physical and biological integrity of the nation's waters."*

Before 1987, regulatory efforts focused on point source pollution; that is, wastes discharged from discrete sources, such as pipes and outfalls. Then, in 1987, amendments to the CWA added provisions requiring that the EPA address non-point source pollution, which includes storm water runoff from farm lands, forests, construction sites, and urban—all credited as the source of more than 50% of the nation's water pollution problems.

Enforcement responsibility of the Clean Water Act has been delegated to Tennessee

Most all regulatory responsibilities established in the Clean Water Act have been delegated to the states. This reflects a philosophy in which the federal government sets the agenda and standards for pollution abatement, while states carry out day-to-day activities of implementation and enforcement. This concept also embraces the notion that discharges into the nation's waters are unlawful, unless specifically authorized by a permit. Permits are therefore the primary enforcement tool used by federal and state regulators. Associated with permits there are civil, criminal, and administrative enforcement provisions as well as vehicles for citizen law suits.

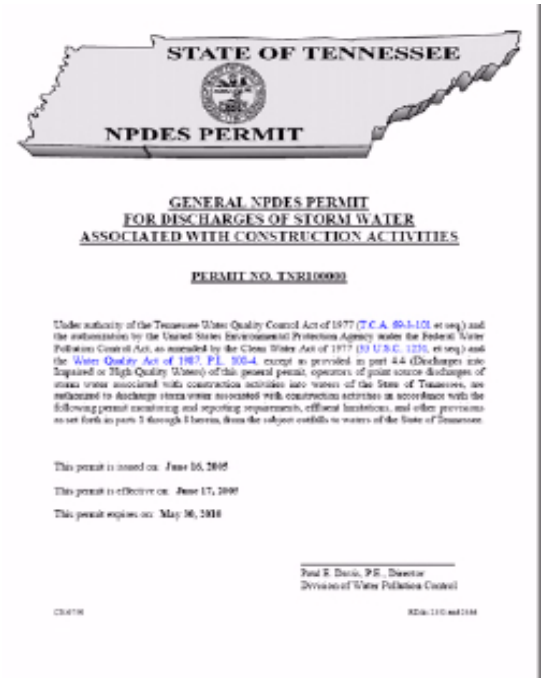
1 - 2. Tennessee's Clean Water Regulations

Tennessee's first water pollution regulatory program substantially predated the federal program. The first water quality statutes in Tennessee date back to 1927. In 1929 the scope of the water regulatory program was expended to include stream pollution which was intended to protect future water supplies. Then in 1943 the state created a Stream Pollution Study Board for the purpose of evaluating all available water quality data in the state and locating the sources of pollution. The work of this panel resulted in the passage of Chapter 128, Public Acts of 1945. This law was in effect until the Tennessee Water Pollution Control Act was passed in 1971. The 1971 Act and the subsequent federal Act in 1972 provides contemporary regulatory framework governing Tennessee's waters.

The permit regulating TDOT construction is the General NPDES Permit for Discharges of Storm Water Associated with Construction Activities or the "CGP"

When the federal Clean Water Act was passed in 1972, Tennessee revised the Water Quality Control Act in 1977 in order to be consistent with the provisions of the federal statute. The Tennessee Department of Environment and Conservation (TDEC) is the state agency charged with implementing the provisions of state and federal clean water legislation.

TDEC regulates storm water discharges by way of a suite of permits. The center of attention in this document is the **State of Tennessee NPDES Permit No. 1000000,** ***General NPDES Permit for Discharges of Storm Water Associated with Construction Activities,*** **or the** ***"Construction General Permit"*** or "CGP" Figure: 1-2" on page 2. This is the permit that regulates activities on TDOT construction sites. In the future there may be different permits issued for specific types of construction. However; if this occurs it will not materially affect the content of this manual or the administration of erosion prevention and sediment controls on TDOT construction sites.


STATE OF TENNESSEE

NPDES PERMIT

GENERAL NPDES PERMIT
FOR DISCHARGES OF STORM WATER
ASSOCIATED WITH CONSTRUCTION ACTIVITIES

PERMIT NO. TNR100000

Under authority of the Tennessee Water Quality Control Act of 1977 (T.C.A. 69-3-101 et seq.) and the authorization by the United States Environmental Protection Agency under the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (33 U.S.C. 1251, et seq.) and the Water Quality Act of 1987, P.L. 100-4, except as provided in part 4.4 (Discharges into Impaired or High Quality Waters) of this general permit, operators of point source discharges of storm water associated with construction activities into waters of the State of Tennessee, are authorized to discharge storm water associated with construction activities in accordance with the following permit monitoring and reporting requirements, effluent limitations, and other provisions as set forth in parts 1 through 8 herein, from the subject outfalls to waters of the State of Tennessee.

This permit is issued on: June 16, 2005

This permit is effective on: June 17, 2005

This permit expires on: May 30, 2010

Paul E. Davis, P.E., Director
Division of Water Pollution Control

Figure: 1-2 The Construction General Permit (CGP)

2 Responsibilities of TDEC, TDOT and Contractors

2 - 1. Responsibilities

This chapter outlines the responsibilities of the three principal parties involved in managing storm water quality on TDOT construction projects. Each party to the contract has specific obligations to ensure that the waters of the state of Tennessee are protected as required by the CGP. While the complexity of each project may be different the basic responsibilities for control of the work remain essentially the same.

2 - 2. TDEC Requirements and Responsibilities

2 - 2.1 TDEC Inspection and oversight

TDEC has primary oversight authority for permit enforcement; however, U.S. EPA, has oversight powers.

The Tennessee Department of Environment and Conservation (TDEC), and the U. S. Environmental Protection Agency (EPA) have the responsibility to oversee that the provisions of the CGP are fulfilled. If there are other permits or special requirements there may be involvement from other state or federal regulators, such as jurisdictional wetlands regulated by the U.S. Army Corps of Engineers (USACE) or endangered species, regulated by the U.S. Fish and Wildlife Service (FWS). It is the duty of the site operator to provide access to the site and all permit related documents for official inspections at any time. This requirement does not include the media or the general public.

2 - 2.2 TDEC Documents Required by the CGP

There are several documents that must be prepared by TDOT and submitted to TDEC in order to legally discharge storm water during the construction of a project. These include:

- **Notice of Intent (NOI):** will be filed by TDOT and must be approved prior to the beginning of construction.
- **Storm Water Pollution Prevention Plan (SWPPP):** will be prepared by TDOT or a qualified consultant and filed with the NOI.
- **Notice of Termination (NOT):** is filed upon completion of the project. Completion means that all construction activities are complete and all temporary permitted storm water discharges have ceased; all disturbed areas have been finally stabilized and all temporary storm water BMPs have been removed.

2 - 3. TDOT Requirements and Responsibilities

2 - 3.1 Preparation of documents

TDOT is responsible for preparation and filing of the NOI, SWPPP and the NOT.

TDOT is responsible for the preparation and filing of the Notice of Intent (NOI) and Storm Water Pollution Prevention Plan (SWPPP) prior to the beginning of construction and the Notice of Termination (NOT) when the project is complete.

The NOI and the SWPPP are the basis of initial implementation of EPSC measures on the construction project. TDOT personnel are responsible for ensuring that all provisions o f the SWPPP and EPSC plans are implemented and maintained throughout construction. Personnel designated by TDOT are responsible for updating and maintaining the SWPPP documents and the EPSC plans.

2 - 3.2 Construction Site Management

2 - 3.2.1 Inspections

TDOT personnel are responsible for conducting the twice weekly inspections required by the CGP.

TDOT designated field personnel are responsible for performing twice weekly inspections during the period when construction is active. Inspections must be done twice each week and performed at least 72 hours apart. Inspection procedures, forms, and record keeping are covered in Section 3 of this manual

2 - 3.2.1.1 Maintenance of Documents

TDOT personnel are responsible for maintaining the SWPPP and inspection records required by the CGP.

TDOT designated field personnel are responsible for the maintenance of the SWPPP and the inspection records during the active construction period after construction is complete, and TDOT is responsible for keeping the records on file for one year after completion of the work.

2 - 4. General Contractor Requirements and Responsibilities

.

Figure: 2-1 Uncontrolled erosion during construction will damages adjacent waters

2 - 4.1 Installation And Maintenance Of Temporary EPSC Measures

The general contractor is responsible for installation and maintenance of all EPSC measures.

The contractor is responsible for implementing the SWPPP, which includes the installation of the temporary Erosion Protection and Sediment Control (EPSC) Best Management Practices (BMPs). All of the measures required on the SWPPP must be in place before any soil-disturbing activities may begin.

Figure: 2-2 These conditions must be corrected as soon as they are discovered.

2 - 4.2 Implementing provisions of the SWPPP

The general contractor is responsible for compliance with all other provisions of the SWPPP.

In addition to the temporary BMPs the contractor is responsible for compliance with all other provisions of the SWPPP. This includes such preparations as the placement of temporary sanitary facilities, proper solid waste containers and storage areas, proper equipment and materials storage areas, and providing materials and equipment necessary to handle any spill of materials that could pollute adjacent water bodies.

2 - 4.3 Supervisory Personnel

The general contractor must have personnel on-site that are qualified to install and maintain EPSC measures and other provisions of the SWPPP.

It is the responsibility of the contractor to have personnel on-site that are qualified to manage, install and maintain BMPs called for in the SWPPP. The contractor or designated representative is to have all training and certifications necessary to manage the work to be performed in accordance with the provisions of the CGP and other federal, state and local regulations as may be appropriate. The contractor's superintendent is responsible for informing all workers and subcontractors of the requirements of the SWPPP.

The contractor's superintendent is responsible for informing all workers and subcontractors of the SWPPP requirements.

2 - 4.3.1 Removal, Replacement, and Phasing of Work

The general contractor is responsible for providing and following the work phasing plan required by the CGP.

At the preconstruction conference, the contractor is to provide a plan for the phasing of the work to be performed so that there will be no more than 50 acres of active disturbance at any time. This plan is to be reviewed and approved by the TDOT project supervisor or designated representative. The general contractor is responsible for removal and replacement of BMPs as may be necessary to complete the project.

The contractor is responsible for removal and replacement of EPSC measures as may be required to complete the work

It is important to understand that EPSC measures need to follow the flow of work. It is the responsibility of the TDOT project supervisor and other TDOT field personnel to ensure that EPSC measures are in place prior to any surface disturbance taking place uphill from an area of disturbance, and that stabilization activities follow in a timely manner so there is no more than 50 acres of active disturbance at any given time

2 - 4.3.2 Contractor's Responsibility for Maintenance of Temporary EPSC Measures

The contractor is responsible for maintaining all temporary EPSC measures as shown on the plans

It is the responsibility of the general contractor to maintain all temporary EPSC measures in accordance with the provisions of the SWPPP and as directed by TDOT representatives. In the event that failures or potential failures of EPSC measures are identified (whether the result of a TDOT inspection or observation), the contractor will, upon notification from TDOT, take action immediately to contain sediment within the boundaries of the site.

3 Project Phasing

Phasing is a tool for low impact development and is required by the CGP.

Phasing is a tool of Low Impact Development (LID) used by TDOT during project development and management. By phasing the amount of actively disturbed area on a construction site, the actual amount of sediment lost can be significantly reduced. The CGP requires that there can be no more than 50 acres of active soil disturbance at any given time. Therefore, it is important that a phasing strategy be worked out for every TDOT project that will disturb greater than 50 acres. However, regardless of the project size, phasing is an integral part of the construction strategy for all TDOT projects.

3 - 1. Project Timing Recommendations

3 - 1.1 Opening/Clearing and Grubbing

Contractors differ in their approach to the order of work; therefore, phasing must be worked out after the project is let.

Opening of a construction site consists of the mobilization activities, e.g., stationing of equipment, setting up staging and materials storage areas, posting of public information, staking, and fencing. Mobilization activities are followed by demolition, clearing, and grubbing. These activities must be preceded by or concurrent with the initial installation of temporary EPSC. Because of the unpredictibility of letting schedules in transportation construction, it is difficult to develop meaningful schedules for opening, clearing, and grubbing during project design. Contractors will also differ in their approach to the order of work which may have been a factor in their bidding. For these reasons, phasing can only be addressed in a general way during design. Actual phasing must be worked out after the project is let and during pre-construction activities.

Responsibility for the final phasing project is the responsibility of TDOT and the general contractor

Ultimately, the responsibility for the final phasing strategy of a TDOT project falls on the construction administration personnel, the Area Engineer, the Construction supervisor, and the general contractor. The contractor is responsible for submitting a phasing proposal which must be approved by the TDOT. The approved phasing plan must then be incorporated into the SWPPP.

3 - 1.2 Phasing Techniques

A variety of techniques are being employed nationally to phase transportation projects. No single strategy will be satisfactory for all projects due to the size of the project, the timing and other permits, environmental and cultural constraints that may come to bear on the work. This section presents some strategies being employed by transportation agencies to implement LID practices.

Phasing of a project is very important. This aerial photograph graphically portrays the amount of disturbance that can be generated by a large highway project.

As in this example, there may also be adjacent construction that further adds to the amount of open areas. Notice the turbidity along the shoreline in the lower left. That is from the residential construction, not the highway construction.

Figure: 3-1 Phasing of highway construction is an important tool in managing erosion and sedimentation on highway projects.

3 - 1.2.1 Minimizing Active Disturbed Area

For large projects, the CGP requires that there may be no more than 50 acres of active disturbance.

This is a practice that is sometimes referred to as the "First Mile Third Mile Rule". It's a good rule of thumb and consistent with the requirements of the CGP which requires that there be no more than 50 acres of active disturbance at any given time. This is reasonably easy to apply to projects in rural areas with generally uniform right-of-way widths. If a right-of-way averages 200 ft. in width then two miles of disturbance is approximately equal to 50 acres. This means that as work progresses to the third mile of the project, restabilization activities must be underway on the first mile. However, site conditions seldom allow a simple progression of work along a corridor. Fill material may come from areas at some distance from an area being graded and other disturbances, such as the installation of culverts, which may require disturbance in other areas. Therefore, work must be coordinated with stabilization activities occurring in sequence as grading activities progress.

Urban projects are another example of projects where it is important to follow grading activities closely with restabilization efforts. For example, a single direct connect interchange may encompass an area of as much as 100 acres or more, and construction must be carefully coordinated with restabilization activities to ensure that the 50-acre rule is maintained.

3 - 1.2.2 Using the Traffic Control Plan (TCP)

The Traffic Control Plan (TCP) is an effective tool for managing EPSC.

Major multi-lane and interchange projects must usually be built in phases in order to maintain traffic flow during construction. The phases are usually divided into logical units of work to complete the project. These phases will also correspond to specific areas of land disturbance related to that unit of work. Many agencies are now using the TCPs as a guide to phasing EPSC related activities. This strategy is most practical for large projects. The primary issue to be resolved is to ensure that the disturbed area in each phase will not result in more than 50 acres of active disturbance at one time in compliance with the requirements of the CGP.

3 - 1.3 Timing for Installation of Temporary Controls

3 - 1.3.1 Timing of Temporary Structural Sediment Controls

3 - 1.3.1.1 Perimeter Protection

Perimeter protection must be in place before any disturbance occurs

Perimeter protection is needed wherever runoff sheet flows from the construction site or construction-related areas to adjacent properties or water bodies. Perimeter protection must be in place prior to any disturbance within the drainage area contributing to the offsite discharge. Perimeter protection must remain in place until the stabilization of the contributing area is sufficient to prevent erosion.

3 - 1.3.1.2 Offsite discharge controls

Offsite discharge controls refers to points of concentrated storm water discharges into an adjacent water body or project drainage course, such as culverts, improved or vegetated channels, slope drains or permanent flumes. The primary concerns with these features is sediment capture, energy dissipation, and channel protection downstream of the discharge point.

If the discharge is directly into an adjacent water course or water body, the primary concern is dissipation of energy and protection of the bed of the receiving water course from scour. It is important to have these controls in place before any disturbance occurs in the upstream drainage basin. If possible, when using geosynthetic materials or temporary flexible channel lining materials, the channel should be seeded and covered at least 30 days or more before disturbance occurs. This will ensure the material is anchored to the ground before any significant flow is experienced.

3 - 1.3.1.3 Concentrated Onsite Discharges

Where the discharge is into constructed channels on site energy dissipation, scour protection and sediment controls may all be appropriate. In these cases, all the EPSC controls should be in place as soon as the construction of the channels and associated features are in place. For example, slope drains cannot be installed until the slopes below have been shaped and the intercepting channels have been prepared. Once the final grades have been reached, other temporary controls can be put in place.

Discharges from temporary pipes and channels should always be set so that the discharges will be in the direction of flow of the receiving channel. This minimizes the potential scour from discharge turbulence.

3 - 1.3.1.4 Stream Crossings and Diversions

Figure: 3-2 Temporary stream diversion used for box culvert replacement

Temporary stream crossings and stream diversions are needed to maintain traffic while replacing bridges and box culverts. While the temporary structures are not EPSC measures in themselves, they must be installed to prevent loss of fines and other sediments that can be generated by materials used to construct the crossing or diversion.

Because these structures divert or actually cross a water course, they require an Aquatic Resource Alteration Permit (ARAP). In most cases, this would be the General Permit for Construction and Removal of Minor Road Crossings. Depending on the water course being crossed, there may also be a U.S. Army Corps of Engineers (USACE) permit involved. This could be any of several Nation Wide Permits (NWPs) issued by the USACE, including: Storm Water Management Facilities; Reshaping of Existing Drainage Ditches; Stream and Wetland Restoration Activities; Linear Transportation Projects; Bank Stabilization; or a project specific 404 permit issued by the USACE. The type of permit depends on the specific activities, the type of water body and associated wetlands, and the amount of disturbance and mitigation requirements.

Permits issued by the Corps do not usually have specific EPSC requirements but they can effect the placement of EPSC measures. For example, if there are 404 jurisdictional wetlands, EPSC measures cannot be placed directly in the wetland areas not covered by mitigation activities.

Stream crossings and diversions must be in place prior to any work being accomplished upstream of the diversion or crossing. Likewise, the diversion and crossing should have appropriate EPSC measures in place to prevent any loss of sediment from the temporary fill or storage of excess materials on site.

3 - 1.3.1.5 Sediment Traps and Basins

Sediment controls are the only line of defence against initial sediment discharges and must be placed before any disturbance occurs.

Sediment traps are the only line of defense against sediment discharges when construction sites are being opened and soil disturbing activities begin. It is vital that sediment trapping devices are in place before any disturbance is initiated in the drainage area upstream of the sediment trap. Sediment trapping devices, installation, and maintenance are discussed in Section 5.

3 - 1.3.2 Timing of Temporary and Permanent Erosion Controls

3 - 1.3.2.1 Temporary Surface Protection

Temporary surface protection includes a wide range of materials and methods, and each one has an application in controlling erosion on construction sites. A detailed description of temporary surface protection materials and methods is provided in Section 5 of the manual.

Temporary surface protection is the first line of defence. Surface cover should be placed as soon as final grade is reached with the appropriate seeding.

The primary means of achieving erosion control on a construction site is to protect the surface from raindrop impact and to hold any dislodged soil particles in place to prevent transport down slope. Protection can be provided by mulches, blankets, hydraulically applied materials, and vegetation. The CGP requires that "temporary or permanent soil stabilization at the construction site (or a phase of the project) must be completed not later than 15 days after the construction activity in that portion of the site has temporarily or permanently ceased." If the disturbed surface is at finished grade, then the temporary controls should be placed over an appropriate seed mix. Whether a temporary or permanent seed mix is used is a function of season. Seed mixes and applications are discussed in Section 5 of the manual.

Figure: 3-3 Temporary cover materials are only used to aid in the establishment of permanent vegetation

Temporary cover must be in place for any suspension of construction activity for 15 or more days.

If the site is not yet at finished grade, and construction activities will resume outside the 15-day period specified by the CGP, then short-term temporary measures should be used to stabilize the soil surface until construction activities resume. It is the responsibility of the general contractor to provide suitable protection in these cases, which might

include slope roughening, application of an approved chemical soil binder; or, if the period extends several months, temporary seeding and mulch could be appropriate. It is important to note these temporary treatments with dates on inspection forms, in the construction diary, and on the SWPPP.

3 - 1.3.2.2 Permanent Surface Protection

The primary permanent erosion control is vegetation. Other temporary cover is used to hold the soil and establish permanent vegetation.

Permanent surface protection is usually an appropriate seed mix for the project location. Permanent seeding can only be done effectively in the spring and fall seasons of the year. Actual periods for planting will vary significantly with latitude and elevation. Other permanent surface covers may include concrete or stone riprap, or other permanent flexible lining materials used to reinforce or armor the soil surface. Turf reinforcing mats or permanent, flexible channel liners must be installed in the appropriate planting season for the region. Other materials should be installed as soon as the area to be protected reaches final grade. This will minimize the intrusion of unwanted vegetation, which can be difficult to control once established

Figure: 3-4 Typical use of gabions as permanent flow controls

3 - 1.3.2.3 Permanent Flow Controls.

Permanent flow controls are usually structures to control flows in channels and to dissipate energy at storm water discharge points. These measures should be placed as soon as final grade and alignment is reached.

4 Temporary Erosion Prevention and Sediment Controls for Construction Sites

4 - 1. Seed Mixes and Planting Seasons

The BMP of choice for permanent erosion control, except for special situations, is vegetation. In order to recognize the various differences in soils and climatic conditions of the state, several interim seed mixes have been suggested for use until more research can be completed to refine and modify these recommendations. The seed mixes were developed by carefully reviewing the species mixes and applications in all the surrounding states and looking closely at the physiographic regions of Tennessee. In addition extension specialists with the University of Tennessee system were consulted to be sure that the recommendations were reasonable.

Seed mixes are to be planted by region and in the appropriate season. The state is divided into three Regions, I – III, shown on the map in Figure: 5-16.

4 - 1.1 Temporary Surface Protection Materials and Methods

4 - 1.1.1 Temporary Seeding

Temporary seeding is a satisfactory method of providing temporary cover for short periods prior to the installation of permanent vegetation or when construction activities must be suspended for periods of as much as 18 months. Temporary seeding must be installed with a mulch or other temporary surface protection material in order to provide surface protection during establishment. Temporary seed mixes utilize fast germinating species that will usually provide cover within 6 to 12 weeks of planting. They will provide temporary cover for periods of up to 18 months. Even though cover crops die out within a growing season, they still provide cover from the plant litter, standing biomass, and the developed root systems.

4 - 1.1.2 Mulches and Bonded Fiber Matrices (BFMs)

4 - 1.1.2.1 Straw and Hay Mulch

Straw and hay mulches must be applied at the specified rate and held in place by crimping or an approved tackifier. Crimping shows better performance on non-cohesive (sandy, silty soils) while tackifiers may work better on cohesive soils (clays). It is critical that the mulch material be applied as a uniform layer that covers the surface of the soil. Gaps or holes in coverage should not be covered before crimping or tacking.

4 - 1.1.2.2 Cellulose Fiber Mulch

Figure: 4-1 Hydraulic mulching

Cellulose fiber mulches are used for hydraulic applications commonly called "Hydromulch". Hydraulic mulch is used to help conserve soil moisture and moderate surface soil temperatures to enhance vegetation establishment. Hydraulic mulch by itself will not provide erosion control. Some type of tacking agent must be used to help hold the mulch in place. Even when tackifiers are used in the mix, erosion control is only achieved on minimum slopes, generally less than 10:1.

4 - 1.1.2.3 Bonded Fiber Matrix (BFM)

Bonded fiber matrix products are hydraulically applied materials that consist of a long cellulose fiber material bound together with a heavy tacking agent. They are an effective erosion control tool for steep slopes where equipment access is very limited. While several bonded fiber matrix materials are on the market, they are proprietary products and must be applied in strict accordance with the manufacturer's recommendations to be effective. Most failures of bonded fiber matrix products can be traced to low application rates or improper mixing of the materials.

4 - 1.1.3 Erosion Control Blankets

Erosion control blankets are made of many different materials. If blankets are to be used, they should be of the Type specified on the plans and on the Qualified Products List. Materials of a different Type or not specifically approved for use by TDOT must be rejected. Erosion control blankets may not be substituted by other surface protection methods unless specifically approved by the project supervisor in writing. To be effective, blankets must be installed properly. Proper installation will be discussed in Section 5.

Figure: 4-2 Installation of temporary channel liners

4 - 1.1.4 Temporary Flexible Channel Liners

Temporary flexible channel liners are biodegradable materials that are similar to, but heavier than erosion control blankets. They are used to protect roadside channels small ephemeral streams, diversions, and vegetated flumes from surface erosion during the establishment of vegetation. They are used only in channels or on the banks of channels designed to be grass-lined. The materials used must be of the Class specified on the plans and must be on the Qualified Products List. These materials may not be substituted unless specifically approved by the project supervisor in writing. To be effective, the flexible channel lining material must be installed properly and securely anchored. Proper installation will be discussed in Section 5.

4 - 1.1.5 Soil Binders and Tackifiers

Soil binders and tackifiers have a variety of applications. They are a tool that is often employed in the field to supplement a primary surface protection material or as a primary short-term surface protection material.

4 - 1.1.5.1 Tackifiers

Tackifiers are materials used to bind mulches together to achieve better adhesion of materials to the soil. When straw or hay mulch are spread, they must either be crimped or bound together with a tackifier to keep them from blowing away or migrating down the slope. The tackifiers must be mixed and proportioned in accordance with the manufacturer's specifications and as specified on the plans and notes. The tacking material must be applied uniformly over the surface of the mulch or soil.

In some cases, tacking agents are added to cellulose fiber mulches to help hold the material in place. This is a good practice during periods of sporadic rainfall and/or high drying winds.

Tacking agents may also be applied directly to the soil as a means of dust control or to help stick mulch in place in dry conditions. This application uses the tack material as a soil binder.

4 - 1.1.5.2 Soil Binders

Soil binders are materials that are typically used alone to provide surface protection for exposed soils. In most cases, they are not used in conjunction with seeding although they can be. In general, soil binding materials do not provide the microclimatic modification that is provided by mulches or blankets. They work by binding the upper layer of soil together, forming a crust on the surface so that soil particles resist being suspended in surface flows. Although they form a surface crust, most of the materials do not seal the surface to the point where infiltration is prevented, so they do not prevent the establishment of vegetation.

Polyacrylamides have been used successfully to help bind cohesive soils and to reduce the suspension of fine clay particles. It is critical when using polymer based materials to use the type specified and to check carefully to be sure it is properly applied. Some polyacrylamides can be highly toxic to aquatic life if released into a water body but these are not labeled for use as soil binding materials used in erosion control.

4 - 1.2 Temporary Sediment Control Methods and Materials

Any basin depression or holding area on a project that detains storm water runoff will trap sediment. The SWPPP takes the capacity of all sediment trapping devices into account when in the design process. Therefore, it is important that all sediment trapping materials and devices be installed before any upstream disturbance occurs. There are two types of temporary sediment trapping structures. Sediment traps are created by depression or device that collects and holds storm water runoff so that sediments can settle from suspension. Temporary sediment basins are structures usually formed from native soil that are have a designed capacity, a controlled outlet structure usually designed to handle storm events of different return frequencies and emergency bypass spillways to handle overflow events. All of the following measures are used to trap sediment on construction sites.

4 - 1.2.1 Temporary Sediment Traps

Temporary traps may be created utilizing any of the materials described below. Sediment traps are usually placed on line, in other words, they are placed in the line of concentrated flows to reduce velocities and hold runoff so that sediments will settle from suspension by gravity. Perimeter protection, BMPs, such as silt fence, also act as sediment traps.

4 - 1.2.1.1 Wattles

Wattles are made of many different materials, the most common being straw, excelsior, and coir. Depending on the type of material, a wattle will both filter and detain storm water, allowing suspended material to settle. Because the materials are biodegradable, wattles have a limited life span. Straw will deteriorate more rapidly than excelsior but in general both materials give about 12 to 18 months of service depending on the climate. Coir is a much tougher fiber and has a service life of two years or more, depending on the climatic conditions. Installation and inspection will be discussed in more detail in Section 5.

Figure: 4-3 Wattles in a roadside borrow ditch used for flow control

4 - 1.2.1.2 Filter Socks and Tubes

Filter socks and tubes are very similar to wattles in both appearance and function. The primary difference is that socks and tubes are usually assembled in the field by blowing the fill materials into the fabric tube. The fill material is usually a mix of seasoned compost mixed with wood chips or fibrous yard waste compost. There needs to be sufficient long strand material in the fill to prevent fine materials from leaching out of the fabric container. Some vendors have proprietary mixes for the fill materials used in their socks. The life of a filter sock depends on the type of compost and climatic conditions. In most cases, they have a useful life of up to 24 months. Installation and inspection will be discussed in more detail in Section 5.

4 - 1.2.1.3 Rock Check Dams

Rock check dams are most often associated with velocity control in channels with significant concentrated flows. However, they provide a silt trapping function as well. The standard drawings show several applications of rock checks in association with other improvements that enhance the silt trapping functions of a single rock check dam. Drawing EC-STR-6, EC-STR-7, EC-STR-11, and EC-STR-12 show several examples of rock and rock checks used to create silt traps. Installation and inspection will be discussed in more detail in Section 5.

Figure: 4-4 Rock check dams are most often used as flow controls in roadside ditches.

4 - 1.2.1.4 Wire-Backed Silt Fence, Enhanced Silt Fence, and Silt Fence Ditch Checks

Wire-backed silt fence, enhanced silt fence, and silt fence ditch checks are also used to create online silt traps. The type and design of these structures must be considered carefully, and proper installation and maintenance is vital to achieve the desired result. Standard drawings EC-STR-4, EC-STR-4A EC-STR-3C, EC-STR-3D provide details of installation. Installation and inspection will be discussed in more detail in Section 5.

4 - 1.2.1.5 Sand and Gravel Bags

Sand and gravel bags can also be used to create sediment traps. There is little, if any, filtering through these types of containments, so they must be heavy enough to function by gravity. Care needs to be exercised in installing sand and gravel bags to ensure surface protection is provided downstream of the dam to prevent channel scour in overtopping conditions. Because the fill material is loose, care needs to be exercised when removing them, so they do not create a sediment problem by breaking open.

4 - 1.2.1.6 Gabions

Gabions are usually designed as permanent structures. However, where extremely concentrated flows need to be checked to protect high quality waters, gabions may be used. They may also be part of a permanent water quality management strategy that can be used for temporary sediment control during construction. Whatever the case, gabions must be designed by a registered engineer and must be installed in accordance with the drawings. Standard drawing numbers EC-STR-55 through EC-STR-59 provide details for gabion construction.

4 - 1.2.1.7 Inlet Controls

Inlet controls are a large family of devices and materials used to trap sediment at drain inlets, side inlets, and culvert entrances. There are so many different devices utilized, including all types of silt fence, rock checks, wattles, filter socks, and fabric covered filter assemblies that they are not considered separately. Any device placed at a drainage inlet to trap sediments is an inlet control sediment-trapping device. Several standard drawings provide design information and details for inlet protection: EC-STR-19, EC-STR-11, and EC-STR-40-54. All inlet controls must be carefully maintained to ensure that they function properly and that water is permitted to pass through the drain without backing up into any active driving lanes and creating a safety hazard. Inlet protection is not inlet prevention, that is, water must be filtered and allowed to pass into the protected inlet.

Figure: 4-5 Inlet controls are essential to prevent sediment from entering the drainage system

4 - 1.2.2 Temporary Sediment Basins

Temporary sediment basins are designed structures. They will have a designed capacity based on engineering criteria set down in the TDOT Drainage Manual. The basics of sediment basin design are found on standard drawings EC-STR-15, EC-STR-16, EC-STR-17.

4 - 1.3 Temporary Flow Controls

Flow controls are utilized either to direct the flow of water around a disturbed area or to reduce the velocity of flow and dissipate the energy. Flows can be either concentrated flows, as in the case of roadside swales, ditches, or streams, or sheet flows over slopes.

4 - 1.3.1 Velocity Controls

Velocity controls can be almost any device that interrupts a flow. In general, the tools that are used for controlling velocity include wattles, filter socks, fabric checks, or rock check dams.

In concentrated flows that have depths of six inches or more, rock checks are usually preferred over other types of materials. In extreme flows and depths exceeding 18 inches, design measures such as gabions and channel armoring may be required to achieve stability.

Sheet flows over roadside slopes are also candidates for velocity reduction measures. Depending on the soils, slopes of 6:1 and greater with horizontal slope lengths of 30 feet and greater are candidates for velocity controls. Non-cohesive soils with a high percentage of very fine sands and silts will often be very difficult to stabilize with only erosion blankets or mulches. In these cases, some type of velocity reduction may be needed to reduce sheet flow velocities. The most effective materials for these applications are wattles and filter socks. Berms made of yard waste or bio-solids have also shown some promise in reducing sheet flow velocities on slopes. However, composts which have high phosphorous leaching potentials should not be used near any nutrient-impaired, threatened, or high quality water body.

4 - 1.3.2 Slope Drains and Flumes

Slope drains or stabilized open flumes are used to convey clean water from uphill areas, down slope to receiving streams or water bodies. Slope drains must be designed to carry the peak discharge from a design storm event and may be made of any pipe material with sealed joints. Open flumes stabilized with rock riprap or a vegetated channel lining material may also be used to convey clean storm water downslope to a receiving water body.

Slope drains and flumes can carry significant amounts of water, depending on the area of the upstream drainage basin. For this reason, it is important that the pipe be securely anchored to the ground, and that the channel at the discharge end of the pipe or flume is protected against excessive scour. This may require some form of energy dissipation and channel armoring of the receiving channel. Where possible, the pipe or flume should be turned so that it discharges in the direction of flow of the receiving channel. This will minimize turbulence and potential for excessive scour.

4 - 1.3.3 Diversions

Diversions are channels created at the upslope portion of the construction site to intercept runoff coming from undisturbed areas of the site and directing it to slope drains or temporary flumes for conveyance to a downslope channel. Diversions can be created by temporary berms, sand and gravel bags, or swales. Temporary diversions are set at very shallow slopes to avoid scour of the channel bottom. Depending on the soil type, the diversion channel may require some type of surface protection to prevent erosion of the channel surface. Diversion channels must be designed with a cross section sufficiently large to carry the selected design storm.

The term diversion is also used to describe temporary channels excavated to route a stream around in-channel construction so that the work can be done in dry conditions and sediment generated by the work will not be discharged into the stream channel. These types of diversions are not considered EPSC measures, as in the case of a diversion ditch.

Figure: 4-6 The photo at the left is a constructed stream diversion. The photo at the right is a diversion berm used to prevent water from flowing over the downhill portion of the slope to the left.

6 Erosion and Sediment Control for Utility Construction within TDOT ROW Utility Contractor Responsibilities

6 - 1. Utility Initiated Construction

Tennessee has a statute requirement for accommodating utilities within TDOT Rights-of-Way. The utility companies have the right to locate public utilities within the ROW upon execution of a Utility Use and Occupancy Agreement issued by TDOT. Utility plans must be submitted to TDOT and conform to the CGP permit requirements and all provisions of the TDOT Standard Specifications, Standard Drawings, Qualified Products List (QPL), and Design Manuals and this Construction Manual.

When utilities initiate construction within the TODT ROW, they are responsible for obtaining and administering all permits

When utilities are locating or relocating within the ROW, the utility is responsible for obtaining all permits required for their work. This includes Section 404 (USACE), ARAP (TDEC), NPDES (TDEC), Section 26a (TVA), Class V Injection Well Permits, and any other permits that may be required by a "Qualified Local Program." Plans and specifications for work conducted within the TDOT ROW must be prepared in accordance with TDOT standards. The utility companies are responsible for ensuring that ecological and cultural resources are in accordance with the provisions of the permit(s) and by complying with all TDOT inspection and quality assurance and quality control requirements. TDOT requires the utility to supply a surety bond that will be held for a period of six months after the completion and acceptance by the state. During this time, TDOT may inspect the work to see that the slopes have been stabilized and that all work is complete per the plans submitted by the utility and the requirements of the TDEC CGP.

6 - 1.1 Inspections

As part of the TDOT's Statewide Storm Water Management Plan (SSWMP), a self-monitoring inspection program has been developed to insure construction compliance with the CGP. TDOT requires that any work taking place within the TDOT ROW must adhere to all provisions of this self-monitoring program. The inspections include the TDEC required twice weekly inspections and QA/QC inspections to be conducted by TDOT approved consultants that have been certified by TDOT for EPSC inspections. The inspections are to ensure that work is in compliance with the plans, permits, specifications, and regulations regarding storm water quality on work within TDOT's ROW.

Utility construction within TDOT ROW must conform to all TDOT requirements for EPSC measures.

The first measure of compliance is whether any conditions exist on the site that could result in a notice of violation (NOV) by the regulatory agency for not following the requirements of a permit. The next layer of compliance is any work that does not conform to TDOT standard specifications, special provisions, construction circulars, plans, etc. These provisions, while required by TDOT, would not necessarily be considered a violation by TDEC.

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Figure: 6-1 Utility relocation is frequently required by highway construction

Utilities that conduct construction within the TDOT ROW will be required to comply with the provisions of the comprehensive inspection program by having trained inspectors conducting the inspections and QA/QC reviews.

6 - 2. Utility Relocation to Accommodate Highway Construction

When utility relocation is required due to highway construction, the utility company is responsible for preparing the plans.

Where utility relocations are required due to a TDOT construction project, the owners of the utility have the option of developing the utility relocation plans and having them included in the TDOT construction project or they may elect to contract the relocation per the section above.

Utility construction documents and EPSC plans can be included in the TDOT contract documents and let with the project.

When the utilities are included in the TDOT roadway project, the EPSC plans developed for the utility work will be included in the TDOT contract documents. The utility construction will be covered by the SWPPP prepared for the TDOT project. All plans must be prepared in conformance with all TDOT standards as outlined in manuals, bulletins and standard specifications. When stream crossings are involved in a project, the consultants preparing the utility relocation plans are required to develop plans for any diversions that may be required, and indicate by notes on the plans or written specifications, the materials and methods to be used for stream bank stabilization.

6 - 2.1 Responsibility for Compliance

Utility companies are responsible for ensuring all documents provided are in compliance with TDOT manuals and design guidance

Utility companies are responsible for ensuring compliance with the provisions of any applicable permits and the design requirements set down by TDOT manuals and specifications as required by the Utility Use and Occupancy Agreement. This includes all TDOT standards and specifications for erosion and sediment control. The utility must indemnify the State and hold harmless from any losses, including but not limited to fines, penalties and attorney fees that the State incurs as a result of the Utility's failure to comply with all federal, state, and local laws or regulations.

Utilities are responsible for providing appropriate EPSC measures and restabilization plans for all stream crossings.

When utility construction is carried out by TDOT, the general contractor and related subcontractors are responsible for day-to-day site management during the construction period. The utility must ensure that copies of the relocation plans are submitted to the TDOT Design Division and the Environmental Division so that they can be reviewed and incorporated into the TDOT construction documents and permits in a timely fashion. It is the responsibility of the utility company to provide complete plans, including EPSC measures appropriate to the work to be accomplished.

5 Storm Water Management on Construction Sites

5 - 1. Mobilization activities

Mobilization activities are actions taken to meet the requirements of the SWPPP and to implement the EPSC plans for the project. Each project will be different in terms of the activities required to prepare for construction. This section discusses a full range of steps that are usually required by the workers at any construction site. Much of the focus in the EPSC plans is on structural BMPs used for erosion prevention and sediment control; however, there are other very important activities that must be in place and functioning before construction can begin.

Mobilization includes all the initial activities associated with opening a project site. For example, establishing storage yards for equipment and materials, locating job shacks, posting necessary documents and installing the required EPSC measures

Figure: 5-1 Mobilization activities are pre-disturbance activities associated with beginning work

5 - 1.1 Preparation of staging sites

5 - 1.1.1 Posting of NOC

The following documents must be posted near the main entrance of the construction site. In general, this would be the temporary office for the job site. In the event there is no temporary office on the project, a notice must be posted near the middle of the project indicating the location of the SWPPP, EPSC plans, and other required documents. Figure: 5-2 shows an onsite posting of SWPPP information and where the documents can be found. The posted information should be located so that it can be read without entering an active area of the job site.

Figure: 5-2 Storm water permit information must be posted on the site

The following information must be posted on the jobsite. The materials must be maintained so they are legible at all times.

- Copy of the notice of coverage (NOC) with the NPDES permit tracking number for the construction project;
- The name, company name, E-mail address (if available), telephone number and address of the project site owner or a local contact person;
- A brief description of the project; and
- The location of the SWPPP if the site is inactive or does not have an on-site location to store the plan.

The SWPPP must be on the job site or at the posted location with the EPSC plans and copies of all the inspection reports. These must be available to regulatory personnel for inspection. Access may be requested by the general public but neither TDOT nor the general contractor are obligated to provide access to the construction site. If such a request is made, it should be referred to the engineering office in charge of the construction project.

5 - 1.1.2 Material storage

Before construction begins, the contractor should establish secure storage areas for materials to be used for construction. This includes bulk materials that may be stored such as aggregates, soil, paints, curing products, fertilizers, petroleum products and other chemicals. These areas should be properly established with provisions to catch any spills. This usually involves providing berms or traps around any type of storage tank. The examples in Figure: 5-3 shows a well-protected tank on the left with a berm and a plastic liner that will trap any potential spill; the tank to the right is not properly protected.

Figure: 5-3 Storage tanks should be properly protected to prevent potential spills.

5 - 1.1.3 Sanitary arrangements

Figure: 5-4 Sanitary facilities must be secured from vandalism

The contractor is responsible for providing sanitary facilities on the construction site in accessible locations for the work crews. Placement should be so that access for servicing at regular intervals will be possible. Temporary sanitary facilities should be placed on level pads and if possible, secured so that they will remain upright in windy or stormy conditions. In areas where vandalism may be a problem, sanitary facilities should be secured so they cannot be easily pushed over. Figure: 5-4 is an example of an overturned portable toilet that was cited in a notice of violation in a formal EPA inspection.

5 - 1.1.4 Waste storage and disposal

Figure: 5-5 Solid waste containers must be serviced regularly.

When mobilizing the construction site, provisions should be made for securing and disposing of solid wastes. Containers should be water tight and covered to prevent loss of material in windy conditions. Pads should be sufficient to allow easy access for servicing. Ingress and egress from waste containers should be improved so that no offsite tracking of sediment will result from traffic depositing waste or when servicing the container.

Storage of bulk waste materials such as recycled asphalt pavement, concrete and soils must be located so that runoff is diverted around the waste storage area and provisions are made to contain any contaminated runoff that may be generated from the stored materials. This usually involves the use of some type of silt barrier or silt trap. In addition, soils and open areas may need to have temporary seeding or treatment with a soil binder to prevent loss of material.

Figure: 5-6 Poor housekeeping cannot be tolerated on a construction site

5 - 1.1.5 Concrete washout

One or more places on the project site should be established for washing out concrete trucks. These places should be clearly marked and have improved ingress and egress to prevent tracking of sediments from the site. Marking should include a sign that clearly designates the site as a concrete truck washout site and the perimeter should be clearly marked by some means such as plastic construction fence. Concrete washout areas are for concrete only. No other waste materials should be disposed of in these areas. An example is provided in Figure: 5-7.

Figure: 5-7 Properly marked concrete truck washout area.

5 - 1.1.6 Site entrance controls

It is the responsibility of the contractor to designate points of ingress and egress to the construction site.

Figure: 5-8 Site entrances, such as the one on the left, should be used to prevent tracking of sedimets onto adjacent streets as in the example to the right.

These access points must be improved in some way to prevent tracking of sediments onto the adjacent roadway. On long projects the contractor may have to establish several entrances over the course of the work. These access points must be maintained so that they are operational at all times. See Figure: 5-8.

5 - 1.2 EPSC implementation

Mobilization also includes the installation of the required EPSC measures included in the SWPPP. On large projects the installation of these measures may be accomplished in several phases. It is the responsibility of the general contractor to present a phasing plan for the work and to follow that plan. The phasing plan becomes a part of the SWPPP and must be kept with the SWPPP and EPSC documents.

5 - 1.2.1 Installation of specified temporary controls

Based on the approved work phasing plan the contractor must install all necessary EPSC measures prior to beginning any earth disturbing activities.

5 - 1.2.2 Review and modification for any potential deficiencies

Figure: 5-9 EPSC drawings and the SWPPP must be reviewed and updated to match field conditions

Even though the EPSC plans are carefully prepared and checked there are unanticipated occurrences and changes that can occur between design and the actual beginning of construction. For this reason it is essential that the initial installation of all measures required on the EPSC plans and in the SWPPP be checked for adequacy before any earth disturbing activities begin. If any potential deficiencies are noted in the actual preparations for construction the contractor and TDOT engineer should be notified and actions taken to correct any deficiencies noted.

5 - 2. Regulatory Compliance

The goal of the SWPPP and the EPSC plans is to protect the water resources of the state of Tennessee. This is accomplished by being sure that the project stays in compliance with the provisions of the CGP and other water related permits, e.g., ARAP and Corps 404 permits. To accomplish this goal, there are several tools available to ensure compliance. The first and

most important is the inspection process. TDOT has a comprehensive self-monitoring process that includes regular site inspections in accordance with the requirements of the CGP and a QA/QC process to ensure that all onsite activities fully comply with all environmental related permits.

Figure: 5-10 Regular inspections as required by the CGP are the best tool to ensure compliance

5 - 2.1 Initiate the inspection process

The inspection process is initiated as part of the project mobilization process. Prior to the beginning of earth moving activities the general contractors representative and the designated TDOT representative who will handle the regular EPSC inspections should jointly perform the initial site inspection. All measures required by the SWPPP and the EPSC plans for the initial phase of the work should be reviewed on the ground. It is suggested that a specialized mobilization checklist be used for this inspection to ensure that all areas of potential storm water pollution are reviewed.

5 - 2.2 File and update records

The only means that TDOT and the general contractor have to demonstrate that the project has been in compliance from the beginning is the paper trail. Therefore, the maintenance of the SWPPP and EPSC documents is essential. Completed inspection forms with an unbroken chronology should be with the SWPPP at all times. These forms note any deficiencies found on site and the actions taken to correct the deficiencies. The EPSC plans should always match the field conditions. That is, the plans should always reflect the structural BMPs that are in place at that time. If changes are made in the field, the plans must be updated within 14 days of the change as required by the CGP.

5 - 2.3 Maintain all EPSC Measures according to the BMP type

Figure: 5-11 Maintenance of EPSC measures is critical to success

Maintenance of the EPSC measures is essential to protecting adjacent waters. Inspections are the primary tool in identifying maintenance needs. Inspections are made to find any BMP failures; however, inspectors are also charged with identifying any potential for failure. It is the potential for failure that triggers the maintenance response. When a potential for failure is identified, the contractor should be notified immediately so that appropriate corrective actions can be taken.

5 - 3. Troubleshooting

Troubleshooting is the action that follows from the identification of a failure or an identified potential for failure of an EPSC practice. In the individual discussions of BMPs some common corrective actions for those specific materials or methods are given. However, troubleshooting must go beyond any specific BMP because the overall objective is to secure the site so that no excess sediment is transported from the site.

5 - 3.1 Immediate Response

When potential for failure is observed, there needs to be an immediate response appropriate to the site conditions and the stage of construction. Typical signs of potential failures include:

- Bulging silt fence
- Leaning silt fence or fabric check
- Fine sediment at the toe of a slope
- Rills in channels or on slopes
- Scour at a channel or pipe discharge point
- Colored or stained discharge water
- Sagging or bulging erosion control blankets
- Bare places in mulch or blanket covered areas
- Spotty germination of seed or germination only at the base of a slope

Observation of any of these conditions can be an indicator of potential for failure of a BMP. Simply noting the potential for failure is only half the job. The next step is troubleshooting the situation to determine what action or actions are need to be taken and what are the options. Factors that must be considered when troubleshooting EPSC problems are as follows.

5 - 3.1.1 Availability of Downhill Backup

Figure: 5-12 Accessibility is not always possible to make repairs to EPSC measures

If there is a potential for failure, or if a BMP has failed, it is important to look immediately downhill to see if, for the conditions at hand, there is sufficient capacity down stream to catch any sediment that might be released as a result of the failure. If there is adequate capacity in terms of sediment storage, the next question is, are there sufficient velocity controls and checks to prevent further scour of any conveyance channels that would carry the sediment release. If the downhill system is sound, maintenance can be scheduled per the provisions of the CGP. If the downhill BMPs are not sufficient to handle any potential release from the BMP, then immediate action must be taken to back up the system. Backing up the system can consist of any number of interim actions from repair and replacement of the failing BMP to downhill actions to prevent any discharge.

5 - 3.1.2 Accessibility for Repair or Replacement

Repairs or replacement of failed or failing BMPs is not always possible due to issues of accessibility, or the availability of materials and equipment. It is also recognized that most EPSC installations are performed by specialized subcontractors. Some time may be necessary to mobilize a subcontractor to affect the needed repairs. If an immediate repair is not possible for one of these reasons, some type of interim action needs to be taken to prevent any potential discharges.

5 - 3.1.3 Potential Interim Actions

There are any number of interim actions that can be taken when it is not possible to immediately repair or replace a failed or failing BMP. This involves working with the contractor and the onsite resources to find a solution that will prevent a discharge until more permanent repairs or replacements can be made. The key is understanding the erosion and sedimentation processes and the means to control each of them. Given the equipment that is usually available on any construction site, some very basic actions can be taken, including:

Figure: 5-13 When failure is probable as in the photograph to the left be sure that the EPSC measures downhill are capable of holding the sediment or add something as simple as the excavated sediment trap shown on the right.

- Excavating temporary sediment pits using the excavated material to create a temporary dike
- Moving rock or gravel to create temporary checks in channels
- Using a motor grader to place a windrow on the contour to create a temporary catchment for sheet flow
- Using a dozer, sheep's-foot roller, or heavy lugged wheeled vehicle to roughen the surface of exposed slopes

Most any of these actions can be taken immediately upon discovery of a problem. However, these are only temporary measures to be taken until more suitable repairs or replacements can be made.

5 - 3.1.4 Question Continuing need

Not all failing BMPs need to be replaced or repaired. Some BMPs may be reaching the end of their service life and may no longer be needed. A good example of this is a fabric ditch check that has collected a significant amount of sediment and begun to lean. However, the channel, except for the sediment load just behind the barrier, is covered with a good stand of vegetation. In this case, the fabric check is no longer needed, the sediment collected should be removed along with the fabric check. Depending on the area disturbed by removal of the sediment, some additional seeding may be required.

5 - 3.1.5 Potential Need for Redesign

In other situations, there may be a catastrophic or repeated failure of a BMP. In these cases, there may be unforeseen circumstances occurring upstream of the BMP that are causing the failure. These may not be always be easy to identify and may require reevaluation of the site. Any increase in the impermeable surface upstream will increase the volume and rate of runoff contributed to a BMP. When these situations occur, the TDOT supervising engineer should be informed of the problem to see if redesign of the BMP is needed. Interim actions should also be put in place by the general contractor to ensure that any sediment is contained onsite.

5 - 3.2 Assessing failures

When actual failures occur, they must be recorded as a part of the inspection process. The troubleshooting section above suggests other actions that can be taken to contain the sediment while appropriate steps are being taken to repair or replace the failure. While these actions are important to

keep the project in compliance with the CGP, the actual failure should be assessed to determine the cause, if possible. Most construction site BMP failures can be attributed to three causes: mechanical failures; anomalous weather events or under design.

5 - 3.2.1 Mechanical Failures

Mechanical failures are the result of equipment or vehicles damaging the EPSC measure. Sometimes mechanical failures can be traced to construction workers removing a BMP in order to gain access to a portion of the site and then failing to replace the structure. Failures of this type should be noted and reported to the general contractor for appropriate action.

Figure: 5-14 Weather is unpredictable and can cause EPSC failures. When heavy weather is experienced, quick response is essential.

5 - 3.2.2 Anomalous Events

Anomalous weather events are those that produce runoff events greater than the design storm used for the project. These are events that are random and simply cannot be predicted. When these do occur, there are often a series of BMP failures and they may result in offsite discharges of sediment. If this should occur, follow the steps outlined in the section on handling offsite releases.

5 - 3.2.3 Under Design

EPSC measures can fail due to under design. This is not necessarily due to negligence or oversight. Most often it is the result of offsite conditions that were not known at the time of plan development or are due to upstream changes that were not anticipated caused by the order of work. If a failure cannot be attributed to an anomalous weather event or mechanical damage, it may be a design failure. In these situations, the supervising engineer should be contacted and asked to review the failure for needed changes. If under design is suspected, always be sure that interim measures have been instituted to backup any potential loss of sediment.

5 - 4. When Failures Resulting in a Release Occur

5 - 4.1 Who to Notify

When EPSC failures occur due to weather and unforeseen conditions, it is important that immediate actions be taken depending on the type and extent of the failures. In general, the following individuals should be notified:

- For maintenance problems, and nonthreatening failures notify the general contractor or the general contractor's onsite representative.
- For situations that involve a sediment discharge from the site into a stream or adjacent property contact the TDOT Environmental Compliance Officer for the region.
- For spills, contact the National Spill Center and the TDEC spill center
- If other permitted areas are impacted, notify the TDOT Environmental Compliance Officer who will contact the appropriate agency.

5 - 4.2 Documentation

Documentation of failures is absolutely essential to keeping a site in compliance and avoiding any Notice of Violation. Assuming that the site was inspected regularly and that EPSC measures were kept in good repair, failures that result in sediment releases are most often the result of an anomalous weather event or a design failure due to unforeseen offsite influences. Whatever the situation, the causes need to be identified and documented.

5 - 4.2.1 Photographic Record

Photographs are a very important part of the record. A photographic record should be made immediately upon discovery of all EPSC measures that fail as a result of the event. The failed measure as well as the resulting damage should be recorded. In so far as possible photographs should be taken of any contributing factors that resulted in the release. This may be offsite influences like large impervious surfaces, roofs, roads, parking lots, or construction sites adjacent to but not relate to the TDOT project.

5 - 4.2.2 Written Records

The written record should include the regular site inspection forms and construction diary entries describing the failures and any forensic findings related to cause. All photographs taken should be documented with a time and date stamp on the photograph and a brief description of what is being shown. Direction of view location of viewer are also important.

5 - 4.2.3 Permit Required

If a discharge of sediment occurs into a water course that is identified as a stream the TDOT Regional Environmental Coordinator should be contacted immediately. They will handle the acquisition of a General Permit for Sediment Removal for Stream Remediation. Until this permit is approved by TDEC actions must be taken to prevent any further discharge of sediment into the stream by any available means. It is essential that no action take place in the stream until notice of approval has been received from TDEC.

5 - 5. Field Procedures

This section presents basic responsibilities of TDOT inspectors charged with administration of the EPSC measures during construction. These are specifically related to procedures and actions that are necessary to ensure compliance with TDOT requirements and standards.

5 - 5.1 Checking for approved materials (QPL)

The general contractor and subcontractors are at liberty to use a variety of EPSC materials to implement the SWPPP. However, many of the materials that appear on the plans in schedules and notes refer to material Types or Class related to the Qualified Products List. This list will change from time to time and materials will be added and deleted from the list. What is important is that the inspector checks the materials that are delivered to the site to ensure that they are on the QPL and listed for the specific application specified. Where a Class or Type designation is given on the plans be sure that the product delivered is in that particular list.

Substitutions or products claimed to be equal to the materials on the QPL are not permitted. If a material is delivered to the site and it is not on the OPL for the application at hand it must be rejected.

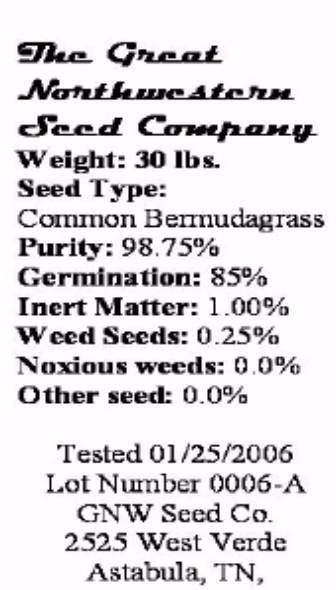


Figure: 5-15 Typical Seed Tag

5 - 5.2 Seed inspection and seeding rates

Seed for permanent or temporary seeding should be delivered to the site in labeled bags. Seed that has already been placed in a drill or hydraulic seeder is to be rejected. The labels on the bags should be dated to indicate when the seed was harvested and tested. In accordance with the state requirements for bulk seed, the seed tag must include as a minimum the following information

- Germination
- Purity
- Dormant seed
- Weed seed
- Noxious weed seed
- Inert matter

The seed should be no older that one year and should not include any noxious weeds. The list of prohibited and noxious weeds is shown in Table 5 - 1.

Unless slopes are prohibitive all seeding should be accomplished with a seed drill with multiple bins for different size seeds.

5 - 5.3 Seeding rates

Seed rates on the plan are given in Pure Live Seed (PLS), which is the product of the purity shown on the seed tag multiplied by the germination. The PLS for the seed tag above would be 0.9875 X 0.85 = 0.84. Thus only 84% of the seed are considered live. If the plan calls for a seed rate of 25lb/acre of hulled bermudagrass find the actual seed rate for the conditions shown on the tag. Actual seed rate required is 25 lb./ac / 0.84 PLS = 29.76 lb./acre. In other words to get an actual rate of 25 lb. per acre it will require 29.76 lb. of seed.

5 - 5.4 Seed drill calibration

To ensure that seed is distributed at the proper rate the seed drills should be calibrated prior to planting. The procedure for calibrating a seed drill is as follows:

- Tie bags around the seed tubes to collect seed
- Drive the seed drill 100 ft.

Find the rate per acre as follows:

43,560 sf/acre x collected seed in lb. / 100 ft. x drill width

For example assume a 15 ft. wide seed drill and a collected seed weight of 0.65 lb.

The seed rate would be:

43,560 sf/acre x 0.65 lb. / 100 ft. x 15 ft. = 18.88 lb./acre.

If 29.76 were required to met the seed rate as in the previous example then the drill would not be putting out enough seed and would have to be adjusted.

Table 5 - 1 Prohibited and Restricted Noxious Weed Seed for Tennessee

(1) Prohibited Noxious-Weed seed shall include:

Balloonvine (Cardiospermum halicacabum)	None per pound
Canada thistle (Cirsium arvense)	None per pound
Crotalaria (Crotalaris spectabilis)	None per pound
Field Bindweed (Convolvulus arvensis)	None per pound
Hedge Bindweed (Convolvulus sepium)	None per pound
Itchgrass (Rottboelia exaltata)	None per pound
Johnsongrass (Sorghum halepense)	None per pound
Nutgrass (Cyperus rotundus & C. esculentus)	None per pound
Sorghum Almum (Sorghum almum)	None per pound
Sicklepod (Cassia obtusifolia)	None per pound

(2) Restricted Noxious-Weed seed shall include:

Buckhorn Plantain (Plantago lanceolata)	200 per pound
Cheat (Bromus secalinus) or Chess (B. commutatus)	300 per pound
Cocklebur (Xanthium spp.)	2 per pound
Corncockle (Agrostemma githago)	100 per pound
Darnel (Lolium temulentum)	100 per pound
Dock (Rumex spp.)	100 per pound
Dodder (Cuscuta spp.)	100 per pound
Giant Foxtail (Setaria faberi)	100 per pound
Horsenettle (Solanum carolinense)	200 per pound
Quackgrass (Agropyron repens)	100 per pound
Wild Mustard or Turnips (Brassica spp.)	27 per pound
Wild Onion or Garlic (Allium spp.)	27 per pound
Plumeless thistles, includes Musk Thistle, Nodding Thistle, and Curled Thistle (Carduus spp.)	100 per pound
Annual Bluegrass (Poa annua)	300 per pound Lawn and turf seed only

(Source Tennessee Department of Agriculture, Division of Marketing, Seed Regulations)

5 - 5.4.1 Seed Mixes and Planting Seasons

The state is divided into three planting regions designated I, II and III as shown in. The seed mixes to be used are shown in Table 5 - 2

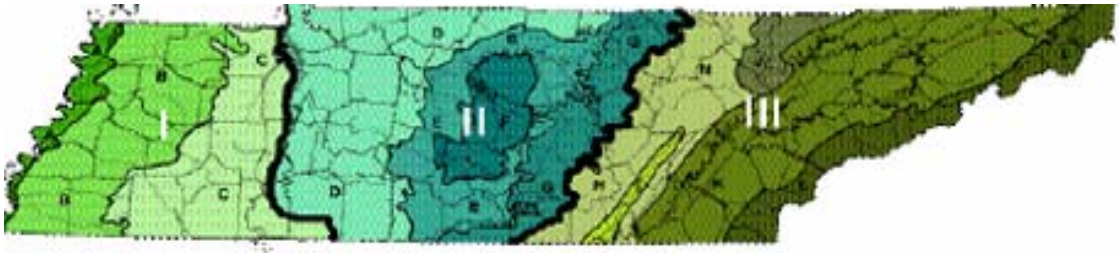


Figure: 5-16 Planting regions of Tennessee for Grass Mixes

Table 5 - 2 Recommended seed mixes and planting seasons

	Zone	Best	Marginal	Mix (lb./acre PLS)
Region I	Poorly drained soils	Feb – Mar 20 Sept 1 – Sept 30	Feb 15 – Apr 30 Sept 1 – Oct 31	Pensacoal bahiagrass (80) (Bermudagrass hulled) (30) Korean lespedeza (20) Kobe lespedeza (10)
	Well drained soils	Apr 1 – July 15		Pensacola bahiagrass (50) Bermudagrass (hulled) (15) Korean lespedeza (30) Foxtail millet (15)
	Grass Channels	Apr 1 – July 15		Bermudagrass (40)
	Temporary Seeding Summer	June 1 – Oct 15		German millet (30) Sudangrass (40)
	Temporary Seeding Fall	Oct 15 – May 31		Annual Ryegrass (40) Foxtail millet (30)
Region II	**Zone**	**Best**	**Marginal**	**Mix (lb/ac PLS)**
	Slopes and Poor/Shallow Soils	Aug 25- Sept 15 **Feb 15 –Mar 21**	Aug 20-Oct 25 Feb 1-Apr 15	Pensacola bahiagrass (100) (Bermudagrass hulled) (40) Korean lespedeza (30) Kobe lespedeza (10)
	Moderate slopes soil >6 in depth	Aug 25 – Sept 15 **Feb 15 – Mar 21**	Aug 25 – Oct 25 Feb 1 – Apr 15	Pensacola bahiagrass (80) (Bermudagrass hulled) (30) Korean lespedeza (20) Kobe lespedeza (10)
	Roadside Channels and Ditches	Aug 15 – Oct 15	Feb 15 – Apr 15	KY 31 Fescue (150) Bermudagrass (hulled) (20)
	Temporary Seeding Summer	May 1 – Sept 15	April 15 – Oct 1	German millet (30) Sudangrass (40)
	Temporary Seeding Winter	Oct 31 – Feb 15	Oct 15 – Mar 1	Annual Ryegrass (40) Foxtail millet (30)
Region III	**Zone**	**Best**	**Marginal**	**Mix (lb/acre PLS)**
	Mountains Steep Slopes>2,500 ft.	July 25*-Aug 15** **Mar 20-Apr 20**	July 15-Aug 30 **Mar 5-May-15**	KY 31 Fescue (100) Kobe Lespedeza (20) Korean lespedeza (10) Redtop (5)
	Mountains Steep Slopes <2,500 ft.	Aug 15-Sept 1 **Mar 1-Apr 1**	July 25-Sept 15 Mar 1- May 10	
	Shallow Soils>2,500 ft.	July 25*-Aug 15** **Mar 20-Apr 20**	July 15-Aug 30 Mar 5-May 15	KY 31 Fescue (40) Korean lespedeza (10) Redtop (10) Crown vetch (10)
	Shallow Soils<2,500 ft.	Aug 15-Sept 1 **Mar 1 – Apr 1**	July 25 – Sept 15 Mar 1 – May 10	
	Soil >6 in moderate slopes>2,500 ft.	July 25*-Aug 15** **Mar 1-Apr 1**	July 15 – Aug 30 Mar 5 – May 15	KY 31 Fescue (60) Kobe lespedeza (15) Korean lespedeza (15)
	Soil >6 in moderate slopes<2,500 ft.	Aug 15**-Sept 1 **Mar 1-Apr 1***	July 25-Sept 15 Mar 1-May 10	
	Roadside Channels >2,500 ft.	July 25*-Aug 15** **Mar 1-Apr 1**	July 15 – Aug 30 Mar 5 – May 15	KY 31 Fescue (150) Italian ryegrass (35) Smooth bromegrass (20)
	Roadside Channels <2,500 ft.	Aug 15**-Sept 1 **Mar 1-Apr 1***	July 25-Sept 15 Mar 1-May 10	
	Temporary Seeding Summer	May 1 – Sept 15	April 15 – Oct 1	German millet (30) Sudangrass (40)
	Temporary Seeding Winter	Oct 31 – Feb 15	Oct 15 – Mar 1	Annual ryegrass (40) Foxtail millet (30)

5 - 6. Installation, Maintenance and Repair of EPSC Measures

The section that follows provides a detailed description of the full palette of EPSC measures for storm water management of TDOT construction sites. Each BMP is rated for relative effectiveness, longevity, ease of installation and ease of maintenance in performing one of the basic EPSC tasks of surface protection, sediment capture or flow control. As appropriate the standard specification and standard drawing for the measure are cited along with a detailed description, installation considerations, common problems, inspection points and suggested actions for repair or replacement.

This section provides a handy reference related to field issues. It does not provide design guidance. Design information is provided in the Design Division Drainage Manual, Chapter 10.

BONDED FIBER MATRIX

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: 209.07 Construction of Structures

Standard Drawing: None

BFMs can be applied to very steep slopes that would be difficult to access with any equipment. Where possible the surface should be roughened and then the seed and fertilizer would be applied. The BFM is then applied at the specified rate within 24 hours of seeding.

Figure: 5-17 Hydraulic Application of Bonded Fiber Matrix

Description: Bonded fiber matrix or BFM consists of a continuous layer of elongated fiber strands bound together by a water resistant bonding agent or tackifier. BFM differs from hydraulically applied mulch in that a BFM is applied at a higher rate of product (3,500-4,000 lbs/ac) and can be used on steep slopes up to 2:1. The BFM is applied uniformly over a prepared and planted seed bed so that there are no areas where the soil surface is visible. Proper coverage provides soil stabilization and protection of the seed bed for approximately one growing season.

Other BMPs serving this function include:

- Erosion control blankets
- Crimped or tacked straw mulch
- Approved soil binders

Applications:

- As surface protection for ***erosion prevention*** on cut or fill slopes and soil stockpiles.

Installation Considerations:

- Place BFM within 24 hours of seeding.
- Do not apply BFM material during high wind conditions.
- Apply BFM uniformly leaving no visible soil.
- Prohibit all types of traffic after application.

- Equipment may include hydraulic seeder/mulcher with adequate capacity to cover the intended area constantly working to a wet edge.

A bonded fiber matrix that is not applied at the specified rate or without proper flow control will not perform as intended. This is an example of a BFM applied to a 2:1 slope at 1/2 the specified rate and had direct runoff from the pavement onto the surface. This is a case of improper application of a BFM.

Figure: 5-18 Improper use and application of a Bonded Fiber Matrix

Inspection and Maintenance:

- Inspect slopes for rill formation. If necessary, make repairs, reseed and reapply BFM material.

Common Problems:

- Bare places on down spray side of an irregular surface due to wind
- Non-uniform application
- Application rates less than manufacturer specificationFigure: 5-18
- Improper mixing or insufficient quantities of tacking agent or mulch.

Corrective Actions:

- If non-uniform coverage is observed reapply material to areas needed. Be sure to check down slope (down spray) sides of rough surfaces for adequate coverage.
- If material is not forming a blanket-like mat there was insufficient tacking material in the mix. Have the contractor reapply with proper mix of tackifier.

CONSTRUCTION FENCE

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing: S-F-10, S-F-10A, S-F-10B.

Construction fence is a handy tool for protecting and marking areas that are to be left undisturbed by construction activities. The orange color shows up well as a warning to keep out.

Construction fence does not provide any sediment control or erosion prevention function other than protecting existing vegetation cover.

Figure: 5-19 Construction fence is a handy tool for marking areas of vegetation to be left undisturbed

Description: Temporary construction fence (orange fence), is not generally thought of as an EPSC material however, it is a handy tool to prevent damage to EPSC measures, vegetation to be preserved and other areas of a construction site that need to be marked for special management. There are several materials that can be used but the most common and visible is the orange plastic material. Other options include chain link or stock wire.

Applications:

- To designate and protect
- Environmentally sensitive areas
- Critically erodible areas
- Areas of vegetation that are to remain intact

Installation Considerations:

- Fencing should be in place prior to beginning construction activities.
- Additional signage may be needed to keep activity away from protected areas.
- Silt fence can be used in conjunction with the other fence material where drainage patterns require sediment control protection; however, temporary construction fence is not a sediment control material.

Problem

Construction fence does not provide any sediment control. This fence was used to prevent equipment and people from falling into the open inlet.

However, there is no sediment protection around the open inlet. Also notice the pile of soil in the upper right, in a rainfall event this material is going to contribute sediment to the unprotected inlet.

Figure: 5-20 Construction fence can protect critical areas but it does not provide erosion or sediment control

Inspection and Maintenance

inspect fence routinely to make sure that it is standing and visible and that the designated areas have not been encroached upon.

Common Problems:

Fencing is damaged or removed

Corrective Actions:

Repair and or replace fence as needed.

Construction fence must be kept in good repair. This installation is not a violation but it detracts from the appearance of the site and can attract unwanted attention.

Figure: 5-21 Poorly maintained construction fence can result in unwanted attention.

CONSTRUCTION SEQUENCING (PHASING)

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: N/A

Standard Drawing: N/A

Description: Construction sequencing is required by the CGP and involves the coordination or timing of the construction schedule to minimize the amount of area disturbed at any one time. By permit no more that 50 acres of a larger project site may be open at any time. This requirement is intended to leave vegetative cover in place until it is necessary to implement clearing operation to accommodate construction activity and to ensure that restabilization activities are carried out in a timely manner reducing the erosion potential for the site. Sequencing is done in coordination with the general contractor and the installation of erosion and sediment control measures. In general, the phases of construction are as follows:

In the upper part of the photograph you can see that the ROW has been cleared but it has been temporarily stabilized while construction is proceeding in the foreground.

In the middle ground of the picture you can see that stabilization has begun on the back slopes and shoulders.

Figure: 5-22 Example of construction phasing

Initial Phase –

1. Delineation of
   - vegetated buffers
   - critical or sensitive areas
   - operation limits
2. Installation of
   - perimeter sediment controls
   - diversion methods
   - sediment containment areas

- stabilized access
- temporary stream crossings
- non-storm water BMPs
- waste management and other pollution control BMPs

Problem

In this case there is no stabilization of the shoulders and the median which are at finished grade. While sediment controls are in place in the median no perimeter protection is in place on the downhill shoulder.

Good phasing practices would have installed permanent seeding on the completed shoulders and median at this stage.

Figure: 5-23 Stabilization activities are not being carried out in a timely fashion.

Intermediate Phase –

1. Right-of-way clearing operations
2. Extensive grading, topsoil removal and stockpile
3. High erosion potential during this phase of large areas of exposed soil
4. Maintenance of
   - velocity controls
   - slope stabilization
   - channel stabilization
   - inlet protection
   - outlet protection

Final Phase -

1. Install permanent vegetative cover
2. All temporary BMPs should be removed after final stabilization.
3. Ensure that all conveyance systems have been permanently stabilized.
4. Permanent water quality treatment facilities should be established.
5. All outlets must have energy dissipation devices in place.
6. File NOT

In phasing the construction operations the contractor is responsible for beginning restabilization of all disturbed areas so that there is never more than 50 acres open. In general open area is considered those areas in the intermediate stage described above.

Applications:

- All construction projects must use construction sequencing.
- The degree of planning and management necessary is project specific
- The general contractor is responsible for submitting a phasing plan for construction activities prior to the beginning of construction. This document becomes part of the SWPPP and is maintained with the SWPPP documents. If there is any change in the schedule of operations it is the responsibility of the contractor to change the SWPPP.

This is a good example of how stabilization should be handled as construction progresses.

The shoulders and drainage ways have all been stabilized as they reached finished grade while the roadbed and shoulders are still being completed.

Figure: 5-24 Good example of stabilization of areas that have reached finished grade

Installation Considerations:

- Size and duration of project
- May use sub-phases for larger sites
- Perimeter controls, sediment traps and runoff diversions should be in place prior to construction activity.
- Prioritize areas to be disturbed relative to proximity of receiving waters.
- Contractor coordination

Inspection and Maintenance:

Inspection of project phasing is primarily related to review and updating of the EPSC plans and the SWPPP documents. As the project progresses it is important to record the opening and termination dates of work in an area and to track the approximate area of disturbed land and areas where restoration has begun. If construction activities are suspended temporarily or permanently for more than 15 days action must be taken to begin temporary or permanent stabilization.

Problem:

The roadbed has been cut to allow the installation of a new box culvert. Traffic was diverted to the right of the picture which is upstream of the culvert replacement where a two new lanes are being added.

Notice several things there is no perimeter protection anywhere so that any sediment from the stockpile, upper left, and shoulder will drain directly into the stream.

The construction was phased but appropriate sediment controls were not provided as work progressed.

Figure: 5-25 Work was phased but proper sediment controls were not provided as work progressed.

Common Problems:

- Weather delays that disrupt scheduling
- Failure to record opening or closing dates in diaries
- Failure to update SWPPP documents as phases progress

EROSION CONTROL BLANKETS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

Specification: 209.06 Construction Requirements, Section 819.28 Erosion Control Blankets

Standard Drawing: EC-STR-34

Description: Erosion control blankets can be organic (biodegradable) which include straw, excelsior, coir, jute/hemp and biodegradable synthetics or synthetic (non-biodegradable) blankets which are usually made of a geosynthetic material, or a composite of both types. Erosion control blankets are supplied in rolls. The materials are spread over the surface and anchored into place with wire staples or plastic pins to provide a continuous sheet over the planted seed bed. These products are designed to dissipate the energy of raindrop impact and prevent mobilization of soil particles in surface flows. Blankets must come from the TDOT Qualified Products List (QPL) for the appropriate slope and condition. The QPL classifies blankets in four types (Type I to Type IV) based on slope.

Early performance testing of erosion control blankets was conducted outside. This picture shows three different types of erosion control blanket. From left to right a woven polypropylene material, an excelsior blanket and a straw blanket. The test shown is on clay soil at a slope of 3:1.

Figure: 5-26 Outdoor testing showing three different types of erosion control blanket

Close up of some different types of materials used in blankets. Top to bottom:

- ***composite of natural and synthetic fiber,***
- ***single net straw blanket***
- ***coir filled synthetic matrix flexible channel liner***
- ***synthetic fiber filled synthetic matrix channel liner.***

Figure: 5-27 Examples of the variety of materials used in blankets and channel liners

Applications:

- Protection of slopes. Type depends upon slope steepness and soil type (See QPL).
- Swales, ditches and channels with calculated shear stresses less than 2 lb/sf or a Class I Flexible Channel Liner. If shear stress is over 2 lb/sf then a permanent turf reinforcing mat (TRM) should be used.

Installation Considerations:

- Slope steepness and soil type
- Longevity required
- Effectiveness for soil type and conditions.
- Relative cost of purchase, installation and maintenance
- Visual impact to the public
- Environmental acceptability. Synthetic and coir materials biodegrade more slowly than other natural materials.
- Vehicle, pedestrians, and equipment must stay off of protected area after installation.
- Surface preparation requires fine grading often involving some hand work.

Proper installation of erosion control blankets is essential to achieving good performance. Installation should always be as required by the manufacturer of the product.

The seed bed below the blanket must be smooth and free of any rocks or clods that will prevent the blanket from staying in direct contact with the soil surface. Edges of the blankets should be overlapped as shown at the left and staples placed as required by the manufacturer.

Figure: 5-28 Proper installation of erosion control blankets is essential to performance

Emerging vegetation can lift an improperly installed blanket from the surface, a condition called pillowing. Pillowing usually results when two few staples are used or as in the case on the far left the material was laid down over emerging vegetation.

Figure: 5-29 A condition called pillowing usually results from improper installation

Inspection and Maintenance

- Inspect the site during installation to ensure that soil surface is properly prepared.
- Inspect the installation before, during and after significant rain events for loss of contact with the surface.

Common Problems:

- When intimate contact with the soil is not maintained:
  - erosion can occur underneath the blanket.
  - rills and gullies form unnoticed
  - if fabric is not installed with the slope it will bridge rills more readily Figure: 5-30
- When blanket is not installed within 48 hours of vegetation planting
  - blanket may not maintain contact with the soil due to vegetation emergence called "tenting" or "pillowing" Figure: 5-29
- When not enough anchors are used
  - blanket will not maintain contact with the soil and can lead to tenting

- more erosion will occur underneath the blanket
- blanket may become unsecured by rainfall and wind

Corrective Actions:

- Repair or replace all damaged materials.
- Re-compact and reseed all eroded areas.
- If emerging vegetation has caused pillowing the fabric should be removed.
- Add additional staples as needed
- If excessive erosion is occurring under a blanket first check to see if there are sufficient staples. If staples are sufficient consider the addition of some type of mid-slope velocity control such as filter socks, wattles or additional check slots.

Problem

Blankets must be installed perpendicular to the contour. This entire slope is failing because of improper installation of the blanket.

Figure: 5-30 Improper installation will result in excessive erosion under the blanket

Problem

Look closely at the picture to the left. Notice the large size of the debris at the surface and the depression about to be covered by the blanket material. Water passing through the blanket will likely continue to enlarge the depression and form a rill under the blanket. Likewise the large debris will hold be blanket above the surface and allow more erosion of the surface.

Figure: 5-31 Example of a poor erosion control blanket installation in the making

This is an example of mechanical damage that can occur on a construction site. Heavy equipment tor the blanket and pulled it from the surface. This section will have to be regraded, reseeded and a new blanket installed.

When these kinds of repairs are needed it often takes time to mobilize the materials and equipment and for the site to dry sufficiently to get access for repairs. In cases like this it is important to document the damage and be sure that interim measures are in place to prevent any sediment discharge from the site

Figure: 5-32 Example of mechanical damage requiring repair

CRIMPED STRAW MULCH

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 801 Seeding

Standard Drawing: None

Straw mulch is usually placed by blowing the straw in to get a uniform surface cover. The standard rate for average slopes up to 4:1 is 2 tons/acre as shown here.

The straw is then pressed into the ground with a crimping tool. This anchors the straw in place and simulates crop stubble which is a natural form of erosion control.

Ground should be soft when crimping takes place and crimping tools must not be sharp so that they will press the straw into the ground.

Figure: 5-33 Example of crimped straw mulch at a 2 ton/acre rate

Description: Crimped straw is a layer of straw or hay mulch spread or blown over the seedbed and then mechanically pressed into the soil surface. The action of rolling a crimping implement over the surface of the straw creates rows of straw that stand up. The remainder of the straw protects the soil's surface. This reduces the velocity of the runoff, promotes infiltration and vegetation establishment and reduces erosion.

Applications:

Crimped straw is used for ***erosion prevention*** and ***vegetation establishment*** on:

- Cut or fill slopes with non-cohesive soils
- Roadsides

Installation Considerations:

- Place mulch within 24 hours of seeding.
- Do not apply during high wind conditions.
- Apply mulch in uniform cover leaving no visible bare places.
- Prohibit foot, equipment and vehicle traffic after application.
- Equipment may include seed application equipment, mulch, tiller or disc, and straw blowing equipment (either square bales or round bales can be blown with equipment).

Inspection and Maintenance

- Inspect slopes for rill formation.
- Check for uniform cover and good attachment.

This is a simple round bale processor used for placing straw on the right of way. There are also straw blowers that use square bales.

Round bales are larger and usually less expensive but they require heavy equipment to load and handle on site. Square bales are usually more expensive but are easy to handle without special equipment.

Figure: 5-34 Round bale processor for placing straw mulch

Common Problems:

- Dry, hardened soil may prevent proper anchoring of the straw the crimping tool will cut the straw rather than poke it into the ground.
- Straw is cut up by a disc that is too sharp
- Straw application not heavy enough or uniform

Corrective Actions:

- If straw is being cut by the crimping tool the ground may have to be moistened to get good crimping
- If the straw is being cut it may also be due to a sharp disc. A dull serrated disc should be required for crimping
- If straw cover is not uniform or not at the specified rate, straw should be added and re-crimped.
- If there has been seedbed damage the areas may have to be re-drilled. A no-till drill is recommended if straw cover is in place.

Straw crimping tool. Notice the serrated blades on the crimper. These blades must be dull so that they do not cut the straw. The straw must be pressed into the ground so that it is anchored and provides resistance to surface flows.

Ground should be moist before crimping is done to be sure that the straw can be pressed into the ground.

Figure: 5-35 Straw crimping tool

This is a close up view of crimped straw at the rate of 2 tons/acre. Notice how the straw stands up in rows and resembles mowed grain or clumps of grass. This standing straw breaks up sheet flow and helps prevent the transport of sediment down slope.

Figure: 5-36 Close up view of crimped straw at 2 tons/acre

DRILL SEEDING

Effectiveness					
Longevity	N/A				
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 801-Seeding

Standard Drawing: None

Drill seeders are preferred for transportation construction projects because they handle multiple seed sizes and types and they press the seed into the soil. This generally provides better micro climatic conditions, access to moisture, and prevents seed from drying up and blowing away.

Figure: 5-37 Typical tractor pulled seed drill used for highway construction

Description: Drill seeding is recommended for planting cover crops and permanent vegetation. The process uses a tool that creates a shallow furrow, places seed in the furrow, and then covers the seed with soil. The compaction keeps the seed in place, retains moisture, and allows for greater percentage of germination than broadcast seeding. The drill distributes the seed evenly, assures the proper depth of planting, and provides a protective cover to maximize germination. Drills have multiple bins to separate small seed from large and fluffy seed. This is a particularly important feature when planting seed mixtures such as those used for highway planting.

Applications:

- All accessible areas of the roadside

Installation Considerations:

- Slope steepness greater than 3:1 will limit safe access of equipment.
- Equipment necessary includes a pull vehicle (tractor or ATV) and appropriate drill type for the specified seed mix.

Inspection and Maintenance

- Drills should be inspected and calibrated for the proper seed distribution
- Inspect temporary seeded slopes for excessive rill formation.
- Protect seeded areas from vehicle and pedestrian traffic until vegetation is established.

Common Problems:

- Uneven seed distribution due to drill malfunction or improper calibration

Seed drill used for highway seeding should have multiple bins that can be calibrated for different seed sizes. This ensures more uniform distribution of the seed and a better vegetation stand.

Figure: 5-38 A multi-been seed drill is the best type for seed mixes with different size seeds

Corrective Actions:

- If necessary, repair and reseed. Mulch as necessary to achieve uniform coverage.

NOTE: Extended dry periods often retard the emergence of vegetation. Prior to disturbing a previously seeded area inspect the areas carefully for the presences of florets indicating early germination. If the florets are present it is usually better to maintain a good mulch cover rather than attempting to reseed or further disturb the seedbed. Disturbance at this point will often set vegetation establishment back rather than enhance it.

Figure: 5-39 No-till drill seeding

No-till seed drills plant seed through existing crop residue or surface mulch cover as shown here.

This is a very effective means of planting permanent seeding through a previously planted cover crop. Prior to planting the standing vegetation from the cover crop should be mowed and then the seed is drilled through the residue of the cover crop.

HYDRAULIC SEEDING AND MULCHING

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 209.02 Classification (e) Temporary Seeding and Mulching

Section 801-Seeding

Standard Drawing: None

Hydromulching or Hydroseeding are terms for placing of mulch, seed, and fertilizer in a water slurry.

For highway constructing a two step process is preferred. The seed and fertilizer are applied first,. Then in a second pass a cellulose fiber mulch is applied.

A dye, usually green, is added to the mulch to help show where the material is applied.

Figure: 5-40 Hydraulic application of seed, fertilizer and mulch is commonly called hydro-mulching.

Description: Hydro-mulching and Hydro-seeding is the application of seed, wood fiber mulch, and/or fertilizer in a water based slurry. This is an economical means of applying these materials if somewhat less effective than other planting methods. Its greatest applications are on steep slopes with limited access or on flat terrain were there will be very limited sheet flows. Dye, usually green, and tackifier are sometimes added to the mixture to mark the areas treated and to hold the material in place. In transportation applications it recommended that seed and fertilizer be applied to the prepared seed bed first, followed by an application of wood cellulose fiber mulch. Applying the materials in two steps doubles the amount of water which has been demonstrated as an aid in germination and establishment.

Problem

Hydraulic mulch applications do not provide erosion protection on steep slopes, slopes generally greater than 4:1 or 5:1.

The photograph to the left is an example of a slope that was hydraulically seeded and mulched that received a heavy rainfall event before the vegetation emerged.

Mulch must be used with some type of soilbinder to provide erosion protection.

Figure: 5-41 Example of erosion on a slope protected only by hydraulic mulch

Applications:

- Used for ***vegetation establishment*** recommended for:
  - seeding inaccessible slopes
  - seeding stock piles
  - seeding flat slopes of the roadside

Installation Considerations:

- Hydraulic mulching and seeding are not erosion controls
- Limited application on non-cohesive soils
- Will vegetation germinate and provide sufficient erosion control?
- If hydro-seeding is used on steep slopes that are difficult to access with a drill use of an approved BFM is recommended to affect erosion prevention.

Problem

The picture at the left shows a hydraulically mulched and seeded slope. The applicaton was very light and coverage was spotty. If you look closely at the middle of the slope you can see that rills are developing and that parts of the slope have no mulch at all.

Figure: 5-42 To be effective it is essential that hydraulic mulch be applied uniformly and at the specified rate.

Construction Methods:

- Place mulch within 24 hours of seed application
- Do not apply during high wind conditions or very dry conditions.
- Apply mulch in uniform cover leaving no visible bare places.
- Prohibit foot, equipment and vehicle traffic after application.
- Hydraulic equipment and adequate water supply are necessary.

Inspection and Maintenance:

- Inspect uniform coverage
- Inspect to be sure application is at specified rate
- Inspect for rill formation

Common Problems:

- Bare places on down spray side of an irregular surface.
- Bare spots or thin cover due to poor application

Corrective Actions:

- Reseed and reapply mulch as necessary.
- If rilling occurs this means that slopes are too steep for hydraulic mulch application. Repair the surface reseed and cover with a straw mulch to prevent erosion. Mulch should be tacked or crimped depending on the soil type.

The hydraulic mulching operation shown here is an example of good uniform coverage on a moderate slope.

Notice the berm at the edge of road shoulder where the slope breaks. This will divert runoff away from the slope and help prevent erosion.

Figure: 5-43 Example of properly applied hydraulic mulch with a berm to intercept runoff

RIPRAP

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 709-Riprap and Slope Pavement

Standard Drawing: Called out on EC-STR-21 but may be used in a variety of surface armor applications

Riprap is a layer of large rock used as a flexible armoring usually for stream banks and channels that sustain deep concentrated flows.

The actual size of the rock riprap is based on the designed flow of the stream or channel being protected.

This shows riprap used for outlet protection at a culvert.

Figure: 5-44 Stone riprap used for culvert outlet protection.

Description: Riprap is a layer of rock or concrete placed on a slope for erosion protection. It is considered hard armor. Surface armor is utilized when vegetated surfaces are not able to resist the shear stress. The upper limit for shear on vegetated channels is 2 lb./sf. Riprap is also used where there is a continual wave action against the slope and to protect bridge abutments. Occasionally it is used around inlets and outlets of pipe and in smaller drainage channels. The material used for riprap can be either quarry rock or field stone, depending on the class of riprap. It must be hard and durable so it won't disintegrate when exposed to water and weather. There are several gradation specifications for the various classes of riprap depending on its use.

Applications:
Rock riprap is used for ***erosion control*** for

- discharge outlets
- ditch channels lining
- slopes, and stream bank stabilization

Installation Considerations:

- Heavy equipment is necessary to place rock and access is a factor in choosing this as a BMP.
- In general riprap is used because permanent protection will not be provided by vegetation
- Flow velocity and volume will determine rock weights

Inspection and Maintenance;

- Check for undermining of riprap
- Inspect the channel down stream of the riprap to be sure there is no excessive scour
- Check for loss of material

Common Problems:

- Vegetative growth in riprap is difficult to remove

This is an example of a roadside channel armored with stone riprap. Notice the tall grass that has grown in the center and along the edges of the channel. This is a maintenance issue that must be considered when using riprap as a permanent channel armor. The grass can only be removed manually or by herbicides. Because it is in a channel there is always a risk of some pollution and the dead grass is not particularly attractive either.

Figure: 5-45 Example of maintenance problem with stone riprap

- Riprap may be undermined at the bed by high flows
- Excessive scour down stream of the riprap
- Volunteer grass can be difficult to remove

Corrective Actions:

- If down stream scour is evident energy dissipation is need up stream. See TDOT Standard Drawing EC-STR-21
- If riprap slumps or there is noticeable sediment being deposited down stream erosion is occurring under the armor layer. It will be necessary to remove the riprap, repair the channel and place a filter fabric barrier between the riprap and the channel bed.
- If riprap begins to migrate down stream the rock may be too light for the flow in the channel. Riprap may have to be removed and replaced with a heavier material.

This is a typical example of riprap used to line the downslope transition of a roadside borrow ditch.

Using natural rubble riprap in this situation maintains recharge and helps reduce velocity, where as concrete lined channels likely increase velocity and reduce recharge which can lead to problems down stream.

Natural rubble riprap can also be more aesthetically pleasing in rural settings.

Figure: 5-46 Example of natural rubble riprap as a roadside borrow ditch downhill transition

SODDING

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 803-Sodding, entire section

Standard Drawing: None

Description: Sod is pre-grown grass in rolls installed on a prepared soil surface. Sod provides an instant vegetative cover for erosion control. Because the sod an established turf material there is no need for other temporary measures. However, sod requires supplemental watering after application if sufficient rainfall is not received during the first three weeks of installation. When sod is placed on a slope staples or anchors are needed to ensure that sod stays in place until it roots into the substrate.

Large sod rolls are the most practical ways of using sod on the highway right-of-way. Large rolls such as the one pictured can be installed with machinery and provide instant surface cover. Water must be available for sod until it is established, usually 3 to 6 weeks depending on the grass and climatic conditions.

Figure: 5-47 Large sod roll

Applications:

Sod is used for ***erosion control*** and, when used as a ***vegetative buffer,*** is considered to be a ***sediment control***.

- Cut or fill slopes
- Swale linings
- Vegetation buffers

Installation Considerations:

- May be necessary to stake or stapled the sod to the soil.
- Supplemental water source must be available
- Should be installed in rolls rather than blocks to minimize edges and moisture loss
- Sod is cost effective when compared to the cost of blankets.
- Sod is usually a turfgrass monoculture. For this reason it will gradually trend toward a mix of more native species depending on moisture and the mowing regimen

Inspection and Maintenance

- Inspect slopes for any undermining of the sod material
- Check for sufficient moisture. Grass may wilt but should not be allowed to completely dry out

- Check for bare areas resulting from sod dead grass or migration of the sod down slope. .

Large rolls of sod can be laid with equipment as shown here. This makes the cost very competitive with other types of surface cover for EPSC purposes.

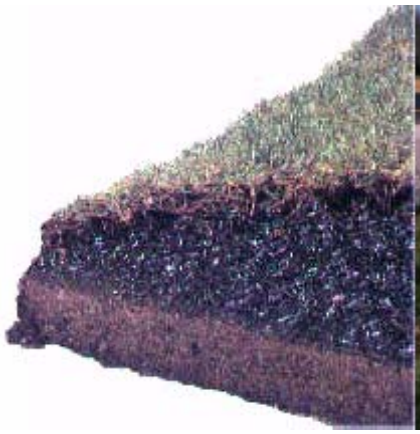
Figure: 5-48 Examples of large sod roll installation equipment.

Common Problems:

- Delivery of dry sod to the site
- Placement of sod on dry soil bed
- Leaving gaps between blocks and or rolls
- Seed bed is rough so that sod does not make good soil contact.

Corrective Actions:

- If sod is dry when delivered to the site it should be rejected and removed from the site.
- If substrate is dry do not lay sod. The top 4 in. of soil should have at least 60% available moisture so that the soil is workable, but not saturated.
- If sod is migrating down slope the rolls should be stapled. Staples should be place at 48 in. centers triangularly space.
- Sod must be laid over a smooth substrate so that the root zone of the grass makes positive contact with the soil.



Sod is also grown with a geosynthetic reinforcing mat imbedded in the sod as shown at the far left.

This has application on erosive soils that will sustain immediate and frequent concentrated flows such as the median ditch shown at the center of the figure.

Figure: 5-49 Example of reinforced sod

SOIL BINDER and TACKIFIERS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: 209.02 (e) and 209.07 (e) Temporary Seeding and Mulching

TDOT Standard Drawing: None

Soil binders are a large family of products that include polyacrylamides, vegetable base products and other chemical based products. These materials can be effective in binding soil together and preventing erosion.

Soil binders are also used in conjunction with hydraulic mulch to provide erosion protection.

Figure: 5-50 Soil binders are often used in conjunction with hydraulic mulches for erosion control

Description: Soil binders and tackifiers are used to bond soil particles together to minimize soil erosion. They include:

- Organic
  - Natural ingredients/environmentally friendly
  - Biodegradable – difficult to 'over do it'
  - Guar-gum based - most popular
- Polyacrylamides (PAM's) also used to remove sediment

They have been demonstrated to be harmless to fish, wildlife, and plants, non-toxic and non-combustible. These materials are effective as a soil stabilizer, dust control, and to hold mulches and seed on the soil surface. While they can be used as a temporary erosion control measure their primary use is as a supplement to other surface protection measures such as straw mulch or blankets.

Applications:

Soils binders or tackifiers can be used to improve ***erosion control*** or as ***dust control***

Installation Considerations:

- Not for use in streams or channels
- The effectiveness of these products depends on rate, slope, and weather. Most will be effective until vegetation is established.
  - Vegetable based materials have up to 6 month longevity
  - Some polyacrylamides have as much as 12 months longevity
- Hydraulic spray equipment and adequate water supply are required for use
- Can be used on rougher surface than blankets or sod.
- Use a color dye to achieve more uniform coverage

Figure: 5-51 Soil binders are applied hydraulically and available as liquids and wettable powders

Inspection and Maintenance:

- Check surface for spots that are not covered properly
- Check for proper rate of application. Have contractor calibrate sprayer and mark areas to be covered by each batch mixed.
- If seed is to be applied with the tackifier be sure that the seed rate is correct for the water volume and area.
- Check for the beginning of rills as polymers do breakdown

Common Problems:

- Irregular application
- Application is less than the required rate

Corrective Action

- If application rate is too light reapply over the entire site.
- If seed applications is light or not uniform as evidenced by spotty germination, reseed the bare spots

TACKED STRAW MULCH

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 801-Seeding

Standard Drawing: None

Straw mulch can also be applied to the surface and then sprayed with a tackifier or soil binder to hold it in place.

The tack material can be a vegetable based material like guar or it a polyacry-lamide approved for the specific application.

Figure: 5-52 Roadside planting with tacked straw mulch

Description: Straw mulch is a layer of straw or hay spread or blown over the planted seedbed. Following the straw application it is tacked in place using an approved tacking agent.

Applications:
Tacked straw is used for ***erosion control*** and ***vegetation establishment*** on:

- Cut or fill slopes,
- Topsoil stock piles
- Flatter roadside areas
- Not recommended for application on non-cohesive soils

Installation Considerations:

- Place straw mulch within 24 hours of seeding and apply the tacking agent.
- Do not apply during high wind conditions.
- Apply mulch in uniform cover leaving no visible bare places, bare places must be covered before tackifier is applied.
- Prohibit foot, equipment and vehicle traffic after application.
- Equipment may include hydraulic applicator, straw blower, (either square bales or round bales can be blown depending on the equipment).

The illustration at the right shows the application of tackifier over a straw mulch. The dye is added to the tackifier material to help the operator be sure that the coverage is uniform.

You can see the slope to the right of the truck has been covered with straw and the operator is applying the tack material.

Figure: 5-53 Application of dyed tackifier material over blown straw

Inspection and Maintenance

- Inspect slopes for rill formation.
- Inspect for uniform cover of straw and tackifier

Common Problems:

- Straw is not applied at specified rate
- Straw application is not uniform
- Insufficient tack is applied to hold the straw

Corrective Actions:

- If rill formation is evident straw is bridging. If possible the straw should be crimped
- If insufficient tack has been applied it will be evident by straw being blown in waves leaving bare spots. Reapply straw and tackifier
- If insufficient straw is applied, bare spots will be evident these need to be covered and additional tackifier applied.
- If the seedbed sustains significant damage the areas may have to be reseeded. If this is necessary a no-till drill should be used. Otherwise, mulch must be removed the damage repaired, then reseed the areas and replace the mulch cover.

TEMPORARY SEEDING

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: 801.06 Seeding and 918.14 Grass Seed

Standard Drawing: None

Description: Temporary seeding is the application of a short lived perennial or annual crop, as an interim erosion control measure. The primary characteristic of a temporary seeding crop is one that germinates rapidly so that other erosion prevention measures may not be needed during the establishment period because it establishes so fast. The cover crops usually consist of a seed mix that contains small grains such as winter wheat or oats or Foxtail (Italian) millet. The appropriate species planting seasons can be found in the Standard Specifications and in the plan notes. It is important to remember that when the crop dies at the end of its life cycle the roots and dead tops are still providing protection. To get optimum protection from the temporary vegetation it should be mowed leaving the residue on the surface. If the site is near an existing road or in a windy location the crop residue can be crimped to hold it in place.

Temporary seeding is used during the winter and summer when permanent seeding is not possible or in situations when rapid temporary cover is needed. Temporary crops are selected because they germinate and cover the surface quickly and also tend to be annual plants that will not reseed and inhibit the development of permanent grasses.

Figure: 5-54 Foxtail millet, left and annual ryegrass, right are staple temporary cover crop species used on the roadside

Applications:

- As slope surface ***erosion control*** on cut or fill slopes, inslopes, and stockpile areas.
- Often used when permanent seeding cannot be accomplished due to season.

Installation Considerations:

- Slope steepness for access for equipment, area size, and application method
- Drill Seeder - preferred method

- Hydraulic seeding may be used for hard to reach areas. Use of a tacking agent in the mix will give better adhesion and reduce blowing and down slope migration.
- No Till Drill
- Hand Seeding – small areas only

Figure: 5-55 Two other common cover crops used on the roadside include oats shown on the left and Sudangrass on the right.

Inspection and Maintenance:

- Inspect slopes for rill formation. If necessary, reseed and reapply mulch as necessary.
- Down stream sediment control backup should be sufficient to contain any anomalous storm event that may occur during establishment.

Common Problems:

- Uneven seed distribution or non uniform cover due to improper drill calibration
- Rill formation due to heavy rains prior to germination
- Seed migration due to wind or water

Corrective Actions:

- Reseed bare spots immediately
- If migration was apparent using a tacking agent on the reseeding mix will usually avoid a reoccurrence of failure.
- If severe rilling has taken place it may be necessary to repair the rills and use mulch, BFM or blanket when reseeding.

SIDE OR CURB INLET PROTECTION

Effectiveness	Varies with type
Longevity	Varies with type
Ease of Installation	Varies with type
Ease of Maintenance	Varies with type

TDOT Specification:

Standard Drawing: EC-STR-39 and EC-STR 39A

This is a non-proprietary device made of a length of perforated pipe filled with 1/2 inch rock and covered with a filter fabric. The pipe is placed across the curb inlet opening as shown.

The device is effective so long as the sediment is removed regularly and the filter fabric is replaced or cleaned as needed.

Figure: 5-56 Curb inlet filter pipeline non-proprietary)

Description: This sediment control is placed at the curb inlet storm drain to minimize the quantity of sediment from runoff entering the storm sewer system. There are many types of curb inlet BMPs. Many act by filtering the storm water and retaining the sediment. Others provide a dam that slows the velocity of the water and allows for sedimentation and the clearer water is then discharged into the storm water sewer system. BMPs for this type of protection include:

- Filter Socks
- Sand and Gravel Bags
- Gravel filled perforated pipe with filter fabric
- Triangular Silt Barrier
- Proprietary Devices

As noted there are numerous proprietary devices currently on the market that perform this function. Most of the products perform the basic function of diverting or capturing sediment laden water, preventing it from entering a curb inlet. Contractors are to utilize the devices that are specified on the Standard Drawings or on the TDOT QPL.

Applications:

As ***sediment control***

- Where active, unstabilized construction area drains to inlet
- As a secondary control where soil may be tracked onto roadway and consequently to storm drain
- Where temporary flooding or ponding of storm water will not create traffic management problems

This is a Type I curb inlet protection, it is composed of Concrete Masonry Units, wire mesh/hardware cloth and size 57 mineral aggregate (1″). This type of protector provides for over topping in anomalous events to pass excess runoff. This is an important feature where flooding of the driving lanes could be a problem.

Type 2 curb inlet protection is used only in low volume low traffic situations. The BMP is made of sand or gravel filled bags placed so that there is a spillway located at a 45degree angle to the curb. See EC-STR-39

Figure: 5-57 TDOT Type 1 Curb inlet protection BMP

Considerations:

- Effective for course sediment removal
- Relatively easy to install and inexpensive
- Not to be used where temporary flooding can cause damage
- Limited use in areas of high volume and high speed traffic that may damage the BMP
- Not very effective for fine sediment
- High maintenance
- Must be properly installed for safety and performance

Inspection and Maintenance:

- To verify operation check inside the drain structure where possible
- Accumulated sediment must be removed to avoid entering inlet and/or being tracked onto roadway
- Accumulated sediment must be removed to allow water to drain to inlet and not create flooding
- May require street sweeping to remove sediments that accumulate at the edge of the pavement

Common Problems:

- These structures are frequently overlooked in inspections if they are dry. Always be sure that the filter material used is not blocked so that no serious street flooding will occur.
- Flooding from a blocked curb inlet due to poor maintenance of filter materials
- Ineffective treatment usually due to anchoring of material
- Sediment left on pavement for further mobilization by traffic or transport to other drains
- Sediment discharged into the storm drain and not noticed during inspections, causing offsite discharges.

Corrective Actions:

- Replace filter material, remove blockage causing flooding or water backup.
- Remove sediment in street and from the storm drain when there is a visible accumulation

Type 3 and Type 4 are designed to completely cover the curb inlet and filter all incoming runoff. The construction details are shown on Standard Drawing EC-STR-39A.

These types of inlet are to be used only in conditions where ponding of runoff on the pavement does not pose a safety hazard to traffic.

Because these devices cover the entire inlet opening maintenance of the filter medium is essential.

Figure: 5-58 Type 3 inlet protection BMPs

- Be sure that material joints are secure and anchored properly. Overlap should be to the downstream side. Where light materials are used in socks such as compost it may be necessary to place heavy anchors over joints.
- The side inlet must be totally surrounded so that all water must pass through or over the protective measure.
- If construction site debris is in evidence check upstream to find the source. Correction may require emptying or replacing storage receptacles or other waste management actions.

Large amounts of sediment can be carried by a single rainfall event. Therefore inlet protection measures must be strong enough to resist heavy flows.

In this example, the sand bags placed to protect the inlet were allowed to deteriorate and then when a significant flow occurred the inlet was almost totally covered by sediment. You can see one remaining sand bag at the upper left side of the inlet.

Figure: 5-59 Sand bag dike washed away by heavy sediment flow

DROP INLET PROTECTION (Catch Basin Filter Assemblies)

Effectiveness	Varies with type
Longevity	Varies with type
Ease of Installation	Varies with type
Ease of Maintenance	Varies with type

TDOT Specification: 209.07 - Construction of Structures (c) Sediment Structures

Standard Drawing(s): EC-STR-19 and EC-STR-40 through EC-STR-51

Description: Drop inlet or Catch Basin inlet protection can be provided by assortment of BMPs. It generally consists of a sediment filter and/or an excavated area surrounding the inlet or upstream from the inlet. Inlet protection measures provide filtration or a temporary detention area to allow sedimentation. Where filtration is the primary means of providing protection careful maintenance of the filter media is essential.

This is a welded wire mesh and washed stone device used to prevent sediment from entering a catch basin. The gravel is placed against a welded wire barrier which is supported by metal posts. See Standard Drawing EC-STR-19.

The open top allows excess runoff flows to pass over the top of the gravel barrier. This type of protection is preferred when there is a chance that water could backup onto the driving lanes.

Figure: 5-60 TDOT Temporary rock catch basin protection

BMPs that may be used for this function include:

- Enhanced Silt Fence (EC-STR-19)
- Filter Socks
- Wattles
- Triangular Silt Barrier
- Sand And Gravel Bags
- Temporary Rock Catch Basin Protection (EC-STR-19)
- Catch Basin Filter Assembly (EC-STR-40to51)

Applications:

- Every internal storm drain inlet receiving sediment-laden water or with the potential to receive sediment-laden storm water. Any external storm drains that may potentially receive sediment from the site.

This is an example of a non-proprietary catch basin filter assembly of the type specified on Standard Drawing sheets EC-STR-41 through EC-STR-51. These are essentially rigid frames covered by a sewn filter fabric cover.

These filter assemblies are very effective in preventing sediment from entering the storm drainage system. However, they must be properly maintained to ensure that flow is maintained. because there is no provision for passing excess runoff in the event of a heavy storm.

Figure: 5-61 TDOT non-proprietary catch basin filter assembly,

Installation Considerations:

- Adequate area is necessary to provide for ponding without interfering with traffic or equipment movement.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden.
- If high flow conditions are expected, use other onsite sediment trapping techniques in conjunction with inlet protection.
- Only inlet protection devices shown in the TDOT Standard Drawings or listed on the TDOT QPL may be used.

Inspection and Maintenance

- Sediment must be removed from pipes and other drainage structures manually or with appropriate equipment. It may not be washed out with water.
- Requires frequent maintenance to remove sediment build up within stilling basin area. Sediment should be removed when depth reaches one-half the height of the BMP.
- May require backhoe, wheel borrow, shovel or other similar equipment for removing sediment buildup from BMP.
- Check for clogged filter medium.
- Structure should be inspected after rainfall events.

Common Problems:

- Drainage area is increased by construction causing failure of the device
- Sediment build up creates excessive ponding and flooding occurs.
- Failure of fabric
- Clogging of filter media
- Sediment is released into the drain and not found during inspections leading to an offsite discharge

Corrective Actions:

- Manually remove sedimets that overtop or bypass EPSC measure
- Remove sediment buildup and properly stabilize sediment on site
- Repair or replace filter fabric as needed
- Clean or replace clogged filter media
- If clogging appears to be caused by construction site debris, check upstream to identify the source. Correction may require emptying or replacing storage receptacles or other waste management actions.

Problem:

This is a silt fence enclosure without any wire reinforcing and the fabric has not been trenched in. Soil has simply been piled on the ends of the fabric. This enclosure will likely fail if any significant flow or ponding occurs.

This does not meet TDOT requirements.

Figure: 5-62 Fabric used for inlet protection should always be wire backed.

Problem

Maintenance of catch basin filter devices is essential to proper performance. The fabric on this filter device has been completely clogged by organic debris in the runoff. There is also a vinyl sign that has blown against on edge in the foreground of the picture.

If this condition is allowed to continue water could back up into the driving lanes and become a hazard.

Figure: 5-63 Catch basin filter device that has become silted in and will no longer drain

FLOATING TURBIDITY CURTAINS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing: EC-STR-38

Description: A floating turbidity curtain is a vertical barrier of geosynthetic fabric designed to deflect, separate, and contain sediment-laden water and allow for enough residence time so that soil particles fall out of suspension and do not migrate to other areas. This BMP is used to capture sediment mobilized in water and is not to be used as sediment control for sediments generated on land. Upslope and adjacent sediment controls are necessary to capture site generated sediment prior to entering water body. This curtain has a flotation device at the top and is anchored at the bottom.

Floating turbidity curtains are used to capture sedimets stirred up during activities in the adjacent water body. They are not a primary silt capture tool for sediments washed from a construction site.

Figure: 5-64 Floating turbidity curtain used to capture sediments in a water body.

Applications:

- Where construction disturbance is directly in a water body or stream below the high water mark
- When construction projects take place on or under water with out deterring the site

Installation Considerations:

- Depth of water, flow conditions and flow direction
- Potential for remobilization of disturbed sediments
- Are impacts to aquatic life less using this BMP rather than would be the case by dewatering the area?
- Location must be parallel to the direction of flow of a moving body of water.
- Because the curtains are weighted or anchored, care must be taken when water is high so that the curtain does not pull away from the anchor or become submerged

- Allow slack in anchoring system so that the curtain can rise and fall with water motion without submerging.
- Cannot be placed across the main flow of a significantly moving body of water.

Inspection and Maintenance

- Curtain should rise and fall with water while maintaining position and shape.
- If water remains cloudy it may be necessary to pump sediment laden water from the confined area.

Problem

Floating turbidity curtains such as the one shown are utilized only to capture sediment generated by work in the steam from being transported downstream.

In this picture an additional silt barrier device should be used between the stone riprap and the water.

Figure: 5-65 Floating turbidity curtains are used to trap sediment generated from in stream actions only.

Common Problems:

- Anchoring devices, i.e. chains attached to weights, are too short or too tight and do not allow curtain to rise and fall with water motions.
- Severe weather may dislodge floating device and allow turbid water release.
- Sediments are allowed to drain from areas above the high water mark.

The floating turbidity curtain will contain sediments generated by disturbances in the water. The picture shows sediment laden water being detained by the turbidity curtain.

The cause of the sediments shown here are from the installation of bridge piling being driven.

Figure: 5-66 Sediment being detained by a floating turbidity curtain.

Corrective Actions:

- If the curtain looses its shape it must be re-anchored. If it continues to break away from anchors more anchor points may be necessary
- If the curtain becomes submerged the anchor points must be readjusted to allow movement with water level
- If sediment is reaching the work are from the shore immediate action must be taken to contain the landside sediment on site.
- If water remains cloudy after 36 hours the water should be pumped from the work area to a filter bag or sediment trap on shore.

This picture shows the proper use of a floating turbidity curtain. The turbidity curtain is only used to trap sediments that are disturbed in the stream bed by the installation of piling and bents.

While it is difficult to see there is a silt fence just below the top of the slope in the foreground and on the far side there is a silt fence to the left side and there are sand bags along the shore line to trap other sediments before they reach the stream.

Figure: 5-67 This shows the installation of bridge pile and bents with a floating turbidity curtain separating the flow from the work area.

FLOATING SILT MATS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing:

Description: A floating mat of woven or non-woven geosynthetic fabric supported by a float system on both sides and across the fabric mat. Its primary use is to catch sediments that may be drained from a bridge maintenance project or sediments generated by heavy construction traffic.

A silt mat is similar to a turbidity curtain but its primary purpose is to collection debris and waste that might fall directly in the water. This most common applicaton is to collect sharp sands and paint generated from maintenance of pipes and bridges crossing streams.

The illustration to the left shows a pipe line being sandblasted prior to repainting.

Figure: 5-68 Floating silt mat used to catch debris or waste falling from above the water

Applications:

- It is placed under active construction to capture sediment and debris before it enters a waterway

Installation Considerations:

- Will effectively operate in high current areas where conventional hanging turbidity curtains fail.

Inspection and Maintenance:

- Remove accumulated sediment and debris

Common Problems:

- Lack of maintenance
- breaking loose from moorings

Corrective Actions:

- Sediment collected in the mat it should be brought ashore, collected. handled properly based on the materials. For example lead paint would have to be transported to a hazardous waste disposal site. Construction sediments can be placed onsite and stabilized to prevent remobilization.

GABIONS/GABION MATRESSES

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: None See Standard Drawings

Standard Drawings: EC-STR-55 through EC-STR-59

Description: Gabions are wire mesh baskets filled with a specific gradation and size of rock. These are used where greater structural strength is necessary to resist erosion caused by heavy concentrated flows. These types of flows are usually experienced at high volume, high velocity discharge points, channel bends and at channel narrows such as bridge crossings.

Gabions are essentially wire baskets filled with rock to create a variety of structures including:

- Walls
- Channel Protection
- Weirs
- Energy dissipation structures

Gabions must be designed by an engineer for the specific application and are generally used as permanent controls rather than for temporary structures.

Figure: 5-69 Example of gabions used as a retaining structure next to a channel

Applications:

- Surface protection at culvert outlets
- Surface protection in high flow channels
- Stream bank stabilization
- Checks in high velocity channels

Figure: 5-70 Examples of gabions used as hydraulic transition structures in high flow channels to prevent bed erosion

Installation Considerations:

- Shear stress
- Flow capacity and depth of flow desired
- Desired shape and slope of waterway
- Flexible, allowing settlement or frost movement without fracture
- Availability of proper stone
- Channel gradient
- Desirability of potential soil deposition, water infiltration and vegetative growth
- Requires engineering and equipment to install
- Gabions need to be designed by the engineer
- Heavy equipment, front end loader, etc., is necessary to install large quantities of rock and move heavy gabion baskets.

Inspection and Maintenance:

Little maintenance is required. Gabions can remain as permanent structures after construction phases are complete.

- Inspect regularly and after storm events.
- Inspect for undercutting and other signs of stability.
- Inspect wire baskets and mattresses for signs of degradation, rust and breakage.
- Repair or replace immediately to maintain engineered performance standards

Figure: 5-71 Examples of gabion and gabion mattresses as transition structures for culverts to prevent scour

Common Problems:

- Slumping of baskets
- Undesirable vegetation growth in gabions

Corrective Actions:

- If baskets slump after installation the baskets have shifted or there has been settling of the base material. The design engineer should be notified immediately to determine the potential for further failure and actions needed to affect repairs.
- Vegetation will often volunteer in gabions because they are porous and will allow vegetation to establish. Woody vegetation can damage the wire baskets if allowed to persist. Herbaceous materials will not likely cause damage but can become unsightly. Because gabions are used in frequent contact with water herbicide use should be limited in favor of mechanical removal of undesirable plant material.

SEDIMENT TRAPS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 209 Project Erosion and Siltation Control

Standard Drawing: EC-SRT-12, EC-STR-13, EC-STR-60 (Other fabric barriers and checks can be used as temporary sediment traps)

Description: A temporary BMP using natural depressions, dike, berm or excavated areas to trap sediment-laden runoff. Sediment traps are used to collect sediment from shallow concentrated flows and sheet flows from 1 acre or less. Traps are temporary settling ponds designed detain runoff for a period sufficient to allow settling of suspended solids. Sediment traps are not designed with controlled outlets structures like a sediment basins. Discharges are by means of overtopping the primary detention structure. Therefore protection from scour is needed at the top of trapping structure and at the downstream toe.

Sediment traps can be any structure created for the purpose of collecting runoff and detaining it to allow sediment to fall from suspension.

This photograph shows a simple excavation that was dug to collect wash water from a wheel washing operation. This type of excavation can also be used as an interim measure to trap any potential sediment release that might occur from a failing BMP upstream.

Figure: 5-72 Simple excavated sediment trap for wheel wash water

Applications:
This BMP is used for ***sediment control***.

- Place near perimeter of site or along a drainage way to aid in velocity control as well as for trapping sediment as in Figure: 5-72.
- As a supplemental measure to other BMPs such as silt fence

Installation Considerations:

- Traps can only serve limited drainage areas, generally less than 1 acre.
- Should only be used to supplement upstream erosion control
- Provide necessary safety signage and precautions to discourage entry into sediment trap area.
- Drainage area should not exceed 1 acre.

Inspection and Maintenance:

- Check for damage or leakage surrounding embankment and perimeter area.
- Ensure that excessive scour does not occur at entry and exit points of the sediment trap.
- Maintain vegetation

Common Problems:

- Lack of maintenance
- Excessive scour at the discharge point of the trap

Sediment traps are created in a variety of ways often by structures intended initially as flow controls. It is very important to remember that while the purpose may be flow or velocity control they will catch sediment and they do need to be maintained and cleaned like any other sediment trapping device. Notice that the wattles in the channel to the right have almost completely been covered by sediment.

Figure: 5-73 Examples of sediment trapping devices

Corrective Actions:

- Remove accumulated sediment when build up reaches a maximum of one-half the design depth and redistribute sediment to an area that is protected from erosion. The picture to the left in Figure: 5-74 shows a fabric trap that is significantly overloaded and about to fail.
- Remove accumulated litter and debris.
- Repair scour damage this may require the use of temporary channel liner or other temporary armoring material.

Problems

These are examples of sediment trapping structures that need maintenance. At the upper left the silt has built up behind the silt barrier to the top of the fabric. If there is another significant rainfall event this sediment and the silt fence will likely end up at the bottom of the slope or in adjacent waters. On the right sediment and trash have built up behind the rock check almost to the level of the top of the check. in this case another significant flow will likely remobilize the sediments and carry them down stream.

Figure: 5-74 Examples of maintenance problems with trapped sediment

SEDIMENT BASINS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 209 Project Erosion and Siltation Control

Standard Drawing: EC-SRT-15, EC-STR-16, EC-STR-17

Description: A temporary BMP usually constructed with an earthen dam and an outlet control device such as a trickle tube designed to provide a predetermined residence time. These are designed structures and are required by the CGP for drainage basins ten acres (4 ha) if possible. Sediment basins should also be designed with an emergency spill way to safely pass excess runoff. The outlet of the control structure must also be designed to prevent scour down stream.

Sediment basins are engineered structures designed to capture and treat runoff from a predetermined drainage basin. These are usually areas greater than 10 acres (4 ha). This photograph shows a sediment basin with the trickle tube control structure. Notice that the berm and the sides of the sediment basin have been seeded to prevent erosion of the slopes and the addition of sediments to the basin.

Figure: 5-75 Sediment basin showing the trickle tube control structure

Applications:
This BMP is used for ***sediment control***.

- Place near perimeter of site or along a drainage trapping sediment as in Figure: 5-75.
- Used as a primary sediment control device

Installation Considerations:

- Must have sufficient ROW for construction.
- Must be completely down stream of the catchment
- Provide necessary safety signage and precautions to discourage entry into sediment basin area.
- Drainage area are generally greater than ten acres (4 ha).

Inspection and Maintenance:

- Check for damage, leakage or scour of surrounding embankment, outlet structure and perimeter area.
- Maintain vegetation on slopes of the containment berms and dike

Common Problems:

- Lack of maintenance
- Excessive scour at the discharge point of the control structure

Corrective Actions:

- Remove accumulated sediment when build up reaches a maximum of one-half the design volume and redistribute sediment to an area that is protected from erosion.
- Remove accumulated litter and debris.
- Repair scour damage may require the use of temporary armoring material.

SILT FENCE

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 209-Project Erosion and Siltation Control, 209.02 (h) and 209.07 (h)

Standard Drawing: EC-STR-3A, EC-STR-3B, EC-STR-3C, EC-STR-3D, EC-STR-3E

Description: Silt fence consists of a temporary vertical barrier of geotextile fabric (filter fabric) attached to and supported by wood or steel posts. The bottom of the silt fence material must be entrenched into the ground. Silt fence may be enhanced by adding wire backing and other forms of support, see TDOT standard drawings. Silt fence is placed before earth disturbing activities have begun and left in place until vegetation is established. Exceptions are at those locations where it is impractical to do so because of interference with construction activities. Silt fence reduces the velocity of the runoff, retains the sediment-laden water and allows for sedimentation and discharge of less sediment-laden storm water. Silt fence provides minimal filtration unless continuously maintained.

Silt fence is easily the most used and abused of all the sediment control tools. It is often cited as erosion control and it is not, it is sediment control. It is frequently installed improperly. Very often it is misused or just over used as in the photograph to the left.

Silt fence is an effective sediment control tool but it must be properly installed and maintained.

Figure: 5-76 Silt fence is an effective tool but can be overdone as seen here. *Photographer: Pete Romocki, American Excelsior Company Photo provided by: International Erosion Control Association*

Applications:

- As a ***sediment control*** BMP
- Storm drain inlets
- Minor swales
- Along site perimeter
- Toe of slope
- Around stockpile areas
- Along stream banks and channels
- Used in conjunction with other sediment control devices

Installation Considerations:

- Place silt fence away from toe of slope to allow for sediment deposition.
- Do not use in high volume, high velocity flows.

Problem

This is a classic example of silt fence being improperly applied. The installation was incorrect because the fence did not extend up the slope so that storm water could not breach the ends of the barrier. You can see that the right side has been breached and that a significant scouring of the backslope has occurred.

Figure: 5-77 Example of improper appli-

- Design for use with sheet flows
- See TDOT Standard Drawings for special applications in concentrated flows
- Silt fence must be removed when site reaches final stabilization.
- Necessary equipment may include a trencher to entrench silt fence material. Vertical posts need to be anchored in place see TDOT Standard Drawings.
- Silt fence should be installed using silt fence slicing technology and equipment where possible

Inspection and Maintenance

- Check for proper installation
- Check for undermining of fabric
- Inspect silt fence for sediment build up.
- Check for damage to silt fence fabric
- Check for erosion along uphill face of fence

Installing silt fence with slicing technology has been demonstrated to be very effective in avoiding problems of having the fabric undermined.

The machine cuts a slit and installs the silt fence in slit. A second pass with a heavy machine can help get better compaction.

To complete the installation posts must be installed and the fabric attached to the posts. This must be done properly if the installation is to be effective.

Figure: 5-78 Silt fence being installed with slicing machine

Common Problems:

- Improperly installed in high velocity flows
- Not trenched in at the base allowing water to pass under fence
- Not placed on contour of slope allowing runoff to flow along uphill face of fence
- Neglected maintenance

- Silt fence placed too close to the bottom of slope which creates build up of sediment against the fabric.

Corrective Actions:

- Remove sediment build-up or muck out the silt fence when build-up reaches one-half the height of the silt fence.
- If silt fence is not parallel to the contour reinstall or place a hook on the down stream end.
- Intermittent checks may also be required depending on the length.

Problems

At the far left the fence has not been trenched in so it is just flapping in the breeze.

To the immediate left the silt fence is holding but barely. The sediment needs to be removed and the slope should be seeded and covered with an appropriate surface protection material.

Figure: 5-79 Typical examples of problems with silt fence

- If undermined retrench the material and compact. Replace any damaged fabric. See TDOT Standard Drawings for proper overlap of fabric.
- If silt fence fails be sure that the sediment released is collected and properly stabilized unless it was discharged into a water course.

This is an example of a well done and appropriate application of silt fence. The fabric is well trenched in and is well secured to the posts. Also note that it is placed on the contour at a reasonable distance from the base of the slope so that large amounts of water laden sediment will not collect against the silt fence in a storm event.

Figure: 5-80 Illustration of a properly applied and installed silt fence

Problems

At the far left the silt fence is too close to the toe of the slope and already beginning to bulge from sediment.

On the right, the end of the silt fence was breached causing scour that is undermining the concrete flume.

Figure: 5-81 Examples of common problems with silt fence usage

SEDIMENT FILTER BAGS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: Section 209.07-Construction of Structures (i) Temporary Sediment Filter Bags

Standard Drawing: EC-STR-2

Description: Filter bags are a made of geosynthetic fabric and are designed to filter sediments from water. Water is usually pumped into the bag from a pit or sediment trap. Flow must be carefully monitored to be sure that flow is maintained or the bag can be ruptured by pressure buildup.

Sediment filter bags are used in situations were there are very sensitive adjacent waters and there is not sufficient room to utilize sediment traps or basins effectively or safely.

Storm water is pumped into these bags which then filter the sediment out of suspension. The bags must be placed on a level, preferably permeable base to be effective.

Figure: 5-82 Sediment bags

Applications:

- Dewatering
- Removing sediment laden sludge and water from sediment traps
- Filters for temporary pipes or pipe culverts

Installation Considerations:

- Limited duration and capacity
- Easily damaged by traffic and equipment
- Equipment is necessary to prepare the bag site and to remove and replace filter bags.
- The sediment bag must be contained by the secondary measures placed around the bag in case of rupture. These secondary measures must always be in place during the use of the bag.

Inspection and Maintenance

- Check for damage to filter bags.
- Check for sediment buildup and clogging of the filter fabric

This is an example of a sediment bag being used near a sensitive stream. The bag is placed on a level gravel pad with a 60 ft. buffer between the pad and the stream. Silt fence has been used down stream to prevent any loss of sediment laden water to the stream.

The water leaching from the bag is collected in a grass swale and directed to the stream at a very minimum slope to prevent any new suspension of sediments.

Figure: 5-83 Example use of a sediment bag adjacent to a environmentally sensitive stream

Common Problems:

- Bags are subject to puncture damage by any sharp object
- Bags rupture

Corrective Actions:

- If a bag is punctured it may be repaired by placing a patch over the tear and stitching the fabric together. If a tear is not repairable then bag must be replaced.
- If bag ruptures sediment must be removed along with the failed materials. Secondary containment measures should be checked for damage and repaired prior to installation of another bag.

ROCK SILT SCREENS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drainage-STR-11

Rock silt screens such as the one shown are handy tools that can be used to filter sediments from concentrated flows in wet weather conveyances and at culvert entrances such as the one shown here.

Figure: 5-84 Rock silt screens are used for sediment control in heavy concentrated flows

Description: Temporary rock silt screens are used at pipe inlets to filter sediments from concentrated flow. They are composed of a riprap dike which is covered with a filter fabric and then covered with a mineral aggregate. The mineral aggregate holds the fabric in place and prevents larger material from clogging the fabric layer.

Applications:

- To protect the inlets of large storm drains and culverts
- Can be used in wet weather conveyances to filter anticipated high sediment loads

Installation Considerations:

- Riprap should be placed on a geotextile fabric.
- Must be of sufficient size to filter runoff volume so that adjacent areas swill not be flooded.

Inspection and Maintenance

- Inspect fence routinely to make sure that the filter material is not clogged. If water is standing behind the silt screen for more than 12 hours the filter is clogged
- Remove sediment when it reaches half the original height of the structure.

Common Problems:

- Filter material is clogged

- Mechanical damage to the structure
- Improper installation allows breaching of structure
- No fabric under riprap

Corrective Actions:

- Repair and or replace filter material and mineral aggregate as needed
- If the structure is breached repair the riprap, replace the fabric and recover with mineral aggregate. Be sure that the center of the berm is at least one foot lower than the edges
- If the structure sags be sure that there is geotextile fabric under the riprap. If there is none the structure should be rebuilt per the standard drawing.

TRIANGULAR SILT BARRIER

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing:

Description: There are two different types of triangular silt barrier available: a flexible fabric covered foam and a semi-rigid polyethylene and a foam core covered with fabric. Each of these products are currently covered by one or more patents and supplied by a single manufacturer. However, they are useful tools for sediment and velocity control on construction projects.

The permeable plastic berm is made of UV resistant high density polyethylene material formed into a triangular berm. It is attached to the surface using staples. For best performance the berm is anchored on top of an erosion control blanket or channel liner. Trenching is not required for installation of this material. The BMP can be easily removed for maintenance and can be reused. Semi-rigid material is porous and has a high flow through rate as compared to the foam and fabric type barrier.

The foam and fabric barrier consist of a triangular-shaped urethane foam core covered with a woven geotextile fabric with aprons that extend from both sides of the base. The aprons are entrenched at the upstream side and anchored to the ground using staples on the downstream end. This BMP can be used on surfaces that do not allow for trenching by securing the aprons with sand or gravel bags. The BMP can be easily removed for maintenance and can be reused. The foam is very supple and can resist light traffic.

This is an example of a product called Triangular Silt Dike®. It is a foam core covered with a woven synthetic filter fabric. These have been demonstrated to be effective for both flow control applications as well as trapping sediment in roadside swales and borrow ditches.

Notice the color of the water downstream compared to the up stream ponded area.

Figure: 5-85 This is a proprietary product called Triangular Silt Dike®

Applications:

Triangular silt barriers can be used for ***velocity control*** and ***sediment control***.

- Check dam
- Shorten slope length
- Velocity control

Installation Considerations:

- Triangular silt barriers can be placed on top of erosion control blanket or channel liners or on bare soils.
- Triangular silt barriers are light weight, easily installed and reusable.
- Ease of removal and replacement facilitates ease of maintenance

Inspection and Maintenance:

- Check for sediment build-up behind barrier
- Make sure that barrier is securely anchored.

Common Problems:

- Lack of maintenance for sediment removal
- Movement, deformation or separation of berm material

This is proprietary semi-rigid plastic material called GeoRidge®.This material is primarily a flow control device but can provide some sediment capture as well.

It does not have the geotextile cover so it must be installed on an erosion control blanket material as shown here.

Figure: 5-86 Semi-rigid plastic material called GeoRidge®

Corrective Actions:

- Have the contractor remove sediment buildup once it reaches half the height of the barrier.
- If separation or deformation of the barrier occurs check for mechanical damage to the material first. If no mechanical damage is present check for sufficient staples proper trenching and proper overlap of material at joints. If undermining has occurred move the barrier to a new location and reinstall it properly. Then repair the damage to the channel.

WATER FILLED BAGS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing:

Description: The reusable, vinyl-coated polyester bladders are laid in position and then filled with water. The weight of the filled bag keeps it in place with no trenching or staking and also helps it conform to the terrain. They are sometimes filled with an interior baffle to keep the bag from rolling. Threaded fittings are used to fill and drain the bags. These can be leased and are installed more quickly than a coffer dam for dewatering an area.

Water filled bags are a handy tool when working in very loose soil or areas where work is occurring right at the waters edge. These bags remain in place by gravity and maintain a reasonably dry work area. If necessary they can be used in conjunction with dewatering equipment.

Figure: 5-87 Water filled bags can be used when work comes right to the waters edge

Applications:

- Where an areas require dewatering
- As ***sediment control*** at perimeter of waterway

Installation Considerations:

- Must have adequate water source available to fill the bags
- Extreme weather can move bags
- Bags are very heavy when filled and cannot be relocated without draining the bag.
- Since bags will usually be placed in a water body an ARAP permit is needed.
- Inspection and Maintenance:
- Check for damage and leaks
- Replace or repair as necessary
- Be aware of any movement of the bags as this may indicate leaks.

Common Problems:

- Bags are heavy and have large footprint and therefore may not be suitable in areas with sensitive adjacent vegetation.
- Vegetation below the bag such as aquatic grasses will be damaged by bags footprint.

Corrective Actions:

- If bags begin to leak have them repaired the with appropriate patching material or replaced.
- If bags move due to heavy wave action it may be necessary to anchor them.

STREET SWEEPING

Effectiveness					
Longevity	N/A				
Ease of Installation	N/A				
Ease of Maintenance					

TDOT Specification:

Standard Drawing: N/A

Description: Street sweeping is often necessary where stabilized construction accesses prove inadequate. This is frequently the case in urban situations where it is difficult to limit access to the road due to right-of-way limitations or where sediments may deposited on the traveled lanes by spillage from trucks. Regardless of the sediment source, street sweeping may be required to keep the streets clean. Sediments tracked onto an adjacent public street is obvious and will quickly result in public complaints to TDEC.

It is important to remember that when sediment is tracked onto adjacent pavements street sweeping is an option for removing loose material.

It can also reduce the sediment likely to be caught in curb inlet traps. Keeping the pavement clean with regular sweeping, particularly in urban situations, will enhance the effec-

Figure: 5-88 Street sweeping can enhance the effectiveness of other sediment controls

Applications:

Street sweeping is a ***sediment control***.

- At access points to remove sediment accumulation on street

Installation Considerations:

- Sweeping may be ineffective if soil is wet or there are heavy accumulations of mud
- May require repeat cleanings

Inspection and Maintenance:

- Street condition should be checked regularly as part of the CGP inspection process.

Common Problems:

- Availability of equipment
- Sediments too heavy to be handled by sweeper

Corrective Actions:

- If street sweeping will not remove the sediments from the streets hand labor may be required or even street washing in severe cases.

STABILIZED CONSTRUCTION ACCESS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing: EC-STR-25 Temporary Road Stabilization and Temporary Culvert Crossing

Description:

Stabilized entrances are temporary sediment removal device installed at the approach from a construction site to a public roadway. This type of BMP is used to limit sediment tracking from vehicles and equipment leaving the construction site. Most construction exits are constructed of a layer Class A-3 Rip-Rap 12″ deep, see EC-STR-25. A layer of geosynthetic fabric is required under the rock to help keep the stone from pressing into the soil. Another form of exit is the cattle guard design, comprised of wooden timber or pipe laid across the exit. The cattle guard type exit provides greater longevity and more positive sediment removal. As may be required by the job site and the sensitivity of the adjacent road and water body the cattle guard is often used with wheel washing. When this is done wash water must be captured in a sediment basin and settled before it is discharged from the site.

Construction entrances such as this one are essential tools to prevent tracking of sediments from the construction site to the adjacent roadway. It is important that a fabric be used under the rock to keep it separated from the subsoil. Even so addition of rock may be necessary during rainy periods

Figure: 5-89 Typical coarse rock construction site entrance

Applications:

- As ***sediment control*** measure at all locations where construction vehicles leave the site. For linear projects locations should be phased with the order of work.
- At all locations where there is a risk of sediment being transported offsite by construction traffic

Installation Considerations:

- Size of stone used depend upon duration and anticipated traffic.
- Must be designed to accommodate vehicle length and turning radius if necessary.
- If these control measures do not adequately control sediment tracking onto paved surfaces, a tire wash station or similar type cleaning station needs to be added.

This is a cattle guard type construction entrance. It is constructed of railroad ties and crushed stone. The stone has an under drain of perforated pipe that carries water and suspended fines to a sediment trap. These types of construction entrances are sometimes more effective in heavy soils.

Figure: 5-90 Cattle guard type construction entrance made with railroad ties

Inspection and Maintenance

- Inspect exit for excessive sediment build up. Remove sediment and rebuild exit as necessary to retain effectiveness and prevent off-site tracking.
- Additional street cleaning may be required.

Common Problems:

- Lack of maintenance

Corrective Actions:

- If rock has been filled with sediment so that it will no longer remove the sediment from wheels and tracks the exit must be rebuilt. Simply adding rock does not always work but the contractor has the option.
- If a cattle guard type access is used remove the logs and/or grate, clear the sediment and reset the logs or grate.

Large quantities of sediment can be carried from a site on vehicle tires. This sediment can end up in unprotected drainage ways causing damage to adjacent waters. In extreme cases wheel washing may be necessary to prevent offsite tracking.

Figure: 5-91 Preventing sediment tracking is an important part of sediment control

COMPOST FILTER SOCKS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing: EC-STR-37

Description: Compost filter socks are a type of sediment control tube made of a synthetic fiber mesh casing filled with, compost, or other approved organic or recycled materials such as wood chips. Filter socks can be used as a substitute for silt fence. It is not necessary to trench in compost filter socks and depending on the fill material they are usually heavier than wattles, which can be an aid in stability. Compost filter socks are alternative to wattles.

This is a compost filter sock used as a flow control and filter in a roadside borrow ditch. Look closely at the color of the water behind the filter sock and the color of the water just down stream in front of the sock. It is much clearer.

Compost must be mixed with wood chips to maintain permeability.

Figure: 5-92 Compost filter sock used to control runoff flow in a grass swale

Applications:

- Perimeter protection,
- Mid slope and toe of slope for velocity control
- inlet protection.

Installation Considerations:

- Limited longevity, usually one year
- Composts can have high nutrient levels that may leach into the runoff
- Can be damaged by traffic and equipment
- If ruptured, can contribute to sediment load
- Not recommended in channels and ditches with heavy concentrated flows
- Equipment is necessary to fill, move and place socks.
- A pneumatic compost blower is needed to fill the casings
- If not blown-in-place equipment, such as front end loader, is required to lift and place filter sock
- Larger diameter socks should be used for higher volume flows as they have been shown to stay in place better due to the weight of saturated filler material.Inspection and Maintenance

- Filter sock should be placed above the high water mark of the channel to prevent breaching of ends
- Center of the sock placed in a channel must be lower than either edge
- Filter sock casings should be checked for damage or leakage of filler material.
- Filter socks must be filled tightly to assure effective performance.
- Check for sediment buildup behind socks.

Common Problems:

- Socks may be damaged during transport and installation
- Movement of the sock may occur due to heavy flows or scour on the downstream face.
- Stakes driven through the casing may damage the fabric
- Undermining of the sock

This is a close up of a compost filter sock. Notice that the mix contains a large amount of hardwood fiber as part of the mulch filler. Fine mulches from biosolids, or manure based composts are not acceptable filler for compost socks.

Figure: 5-93 Close up of compost mulch filled filter sock

Corrective Actions:

- Small tears in the casing material can be repaired with zip-ties as shown in the picture.
- If undermining of the sock occurs the sock should be moved a few feet down stream and keyed into the channel approximately 6 in. and restaked. Do not try to repair the undermined area in place.
- Stakes should be driven at an angle to the flow and on the down stream side of the sock not through the casing.
- If the ends of the sock are breached check to be sure that the sock was long enough to extend above the high water mark. If not replace with a longer sock. If the damage occurred due to an anomalous event, move the sock a few feet down slope, key it in to the bed and restake. Repair damage to the bank as needed.

Stakes should never be driven through the fabric of the filter sock. This photograph shows a filter sock with the stake in the proper place driven at a approximately a 30 degree angel to vertical

Also note the black stitching in the fabric. This was necessary to patch a hole created when the stake was improperly driven though the fabric netting.

Figure: 5-94 Compost filter sock showing staking

WATTLES or TUBES

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing:

Description: A wattle is a short lived synthetic net casing filled with biodegradable fibers such as straw, excelsior, or coir. Wattles are available in diameters of about 8 in to 20 in and in lengths of 16 ft. to 20 ft. Wattles are most often used to reduce the velocity of the runoff, but they also detain the sediment-laden water allowing for sedimentation filtration. Therefore they provide both flow control and sediment control.

Wattles are used primarily as a flow interruption device to slow the velocity of storm water runoff across slopes and in roadside ditches and swales.

As shown in this illustration they can significantly improve the performance of slope coverings by disrupting the sheet flow under the surface covering on long slopes.

They also function as a secondary sediment trap when used in borrow ditches and swales.

Figure: 5-95 Example of wattles used as a flow interruption device on slopes

Applications:

- Velocity control
  - Slopes – Top, mid and bottom
  - Channels
  - Ditches/swales
- Sediment control
  - Perimeter
  - Channels
  - Ditches/swales

Installation Considerations:

- Use will determine diameter size of wattle needed.
- Used to supplement surface protection erosion prevention measures on long slopes, particularly on non-cohesive fine sands and silts.
- The type of wattle depends on the longevity needed. Coir wattles are denser and last longer than excelsior or straw wattles. Actual service life is dependent on the climate of the region.

Inspection and Maintenance

- When used as velocity control, wattle should be wider than the channel to prevent undercutting of breaching of the ends.
  - Center of the dam must be lower than either edge
  - Provide stabilized outlet below the lowest wattle in the channel
  - Check for damage after storm events such as; separation of joints, under cutting, or excessive scour at the down stream edge of the wattle

Wattles are made of a variety of materials including coir, excelsior, and straw. The fiber net surrounding the roll may be synthetic material or a natural fiber as shown.

Wattles are available in diameters beginning at 8 in. up to 20 in. in diameter.

Figure: 5-96 Erosion wattles come in diameters of 8 in. to 20 in.

Common Problems:

- Undermining of the wattle when not properly staked.
- Installed without low point in center, narrower than channel and/or not high enough on sides. Result, water goes around the check dam and creates scour at edges.
- Not using large enough diameter wattle for the application and the wattle is ineffective
- When used at mid-slope, wattle is not placed on contour or perpendicular to slope and water bypasses BMP

When wattles are used as a flow interruption device in channels they need to extend up the slope for a distance sufficient to prevent breaching of the ends.

In roadside ditches such as the one at the left they should be used in conjunction with some type of channel lining until vegetation is established.

Figure: 5-97 Wattles used in a channel as flow interruption and velocity control

Corrective Actions:

- Remove sediment from behind dam when level reaches 1/2 height of wattle
- If the ends are breached repair the breach and extend the ends to at least a foot above the high water mark
- If the wattle is undermined remove the wattle and move it to a new location and trench it in properly. Depending on the age of the wattle it may not be possible to reuse the material
- If erosion is occurring on the uphill side of wattles placed on slopes it may be necessary to reinstall the wattles so they are parallel to the contour, or add small checks along the upstream side to slow the runoff running along the face of the wattle. A hook should be placed at the down stream end to trap any sediment mobilized from behind the wattle.

When wattles are used in a channel it is important to remember that they also serve as a sediment collection device.

In the illustration on the left the space behind the wattle has completely been filled by sediment. Because the sediment makes a smooth transition over the top of the wattle velocity is not significantly reduced and a scour hole has developed that will completely under mine the wattle in a few more events.

It is important that the sediment be removed regularly as it builds up behind any flow interruption device.

Figure: 5-98 Example of scour developing under wattle due to sediment buildup

CHECK DAM

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: 209.07 Construction of Structures (d) Check Dams

Standard Drawing: EC-STR-6

Check dams such as the one shown to the left are constructed of sharp crushed stone 4 in.-8 in. in diameter. The center of the dam is lower than the edges to prevent end breaching. Note that the dam in the picture is retaining water because the pore space between the rocks has been filled in with silt limiting the flow through the rock.

Figure: 5-99 Properly installed rock check dam

Description: Check dams are small dams constructed of appropriately sized rock. Check dams are constructed across a swale or drainage ditch, for the purpose of reducing the velocity of concentrated storm water flows to non-erosive velocities thereby reducing erosion. Check dams are used where steeper slopes or rocky soil conditions prevent the installation of other erosion or sediment control devices. Check dams may be temporary or permanent controls. Rock checks are elected for strength, performance, and longevity based upon site conditions. Rock check dams will tolerate higher velocity flows than other types of check such as wattles or filter socks.

Other BMPs serving this function include:

- Enhanced Silt Fence
- Filter Socks
- Wattles
- Triangular Silt Dike
- Sand And Gravel Bags
- Enhanced Silt Fence Check

Applications:

- In drainage ways, swales, ditches and channels to reduce velocity
- As a supplemental measure to other BMPs
- Capture sediment (secondary function)

Installation Considerations:

- Check dams, in effect, reduce the slope in drainage ways. This may lead to an overall reduction in the capacity of the drainage way. This capacity reduction will be considered in design so that the flows within the drainage way do not exceed volume capacities. However, if overflow is observed it may be necessary to reevaluate the design of the BMP and the channel.
- Should not be used in perennial streams or in channels.
- Equipment required may include tractor, front end loader or other equipment able to move and place rock

Inspection and Maintenance

- Check dam should of the specified rock size and be wider than channel to prevent undercutting
- Center of the dam must be lower than either edge
- Provide stabilized outlet below the lowest check
- Check for damage after storm event and re-build if necessary.
- Remove sediment from behind dam when level reaches 1/3 height of dam

Common Problems:

- Rock berm or any other BMP used as a ditch check, is installed without low point in center, narrower than channel and/or not high enough on sides, resulting in water going around the check dam and creating scour at the edges.

This check dam was installed with a level top and covered with chain link fabric in an effort to stabilize the rock. Trash and debris was allowed to accumulate behind the check. When a significant flow occurred the trash caught in the wire pulled the wire away from the rock and rock and sediment were all moved down stream. In addition the end of the check was also breached and the sediment from the scour hole can be seen clearly in the front of the photograph.

Figure: 5-100 This check dam failed due to trash buildup even though it had a chain link fabric covering the rock

Corrective Actions:

- If the ends of the check dam have been breached as shown in Figure: 5-100 the check dam must be rebuilt and extended. Do not rebuild in the same location as it will likely be undermined by another large event.
- If rock is lost from the top of the structure it can be replaced by new sharp rock of the same size as the dam. Do not use smaller or larger rock as it will not seat.
- Be sure all trash and debris is removed as this material may catch more trash and place undue stress on the check dam. Casing the rock check in wire fabric is not recommended.
- If damage is a continuing problem request design review for using multiple checks or replacement with a gabion check.

This check dam was installed with a level top and covered with chain link fabric in an effort to stabilize the rock. Trash and debris was allowed to accumulate behind the check.

When a significant flow occurred the trash caught in the wire pulled the wire away from the rock and rock and sediment were all moved down stream. In addition the end of the check was also breached and the sediment from the scour hole can be seen clearly in the front of the photograph.

Figure: 5-101 This check dam failed due to trash buildup even though it had a chain link fabric covering the rock

LEVEL SPREADER

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing:

Description: A level spreader converts concentrated flow to sheet flow, It consists of a depressed area that allows the concentrated flow to collect and is directed over a level berm and dispersed uniformly as sheet flow. Downstream flow should be over a well vegetated area to prevent scour and help remove any suspended material.

Level spreaders are flow control tools that convert concentrated flows to sheet flow. When runoff is gathered into a concentrated flow the ability of the water to erode and suspend sediments is increased. The deeper the flow and the steeper the slope the greater the potential damage.

Placing a simple barrier of stone or foam material on the contour, such as the one shown here, will convert the concentrated flow back to sheet flow, minimizing the potential damage.

Figure: 5-102 Level spreader

Applications:

- Where concentrated flows discharge within a vegetated area adjacent to receiving waters
- Where converting concentrated flow to sheet flow improves the effectiveness of another BMP

Installation Considerations:

- Must be installed correctly with 0% grade on the spreader lip to ensure a uniform distribution of flow; otherwise water will channelize below the structure and become a source of erosion.
- Flows may reconcentrate if receiving waters are more than 300 ft. below level spreader
- Most effective at slopes of 10:1 or flatter
- For use with relatively sediment-free runoff in areas where flow volumes are low.
- Use in area above stabilized vegetation, existing vegetation is preferred. Vegetation must be established prior to installation so application may be limited to growing season.
- Level spreader must be constructed to avoid sharp drops in elevation or hydraulic “jumps”
- If fill is used, it must be compacted prior to seeding
- Drainage area should be limited to 5 acres or less.

Inspection and Maintenance

- Inspect down stream for signs of concentrated flow
- Inspect grade of spreader to maintain even distribution
- If spreader if formed of rock, or soil, damage or apparent weakening should be repaired
- Check vegetation cover to be sure it is not being damaged or silted over

Common Problems:

- Spreader not constructed level and is therefore ineffective
- Scour at the toe of the spreader dike
- Downstream damage to vegetation or silting over of vegetation

Corrective Actions:

- Remove accumulated sediment, litter and debris to prevent resuspension
- Maintain the vegetation downstream of the spreader dike. This may include mowing or removal of heavy sediment deposits.

To be effective a level spreader must be set so that the top is perfectly level and be set into the ground so that the concentrated flow from the upstream side cannot undermine the structure. The elevation of the top of the level spreader must also be set above the elevation of the water surface of the concentrated flow.

Figure: 5-103 Installation of a level spreader

SAND AND GRAVEL BAGS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing:

Description: Sand or gravel bags are made from durable, weather resistant geotextile fabric. The fabric pores must be tight enough to retain the filler material. The bags usually measure about 24″ x 12″ x 6″. These bags do not provide filtration. They aid in sediment control by reducing the velocity of runoff, retaining the sediment-laden water and allowing for sedimentation and discharge of less sediment-laden storm water. Ends of bags must be tightly abutted and overlapped to direct flow away from bag joints. When used as check dam, in general, the maximum spacing between dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam. Dams must be constructed so there is a lower portion in the center of the dam to direct flow

.

Sand and gravel filled bags can be an effective tool in controlling concentrated flows in roadside borrow ditches and channels. They are sometimes more convenient than rock check dams because the bags can be more easily moved and replaced as needed to accommodate work.

If sand is used it should be inert clean sand and the bags must be in good condition. Be ware of synthetic materials that may be sensitive to ultraviolet light which can cause rapid deterioration of the bags.

Figure: 5-104 Sand bags used as a check dam in a roadside borrow ditch

Applications:

Sand and gravel bags can be used for velocity control, runoff management and sediment control.

Applications included:

- Storm drain inlets, sediment traps, diversion berms, in drainage ways, swales, ditches and channels
- On paved surfaces and paved channels

Installation Considerations:

- Short term duration and easily damaged by traffic and equipment
- If a bag ruptures, fill material can contribute to sediment load
- Relies on gravity for stability, bags can move in high concentrated flow conditions

Inspection and Maintenance

- Sand and gravel bag berms must be wider than the high water mark of the channel to prevent undercutting
- Center of the dam must be lower than either edge
- Check for damaged or torn bags
- Check for sediment buildup behind bags

Common Problems:

- Bags can rupture and contribute to sediment load.
- Mechanical damage to bag fabric

Corrective Actions:

- If ruptures occur remove sediment and replace damaged bags
- If the sand bags are undermined remove the barrier and replace downstream of the damaged location. Do not attempt to repair in place as undermining may reoccur.
- If ends are breached place new bags in the breach and extend the ends of the berm to a higher elevation. Repair bank damage as needed
- If there is a high quality water adjacent sand and gravel bags should be backed up with a fabric silt barrier.

Sand and gravel bags can be a handy tool in situations where there is a need to prevent sediments from entering a water body immediately adjacent to a construction site such as a river crossing.

Here a bridge is being replaced and the old bulkhead is being preserved. It would not be possible to drive stakes into the bulk head for wattles or silt fence and a rock check would not be practical so sand bags provide the ideal solution.

Figure: 5-105 Sand bags are handy when it is not possible to drive stakes into the ground

SURFACE ROUGHENING

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing: None

Description: A technique to create horizontal grooves, or depressions, which run parallel to the slope contours. These grooves will decrease runoff velocities, trap sediment, and increase water infiltration into the soil. Tracked machinery, or sheep's-foot rollers are driven up and down the slope (perpendicular to contours) to create the horizontal grooves and depressions.

Roughening is generally used as a supplement to overseeding or as an aid in holding a hydraulically applied material on steep slopes.

Slope roughening is a technique used to enhance the performance of slope coverings and minimize sediment loss during seeding and planting operations.

Roughening compacts the soil surface and provides ridges that collect and infiltrate water as it moves over the slope.

Roughening is a supplemental technique and not a primary EPSC tool to be used by itself.

Figure: 5-106 Slope roughening is a supplemental practice that helps reduce flow over slopes, holds seed in place and increases infiltration

Applications:

Slope roughening provides ***velocity control*** on slopes and supplements other flow and surface protection materials.

- Cut or fill slopes
- Topsoil stockpiles

Installation Considerations:

- Slope steepness
  - Moderate Slopes (3:1 to 2:1) can use the stair-step cut or groove cut. Each method is designed to capture sediment as it moves down slope. The grooves should be at least 3 inches deep and less than 16 inches apart.
  - Flat Slopes (3:1 or flatter) can use shallow grooves (less than 1 inch) that are

constructed parallel to the slope contour.

- Slope roughening difficult on 2:1 or steeper slopes.
- May increase time required to finish slopes.
- Ruts, grooves or depressions should be made approximately horizontal to the slope or parallel to the slope contours.
- Loose material collected at the ends of the tracked row or series should be removed and redistributed to a stabilized portion of the site or reworked onto the slope.
- Equipment may include tracking machinery such as a bulldozer, sheepsfoot roller or front end loader with implement s like disks or harrows to form the necessary grooves in the soil surface.

Inspection and Maintenance

- Inspect slopes for rill formation. If necessary, re-seed and mulch as necessary
- Be sure that the roughening groves are generally parallel to the contour.

Common Problems:

- Tracking in wrong direction as in Figure: 5-107
- Allowing runoff to overtop the slope

Corrective Actions:

- If slope is tracked in the wrong direction retrack to create groves parallel to the contour
- Roughening is a temporary measure that should be used in conjunction with some other erosion prevention method such as temporary seeding, bonded fiber matrix, or mulch.

Problem

This is an example where the track vehicle was run parallel to the contour creating groves that run up and down the slope. When this is done it will actually increase rilling regardless of seeding or surface cover.

If this occurs the slope should be regraded and the track vehicle run up and down the slope.

Figure: 5-107 Example of improper slope roughening

DIVERSIONS/INTERCEPTORS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification: None

Standard Drawing: EC-STR-27

Description: An interceptor ditch or swale is used to collect water above cut or fill slopes and divert it to the bottom of the grade so it does not create erosion on the slope. It prevents runoff from upslope entering disturbed areas by intercepting and diverting it to a stabilized outlet. These can also intercept sediment laden water and divert it to a sediment trapping device. Interceptor ditches are constructed at very flat slopes (0.005 to 0.02) and sized for a design storm of a selected return frequency and duration.

Diversions such as the one shown are often used to shorten the length of slope faces. Storm water is collected in the swale and then transitioned down slope in an improved channel.

In this case a temporary channel liner is being used to stabilize the swale until vegetation can become established.

Figure: 5-108 Interceptor swale used to shorten the slope and minimize runoff down the slope face

A diversion berm or dike is used much in the same manner as an interceptor swale. It is constructed to divert the flow away from a slope face or active construction area and into a stabilized outlet or sediment trap or sediment basin. Other BMPs that can be used to divert or intercept surface flows include: triangular silt dikes and sand bags.

Applications:

- Top of slope, mid-slope, toe of slope or any area that requires the diversion or interception of storm water to direct flow to a stabilized channel.
- As temporary channel to direct flow to a pipe slope drain
- To direct flows around a disturbed area
- To reduce slope length
- Perimeter of the construction site to prevent sediment-laden runoff from leaving the site
- To direct sediment-laden runoff to a sediment trapping device

Interceptor berms can be very effective in keeping storm runoff from leaving a construction site at the perimeter.

In this example there is sensitive habitat to the right of the picture and the site drains into this area. The interceptor berm was installed to intercept runoff and transfer it to a sediment basin near the upper left of the photograph.

Figure: 5-109 Example of an unreceptive berm used to divert runoff to a sediment basin.

Installation Considerations:

- Where feasible, the outlet end of the interceptor ditch should be directed away from the project and onto established vegetation, discharge should be in the existing direction of flow
- Outlets should be stabilized prior to construction of interceptor ditches.
- Interceptor channels must be lined with an appropriate channel liner or permanent vegetation.
- Equipment necessary may include back hoe, motor grader or similar type equipment for excavation and/or placing soil for berm.

Inspection and Maintenance

- Check for eroded areas within the ditch.
- Check discharge point(s) for scour

Common Problems:

- Storm water bypasses diversion or interceptor by overtopping
- Erosion at the discharge end of diversion
- Scour of channel bottom

Corrective Actions:

- If scour occurs in the channel be sure that liner is anchored properly. If vegetation was used as a lining it may be necessary to use a flexible channel liner to minimize scour
- If overtopping of berm occurs add additional height to down hill side of channel and recompact the berm.
- If excessive scour occurs at the end of the channel provide additional armoring to the discharge point. This may require additional grading and design to reduce energy.

TEMPORARY SLOPE DRAIN

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing: EC-STR-27

Description: A pipe slope drain is designed to convey water collected at the top of a slope to a suitable discharge point. Runoff is diverted by a berm or temporary channel into the pipe at the top of a slope. The pipe material may be any stable material capable of transporting the designed flows: flexible tubing, corrugated pipe, plastic pipe, etc. Mid-slope joints must be water tight to avoid erosion mid slope. Inlets and outlets must be anchored and aligned in the direction of flow of the receiving channel, and must be protected with velocity dissipation such as riprap.

Slope drains are used to intercept water from up slope and transition it into channels at the base of the slope. Appropriate protection must be provided at the discharge end of the pipe.

Notice the berm at the top of the slope to intercept the runoff and transition it to the pipe. At the base of the slope the pipe is turned so that it discharges in the direction of flow in the channel.

Figure: 5-110 Example of a temporary slope drain

Applications:

Used for ***Flow Control*** and as an enhancement to ***erosion prevention***

- On slopes before permanent storm water drainage structures have been installed
- Where diversion measures have been used to concentrate flows
- On any slope where concentrated runoff crossing the face of the slope may cause gullies, channel erosion, or saturation of slide-prone soils as shown in the picture.

Installation Considerations:

- Whether slope drain should be implemented as a temporary or permanent structure
- Structure should be designed to ensure that it will accommodate the appropriate design storm conditions.

Inspection and Maintenance

- Check the pipe for scour that may undermine the pipe

- Check joints for signs of leakage
- Check outlet for scour or erosion of channel bank.
- Check pipe to be sure it is anchored and does not move away from the channel

Common Problems:

- Water is not diverted into slope drain, bypasses inlet area and erodes face of slope.
- Joints leak and cause mid-slope erosion
- Outlet erodes due to lack of protection and energy dissipation or pipe movement

Corrective Actions:

- If failure is at the inlet, repair and reinforce the inlet area. This may require the use of flexible channel lining materials, additional soil and compaction or the use of rock.
- If joints leak the joints should be tightened or resealed depending on the material
- If pipe movement is noted place thrust blocks or other measures to anchor the pipe.
- If scour of the outlet occurs provide additional channel protection and consider additional energy dissipation options. This may require checking the original engineering design.

This shows a series of slope drains that discharge into a grass swale that has been vegetated. Rock checks are provided at each discharge point to prevent scour of the swale

Figure: 5-111 Series of slope drains that discharge to an improved roadside swale

VEGETATED BUFFER

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

Standard Drawing:

Description: Vegetated buffers are areas of either natural or established vegetation that are placed or preserved between active construction and receiving waters. Vegetation buffers reduce the velocity of storm water runoff, allow for soil infiltration and ground water recharge, and trap sediment as runoff moves across the buffer zone. Established grass is the most desirable buffer material.

Vegetated buffers provide a natural filter for removing sediments from storm water runoff. This illustration shows a vegetated strip between the riprap slope protection for a park road and the gabion bank protection along the stream channel. This is a designed buffer. The vegetation on the opposite side of the creek is a natural riparian buffer.

Figure: 5-112 Illustration of a natural riparian buffer and a constructed vegetated buffer

Applications:

- Vegetative buffer strips are used for ***sediment control, velocity control*** and ***runoff management***.
- Usually vegetation is preserved at the site perimeter or adjacent to a water body as in Figure: 5-112 and Figure: 5-113.
- The CGP requires buffers 60 ft. wide around streams. The existing vegetation must be left undisturbed in these areas in so far as practical and no activity can occur in the creek without an Aquatic Resource Alteration Permit (ARAP).

Installation Considerations:

- Slope steepness
- Design for sheet flow, not concentrated flow.
- Buffer areas should be clearly delineated by construction fence or some other acceptable marking system.
- Concentrated flows draining onto buffer strips should be converted to sheet flow prior to entering buffer. (Use level spreader)

- In general, if there is approximately 60 ft. of existing vegetation between a disturbed area and the drainage, additional sediment controls such as silt fence may not be needed unless very heavy sediment loads are anticipated.
- Vegetated buffers require established ground cover plant growth for effectiveness.
- Adequate area must be available. If ROW is limited other actions must be taken to protect the water body.

Inspection and Maintenance

- Inspect slopes for concentrated flows and rill formation, particularly steep stream banks.
- Inspect buffer for accumulations of litter and debris.
- Inspect for any heavy sediment buildup in the buffer. Heavy sedimentation can kill the vegetation and render the buffer useless.
- Check the delineation markers for the buffer and be sure they are in place and clear.

Corrective Actions:

- Use vegetation management techniques to maintain plant materials, i.e. proper mowing, prevent traffic encroachments; provide supplemental irrigation and fertilizer as may be needed to maintain a vigorous cover.
- If heavy sedimentation is found covering vegetation it must be removed. This generally requires hand labor.
- If heavy sediment is appearing routinely other measures such as silt fence may be needed in order to prevent damage to the vegetated buffer.

The CGP requires a vegetated buffer zone of at least 60 ft. be provided between streams and adjacent construction measured from the top of the bank. The buffer can be an average width along the entire corridor so long as the buffer is never less than 25 ft. at any point.

Figure: 5-113 CGP buffer requirements for construction sites adjacent to streams

WINTER MANAGEMENTNTDOT

Effectiveness	N/A
Longevity	
Ease of Installation	
Ease of Maintenance	

Specification: N/A

Standard Drawing: N/A

Description: Winter activities involve snow management, inspections and planning for spring thaw conditions. Snow management is the use of plowing, dozing or blowing snow to relocate it to an area off the traveled way or work areas of a construction site. In the case of highway construction sites, the stored snow should located on areas down stream of the exposed, unvegetated areas of the site. Melt water should be directed to a protected channel not over a disturbed area. Be alert for any other winter damage to BMPs that could lead to water quality problems when temperatures return above freezing.

Snow management, while minimum in most areas of the state, needs to be taken into account on projects at higher elevations. Snow that accumulates from plowing at the roadside often leads to high concentrated flows in roadside channels during periods of thaw. If these traverse a construction site it is important to have sufficient sediment and flow controls in place prior to the thaw period. This must be anticipated if a site is closed for the winter.

Figure: 5-114 Example of heavy flows that can be generated by snow melt

Applications:

- Projects that extend through the winter months or high elevation areas of the state where significant snow accumulations may occur.

Installation Considerations:

- Equipment access
- May have limited use where snow accumulations aren't significant
- Move snow to areas that are less environmentally sensitive and that would be affected by snow accumulation or heavy snow melts.
- Avoid snow accumulation near drainage areas or conveyance systems as to not block flow.
- Snow should be placed in a stabilized area of the site to reduce negative snow melt impacts.

Inspection and Maintenance:

- Move or remove snow as necessary to reduce impacts
- Check for build up of ice dams that might divert concentrated flows onto exposed areas.
- Check all other BMPs to be sure that show loads have not damaged them. Silt fences are particularly susceptible to snow damage.

Common Problems:

- Heavy snow buildups up stream of exposed work areas of a construction site. Melt water running over the exposed area can mobilize large amounts of sediment**.**
- Snow fence and fabric checks are often damaged by heavy snow and ice loads.
- Ice dams are created by compacted snow loads and can divert streams out of their channels.

Corrective Actions:

- Mechanically remove any heavy snow accumulations up stream of the exposed areas of the site.
- Be sure that streams and channels have sufficient capacity to handle rapid snow melt by removing any ice blockages.
- Replace and repair any silt barriers or fabric checks that may have been damaged by ice and snow.
- Check for any chemicals, deicing materials or other spills that may be mobilized during a thaw. Materials that can freeze will often damage their containers and leach into the soil or contaminate storm water.

A turbidity curtain remains in place during winter freeze. These kind of BMPs need to be checked carefully in the spring to be sure they are not damaged by ice and freeze conditions.

Other BMPs such as silt fence, check dams in swales, ditches, and construction entrances need to be checked for damage as well.

Figure: 5-115 All BMPs need to be checked for damage before reopening a construction site that may be shut down for winter.

BRANCHPACKING

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

TDOT Standard Plate:

Figure: 5-116 Branch Packing, (From NRCS Engineering Field Handbook)

Description: Use of live brush layers with wood staking and compacted backfill, to repair small, local failures such as slumps and holes in embankments or streambanks.

Applications:

- Effective method to repair holes in embankments or streambanks that range from 2.5 to 5 feet in height and depth.
- Reinforce the repaired area immediately.
- Inexpensive.

Installation Considerations:

- Steepness of embankment or streambank.
- Vegetation type.
- Soil type.
- Cutting diameter 0.5″-2″; cutting length 5′-12′
- Effective when cuttings are harvested and installed during dormant periods.
- Design for use with sheet flows not concentrated flows or open channel flows.
- Not effective in slump areas greater than 5 feet deep or 5 feet wide.
- ARAP permit would be required for work in a channel

Inspection and Maintenance

- Vitality of live cuttings. Scratch the cutting bark to ensure green tissue inside.

Common Problems:

- Cuttings do not maintain intimate contact with soils.
- Compaction is not sufficient.
- Insufficient number of wood stakes.

BRUSH MATTRESS

Effectiveness	■	■	■	■	
Longevity	■	■	■	■	■
Ease of Installation	■				
Ease of Maintenance	■	■	■	■	

TDOT Specification:

TDOT Standard Plate:

Description: Live cuttings installed perpendicular to the slope direction to form a mattress. Cut ends of live cuttings are keyed into the toe of the slope to provide protection at the flow line.

Figure: 5-117 Brush Mattress (From NRCS Engineering Field Handbook)

Applications:

- Provide immediate, low to medium strength protection on streambanks.
- Effective on streambanks with steepness less than 2:1.
- Captures sediment during floods.
- Rapidly restores riparian vegetation and streamside habitat.

Installation Considerations:

- Steepness of embankment or streambank
- Vegetation type
- Soil type

- Cutting diameter 0.5 in. -2 in.; cutting length 5 ft. - 12 ft.
- Toe protection
- Effective when cuttings are harvested and installed during dormant periods.
- Design for use with mild open channel flow conditions.
- ARAP permit would be required for work in a channel.

Inspection and Maintenance

- Vitality of live cuttings. Scratch the cutting bark to ensure green tissue inside.
- Toe area must be protected by rocks, rolled wattles or live fascines.
- Mattress must be covered by soil and compacted.

Common Problems:

- Cuttings do not maintain intimate contact with soils.
- Cut end of cuttings does not reach below constant water level.
- Cables that tie the mattress on streambanks are not properly secured.

BRUSH LAYERING

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

TDOT Standard Plate:

Description: Live cuttings installed into embankments or streambanks between layers of soil. The cuttings are installed in a crisscross or overlapping pattern to reinforce the soil. As roots establish a further stabilization is achieved.

Figure: 5-119 Brush Layering, (From NRCS Engineering Field Handbook)

Applications:.

- Live cuttings protruding beyond the face of the embankment or streambank increase the hydraulic roughness to reduce overland or stream flow.
- Layers of live cuttings filter sediment out of the surface runoff.
- Stabilize slopes to prevent from shallow sliding.
- Embankments or streambanks reinforced by the root-stem-soil structure of live cuttings.
- Effective on fill and cut slopes.

Installation Considerations:

- Steepness of embankment or streambank
- Vegetation type
- Soil type
- Cutting diameter 0.5 in. -2 in. cutting length 5′-12′
- Effective when cuttings are harvested and installed during dormant periods.
- Design for use with sheet flows not concentrated flows or open channel flows.
- ARAP permit would be required for work in a channel

Inspection and Maintenance

- Vitality of live cuttings. Scratch the cutting bark to ensure green tissue inside.
- Cutting number per linear foot: 10-12.

Common Problems:

- Cuttings do not maintain intimate contact with soils.
- Cuttings are not laid in crisscross directions.

COCONUT FIBER (COIR) WATTLES

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

TDOT Standard Plate:

Figure: 5-120 Coir wattles for toe protection

Description: Coconut husk fibers bound together with twine woven from coconut or other synthetic fibers to form a cylindrical structure. This BMP is installed at the toe of the slope, generally between the normal and high water flow line. This is a specialized application of coir wattles used for stream bank restoration and restabization.

Applications:

- Trap sediment that encourages plant growth within the fiber roll.
- Provide toe protection.
- Flexible; match well with existing curvature of streambank or shoreline.
- Produce a well-reinforced streambank with little site disturbance.
- Should be used in combination with other biotechnical techniques.

Installation Considerations:

- Steepness of embankment or streambank
- Best with other biotechnical methods
- ARAP permit would be required for work in a channel

Inspection and Maintenance

- Size of roll
- Anchoring method
- Matching contours
- Backfill on both sides of roll to encourage vegetation

Common Problems:

- Wattle is not matching contours.
- Wattle is not properly staked and anchored
- Wattle overlapped improperly

DORMANT POST PLANTING

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

TDOT Standard Plate:

Description: Live dormant posts planted along streambanks in a square or triangular pattern to form a living protective matrix..

Figure: 5-121 Dormant Post Planting (From NRCS Engineering Field Handbook Chapter 16)

Applications:

- Posts protruding out of streambanks can dissipate flow energy and trapping sediment.
- Enhance conditions for colonization of native species.
- Self-repairing, damaged posts can develop multiple stems.

Can be used in combination with other biotechnical techniques.

- Well suited to smaller, non-gravely streams where ice damage is not a problem.

Installation Considerations:

- Curvature of creek bends
- Stream velocity
- Cutting diameter 2.5″-5.5″; cutting length 6′-10′
- Not suitable where posts cannot reach water table.
- Design for use at outer side of creek bend
- ARAP permit would be required for work in a channel

Inspection and Maintenance

- Size of dormant post
- Depth of burial
- Interval between posts

Common Problems:

- Bottom end of post does not reach below water table.
- Distance between posts is more than specified.
- Cutting mortality.

JOINT PLANTING

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

TDOT Standard Plate:

Description: Rock riprap with live stakes tamped into joints or openings between rocks.

Figure: 5-122 Joint Planting (From NRCS Engineering Field Handbook Chapter 16)

Applications:

- Improve the strength of rock riprap alone.Enhance aesthetics of existing rock riprap.
- Provide better habitats than riprap alone.
- Provides immediate protection and is effective in reducing erosion on actively eroding banks

- **Installation Considerations**:
- Steepness and height of embankment or streambank
- Vegetation type
- Soil type
- Cutting diameter 1 in. -2 in. cutting length 1.5 ft. - 3 ft.
- Effective when cuttings are harvested and installed during dormant periods.
- Best for use with existing rock riprap that have openings between rocks for cutting installation.
- ARAP permit would be required for work in a channel

Inspection and Maintenance

- Vitality of live cuttings. Scratch the cutting bark to ensure green tissue inside.
- More than half of the cuttings shall be inserted into existing rock riprap.

Common Problems:

- Cuttings do not maintain intimate contact with soils.Less than half of the cutting is buried into soil.
- Cutting mortality.

VEGETATED GEOGRIDS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

TDOT Standard Plate:

Figure: 5-123 Vegetated GeoGrids (From NRCS Engineering Field Handbook Chapter 16)

Description: Brush layering incorporated with geogrids and natural or synthetic geotextiles wrapped around each soil lift between the layers of live cuttings.

Applications:

- High strength technique that stabilizes steep slopes up to 1:1.
- Applicable in restoring outside bends where erosion is a problem.
- Capture sediments at the toe of the streambank, which provides protection to the structure.
- Provide immediate stabilization after construction.

Installation Considerations:

- Steepness and height of embankment or streambank
- Tensile strength of geogrids
- Vegetation type and soil type
- Cutting diameter 0.5 in. - 2 in.; cutting length 5 ft. -12 ft.
- Effective when cuttings are harvested and installed during dormant periods.
- Design for use with sheet flows not concentrated flows or open channel flows.
- Labor intensive; can be complex and expensive.
- ARAP permit would be required for work in a channel

Inspection and Maintenance

- Vitality of live cuttings. Scratch the cutting bark to ensure green tissue inside.
- Backfill on installed layers to ensure sufficient soil contact with live cuttings.

Common Problems:

- Cuttings do not maintain intimate contact with soils.
- Geotextile inside of geogrids to protect fine fills is punctured due to careless handling.

LIVE CRIBWALLS

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

TDOT Standard Plate:

Description: Box-like interlocking structure of untreated log or timber members with live cuttings installed in between structural members. Structure is also filled with suitable soils that allow live cuttings to root inside the crib structure and extend into the slope

Applications:

- Suitable for outside bends of streams where high strength is needed.
- Appropriate at the base of a slope as a toe protection.
- Effective where a steep slope face is needed and a more vertical structure is required.
- Maintains a natural appearance and provides aquatic habitats.
- Provides immediate protection from erosion, while established vegetation provides long-term stability.
- Fit odd shape of streambanks well.

Figure: 5-124 Live crib wall (From NRCS Engineering Field Handbook Chapter 16)

installation Considerations:.

- Steepness and height of embankment or streambank
- Vegetation type
- Soil type
- Cutting diameter 0.5 in -2 in. cutting length 5 ft - 12 ft.
- Effective when cuttings are harvested and installed during dormant periods.
- Design for use with sheet flows not concentrated flows or open channel flows.
- Has to be battered if the system is built on a smooth, evenly sloped surface.
- Labor intensive; can be complex and expensive.
- ARAP permit would be required for work in a channel

Inspection and Maintenance

- Vitality of live cuttings. Scratch the cutting bark to ensure green tissue inside.
- Backfill into the cribs and compact soils to ensure sufficient soil contact.

Common Problems:

- Cuttings do not maintain intimate contact with soils.
- Crib's structural members are not secured as specified.
- Backfills are not compacted.

LIVE FASCINES

Effectiveness					
Longevity					
Ease of Installation					
Ease of Maintenance					

TDOT Specification:

TDOT Standard Plate:

Description: Live woody cuttings tied together in linear cylindrical bundles. These are installed on gentle slopes or streambanks and in shallow trenches that normally match contours.

Figure: 5-125 Live fascine (Southeast Michigan Resource Conservation & Development Council)

Applications:

- Terrace and step-like structures break up continuous slope length and slow down sheet flow.
- Protect slopes from shallow slope failures (1 to 2 ft. in depth).
- Suitable for gentle slopes (less than 3:1).
- Require less site disturbance if installed properly.
- Other soil stabilization techniques such as live staking, post planting and rolled erosion control products can be easily applied together.

Installation Considerations:

- Steepness of embankment or streambank
- Vegetation type and soil type
- Cutting diameter 0.5 in.-2 on.; cutting length 5 ft. -12 ft.
- Effective when cuttings are harvested and installed during dormant periods.
- Design for use with sheet flows not concentrated flows or open channel flows.
- ARAP permit would be required for work in a channel

Inspection and Maintenance

- Vitality of live cuttings. Scratch the cutting bark to ensure green tissue inside.
- Backfill on installed fascines to ensure sufficient soil contact.
- Fascines must be secured in the trenches.

Common Problems:

- Cuttings do not maintain intimate contact with soils.

7 Construction Site Compliance Measures Compliance Measures

7 - 1. Comprehensive Inspections TDOT Self-Monitoring Program

This section reviews the measures that are required to maintain compliance with the environmental related permits on construction projects with a particular emphasis on the CGP. TDOT has a comprehensive self-monitoring program to ensure compliance with the provisions of the TDEC, CGP and other environmentally related permits that impact highway construction projects.

7 - 1.1 Regular Inspections

Designated TDOT project inspectors will conduct inspections of all EPSC and other environmentally related facilities as required by the CGP. Inspections will be recorded on TDOT approved form and filed with the SWPPP and EPSC documents for the project.

Regular inspections are the primary tool for ensuring compliance with the provisions of the CGP. Designated TDOT inspectors, trained in the CGP requirements and field management EPSC measures are responsible for conducting these inspections and maintaining complete records.

QA oversight will be provided by the TDOT Environmental Compliance Officers who will also be responsible for conducting EPSC training.

Figure: 7-1 Inspections required by the CGP will be conducted by designated TDOT personnel

7 - 1.2 Quality Assurance Inspections

TDOT has developed a comprehensive self monitoring program as part of the Statewide Storm Water Management Program (SSWMP). This program includes the inspections required by TDEC in the CGP and a QA program to ensure uniform compliance statewide. The frequency of QA inspections is to be based on several criteria such as the size of the project, adjacency to or discharge into high quality or 303(d) listed waters, and other evaluation criteria that may be developed and refined as the SSWMP is implemented. TDOT Environmental Compliance Officers will conduct QA inspections of all construction sites in their designated regions. These inspections will be made to see that all measures for compliance are being followed and that the project is in full compliance.

If deficiencies are found the TDOT Environmental Compliance Officer and project inspector will meet with the prime contractor and discuss measures needed to correct the noted deficiencies. These actions will be noted on the QA inspection report forms. The prime contractor, TDOT site inspector and Environmental Compliance Officer will all sign off on the QA report.

When non-compliance issues are found in the QA inspections, a follow-up inspection will be made within seven days to ensure that all corrections have been made as required. If the issues have not been corrected, the Environmental Compliance Officer may order suspension of work on the project until the necessary corrections have been made. Notices of action taken will be forwarded to TDEC for further action.

The objective of TDOT's Self-Monitoring Programs is to see that the all construction projects remain in full compliance with the provision of the CGP and other environmentally related permits. TDOT is not responsible for regulatory actions or assessing penalties for violation of the CGP. These action are the sole responsibility of TDEC.

7 - 2. Inspections and Actions

TDEC is the designated regulatory agency for storm water quality permits and enforcement in Tennessee. They are responsible for ensuring compliance with all state and federal statutes related to the waters of the state. This section discusses these responsibilities and actions that may be taken by TDEC.

7 - 2.1 Informal Inspections

TDEC personnel may from time to time conduct "windshield" or "drive-by" inspections of construction projects. These are informal inspections and will usually not result in any specific action. If some small problems are noted, it may result in an informal letter to TDOT indicating that there was a problem observed and the date indicating that some action should be taken.

If a serious violation is noted the TDEC representative may enter the site and contact the prime contractor or onsite TDOT representative to report the problem. At that time they may elect to conduct a more detailed inspection including a review of the SWPPP and other documents to see that they are up-to-date. At this time they may issue a Notice of Violation (NOV) for any deficiencies found.

7 - 2.2 Formal Inspections

TDEC and or EPA may conduct a formal inspection of a construction site and the SWPPP documents at anytime. In general, formal inspections will be announced formally in writing giving the date and time of the inspection. While it is not necessary to announce an inspection (as in the case of the informal inspection above) it is usually done as a courtesy. During a formal inspection the reviewers will check all SWPPP documents for currency, the chronology of the inspection process and all of the onsite EPSC measures to be sure they are working and conform to the EPSC plans.

They will also review other issues related to housekeeping to ensure that work areas are secure and there are no evidence of spills. All storage and waste facilities will be reviewed to be sure they are in compliance with the CGP.

Any violations found during this inspection will result in the issuance of a NOV. After an NOV has been issued, the department has 30 days to respond to the issues in the citation. The response cannot argue the NOV; it may only correct potential oversights. For example, the chronology of inspections may not be continuous since the beginning of the project because several forms were misfiled. This is a mistake and can be corrected. However, a citation for a failed BMP that released sediment into an adjacent land area cannot be argued.

7 - 2.3 Public Complaints

TDEC must respond to any complaints from the general public. They may at their discretion, visit the site and conduct an unannounced inspection or they may issue an NOV based on the information received. TDOT must respond to these actions as they would for any other regulatory action.

7 - 3. Penalties for Violations

There are two types of penalties that can be assessed by TDEC, for violations of the provisions of the CGP criminal and civil.

7 - 3.1 Civil penalties

Civil penalties are those actions that involve oversights, or unintentional, first time, violations of the rules. Actions that could result in civil penalties would include violations of the GP or Clean Water Act, such as

- Failure to complete a filing requirement
- Failure to allow or perform an entry, inspection, monitoring or reporting requirement
- Or violations of a final determination or order of the board, panel or commissioner; or violations of any other provision of the CGP or any rule or regulation promulgated by the TDEC board

Violations of this sort are subject to a civil penalty of up to $10,000 per day for each day that the act or omission continues or occurs.

7 - 3.2 Criminal penalties

Criminal penalties are assessed against individuals or entities that have a record of violations and/or it can be demonstrated that, in committing the violation, there was significant economic gain. A person who unlawfully pollutes waters of the State or violates, neglects or refuses to comply with provisions of the CGP commits a Class C misdemeanor. Each day such a violation occurs is punishable by a fine of $25,000 for each day that the violation exists and up to one year in prison, or both.

Any person who willfully and knowingly falsies any records, information, plans, specifications or other data required by TDEC or who willfully and knowingly pollutes the waters of the state, or willfully fails, neglects or refuses to comply with any of the provisions of the CGP, commits a Class E felony which is punishable by a fine of $25,000, and up to two years in prison, or both. Reference: Penalties that Apply to Violation of Various Water Quality Acts in Tennessee/Citizen Suits, Water Quality Control Act of 1977 [Tennessee Code Annotated, ' 69-3-101 et seq.]

7 - 4. Certification Compliance of Personnel

7 - 4.1 Certification of TDOT personnel

For all TDOT employees engaged in design or the day-to-day construction activities, the prime contractor and designated representatives must have successfully completed the prescribed course of training Erosion Prevention and Sediment Control (EPSC) for TDOT Projects. Certification must be maintained by completing any additional training requirements or testing that may be adopted by TDOT.

7 - 4.2 Certification of prime contractor personnel

The prime contractor's project superintendent and other onsite supervisory personnel are required to be certified by successfully completing the EPSC training required by TDOT for contractor certification. A responsible certified person designated by the prime contractor will be available on site during active construction that initiates or continues disturbance. The supervisory function of the prime contractor is not transferable to subcontractors.

7 - 4.3 Certification compliance of subcontractors

Sub-contractors are considered designated representatives of the general conductor. If subcontractors are engaged in soil disturbing activities or other activities that impact the EPSC measures of the site, they must also have a designated supervisor onsite that is certified in EPSC measures as prescribed by TDOT for construction sites. This is in addition to the requirement for the prime contractor to have a certified supervisor on site.

7 - 5. Incentives and Disincentives

7 - 5.1 Enforcement roles

7 - 5.1.1 The project supervisor and Environmental Compliance Officer

The TDOT project supervisor has the primary responsibility of enforcing the storm water pollution prevention requirements of the contract together with the Environmental Compliance Officer for the region and the TDOT designated project inspector. The responsibilities of the project supervisor begin before the start of construction. Careful study and analysis of the project plans and specifications, visit(s) to the jobsite, and reviewing project requirements with the Environmental Compliance Officer and TDOT design team make it much easier to enforce EPSC requirements during construction of the project. Additional responsibilities include:

Prior to start of construction:

- Perform a baseline inspection of the construction site documenting with pictures and notes all outfall areas and any EPSC issues (both on and offsite) that may be needed as historical data for future EPSC inspections.
- Designate appropriate regional staff as EPSC inspectors to assist in preventing storm water pollution.
- Ensure that the proper forms have been filed with TDEC for the project; this includes:
  - Waste and borrow areas
  - Single purpose batching plants
  - Any other offsite facilities that will be used to service the project
- Verify that the NOC has been received.
- Schedule the Environmental Pre-construction conference. Examples of some of the items that should be covered in the pre-construction conference are:
  - SWPPP submittal and acceptance dates
  - Maximum disturbed soil area allowed
  - Housekeeping
  - Offsite sediment tracking
  - Secondary containment of hazardous materials
- Inform the prime contractor of the responsibility to confirm that subcontractors are also certified per TDOT requirements and will abide by the SWPPP requirements of the contract
- Review the enforcement procedures that will be used to if the project is deemed to be out of compliance with TDOT and TDEC permit requirements
- Approve the SWPPP. The SWPPP must be thoroughly reviewed and corrections made prior to the start of any soil disturbing activity. Examples include:.
  - Review offsite waste and borrow sites, batch plants or storage facilities that service the project for compliance.
  - The phasing plans are provided and will meet the maximum 50 acre disturbance rule.
  - Noting any BMP changes on the EPSC plans

During construction:

Ensure that the prime contractor deploys BMPs when and where they are required. The SWPPP states when and where the BMPs are required. The EPSC inspections conducted by the contractor, project supervisor or designated TDOT inspector should document when and where BMPs are not implemented as required.

- Oversee designated TDOT site inspections. The project supervisor is responsible for ensuring that the inspector(s) for the project is performing required SWPPP inspections on the site per the CGP and the EPSC inspection reports are in the project files.
- Ensure that the contractor maintains BMPs as required. BMPs that are damaged by weather, construction activities, or vandalism must be repaired or replaced within the required maintenance time frame. For example, sediment build up behind silt fences, fiber rolls, check

dams, and in sediment traps and sediment basins must be removed when they reach one-half of their capacity. Stabilized construction entrances must have accumulated sediment removed when they are no longer effective at removing sediment from vehicles.

- Ensure the contractor submits an annual certification of compliance as specified. Sign, date, and file this certification in the project records.
- Ensure that the contractor complies with the provisions that restrict the size of the contractor's active disturbed soil areas.
- Meet with personnel from regulatory agencies, such as the USEPA, TDEC and the TDOT QA Team to discuss storm water issues and measures.
- Identify changes to the plans or project schedule that require amendments to the SWPPP. Review and approve amendments, and ensure that they are properly inserted in the SWPPP. Amendments to the SWPPP are required when there is a change in construction operations, contractor's work schedule, or field conditions which may affect the discharge of pollutants, and when any condition of TDOT's Permits are violated.
- Inform the contractor of SWPPP nonconformance, Notice(s) of Violation(s) (NOVs), and other regulatory enforcement actions and maintain written documentation of communications with contractor and regulatory agencies.
- If nonconformance occurs, take appropriate contractual sanctions against the prime contractor based on the nature and severity of the situation. Sanctions are outlined in "Contract Enforcement Procedures."

Before Project Acceptance:

- As required by the contract, determine that all slopes are stabilized.
- Require the contractor to remove temporary BMPs such as silt fences or other measures that are not a part of permanent erosion control or that the regional maintenance unit has not requested to be left in place.
- Conduct a final walk-through of the project area with the Project Supervisor and QA team within the region.
- Upon meeting final soil stabilization requirements, file the NOT.

7 - 5.1.2 Environmental Compliance Officers and Inspectors

These staff members are the TDOT's first line of defense on the construction site. Completing SWPPP inspections and timely reporting to the project supervisor of missing, improperly implemented, or inadequately maintained BMPs are the responsibility of the designated TDOT project inspector. It is critical that these personnel are well trained in proper BMP installation and are familiar with the SWPPP contract special provisions. They also are assigned the responsibility to:

- Review and become familiar with the SWPPP, storm water specifications, and EPSC plans
- Conduct the site storm water inspections
- Record all storm water management activities, or inactivity and conversations with the contractor regarding storm water pollution prevention. Record site visits from regulatory agencies such as TDEC or USEPA, and any inspection the agencies perform
- Monitor the weather reports of the National Weather Service for rainfall predictions. If rainfall is predicted, direct the contractor to deploy appropriate BMPs as identified by the SWPPP and EPSC plans
- Inform the project supervisor and/or the Environmental Compliance Officer immediately of any problems with BMPs during the implementation of the SWPPP and EPSC plans and any observed discharges
- Identify changes in construction that may require amendments to the SWPPP and notify the Environmental Compliance Officer and project supervisor of these findings
- For sites covered by permits, confirm site access and the safety of representatives of regulatory agencies and local agencies when they are onsite for any reason.
- Monitor and document any non-TDOT construction projects adjacent to the TDOT projects to ensure that those projects do not create discharges that could overburden or adversely impact TDOT's EPSC measures or could violate any provisions of the CGP.

7 - 5.1.3 Environmental Compliance Officer

- Review and recommend corrections to the SWPPP and EPSC plans prior to the project supervisor providing written approval

- Present TDOT's storm water contract enforcement procedures with the contractor during the pre-construction meeting
- Provide assistance inspections on a regular basis
- Assist project supervisor with preparation of reports, and with written responses to regulatory agency actions.
- Ensure that field construction personnel are appropriately trained.
- Lead the QA team

7 - 5.1.4 Department's QA Team

- Work with Environmental Compliance Officer to perform compliance inspections and review project files, for inspection reports and compliance of working SWPPP documents and EPSC plans.
- Assist in preparation of timely inspection reports
- Recommend actions or methods that would bring any nonconformance into compliance.
- Report to Regional Environmental Division and TDEC all compliance ratings.
- Assist in developing and maintaining QA criteria for project and contractor reveiw.

7 - 5.2 Contract Enforcement Procedures

If nonconformance occurs, the TDOT project supervisor must take appropriate contractual sanctions against the contractor based on the nature and severity of the situation. The Standard Specification and the Contract Special Provisions provide several levels of sanction that may be enforced on a progressive basis to attain conformance. Serious discharges or an imminent threat of discharge on a project may require an immediate escalation to a higher level of enforcement.

7 - 5.2.1 Methods of Discovery of Nonconformance

Evidence of nonconformance may come from one of several sources as follows:

- Site assessment (visual) – Some nonconformance issues are obvious and can be noticed without specifically inspecting for them. These nonconformance issues may be easily noticed as the Inspector is driving through the job site on the way to the office or when inspecting other activities. Such nonconformance could include wind erosion, tracking onto local streets, poor housekeeping, location of concrete washouts, and BMP installations.
- Monitoring – Nonconformance may be discovered through regular inspections or routine monitoring. This could include the daily diary entries, and inspections as required by the CGP.
- Prime contractor's failure to comply with administrative requirements, such as failure to respond to inspection reports, or failure to implement necessary SWPPP or EPSC amendments.
- Complaints from the public – Complaints may come directly to TDOT or by means of the Public Information Office. If complaints from the public are not investigated and responded to immediately, they often result in complaints being filed with TDEC. TDEC is mandated to follow up on all public complaints and may follow up with a site inspection, or it can initiate an enforcement action.
- Discharges (observed or reported) – Discharges of sediment or other pollutants from the project site due to the failure or lack of a BMP may be observed by TDOT staff or reported by a local municipality, regulatory agency, environmental group, or the general public. Discharges must be reported to the Environmental Compliance Officer verbally within 24 hours.

7 - 5.2.2 Contractual Enforcement

The CGP requires that TDOT be responsible for storm water pollution control on TDOT Right-of-Way. Contract documents (e.g., Standard Specifications, Contract Special Provisions, Plans, etc.) make the contractor responsible for implementation of storm water pollution control practices on their project. The TDOT project supervisor and Environmental Compliance Officer should use a progressive contract enforcement policy and be ready to escalate action immediately when a contractor fails to respond in a timely manner.

If the prime contractor or TDOT representative identifies a deficiency in the implementation of the approved SWPPP, EPSC plans or amendments to them, and the deficiency is not corrected immediately or by a date required by the provisions of the CGP, the project is in nonconformance with the CGP provisions. A verbal notification should be given and a notice of warning (NOW) should be sent to the

prime contractor stating the nonconformance and outlining the possible penalties, or contract enforcement actions, that may be taken. For more serious nonconformance, immediate contract sanctions may be necessary. If nonconformance continues, actions should be escalated until conformance is achieved.

7 - 5.2.3 Payment for EPSC Measures

EPSC controls are to be compensated for by paying each item as work is performed. Sufficient multipliers should be employed in the bid quantities to allow for field additions, adjustments and replacements as the work progresses. When a cost breakdown for the EPSC measures has been submitted and approved, the prime contractor should be paid according to actual work completed under that cost breakdown. Payment for EPSC measures according to the cost breakdown encourages timely installation of BMPs because it more fairly compensates the prime contractor in a month in which they implement a large number of BMPs, such as the month preceding the start of construction in a designated area when EPSC measures are installed. It allows for no payment for EPSC measures during a month when no EPSC work is completed.

7 - 5.2.3.1 Retention of Monthly Progress Estimate Payment

The first level of penalty to the prime contractor for nonconformance with the requirements of the CGP is the retention of a portion of the monthly progress pay estimate per Standard Specifications Subsection 109.06.

The withheld funds under Subsection 109.06,is for the contractor's failure to implement proper construction quality such as water pollution control on the project. This is in addition to other amounts recovered by the contract, and must be released for payment on the next monthly estimate for partial payment following the date when approved water pollution control measures have been implemented and maintained, and when water pollution has been adequately controlled as determined by the project supervisor.

7 - 5.2.3.2 Discharge of Subcontractor or Worker

If a subcontractor or a worker on a project shows a disregard for storm water pollution prevention requirements or does not have sufficient training to perform the work in a manner consistent with the approved SWPPP and EPSC plans the project supervisor may direct that individual or subcontractor to be removed from the project per Standard Specifications 108.04.

7 - 5.2.3.3 Temporary Suspension of Work

If immediate action is required due to the imminent threat of discharge or regulatory action, and the prime contractor does not respond to written notification of deficiency in a timely manner, the project supervisor or his appointed representative shall suspend work on the project per Standard Specifications Subsections 105.01 and 107.08.

A letter ordering the suspension of work must include references to applicable subsections of the specifications and, if possible, state the conditions under which work may be resumed. The project supervisor or designated representative may choose to suspend only the work that is contributing to or causing contract nonconformance. If the prime contractor continues to fail to take adequate action, the project supervisor or designated representative can subsequently suspend all work. When all work on the project is suspended, the only work that can be done on the project is EPSC and traffic control related work.

Continued failure to comply will be considered in the removal of the prime contractor from the TDOT pre qualified prime contractors list.

7 - 5.2.3.4 Retention of Progress Payment for Fines and Penalties

When regulatory enforcement actions propose assessing or levying fines due to the prime contractor's violation of the CGP or other related storm water quality permits, the SWPPP and EPSC plans, or Federal or State law, the project supervisor may retain funds from the monthly progress payment up to the total amount of the fines. For retention under this provision, the project supervisor must first give the prime contractor written notice of means and method, prior to withholding the funds per Standard Specifications Subsection 107.01

7 - 5.2.3.5 Administrative Deduction

Deductions (as opposed to retentions) are those amounts deducted from the contract for specific purposes. The project supervisor must identify, initiate, and control all deductions. As soon as a final determination is made as to the amount of a liquidated damage due to the prime contractor's violation of the CGP or related storm water permits, the SWPPP, EPSC plans, or Federal or State law, regulations or requirements, that amount will be deducted from the payment due to the prime contractor.

7 - 5.2.3.6 Termination of Control

If, after the withholding of progress payments and suspension of work, a prime contractor does not respond to the direction of the project supervisor to comply with EPSC requirements the project supervisor may mobilize another prime contractor or TDOT maintenance personnel to complete the work.

7 - 5.2.3.7 Termination of Contract

The Standard Specifications specify the contractual requirements for termination when the Department determines, that it is in the Department's best interest not to continue with a project per Standard Specifications Subsection 108.08.

Glossary

Glossary

A

Active Construction Area. The area where the contractor intends to be actively involved in soil disturbing work during the ensuing 15 day period during the winter season. This may include areas where soils have been disturbed, as well as areas where soil disturbance has not yet occurred.

Apron. A lining of the bed of the channel upstream or downstream from a lined or restricted waterway. A floor or lining of concrete, rock, etc., to protect a surface from erosion, such as the pavement below chutes, spillways, at the toes of dams, or along the toe of bank protection.

Aquifer. Water-bearing geologic formations that permit the movement of ground water.

ARAP. Aquatic Resource Alteration Permit

Armor. Artificial surfacing of bed, banks, shore or embankment to resist erosion or scour.

Articulated. Made flexible by hinging, particularly of small rigid slabs adapted to revetment.

B

Backfill. Earth used to fill a trench or excavation.

Backwater. An unnaturally high stage in stream caused by obstruction or confinement of flow, as by a dam, a bridge, or a levee. Its measure is the excess of unnatural over natural stage, not the difference in stage upstream and downstream from its cause.

Baffle. A pier, vane, sill, fence, wall, or mound built on the bed of a stream to parry, deflect, check, or disturb the flow, or to float on the surface to deflect or dampen cross currents or waves.

Bank. The lateral boundary of a stream-confining water flow. The bank on the left side of a channel looking downstream is called the left bank, etc.

Bank Protection. Revetment or other armor protecting a stream bank from erosion, includes devices used to deflect the forces of erosion away from the bank.

Base Flow. The groundwater flow contribution to a creek. During dry periods, base flow constitutes the majority of stream flow.

Basin. (1) The surface of the area tributary to a stream or lake. (2) Space above or below ground capable of retaining or detaining water or debris.

Bed. The earth below any body of water, limited laterally by bank or shore.

Bed Load. Sediment that moves by rolling, sliding, or skipping along the bed, and is essentially in contact with the stream bed.

Bedding. The foundation under a drainage structure.

Berm. (1) A bench or terrace between two slopes. (2) A nearly horizontal part of the beach or backshore formed at the high water line by waves depositing material. Some beaches have no berms, other have one or several.

Best Management Practice (BMP). (1)A measure that is implemented to protect water quality

and reduce the potential for pollution associated with storm water runoff. (2) Any program, technology, process, silting criteria, operating method, measure, or device that controls, prevents, removes, or reduces pollution.

Bonded Fiber Matrix (BFM), A bonded fiber matrix is a hydraulically applied mix of elongated cellulose fibers bound together by a water-resistant tackifing agent. It is completely biodegradable with a functional life of one growing season.

Bulkhead. A steep or vertical structure placed on a bank, bluff, or embankment to retain or prevent sliding of the land and protect the inland area against damage.

Bulking. The increase in volume of flow due to air entrainment, debris, bedload, or sediment in suspension.

C

Capacity. The effective carrying ability of a drainage structure. Generally measured in cubic feet per second (M^3/sec)

Catch Basin. A drainage structure which collects water. May be either a structure where water enters \through a grating.

CGP, Construction General Permit

Channel. The space above the bed, and between banks, occupied by a stream, borrow ditch, swale or other wet weather conveyance.

Channelization. The process of making a channel or channels.

Check. A sill or weir of any material placed in a channel to control stage or velocity.

Check Dam. A small dam generally placed in steep ditches for the purpose of reducing the velocity in the ditch, swale not classified a stream.

Clean Water Act (CWA). The Federal Water Pollution Control Act enacted in 1972 by Public Law 92-500 and amended by the Water Quality Act of 1987. The Clean Water Act prohibits the discharge of pollutants to Waters of the United States unless said discharge is in accordance with an NPDES permit. The 1987 amendments include guidelines for regulating municipal, industrial, and construction storm water discharges under the NPDES program.

Cleanout. An access opening to a roadway drainage system. Usually consists of a manhole shaft, a special chamber or opening into a shallow culvert or drain.

Cobble. Rock, smaller than a boulder and larger than gravel; arbitrarily 0.5 to 12 kg, or 75 to 200 mm in diameter.

Coefficient of Runoff. Percentage of gross rainfall, which appears as runoff.

Concentrated Flow. Flowing water that has been accumulated into a single, fairly narrow stream.

Concentration. In addition to its general sense, means the unnatural collection or convergence of waters so as to discharge in a narrower width, and at greater depth or velocity.

Conduit. Any pipe, arch, box or drain tile through which water is conveyed.

Constriction. An obstruction narrowing a waterway.

Construction Activity. Includes clearing, grading, or excavation and contractor activities that result in soil disturbance.

Construction Site. The area involved in a construction project as a whole.

Conveyance. (1) A measure of the water carrying capacity of a stream or channel. (2) Any natural or man-made channel or conduit in which concentrated water flows.

Creek. A small stream, usually perennial

Crib. An open-frame structure loaded with earth or stone ballast to act as a baffle in bank protection.

Culvert. A closed conduit, other than a bridge, which allows water to pass under a highway. A culvert has a span of less than 6.1 m, or if multispan, the individual spans are 3.0 m or less.

Cutoff Wall. A wall at the end of a drainage structure, the top of which is an integral part of the drainage structure. This wall is usually buried, and its function is to prevent undermining of the drainage structure if the natural material at the outlet of the structure is scoured by the water discharging from the end of the structure. Cutoff walls are sometimes used at the upstream end of a structure when there is a possibility of erosion at this point.

D

Debris. Any material including floating woody materials and other trash, suspended sediment, or bed load moved by a flowing stream.

Debris Barrier. A deflector placed at the entrance of a culvert upstream, which tends to deflect heavy floating debris or boulders away from the culvert entrance during high-velocity flow.

Debris Basin. Any area upstream from a drainage structure utilized for the purpose of retaining debris, in order to prevent clogging of drainage structures downstream.

Debris Rack. A straight barrier that, when placed across the stream channel, tends to separate light and medium floating debris from stream flow and prevent the debris from reaching the culvert entrance.

Degradation. General and progressive lowering of the longitudinal profile of a channel by erosion.

Denuded. Land stripped of vegetation.

Deposit. An earth mass of particles settled or stranded from moving water or wind.

Design Discharge. The quantity of flow that is expected at a certain point as a result of a design storm. Usually expressed as a rate of flow in cubic meters per second.

Design Frequency. The recurrence interval for hydrologic events used for design purposes. As an example, a design frequency of 50 years means a storm of a magnitude that would be expected to recur on the average of every 50 years (See Probability of Exceedance).

Design Storm. That particular storm which contributes runoff which the drainage facilities were designed to handle. This storm is selected for design on the basis of its probability of exceedance or average recurrence interval (See Probability of Exceedance).

Detention. The process of temporarily collecting and holding back storm water for later release to receiving waters.

Detention Storage. Surface water moving over the land is in detention storage. Surface water allowed to temporarily accumulate in ponds, basins, reservoirs or other types of holding facility and which is ultimately returned to a watercourse or other drainage system as runoff, is in detention storage (See Retention Storage).

Dike. (1) Usually an earthen bank alongside and parallel with a river or open channel to restrict overflow (See Levee). (2) An asphalt, concrete berm along the edge of a shoulder.

Dike, Toe. Embankment constructed to prevent lateral flow from scouring the corner of the downstream side of an abutment embankment. Sometimes referred to as training dikes.

Discharge. A volume of water flowing out of a drainage structure or facility. Measured in cubic meters per second.

Dissipate. Expend or scatter harmlessly, as of energy of moving water.

Disturbed Areas. Areas that have been purposefully cleared, grubbed, excavated, or graded by the contractor; ground surface that has been disrupted by construction activities, including construction access/roads, staging, and storage sites producing significant areas of exposed soil and soil piles.

Ditch. Small artificial channel, usually unlined.

Diversion. (1) The change in character, location, direction, or quantity of flow of a natural drainage course (a deflection of flood water is not a diversion). (2) Draft of water from one channel to another. (3) Interception of runoff by works which discharge it through unnatural channels.

Drain. Conduit intercepting and discharging surplus ground or surface water.

Drainage. (1) The process of removing surplus ground or surface water by artificial means. (2) The system by which the waters of an area are removed. (3) The area from which waters are drained; a drainage basin.

Drainage Area (Drainage Basin) (Basin). That portion of the earth's surface upon which falling precipitation flows to a given location.

Drainage Course. Any path along which water flows when acted upon by gravitational forces.

Drainage Divide. The rim of a drainage basin. A series of high points from which water flows in two directions, to the basin and away from the basin.

Drainage Easement (See Easement).

Drainage System. Usually a system of underground conduits and collector structures which flow to a single point of discharge.

Drawdown. The difference in elevation between the water surface elevation at a constriction in a stream or conduit and the elevation that would exist if the constriction were absent. Drawdown also occurs at changes from mild to steep channel slopes and weirs or vertical spillways.

Dry Weather Flows. A small amount of water which flows almost continually due to lawn watering, irrigation or springs.

Dune. A sand wave of approximately triangular cross section (in a vertical plane in the direction of flow) formed by moving water or wind, with gentle upstream slope and steep downstream slope and deposition on the downstream slope.

E

Easement. Right to use the land of others.

Encroachment. Extending beyond the original or customary limits, such as by occupancy of the river and/or flood plain by earth fill embankment.

Endwall. A wall placed at the end of a culvert. It may serve three purposes: 1) to hold the embankment away from the pipe and prevent sloughing into the pipe outlet channel, 2) to provide a wall which will prevent erosion of the roadway fill, and 3) to prevent flotation of the pipe.

Energy. Potential or kinetic, the latter being expressed in the same unit (meters) as the former.

Energy Dissipater. A structure for the purpose of slowing the flow of water and reducing the erosive forces present in any rapidly flowing body of water.

Energy Head. The elevation of the hydraulic grade line at any section plus the velocity head of the mean velocity of the water in that section.

Entrance. The upstream approach transition to a constricted waterway.

Environmental Protection Agency (EPA). Government agency that issued the regulations to control pollutants in storm water runoff discharges (Clean Water Act and NPDES permit requirements).

Ephemeral. Of brief duration, as the flow of a stream in an arid region

EPSC. Erosion Prevention and Sediment Control

Erosion. The wearing away of natural (earth) and unnatural (embankment, slope protection, structure, etc.) surfaces by the action of external forces. In the case of drainage terminology, this term generally refers to the wearing away of the earth's surface by flowing water. It can also refer to the wear on a structural surface by flowing water and the material carried therein.

Erosion Control. Vegetation, such as grasses and wildflowers, and other materials, such as straw, fiber, stabilizing emulsion, protective blankets, etc., placed to stabilize areas disturbed by grading operations, reduce loss of soil due to the action of water or wind, and prevent water pollution.

Excavation. The process of removing earth, stone, or other materials.

Existing Vegetation. Any vegetated area that has not already been cleared and grubbed.

F

Filter Fabric (RSP fabric)**.** An engineering fabric (geotextile) placed between the backfill and supporting or underlying soil through which water will pass and soil particles are retained.

Filter Layer. A layer of even-graded rock between rock riprap and underlying soil to prevent extrusion of the soil through the riprap.

Filter Sock. A fabric tube filled with wood chips, compost or some other filter medium, used to filter sediment from storm water or to reduce velocity of flow in channels and slopes.

Filter Strip. A strip of vegetation left between exposed soil and a ditch or other receiving water for the express purpose of trapping sediment.

Flocculants. Substances (chemical additives) that cause solids suspended in storm water to aggregate into a mass and settle out of suspension.

Flood Plane. The position occupied by the water surface of a stream during a particular flood. Also,

loosely, the elevation of the water surface at various points along the stream during a particular flood.

Flood Stage. The elevation at which overflow of the natural banks of a stream begins to cause damage in the reach in which the elevation is measured.

Flood Waters. Former stream waters which have escaped from a watercourse (and its overflow channel) and flow or stand over adjoining lands. They remain as such until they disappear from the surface by infiltration, evaporation, or return to a natural watercourse. They do not become surface waters by mingling with such waters or stream waters by eroding a temporary channel.

Floodplain. Normally dry land areas subject to periodic temporary inundation by stream flow or tidal overflow. Land formed by deposition of sediment by water; alluvial land.

Flow. A term used to define the movement of water, silt, sand, etc.; discharge; total quantity carried by a stream.

Flow Line. A term used to describe the line connecting the low points in a watercourse.

Free Outlet. A condition under which water discharges with no interference such as a pipe discharging into open air.

Free Water. Water which can move through the soil by force of gravity.

Freeboard. (1) The vertical distance between the level of the water surface usually corresponding to the design flow and a point of interest such as a bridge beam, levee top or specific location on the roadway grade. (2) The distance between the normal operating level and the top of the sides of an open conduit; the crest of a dam, etc., designed to allow for wave action, floating debris, or any other condition or emergency, without overtopping the structure.

French Drain. A trench loosely backfilled with stones, the largest stones being placed in the bottom, with the size of stones decreasing towards the top. The interstices between the stones serve as a passageway for water.

Friction. Energy-dissipating conflict among turbulent water particles disturbed by irregularities of channel surface.

G

Gabion. A wire basket or cage filled with stone and placed as, or as part of, a bank-protection structure.

Gauging Station. A location on a stream where measurements of stage or discharge are customarily made. The location includes a reach of channel through which the flow is uniform, a control downstream from this reach, and usually a small building to house the recording instruments.

Construction General Permit. A general permit for storm water discharges associated with construction activity issued by TDEC as part of the NPDES storm water regulations required by the Clean Water Act.

Grade. Elevation of the surface of the earth can be a designated point or the bed or invert of a channel.

Gradient (Slope). The rate of ascent or descent expressed as a percent or as a decimal as determined by the ratio of the change in elevation to the length.

Gravel. Rock larger than sand and smaller than cobble, arbitrarily ranging in diameter from 5 to 50 mm.

Groin. A fingerlike barrier structure usually built perpendicular to the shoreline or oblique to primary motion of water, to trap littoral drift, retard erosion of the shore, or to control movement of bed material.

Ground Water. That water which is present under the earth's surface. Ground water is situated below the surface of the land, irrespective of its source and transient status. Subterranean streams are flows of ground waters parallel to and adjoining stream waters, and usually determined to be integral parts of the visible streams.

Grouted. Bonded together with an inlay or overlay of mortar.

Gully. Diminutive of gulch. A well-defined and sharply cut, erosional channel with a cross sectional area greater than 16 sq.in.

H

High Water. Maximum flood stage of a stream or lake; periodic crest stage of tide. Historic HW is stage recorded or otherwise known.

Hydraulic. Pertaining to water in motion and the mechanics of the motion.

Hydric. Characterized by, relating to or requiring an abundance of moisture. Also refers to soils that are formed in wet conditions.

Hydrologic. Pertaining to the cyclic phenomena of waters of the earth; successively as precipitation, runoff, storage and evaporation, and quantitatively as to distribution and concentration.

Hydrology. The science of the occurrence and movement of water upon and beneath the land areas of the earth. Overlaps and includes portions of other sciences such as meteorology and geology. The particular branch of Hydrology that a design engineer is generally interested in is surface runoff that is the result of excessive precipitation.

Hydrophyte. A perennial vascular aquatic plant having its over-wintering buds under water; a plant growing in water or in soil too waterlogged for most plants to survive. These are plants found in wetlands.

Hydrostatic. Pertaining to pressure by and within water due to gravitation acting through depth.

Hyetograph. Graphical representation of rainfall depth plotted in units of time, e.g. depth of precipitation in a five minute period.

I

Impervious. A surface that cannot be easily infiltrated; for instance, rain does not readily penetrate or infiltrate asphalt or concrete surfaces.

Infiltration. The passage of water through the soil surface into the ground.

Inlet. An entrance into a ditch, storm drain, or other water conveyance system.

Inundate. To cover with a flood.

Invert. The bottom of a drainage facility along which the lowest flows would pass.

J

Jacking Operations. A means of constructing a pipeline under a highway without open excavation. A cutting edge is placed on the first section of pipe and the pipe is forced ahead by hydraulic jacks. As the leading edge pushes ahead, the material inside the pipe is dug out and transported outside the pipe for disposal.

Jetty. An elongated, artificial obstruction projecting into a stream or the sea from bank or shore to control shoaling and scour by deflection of strength of currents and waves.

L

Lake. A water filled basin with restricted or no outlet. Includes reservoirs, tidal ponds and playas.

Laminar Flow. That type of flow in which each particle moves in a direction parallel to every other particle and in which the head loss is approximately proportional to the velocity (as opposed to turbulent flow).

Lateral. In a drainage system, a drainage conduit transporting water from inlet points to the main drain trunk line.

Level Spreader. A device used to transform concentrated flows to uniform sheet flow

Levee. An embankment to prevent inundation, usually on or along the bank of a stream or lake to protect outer lowlands(See Dike).

Lining. Protective cover of the perimeter of a channel.

Littoral. Pertaining to or along the shore, particularly to describe currents, deposits, and drift.

Loading. The total amount of material entering a system from all sources.

Local Depression. A low area in the pavement or in the gutter established for the special purpose of collecting surface waters on a street and directing these waters into a drainage inlet.

M

Marginal. Within a borderland area; more general and extensive than riparian.

Marsh. An area of soft, wet, or periodically submerged land, generally treeless and usually characterized by grasses and other low vegetation.

Mean Depth. For a stream at any stage, the wetted normal section divided by the surface width. Hydraulic mean depth.

Meander. In connection with streams, a winding channel usually in an erodible, alluvial valley. A reverse or S-shaped curve or series of curves formed by erosion of the concave bank, especially at the downstream end, characterized by curved flow and alternating shoals and bank erosions. Meandering is a stage in the migratory movement of the channel, as a whole, down the valley.

Mesh. Woven wire or other filaments used alone as revetment, or as retainer or container of masses of gravel or cobble.

Mulch. A natural or artificial layer of plant residue or other material that covers the land surface and conserves moisture, holds soil in place, aids in establishing vegetation, and reduces temperature fluctuations.

N

National Pollutant Discharge Elimination System (NPDES). The EPA program to control the discharge of pollutants to waters of the United States. NPDES is a part of the federal CWA, which requires point and nonpoint source dischargers to obtain permits. These permits are referred to as NPDES permits.

Navigable Waters. Those stream waters lawfully declared or actually used as such. Navigable Waters of the United States are those determined by the Corps of Engineers or the U.S. Coast Guard to be so used in interstate or international commerce. Other streams have been held as navigable by courts under the common law that navigability in fact is navigability in law.

Nonactive Construction Area. Any area not considered to be an active construction area. Typically, active construction areas become nonactive construction areas whenever construction activities are expected to be discontinued for a period of 20 or more days during the winter season.

Nonpoint Sources (NPS). Diffuse sources from which contaminants originate to accumulate in surface water or groundwater. These sources can add to a cumulative problem with serious health or environmental consequences.

Normal Depth. The depth at which flow is steady and hydraulic characteristics are uniform.

Normal Water Surface (Natural Water Surface). The free surface associated with flow in natural streams.

Notice of Intent (NOI). A formal notice to the TDEC that a construction project is seeking coverage under The Construction General Permit is about to begin. The NOI provides information on the owner, location, and type of project, and certifies that the permittee will comply with conditions of the construction General Permit. The NOI is *not* a permit application and no approval is required.

Notice of Termination (NOT). A formal notice to TDEC that the Construction General Permit site is terminating coverage under the permit.

O

Off-Site Drainage. Flow of water that originates outside the property.

On-Site Drainage. Flow of water that originates inside the property.

Open Channel. Any conveyance in which water flows with a free surface.

Ordinary High Water Mark. The line on the shore established by the fluctuation of water and physically indicated on the bank (1.5 + years return period).

Outfall. Discharge or point of discharge of a culvert or other closed conduit.

Overflow. Discharge of a stream outside its banks; the parallel channels carrying such discharge.

P

Peak Flow. Maximum momentary stage or discharge of a stream in flood; design discharge.

Perched Water. Ground water located above the level of the water table and separated from it by a zone of impermeable material.

Permanent Erosion Control. Permanent erosion control is most often associated with the reestablishment of vegetation. This can be either grasses as in the case of most transportation facilities or reforestation needed to reestablish woody vegetation after fires.

Permeability. The property of soils which permits the passage of any fluid. Permeability depends on grain size, void ratio, shape and arrangement of pores.

Permeable. Open to the passage of fluids, as for (1) pervious soils and (2) bank-protection structures.

Permit. An authorization, license, or equivalent control document issued TDEC to implement the requirements of an environmental regulation.

Physiographic Region. A geographic area whose pattern of landforms differ significantly from that of adjacent regions.

Pier. Vertical support of a structure standing in a stream or other body of water. Used in a general sense to include bents and abutments.

Pile. A long, heavy timber or section of concrete or metal that is driven or jetted into the earth or bottom of a water body to serve as a structural support or protection.

Point Sources. A source of pollutants from a single point of conveyance such as a pipe. For example, the discharge pipe from a sewage treatment plant or factory is a point source.

Practicable. Capable of being done within reasonable natural, social, and economic constraints.

Precipitation. Discharge of atmospheric moisture as rain, snow, or hail, measured in depth of fall or in terms of intensity of fall in unit time.

Preserve. To avoid modification to the functions of the natural floodplain environment or to maintain it, as closely as practicable, in its natural state.

Probability. The chance of occurrence or recurrence of a specified event within a unit of time, commonly expressed in three ways. Thus a 10-year flood has a chance of 0.1 per year and is also called a 10%-chance flood.

Probability of Exceedance. The statistical probability, expressed as a percentage, of a hydrologic event occurring or being exceeded in any given year. T

Q

Quality Assurance/Quality Control. (QA/QC) A system of procedures, checks, audits, and corrective actions to ensure that all research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

R

Rainfall. Point precipitation: That which registers at a single gauge. Area precipitation: Adjusted point rainfall for area size.

Reach. The length of a channel uniform with respect to discharge, depth, area, and slope. More generally, any length of a river or drainage course.

Regulatory Framework. A particular set of laws, rules, procedures, and agencies designed to govern a particular type of activity or solve a particular program.

Repose. The stable slope of a bank or embankment, expressed as an angle or the ratio of horizontal to vertical projection.

Restore. To reestablish a setting or environment in which the functions of the natural and beneficial floodplain values adversely impacted by a development can continue to operate.

Restriction. Artificial or natural control against widening of a channel, with or without construction. .

Retention. The holding of runoff in a basin without release except by means of evaporation, infiltration, or emergency bypass. .

Retention Storage. Water that accumulates and ponds in natural or excavated depressions in the soil surface with no possibility for escape as runoff (See Detention Storage). .

Revegetation. Planting of indigenous plants to replace natural vegetation that is damaged or removed as a result of construction projects or permit requirements. .

Revetment. Bank protection to prevent erosion. .

Rill. A streamlet or small surface channel caused by the erosion of the soil surface with a cross sectional area of up to 16 sq.in. .

Rill Erosion. The formation of numerous, closely spaced streamlets due to uneven detachment of surface soils by runoff on slopes. .

Riparian. Pertaining to the banks of a stream.

Riprap. A layer, facing, or protective mound of broken concrete, sacked concrete, rock, rubble, or stones randomly placed to prevent erosion, scour, or sloughing of a structure or embankment; also, the stone used for this purpose. .

River. A large stream, usually active when any streams are flowing in the region. .
Rock. (1) Cobble, boulder, or quarry stone as a construction material. (2) Hard natural mineral, in formation as in piles of talus.

Rock Check. A low dam made of coarse rock placed across a channel as a means of trapping sediment and reducing velocity..

Rubble. Rough, irregular fragments of rock or concrete. .

Runoff. (1) The surface waters that exceed the soil's infiltration rate and depression storage. (2) The portion of precipitation that appears as flow in streams. Drainage or flood discharge which leaves an area as surface flow or a pipeline flow, having reached a channel or pipeline by either surface or subsurface routes.

S

Sand. Granular soil coarser than silt and finer than gravel, ranging in diameter from 0.05 mm to 5 mm. .

Scour. The result of erosive action of running water, primarily in streams, excavating and carrying away material from the bed and banks. Wearing away by abrasive action.

Sediment. Fragmentary material that originates from weathering of rocks and is transported by, suspended in, or deposited by water. .

Sediment Bags. Large bags made of filter fabrics used to trap and filter sediment form storm water. Storm water is usually collected in a basin and then pumped to the sediment bag..

Sediment Control. Actions take to trap sediments suspended in storm water by settling, filtration, or chemical deflocculation..

Sedimentation. Gravitational deposit of transported material in flowing or standing water. .

Sediment Trap. A device used to trap and remove sediment from storm water by settling, or filtration.

Sheet Erosion. Erosion of thin layers of soil by sheets of flowing water.

Sheet Flow. Any flow spread out and not confined; i.e., flow across a flat open field. .

Sheet Pile. A pile with a generally slender, flat cross-section that is driven into ground or bottom of a water body and meshed or interlocked with like members to form a wall or bulkhead.

Silt. (1) Water-borne sediment. Detritus carried in suspension or deposited by flowing water, ranging

in diameter from 0.005 to 0.05 mm. The term is generally confined to fine earth, sand, or mud, but is sometimes both suspended and bedload. (2) Deposits of water-borne material, as in a reservoir, on a delta, or on floodplains.

Silt Fence. Fabric materials used to filter suspended sediments from storm water.

Sinuosity. The ratio of the length of the river thalweg to the length of the valley proper.

Slide. Gravitational movement of an unstable mass of earth from its natural position. .

Slipout. Gravitational movement of an unstable mass of earth from its constructed position. Applied to embankments and other man-made earthworks. .

Slope. (1) Gradient of a stream. (2) Inclination of the face of an embankment, expressed as the ratio of horizontal to vertical projection. 3) The face of an inclined embankment or cut slope. In hydraulics it is expressed as percent or in decimal form. .

Source Control BMP. An effort to prevent or limit the exposure of significant materials to storm water at the source.

Stone. Rock or rock-like material; a particle of such material, in any size from pebble to the largest quarried blocks. .

Storage. 1.Detention or retention of water for future flow which occurs naturally in channel and marginal soils, or artificially in reservoirs. 2. an area used to hold manufactured or bulk materials related to construction projects.

Storage Basin. Space for detention or retention of water for future flow, naturally in channel and marginal soils, or artificially in reservoirs. .

Storm. A disturbance of the ordinary, average conditions of the atmosphere which, unless specifically qualified, may include any or all meteorological disturbances, such as wind, rain, snow, hail, or thunder.

Storm Drain. That portion of a drainage system expressly for collecting and conveying former surface water in an enclosed conduit. Often referred to as a 'storm sewer', storm drains include inlet structures, conduit, junctions, manholes, outfalls and other appurtenances. .

Storm Water. Storm water runoff, snow melt runoff, and surface runoff and drainage. .

Storm Water Management. The recognition of adverse drainage resulting from altered runoff and the solutions resulting from the cooperative efforts of public agencies and the private sector to mitigate, abate, or reverse those adverse results. .

Storm Water Pollution Prevention Plan (SWPPP). A plan required by storm water regulations or permits that includes site map(s), an identification of construction/contractor activities that could cause pollutants in the storm water, and a description of measures or practices to control these pollutants. .

Subdrain. A conduit for collecting and disposing of underground water. It generally consists of a pipe, with perforations in the bottom through which water can enter. .

Subsidence. A general lowering of the land surface by consolidation or removal of underlying soil.

Substrate. The layer of earth or rock that lies immediately below the surface soil. .

Sump. In drainage, any low area that does not permit the escape of water by gravity flow. .

Support Base Floodplain Development. To encourage, allow, serve, or otherwise facilitate additional base floodplain development. Direct support results from an encroachment, while indirect support results from an action out of the base floodplain. .

Surcharge. A condition where the hydraulic capacity of the storm drain system is temporarily exceeded (e.g., during a storm event), and the amount of water that enters the system exceeds the conveyance capacity.

Surface Runoff. Water movement on earth's surface, whether flow is over the surface of the ground, or in channels. .

Surface Waters. Surface waters are those which have been precipitated on the land from the sky or forced to the surface in springs, and which have then spread over the surface of the ground without being collected into a definite body or channel. They appear as puddles, sheet or overland flow, and rills, and continue to be surface waters until they disappear from the surface by infiltration or evaporation, or until by overland or vagrant flow, they reach well-defined watercourses or standing bodies of water like lakes or seas. .

Suspended Load. Sediment that is supported by the upward components of turbulent currents in a stream and that stay in suspension for an appreciable amount of time. .

Suspended Solids. Organic or inorganic particles, which are suspended in and carried by the water. The term includes sand, mud, and clay particles, as well as solids in wastewater. .

T

Tapered Inlet. A transition to direct the flow of water into a channel or culvert. A smooth transition to increase hydraulic efficiency of an inlet structure .

TDEC. Tennessee Department of Environment and Conservation

TDOT. Tennessee Department of Transportation

Temporary Construction Site BMPs. BMPs that are required, only temporarily, to address a short-term storm water contamination threat. For example, silt fences are located near the base of newly graded slopes that have a substantial area of exposed soil. Then, during rainfall, the silt fences filter and collect sediment from runoff flowing off the slope. .

Terrace. Berm or bench-like earth embankment with a nearly level plain bounded by rising and falling slopes. .

Tetrahedron. Bank protection element, basically composed of 6 steel or concrete struts joined together (like the edges of a triangular pyramid) with subdividing struts and tie wires or cables. .

Tetrapod. Bank protection element, precast of concrete, consisting of 4 legs joined at a central block, each leg making an angle of 109.5 degrees with the other three, like rays from the center of a tetrahedron to the center of each face. .

Texture. The arrangement and interconnection of surface and near-surface particles of terrain or channel perimeter. .

Time of Concentration. The time required for storm runoff to flow from the most remote point of a drainage area to the point under consideration (in flow time). It is usually associated with the design storm.

Total Maximum Daily Load (TMDL). A process established by the Clean Water Act to guide

the application of state water quality standards to individual water bodies and watersheds by defining the amount of a particular pollutant that a water body can absorb on a daily basis without violating applicable water quality standards. Once this load is determined, the regulatory agency allocates a portion to each source of that pollutant within a particular watershed. .

Total Suspended Solids (TSS). The weight of particles that are suspended in water. Suspended solids in water reduce light penetration in the water column, can clog the gills of fish and invertebrates, and are often associated with toxic contaminants because organics and metals tend to bind to particles.

Training. Control of current direction. .

Transition. A relatively short reach or conduit leading from one waterway section to another of different width, shape, or slope.

Transport. To carry solid material in a stream in solution, suspension, saltation, or entrainment.

Trash Rack. A grid or screen across a stream designed to catch floating debris. .

Tributary. A river or stream which flows into a larger river or stream. .

Trunk (or Trunk Line). In a drainage system, the main conduit for transporting the storm waters. This main line is generally quite deep in the ground so that laterals coming from fairly long distances can drain by gravity into the trunk line.

Turbidity. A measure of the amount of material suspended in the water. Increasing the turbidity of the water decreases the amount of light that penetrates the water column. High levels of turbidity are harmful to aquatic life. .

Turbulence. The state of flow wherein the water is agitated by cross-currents and eddies, as opposed to a condition of flow that is quiet and laminar. .

Turbulent Flow. That type of flow in which any particle may move in any direction with respect to any other particle, and in which the head loss is approximately proportional to the square of the velocity. .

U

Undercut. Erosion of the low part of a steep bank so as to compromise stability of the upper part. .

Underflow. The downstream flow of water through the permeable deposits that underlie a stream. (1) Movement of water through a pervious subsurface stratum, the flow of percolating water, or water under ice, or under a structure. (2) The rate of flow or discharge of subsurface water. .

Urban Runoff. A substance, such as rain, that runs off of surfaces in a watershed in excess of the amount absorbed by the surfaces (usually the ground). Urban runoff can contain sediments and contaminants (nonpoint source pollution) that can add to water quality degradation in the watershed. Increases in impervious surface usually result in increased urban runoff.

V

Velocity. The rate of motion of objects or particles, or of a stream of particles..

Velocity Head. A term used in hydraulics to represent the kinetic energy of flowing water. This "head"

is represented by a column of standing water equivalent in potential energy to the kinetic energy of the moving water, calculated as (V2/2g), where the "V" represents the velocity in meters per second and "g" represents the potential acceleration due to gravity, in meters per second per second.

Vernal Pools. Vernal pools are seasonally flooded landscape depressions that support distinctive (and many times rare) plant and animal species adapted to periodic or continuous inundation during the wet season, and the absence of either ponded water or wet soil during the dry season.

W

Wash. Flood plain or active channel of an ephemeral stream, usually in recent alluvium. .

Water Table. The surface of the groundwater below which the void spaces are completely saturated.

Watercourse. A definite channel with bed and banks within which water flows, either continuously or in season. A watercourse is continuous in the direction of flow and may extend laterally beyond the definite banks to include overflow channels contiguous to the ordinary channel. The term does not include artificial channels such as canals and drains, except natural channels trained or restrained by the works of man. The term also does not include depressions or swales through which surface or errant waters pass.

Waters of the United States. (a) All waters, which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide; (b) All interstate waters, including interstate wetlands; (c) All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters: (1) which are or could be used by interstate or foreign travelers for recreational or other purposes; (2) from which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or (3) which are used or could be used for industrial purposes by industries in interstate commerce; (d) All impoundments of waters identified in paragraphs (a) through (d) of this definition; (f) The territorial sea; and (g) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (a) through (f) of this definition. Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.11 (m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States. .

Watershed. The area that contributes surface water runoff into a tributary system or water course. .

Waterway. (1) That portion of a watercourse that is actually occupied by water. (2) A navigable inland body of water..

Wattles. Bundles or branches, or rolls made of materials such as excelsior, coir or straw. Generally placed perpendicular to the flow to act as a sediment trap, filter or as a velocity control measure.

Weephole. A hole in a wall, invert, apron, lining, or other solid structure to relieve the pressure of groundwater.

Weir. A low overflow dam or sill for measuring, diverting, or checking flow.

Wetland. Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wet Weather Flow. Rainfall (storm water) runoff.

Windbreak. (1) A barrier fence or line of trees to break or deflect the velocity of wind. (2) Any device designed to block wind flow and intended for protection against any ill effects of wind, particularly wind erosion.