# The Stormwater Practitioners Guide

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# Abbreviations and Acronyms

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Official |
| BFM | Bonded Fiber Matrix |
| BMP | Best Management Practice |
| CCS | Cellular Confinement System |
| CFLHD | Central Federal Lands Highway Division |
| CFR | Code of Federal Regulations |
| CFT | Cross Functional Team |
| CNPCP | Coastal Nonpoint Pollution Control Program |
| CWA | Clean Water Act |
| CWB | Clean Water Branch |
| CZARA | Coastal Zone Act Reauthorization Amendments |
| CZM | Coastal Zone Management |
| CZMA | Coastal Zone Management Act |
| DLNR | Department of Land and Natural Resources |
| DOH | Department of Health |
| DOT | Department of Transportation |
| DSA | Disturbed Soil Area |
| EMD | Environmental Management Division |
| EO | Executive Order |
| EPA | Environmental Protection Agency |
| ESA | Environmentally Sensitive Area |
| ETAP | Environmental Technologies Action Plan |
| FAC | Facultative |
| FACU | Facultative Upland |
| FACW | Facultative Wetland |
| FHWA | Federal Highway Administration |
| FH | Forest Highway |
| FLAP | Federal Lands Access Program |
| FLH | Federal Lands Highway |
| GPS | Global Positioning System |
| HAR | Hawaii Administrative Rules |
| HDOT | Hawaii Department of Transportation |
| HGM | Hydrogeomorphic |
| HRS | Hawaii Revised Statutes |
| IWPPP | In Water Pollution Prevention Plan |
| JD | Jurisdictional Delineation |
| LEDPA | Least Environmentally Damaging Practicable Alternative |
| LOP | Letter of Permission |
| LRR | Land Resource Region |
| MLRA | Major Land Resource Area |
| NAEL | National Elk Wildlife Refuge |
| NHD | National Hydrographic Datum |
| NPDES | National Pollution Discharge Elimination System |
| NPS | Non-Point Source |
| NRCS | Natural Resource Conservation Service |
| NRPW | Non-Relatively Permanent Water |
| NWI | National Wetland Inventory |
| NWPL | National Wetland Plant List |
| OBL | Obligate |
| OHWM | Ordinary High Water mark |
| OP | Office of Planning |
| PAH | Polycyclic Aromatic Hydrocarbons |
| PDT | Project Delivery Team |
| PE | Project Engineer |
| PEM | Palustrine Emergent |
| PFO | Palustrine Forested |
| POC | Pollutants of Concern |
| PSS | Palustrine Scrub/Shrub |
| QA | Quality Assurance |
| QSP | Qualified Stormwater Professional |
| RE | Resident Engineer |
| REAP | Rain Event Action Plan |
| ROW | Right of Way |

| | |
|---|---|
| RPW | Relatively Permanent Water |
| SR | State Route |
| SRNF | Six Rivers National Forest |
| SWANCC | Solid Waste Agency of Northern Cook County |
| TMDL | Total Maximum Daily Load |
| TNW | Traditional Navigable Water |
| TSS | Total Suspended Solids |
| SDWA | Safe Drinking Water Act |
| SWPPP | Storm Water Pollution Prevention Plan |
| UPL | Upland |
| US | United States |
| USACE | United States Army Corps of Engineers |
| USC | United States Code |
| USDA | United States Department of Agriculture |
| USGS | United States Geological Service |
| USFWS | United States Fish and Wildlife Service |
| UTM | Universal Transverse Mercator |
| WUS | Waters of the United States |
| WWB | Wastewater Branch |

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# CHAPTER 1:

# BACKGROUND AND REGULATORY INFORMATION

# 1 Introduction

## 1.1 Summary

The FHWA-CFLHD is proposing refinements to how its Permanent Stormwater Management Design Process is implemented. This section aims to document the permanent Stormwater Design process so that projects can consistently evaluate stormwater BMPs during project development. This will improve stormwater treatment on FHWA-CFLHD projects, improve consistency with regulatory and permitting requirements, and reduce the movement of roadway pollutants to downstream and end of pipe receptors. The goal is to reduce the amount of runoff generated to the extent practicable before relying on engineered stormwater facilities to meet water quantity and water quality requirements, thereby reducing maintenance needs for our partner agencies. Through this process, FHWA is working internally with project management, project delivery and construction management teams to define improvement areas. The key outcomes from this process are to develop a stormwater compliance process that is an integral part of our project delivery process while remaining scalable and adaptable to meet the large variation in types of projects that we deliver across our fourteen state region. We are incorporating improvements in the following areas:

1. Stormwater Treatment Guidance:
   a. Permanent Best Management Practices (BMP) Selection during project design.
   b. Temporary BMP selection for stormwater and SWPPP management during construction.
2. Improved Clean Water Act compliance and improved permitting review timelines for the transportation projects we design, oversee, and construct.

This manual focuses on the FHWA-CFLHD's cradle to grave delivery approach with stormwater treatment considerations from early project planning to final stabilization during construction. The impetus for developing this Stormwater Practitioner's Guide is to have a transparent and technically based BMP selection process that documents key decision milestones for the design and implementation of stormwater BMPs. The BMP Selection process is one component of an overall Integrated Stormwater Treatment Design Process. The Integrated Stormwater Treatment Design Process integrates an understanding of pollution sources, low impact development, BMPs evaluation and selection, pollution prevention, impact minimization techniques, and other practices to reduce the runoff generated by the project once the project goals and objectives have been defined and site characterization has occurred.

## 1.2 Purpose

The Federal Highway Administration (FHWA), Central Federal Lands Highway Division (CFLHD) is proposing updates to improve stormwater management and the implementation of Best Management Practices (BMPs) on the transportation projects they design and oversee.

The purpose of this manual is to provide guidance on common BMPs used in protecting water quality during planning, design and construction activities, with a heavy emphasis on work that is occurring adjacent to, over, or in the boundaries of waters meeting the definition of Waters of the United States (US) (WUS) under the Clean Water Act (30 Code of Federal Regulations [CFR] 328). A key component to successfully accomplish this goal is an integrated storm water management approach to protecting water quality throughout the life of a project; from project planning and design to after construction completion.

Integrated stormwater management is simply thinking about all of the factors that somehow affect this precipitation as it moves from the land surface to an eventual receiving water. It is the process of accounting for all of these factors (e.g. rate, volume, quality, ground water impact) in a logical process so that inadvertent mistakes are not made that could eventually harm a resource. The treatment train approach to stormwater and non-stormwater management mimics this natural sequence as the project design and construction team looks at potential pollutant sources and determines how best to address them, starting with the most basic of solutions and increasing in complexity only if needed, since simple methods of management are often the most practical.

Numerous planning, design, and construction techniques known as BMPs exist to protect natural receiving waters against pollutants commonly associated with the operation, maintenance and construction of transportation facilities. Early consideration of storm water management and BMP alternatives during project design is critical to successful water quality management during construction. The correct selection, installation, and maintenance of BMPs are also paramount in ensuring they effectively treat the pollutants of concern (POC) identified for a particular project.

The purpose of this practitioner guide is to provide regulators, developers, contractors, site managers and inspectors with a guide to an integrated stormwater management approach to project design and construction on FHWA-CFLHD projects. Chapter 2 of this guide provides a summary of key components of an integrated stormwater management approach. Chapter 3 provides a BMP Selection Tool through the utilization of effective BMPs for managing pollutants on transportation construction projects. Improvements in construction techniques and BMP technologies are constantly evolving. Most of the BMPs discussed in this manual have been used effectively by departments of transportation (DOT) across the country. The BMP Selection Tool provides a transparent and technically based BMP selection process that documents the decisions made during project development while promoting consistency in the stormwater management process.

Chapter 4 summarizes the standard construction stormwater and non-stormwater controls BMPs that are commonly implemented on transportation construction projects. This manual builds off of the wealth of available information on the subject of BMPs and proper implementation during construction. The BMPs contained in the Selection Tool do not constitute an exhaustive list of BMPs, but instead provide a summary of common practices utilized for managing pollutant generating activities on transportation projects.

Finally, Chapter 5 provides a summary of additional BMPs which are commonly utilized for isolating construction from flowing or standing water.

Each BMP measure summarized in this manual consists of the following:

- General description;
- Applications;
- Standards and Specifications;
- Limitations; and
- Inspections and Maintenance.

The BMPs included in this manual focus on the areas of site management, erosion control, sediment control, waste management, tracking controls, and non-stormwater controls during construction including clean water diversion or isolation of a work area from water. They are established practices and procedures to control potential pollutants at their source. These BMPs supplement the standard erosion and sediment control measures included in project plans. Proper installation maintenance and inspection of these BMPs on FHWA-CFLHD projects will further help protect the valuable water resources from avoidable impacts and harmful pollutants.

## 1.3 ACKNOWLEDGEMENTS

Appreciation and acknowledgment is extended to the many stormwater management manuals that were referenced during the development of this FHWA-CFLHD manual. This manual was made possible by the combined efforts of many professionals:

- Thomas Parker (Lead), Federal Highway Administration, Central Federal Lands Highway Division, Transportation Specialist.
- Opal Forbes, FHWA-CFLHD, Environmental Protection and Permitting Specialist.

## 1.4 DISCLAIMER

The information presented in this Practitioners Guide was taken from available and relevant sources deemed to be representative of appropriate BMPs. This manual has been prepared as a reference guideline, however, due to site specific conditions, the selection of the BMPs must be used in conjunction with best professional judgment and sound engineering principles to assure proper function and performance of the BMPs contained herein. The author(s) do not guarantee the accuracy or completeness of this document and will not assume any liability or responsibility for the use of, or for any damages resulting from the use of any information contained herein. The detail and the wording in this manual will not necessarily result in compliance with the appropriate Standard Specifications. Compliance with other requirements such as the Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects (FP-14), State Water Quality Standards, and/or State Water Pollution Control Criteria are deemed the responsibility of the engineer / planner and construction contractor.

The FHWA, their employees, contractors, and subcontractors make no warrant, expressed or implied, and assume no legal liability for the information in this manual; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This manual has been prepared by the FHWA as voluntary guidance on stormwater compliance and best management practices (BMPs). The recommendations and protocols discussed in this manual are intended to be suggestions for FHWA to use at their discretion. The guidance and BMPs are strictly voluntary and are not intended to implement, replace, duplicate, interpret, amend, or supplement any current statute, regulation or permit requirement. Adherence to the guidance and BMPs does not ensure compliance with any local, state, or federal statute or regulation nor does failure to follow the guidance and BMPs necessarily imply a violation of the National Environmental Policy Act, Clean Water Act, Coastal Zone Management Act, Endangered Species Act or other relevant statutes or legal requirements.

This guide is not intended to be a manual for designing plans and specifications, but a source of information about erosion, sediment, stormwater and non-stormwater control BMPs to aid during the development of plans and specifications. The contents should not be interpreted as necessarily representing the policies or recommendations of other referenced agencies or organizations. Refer to state, federal and local regulations and permits for applicable design criteria. For additional detailed design guidance, please refer to the numerous references and manuals listed in the References section of this document. For further reference, see Federal, state and local stormwater and water quality regulations and requirements.

## 1.5 Scope of this Guide

Water quality can be affected when runoff carries sediment or other pollutants into streams, wetlands, lakes, marine waters and/or into groundwater. Stormwater management can help to reduce these effects. Stormwater management involves careful application of site design principles, construction techniques and source controls to prevent sediment and other pollutants from entering surface or groundwater, treatment of runoff to reduce pollutants, and flow controls to reduce the impact of altered hydrology. This is especially true during the planning, construction, and maintenance of transportation infrastructure projects.

Numerous Department of Transportations and Stormwater Associations have evaluated and prepared BMP manuals to evaluate their effectiveness for different pollution generating activities. These manuals have been reviewed and integrated into this practitioner's guide. Additionally, non-stormwater BMPs including clear water diversion and isolation techniques for construction projects that require work within or around wet areas are especially important given the nature of the work. An understanding of techniques is required to understand the anticipated in-water impacts from construction related erosion and sediment. Construction activities in or near open water can be managed to mitigate risks to water quality through the implementation of these or similar techniques. Technology is always changing, and additional materials, techniques, and products may be developed which expand upon the BMPs referenced within this manual.

## 1.6 Regulatory Setting

Legal protection of water resources are guided by federal statutes and state statues and rules. The three primarily federal laws include: the Clean Water Act , the Coastal Zone

Management Act and the Coastal Zone Act Reauthorization Amendments , and the Safe Drinking Water Act.

## 1.6.1 Federal Requirements:

### 1.6.1.1 Clean Water Act

In 1972, Congress amended the Federal Water Pollution Control Act, making the addition of pollutants to WUS from any point (A point source is any discrete conveyance such as a pipe or a man-made ditch.) unlawful unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. This act and its amendments are known today as the Clean Water Act (CWA). Congress has amended the act several times. In the 1987 amendments, Congress directed dischargers of storm water from municipal and industrial/construction point sources to comply with the NPDES permit scheme. The following are important CWA sections:

- Sections 303 and 304 require states to issue water quality standards, criteria, and guidelines.
- Section 401 requires an applicant for a federal license or permit to conduct any activity that may result in a discharge to waters of the U.S. to obtain certification from the state that the discharge will comply with other provisions of the act. This is most frequently required in tandem with a Section 404 permit request (see below).
- Section 402 establishes the NPDES, a permitting system for the discharges (except for dredge or fill material) of any pollutant into waters of the U.S. State's and/or the Environmental Protection Agency (EPA) usually administer this permitting program. Section 402(p) requires permits for discharges of storm water from industrial, construction, and municipal separate storm sewer systems (MS4s).
- Section 404 establishes a permit program for the discharge of dredge or fill material into waters of the United States. This permit program is administered by the U.S. Army Corps of Engineers (USACE).

The goal of the CWA is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

#### *1.6.1.1.1 Waters of the United States*

The USACE derives its regulatory authority over jurisdictional WUS from two federal laws: 1) Section 10 of the Rivers and Harbors Act of 1899 and 2) Section 404 of the Clean Water Act (CWA) of 1972.

Section 10 of the Rivers and Harbors Act of 1899 prevents unauthorized obstruction or alteration of navigable WUS. Navigable waters are defined as *"subject to the ebb and flow of the tide and/or presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce"* (33 CFR 322.2(a)). A Section 10 permit is required for non-fill discharging activities that would place any structure below, within, or over navigable WUS, or would involve excavation/dredging or deposition of material or any obstruction or alteration in navigable WUS.

The CWA defines WUS subject to agency jurisdiction in 40 CFR 230.3. Under Section 404 of the CWA, dredged and fill material may not be discharged into jurisdictional WUS (including wetlands) without a permit. Wetlands are a subset of jurisdictional WUS and are jointly defined by the USACE and the U.S. Environmental Protection Agency (40 Code of Federal Regulations [CFR] 230.3) as *"those areas that are inundated or saturated by surface or groundwater 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."*

The USACE issues two types of 404 permits: General and Standard permits. There are two types of General permits: Regional permits and Nationwide permits. Regional permits are issued for a general category of activities when they are similar in nature and cause minimal environmental effect. Nationwide permits are issued to allow a variety of minor project activities with no more than minimal effects.

Ordinarily, projects that do not meet the criteria for a Nationwide Permit may be permitted under one of the USACE's Standard permits. There are two types of Standard permits: Individual permits and Letters of Permission. For Standard permits, the USACE decision to approve is based on compliance with U.S. Environmental Protection Agency's (EPA) Section 404 (b)(1) Guidelines (EPA Code of Federal Regulations [CFR] 40 Part 230), and whether the permit approval is in the public interest. The Section 404(b)(1) Guidelines (Guidelines) were developed by the U.S. EPA in conjunction with the USACE, and allow the discharge of dredged or fill material into the jurisdictional waters (i.e. WUS) only if there is no practicable alternative which would have less adverse effects. The Guidelines state that the USACE may not issue a permit if there is a least environmentally damaging practicable alternative (LEDPA) to the proposed discharge that would have lesser effects on WUS and not have any other significant adverse environmental consequences. According to the Guidelines, documentation is needed that a sequence of avoidance, minimization, and compensation measures has been followed, in that order. The Guidelines also restrict permitting activities that violate water quality or toxic effluent (The U.S. EPA defines "effluent" as "wastewater, treated or untreated, that flows out of a treatment plant, sewer, or industrial outfall.") standards, jeopardize the continued existence of listed species, violate marine sanctuary protections, or cause "significant degradation" to WUS. In addition, every permit from the USACE, even if not subject to the Section 404(b)(1) Guidelines, must meet general and regional requirements. See 33 CFR 320.4 for general policies for evaluating permit applications. Below in Figure 1 is a graphical depiction of the boundary of WUS under Section 10 of the RHA and Section 404 of the CWA.

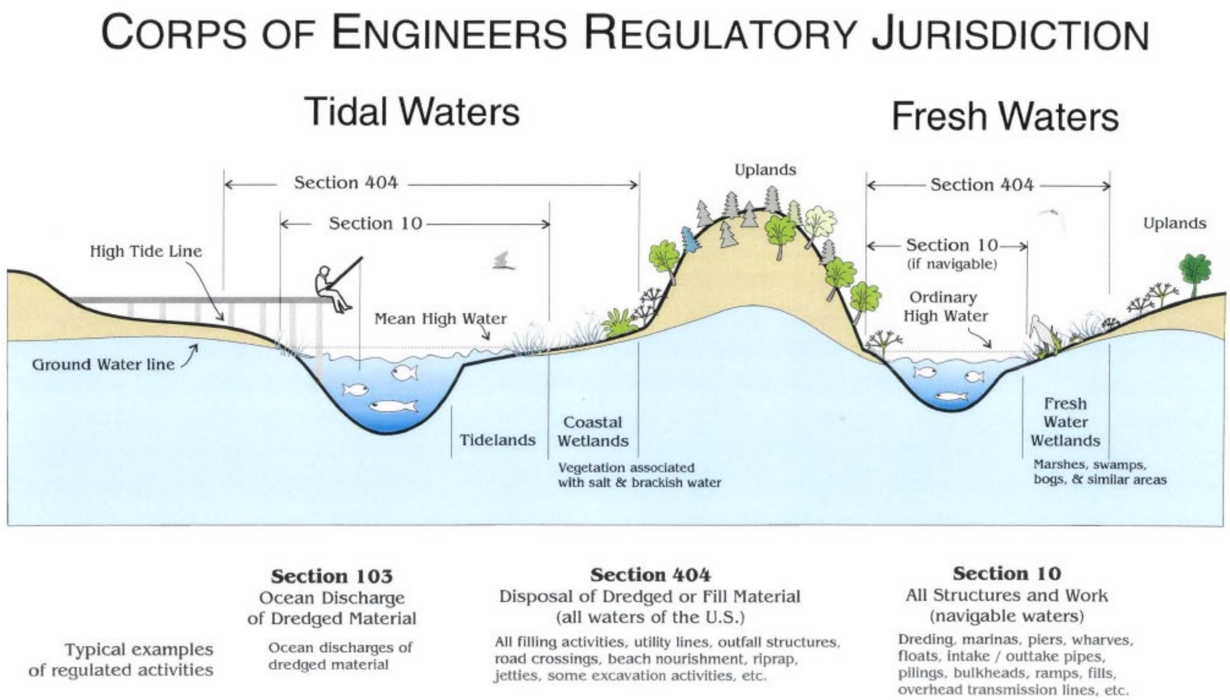



**Figure 1. Regulatory Boundaries in Waters of the United States.**

### 1.6.1.2 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) (United States Code (USC) Sections 3501 et seq., as amended in 1990 under the Coastal Zone Act Reauthorization Amendments), administered by the National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean and Coastal Resource Management, provides for management of the nation's coastal resources and balances economic development with environmental conservation. The national goal for the CZMA program is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone."

The purpose of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990 is to improve the management of the coastal zone and enhance environmental protection of coastal zone resources. Section 6217 of CZARA seeks to address Non-Point Source (NPS) pollution problems in coastal waters by implementing the Coastal Nonpoint Pollution Control Program (CNPCP). The CNPCP is a statewide coastal zone program that establishes and oversees a set of management measures to prevent and reduce NPS pollution from six sources: forestry, agriculture, urban areas, marinas, hydromodifications, and wetlands and riparian areas. The CNPCP also includes a monitoring and tracking condition to ensure that the management measures are being implemented. This program is administered jointly by the EPA and the NOAA.

Section 307 of the CZMA, requires federal agency activities and development projects affecting any coastal use or resource to be undertaken in a manner consistent to the maximum extent practicable with the state's Coastal Zone Management (CZM) program. Also, activities requiring a federal permit or license, and activities conducted with federal financial assistance, that affect coastal uses and resources must be conducted in a manner consistent with the state's CZM program. The CZMA federal consistency provision ensures that federal agencies cannot act without regard for, or in conflict with, state policies that have been officially incorporated into a state's CZM program. Federal actions affecting any coastal use or resource must be reviewed by the state CZM program to ensure that proposed activities are consistent with state enforceable policies.

#### 1.6.1.3 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA), which was originally passed in 1974, protects public health by regulating the nation's drinking water supply. It is administered by the EPA and implemented by state agencies. State regulatory agencies are responsible for protecting their State's drinking water resources, including both surface and groundwater sources, and ensures that public water systems meet federal and state health-related standards for drinking water. This usually includes management of wastewater within the state. This that the use and disposal of wastewater does not contaminate water sources and affect drinking water and public health.

#### 1.6.1.4 Endangered Species Act

The purpose of the Endangered Species Act (ESA) is to protect and promote recovery of imperiled species and the ecosystems upon which they depend. The federal ESA is administered by NOAA Fisheries Service for marine mammal species and anadromous species. USFWS administers the ESA for freshwater fish species, and for birds, mammals, reptiles, amphibians, invertebrates, and plants.

Three provisions of the ESA may apply directly to stormwater management: Section 4(d) rules, Section 7 consultations and Section 10 habitat conservation plans.

Section 4(d) of the ESA requires USFWS or NOAA Fisheries Service to implement protective measures that prevent further damage to threatened species. Section 4(d) applies only to threatened species; endangered species are afforded full legal protection without room for maneuvering. "Take" of any species listed as endangered is prohibited by the ESA. Take of threatened species may be allowable under permit, provided project-related take does not interfere with species survival or recovery.

ESA compliance involves determination of effect on listed species, and may lead to consultation with USFWS/NOAA Fisheries Service under Section 7.

#### 1.6.1.5 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) is the primary law governing marine fisheries management in U.S. Federal waters. It establishes a national program for the conservation and management of the fishery resources of the United States to prevent overfishing, rebuild overfished stocks, ensure conservation, facilitate long-term protection of essential fish habitats (EFH), and realize the full potential of the Nation's fisheries. In accordance with Section 305(b) of the MSA, Funding Agencies must consult with NOAA's NMFS regarding any of their actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect EFH. For additional guidance, please view the EFH Regulatory Guidelines (http://www.habitat.noaa.gov/pdf/efhregulatoryguidelines.pdf).

## 1.6.2 STATE REQUIREMENTS:

### 1.6.2.1 Clean Water Act

States have varying involvement in the administration and enforcement of the CWA. The administration of the permit program was initially the sole responsibility of the federal government. However, Congress provided that states desiring to administer their own permit programs could do so if the EPA approved their programs as meeting the minimum standards of Federal law and implementing regulations. In approving state NPDES programs, EPA does not delegate its own authority to the state, but rather authorizes the state to administer its program in lieu of the federal program and pursuant to the state's own legal authorities.

In doing so, the CWA requires EPA to carefully review the state's authority, to ensure that it is at least as stringent as the federal program. This requirement is intended to ensure that the transition from Federal to state programs will not slow progress toward achievement of the goals of the CWA. It is designed to allow states to retain or adopt standards more stringent than federal requirements, while ensuring a consistent minimum level of protection among the fifty states and federal territories. Congress felt strongly that such national consistency was essential to protect against the unfair competition which could result if states were allowed to establish weaker pollution controls to lure industries from those states having more stringent pollution controls.

The minimum federal requirements for state program approval therefore dictate that the program created by a state be more than just similar to the federal program. This is not to say, however, that approved state programs must be absolute uniformity with the federal program. States retain flexibility, both in the implementation and the administration of the program to account for particular problems experienced by individual states.

EPA's policy has been to transfer the administration of the NPDES program to state governments to the fullest extent possible, consistent with statutory intent and good management practice. Since 1972, thirty-seven jurisdictions have been approved to administer their own NPDES programs. EPA recognizes, as did Congress, the wisdom of state and local management of day-to-day operations so long as federal requirements are met. State specific NPDES requirements are summarized in Appendix A. The following are important CWA sections:

- Under Section 401 of the CWA, any project requiring a federal license or permit that may result in a discharge to a WUS must obtain a 401 Certification, which certifies that the project will be in compliance with state water quality standards. The most common federal permits triggering 401 Certification are CWA Section 404 permits issued by the USACE. The 401 permit certifications are obtained from the state regulatory agency or Environmental Protection Agency (EPA), dependent on the project location, and are generally required before the USACE issues a 404 permit. In some cases, the state agency may have specific concerns with discharges associated with a project. As a result, they may issue a set of requirements that define activities, such as the inclusion of specific features, effluent limitations, monitoring, and plan submittals that are to be implemented for protecting or benefiting water quality. These requirements can be issued to address both permanent and temporary discharges associated with a project.

- Section 402(b) of the CWA authorizes the approval of state programs in lieu of federal administration and sets forth most of the underlying authorities the state must possess. These include the authority to issue permits in conformance with federal requirements (i.e. technology based and water quality based controls), authority to provide adequate public input into the permit issuance process, authority to develop a pre-treatment program to regulate indirect discharges of pollutants into municipal treatment works, authority to inspect, monitor, and enforce, both civilly and criminally, violations of the Act.
- Section 303(e), 318, and 405 contain additional state program requirements with respect to continuing planning processes, aquaculture and disposal of sewage sludge.
- Under Section 402 of the CWA, States play an integral role in NPDES regulatory oversight and development of state specific requirements. Most states are authorized by the EPA to assume responsibility for NPDES permitting. Each state permit is normally issued for a period of 5 years. However, some states are not able to meet the 5-year deadline to re-issue the permits and administratively extend the permits until the new permit can be issued. General NPDES permitted activities typically include the following areas:
    - ➢ Construction Activities (i.e. Construction General Permit (CGP));
    - ➢ Industrial Activities;
    - ➢ Municipal Sources;
    - ➢ Transportation Sources; and
    - ➢ Oil and Gas Facilities;

#### 1.6.2.2 Coastal Zone Management Act

The CZMA outlines three national programs, the National Coastal Zone Management Program, the National Estuarine Research Reserve System, and the Coastal and Estuarine Land Conservation Program (CELCP). The National Coastal Zone Management Program aims to balance competing land and water issues through state and territorial coastal management programs, the reserves serve as field laboratories that provide a greater understanding of estuaries and how humans impact them, and CELCP provides matching funds to state and local governments to purchase threatened coastal and estuarine lands or obtain conservation easements.

The National Coastal Zone Management Program works with coastal states and territories to address some of today's most pressing coastal issues, including climate change, ocean planning, and planning for energy facilities and development.

The program is a voluntary partnership between the federal government and U.S. coastal and Great Lakes states and territories authorized by the Coastal Zone Management Act (CZMA) of 1972 to address national coastal issues. The program is administered by NOAA.

The act provides the basis for protecting, restoring, and responsibly developing our nation's diverse coastal communities and resources. To meet the goals of the CZMA, the national program takes a comprehensive approach to coastal resource management—balancing the often competing and occasionally conflicting demands of coastal resource use, economic development, and conservation. The program includes key elements:

- Protecting natural resources,
- Managing development in high hazard areas,
- Giving development priority to coastal-dependent uses,
- Providing public access for recreation,
- Prioritizing water-dependent uses, and
- Coordinating state and federal actions.

While the legislation includes basic requirements for state partners, it also allows the flexibility needed to design programs that best address local challenges and work within state and local laws and regulations. By using both federal and state funds, the program strengthens the capabilities of each partner to address coastal issues.

A wide range of issues are addressed through the program, including coastal development, water quality, public access, habitat protection, energy facility siting, ocean governance and planning, coastal hazards, and climate change.

The primary components of the national program include the following:

- The federal consistency component ensures that federal actions with reasonably foreseeable effects on coastal uses and resources must be consistent with the enforceable policies of a state's approved coastal management program. This also applies to federally authorized and funded nonfederal actions.
- The Coastal Zone Enhancement Program provides incentives to states to enhance their state programs within nine key areas: wetlands, coastal hazards, public access, marine debris, cumulative and secondary impacts, special area management planning, ocean and Great Lakes resources, energy and government facility siting, and aquaculture.
- The Coastal Nonpoint Pollution Control Program ensures that participating states have the necessary tools to prevent and control polluted runoff.

Below are states with FHWA-CFLHD and information regarding their regulatory programs.

#### *1.6.2.2.1 CALIFORNIA*

The California Coastal Management Program, approved by NOAA in 1978, is administered by three state agencies:

- The California Coastal Commission manages development along the California coast except San Francisco Bay, where the
- San Francisco Bay Conservation and Development Commission oversees development.

- The California Coastal Conservancy purchases, protects, restores, and enhances coastal resources, and provides access to the shore.

The primary authorities for the California Coastal Management Program are the California Coastal Act, McAteer-Petris Act, and Suisan Marsh Preservation Act. The California coastal zone generally extends 1,000 yards inland from the mean high tide line. The coastal zone for the San Francisco Bay Conservation and Development Commission includes the open water, marshes, and mudflats of greater San Francisco Bay, and areas 100 feet inland from the line of highest tidal action.

#### *1.6.2.2.2 HAWAII*

The Hawaii Coastal Management Program, approved by NOAA in 1978, is led by the Hawaii Office of Planning. The coastal management program is a network of authorities and partnerships collectively implementing the objectives and policies of Hawaii's Coastal Zone Management Statutes (Chapter 205A, HRS). The entire state of Hawaii falls within Hawaii's coastal zone boundary.

#### *1.6.2.2.3 TEXAS*

The Texas Coastal Management Program, approved by NOAA in 1996, is administered by the Texas General Land Office in conjunction with the Coastal Coordination Advisory Committee. The Coastal Coordination Act is the primary authority for the Texas Coastal Management Program. The Texas coastal zone is generally the area seaward of the Texas coastal facility designation line, up to three marine leagues into the Gulf of Mexico.

## 1.7 WATERSHED CONSIDERATIONS

Why are we concerned with stormwater runoff at the watershed level? Stormwater runoff is rain or snowmelt that flows over land and does not percolate into the soil. Stormwater runoff occurs naturally, in small amounts, from almost any type of land surface, especially during larger storm events.

However, impervious surfaces, such as buildings, homes, roads, sidewalks, and parking lots, can significantly alter the natural hydrology of a watershed by increasing the volume, velocity, and temperature of runoff and by decreasing its infiltration capacity. The increased volume and velocity of stormwater runoff causes:

- Increased land erosion;
- Severe stream bank erosion;
- Flooding;
- Degradation of the biological habitat in receiving waters;
- Increased sedimentation in receiving waters; and
- Reducing infiltration rates which can lower ground water levels and affect drinking water supplies.

The manipulation of the natural hydrology of an area is referred to as hydrological manipulation or hydromodification. Hydromodification is the alteration of the natural flow of water through a landscape, and often takes the form of channel modification or channelization. A broader definition of hydromodification covers not just channel modification but also changes in land use or cover. Conversion of the open landscape to features such as roads, buildings, houses, sidewalks, parking lots, and flood control channels adds impervious surfaces and modifies runoff patterns, causing rainfall to run off into streams more quickly with higher energy, and large flow events to occur more frequently. Therefore, correcting the root causes of hydromodification ought to be most effective if based on integrated watershed-scale solutions.

Hydromodification causes changes in runoff, as well as reduced sediment transport into the stream from surrounding land which can lead to stream channel erosion. The eroded sediments may transport pollutants and/or deposit in downstream habitats such as streams, lakes, reservoirs bays and estuaries. Population growth and the development of urban/urbanized areas are major contributors to the amount of pollutants in runoff as well as the volume and rate of runoff from impervious surfaces.

Hydromodification is one of the leading sources of impairment in streams, lakes, estuaries, aquifers, and other water bodies in the United States. Hydromodification activities such as channelization and channel modification, dams, and streambank and shoreline erosion control structures change a water body's physical structure as well as its natural function. These changes can cause problems such as changes in flow, increased sedimentation, higher water temperature, lower dissolved oxygen, degradation of aquatic habitat structure, loss of fish and other aquatic populations, and decreased water quality. It is important to properly manage hydromodification activities to reduce nonpoint source pollution in surface and ground water.

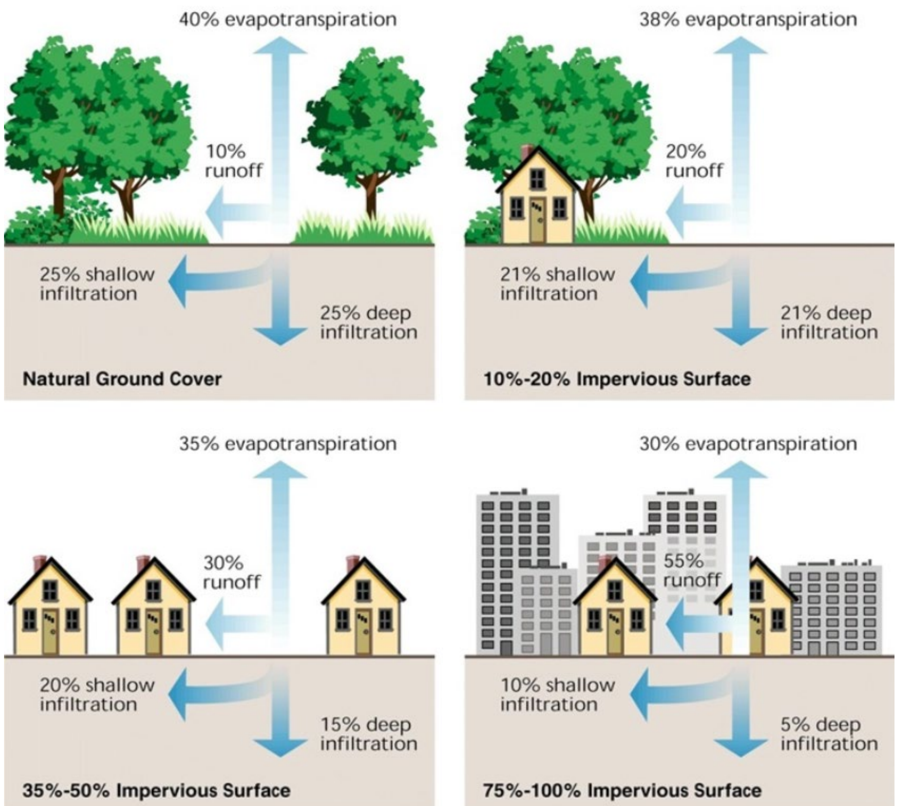



**Figure 2. Relationship between impervious surface area, surface runoff, infiltration and evapotranspiration**

## 1.8 Considerations for working in Riverine Systems

Rivers, Streams, creeks, drainages, gulches and other aspects of the riverine systems involve complex processes that do complicated work. In their natural state, streams gather, store, and move water. However, it is important for understanding stream processes to realize that streams and rivers are not only moving water; streams also move sediment, nutrients, and woody debris from mountain peaks to the sea.

Human land uses that significantly alter the ability of a creek to transport water and sediment will likely cause a stream to become unstable and increase the likelihood that catastrophic erosion or sedimentation may occur during a flood event. The relationship between water in a stream and its ability to transport sediment is shown as a balancing scale (Figure 3). When any one or more of the variables of this scale change, the system is no longer in balance, and aggradation or degradation of the river/stream bed and banks may occur. Given time and freedom to make adjustments, a stream will adjust its slope and sediment transport capability toward an equilibrium condition.

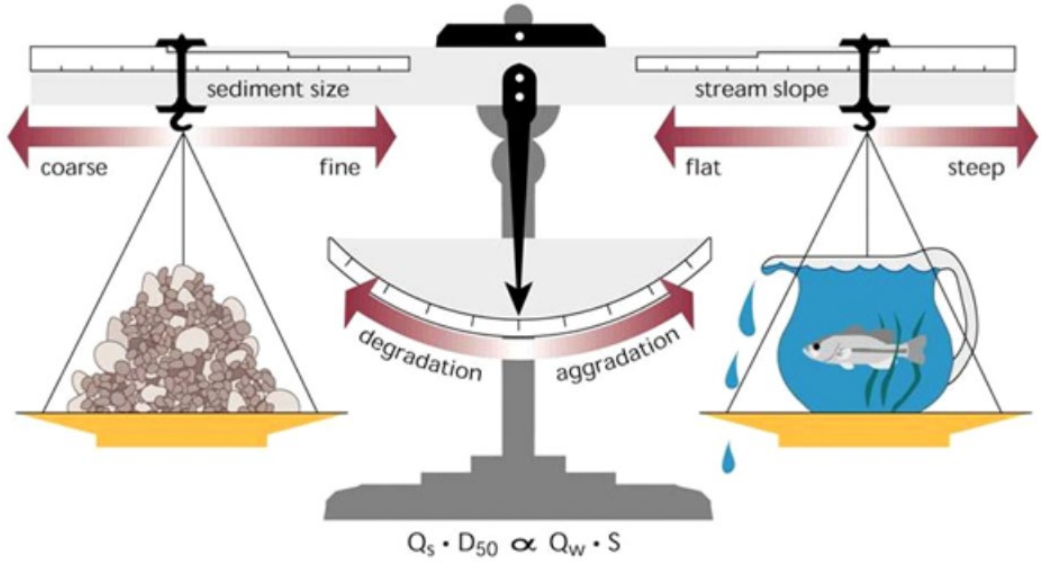



**Figure 3: Lane's Balance of Sediment Supply & Sediment Size with Slope (energy grade) & Discharge**

Throughout North America, river scientists and managers are now bringing this principle of river "stability" into the management of river channels by recognizing that stable rivers carry water, sediment and debris, even during high water, without drastic changes occurring in the depth, width, length, or slope of the channel. The term "dynamic equilibrium" is often used to describe a naturally stable stream channel. The channel may shift its location over time but ultimately will maintain consistent dimensions and habitat values. Channels remain stable when they are not impeded by unnatural constrictions like undersized transportation structures such as bridges and culverts and have access to a vegetated floodplain. When development changes the relationship of the river with its floodplain or alters the ability of a channel to transport its water and sediment load, it becomes increasingly difficult to protect this infrastructure.

Fluvial (river-related) erosion refers to streambed and streambank erosion associated with the sudden and catastrophic physical adjustment of stream channel dimensions (width and depth) and location that can occur during elevated discharges. Much of this damage occurs where rivers and streams have been separated from their floodplains by some kind of development (either temporarily or permanently) thus concentrating erosive energy within the channel. Other examples are where rivers are unable to transport their sediment due to a constriction in the channel (e.g. culvert, weir, diversion structure, road embankment) which creates a sediment deficit downstream, or where excessive inputs (e.g. massive soil erosion from a burn or landslide scar) build up the river bed and exacerbate overbank flows. In these instances, a stream is likely to become destabilized and is more prone to sudden lateral or vertical shifting which may produce unexpected consequences for surrounding landowners. The dollar cost of such damage may well be equaled by other economic losses including diminished recreation opportunities, impaired ecological functions, and long-term channel instability.

Cutting a river off from its floodplain by building levees, berms and roadways, armoring with stone, or dredging a channel will cause a river to adjust through physical change. The result of containing greater flows in the channel (i.e., preventing access to the floodplain) is to increase the erosive power (friction) that must be resisted by the channel boundary materials; i.e., the rocks, soil, vegetation, or manmade structures that make up the bed and banks of the river. Figure 4 shows a common scenario of channel evolution process as described by Stanley Schumm (1984). It is important to note that this diagram only illustrates channel response at one location. There are equally profound physical adjustments that occur upstream and downstream from the site of a river corridor alteration as bed degradation (head cuts) migrate up through the system and aggradation in the form of sedimentation occurs downstream. Similarly another common form of channel evolution may occur where a stream starts in a stable condition but is overloaded with sediment from upstream sources and quickly aggrades (i.e. fills in) its channel spilling out onto the surrounding floodplain with significant destructive potential.

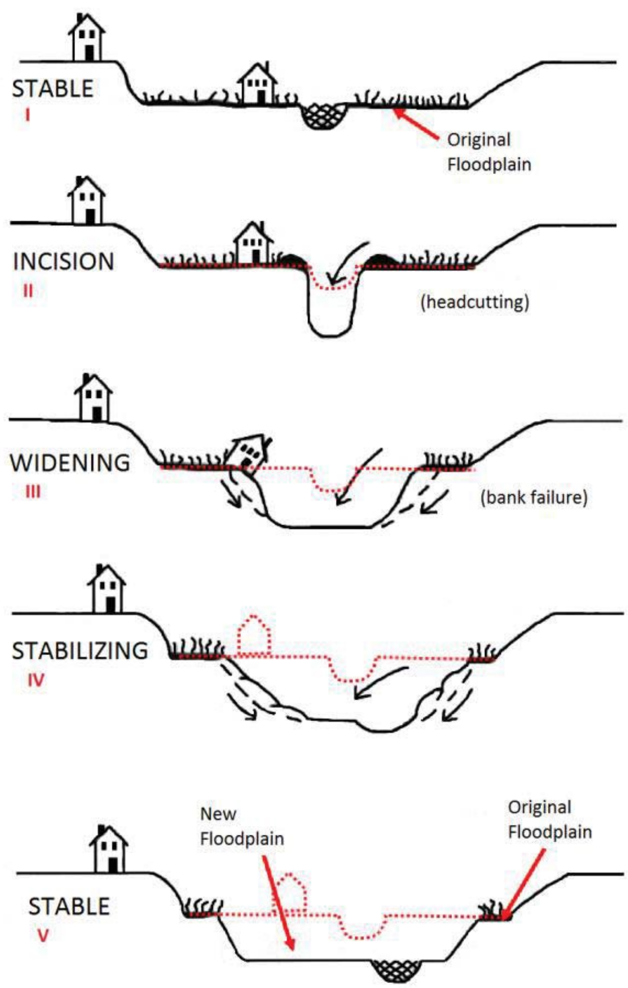



**Figure 4: Channel Evolution Process**

Understanding fluvial processes is paramount when designing transportation infrastructure that must border, cross, or interact with a riverine system. It is important to recognize the temporal aspect of channel response to change. Fluvial systems are energized by episodic events. Channel adjustment in response to management practices or encroachments may take effect immediately but may also persist for decades depending on the sensitivity and morphology of the stream channel, the magnitude of alteration, and the frequency of high flow events. Consideration of these processes and efforts to maintain stable channel dimension and access to riverine floodplains should be considered during design of permanent and temporary transportation structures within the riverine system.

## 1.9 THE RIPARIAN ZONE

Riparian areas are unique vegetation communities that occur adjacent to waterways and wetlands, and provide habitat for numerous floral and faunal species. They generally occupy transitional areas between aquatic and upland habitats, and may function as vegetative buffers for aquatic resources. The riparian zone can be rich with diversity of plant species occupying several vegetative layers. Riparian vegetation composition and structure is regulated by: (1) frequency, magnitude, duration, and seasonal timing of stream flooding and (2) subsurface moisture conditions.

The condition of the riparian zone adjacent to streams has a critical impact on water quality. Permanent and deeply rooted stream bank vegetation slows run-off of nutrients and pollutants, reduces sedimentation and solar heating, provides wildlife habitat, overhead cover and organic food supply for aquatic species. Riparian areas typically do not satisfy the USACE regulatory definitions for wetlands (i.e. hydrophytic vegetation, hydric soils, and hydrology) and frequently occur in locations transitional between these jurisdictional wetlands and adjoining uplands.

However, riparian areas perform many of the same functions as do wetlands, including maintenance of water quality, storage of floodwaters, and enhancement of biodiversity. Although riparian habitats are often combined with wetlands (as a result of their intimate relationship to the hydrological regime), riparian areas differ from wetlands in that they are generally linear, more terrestrial (less hydric), and are often dependent on a natural disturbance regime relating to flooding and stream dynamics. Though they provide similar functions, the USACE does not regulate placement of fill in riparian areas because they do not meet the three criteria of wetland habitats requiring that hydrophytic vegetation, hydric soils, and evidence of a hydrological regime be present. Figure 5 depicts a cross section of the conceptual riparian zones.

A healthy riparian zone provides many important benefits including:

- Water Quality Protection;
- Flood Control;
- Streamflow Maintenance;
- Water Temperature;
- Wildlife Habitat;
- Recreation Benefits; and
- Economic Benefits

Riparian vegetation intercepts surface runoff and associated pollutants (sediment, nitrogen, phosphorous, pesticides, heavy metal, etc.) and can buffer their effects on water quality. Loss of riparian areas reduce water quality values, faunal populations, and can result in property damage or loss of lands from bank erosion. Removal of riparian vegetation results in increased water temperatures and decreased dissolved oxygen. The loss of shade exposes soils to drying out by wind and sunlight and reduces the water storage capacity of the riparian area. Loss of riparian vegetation causes streambank erosion. The riparian zone should be considered during project design and efforts made to promote riparian function in project design. Suitable riparian buffer widths are highly variable and are dependent on several variables including slope, soil type, and vegetation mix.

Riparian area health and streambank stability are simply a reflection of the conditions in the surrounding landscape. When studying the river, stream, gulch in your project area, it is important to keep in mind that extensive stretches of eroding streambanks are only symptoms of an unhealthy system and are not the true cause of the problems.

Healthy streams and riparian areas are naturally resilient which allows them to accommodate and recover from natural disturbances such as flood events. Streambank stability is a function of a healthy riparian area. When the riparian area is degraded, the stream health will often degrade in kind and its resiliency to natural disturbances will diminish. Excessive flooding, erosion, and sedimentation will often increase. Degraded riparian areas are less effective for storing floodwaters. As more sediment is deposited, water quality is also diminished. High levels of sediment in a stream suffocate fish, fill in spawning areas and pools, and kill aquatic invertebrates.

As additional sediment is deposited in streams, the streambed may aggrade and become shallower, forcing water to spread out and cause bank erosion. Eroding banks contribute to sedimentation and lead to a wide shallow stream with little habitat value. These factors result in significant reductions in aquatic stream life. Excessive bank erosion causes wider, shallower channels and lowers the water table. A shallower stream also has a lower dissolved oxygen content and a higher temperature, which supports less aquatic life.

In other streams, headcutting may occur, which is the cutting of the streambed to a lower bed elevation. As the streambed lowers, the water table also lowers. This causes riparian vegetation to die-off and be replaced with upland vegetation, which is less successful in stabilizing the streambank. In either case, headcutting or aggradation of the streambed greatly diminishes the natural resiliency of riparian areas.

The first step to designing a transportation project within the riparian zone is to determine the best way to find ways to promote riparian functions while still meeting project needs. By doing so, mitigation for project impacts to aquatic resources can often be completed in close proximity to project impacts. While preservation and conservation of healthy streams and riparian areas should receive high priority, it is clear that restoration of degraded areas is also equally as necessary during the construction of transportation projects.

Prior to roadway construction, rivers and streams generally meandered back and forth along smooth, sinuous paths, with well establish floodplains; the width of these meanders and floodplains varying primarily due to valley slope. However, when man-made structures such as bridges and culverts are placed along stream channels, this natural pattern is interrupted as the streams are forced to flow around tight bends or through narrow constrictions. Quite often, these impacts are unavoidable to meet the transportation needs. Protection of the roadway is usually accomplished through solely traditional engineering practices. Alternatively utilizing solely natural stream/channel design on projects is often impracticable due to design requirements or minimum engineering standards. Sometimes plants fail to grow or are replaced by invasive species. Plants and other natural components are harder to model for stability due to buoyancy, decomposition, and other factors. Plants and other natural components may be subject to scouring. Plants can also be uprooted by freezing and thawing, flood flows, and debris loads. Livestock and wildlife often feed on the plants and may destroy them. Because of these variables, utilizing solely bioengineering practices may require the project to receive more frequent maintenance for a period of time, especially early in the project life until vegetation reaches maturity.

However, traditional roadway design principles can be partnered with appropriate bioengineering practices to improve synergy between the roadway and riparian systems. See Streambank Stabilization BMP in Chapter 5 for more details. Common bioengineering principles that can be evaluated include:

- Fiberschines
- Brush Mattress
- Brush Layering
- Stake Plantings
- Pole Plantings
- Post Plantings
- Brush/Tree Revetment
- Brush Trench
- Vertical Bundles
- Live Wattles or Fascines
- Rootwad Installation
- Living Cribwalls
- Engineered Log Jams
- Boulder Revetments
- Rock Toe Revetments
- Rock/Log Vanes
- Rock/Log Weirs
- Erosion Control Fabric
- Others

### 1.9.1 Practices to Promote

- Protect or establish native or non-invasive shrubs, trees, or other vegetation along streams to help prevent bank erosion, trap sediment and filter other pollutants.
- Maximize riparian buffer width while balancing sociologic and economic constraints
- Consider riparian functions during project design. Plan land disturbing activities to protect riparian zones.
- Integrate bioengineering concepts where practicable.

### 1.9.2 Practices to Avoid

- Straightening sections of streams.

- Removing streamside shrubs, trees and other vegetation.
- Excessive hard armoring in riparian zone including the stream channel.

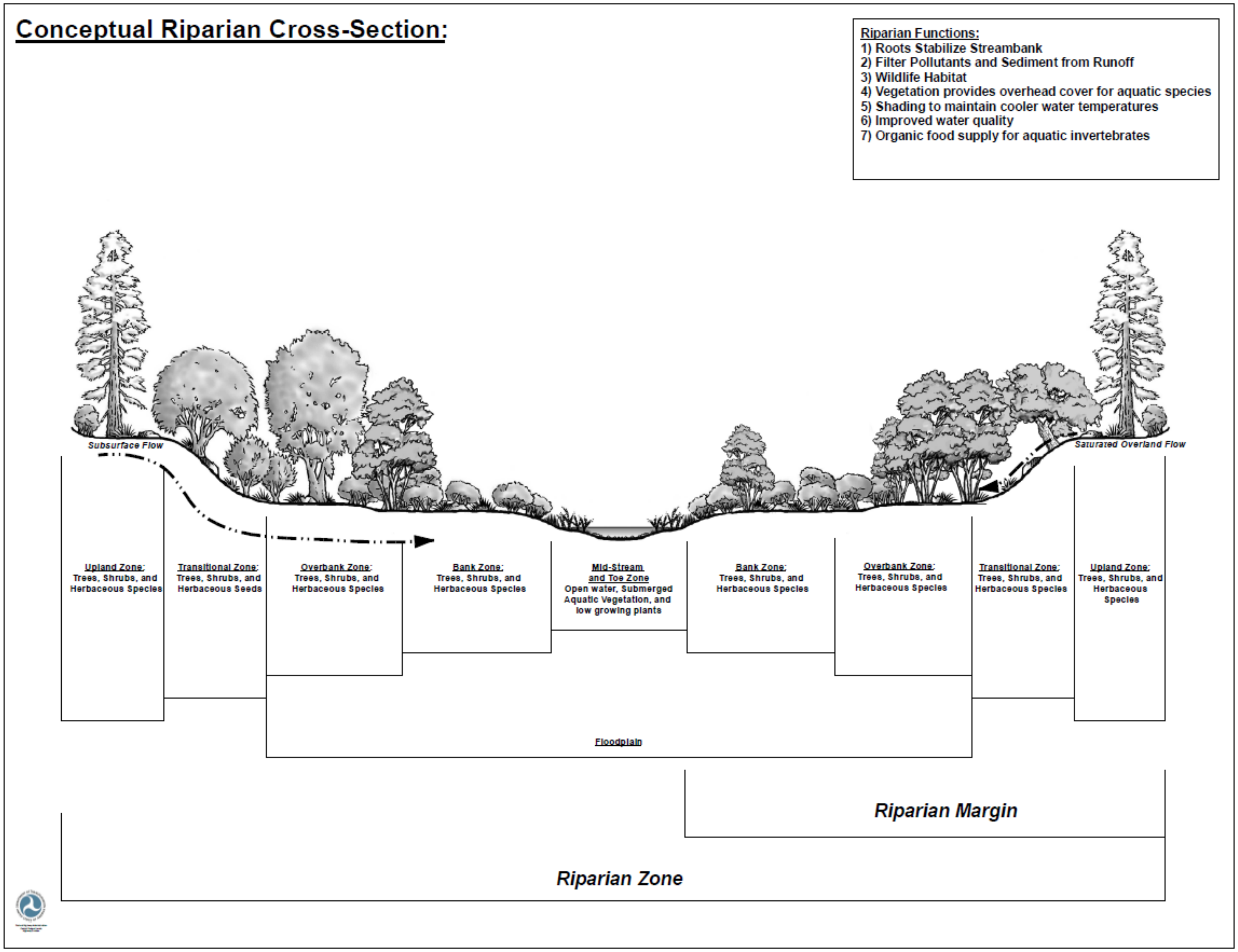



**Figure 5: Conceptual Riparian Cross Section**

# CHAPTER 2:

# STORMWATER PLANNING CONSIDERATIONS, POLLUTANTS OF CONCERN AND STORMWATER POLLUTION PREVENTION PLAN DEVELOPMENT

# 2 INTEGRATED APPROACH TO STORMWATER MANAGEMENT

In order for site designs to reflect the best stormwater management strategies, it is essential that stormwater be considered early in the site design process—before the site layout is established. Otherwise, the choice/location of stormwater controls will be constrained by prior site design decisions (e.g., predetermined grading contours), and may be limited to more expensive, higher maintenance, and less aesthetically pleasing options.

When stormwater controls are considered early, they can be effectively integrated into site design and planning. There are often opportunities to use existing or proposed site features for stormwater controls and/or repeat small-scale stormwater controls over an entire site. Small-scale controls are typically low-cost and cumulatively very effective.

In some cases, site design necessitates trade-offs among competing goals; however, especially when considered early in the process, stormwater goals can often complement other goals and agency requirements, including those related to vegetation preservation, landscaping, aesthetics, open space, recreational areas, and/or habitat.

As research, technology and information transfer have improved over recent years, alternative approaches are being sought by the public and regulatory agencies to reduce the effects of stormwater runoff from new development and redevelopment. Designers also are seeking alternatives to expedite permitting processes, reduce construction costs, reduce long-term operation and maintenance costs and increase property values.

What is better site design and low impact development, and how does it differ from conventional design? Better site design incorporates non-structural and natural approaches to new and redevelopment projects to reduce effects on watersheds by conserving natural areas, reducing impervious cover and better integrating stormwater treatment.

The aim of better site design is to reduce the environmental-impact "footprint" of the site while retaining and enhancing the owners purpose and vision for the site. Many of the better site-design concepts employ non-structural on-site treatment that can reduce the cost of infrastructure while maintaining or even increasing the value of the property relative to conventional designed developments.

The goals of better site design include:

- Prevention of stormwater effects rather than having to mitigate for them;
- Management of stormwater (quantity and quality) as close to the source as possible and minimization of the use of large or regional collection and conveyance;
- Preservation of natural areas, native vegetation and reduction of the effect of on watershed hydrology
- Usage of natural drainage pathways as a framework for site design;
- Utilization of simple, non-structural methods for stormwater management that are lower cost and lower maintenance than structural controls;
- Creation of a multifunctional landscape;

Site design should be done in unison with the design and layout of stormwater infrastructure in attaining stormwater management and land use goals. The stormwater better site-design process used a three-step process as follows:

1. **Avoiding the Impacts** – Preserving natural features and use conservation design techniques
2. **Reducing the Impacts** – Reducing impervious cover.
3. **Managing the Impacts** – Using natural features and natural low-impact techniques to manage stormwater

The first step in the planning and design process is to avoid or minimize disturbance by preserving natural areas or strategically locating development based on the location of resource areas and physical conditions at a site. Once sensitive resource areas and site constraints have been avoided, the next step is to minimize the impact of land alteration by reducing impervious areas. Finally, for the areas that must be impervious, alternative and natural stormwater management techniques are chosen as opposed to the more routine structural, "pipe-to-pond," approach.

Below in this section are strategies for incorporating better site design into projects during development.

## 2.1 Strategies for Stormwater Quality Management into Project Development

### 2.1.1 Assemble a Collaborative Team Early

In order for site designs to reflect the best stormwater management strategies, stormwater controls must be considered early in the site design process. To do that, involve the project engineer and other design professionals during the conceptual design stage, when the initial site layout is being determined. In the past, only planners and designers may have been involved at this stage of the design.

The collaborative design process may involve the following members of the Project Delivery Team (PDT) or Cross Functional Team (CFT):

- Project Owner
- Project Manager
- Planners
- Designers
- Engineers (Civil, Geotechnical, Etcetera.)
- Hydrologists
- Surveyors
- Landscape Architects
- Arborists
- Environmental Consultants
- Landscape Architects
- Land Management Agencies
- Permitting Agency Staff

It is also helpful to arrange a meeting with the local permitting agency to get agency input at the conceptual design stage; in most jurisdictions, this is referred to as the pre-application meeting.

It is equally important that those involved in site planning and design work collaborate throughout the site design process; that way, stormwater quality features can be optimally integrated into the site and project design. This might be facilitated by periodic meetings of the project team and by routing various designs to the different disciplines for review and comment.

### 2.1.2 Consider the Site and its Surroundings

Gather information about the following site characteristics, which will greatly influence the type of stormwater quality controls used on your project:

- Climatic region and terrain may lead to design modifications or BMP preferences
- Existing natural hydrologic features and natural resources, including any contiguous natural areas, wetlands, watercourses, seeps, or springs.
- Existing site topography, including contours of any slopes of 4% or steeper, general direction of surface drainage, local high or low points or depressions, and any outcrops or other significant geologic features.
- Zoning, including requirements for setbacks and open space. Location-specific restrictions could impact the selection of BMPs
- Soil types (including hydrologic soil groups) and depth to groundwater, which may determine whether infiltration is a feasible option for managing site runoff. A preliminary determination of infiltration feasibility may be made using maps in hydrology and flood control design manuals published by the local permitting agency. Also, site-specific information (e.g. from boring logs or geotechnical studies) may be required by the permitting agency, depending on the site location and characteristics.
- Existing site drainage. For undeveloped sites, determine drainage patterns by inspecting the site and examining topographic maps and survey data. For previously developed sites, locate site drainage and connections to the municipal storm drain system from a site inspection, municipal storm drain maps, and/or the approved plans for the existing development (typically on file with the local municipality).
- Existing vegetative cover and impervious areas, if any.
- Existing trees and arborists reports, if any.

### 2.1.3 Identify Opportunities and Constraints

Using the site features information gathered above, identify the principal opportunities and constraints for stormwater quality management on the site.

**Opportunities** might include existing natural areas, low (depressed) areas, oddly configured or otherwise un-developable parcels, easements, and open space (which potentially can double as locations for stormwater quality controls with the permitting agency's approval). Also look at elevation differences on the site which might provide hydraulic head (difference in water surface elevation between inflow and outflow) for structural treatment control measures.

**Constraints** might include impermeable soils, high groundwater, contaminated soils or groundwater, steep slopes, geotechnical instability, high intensity land use, expected heavy pedestrian or vehicular traffic, safety concerns, or compatibility with surrounding land uses. Also, there might be competing environmental concerns on the project site.

### 2.1.4 PRESERVE VALUABLE SITE FEATURES

Consider these techniques to preserve natural and environmentally-sensitive features on your site:

- Define the construction limits and boundaries for protected areas, identifying areas that are most suitable for development and areas that should be left undisturbed.
- Cluster the disturbance, including staging and stockpile areas, to reduce disturbance and conserve natural areas.
- Preserve natural vegetation. Vegetation is an integral part of the natural hydrologic cycle. Vegetation intercepts rainfall, and plant roots take up water that soaks into the ground. Also, roots and decaying organic matter such as leaf litter protect the soil structure and soil permeability, and therefore help preserve the pollutant-removal processes that occur in soil. When designing a site, retain as much natural vegetation as possible.
- Consider preserving trees (consider the number, quality and health and location of existing trees), even if the local jurisdiction would allow their removal, for all the reasons given above.
- Set back the construction from rivers, streams, gulches, wetlands, riparian habitats, and shorelines when practicable, or consider context sensitive solutions when designing permanent and temporary structures in these locations (See Figure 10 versus 11). Check with regulatory agencies for additional permitting requirements when designing in these environments.
- Designate and protect natural buffers for waterways and natural areas. If disturbing buffer areas during construction is unavoidable, make revegetation plans to replant them with plants and trees adapted and suited to the site conditions, preferably low-maintenance plants that are suited to the riparian zone. Such plants have a better chance of survival and adaptation to the site over time without an over reliance on water and fertilizers/pesticides.
- Understand the regulatory status of the receiving water to which the site drains. Depending on the nature of the receiving water, certain BMPs may be promoted, restricted or prohibited, or special design or sizing criteria may apply.
    - Determine if the watershed has characteristics that may require special design considerations or constrain the BMP selection.
    - Determine if the watershed and receiving water characteristics require special design considerations that affect the BMP selection. The BMP design is influenced by the type and condition of the receiving waters

downstream. Higher pollutant removal may be needed to protect the downstream resources, leading to a shorter BMP selection list.

### 2.1.5 Lay Out the Site with Topography and Soils in Mind

To minimize stormwater-related impacts, consider applying the following design principles to the site layout:

- Choose a design that replicates the site's natural drainage patterns as much as possible.
- Where possible, conform the site layout to natural landforms.
- Identify topographic lows that might be suitable for locating stormwater quality treatment features.
- Concentrate construction on portions of the site with less permeable soils, and preserve areas that will actively promote infiltration.
- When possible, avoid disturbing steep slopes and erodible soils.
- When possible, avoid excessive grading and disturbance of vegetation and soils.
- When possible, avoid the use of closed conduit systems.
- When possible, avoid compacting soils in open and/or landscape areas.
- Include grading notes addressing temporary drainage and phasing for disturbed soil areas.

### 2.1.6 Put Landscaping to Work

Stormwater quality features can often be integrated into landscape areas such as the site perimeter, ditches, medians, and roadside areas. For example, instead leveling waste material, consider creating depressed areas (i.e. bioretention, biofiltration, bioswales) to accept and filter water before sending it off the site. Using landscape areas for stormwater quality features may require some changes in the conventional approach to landscape designs, and may result in larger/wider disturbance areas.

### 2.1.7 Stop Pollution at Its Source

Rather than managing stormwater runoff only at the final point of discharge from a site, look for opportunities to manage pollution where it is first generated. Source control measures keep pollutants from entering stormwater to begin with, whereas treatment control measures remove pollutants from stormwater runoff.

Evaluate the site to look for opportunities to prevent pollution sources on the land from becoming mobilized by runoff. Construction sites can be one of the largest sources of nonpoint source pollution, especially sediment, during the period of time when the soil is exposed and susceptible to erosion. Control of these sites during this exposure is essential to proper stormwater management. During this step assess whether any Better Site Design (BSD), Low Impact Development (LID) or temporary sediment control techniques can be applied at the site to prevent erosion and minimize site disturbance during construction.

Many sources of information on the control of construction site runoff are available and are incorporated by reference to this guide. Only general descriptions of the temporary sediment control practices will be given in the Manual because the details associated with these practices are available in many other publications.

- Vegetated buffers
- Access/egress and drainage protection
- Runoff control (sediment control basins)
- Perimeter controls (access and egress, inlet protection)
- Soil and Slope stabilization
- Exposed soil covers and reinforcement
- Inspection and maintenance

Keeping the project site clean of debris, proper storage and application of chemicals, exposure of unprotected soil and adequate air quality regulation are all pollution control elements that should be exercised before the BMP selection process even begins. Specific recommended practices include things such as:

- Good Housekeeping (or other suitable term) including landscaping, street sweeping, pavement maintenance, catch basin maintenance and litter control
- Chemical controls including proper storing and stockpiling of material, fertilizer/pesticide management and spill prevention control countermeasures
- Rain Event Action Plans
- Streambank stabilization

### 2.1.8 Reduce Runoff Close to Its Source

Another way to stop pollution at its source is to reduce runoff wherever possible through the incorporation of Low Impact Development (LID) also known as Better Site Design (BSD) or Sustainable Development measures. Reducing site runoff will also reduce the volume and duration of flows to local creeks, thus reducing the potential for downstream erosion and habitat impairment. LID measures can reduce project costs for projects that typically require runoff treatment because these techniques can reduce the need for stormwater quality treatment.

The main ways to reduce runoff are to promote infiltration, minimize impervious surfaces, disconnect impervious surfaces (disconnecting impervious surfaces means to intercept the runoff by draining the roof or pavement to a pervious area and not directly to the storm drain system), and promote planting of trees and shrubs to intercept and slow the runoff.

## 2.1.9 Promote Infiltration Where Feasible

On undeveloped, undisturbed land, rain slowly percolates into the soil and impurities are filtered out and transformed through natural biological processes. When designing a site, look for ways to promote infiltration by disconnection of impervious surfaces and allowing soil to filter and naturally transform impurities. For example, consider dispersing runoff over a landscaped area rather than concentrating in a ditch. Of course, infiltration is not appropriate where it may pose a threat to groundwater quality or cause other problems such as destabilizing a site.

As part of an amended soil layer, proper mulch can also have a measurable benefit in promoting infiltration by supporting a healthy soil, trapping moisture, and slowing the runoff.

Consider infiltration stormwater quality treatment control measures for your site where feasible including such devices as: the infiltration basin and infiltration trench.

## 2.1.10 Minimize Impervious Surfaces

During design, try to limit overall coverage of pavement. This can be accomplished—where consistent with project purpose and need—by designing narrower streets and sidewalks, smaller parking lots (fewer/smaller stalls where possible, and more efficient lanes), indoor or underground parking, and incorporating porous pavement into the design. Examine site layout and circulation patterns and identify areas where landscaping, porous pavement, or stormwater measures can be substituted for pavement.

## 2.1.11 Where Feasible, Avoid Draining Impervious Areas Directly to a Storm Drain

When the built and landscaped areas are defined on your project plans, look for opportunities to minimize impervious areas that are directly connected to the storm drain system. Several options that can be considered for this, include:

- Direct runoff from impervious areas to adjacent pervious areas or depressed landscaped areas.
- Select porous pavements and surface treatments. Inventory paved areas on the preliminary site plan and identify locations where permeable pavements, such as crushed aggregate, turf block, or unit pavers can be substituted for conventional concrete or asphalt paving. Typically, these materials work best in low-traffic parking areas, rather than high-traffic areas such as drive aisles.

## 2.1.12 Treat Runoff

Treating runoff is required for projects above certain size thresholds (which vary with respect to project category). As previously noted, providing LID measures can reduce or possibly even eliminate the required treatment.

Treatment is accomplished by either detaining runoff long enough for pollutants to settle out or by filtering runoff through sand, soil, or an engineered soil matrix. Typically, the limiting design factors will be available space, available hydraulic head, and soil permeability. In some cases, a small adjustment of elevations within the design can make a particular treatment option feasible and cost effective.

When developing a drainage and treatment strategy, also consider whether to route most or all drainage through a single detention and treatment control measure or to disperse smaller control measures throughout the site. Directing runoff to a single treatment area may be simpler and easier to design, but designs that integrate smaller techniques such as swales, small landscaped areas, and planter boxes throughout the site are typically more cost-effective, less maintenance intensive, and more attractive. The various treatment control measures that may be acceptable for use are:

**Bioretention**

- Rain gardens
- Depressed parking lot islands
- Road medians
- Tree pits/stormwater planters

**Filtration**

- Media filters (surface, underground, perimeter) described by media and function
- Surface flow (vegetative) filters (grass channels dry or wet swales, filter strips)
- Combination media/vegetative filters

**Infiltration**

- Trenches
- Basins
- Dry wells
- Underground Systems

**Stormwater Ponds (design based upon components needed to fulfill the desired function)**

- Components include pre-treatment, various storage volumes (detention needed), and biologic character.
- Functions include water quality (including thermal impact) and flow control (rate and volume), which determine whether they are wet/dry or some combination

**Constructed Wetlands (selection criteria similar to ponds)**

- Components include pre-treatment (see also next section), various storage volumes (detention needed), biologic character
- Functions include primarily water quality and flow control, but could also include ecological factors

### 2.1.13 Hydromodification Management

Urbanization, vegetation removal, agricultural practices will often cause an increase in peak flow as well as runoff duration. Hydromodification Management addresses changes to runoff characteristics from urbanization and other sources that would otherwise result in the artificially altered rate of erosion or sedimentation within downstream natural channels. Hydromodification control measures should be provided (as required) to mitigate this effect. These measures function through attenuation, infiltration, and dispersion of runoff.

## 2.2 Construction Sites and Potential Pollutants

Stormwater runoff contains numerous natural constituents. However, activities such as construction, if not adequately managed, can increase these constituent concentrations to levels that may impact water quality. Pollutants associated with stormwater may include sediment, nutrients, pesticides, metals, pathogens, litter, petroleum products and chemicals.

There are a number of potential storm water pollutants that are common to Transportation construction sites. The soil-disturbing nature of construction activities and the use of a wide range of construction materials and equipment are the sources of contaminants with the potential to pollute storm water discharges.

Common construction activities that increase the potential for polluting storm water with sediment include:

- Clearing and grubbing operations
- Demolition of existing structures
- Grading operations
- Soil importing and stockpiling operations
- Clear water diversions and Isolation Technique BMPs
- Landscaping operations
- Excavation operations
- Concrete placement and finishing operations

Common construction materials with the potential to contribute pollutants, other than sediment, to storm water include the following:

- Vehicle fluids, including oil, grease, petroleum, and coolants
- Asphalt concrete and Portland cement concrete materials and wastes
- Joint seal materials, form oil, and concrete curing compounds
- Paints, solvents, and thinners
- Wood products
- Metals and plated products

- Fertilizers, herbicides, and pesticides

Construction-related waste must also be managed to prevent its introduction into storm water. Typical waste on construction sites includes:

- Used vehicle fluids and batteries
- Wastewater from vehicle cleaning operations
- Green waste from vegetation removal
- Non-storm water from dewatering operations
- Trash from materials packaging, employee lunch/meal breaks, etc.
- Contaminated soils
- Slurries from sawing and grinding operations
- Wastewater/waste from concrete washout operations
- Hazardous materials waste
- Sanitary waste
- Partially empty buckets and drums improperly sealed

Erosion and sedimentation during construction are perhaps the most visible water quality impacts due to construction activities. Other less visible impacts are associated with offsite discharge of pollutants such as metals, nutrients, soil additives, pesticides, construction chemicals, and other construction waste. After the construction project is complete, the changes to the landscape due to the project may alter the existing runoff regime or introduce new sources of pollutants that continue to impact water quality into the future. The magnitude of stormwater impacts depends on construction activities, climatic conditions, and site conditions. Development of a comprehensive SWPPP requires a basic understanding of the impacts, construction phasing (including means and methods), pollutant sources and other contributing factors, as well as suitable BMPs which can eliminate or reduce these impacts. A brief summary of common stormwater pollutants associated with transportation facilities and their impact on water quality are described below.

## 2.3 Potential Pollutants

### 2.3.1 Total Suspended Solids (TSS) AKA Sediment and Soil

Sediment or TSS is considered a pollutant when it significantly exceeds natural concentrations and can have a detrimental effect on the beneficial uses designated for the receiving water. Possible sources of TSS include natural erosion, runoff from construction sites, and other operations where the surface of the ground is disturbed. In addition, increased runoff from new impervious surfaces can accelerate the process of channel erosion, which in turn can increase TSS in runoff.

Sediment from soil erosion is made up of soil particles and gravel washed into rivers, lakes, streams and marine environments. It is the major pollutant in surface waters. Excessive sediment in waterbodies impairs aquatic ecosystems, reduces public water storage and increases drinking water treatment costs. These sediment particles are also a vehicle to transport other pollutants including nutrients, metals, petroleum products and bacteria to surface waters.

Runoff from construction sites is the major source of sediment in urban areas under development. Another major source of sediment is off-site streambank and streambed erosion. Though part of natural processes as described in the last section, this erosion can be by product caused from higher peak runoff flow rates and volumes in modified landscapes.

### 2.3.2 NUTRIENTS

Excessive inputs of nutrients such as phosphorus and nitrogen to receiving waters can overstimulate the growth of aquatic plants to the detriment of other aquatic life and to some beneficial uses of the receiving water. Nutrients generally have more adverse effects in water bodies with slow flushing rates, such as slow moving streams and lakes. Also, nutrients attached to TSS in storm water runoff can cause problems where they settle out downstream.

Sources of phosphorus that may be present in highway runoff include tree leaves, surfactants and emulsifiers, and natural sources such as the mineralized organic matter in soils. Phosphorus may be present in storm water discharges as dissolved or particulate orthophosphate, polyphosphate, or organic phosphorous.

Potential sources of nitrogen in highway runoff include atmospheric fallout, nitrite discharges from automobile exhausts, fertilizer runoff, and natural sources such as mineralized soil organic matter. Nitrogen may be present in storm water discharges as nitrate, nitrite, ammonia/ammonium, or organic nitrogen.

Phosphorus and nitrogen are the primary forms of nutrients that can cause water pollution. Lawn fertilizers used to establish and maintain vegetation can be significant sources of phosphorus. Nitrogen is also included fertilizers, but is also found in animal wastes, grass clippings and effluent from leaking septic systems.

Phosphorus and nitrogen are sources of food for the algae and bacteria that live in lakes, streams, rivers and marine environments. Waters polluted with these nutrients develop large numbers of algae and bacteria that can deplete available oxygen, causing fish and other beneficial organisms to die (Hypoxic and Anoxic conditions).

Nutrient pollution can be prevented by composting grass clippings and animal wastes, and repairing leaking septic systems. Nutrient pollution from construction sites can be minimized by applying fertilizer at the rate recommended by a soil test, or conserving topsoil to reduce or eliminate the need for fertilizer soil amendments.

### 2.3.3 PESTICIDES

A pesticide is a chemical agent designed to control pest organisms. The most common forms of pesticides are organic chemicals designed to target insects (insecticides) or vascular plants (herbicides). Pesticides have been repeatedly detected in surface waters and precipitation in the United States. Water is one of the primary media in which pesticides are transported from targeted applications to other parts of the environment. As the use of pesticides has increased, concerns about the potential adverse effects of pesticides on the environment and human health have also increased.

### 2.3.4 METALS (PARTICULATE AND DISSOLVED)

Metals in storm water runoff may be in a dissolved phase or a particulate form attached to TSS. Some Treatment BMPs are effective for removing specific particulate metals, but not for removing dissolved metals. If there are special requirements to remove dissolved metals (e.g., to address a TMDL or other site-specific requirement), then the designer should contact the State regulatory agency (i.e. Department of Environmental Quality, Water Quality Control Board, Clean Water Branch, etc.) to identify the appropriate BMP requirements. Metals in the particulate phase may be removed through sedimentation or biofiltration.

Possible sources of metals in highway runoff include the combustion products from fossil fuels, the wearing of brake pads, and the corrosion of metals, paints and solder. Metals can also reach receiving waters through the natural weathering of rock and soil erosion.

### 2.3.5 PATHOGENS

Pathogenic microorganisms including viruses, bacteria, protozoa, roundworms, tapeworms, and flatworms (aka flukes) are of concern in storm water runoff. The direct measurement of specific pathogens in water is extremely difficult. For that reason, the coliform group of organisms is commonly used as an indicator of the potential presence of pathogens of fecal origin.

Sources of total and fecal coliforms in storm water runoff are ubiquitous (e.g., soil particles, droppings of wild and domestic animals, etc.). Human sources could include illicit sewer connections and seepage from septic tanks.

### 2.3.6 TRASH

Trash in storm water is defined as manufactured objects made from paper, plastic, cardboard, glass, metal, etc. This definition does not include materials of natural origin such as gravel or vegetation. Trash in surface waters can inhibit the growth of aquatic vegetation, harm aquatic organisms by ingestion or entanglement, convey other pollutants, such as toxic substances, and cause aesthetic problems on shorelines.

### 2.3.7 PETROLEUM PRODUCTS

Petroleum products float on water and are visible. The hydrocarbons in petroleum have a strong characteristic for attaching to sediment particles. Hydrocarbons are known to be toxic to aquatic organisms. Common sources of petroleum products at the construction site are oil storage, fuel facilities, leaks from crankcases and improper disposal of drain oil.

### 2.3.8 Chemicals

Paints, solvents, sealants, cleaning agents and caulks may be found on construction sites. These chemicals along with chemically composed or treated construction materials may enter the runoff water. Water quality is easily degraded by these chemicals and removal during water treatment processes may be feasibly, fiscally, and logistical difficult.

## 2.4 Water Chemistry

Pollutants in stormwater can be affected by multiple chemical factors including pH, hardness, salinity, and temperature.

### 2.4.1 pH

pH is a measure of hydrogen ion concentration, with low pH ($pH<7$) being acidic, pH = 7 being neutral, and high pH ($7<pH<14$) being basic or alkaline. In addition to direct impact on fish and other wildlife, pH also significantly affects other chemical characteristics of stormwater. Lowering pH increases the solubility of metals, resulting in a higher fraction of metals present in the dissolved state. Raising pH increases the levels of the more toxic form of ammonia.

### 2.4.2 Hardness

Water hardness measures the presence of multivalent cations (positively charged ions) dissolved in water, particularly calcium and magnesium divalent cations (ions with a charge of +2). Increased water hardness typically decreases the toxicity of metals for fish. Hardness does not have a substantial effect on the toxicity of metals for fish in marine waters.

### 2.4.3 Salinity and Temperature

Salinity is the dissolved salts content of a body of water. Increases in salinity of surface waters can reduce the amount of oxygen that can be dissolved in the water. Increased temperature has a similar effect on dissolved oxygen. Salinity also affects metal toxicity, frequently increasing it.

## 2.5 Transport of Stormwater Pollutants

Stormwater pollutants enter receiving waters through many routes. The following sections describe what happens to stormwater pollutants when these substances come into contact with stormwater.

### 2.5.1 Initial Transport

Pollutants are deposited on road surface as particulates (e.g., brake pad dust, dirt, and salt) and liquids (e.g., oil, antifreeze, gasoline), then washed off the undercarriage of vehicles during storm events (e.g., rusted metal, hydrocarbons), or washed onto roads from adjacent exposed soils or landscaping. Pollutants on the roadway surface may coat or bind to soil particles, or may remain unbound on the road surface.

When precipitation hits impervious surfaces such as roadways, roofs, and sidewalks, contaminants may be picked up and transported in stormwater runoff, whether bound to particulate matter, dissolved in solution, or in suspension. Particulate material may be transported as suspended load or as bed load (bumping along the bottom or "bed" of the channel).

### 2.5.2 During "First Flush"

First flush describes the elevated pollutant concentrations that are often experienced during the initial part of a storm. Pollutant concentrations may peak during the "first flush" of a storm, but concentration peaks may or may not coincide with the load peaks since that is a factor of both concentration and volume of runoff. Different pollutants may also have peaks at different times during a storm, depending on how easily they are entrained. The prominence of the first flush varies considerably between storms and between locations. Factors influencing the magnitude of the first flush include the availability of pollutants on the road surface, and the form of the drainage area. The simpler and shorter a drainage area is, the more likely it is that the first flush will be clearly expressed.

Along with the storm event first flush, there may be a seasonal first flush when pollutants that have accumulated during an extended dry period are collected during the first storms of the season. Larger pollutant loads and higher median concentrations are often observed during the first storms of the season than storms later in the wet season or those closely following a series of storms. A seasonal first flush is not always present.

### 2.5.3 After Entry into a Water Body

Once stormwater carrying pollutants enters a receiving water body, several things can happen to the pollutant load. Compounds bound to soil and other solids may settle out of the water column or be filtered out by vegetation. Chemicals can be removed from the water column by biological uptake (i.e., plants and aquatic animals), or become attached to sediment and organic matter. Pollutants also may be degraded biologically (e.g., by microbes), chemically, or with sunlight (photodegradation). Compounds that are not removed from the water column may be transported to other water bodies. Pollutants that are deposited and removed from the water column may be re-entrained later, either by erosion, or by reentering a dissolved state if the chemical environment changes.

### 2.5.4 During Downstream Transport

During transport downstream, the concentration of pollutants from a discharge of highway runoff will decrease through three mechanisms. The first is dilution by increased flow in the stream from tributaries and additional base flow. Second is pollutant removal as described above. Finally, dispersion as the plume of stormwater becomes elongated due to mixing and irregular flow within the stream. This last effect means that the peak concentration in the plume will decrease, while the extent of the plume will increase.

# 2.6 Impacts of Water Quality Pollution on Aquatic Organisms

Fisheries are an important biological, ecological and economic resource. Anthropogenic (human-caused) pollution via stormwater can harm fish by reaching lethal levels of toxicity, by affecting the health and viability of fish populations, by damaging or changing food sources (such as macorinvertebrates), and by physical changes to the aquatic habitat. To protect this dwindling resource, stormwater must be treated based on both pollutants generated and vulnerability of species in receiving waters.

The toxicity to fish of a given chemical is often not directly related to chemical concentration. Instead, toxicity to fish is affected by the bioavailability of the compound. Bioavailability of a compound to fish can be affected by water temperature, pH, dissolved organic carbon, suspended sediment, and hardness (pH and hardness are discussed in the water chemistry section of this chapter); other water quality parameters are discussed below.

## 2.6.1 Water Temperature

Elevated temperatures can have lethal or non-lethal effects to aquatic organisms, depending on the temperature and duration of exposure. Acute non-lethal effects of temperature include behavior adjustments such as reduced feeding and relocation to cooler waters. Chronic non-lethal effects of elevated temperatures include reduced growth and development, both of which can affect survival and reproduction of aquatic species.

## 2.6.2 Sediment

Sediment can affect fish both directly (when suspended) and indirectly (when settled and accumulating). In suspended form, sediment may damage gill tissue, particularly if the sediment particles are angular. Several fish species are sight feeders, and murky waters can decrease their ability to find food. Suspended solids also can increase the stress response in fish, which in time can disrupt the proper functioning of other systems and alter fish behavior. Suspended solids may have a substantial effect on the bioavailability of other pollutants. Contaminants can absorb or bond to the surface of the particles, preventing them from being absorbed by fish and becoming toxic.

When sediments settle and accumulate, they can degrade fish habitat, including sensitive spawning habitat which may require clean gravel. Changes in a water body’s substrate due to excessive sedimentation can also lead to a change in the benthic macroinvertebrate community, and thus food sources for fish. Impairment of habitat can have long-term or delayed adverse effects on fish populations.

## 2.6.3 Metals

Stormwater from roadways contains metals in concentrations that may be toxic to fish, particularly copper, zinc, lead, and cadmium. The three known physiological pathways of metal exposure and uptake in fish species are gill surfaces, olfactory receptor neurons, and the digestive system. Dissolved metals are the most bioavailable form, and can be taken up by the fish directly through the gills.

Toxicity is affected by water's pH, hardness and salinity, and by other chemicals in the water.

## 2.6.4 Nutrients

Nutrients consist of chemicals that stimulate growth, particularly nitrogen and phosphorus. The largest concern about nutrients is their overstimulation of algal growth in receiving waters, particularly stagnant waters such as ponds, lakes or sloughs. Algae may affect the food chain by competing for surfaces with organisms that fish use as a food source, or in more extreme cases, cause eutrophication. Eutrophic waters experience explosive growth in algal populations, followed by a crash as nutrients are depleted. The algal die-off and decomposition uses up the dissolved oxygen in the water (i.e. hypoxic or anoxic conditions), causing fish and other aquatic life to suffocate or flee the area.

Different forms of nitrogen and phosphorous exhibit different degrees of algal growth, with orthophosphates typically having the highest potential to cause eutrophication, usually because phosphorus is the nutrient limiting plant growth—many algae can fix their own nitrogen from the atmosphere. Stagnant waters and slow moving streams are particularly vulnerable to these hazards.

## 2.6.5 Organic Pollutants

Many different organic pollutants are toxic to aquatic life, including pesticides, herbicides, pthalates, phenols, and poly aromatic hydrocarbons (PAHs). Typical levels of these pollutants in roadway runoff are not clearly defined, and in many cases may be below toxic concentrations.

## 2.6.6 Acute and Chronic Effects

Acute (limited duration) and chronic (longer duration) exposure of aquatic life to contaminants can result in various non-lethal effects. Physiological effects include altered respiration rate, blood chemistry (glucose levels, cortisol levels, etc.), swimming speed, breathing rate, and oxygen consumption. Numerous chemicals act as endocrine-disrupting compounds (EDCs), including estrogenic compounds, PAHs, flame retardants, and metal compounds. Chronic exposure to these compounds can affect species behaviorally, resulting in altered hormone-dependent behaviors (e.g., spawning, migration), and physiologically, resulting in physical changes (e.g., intersex, the presence of both male and female reproductive organs in an individual).

## 2.6.7 Indirect Impacts to Water Quality

The placement and design of highway facilities can modify elements of the landscape that have beneficial hydrologic and water quality functions. Those modifications can affect the hydrology and water quality of receiving waters, even if no highway runoff reaches them. The most important of these landscape elements are riparian zones and wetlands.

### 2.6.7.1 Riparian Zones

Riparian zones can, when in good condition, provide several water quality benefits. Trees and shrubs produce shading, which is important for regulating temperature in smaller streams. They also act as sources of food and nutrients for the biotic community of the stream, including macroinvertebrates, fish, and amphibians. During high flow events, the same trees and shrubs slow down overbank floodwaters (floodplain roughness) and provide refugia for fish. Vegetation on the stream bank is important for controlling lateral erosion. Riparian zones can also be effective at removing nutrients, sediment and other pollutants carried by runoff from adjacent developed or agricultural lands.

Destruction of riparian vegetation can therefore lead to the following adverse impacts:

- Increased stream temperature
- Increased pollutant loads derived from adjacent land use
- Reduced food supply for aquatic animals
- Increased bank erosion, which in turn leads to increased turbidity, and potentially sediment deposits on spawning gravels and modified stream geometry
- Loss of high flow refugia for fish.

#### 2.6.7.2 Wetlands

Wetlands provide both water quality and hydrologic benefits. Even degraded wetlands can effectively provide those functions. The wetlands usually perform these functions for the drainage area as a whole, not just for highway runoff. Impacts to wetland can reduce the capability and the capacity of the wetland to perform certain water resources functions. Loss of capability could result from changes in vegetation composition, structure or density, or from altered hydrology. Loss of capacity would result from a reduction of size, diversion of water away from the wetland, or other modification of the hydrology.

Loss of wetlands can lead to the following adverse impacts:

- Increased pollutant loads discharged to streams and lakes
- Higher flood peaks downstream of the wetland
- Reduced low flow discharges downstream of the wetland
- Loss of aquatic habitat.

#### 2.6.7.3 Development

Induced or facilitated development may also be considered a secondary or indirect impact of a project on water resources. The result of development is the addition of impervious area with new roads, buildings and landscape modifications. It is not the responsibility of the PDT to analyze all the potential impacts from associated development in any depth, but they should be addressed in NEPA analysis if reasonably foreseeable.

## 2.7 Step by Step Process for SWPPP Development and Implementation.

FHWA requires Contractors to prepare and implement a program to effectively control water pollution during the construction of all projects (see FP-14 Standard Specification Section 107 and 157). Projects resulting in disturbed soil area (DSA) greater than one acre are subject to the CGP depending on the project location (See Chapter 1.4.2) unless it qualifies as routine maintenance to maintain original line and grade, hydraulic capacity, and original purpose of the facility and is exempted by the controlling CGP. When the routine maintenance exemption applies, the project is not deemed a construction activity and does not require a SWPPP. Some states have a 5-acre maximum for the routine maintenance exemption.

FHWA Standard Specifications require that for the projects requiring a SWPPP, Contractors update and submit a preliminary FHWA SWPPP or prepare their own SWPPP and submit it to the CO for approval, generally prior to submitting an NOI.

If two or more small projects [less than one acre of soil disturbance] in the same corridor are part of a larger common plan of development [one acre or more], then these small projects are also subject to the requirements of the CGP to develop and implement a SWPPP.

There may be instances where a SWPPP is required even when there is less than one acre of DSA, if it is determined that the project poses a significant water quality risk; this determination will be made by the FHWA Environmental Specialist in coordination with the Project Manager or the Construction Project Engineer or if mandated, by a regulatory agency. Potential examples when this might occur could be work over a 303d waterbody, water implosions, etc.

FHWA requires that an Erosion and Sediment Control Plan (ESCP). addressing control measures be prepared and implemented by the construction Contractor for projects resulting in soil disturbance of less than one acre. The Erosion and Sediment Control plan should include basic BMPs and the site layout.

Projects that have a DSA between one and less than five acres sometimes qualify for a rainfall erosivity waiver under the CGP if the rainfall erosivity factor (R factor) is less than a value of five. The R factor takes into account project location, length of construction period, and time of year. Projects that begin and complete construction within a short period during the dry period of the year may qualify for a rainfall erosivity waiver. The period considered must include final stabilization, so if there is vegetation needed to file an notice of termination (NOT) or notice of cessation (NOC), projects generally do not qualify.

Projects that qualify for a rainfall erosivity waiver do not need to prepare a SWPPP but are required to submit proper documentation (to be exempted from the CGP) as well as prepare and implement a site-specific Erosion and Sediment Control Plan

### 2.7.1 CONSTRUCTION BMP APPLICABILITY

The flowchart presented in Figure 6 guides the user as to whether the project triggers a SWPPP or a ESCP. The flowchart also includes general questions to determine applicability of BMP categories that are described in Sections 3-5 of this Manual.

The steps described below correspond to the steps shown in Figure 5.

**Step 1 - Start**

The Contractor, the Stormwater Manager, the Certified Professional in Erosion and Sediment Control (CPESC) or project designer should use Figure 6, the guidance provided in this section, and the SWPPP/ESCP Preparation Manual to determine the project's entire BMP selection and applicability for the duration of the construction phase.

**Step 2 - Is a Construction project being proposed?**

A construction project is defined as any activity, including, but not limited to, clearing, grading, grubbing, or excavation.

If the project qualifies as a construction project, proceed to step 3.

**Step 3 - Will the project create one acre or more of Disturbed Soil Area?**

If the construction project will disturb more than one acre of soil, it is subject to the CGP depending on its location and must prepare and maintain an up to date SWPPP during the entire duration of the project.

If the project disturbs less than an acre of soil, the project must have a ESCP prepared and implemented.

**Step 4 - Can the construction project qualify for a Rainfall Erosivity Waiver?**

If a project will be a short duration and is more than one acre but less than five acres of soil disturbance, it might qualify for an EPA rainfall erosivity waiver.

If you answered yes, the project does not need coverage under the CGP but it still requires some paperwork to be filed. In addition, a ESCP must be prepared and implemented.

If you answered no, then project is subject to SWPPP requirements. See Section 107 and 157 of the FP-14 Standard Specification for further guidance on preparing a SWPPP.

**Step 5 - Are any soil areas expected to be exposed and need stabilization as part of the project or is there a need to stabilize concentrated flow conveyances?**

Any project subject to CGP is required to implement appropriate controls year-round. If the project has exposed soil areas or unlined conveyances, the Stormwater Manager or PE must be diligent in ensuring appropriate BMPs are implemented. See Section 4 of this Manual for specific BMP factsheets and proceed to Step 6.

If there are no soil areas needing stabilization and no unstable conveyances, then proceed to Step 6.

**Step 6 - Will the project require temporary controls to intercept/slowdown onsite or offsite flows?**

If the project has areas where offsite flows are coming onto the project area, flows must be conveyed and the Stormwater Manager or PE must ensure that no materials or contaminants including soil are being carried by the offsite flows. Onsite flows must be conveyed via lined or vegetated channels to reduce potential for turbid flows. See Section 4 of this Manual for specific BMP factsheets to control sediment laden runoff.

**Step 7 - Will the project require a dust control plan or is there a potential for dust control BMPs to be applicable?**

Utilize Section 4 of this Manual for specific BMP factsheets if the contract documents require the preparation and implementation of a Dust Control Plan or if there is a potential for dust to be generated at any time during the duration of the construction project.

**Step 8 - Will the project require tracking controls in any area within project limits?**

Any areas where construction vehicles are entering or exiting the project must be stabilized to prevent tracking of sediment or other materials. See Section 4 of this Manual for specific BMP factsheets for tracking control. Additionally, Street Sweeping should be evaluated and implemented either standalone or in combination to ensure compliance with all permits and contract documents.

**Step 9 - Will the project day to day operations require good housekeeping practices or have a need for non-stormwater BMPs?**

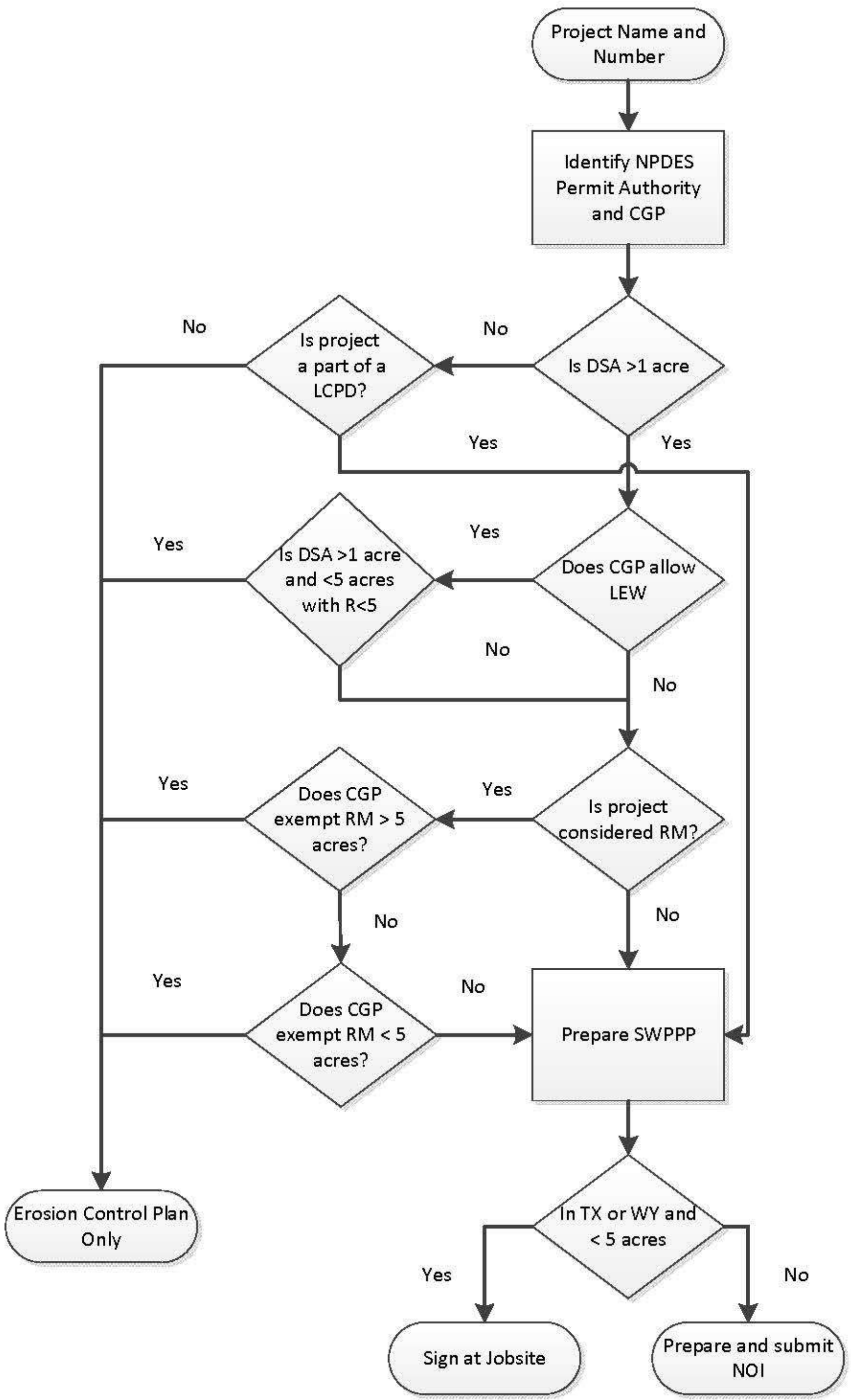
Section 4 of this Manual includes a list of source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with stormwater.

**Step 10 - Will the project include storage of materials, spill prevention needs, waste management or other housekeeping practices?**

All materials or wastes either stored or generated during the construction phase must be properly stored and disposed of. Section 4 of this Manual includes lists of BMPs that must be utilized at the Contractor’s yard, where the materials are stored, or where construction activities are being conducted to ensure proper usage, containment, and disposal of materials and waste products.

**END - Specific BMP factsheets should be reviewed and the Project’s SWPPP or ESCP text and tables along with the Erosion and Sediment Control Drawings should be modified to ensure appropriate controls are implemented year-round**

STORMWATER PLAN DECISION TREE




Acronyms

| | |
|---|---|
| NPDES | National Pollutant Discharge Elimination System – Clean Water Act |
| CGP | Construction General Permit |
| LEW | Low Erosivity Waiver (<5 acres and R<5) |
| R | Rainfall Erosivity Value based on location and duration of project |
| LCPD | Larger Common Plan of Development |
| DSA | Disturbed Soil Area |
| RM | Routine Maintenance maintaining line, grade, and hydraulic capacity for same functions as existing facility. |
| SWPPP | Storm Water Pollution Prevention Plan |
| NOI | Notice of Intent |

**Figure 6. Stormwater Plan Decision**

### 2.7.2 Internal Roles and Responsibilities

NPDES compliance clearly requires an interdisciplinary approach. However, roles and responsibilities for the various NPDES requirements need to be defined and responsibility/accountability for the overall program needs to be assigned within an agency. The following recommendations are made to promote consistency within FHWA and thereby facilitate development and maintenance of the standard operating procedures for a Clean Water Act Compliance Program. In general:

- Environmental staff should be responsible and accountable for defining the NPDES processes required for program compliance, as well as monitoring and refining those processes for adequacy and continuous improvement.
- Project Management staff should be responsible and accountable for ensuring that all program level processes are addressed and executed to the appropriate degree on the project development and delivery level.
- Environmental staff should be responsible for compiling or reviewing the stand-alone SWPPP, as well as preparing and submitting the NOI and NOT.
- Design staff should be responsible for development of the Erosion and Sediment Control (ESC) plans and specifications included in the PS&E package.
- Construction staff should be responsible for implementing and maintaining the SWPPP during the life of the construction project.
- Technical Services staff should act as a program and/or project resource to provide necessary support information, such as custom analysis, design, or evaluation of standard drawings, SCRs, and new products.

### 2.7.3 External Roles and Responsibilities

It is recommended that FHWA use program agreements to define general agency roles and responsibilities associated with their Clean Water Act Program(s). Project Agreements should be used to clearly define project-specific partner roles and responsibilities early in the project development process. Partner agencies should be considered for one or more of the following roles and responsibilities:

- Providing re-vegetation design, specifications, seed mixes or can implementation permanent re-vegetation actions if preferred.
- Removing temporary erosion and sediment control devices that need to be left in place until final stabilization is achieved
- Submitting an NOI and assuming the NPDES responsibilities when construction work is complete but final stabilization has not yet been achieved.

Assigning these roles and responsibilities to the local FHWA partner agencies is considered appropriate for three primary reasons:

- The owning agency or the management agency has intimate local knowledge of the climatic, soil conditions and ground cover type and density that can be supported. This knowledge allows them to identify and develop the most appropriate final stabilization strategy and design.

- The owning agency has responsibility for maintenance of the roadside and thereby, a vested interest in ensuring that final stabilization can be achieved and maintained.
- The brief, contractual nature of the FHWA presence makes it very difficult to address NPDES requirements between the end of the construction contract and final stabilization. This is especially true in arid to semi-arid regions where final stabilization may take time to achieve.

## 2.7.4 Step By Step Process Description and Recommendations

The 2007 EPA SWPPP Preparation Guide is a reference that can be used by the PDT as basic guidance for project-level compliance. Additional State and local requirements apply for compliance with state and local requirements. When available these have been discussed in the state requirements section.

The EPA guidance describes seven steps for developing and implementing project-specific SWPPPs. These steps are expanded below to correlate with common Infrastructure delivery milestones. Recommendations for improving the SWPPP development and implementation practices within FLH are listed below in the context of EPA's 7-step process. The following recommendations are provided to assist with the details of completing various tasks associated with SWPPP development and implementation in accordance with the 2007 EPA Guide and state specific requirements.

### 2.7.4.1 STEP 1 - DATA COLLECTION: (Site Assessment and Planning; Chapter 3 in 2007 EPA Guide

During this step, project development team is identifying, documenting, and communicating the applicable NPDES requirements and other related environmental issues. This includes identifying the governing construction general permit (CGP), applicable state and local ordinances, and sensitive resources such as impaired waters, presence of Threatened or Endangered Species or critical habitat, etc.

- Topography
- Drainage
- Soils
- Ground Cover
- Adjacent Areas
- Requirements

Inventory the existing site conditions to gather information which will help you develop the most effective erosion and sediment control plan. The information obtained should be plotted on a map and verbally explained in the narrative portion of the plan.

**TOPOGRAPHY -** A small scale topographic map of the site should be prepared to show the existing contour elevations at intervals of from 1 to 5 feet depending upon the slope of the terrain. Existing topographic maps (e.g., USGS or local government topographic maps) can be a good starting point, however, the information should be verified by a field investigation.

**DRAINAGE PATTERNS -** All existing drainage swales and patterns on the site should be located and clearly marked on the topographic map. Live or intermittent streams should be shown on the map.

**SOILS -** Major soil type(s) on the site should be determined and shown on the topographic map. Soils information can be obtained from a soil survey if one has been published for your project location. Commercial soils evaluations are also available. Soils information should be plotted directly onto the map or an overlay of the same scale for ease of interpretation.

**GROUND COVER -** The existing vegetation such as tree clusters, grassy areas, and unique vegetation should be shown on the map. In addition, existing denuded or exposed soil areas should be indicated.

**ADJACENT AREAS -** Areas adjacent to the site should be delineated on the topographic map. Such features as streams, roads, houses or other buildings, wooded areas, etc. should be shown. Streams which will receive runoff from the site should be surveyed to determine their carrying capacity.

### 2.7.4.2 STEP 2 - DATA ANALYSIS:

When all of the data in Step 1 are considered together, a picture of the site potentials and limitations should begin to emerge. The site planner should be able to determine those areas which have potentially critical erosion hazards. The following are some important points to consider in site analysis:

#### *2.7.4.2.1 Topography*

The primary topographic considerations are slope steepness and slope length. Because of the effect of accumulated runoff, erosion potential is greater on long, steep slopes. When the percent of slope has been determined, areas of similar steepness should be outlined. Slope gradients can be grouped into three general ranges of soil erodibility:

| | |
|---|---|
| 0.7 % | Low Erosion Hazard |
| 7-15% | Moderate Erosion Hazard |
| >15% | High Erosion Hazard |

Within these slope gradient ranges, the erosion hazard becomes greater as the slope length increases. Therefore, in determining potential critical areas, the site planner should be aware of excessively long slopes. As a general rule, the erosion hazard will become critical if the slope exceeds the following criteria:

| Slope Gradient Ranges | Slope Length |
|---|---|
| 0.7 % | 300 Feet |
| 7-15% | 150 Feet |
| >15% | 75 Feet |

#### 2.7.4.2.1 Natural Drainage

The existing drainage patterns, which consist of overland flow, swales and depressions, and natural watercourses, should be identified in order to plan around critical areas where water will concentrate. Where possible, natural drainages should be used to convey runoff over and off the site to avoid the expense and problems of constructing an artificial drainage system. Man-made ditches and waterways can become part of the erosion problem if they are not properly designed and constructed. Care should also be taken to be sure that the increased runoff from the site will not erode or flood the existing natural drainage system. Possible sites for stormwater detention should be located at this time.

#### 2.7.4.2.2 Soils

Such soils properties as natural drainage, depth to bedrock, depth to seasonal water table, permeability, shrink-swell potential, texture, and erodibility should exert a strong influence on land development decisions.

Reference to soil maps and accompanying supportive data contained in soil surveys enables planners to determine the soil conditions in proposed construction areas. Soil surveys have proven to be of great savings in time and money, and their use has resulted in improved designs, more effective planning, and more accurate preliminary estimates of construction costs. In many cases, the survey will provide adequate information, but in other situations, it may only provide warnings or indications of soil-related problems that are likely to been countered. In such cases, a more in-depth, on-site investigation may be needed.

Soil surveys are helpful in providing information on soil properties. This information can aid in determining soil suitability as a source of topsoil, fill for highway subgrade, or sand and gravel. The interpretations also show the degree of limitation of soils used for such purposes as: building foundations, highways, streets, roads, parking lots, pipelines, underground utility lines, and septic tank adsorption fields.

Soil surveys describe soil properties that become important in erosion and sediment control planning for construction sites. These properties include the following:

***Erodibility -*** The major soil consideration from an erosion and sediment control standpoint is its erodibility. An erodibility factor (K) indicates the susceptibility of different soils to the forces of erosion. A soil survey report includes the K factor for each soil found in the survey area. These K factors are used in the Universal Soil Loss Equation to determine soil loss from an area over a period of time due to splash, sheet, and rill erosion. K factors can be grouped into three general ranges:

| Erodibility Factors (K) | Erodibility |
|---|---|
| 0.23 and lower | Low |
| 0.23 to 0.36 | Moderate |
| 0.36 and up | High |

Cohesiveness of soil particles varies with different layers of the same soil, causing varying degrees of erodibility at different depths. Therefore, depth of excavation must be considered in determining soil erodibility on a construction site.

***Slope -*** Slope ranges are recorded in soil surveys. Cut and fill slopes can be identified by studying soil maps. The erosion potential increases as the slope becomes longer and steeper.

***Soil Permeability -*** Permeability is one of the major factors influencing erosion. Soil permeability is a characteristics of the soil that enables it to transmit water or air. Deep, permeable soils are less erodible simply because more of the rainfall soaks in, reducing surface runoff. Permeability also varies with different layers and must be considered when excavating.

***Hydrologic Soil Group -*** The hydrologic soil group is a direct reflection of the infiltration rate of the soil. The hydrologic soil groups, based on the infiltration and transmission rates of the soil, are:

A. (Low runoff potential) Soils having high infiltration rates even when thoroughly wetted.

B. Soils having moderate infiltration rates when thoroughly wetted.

C. Soils having slow infiltration rates when thoroughly wetted.

D. (High runoff potential) Soils having very slow infiltration rates when thoroughly wetted.

***Texture -*** Soil texture refers specifically to the proportions of clay, silt, and sand below 2 millimeters in diameter contained in a mass of soil. The USDA textural triangle is commonly used to assess the percentages of clay, silt, and sand in the basic soil textural classes.

Soil texture is a primary factor affecting soil erodibility and is reflected in the erodibility factor (K). Erodibility tends to increase with greater silt and very fine sand content. Soils with high clay content are generally more resistant to detachment, but once detached, the clay particles are easily transported.

***Shrink-Swell Potential -*** Certain soils have clays that shrink when dry and swell when wet. In this situation, special foundations are required to allow for this variation. By consulting the soil survey, soils with these problems can be identified and the necessary precautions can be taken.

***Flood Hazard -*** Although soil survey information does not take the place of hydrologic studies, it does provide estimates of where floods are most likely to occur. The hazards of flooding and ponding are rated in soil surveys, and flood-prone areas are shown on soil maps.

***Soil Reaction (pH) -*** Soil survey information includes the pH of the individual layers of each soil. This factor becomes very helpful when planning the establishment of vegetation on a construction site.

***Wetness -*** Data indicating natural soil drainage, depth to seasonal water table, and suitability for winter grading for various kinds of soils are available in soil surveys. With this information such things as seasonal limitations on the use of heavy earth-moving machinery and the hazard estimation of flooding or damage to underground structures due to soil wetness can be determined.

***Depth to Bedrock -*** Soil surveys indicate the type of bedrock and the areas where bedrock will be encountered at a depth of less than 5 to 6 feet. This factor becomes very helpful in determining time and cost of excavation.

#### *2.7.4.2.3 Ground Cover*

Ground cover is the most important factor in terms of preventing erosion. Any existing vegetation which can be saved will help prevent erosion. Trees and other vegetation protect the soil as well as beautify the site after construction. If the existing vegetation cannot be saved, the planner should consider staging construction and using temporary seeding, or temporary mulching.

Staging of construction involves stabilizing one part of the site before disturbing another. In this way, the entire site is not disturbed at once and the time without ground cover is minimized. Temporary seeding and mulching involve seeding or mulching areas which would otherwise lie exposed for long periods of time. The time of exposure is limited; thus the erosion hazard is reduced.

#### *2.7.4.2.4 Adjacent Areas*

An analysis of adjacent properties should focus on areas downslope from the construction project. Of major concern, should be watercourses which will receive direct runoff from the site. The potential for sediment pollution of these watercourses should be considered as well as the potential for downstream channel erosion due to increased volume, velocity and peak flow rate of stormwater runoff from the site. The potential for sediment deposition on adjacent properties due to sheet and rill erosion should also be analyzed so that appropriate sediment trapping measures can be planned and installed prior to any land-disturbing activity.

#### *2.7.4.2.5 Regional or Local Requirements*

Find out what the requirements are for the development. Contact the appropriate authority for information regarding permits, fees and plan submission, as well as any other requirements.

### 2.7.4.3 STEP 3 - SITE PLAN DEVELOPMENT: (SWPPP Development - Selecting Erosion and Sediment Control BMPs; Chapter 4 in 2007 EPA Guide) and Selecting Good Housekeeping BMPs (Chapter 5 in 2007 EPA Guide))

During this step, project development staff are developing an erosion and sediment control plan as part of the contract package. The plan should include standard drawings, details, quantities, and specifications for all structural BMPs. BMPs should be selected from the approved BMPs listed within this manual. Wherever possible, rely on erosion controls to keep sediment in place. Back up those erosion controls with sediment controls to ensure that sediment doesn’t leave the site.

Project development staff should also include contract specifications and pay items for non-structural BMPs to address unique site conditions, requirements or risks as needed.

Examples include water quality monitoring and/or an on-site Erosion and Sediment Control Supervisor.

The project delivery team should provide progress reviews of the plans and specifications (typically 15, 30, 50, 70, and 95%) to ensure compliance with the NPDES CGP requirements and to facilitate development of the stand-alone SWPPP described in Step 4 and the Notice of Intent (NOI) described in Step 5. During this step, project staff are responsible for selecting good housekeeping BMPs and providing appropriate contract language in the specifications. EPA defines good housekeeping BMPs as those designed to prevent contamination of stormwater from a wide range of materials and wastes at the construction site. The areas to focus on during this step area:

#### 2.7.4.3.1 Develop Site Plan Design

After analyzing the data and determining the site limitations, the planner can develop a site plan. When designing the site plan, keep in mind that increases in runoff may require structural runoff control measures or channel improvements. Both items are expensive, and even more so when the site plan must be re-designed to accommodate the runoff control measures. Therefore, try to minimize the increase in runoff or include runoff control measures in the initial design.

The following are some points to consider when developing the site plan:

1. Fit development to terrain. The development of an area should be tailored to the existing site conditions. This will avoid unnecessary land disturbance, thereby minimizing the erosion hazards and costs. Cutting and filling should be minimized, or avoided if possible. Slopes should be at a maximum of 2:1 to provide for final stabilization.
2. Confine construction activities to the least critical areas. Any land disturbance in the critically erodible areas will necessitate the installation of more costly control measures.
3. Cluster development together. This minimizes the amount of disturbed area, concentrates utility lines and connections in one area, and provides more open natural space. The cluster concept not only lessens the erodible area, but it reduces runoff and generally reduces development costs.
4. Minimize impervious areas. Keep paved areas such as parking lots and roads to a minimum. This goes hand in hand with cluster development in eliminating the need for duplicating parking areas, access roads, etc. The more land that is kept in vegetative cover, the more water will infiltrate, thus reducing runoff and erosion.
5. Utilize the natural drainage system. If the natural drainage system of a site can be preserved instead of being replaced with storm sewers or concrete channels, the potential for downstream damages due to increased runoff can be minimized.

- Include topographic mapping in SWPPP document to better show drainage patterns and discharge points.
- Show “clearing limits” on Erosion and Sediment Control plans.

- Determine if a pay item for Erosion Control Supervisor is appropriate,

#### 2.7.4.3.2 Measure Area of Disturbance

- Area of disturbance should be based on clearing limits, not slope stake limits.
- Where no definition is provided by the CGP, consider defining "disturbance" as any erodible surface of 1 acre or more, except travel ways of gravel or better surface type.

#### 2.7.4.3.3 Determine Drainage Area

- Calculate area draining to all non-standard, structural BMP devices. An example is a sediment basin.
- Provide sediment basin(s) when the area of disturbance within a given drainage area is ten acres or more. (EPA sediment basin sizing criteria – lesser of 3,600 cubic feet per acre or volume of Q2 runoff from drainage area.)

#### 2.7.4.3.4 Determine Runoff Coefficient

- Required for sediment basin design in drainage areas of 200 acres or less.

### 2.7.4.4 STEP 4 - PLAN FOR EROSION AND SEDIMENT CONTROL

When the layout of the site has been determined, a plan to control erosion and sedimentation from the disturbed areas must be formulated.

The project delivery team should be guided by the appropriate state minimum standards. These minimum standards establish a level of control for all projects. The site planner should determine which of the "minimum standards" are applicable to the site and select conservation practices which can be used to comply with these regulations. If the site planner feels that any of the "minimum standards" are not justified on a given project, the site planner should apply for a variance in accordance with appropriate procedures.

The following procedure is recommended for erosion and sediment control planning:

#### 2.7.4.4.1 Determine the Limits of Clearing and Grading

Decide which areas must be disturbed in order to accommodate the proposed construction. Pay special attention to critical areas which must be disturbed.

#### 2.7.4.4.2 Divide the Site into Drainage Areas

Determine how runoff will travel over the developed site. Consider how erosion and sedimentation can be controlled in each small drainage area before looking at the entire site. Remember, it is easier to control erosion than to contend with sediment after it has been carried downstream.

#### 2.7.4.4.3 Select Erosion and Sediment Control Practices

Erosion and sediment control practices can be divided into three broad categories: vegetative controls, structural controls, and management measures. Each of these categories have temporary and permanent control measures to be considered. Vegetative and structural practices should be selected and designed in accordance with state standards and specifications. Management measures are construction management techniques which, if properly utilized, can minimize the need for physical controls and possibly reduce costs.

1. Vegetative Controls. Keep in mind that the first line of defense is to prevent erosion. This is accomplished by protecting the soil surface from raindrop impact and overland flow of runoff. The best way to protect the soil surface is to preserve the existing ground cover. Where land disturbance is necessary, temporary seeding or mulching should be used on disturbed areas which will be exposed for long periods of time.

   Erosion and sediment control plans must contain provisions for permanent stabilization of denuded areas. Selection of permanent vegetation should include the following considerations:

   a) Applications to site conditions;

   b) Establishment requirements;

   c) Maintenance requirements; and

   d) Aesthetics

2. Structural Controls - Structural control practices are generally more costly than vegetative controls. However, they are usually necessary since not all disturbed areas can be protected with vegetation. Structural controls are often used as a second or third line of defense to capture sediment before it leaves the site.

   It is very important that structural practices be selected, designed and constructed according to the standards and specifications in this guide. Improper use or inadequate installation can result in failure of the control and subsequent release of any trapped sediment.

3. Management Measures - Good construction management is as important as structural and vegetative practices for erosion and sediment control, and there is generally little or no cost involved. Following are some management considerations which can be employed:

   a) Include erosion and sediment control as an agenda item for the pre-construction meeting.

   b) Sequence construction so that no area remains exposed for unnecessarily long periods of time (longer than 14 days if no work is occurring on disturbed site).

      - Work in a logical sequence, especially for drainage items.

      - Anticipate the site conditions and drainage patterns that will exist as the construction progresses toward the final product.

      - Have the materials on-hand to complete the work without delay. Apply temporary stabilization immediately after grading.

   c) On large projects, stage the construction if possible, so that one area can be stabilized before another is disturbed.

   d) Consider the time of year:

- Be prepared for sudden thunderstorms (i.e. See Rain Event Action Plans)
- Install erosion and sediment controls immediately.
- Use straw mulch, especially during poor germination periods.

e) Physically mark off limits of land disturbance on the site with tape, signs or other methods, so that workers can see areas to be protected.

f) Develop and carry out a regular inspection and maintenance schedule for erosion and sediment control practices.

g) Designate one individual (preferably the job superintendent) responsible for implementing the erosion and sediment control plan. Make sure that all workers understand the major provisions of the erosion and sediment control plan. Establish reporting procedures for problems identified by workers.

**PLAN FOR STORMWATER MANAGEMENT -** Where increase runoff will cause the carrying capacity of a receiving channel to be exceeded, the site planner must select appropriate stormwater management measures.

#### 2.7.4.5 STEP 5 - PREPARE THE PLAN (SWPPP Development - Inspections, Maintenance, and Recordkeeping (Chapter 6 in 2007 EPA Guide.) and Certification and Notification (Chapter 7 in 2007 EPA Guide, Section 7 of the 2017 EPA Construction General Permit)

All the necessary planning work has been done in steps 1-4. The final step consists of consolidating the pertinent information and developing it into a specific erosion and sediment control plan for the project.

The plan consists of two parts: a narrative and site plan. The narrative verbally explains the problems and their solutions with all necessary documentation. The site plan is a map(s) or drawing(s) that depicts information contained in the narrative.

During this step the project delivery team should include contract specifications for inspection, maintenance, and recordkeeping required during construction. Contract specifications should identify the government provided SWPPP as a key project record and require appropriate care and maintenance throughout the life of the construction project including submittal of the SWPPP and all supporting documentation at the end of construction.

EPA and many state general permits require that a sign be posted near the main entrance of construction sites. It is common for the permits to require that the sign contain a copy of the NOI, the location of the SWPPP, and a contact person for viewing the SWPPP.

The project delivery team is responsible for compiling a stand-alone SWPPP (unless this activity has been delegated to the contractor) that will be provided to Construction for directing and documenting the implementation of the SWPPP. Elements of the stand-alone SWPPP include the CGP, erosion and sediment control plan from the contract package, associated narrative, contract specifications, NOI, inspection forms, and any other information required to comply with the CGP. During this step, the project delivery team is responsible for preparing the NOI, obtaining an authorized signature on the certification, and submitting the NOI in accordance with the CGP. Consider paying for maintenance of ESC items with equipment and labor hours, or prorating a lump sum amount over the life of the contract.

### *2.7.4.5.1 General Requirements*

All operators associated with a construction site under the CGP must develop a SWPPP consistent with the state or EPA requirements prior to the submittal of the NOI. The SWPPP must be kept up-to-date throughout coverage under the CGP.

If a SWPPP was prepared under a previous version of this permit, the operator must review and update the SWPPP to ensure that this permit's requirements are addressed prior to submitting an NOI for coverage under the CGP.

- The SWPPP does not establish the effluent limits that apply to your site's discharges; these limits are established in the CGP.
- You have the option of developing a group SWPPP where you are one of several operators at your site. For instance, if both the owner and the general contractor of the construction site are operators and thus are both required to obtain a permit, the owner may be the party undertaking SWPPP development, and the general contractor (or any other operator at the site) can choose to use this same SWPPP, as long as the SWPPP addresses the general contractor's (or other operator's) scope of construction work and functions to be performed under the SWPPP. Regardless of whether there is a group SWPPP or several individual SWPPPs, all operators would be jointly and severally liable for compliance with the permit.
- Where there are multiple operators associated with the same site through a common plan of development or sale, operators may assign to themselves various permit-related functions under the SWPPP provided that each SWPPP, or a group SWPPP, documents which operator will perform each function under the SWPPP. However, dividing the functions to be performed under each SWPPP, or a single group SWPPP, does not relieve an individual operator from liability for complying with the permit should another operator fail to implement any measures that are necessary for that individual operator to comply with the permit, e.g., the installation and maintenance of any shared controls. In addition, all operators must ensure, either directly or through coordination with other operators, that their activities do not cause a violation and/or render any other operators' controls and/or any shared controls ineffective. All operators who rely on a shared control to comply with the permit are jointly and severally liable for violations of the permit resulting from the failure to properly install, operate and/or maintain the shared control.

### *2.7.4.5.2 SWPPP Contents*

At a minimum, the SWPPP must include the following information and as specified in other parts of the applicable permit.

**All Site Operators.** Include a list of all other operators who will be engaged in construction activities at the site, and the areas of the site over which each operator has control.

**Stormwater Team.** Identify the personnel (by name or position) that are part of the stormwater team, as well as their individual responsibilities, including which members are responsible for conducting inspections.

**Nature of Construction Activities.** Include the following: (If plans change due to unforeseen circumstances or for other reasons, the requirement to describe the sequence and estimated dates of construction activities is not meant to "lock in" the operator to meeting these dates. When departures from initial projections are necessary, this should be documented in the SWPPP itself, or in associated records, as appropriate.)

a) A description of the nature of your construction activities, including the age or dates of past renovations for structures that are undergoing demolition;

b) The size of the property (in acres or length in miles if a linear construction site);

c) The total area expected to be disturbed by the construction activities (to the nearest quarter acre or nearest quarter mile if a linear construction site);

d) A description of any on-site and off-site construction support activity areas covered by the CGP;

e) The maximum area expected to be disturbed at any one time, including on-site and off-site construction support activity areas;

f) A description and projected schedule for the following:

   i. Commencement of construction activities in each portion of the site, including clearing and grubbing, mass grading, demolition activities, site preparation (i.e., excavating, cutting and filling), final grading, and creation of soil and vegetation stockpiles requiring stabilization;

   ii. Temporary or permanent cessation of construction activities in each portion of the site;

   iii. Temporary or final stabilization of exposed areas for each portion of the site; and

   iv. Removal of temporary stormwater controls and construction equipment or vehicles, and the cessation of construction-related pollutant-generating activities.

g) A list and description of all pollutant-generating activities on the site. For each pollutant-generating activity, include an inventory of pollutants or pollutant constituents (e.g., sediment, fertilizers, pesticides, paints, caulks, sealants, fluorescent light ballasts, contaminated substrates, solvents, fuels) associated with that activity, which could be discharged in stormwater from your construction site. You must take into account where potential spills and leaks could occur that contribute pollutants to stormwater discharges, and any known hazardous or toxic substances, such as PCBs and asbestos, that will be disturbed or removed during construction;

h) Business days and hours for the project;

i) If you are conducting construction activities in response to a public emergency, a description of the cause of the public emergency (e.g., mud slides, earthquake, extreme flooding conditions, widespread disruption in essential public services), information substantiating its occurrence (e.g., state disaster declaration or similar state or local declaration), and a description of the construction necessary to reestablish affected public services.

**Site Map.** Include a legible map, or series of maps, showing the following features of the site:

a) Boundaries of the property;

b) Locations where construction activities will occur, including:

   i. Locations where earth-disturbing activities will occur (note any phasing), including any demolition activities;

ii. Approximate slopes before and after major grading activities (note any steep slopes);

iii. Locations where sediment, soil, or other construction materials will be stockpiled;

iv. Any water of the U.S. crossings;

v. Designated points where vehicles will exit onto paved roads;

vi. Locations of structures and other impervious surfaces upon completion of construction; and

vii. Locations of on-site and off-site construction support activity areas.

c) Locations of all waters of the U.S. within and one mile downstream of the site's discharge point. Also identify if any are listed as impaired, or are identified by the EPA as a Tier 1, Tier 2, or Tier 3 water for antidegradation requirements;

a. EPA's CGP has special requirements for discharges to waters that receive Tier 2, Tier 2.5, or Tier 3 protections for antidegradation purposes.

b. EPA's antidegradation regulation, at 40 CFR 131.12, provides a framework for maintaining and protecting water quality for:

i. existing uses (known as "Tier 1");

ii. high quality waters by establishing a process for authorizing the lowering of water quality where existing water quality exceeds levels needed to support propagation of fish, shellfish, and wildlife and recreation in and on the water (known as "Tier 2"); and

iii. Outstanding National Resource Waters (known as "Tier 3"). While EPA's antidegradation regulation only outlines three levels of antidegradation protection, some states and tribes include an additional level of antidegradation protection between Tier 2 and Tier 3 (sometimes known as "Tier 2.5").

c. High quality (Tier 2) waters may be identified on a parameter-by-parameter basis or on a water body-by-water body basis consistent with the requirements of 40 CFR 131.12(a)(2). States and tribes using a parameter-by-parameter basis (sometimes called a "pollutant-by-pollutant approach") do not maintain a list of Tier 2 waters, but instead identify a high quality water at the time an entity proposes an activity that would lower water quality. In contrast, states and tribes using a water body-by-water body basis typically identify high quality waters in advance on a list by weighing a variety of factors (e.g., chemical, physical, biological, and other information) to classify a water body's overall quality.

i. Tier 2 Waters: Listed as "High Quality Waters", and all wetlands that are not designated as an Outstanding Resource Water.

ii. Tier 2.5 Waters: Listed as "Outstanding Resource Water", "Public Water Supply", "Tributary to Public Water Supply", all wetlands bordering Outstanding Resource Waters, and vernal pools.

iii. Tier 3 Waters: Defined as "Special Resource Water".

d) Areas of federally listed critical habitat within the site and/or at discharge locations;

e) Type and extent of pre-construction cover on the site (e.g., vegetative cover, forest, pasture, pavement, structures);

f) Drainage patterns of stormwater and authorized non-stormwater before and after major grading activities;

g) Stormwater and authorized non-stormwater discharge locations, including:

i. Locations where stormwater and/or authorized non-stormwater will be discharged to storm drain inlets; and (The requirement to show storm drain inlets in the immediate vicinity of the site on your site map only applies to those inlets that are easily identifiable from your site or from a publicly accessible area immediately adjacent to your site.)

ii. Locations where stormwater or authorized non-stormwater will be discharged directly to waters of the U.S.

h) Locations of all potential pollutant-generating activities identified in 2.7.4 5.2.3(g) above;

i) Locations of stormwater controls, including natural buffer areas and any shared controls utilized to comply with this permit; and

j) Locations where polymers, flocculants, or other treatment chemicals will be used and stored.

### *2.7.4.5.3 Non-Stormwater Discharges.*

Identify all authorized non-stormwater discharges that will or may occur. The following non-stormwater discharges associated with your construction activity are typically authorized under the CGP provided that, with the exception of water used to control dust and to irrigate vegetation in stabilized areas, these discharges are not routed to areas of exposed soil on your site and you comply with any applicable requirements for these discharges:

a) Discharges from emergency fire-fighting activities; Fire hydrant flushing;

b) Landscape irrigation;

c) Water used to wash vehicles and equipment, provided that there is no discharge of soaps, solvents, or detergents used for such purposes;

d) Water used to control dust;

e) Potable water including uncontaminated water line flushing;

f) External building wash down, provided soaps, solvents, and detergents are not used, and external surfaces do not contain hazardous substances (e.g., paint or caulk containing polychlorinated biphenyls (PCBs));

g) Pavement wash waters, provided spills or leaks of toxic or hazardous substances have not occurred (unless all spill material has been removed) and where soaps, solvents, and detergents are not used. You are prohibited from directing pavement wash waters directly into any water of the U.S., storm drain inlet, or stormwater conveyance, unless the conveyance is connected to a sediment basin, sediment trap, or similarly effective control;

h) Uncontaminated air conditioning or compressor condensate;

i) Uncontaminated, non-turbid discharges of ground water or spring water;

j) Foundation or footing drains where flows are not contaminated with process materials such as solvents or contaminated ground water; and

k) Construction dewatering water discharged in accordance with the CGP.

### 2.7.4.6 Description of Stormwater Controls.

For each of the CGP erosion and sediment control effluent limits, pollution prevention effluent limits, and construction dewatering effluent limits, as applicable to your site, you must include the following:

i. A description of the specific control(s) to be implemented to meet the effluent limit;

ii. Any applicable stormwater control design specifications (including references to any manufacturer specifications and/or erosion and sediment control manuals/ordinances relied upon);

iii. Routine stormwater control maintenance specifications; and

iv. The projected schedule for stormwater control installation/implementation.

You must also include any of the following additional information as applicable.

i. **Natural buffers and/or equivalent sediment controls**:

You must include the following:

a) The compliance alternative to be implemented;

b) If complying with alternative 2, the width of natural buffer retained;

c) If complying with alternative 2 or 3, the erosion and sediment control(s) you will use to achieve an equivalent sediment reduction, and any information you relied upon to demonstrate the equivalency;

d) If complying with alternative 3, a description of why it is infeasible for you to provide and maintain an undisturbed natural buffer of any size;

e) For "linear construction sites" where it is infeasible to implement compliance alternative 1, 2, or 3, a rationale for this determination, and a description of any buffer width retained and/or supplemental erosion and sediment controls installed; and

f) A description of any disturbances that are exempt under Part 2.2.1 that occur within 50 feet of a water of the U.S.

ii. **Perimeter controls for a "linear construction site":** For areas where perimeter controls are not feasible, include documentation to support this determination and a description of the other practices that will be implemented to minimize discharges of pollutants in stormwater associated with construction activities.

Note: Routine maintenance specifications for perimeter controls documented in the SWPPP must include the requirement that sediment be removed before it has accumulated to one-half of the above-ground height of any perimeter control.

iii. **Sediment track-out controls:** Document the specific stabilization techniques and/or controls that will be implemented to remove sediment prior to vehicle exit.

iv. **Sediment basins:** In circumstances where it is infeasible to utilize outlet structures that withdraw water from the surface, include documentation to support this determination, including the specific conditions or time periods when this exception will apply.

v. **Treatment chemicals:**

You must include the following:

a. A listing of the soil types that are expected to be exposed during construction in areas of the project that will drain to chemical treatment systems. Also, include a listing of soil types expected to be found in fill material to be used in these same areas, to the extent you have this information prior to construction;

b. A listing of all treatment chemicals to be used at the site and why the selection of these chemicals is suited to the soil characteristics of your site;

c. If the applicable EPA Regional Office authorized you to use cationic treatment chemicals for sediment control, include the specific controls and implementation procedures designed to ensure that your use of cationic treatment chemicals will not lead to an exceedance of water quality standards;

d. The dosage of all treatment chemicals to be used at the site or the methodology to be used to determine dosage;

e. Information from any applicable Safety Data Sheet (SDS);

f. Schematic drawings of any chemically enhanced stormwater controls or chemical treatment systems to be used for application of the treatment chemicals;

g. A description of how chemicals will be stored consistent with the CGP;

h. References to applicable state or local requirements affecting the use of treatment chemicals, and copies of applicable manufacturer's specifications regarding the use of your specific treatment chemicals and/or chemical treatment systems; and

i. A description of the training that personnel who handle and apply chemicals have received prior to permit coverage, or will receive prior to use of the treatment chemicals at your site.

vi. **Stabilization measures:**

You must include the following:

a. The specific vegetative and/or non-vegetative practices that will be used;

b. The stabilization deadline that will be met in accordance with Part 2.2.14.a.i-ii;

c. If complying with the deadlines for sites in arid, semi-arid, or drought-stricken areas, the beginning and ending dates of the seasonally dry period and the schedule you will follow for initiating and completing vegetative stabilization; and

d. If complying with deadlines for sites affected by unforeseen circumstances that delay the initiation and/or completion of vegetative stabilization, document the circumstances and the schedule for initiating and completing stabilization.

vii. **Spill prevention and response procedures:**

You must include the following:

a. Procedures for expeditiously stopping, containing, and cleaning up spills, leaks, and other releases. Identify the name or position of the employee(s) responsible for detection and response of spills or leaks; and

b. Procedures for notification of appropriate facility personnel, emergency response agencies, and regulatory agencies where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity consistent with Part 2.3.6 and established under either 40 CFR 110, 40 CFR 117, or 40 CFR 302, occurs during a 24-hour period. Contact information must be in locations that are readily accessible and available to all employees.

You may also reference the existence of Spill Prevention Control and Countermeasure (SPCC) plans developed for the construction activity in accordance with Part 311 of the CWA (Section 107, FP-14), or spill control programs otherwise required by an NPDES permit for the construction activity, provided that you keep a copy of that other plan on site.

viii. **Waste management procedures:** Describe the procedures you will follow for handling, storing and disposing of all wastes generated at your site consistent with all applicable federal, state, tribal, and local requirements, including clearing and demolition debris, sediment removed from the site, construction and domestic waste, hazardous or toxic waste, and sanitary waste.

ix. **Application of fertilizers:** Document any departures from the manufacturer specifications where appropriate.

### 2.7.4.7 STEP 6 – SWPPP IMPLEMENTATION (Chapter 8 in 2007 EPA Guide.)

The SWPPP is the tool used in preventing stormwater pollution during construction. However, it is just a plan. Implementing the SWPPP, maintaining the BMPs, and then constantly reevaluating and revising the BMPs and SWPPP are the keys to protecting receiving waters in the project area.

Implementation of SWPPP starts before construction activities commence. The following steps are included within this activity.

1. Complete the necessary trainings with contractor and sub-contractor employees.
2. Ensure roles and responsibility in the SWPPP are clearly understood for owner, operators, as well as sub-consultant staff who are working for the prime contractor. (Multiple parties have roles and responsibilities for carrying out or maintaining stormwater BMPs at a given site.)
3. Implement the SWPPP before construction starts.
4. Conduct inspections and maintenance activities for BMPs.
5. Update and evaluate the SWPPP.

#### *2.7.4.7.1 SWPPP Implementation 1: Train Contractors and Sub-Contractors:*

The projects construction workers and subcontractors might not be familiar with stormwater BMPs, and they might not understand their role in protecting local rivers, lakes and coastal waters. Training of construction staff and subcontractors in the basics of erosion control, good housekeeping, and pollution prevention is one of the most effective BMPs you can institute at your site.

Basic training should include:

- Spill prevention and cleanup measures, including the prohibition of dumping any material into storm drains or waterways;
- An understanding of the basic purpose of stormwater BMPs, including what common BMPs are on-site, what they should look like, and how to avoid damaging them; and
- Potential penalties associated with stormwater noncompliance.

Staff directly responsible for implementing the SWPPP should receive comprehensive stormwater training, including:

- The location and type of BMPs being implemented
- The installation requirements and water quality purpose for each BMP
- Maintenance procedures for each of the BMPs being implemented
- Spill prevention and cleanup measures;
- Inspection and maintenance recordkeeping requirements

You can train staff and subcontractors in several ways: short training sessions (food and refreshments will help increase attendance), posters and displays explaining your site's various BMPs, written agreements with subcontractors to educate their staff members, signs pointing out BMPs and reminders to keep clear of them. Every construction site operator should try to train staff and subcontractors to avoid damaging BMPs. By doing so, operators can avoid the added expense of repairs.

#### *2.7.4.7.2 SWPPP Implementation 2: Roles and Responsibilities:*

Several personnel have responsibilities during the SWPPP implementation. These should be clearly documented in the SWPPP. At any given site, there might be multiple parties (developer, general contractor, builders, subcontractors) that have roles and responsibilities for carrying out or maintaining stormwater BMPs at a given site. In some cases (state requirements vary), there may be one entity that has developed the SWPPP and filed for permit coverage and, therefore, is designated as the operator. When other parties at a site are not officially designated as operators, many operators are incorporating the roles and responsibilities of these non-operators in the agreements and contract requirements they have with these companies and individuals. Several states have stormwater regulations that hold other parties liable even if they are not identified as the operator.

Some of the responsibilities of CFLHD staff include:

- The PE/RE is responsible for ensuring SWPPP training with contractor and sub-contractor staff occurs and is documenting in the training log of the SWPPP.
- The PE/RE is responsible for ensuring inspections, maintenance, and recordkeeping are performed by the construction contractor in accordance with the CGP and the SWPPP.
- The PE/RE is responsible for reviewing and approving contractor requested modifications to SWPPP.
- The PE is responsible for directing changes to the SWPPP as needed to ensure compliance with the CGP.
- The PE/RE is responsible for requesting support from Project Delivery Team, as needed.
- The COE or PE should conduct a Quality Assurance (QA) review of NPDES compliance during every project site visit. The QA review should include inspection of the SWPPP to ensure that it is properly maintained. The QA review

should also include an inspection of site conditions to ensure that site conditions match the SWPPP and that erosion and sediment control is effective. The COE's QA reviews should be documented in the SWPPP.

- The PE should be responsible for submitting the final post-construction SWPPP to the Environment group when construction work is complete so that NOT documentation can be prepared.

### *2.7.4.7.3 SWPPP Implementation 3: Implement the SWPPP Before Construction Starts:*

Once the permit coverage has been obtained and the project is ready to begin construction, it is time to implement the SWPPP. The project must implement appropriate parts of your SWPPP before construction activity begins. This generally involves installing storm drain inlet protection, construction entrances, sediment basins, and perimeter silt fences before clearing, grading, and excavating activities begin.

After construction activities begin, the SWPPP should describe when additional erosion and sediment controls will be installed (generally after initial clearing and grading activities are complete). It is also a trigger for when to begin BMP inspections once clearing and grading activities begin.

### *2.7.4.7.4 SWPPP Implementation 4: Conduct Inspections and Maintain BMPs:*

The contractor should develop an inspection schedule for the project that considers the size, complexity, and other conditions of the project. This may include less formal inspections as well as the regularly scheduled weekly and monthly compliance inspections. Additional inspections may be required before, during and after anticipated wet weather events (i.e. rain or snow). Conducting inspections during rain events also allows a construction site operator to address minor problems before they turn into major problems.

Taking photographs can help you document areas that need maintenance and can help identify areas where subcontractors might need to conduct maintenance. Photographs can also help provide documentation to EPA or state inspectors that maintenance is being performed.

***Recommended Inspection Sequencing:***

You should conduct thorough inspections of your site, making sure to inspect all areas and BMPs. The seven activities listed below are a recommended inspection sequence that will help you conduct a thorough inspection.

1. Plan the inspection:
   - □ Create a checklist to use during the inspection;
   - □ Obtain a copy of the site map with BMP locations marked
   - □ Plan to walk the entire site, including discharge points from the site and any off-site support activities such as concrete batch plants should also be inspected
   - □ Follow a consistent pattern each time to ensure you inspect all areas (for example, starting at the lowest point and working uphill)

2. Inspect discharge points and downstream off-site areas:
   - ◻ Inspect discharge locations to determine whether erosion and sediment control measures are effective
   - ◻ Inspect nearby downstream locations, if feasible
   - ◻ Walk down the street to inspect off-site areas for signs of discharge. This is important in areas with existing curbs and gutters
   - ◻ Inspect downslope municipal catch basin inlets to ensure that they are adequately protected
3. Inspect perimeter controls and slopes:
   - ◻ Inspect perimeter controls such as silt fences to determine if sediment should be removed
   - ◻ Check the structural integrity of the BMP to determine if portions of the BMP need to be replaced
   - ◻ Inspect slopes and temporary stockpiles to determine if erosion controls are effective
4. Compare BMPs in the site plan with the construction site conditions:
   - ◻ Determine whether BMPs are in place as required by the site plan;
   - ◻ Evaluate whether BMPs have been adequately installed and maintained
   - ◻ Look for areas where BMPs are needed but are missing and are not in the SWPPP
5. Inspect construction site entrances:
   - ◻ Inspect the construction exits to determine if there is tracking of sediment from the site onto the street
   - ◻ Refresh or replace the rock in designated entrances
   - ◻ Look for evidence of additional construction exits being used that are not in the SWPPP or are not stabilized
   - ◻ Sweep the street if there is evidence of sediment accumulation
6. Inspect Sediment controls:
   - ◻ Inspect any sediment basins for sediment accumulation
   - ◻ Remove sediment when it reduces the capacity of the basin by the specified amount (many permits have specific requirements for sediment basin maintenance. Check the appropriate permit for requirements and include those in your SWPPP)
7. Inspect pollution prevention and good housekeeping practices:
   - ◻ Inspect trash areas to ensure that waste is properly contained
   - ◻ Inspect material storage and staging areas to verify that potential pollutant sources are not exposed to stormwater runoff

- Verify that concrete, paint, and stucco washouts are being used properly and are correctly sized for the volume of wash water
- Inspect vehicle/equipment fueling and maintenance areas for signs of stormwater pollutant exposure

#### *2.7.4.7.5 SWPPP Implementation 5: Update and Evaluate the SWPPP:*

Like the construction site, the SWPPP is dynamic. It is a document that must be amended to reflect changes occurring at the site. As plans and specifications change, those changes should be reflected in the SWPPP. If a BMP is not working and it is decided to replace it with another, this change must be reflected in the SWPPP. Document in the SWPPP transitions from one phase of construction to the next, and make sure that new BMPs required for that next phase are implemented.

During construction, the effectiveness of BMPs should be evaluated as part of the routine inspection process. An informal analysis of both the inspection's findings and the contractor's list of BMP repairs will often reveal an inadequately performing BMP. An inspection immediately after a rain event can indicate whether another approach is needed.

It may be necessary to remove an existing BMP and replace it with another, or another BMP can be added in that area to lessen the impact of stormwater on the original installation. When the SWPPP is updated, the contractor can simply mark it up, particularly for relatively simple changes and alterations. More significant changes might require a rewriting of portions of the narrative component of the SWPPP. The site map should also be updated as necessary to reflect the site conditions.

### 2.7.4.8 STEP 7 – FINAL STABILIZATION AND PERMIT TERMINATION (Chapter 9 in EPA guidance.)

As construction progresses, areas not under construction must be stabilized. EPA and most states have specific requirements and time frames that must be followed. Generally, it is a wise management practice to stabilize areas as quickly as possible to avoid erosion problems that could overwhelm silt fences, sediment basins, and other temporary sediment control devices.

When construction project or an area within the overall project is completed, the contractor must take steps to permanently and finally stabilize it. Each permit has specific requirements that must be met for final stabilization. After an area is fully stabilized, the contractor should remove temporary sediment and erosion control devices (i.e. silt fences). The project might also be able to stop routine inspections in these stabilized areas. However, in some states such as Colorado, inspections are required every 30 days (after the construction has been completed and the site is stabilized) until permit coverage has been terminated to remain in permit compliance. Also, final stabilization often takes time (weeks or even months), especially during times of low rainfall, during the colder months of the year, especially in arid regions.

It is important to understand that native vegetation must be established uniformly over each disturbed area on the site. For example, stabilizing seven of ten slopes, or leaving an area equivalent to 30 percent of the disturbed area completely un-stabilized will not satisfy the uniform vegetative cover standard required by the permit.

The contractor must establish vegetation over the entire disturbed soil area at a minimum density of 70 percent of the native vegetative coverage. For example, if native vegetation covers 50 percent of the undisturbed ground surface (e.g., in an arid or semi-arid area), the contractor must establish 35 percent vegetative coverage uniformly over the entire disturbed soil area ($0.70 \times 0.50 = 0.35$ or 35 percent). Additionallly, several states require perennial native vegetative cover that is self-sustaining and capable of providing erosion control equivalent to preexisting conditions to satisfy the 70 percent coverage requirement.

In lieu of vegetative cover, alternate measures that provide equivalent soil stabilization can be applied to the disturbed soil area. Such equivalent measures include blankets, reinforced channel liners, soil cement, fiber matrices, geotextiles, rock mulch or other erosion resistant soil coverings or treatments. The construction general permit might allow all or some of these alternate measures for equivalent soil stabilization for final stabilization however permit requirements will vary.

**PERMIT TERMINATION**

Once the construction activity has been completed and disturbed areas are finally stabilized, it is time to review the general permit for specific steps to end the projects permit coverage. EPA and many states require the permittee to submit a form, often called a notice of termination (NOT), to end coverage under that construction general permit. Before terminating permit coverage, make sure the project has accomplished the following activities:

- Remove any construction debris and trash
- Remove temporary BMPs (such as silt fence). Remove any residual sediment as needed. Seed and mulch any small bare spots. BMPs that will decompose, including some fiber rolls and blankets, may be left in place
- Check areas where erosion-control blankets or matting were installed. Cut away and remove all loose, exposed material, especially in areas where walking or mowing will occur. Reseed all bare soil areas
- Ensure that 70 percent of background native vegetation coverage or equivalent stabilization measures have been applied for final soil stabilization of disturbed areas
- Repair any remaining signs of erosion
- Ensure that post-construction BMPs are in place and operational. Provide written maintenance requirements for all post-construction BMPs to the appropriate party
- Check all drainage conveyances and outlets to ensure they were installed correctly and are operational. Inspect inlet areas to ensure complete stabilization and remove any brush or debris that could clog inlets. Ensure banks and ditch bottoms are well vegetated. Reseed bare areas and replace rock that has become dislodged
- Seed and mulch or otherwise stabilize any areas where runoff flows might converge or high velocity flows are expected
- Remove temporary stream crossings. Grade, seed, or re-plant vegetation damaged or removed

- Ensure subcontractors have repaired their work areas before final closeout

Depending on the project agreement, final stabilization may be the responsibility of FHWA or it may be transferred to the owning and maintaining agency. If the owner agency has agreed to take responsible for final stabilization, Construction should submit the final as-built SWPPP to the FLH Environment group. The Environment group will should prepare and submit the NOT, and transfer the SWPPP to the owner agency. The owner agency would then be responsible for filing an NOI and assuming all of the NPDES requirements through final stabilization in accordance with the program or project agreement. This is a practice successfully applied in CFL. However, If FLH is responsible for final stabilization which is the standard approach to construction projects we oversee; then FLH will remain responsible for all NPDES requirements until final stabilization is achieved and the final SWPPP is submitted to the Environment group. Environment will prepare and submit the NOT and archive all SWPPP related records with the construction records during construction closeout. See Permit Termination below for more details.

# CHAPTER 3:

# PERMANENT POST CONSTRUCTION STORMWATER BEST MANAGEMENT PRACTICES

# 3 STORMWATER TREATMENT PROGRAM – PERMANENT BEST MANAGEMENT PRACTICES AND SELECTION MATRIX

## 3.1 SUMMARY

Generally, the Permanent BMP Selection process uses metrics and ratings for treatment suitability (effectiveness) for pollutants of concern, site suitability and physical constraints, maintenance needs and constraints, and costs to document the decision-making process for selecting among a suite of potential BMPs for a project. However, the BMP Selection process prioritizes the use of "preferred" BMPs, which include infiltration-focused technologies and those BMPs that maintain or improve soil health. The hope is that documentation of this process will improve and reduce review timelines by the regulatory agencies as they understand how BMPs were evaluated and selected on our projects.

BMP Selection is based off "primary treatment mechanisms" rather than removal efficiency data reported for specific BMPs to determine the treatment suitability for pollutants of concern. Primary treatment mechanism refers to the prevailing unit operations that result in the removal or chemical breakdown of a given compound. If a BMP employs a given treatment mechanism, then by definition the BMP is considered effective at treating the pollutant of concern.

The goal is to promote integrated stormwater design and LID in the FHWA-CFLHD project development and design process. Under this process, consideration is given to these approaches at the project planning phase and throughout the preliminary and final design phases. The goal for FHWA-CFLHD, which is consistent with the regulatory agencies' position, is to reduce the amount of runoff generated to the extent practicable before relying on engineered stormwater facilities to meet water quantity and water quality requirements. The "traditional" POC for roadway projects (e.g., suspended solids, oil and grease, and particulate metals) are addressed in this process, while extra focus may be given to BMPs that address other POCs of concern to other regulatory agencies.

## 3.2 STORMWATER TREATMENT GUIDANCE AND BMP SELECTION MATRIX

Permanent stormwater treatment during design starts with problem definition of a specific receiving water or watershed and continues through development of the conceptual design for the selected stormwater treatment system. Stormwater management begins with simple methods that minimize the amount of runoff that occurs from a site and methods that prevent pollution from accumulating on the land surface and becoming available for wash-off. Even though we know that we will never be able to fully accomplish either of these goals, we can make substantial progress using better site design and low impact development techniques, pollution prevention, volume minimization, structural BMP techniques and lastly temporary construction erosion and sediment control.

After all of the efforts possible are made to minimize runoff and surface wash-off, we must recognize that runoff from our transportation projects will occur. Therefore, the next major category of BMPs focuses on the collection and treatment of this runoff locally and regionally, either as stand-alone practices or in treatment train combinations. Some of the available BMPs are best used to reduce or manage runoff volume, while others focus on water quality protection. Some planning and construction BMPs are easy to implement, while others involve more extensive engineering and design. Figure 7 illustrates the conceptual stormwater treatment design process, of which the BMP selection process is one part. Through the process, the project delivery team integrates pollution prevention and minimization techniques, LID, BSD and other practices to reduce the runoff generated by the project once the project goals and objectives have been defined and site characterization has occurred.

As Figure 7 illustrates, BMP Selection is applied after the site characterization, project objectives and treatment goals have been defined and after the preliminary conceptual site layout and integrated stormwater design considerations have been developed. At this point, the Project Team has considered appropriate LID/BSD options to reduce runoff and the design process is at the point where "end-of-pipe" stormwater treatment options are needed. Figure 8 shows the components (or metrics) of the selection process, key "check-in" points within the PDT and the regulatory agencies, and the "streamlining benefits" of the BMP selection process.

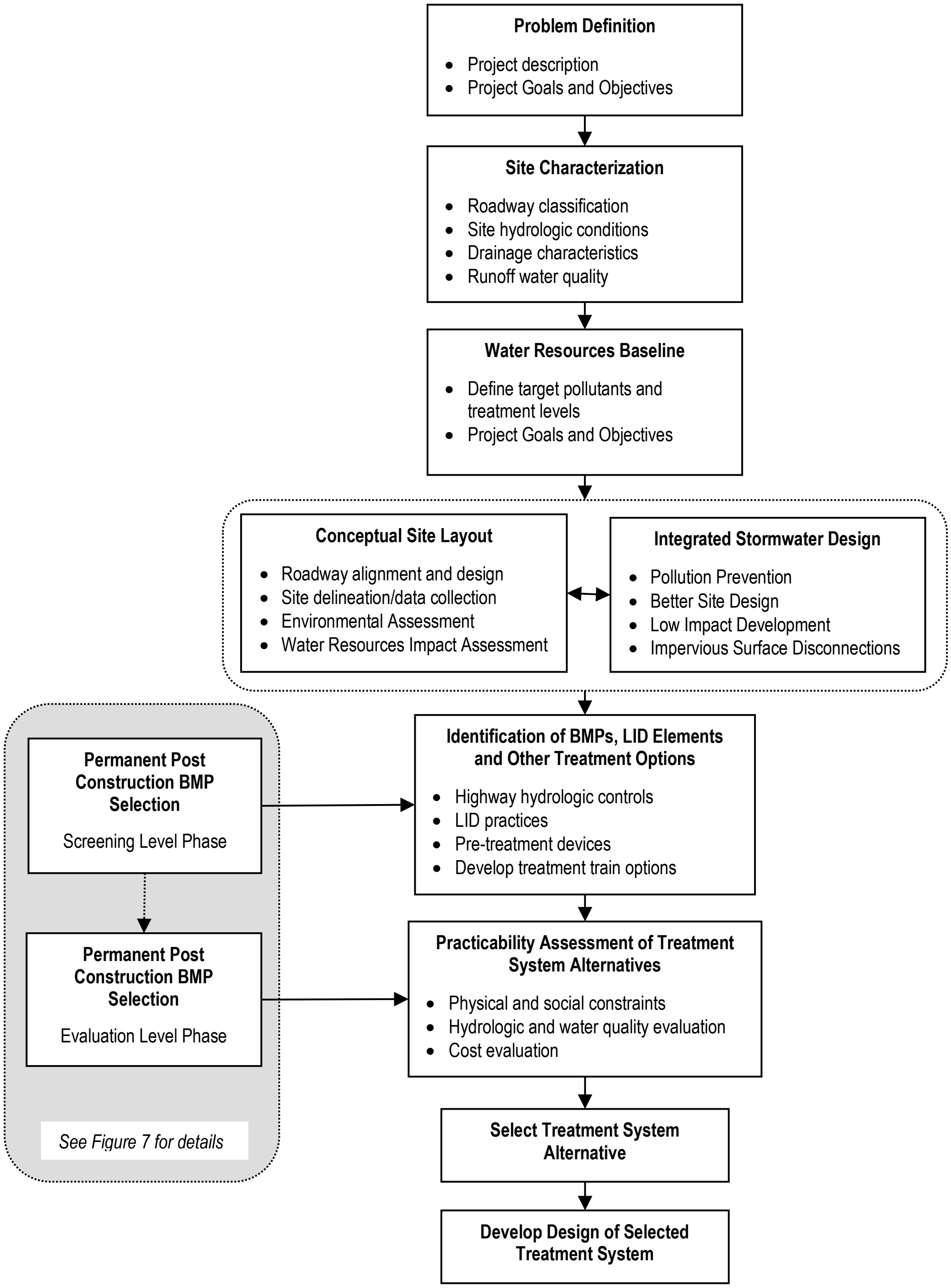



**Figure 7. Conceptual Stormwater Treatment Design Process**

BMP Selection includes metrics and ratings for treatment suitability (effectiveness) of pollutants of concern, site suitability and physical constraints, maintenance needs and constraints, and costs. The selection process is generally applied in two steps: (i) BMP screening level; and (ii) treatment train alternatives evaluation. The BMP screening step in the selection process evaluates individual BMPs and is used to identify the most appropriate BMPs for the project. Those BMPs that are screened through are used to develop treatment train alternatives. These alternatives are evaluated further and in more detail with respect to conceptual design layouts for the individual components of the treatment train. The alternatives are evaluated using similar metrics from the screening step. As Figure 8 shows, there are at least two opportunities for the regulatory agencies and the Project Team to discuss documented decisions in the selection process.

Permanent post construction BMPs have been identified as part of the literature review for treatment effectiveness. Most BMPs have been evaluated for effectiveness at treating certain pollutants of concern. BMPs that have a treatment mechanism effective for target pollutant removal, have been identified as preferred alternatives for treating these pollutants. If "preferred" BMPs for the target pollutants are feasible and appropriate for the project site, streamlining of the BMP selection process is possible and the formal evaluation can be by-passed as this BMP has been determined to be suitable for treatment of the target pollutants, as illustrated in Figure 8. However, the stormwater/hydraulics engineer still needs to design the system and ensure that the BMP is feasible and meets design standards. Permanent BMPs fall into the following categories:

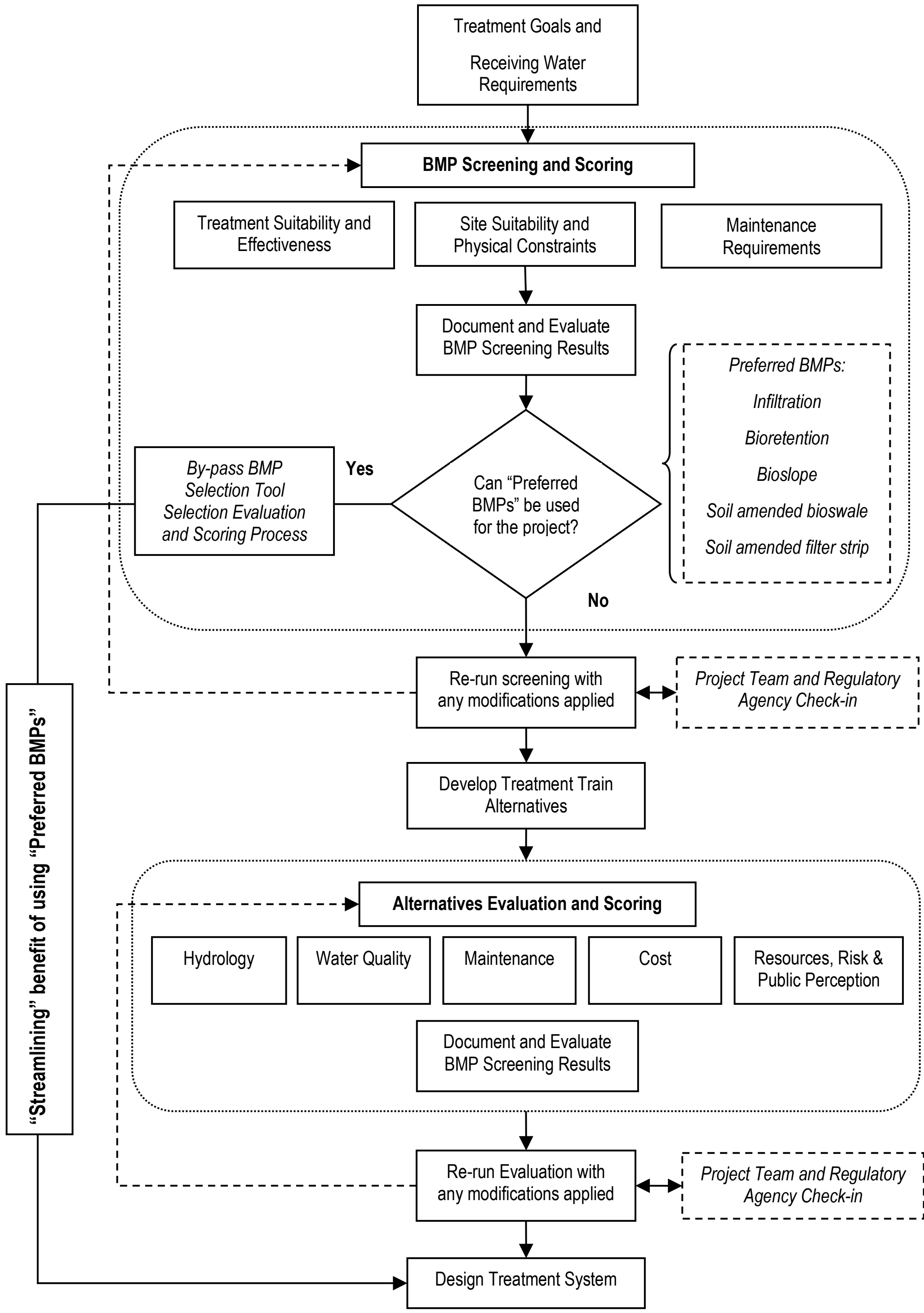



**Figure 8. Schematic of Permanent Post Construction BMP Selection Tool**

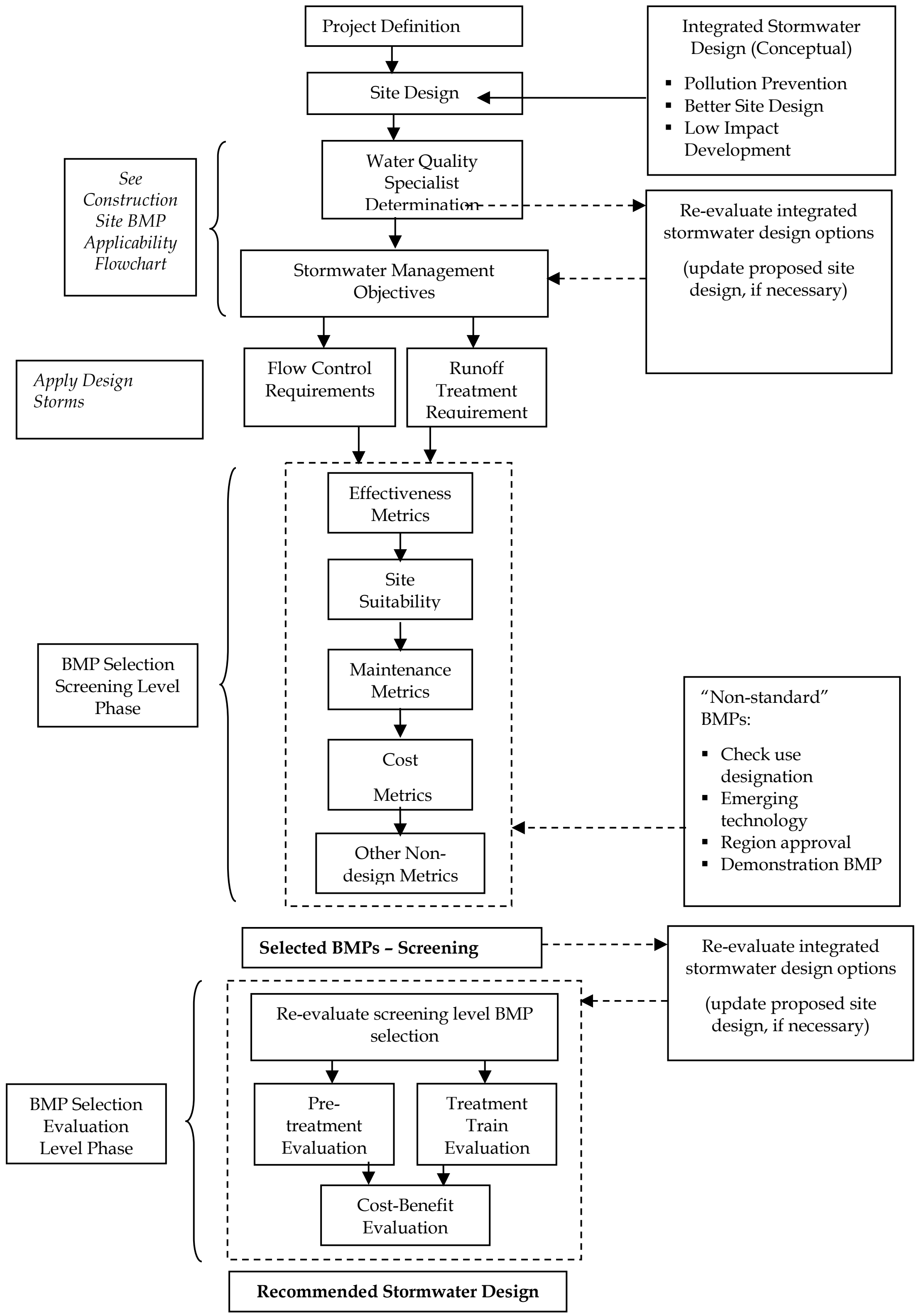



**Figure 9. BMP Selection Process**

## 3.3 PERMANENT BMPS

Post-construction BMPs are the BMPs that exist following construction of new development or re-development. Post-construction BMPs are typically permanent structural BMPs but include other BMPs such as pollution prevention, street sweeping, and pretreatment practices. The objective of post construction or permanent BMPs is to limit the amount of pollutants that could potentially be discharged to a receiving water. The mechanism by which pollutants are removed from storm runoff is through either a filtering process or by allowing sediment to settling out of the runoff. A water quality capture volume is used to provide adequate volume for sediment to settle.

Implementation of PC BMPs will be successful if used appropriately, taking into account a number of factors. The information provided below on the various post construction BMPs include general details regarding appropriate applications to assist the project CFT in determining which post construction BMPs are appropriate for a given location, but does currently do not provide detailed design procedures. Additional details including appropriate applications, limitations, standards and specifications, inspection and maintenance and design details will be provided in a subsequent version of this manual.

### 3.3.1 PRETREATMENT

Sediment, trash, debris, and organic materials found in stormwater runoff can clog and significantly affect the functionality of structural stormwater BMPs. Reducing these burdens prior to entering structural stormwater BMP(s) will preserve their long-term functionality, particularly for filtration and infiltration BMPs. Pretreatment reduces maintenance and prolongs the lifespan of structural stormwater BMPs by removing trash, debris, organic materials, coarse sediments, and associated pollutants prior to entering structural stormwater BMPs. Implementing pretreatment devices also improves aesthetics by capturing debris in focused or hidden areas.

Pretreatment practices include settling devices, screens, and pretreatment vegetated filter strips. Selecting the appropriate pretreatment device is critical and is primarily based on the downstream structural BMP and the contributing drainage area (size, land use, underlying soils, trees/vegetation, etc.). The variety of pretreatment methods and flexibility of design allows for site-specific utilization of the most applicable pretreatment practice. It is recommended that pretreatment practices be designed for easy maintenance and capture a minimum of 25 percent of the sediment from runoff. Pollutants are captured primarily by physical screening or sedimentation/settling.

Pretreatment practices capture solids that are quickly settled or screened, including gross solids and most sand particles (roughly 100 microns (µm) and larger), although some pretreatment practices also capture floatables. In many watersheds, this material accounts for a large portion of the total pollutant load. Installing multiple pretreatment practices of the same type in series rarely increases performance because the pollutants will be captured by the first practice (if properly designed and maintained) and subsequent pretreatment practices will not be effective. Structural stormwater BMPs such as wet ponds and filtration practices generally capture large silts in addition to sands and gross solids, approximately down to 10 µm-sized particles. To capture fine silts, clays, and dissolved or colloidal pollutants, structural stormwater BMPs with advanced treatment such as infiltration, chemical reactions, or biodegradation must be used.

Pretreatment practices that are compatible with structural stormwater BMPs rely upon two primary treatment mechanisms (1) settling and/or (2) physical screening. Figure 10 provides a summary of pretreatment characteristics. Pretreatment BMPs include:

- **Settling devices** - Pretreatment settling devices are flow-through structures or devices, proprietary or non-proprietary, above or below ground, where settling is the primary mechanism of pollutant removal. Some of these devices also provide treatment in addition to settling by utilizing a variety of mechanisms to separate and capture pollutant-laden material.
- **Screens** - Pretreatment screens are small catch basins or conveyance trenches in which screening is the primary mechanism of pollutant removal. These pretreatment devices use a perforated plate or mesh screen to separate and collect sediment, trash, debris and organic material as runoff passes over or through them. Screens often comprise thin sheets of metal, plastic, or fabric (e.g., geotextile) with holes or slots that allow water to pass through but limit particulate pollutant passage by deflection or sieving.
- **Vegetated filter strips** - Pretreatment vegetated filter strips, also sometimes called buffer strips or buffers, are sloped surfaces that rely on shallow (i.e., water level less than the height of the vegetation), distributed flow through dense vegetation to reduce flow velocity, allow particles to settle, and allow particle interception by the vegetation as their primary mechanism of pollutant removal. Pretreatment vegetated filter strips are not to be confused with treatment vegetated filter strips, which are designed and used as standalone structural stormwater BMPs. Concentrated or channelized flow is common to structural stormwater BMP treatment swales, but is not appropriate for pretreatment vegetated filter strips.

**Figure 10: Pretreatment BMP Summary of Characteristics**

| Pretreatment BMP | Mechanism of pollutant removal | Relative pollutant removal | Capital cost | Relative maintenance frequency | Relative maintenance effort | Relative space requirements | Cold Climate Suitability |
|---|---|---|---|---|---|---|---|
| Settling Devices | Screening and Settling | Medium | Medium to High | Medium[1] | Low to Medium | Low to Medium | Medium to High |
| Screens | Screening | Low | Low | High | Medium | Low | Low |
| Vegetated Filter Strips | Screening and Settling | Medium | Low | Low | High | High | Medium |

[1]Pretreatment settling devices are prone to plugging, which will drive maintenance costs up.

## 3.3.2 INFILTRATION BMPS

An infiltration basin is a natural or constructed impoundment that captures, temporarily stores and infiltrates the design volume of water. Drawdown of this stored runoff occurs through infiltration into the surrounding naturally permeable soil. The required drawdown time is 48 hours or less. Water that is stored but not infiltrated must leave the BMP, typically through an outlet, within the required drawdown time. In the case of a constructed basin, the impoundment is created by excavation or embankment. Infiltration basins are commonly used for drainage areas of 5 to 50 acres with land slopes that are less than 20 percent. Typical depths range from 2 to 6 feet, including bounce in the basin. The sizing is to control stormwater volumes at the regional or development scale as opposed to bioretention basins (rain gardens) that are designed at the site scale. Typical dimensions range from 1,000 square feet up to an acre. Infiltration basins are commonly constructed with plant species that can tolerate and thrive in this unique growing environment.

Figure 11 provides a summary of infiltration BMP selection considerations. BMPs that infiltrate stormwater runoff into underlying soil include, but are not limited, to:

- **Bio-infiltration Strips, Swales or Basins -**Often called rain gardens, bio-infiltration basins use engineered or mixed soils and plantings to capture and infiltrate runoff. Pollutants are removed using highly permeable soils that are able to draw the basin down in less than 48 hours.

- **Infiltration Basin** - A natural or constructed impoundment that captures, temporarily stores and infiltrates the design volume of water into the surrounding naturally permeable soil over several days. In the case of a constructed basin, the impoundment is created by excavation or embankment.

- **Infiltration Trench** - A shallow excavated trench that is backfilled with a coarse stone aggregate allowing for the temporary storage of runoff in the void space of the material. Discharge of this stored runoff occurs through infiltration into the surrounding naturally permeable soil.

- **Pervious Pavement** (i.e. Asphalt, Concrete, Interlocking Block, Other) - Permeable pavements are paving surfaces that allow stormwater runoff to filter through surface voids into an underlying stone reservoir for infiltration and/or storage. The most commonly used permeable pavement surfaces are pervious concrete, porous asphalt, and permeable interlocking concrete pavers. All permeable pavements have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer, optional underdrains and geotextile over un-compacted soil subgrade. Discharge of this stored runoff occurs through infiltration into the surrounding naturally permeable soil. The amount of water that infiltrates can be maximized by raising the underdrain above the native soil or using an upturned elbow in the underdrain. Water captured by the BMP must drawdown within 48 hours. The drainage area leading to permeable pavements should not exceed twice the surface area of the final pavement surface.

- **Underground Infiltration Systems** (i.e. dry well, French drain, soak-away pits) - A smaller variation of an infiltration trench. It is a subsurface storage facility (a structural chamber or an excavated pit backfilled with a coarse stone aggregate) that receives and temporarily stores stormwater runoff. Discharge of this stored runoff occurs through infiltration into the surrounding naturally permeable soil. Due to their size, dry wells are typically designed to handle stormwater runoff from smaller drainage areas.;
- **Tree Trenches or Tree boxes** -A system of trees that are connected by an underground infiltration structure. The system consists of a trench lined with geotextile fabric with structural stone, gravel or soil boxes in which the trees are placed. Tree systems consist of an engineered soil layer designed to treat stormwater runoff via filtration through plant and soil media, and through evapotranspiration from trees. Discharge of this stored runoff occurs through infiltration into the surrounding naturally permeable soil.
- **Dry Swale with Check Dams** - Similar to vegetated swales designed for stormwater conveyance, dry swales with check dams are designed as linear, multi-celled stormwater infiltration BMPs. By incorporating earthen, structural or rock check dams, runoff is retained and infiltrated along a series of narrow, shallow basins or cells. Coarse vegetation such as decorative plantings or even turf grass slow runoff movement. This system is designed to move, store, and infiltrate runoff from impervious surfaces such as linear roadways or parking lots.

**Figure 11: Stormwater infiltration BMPs – Selection Considerations**

| Stormwater BMP | Cost | Recommended Contributing Area | Maintenance Requirements | Pre-Treatment | Habitat Quality[1] |
|---|---|---|---|---|---|
| Infiltration Basin | Low | 50 acres or less | Simple to Intensive | Needed Oil/Water Separator, Vegetated Filter, Sediment Basin, Water Quality Inlets | Low |
| Bio-Infiltration Basin | Low | 5 acres or less | Simple to Intensive | Needed Oil/Water Separator, Vegetated Filter, Sediment Basin, Water Quality Inlets. | Medium-High |
| Infiltration Trench | Low | 5 acres or less | Medium | Needed Oil/Water Separator, Vegetated Filter, Sediment Basin, Water Quality Inlets | None |
| Underground Infiltration | High | 10 acre or less | Medium | Needed Oil/Water Separator, Water Quality Inlets | None |

| | | | | | |
|---|---|---|---|---|---|
| Dry Swale with Check Dams | Low | 5 acres or less | Simple to Medium | Needed Vegetated Filter, Water Quality Inlets | Low to Medium |
| Permeable Pavement | Medium | Target only surface area of permeable pavement, not to exceed twice the surface area of permeable pavement. | Medium | No Pretreatment Required | None |
| Tree Trench/Tree Box | High | 0.25 acres or less per tree | Intensive | Needed Oil/Water Separator, Water Quality Inlets | Medium |
| [1] Habitat quality refers to the possible diversity of plantings commonly installed with each BMP | | | | | |

### 3.3.3 FILTRATION BMPS

Filtration practices treat stormwater by filtering pollutants. They are effective at attenuating suspended sediment and pollutants associated with that sediment. Most filtration practices utilize an underdrain and engineered soil media to attenuate pollutants and can be sized, in appropriate conditions, to treat the water quality volume. Some infiltration and/or loss of water through evapotranspiration occurs in most filtration practices. Figue 12, provides a summary of Stormwater filtration BMP properties. Filtration BMPs include, but are not limited, to:

- **Media Filters:**
    - **Surface sand filter** - For a surface sand filter, a flow splitter is used to divert runoff into an off-line sedimentation chamber. The chamber may be either wet or dry, and is generally used for pre-treatment. Runoff is then distributed into the second chamber, which consists of a sand filter bed (~18 inches) and temporary runoff storage above the bed. Pollutants are trapped or strained out at the surface of the filter bed. The filter bed surface may have a sand or grass cover. A series of perforated pipes located in a gravel bed collect the runoff passing through the filter bed, and return it to the stream or channel at a downstream point. If underlying soils are permeable, and groundwater contamination unlikely, the bottom of the filter bed may have no lining, and the filtered runoff may be allowed to infiltrate.
    - **Underground sand filter** - The underground sand filter was adapted for sites where space is at a premium. In this BMP, the sand filter is placed in a 3 chamber underground vault accessible by manholes or grate openings. The vault can be either on-line or off-line in the storm drain system. The first chamber is used for pre-treatment and relies on a wet pool as well as temporary runoff storage. It is connected to the second sand filter chamber by an inverted elbow, which keeps the filter surface free from trash and oil. The filter bed is ~18 inches in depth and may have a protective screen of gravel or

permeable geotextile to limit clogging. During a storm, the water quality volume is temporarily stored in both the first and second chambers. Flows in excess of the filter's capacity are diverted through an overflow weir. Filtered runoff is collected, using perforated underdrains that extend into the third "overflow" chamber.

- **Perimeter sand filter** - The perimeter sand filter consists of two parallel trench-like chambers that are typically installed along the perimeter of a parking lot (See schematic of Delaware sand filter). Parking lot runoff enters the first chamber, which has a shallow permanent pool of water. The first trench provides pre-treatment before the runoff spills into the second trench, which consists of a sand layer (~12 inches to 18 inches). During a storm event, runoff is temporarily ponded above the normal pool and sand layer, respectively. When both chambers fill up to capacity, excess parking lot runoff is routed to a bypass drop inlet. The remaining runoff is filtered through the sand, and collected by underdrains and delivered to a protected outflow point.

- **Vegetative Filters:**
  - **Grass channels** - Grass channels are designed to meet a runoff velocity target for a water quality storm as well as the peak discharge from a 2-year design storm. The runoff velocity should not exceed 1.0 feet per second (fps) during the water quality storm. Grass channels can be designed to pass larger storms and serve as conveyance tools. Pre-treatment can be created by placing checkdams across the channel below pipe inflows, and at various other points along the channel. Grass channels do not provide adequate pollutant removal benefits to act as a stand-alone BMP.
  - **Dry swales** - In dry swales, the entire water quality volume is temporarily retained by checkdams during each storm. Unlike the grass channel, the filter bed in the swale has a deep bed (~30 inches) of prepared soil. Water is filtered through the sandy loam to underdrains and the swale is quickly dewatered. In the event that surface soils clog, the dry swale has a pea gravel window on the downstream side of each checkdam to route water to the underdrain. Dry swales are often preferred in residential areas because they prevent standing water.
  - **Wet swales** - Wet swales occur when the water table is located very close to the surface. This wet swale acts as a very long and linear shallow wetland treatment system. Like the dry swale, the entire water quality treatment volume is stored within a series of cells created by checkdams. Cells may be planted with emergent wetland plant species to improve pollutant removal.
  - **Filter strips** - Filter strips rely on the use of vegetation to slow runoff velocities and filter out sediment and other pollutants from stormwater. To be effective, however, filter strips require the presence of sheet flow across the entire strip. Once flow concentrates to form a channel, it effectively short-circuits the filter strip. In the most common design, runoff is directed from a parking lot into a long filtering system composed of a stone trench, a grass

strip and a longer naturally vegetative strip. The grass portion of the filter strip provides pre-treatment for the wooded portion. In addition, a stone drop can be located at the edge of the parking lot and the filter strip to prevent sediments from depositing at this critical entry point. The filter strip is typically an on-line practice, so it must be designed to withstand the full range of storm events without eroding. Filter strips do not provide adequate pollutant removal benefits to act as a stand-alone BMP.

- **Bioretention (Rain Gardens)** - Often called rain gardens, biofiltration basins use engineered or mixed soils and plantings to capture and filter runoff. Discharge of filtered runoff occurs primarily through an underdrain, though some infiltration into the underlying soil occurs below the underdrain.

- **Other Filters:**
  - **Organic Filters** - The organic filter functions in much the same way as the surface sand filter, but uses leaf compost or a peat/sand mixture as the filter media instead of sand (compost and peat should not be used when the target pollutant for removal is a dissolved nutrient. The organic material enhances pollutant removal by providing adsorption of heavy metals. In an organic filter, runoff is diverted with a flow splitter into a pre-treatment chamber, from which it passes into one or more filter cells. Each filter bed contains a layer of leaf compost or the peat/sand mixture, followed by a filter fabric and perforated pipe and gravel. Runoff filters through the organic media to the perforated pipe and ultimately to the outlet. The filter bed and subsoils can be separated by an impermeable polyliner to prevent movement into groundwater. It is HIGHLY RECOMMENDED that the facility be actively managed to keep it dry before it freezes in the late fall.
  - **Catch Basin Inserts** - Products added to catch basins (drain and curb inlets) for the use of capturing or retaining stormwater pollutants. Product examples include pipe hoods, inlet filters and curb screens. Catch basin inserts can be installed in existing (retrofit) structures, or as part of a new installation. In many cases, catch basins were installed on a site prior to regulatory oversight, or without specific removal targets in mind. Retrofitting catch basins with an insert can improve the efficiency of catch basins and in some cases make a basin easier to maintain (although typically on a more frequent basis). Depending upon the design of the catch basin insert, they can target a wide range of pollutants, including heavy metals, hydrocarbons, sediments, trash and debris.

**Figure 12: Stormwater Filtration BMPs – Considerations and Performance**

| Stormwater BMP | Cost | Recommended Contributing Area | Maintenance Requirements | Pre-Treatment | Pollutant Removal [2] | Habitat Quality[1] |
|---|---|---|---|---|---|---|
| Dry Swale with Check Dams | Low to Medium | 5 acres or less | Simple to Medium | Oil/Water Separator Sediment Basin (depending on | TSS: Medium<br>TN: Low<br>TP: Medium | Low to Medium |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | watershed soil types, contributing drainage area, and potential for system fouling/plugging) | Chloride: Low<br>Metals: Medium<br>Oils and Grease: Low<br>Pathogens: Low | |
| Wet Swale | Low | 5 acres or less | Simple | Oil/Water Separator | TSS: Medium<br>TN: Low<br>TP: Low<br>Chloride: Low<br>Metals: Low<br>Oils and Grease: Low<br>Pathogens: Low | Low to Medium |
| Bio-Infiltration Basin | Low | 5 acres or less | Simple to Intensive | Needed Oil/Water Separator, Vegetated Filter, Sediment Basin, Water Quality Inlets. | TSS: High<br>TN: Low/Medium<br>TP: Medium/High<br>Chloride: Low<br>Metals: High<br>Oils and Grease: High | Medium-High |
| Permeable Pavement | Medium | Target only surface area of permeable pavement, not to exceed twice the surface area of permeable pavement. | Medium | No Pretreatment Required | TSS: High<br>TN: Medium/High<br>TP: Medium/High<br>Chloride: Low<br>Metals: High<br>Oils and Grease: High | None |
| Tree Trench/Tree Box | High | 0.25 acres or less per tree | Intensive | Needed Oil/Water Separator, Water Quality Inlets | TSS: High<br>TN: Medium/High<br>TP: Medium/High | Medium |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | Chloride: Low<br>Metals: High<br>Oils and Grease: High<br>Pathogens: High | |
| Media Filter (Sand Filter) | Low | | Simple to Moderate | Needed Oil/Water Separator, Vegetated Filter, Sediment Basin | TSS: High<br>TN: Medium<br>TP: Medium/High<br>Chloride: Low<br>Metals: Medium/High<br>Oils and Grease: High<br>Pathogens: High | Low |
| [1] Habitat quality refers to the possible diversity of plantings commonly installed with each BMP<br>[2] Low = < 30%; Medium = 30-65%; High = 65-100% | | | | | | |

### 3.3.4 Other Permanent BMPs

These include:

- Soil Amendment Features
- Outlet protection/velocity dissipation devices
- Slope Protection
- Manufactured Products for Stormwater Inlets
- Other proprietary permanent structural BMPs

## 3.4 Defining Treatment Effectiveness Using Treatment Mechanisms

The key issue with rating the "treatment effectiveness" of BMPs in the BMP Selection Tool is the wide range of removal efficiencies reported for the BMPs. One approach is to rate a BMP's treatment effectiveness based on the removal efficiencies reported in literature. However, the reported efficiencies vary greatly (e.g., at times from 20-80 percent removal by concentration). The wide range in removal efficiencies is a result primarily of the varying site conditions, influent concentrations, flow rates, and specific BMP designs. In addition, the number of studies reported in the literature for each BMP is still relatively limited, despite the development of such databases as the International

BMP Database. Efforts to add to the dataset have so far not resulted in any clear increase in the precision of effectiveness data.

In an attempt to address this issue, FHWA, is proposing that treatment effectiveness be defined in terms of their "primary treatment mechanisms" rather than by removal efficiency data reported for specific BMPs. Primary treatment mechanism refers to the prevailing unit operations or processes (borrowing the term from the wastewater treatment field) that results in the removal or chemical breakdown of a given compound. The approach defines a given treatment mechanism as effectively treating a specific target pollutant, and if a BMP employs that treatment mechanism, then by definition the BMP would be considered effective at treating for the POC. Ratings of "high, medium, low" are used.

**Types of Treatment Mechanisms.** In general, a limited set of unit processes exist that different BMPs rely on to remove constituents from water. The reality of stormwater treatment is that the more complex unit processes, such as ultraviolet disinfection or chemical precipitation/flocculation, will generally not be used because of the economics of treating such large volumes of water.

The treatment effectiveness of a BMP is essentially related to which processes are actually utilized by the BMP and the ability of the BMP to maximize the process(es). Six primary treatment mechanisms are considered most appropriate for stormwater. The descriptions of these mechanisms are summarized below:

- **Hydrologic attenuation** – Hydrologic attenuation achieves pollutant reduction through runoff volume reduction. Infiltration is the primary means of hydrologic attenuation for the purposes of the types of BMPs used in stormwater management. Attenuation reduces the pollutant load discharged to surface waters, but does not necessarily reduce pollutant concentrations. Infiltration includes several different treatment mechanisms. Processes such as sorption, filtration, and microbial degradation occur as runoff infiltrates through the soil matrix.

- **Sedimentation/density separation** - Density separation refers to the unit processes of sedimentation and flotation that are dependent on the density differences between the pollutant and the water to effect removal. Sedimentation is the gravitational settling of particles having a density greater than water. Flotation is similar to gravitational sedimentation except in the opposite direction. Typically, floatable materials such as trash, debris, and hydrocarbons are removed through treatment processes that utilize the location of these pollutants on the water surface for removal. Stormwater treatment that incorporates vegetation and or permanent water bodies usually has a diverse microbial population, and it is not possible to optimize conditions for all beneficial species.

- **Sorption** - Sorption refers to the individual unit processes of both absorption and adsorption. Absorption is a physical process whereby a substance of one state is incorporated into another substance of a different state (e.g., liquids being absorbed by a solid or gases being absorbed by water). Adsorption is the physiochemical adherence or bonding of ions and molecules (ion exchange) onto the surface of another molecule. In stormwater treatment application, particularly for highway runoff, the primary pollutant types targeted with absorption unit processes are petroleum hydrocarbons, while adsorption processes typically target dissolved metals, nutrients, and organic toxicants such as pesticides and polycyclic aromatic hydrocarbons (PAHs). Different types of filter media may provide either or both of these unit processes.

- **Filtration** - Filtration can encompass a wide range of physical and chemical mechanisms, depending on the filtering media, typically some sand media, natural soil, grassy vegetation, or mixes of chemically active ingredients such as perlite, zeolite, and granular activated carbon. Filtration removes particulate matter either on the surface of the filter or within the pore space of the filter. Filtration such as a sand filter can provide the added benefit of removing stormwater constituents that may be attached to solids such as metals and bacteria. Filtration can also provide opportunities for sorption processes to occur, reducing dissolved and fine suspended constituents. Filtration can often be an effective preliminary treatment for stormwater, by increasing the longevity of downstream BMPs and reducing maintenance frequency.
- **Uptake/Storage** - Uptake and storage refer to the removal of organic and inorganic constituents by plants and microbes through nutrient uptake and bioaccumulation. Nutrient uptake converts required micro- and macro-nutrients into living tissue. In addition to nutrients, various algae and wetland and terrestrial plants accumulate organic and inorganic constituents in excess of their immediate needs (bioaccumulation). The ability of plants to accumulate and store metals varies greatly. Significant metal uptake by plants will not occur unless the appropriate species are selected.
- **Microbial mediated transformation** – Microbial activity promotes or catalyzes redox reactions and transformations including degradation of organic and inorganic pollutants and immobilization of metals. Bacteria, algae, and fungi present in the soil or water column are primarily responsible for the transformations. Stormwater treatment that incorporates vegetation or permanent water pools usually has a diverse microbial population. These transformations can remove dissolved nitrogen species, metals, and simple and complex organic compounds. Soils may be inoculated with desirable microbes to promote specific reactions.

Figure 13 below summarizes the stormwater-related pollutants of concern considered to be effectively removed by each treatment mechanism.

| **Figure 13: Treatment Mechanism- Target Pollutant Matrix** | | Mechanism | | | | | |
|---|---|---|---|---|---|---|---|
| | | Hydrologic Attenuation [1] | Density Separation | Sorption (Chemical Activity) | Filtration | Uptake/ Storage [2] | Microbial Transformation [3] |
| Target Pollutant | Sediment/Particulate (Suspended Solids) | ■ | ■ | | ■ | | |
| | Nutrients [4] | ■ | □ | ■ | | ■ | ■ |
| | Oil and Grease | ■ | ■ | ■ | ■ | | ■ |
| | Polycyclic Aromatic Hydrocarbons (PAH) | ■ | □ | ■ | □ | ■ | ■ |
| | Metals (Particulate) | ■ | ■ | | ■ | | |
| | Metals (Dissolved) | ■ | | ■ | □ | □ | □ |

■= Treatment mechanism effective for target pollutant removal

□= Depending on chemical activity or filter media

1 Refers to infiltration which is credited for overall pollutant mass load reduction of all target pollutants primarily through volume reduction; pollutant removal is also achieved through filtering, sorption, and microbial transformation in the soil column.

2 Dependent on plant species

3 Dependent on types of microbes present (in soil and water column)

4 May not be considered a highway target pollutant but included for completeness

## 3.5 Treatment Effectiveness Matrix

Based on information compiled in Figure 13 the treatment mechanisms utilized by each of the BMPs has been evaluated for treatment effectiveness.  Figure 14 indicates whether the treatment mechanism is a key (or main) pollutant removal mechanism of the BMP, or whether it is a secondary (or "associated") mechanism.

The lower portion of Figure 14 cross references Figure 13 with the current list of BMPs to identify which target pollutants are addressed by each BMP. The table indicates whether the BMP has high, moderate, or low capability of removing a target pollutant. The rating is largely a function of whether the BMP employs the key treatment mechanism identified to be effective at removing that particular pollutant. A BMP may be rated moderate or low for a target pollutant if the key treatment mechanism is a secondary process within the BMP. Alternatively, a BMP may be rated high for a target pollutant if at least one key treatment mechanism occurs as part of the BMP treatment process.

In application, this approach indicates that all of the BMPs included in the BMP Selection Tool are considered highly capable of removing particulates and total suspended solids, while infiltration, bioretention, bioslope, and constructed wetlands are the BMPs with high capability to remove dissolved metals. Porous pavements are also considered effective at removing dissolved metals, but are not considered to be stand-alone BMPs and will require the approval of the Pavement Engineer prior to use on a project. Soil-amended grass swales and filter strips, extended dry detention ponds and wet ponds, proprietary filtration facilities and media filters may also be moderately effective for dissolved metals. Similarly, the matrix can be used to identify which BMPs are considered effective in removing the other target pollutants.

Using "treatment mechanisms" (or unit processes) to define a BMP's effectiveness at removing target pollutants circumvents the need to rely strictly on the wide-ranging removal efficiency data for this purpose.  It also allows for new BMPs to be easily integrated into the framework.

**Figure 14: Treatment Mechanism- BMP Matrix**

| | | Post Construction Best Management Practice | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre-treatment | | Infiltration | | | | Filtration | | | | Pool-Ponds | | | Space-Constrained or Urban Application | | | |
| | | Oil Control Facilities | Sediment Control | Infiltration Pond | Bioretention | Bio-slope | Porous Pavement (Not stand-alone) | Grass Swale (soil amended) | Filter Strip (soil amended) | Grass Swale (no soil amendment | Filter Strip (no soil amendment) | Constructed wetlands | Extended Detention Dry Pond | Wet Pond | Wet Vaults | Media Filters (non-proprietary) | Proprietary Separation (pretreatment) | Proprietary Filtration Facilities |
| Treatment Mechanism | Hydrologic Attenuation | | | ■ | ■ | ■ | ■ | □ | □ | □ | □ | □ | ■ | □ | | | | |
| | Density Separation (Sedimentation or Flotation) | ■ | ■ | □ | □ | □ | | □ | □ | □ | □ | ■ | ■ | ■ | ■ | | ■ | |
| | Sorption | □ | | □ | ■ | ■ | | ■ | ■ | □ | □ | ■ | □ | □ | | □ | □ | ■ |
| | Filtration | □ | □ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | □ | □ | □ | | ■ | □ | ■ |
| | Uptake/Storage[1] | | | □ | ■ | □ | | □ | □ | □ | □ | ■ | □ | □ | | | | |
| | Microbial Transformation[1] | | | □ | ■ | □ | | □ | □ | □ | □ | ■ | □ | □ | | □ | | □ |
| Target Pollutant | Sediment/Particulate (TSS) | ○ | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● |
| | Nutrients | □ | □ | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ● | ○ | ○ | | - | | |
| | Oil and Grease | ● | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ● | ○ |
| | Polycyclic Aromatic Hydrocarbons (PAH) | □ | □ | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ● | ○ | ○ | | ○ | | |
| | Metals (Particulate) | ○ | ○ | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● |
| | Metals (Dissolved) | □ | | ● | ● | ● | - | ● | ● | ○ | ○ | ● | ○ | ○ | | ○ | | ● |

■ = Key treatment mechanism for BMP □ = Associated treatment mechanism for BMP; dependent on plant species/ microbes present.

Capability to remove target pollutant: ● = High; ○ = Moderate; - = Low

1 Dependent on types of plant species or microbes (in soil and water column) present

## 3.6 BMP Selection– Metric Ratings

As noted above, the BMP Selection Tool includes metrics and ratings for treatment suitability (effectiveness) for POC, site suitability and physical constraints, maintenance needs and constraints, and costs. The draft ratings for the BMPs included in the BMP Selection Tool are summarized in the Table below.

**Figure 15: BMP Performance Summary Table**

**Best Management Practice**

**Rank:** ●=High ○=Medium - =Low blank=none/not applicable

| | | Pretreatment | | Infiltration | | | | Filtration | | | | Pool-Ponds | | | Space-Constrained or Urban Application | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oil Control Facilities | Sediment Control | Infiltration Pond | Bioretention | Bioslope | Porous Pavement (Not stand-alone) | Grass Swale (soil amended) | Filter Strip (soil amended) | Grass Swale (no soil amendment) | Filter Strip (no soil amendment) | Constructed wetlands | Extended Detention Dry Pond | Wet Pond | Wet Vaults | Media Filters (non-proprietary) | Proprietary Separation (pretreatment) | Proprietary Filtration Facilities |
| Application to Stormwater Management | Water Quality | - | - | ○ | ● | ● | ○ | ● | ● | ● | ● | ● | ○ | ○ | ○ | ● | ● | ● |
| | Channel Protection | □ | □ | ● | ● | ○ | ● | - | - | - | - | ● | ● | ○ | ● | | □ | |
| | Peak Discharge | □ | □ | ● | ● | ○ | ● | - | - | - | - | ● | ● | ● | ● | - | □ | □ |
| | Recharge | □ | □ | ● | ○ | ● | ● | - | - | - | - | - | - | - | | □ | □ | □ |
| Receiving Water Application [2] | Drinking Water Protection | - | - | - | ○ | ○ | - | ○ | ○ | ○ | ○ | ● | ○ | ● | ● | ● | ● | ● |
| | Aquatic Species Protection | - | - | ● | ○ | ● | ● | ○ | ○ | ○ | ○ | ● | ○ | ○ | ○ | ○ | - | - |
| | Water Quality Protection | - | - | ● | ● | ● | ● | ○ | ○ | ○ | ○ | ● | ○ | ● | - | ○ | ● | ● |
| | Wetlands Protection | - | - | ○ | ○ | ● | ○ | ○ | ○ | ○ | ○ | ● | ○ | ● | - | - | - | - |
| | Sensitive Water Protection | - | - | ○ | ○ | ● | ○ | - | - | - | - | ○ | ○ | ● | - | - | - | - |
| Water Quality Treatment Effectiveness [3] | Sediment/Particulate (Suspended Solids) | ○ | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● |
| | Nutrients [4] | □ | □ | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ● | ○ | ○ | | - | | |
| | Oil and Grease | ● | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ● | ○ |
| | Polycyclic Aromatic Hydrocarbons (PAH) | □ | □ | ● | ● | ● | ○ | ○ | ○ | ○ | ○ | ● | ○ | ○ | | ○ | | |
| | Metals (Particulate) | ○ | ○ | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● |

| **Figure 15: BMP Performance Summary Table** | | **Best Management Practice** | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pretreatment | | Infiltration | | | | Filtration | | | | Pool-Ponds | | | Space-Constrained or Urban Application | | | |
| | | Oil Control Facilities | Sediment Control | Infiltration Pond | Bioretention | Bioslope | Porous Pavement (Not stand-alone) | Grass Swale (soil amended) | Filter Strip (soil amended) | Grass Swale (no soil amendment | Filter Strip (no soil amendment) | Constructed wetlands | Extended Detention Dry Pond | Wet Pond | Wet Vaults | Media Filters (non-proprietary) | Proprietary Separation (pretreatment) | Proprietary Filtration Facilities |
| | Metals (Dissolved) | □ | | ● | ● | ● | - | ● | ● | ○ | ○ | ● | ○ | ○ | | ○ | | ● |
| **Rank:** ⇧=large ⇔=medium ⇩=small blank=none/not applicable | | | | | | | | | | | | | | | | | | |
| Physical Site Suitability [4] | Surface Area (large is greater area) | ⇩ | ⇩ | ⇔ | ⇩ | ⇔ | ⇩ | ⇔ | ⇔ | ⇔ | ⇔ | ⇧ | ⇧ | ⇧ | ⇩ | ⇔ | ⇩ | ⇩ |
| | Drainage Area (large is greater area) | ⇩ | ⇩ | ⇧ | ⇩ | ⇔ | ⇩ | ⇔ | ⇔ | ⇔ | ⇔ | ⇧ | ⇧ | ⇧ | ⇩ | ⇩ | ⇩ | ⇩ |
| | Soil Infiltration Rate (large is higher rate) | □ | □ | ⇧ | ⇧ | ⇧ | ⇧ | ⇔ | ⇔ | ⇔ | ⇔ | ⇩ | ⇩ | ⇩ | □ | □ | □ | □ |
| | Slope (gradient)(large is steeper) | □ | □ | ⇩ | ⇔ | ⇩ | ⇩ | ⇔ | ⇔ | ⇔ | ⇔ | ⇩ | ⇔ | ⇩ | □ | ⇩ | □ | □ |
| | Groundwater depth (large is deeper) | □ | □ | ⇔ | ⇔ | ⇔ | ⇔ | ⇔ | ⇔ | ⇔ | ⇔ | ⇧ | ⇧ | ⇧ | □ | ⇧ | □ | □ |
| | Confined space/safety (large is greater required) | ⇧ | ⇔ | ⇩ | ⇩ | TBD | TBD | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇔ | ⇔ | ⇧ | ⇩ | ⇧ | ⇧ |
| | Dependency on Soil Characteristics | □ | ⇩ | ⇧ | ⇧ | ⇔ | ⇧ | ⇔ | ⇔ | ⇔ | ⇔ | ⇧ | ⇧ | ⇧ | □ | □ | □ | □ |
| **Rank:** H=High M=medium L=Low blank=none/not applicable | | | | | | | | | | | | | | | | | | |
| Maintenance Factors | Maintenance Level of Effort | M | M+ | M+ | M | TBD | TBD | L | L | L | L | L | M | M+ | H | M | H+ | H |
| | Frequency of Maintenance | M | M+ | M+ | M+ | TBD | TBD | L | L | L | L | L | M | M+ | H | M | H | H |

**Figure 15: BMP Performance Summary Table**

| | | Best Management Practice | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pretreatment | | Infiltration | | | | Filtration | | | | Pool-Ponds | | | Space-Constrained or Urban Application | | | |
| | | Oil Control Facilities | Sediment Control | Infiltration Pond | Bioretention | Bioslope | Porous Pavement (Not stand-alone) | Grass Swale (soil amended) | Filter Strip (soil amended) | Grass Swale (no soil amendment | Filter Strip (no soil amendment) | Constructed wetlands | Extended Detention Dry Pond | Wet Pond | Wet Vaults | Media Filters (non-proprietary) | Proprietary Separation (pretreatment) | Proprietary Filtration Facilities |
| | Reliability/Durability (Appurtenances) | M | L | L | L | TBD | TBD | L | L | L | L | L | L | M+ | H | L | H | H |
| | Need for "Specialized" equipment | M | L | H | L | TBD | TBD | L | L | L | L | L | L | M | H | L | H+ | H |
| | Operation and Maintenance Cost (Including Waste Disposal) | H | M+ | H | M | TBD | TBD | L | L | L | L | H | M+ | H | H | M | H+ | H |
| **Rank:** +=Favorable /=Neutral -=Unfavorable blank=none/not applicable | | | | | | | | | | | | | | | | | | |
| Non-Design Factors | Community Acceptance | / | / | / | + | + | / | / | / | / | / | + | / | / | / | / | / | / |
| | Construction Cost | / | / | - | / | / | - | + | + | + | + | - | - | - | - | / | / | / |
| | Wildlife Habitat | | | / | + | / | | / | / | / | / | + | / | + | | | | |

*See notes below for Rating Categories

Assumes soil amendments (compost; organic materials) are used to enhance pollutant removal and effectiveness

Assumes appropriate plantings (e.g. metal hyper-accumulating species) are used.

***Notes:***

*1. Application to Stormwater Management Objectives*
*Water Quality – Objective for sites subject to water quality goals or requirements (see Matrix Receiving Water Application Component). In almost all cases, water quality objective is applicable. Specific water quality objectives are addressed further under Matrix Receiving Water Application Component.*
*Channel Protection – Objective for sites subject to channel protection requirements to protect streams.*
*Peak Discharge – Objective for sites subject to flood control. In almost all cases, flood control objective is applicable.*
*Recharge – Objective for sites subject to a recharge requirement to infiltrate runoff.*
*(1) Ratings (low, medium, high) are qualitative in nature and are based on a compilation of design criteria and effectiveness factors. These rating are to be applied in the context of comparing BMPs within the BMP selection process.*

*2. Receiving Water Application*
*Drinking water Protection – For groundwater; use the sensitive lakes category to define BMP design restrictions for surface water drinking supplies.*

*Aquatic Species Protection – minimizes channel erosion; provides channel protection; promotes baseflow; stream temperature.*
*Water Quality Protection – provides enhanced pollutant removal for TMDL/303(d) listed pollutants of concern (corresponds with Matrix Water Quality Treatment Effectiveness Component).*
*Wetlands Protection – maintains wetland hydroperiods and provides enhanced removal of nutrient (phosphorus) loads.*
*Sensitive Lakes Protection – provides enhanced removal of nutrient loads (primarily phosphorus).*
***Rating Notes:*
*High – provides positive benefits to meet needs under receiving water category.*
*Medium – provides limited benefit or is not a detriment to receiving water category.*
*Low – Potentially detrimental to receiving water category.*

*3. Water Quality Treatment Effectiveness*
*Based on treatment mechanisms documented in Table 2.*
*Data Sources:*
*NCHRP. 2006. Evaluation of Best Management Practices and Low Impact Development for Highway Runoff Control.*
*Portland Bureau of Environmental Services. 2006. Effectiveness Evaluation of Best Management Practices for Stormwater Management in Portland, Oregon.*
*Water Environment Research Federation. Undated. International Stormwater BMP Database. www.bmpdatabase.org*

*4. Physical Site Suitability*
*Surface Area – size of surface area BMP requires in terms of percentage total contributing surface area.*
*Surface Area Rating: Small <5%; Medium <10%, Large >10% of impervious area*
*Drainage Area – size of drainage area generally acceptable for the "conventional" application of the BMP.*
*Drainage Area Rating: Small < 2 acres; Medium <10 acres, Large >10 acres of drainage area*
*Soil Infiltration Rate – acceptable soil infiltration rates for optimum BMP performance.*
*Soil Infiltration Rate Rating: Small < 0.5 in/hr; Medium <2.5 in/hr; Large >2.5 in/hr*
*Slope (gradient) – acceptable site slopes/topography to construct BMP and allow proper function.*
*Slope Rating: Small <2%; Medium <5%; Large >5% slope*
*Groundwater level – depth to groundwater allowable for proper function of BMP*
*Groundwater Level Rating: Shallow/Small <10 ft below ground surface; Medium <50 ft bgs; Deep/Large >50 feet bgs*
*Dependency on Soil Characteristics – Dependency as it relates to maintaining treatment effectiveness.*

*5. Maintenance Factors*
*Based on data provided by ODOT staff and consideration of literature.*
*Data Sources:*
*NCHRP. 2006. Evaluation of Best Management Practices and Low Impact Development for Highway Runoff Control.*

*6. Non-Design Factors*
*Community acceptance – accounts for general sense of visual preference, reported nuisance problems, vegetative management; subjective in nature.*
*Construction Cost – general cost rating to construct the BMP. Rating should not preclude preparing design-level engineering cost estimates when evaluating the preferred alternative.*
*Wildlife Habitat – provides potential habitat for wildlife.*
***Ratings (favorable, neutral, unfavorable) are qualitative in nature and are based on a compilation of information from references on these factors. The rating is to be applied in the context of comparing BMPs within the BMP selection process.*

# CHAPTER 4:

# CONSTRUCTION SITE PLANNING AND BEST MANAGEMENT PRACTICES

# 4 Construction Site Best Management Practices

A critical next step in protecting water quality is the implementation of stormwater, non stormwater, and waste management control BMPs during construction. Construction Site BMPs are applied during construction activities to reduce the pollutants in storm water discharges throughout construction. These Construction Site BMPs provide temporary erosion and sediment control, as well as addressing other potential pollutants controls and measures. There are six categories of BMPs suitable for stormwater pollutant control on construction sites. They are:

- Soil Stabilization Practices;
- Sediment Control Practices;
- Tracking Control Practices;
- Wind Erosion Control;
- Non-storm Water Controls; and
- Waste Management and Material Pollution Controls.

It is generally accepted that practices that perform well by themselves can be complemented by other practices to raise the collective level of erosion control effectiveness and sediment retention. Effective erosion and sediment control planning relies on a system of BMPs (e.g., mulches for source control, fiber rolls on slopes for reducing runoff velocities, silt fence at the toe of slopes for capturing sediment, etc.) which is commonly referred to as a treatment train.

The greatest water pollution threat from soil-disturbing activities is the introduction of sediment from the construction site into storm drain systems or natural receiving waters. Soil-disturbing activities such as clearing, grading, grubbing, and earthwork increase the exposure of soils to wind, rain, and concentrated flows that cause erosion. A three-pronged approach is necessary to combat this storm water threat:

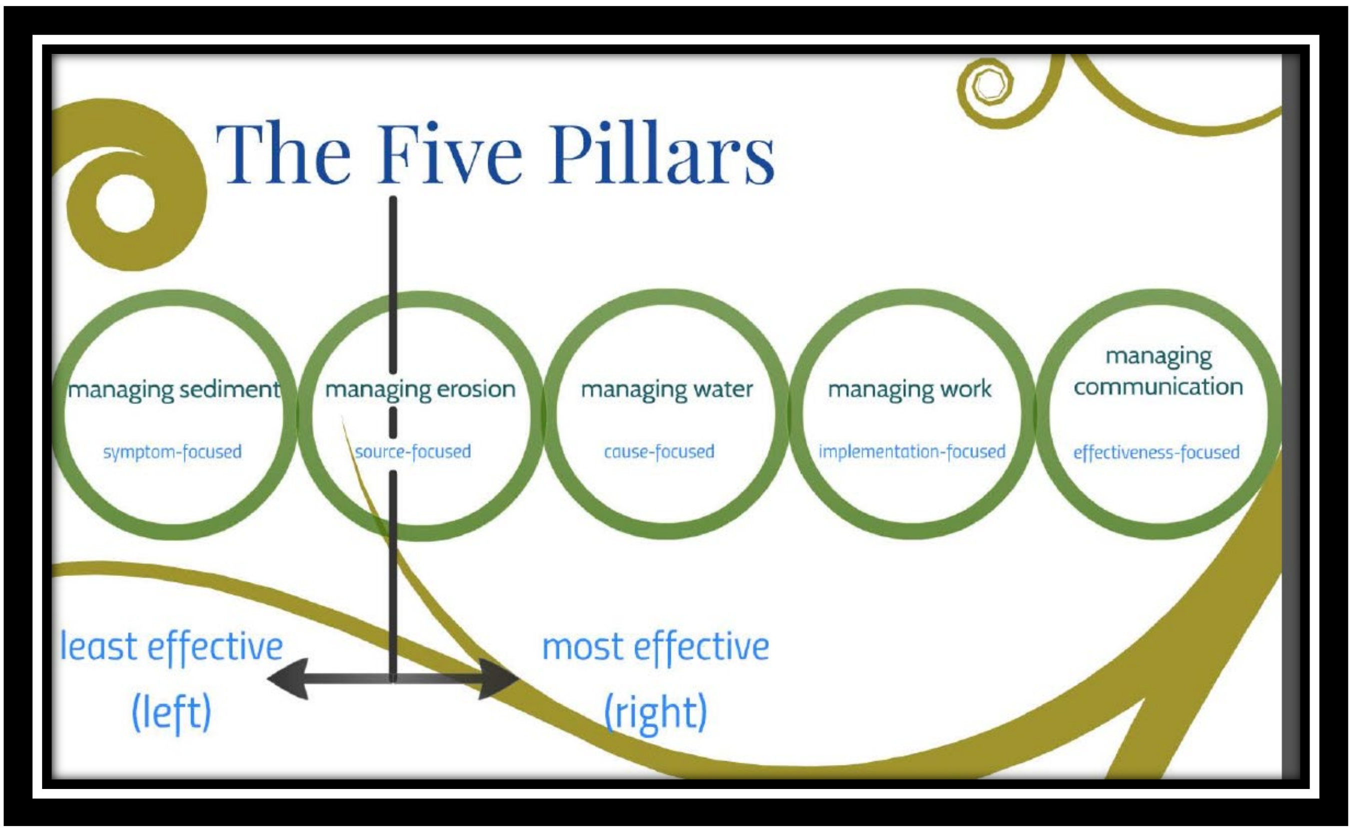
- Temporary soil stabilization practices reduce erosion associated with disturbed soil areas (DSAs).
- Temporary run-on control practices prevent storm water flows (sheet and concentrated) from contacting DSAs.
- Temporary sediment control practices reduce sediment caused by erosion from entering a storm drain system or receiving water.

Soil stabilization BMPs reduce the erosive impact of rain on exposed soil. Run-on control practices reduce the erosive impacts by preventing storm water flows from contacting DSAs. Sediment control BMPs remove sediment from storm water by ponding and settling, and/or filtering prior to discharge offsite. It is imperative that soil stabilization and sediment control BMPs are implemented together to reduce the discharge of sediment from the construction site.

## 4.1 Effectively Managing Stormwater During Construction

The following conditions on construction sites contribute to erosion caused by storm water flows:

- Larger areas of impermeable structures and surfaces reduce natural infiltration resulting in increased storm water flow volume and velocity.
- Changes to surface flow patterns cause storm water flows to be more erosive.
- Concentration of flows to areas that are not naturally subjected to such runoff volume increases erosion.
- Proper management of a construction project minimizes or prevents soil erosion and sediment discharges. Good construction management for soil conservation requires an understanding of the following basic principles:

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### 4.1.1 Managing Communication

- □ Internal
  - o Design team connection
  - o Contract administration team connection

  - Construction team connection
  - Training - inspector, designer, contractor, internal environmental stakeholders
- Contractors
  - General vision casting – priorities and expectations
  - Involvement in planning and design
  - Pre-bid meeting
  - Plan notes
  - Detailed sequencing
  - Pre- and post- bid training
  - Preconstruction conference
  - Onsite stormwater meeting
  - Co-managing/co-learning - inspection, project and liaison meetings, industry events
- External – informal/formal
  - General public
  - Neighbors
  - Political entities and individuals
  - Regulatory agencies
  - Business owners and advocates
  - Environmental advocates
- Professional
  - Research
  - Outreach
  - Training

These are the majority of communication practices, but each project may have additional practices based on site specific requirements.

### 4.1.2 MANAGING WORK

- Project Planning requirements
- Limit and delay disturbance
  - General limitations
  - Local limitations
- Sequenced construction
  - Early installation of cross drains
  - Strip-Cut-Cover
  - Move the compliance point
- Phased Erosion and Sediment Control Plan
  - Initial
  - Intermediate
  - Final
- Alternative Contract Administration
  - Incentive/disincentive
  - Lump sum
  - Permit coverage transfer

- Construction Discharge Permit coverage
  - Owner permittee
  - Owner representative permittee
  - Co-permittee with the contractor
  - Contractor permittee

## 4.1.3 MANAGING WATER

Another key component in the control of erosion is the diversion of storm water flows around DSAs or the conveyance of flows around or through DSAs in a non-erosive manner.

- Run on – diversions (swales and berms)
- Flow through –
  - Early installation of cross drains
  - Temporary diversion
  - Offset cross drains
- Dewatering – groundwater/surface water (springs/ excavated work areas)
- Runoff – managing erosion, managing sediment
  - Raindrop mitigation (cover)
  - Slope drains
  - Temporary earth berms
  - Ditch checks
  - Vegetative buffer
  - Level spreader
- Post Construction Stormwater BMPs
  - Refer to Chapter 3 for details on Post Construction Stormwater BMPs

## 4.1.4 MANAGING EROSION

Soil stabilization is a key component in the control of erosion. By stabilizing DSAs with covers or binders, the exposed soils are less likely to erode from the effects of wind or rain.

- Limit/Delay disturbance
- Reduce footprint/flatten slopes (retaining wall, soil nailing, buttress, etc.)
- Early vegetation/buffer establishment (temp/perm, preserve, establish)
- Early permanent feature establishment (drainage, slopes, vegetation, channel linings, bridge, roadway)
- Erosion control products
  - Rolled erosion control products
  - Hydraulic erosion control products
  - Compost blanket
- Permanent Ditch Linings (concrete, rip rap, articulated block mat, etc.)
- Ditch checks (wattles, silt fence, sand bags, rock checks, other manufactured products, etc.)
- Temporary/permanent road surfacing
- Stabilized construction access/haul roads

- Permanent roadway buildup
    - Surface treatments
    - Crushed aggregates base course
    - Asphalt base course

### 4.1.5 Managing Sediment – The Last Line of Defense

Storm water runoff may originate from active or inactive DSAs whether or not proper erosion and/or run-on controls have been implemented. Implementing proper sediment control BMPs can reduce sediment amounts in storm water discharges.

- Slowed water
    - Vegetated buffers
    - Sediment barriers – silt fence, sediment retention barrier, brush barrier
    - Ditch checks – wattles, silt fence, sand bags, rock checks, other manufactured products
    - Inlet protection – staged, wattles, aggregate, silt fence, sand bags, manufactured inlet protection devices
- Captured water
    - Sedimentation basin
    - Detention basin/tank
- Passive chemical treatment (if allowed by permit)
    - Flocculant dosing
        - With sediment basin
        - With ditch check
- Active chemical treatment (if allowed by permit)
    - Recirculation with flocculant
    - Pumping with filtration
- Physical removal practices
    - Stabilized construction exit
    - Wheel wash

### 4.1.6 Ensuring Effective Protection

An effective combination of soil erosion and sediment controls should be implemented to prevent sediment from leaving the site and/or entering a storm water drainage system or receiving water.

Soil stabilization and other erosion control BMPs are not 100 percent effective at preventing erosion. Soil erosion control BMPs must be supported by sediment control BMPs to capture sediment on the construction site.

Sediment control BMPs alone are not 100 percent effective primarily due to their capacity limits. To be effective for storm water protection, the amount of sediment must be reduced at the source using soil erosion control BMPs, and then sediment control BMPs are used to further reduce the sediment that leaves the site or enters the storm drain system.

### 4.1.7 Inspection and Maintenance – Ensure Protection for the Duration of the Project

Inspection and maintenance are required for all BMPs (soil stabilization, run-on control, and sediment control) to maintain effectiveness for reducing or eliminating the amount of sediment that leaves a site. The 2017 EPA CGP (Section 7.2.7) directs permit holders to identify the procedures for Inspection, Maintenance, and Corrective Action that they will take to ensure compliance. The permit holder must describe the procedures that will be followed for maintaining stormwater controls, conducting site inspections, and, where necessary, taking corrective actions, in accordance with the permit. It also requires that the SWPPP includes the inspection schedule that will be followed.

The Project Engineer (PE) is responsible for ensuring that construction personnel monitor the contractor's water pollution control practices and maintain compliance with the approved project SWPPP. This includes reviewing the contractor's SWPPP, reviewing written inspection reports, and conducting field inspections. All construction personnel should also be aware of the water pollution control requirements and participate in the monitoring program. Key steps to a successful monitoring and inspection program are summarized below.

**Step 1. Do your Homework**

a. Review this Practitioner's Guide and all appendices.

Construction personnel with storm water responsibilities should familiarize themselves with BMP requirements. In particular, become familiar with (1) the rainy season dates for your geographical area, (2) the definitions of DSA, active DSA, and non-active DSA, and (3) the requirements for soil stabilization and sediment control BMPs for the season and specific Rainfall Area.

b. Review the Project Plans.

Review the Project Plans in the context of storm water pollution control. Visualize storm water run-on and runoff flow patterns when reviewing the plans. Review the general layout and existing drainage courses. Identify potential problem areas where storm water may run onto the site or discharge off site.

Identify the locations where structures are being constructed or modified. Be familiar with the right-of-way and easement limits. Determine the limits of clearing and grubbing activities (i.e. Construction Limits). Identify the project phase or stage. Try to determine DSAs and Environmentally Sensitive Areas (ESAs). Is the next phase going to include soil-disturbing activities and is it scheduled within the rainy season? Do the DSAs have provisions in the plans for permanent erosion control? Determine if permanent erosion control can be placed when activity in the DSA is complete.

c. Review the SCRs

Review the SCRs for site-specific water pollution control requirements such as:

(1) permits for the construction project, (2) limits on active DSAs, (3) rainy season dates and requirements, (4) minimum BMP requirements, (5) BMP maintenance and inspection requirements, and (6) final erosion control requirements. Final erosion control requirements include (1) required products, (2) application process, (3) application rate, (4) seeding window, and (5) planting requirements.

The SCRs also include a section on water pollution control permits or requirements imposed on the project by other agencies. Typical agencies include the USACE, USFWS, NMFS, state departments of health and environment, local flood control agencies, and others. There may be special requirements for water bodies or Endangered Species that need special water pollution control consideration.

Review the SCRs bid items related to water pollution control. There may be lump sums or unit prices for water pollution control items including SWPPP/ESCP preparation, permanent erosion control, and temporary erosion and sediment controls.

Review the section of the SCRs for site-specific activities such as: (1) dewatering, (2) sampling and analysis, (3) BMP maintenance cost allocation between FHWA and the contractor, and (4) sanctions against the contractor in the event of non-compliance with the water pollution control requirements.

d. Review the SWPPP.

The SWPPP for the project is the contractor's plan to ensure conformance with FHWA water pollution control requirements on the construction site. The SWPPP contains conceptual details about the BMPs to be used on the site, their locations, implementation timeframes, and inspection and maintenance schedules. The contractor must comply with the approved SWPPP/ESCP. If conditions change on the construction site that impact storm water pollution controls, the contractor must amend the SWPPP.

The SWPPP contains the approval signature, lists any amendments, describes unique features of the construction site, and contains the construction and water pollution control schedules. It also identifies the BMPs selected for soil stabilization, sediment control, non-storm water controls, waste management, and materials disposal controls and references locations on the vicinity map and water pollution control drawings.

e. Review the Schedule.

The accepted Baseline schedule as well as the monthly updates and three-week "look-ahead" schedules are important references to better anticipate which BMPs will be implemented or needed. A project schedule is required in both SWPPPs and must show how the rainy season relates to soil-disturbing and re-stabilization activities and must also show major activities sequenced with implementation of BMPs.

**Step 2. Establish an Inspection Schedule**

a. Prior to the rainy season, inspect the site to ensure that the contractor has the necessary materials to stabilize required DSAs and to implement the necessary sediment controls.

b. Year round, inspect the construction site prior to a forecast storm, after a rain event that causes runoff from the construction site, and at 24-hour intervals during an extended rain event. Refer to Section 4.4, Rain Event Action Plan.

c. Conduct inspections at other frequencies as required by the SCR's and permit requirements.

d. Work with the PE, and Inspectors during site inspections and to receive assistance when necessary.

**Step 3. Conduct the Inspection**

a. Document the Inspection in a Construction Site Inspection Checklist.

b. Encourage the contractor to participate in the inspection. This provides the opportunity for verbal feedback and discussion.

c. If the project involves significant structures work, encourage the Structures representative or inspector to participate in the inspection. Take a copy of the most current and approved site plan(s) and SWPPP on the inspection for identification of site features and for taking notes at specific areas.

d. Fill out the Inspection Checklist and add findings in writing. Use clear and concise language and give specific locations where problems were observed.

e. Take photographs during the inspection to document the existing conditions. This is especially important if the contractor does not attend the inspection. When photos of problem areas are taken, try to follow up with photos showing corrections.

f. Inspect the entire site, including the perimeter, especially where there is potential for run-on or discharge from the site. Look for areas of potential concentrated flows and for adjacent water bodies or drainage facilities that may be affected by discharges from the site. Start the inspection at the lowest point, or the area with the highest potential for discharge. Inspect all potential discharge points. The SWPPP should identify discharge points; however, there may be areas with discharge potential that were not identified in the SWPPP.

g. Inspect the contractor's yard(s), where required.

h. Look for changes in construction or site conditions that may require an amendment to the SWPPP.

i. Inspect for proper implementation of non-storm water management BMPs and waste management and materials pollution control BMPs.

j. For inspections during the rainy season, evaluate active and non-active DSAs. (The PE or RE should periodically evaluate the classification of construction areas as active DSAs or non-active DSAs.) Determine the total area of DSA and compare it to the limit for DSAs in the SCR. If the existing DSA exceeds the limit, identify areas that can be stabilized to reduce the amount. Active DSAs require protection prior to the onset of rain. Evaluate erosion and sediment control BMPs based on the requirements related to Rainfall Area, season and active/non-active status as defined in the SWPPP and BMP Manual. Be sure to inspect the entire site during a rain event, especially when run-off from the site occurs.

k. During the non-rainy season, identify the active and non-active DSAs. Depending on the Rainfall Area, DSAs may continue to require erosion and sediment control BMPs during the non- rainy season.

l. For individual BMPs, note if the BMP is properly installed. Also note if the BMP is in need of repair or maintenance.

**Step 4. Report the Inspection Results**

a. If the PE or RE did not attend the inspection, communicate the results to the Resident Engineer.

b. Ideally, observations should be discussed with the contractor during the inspection.

c. Missing BMPs and non-compliance issues must be communicated to the contractor. Refer to the contractor's SWPPP for required BMPs.

**Step 5. Follow-up with Corrective Measures**

The contractor must install missing BMPs and correct improperly installed or damaged BMPs immediately or by a date and time as approved in writing by the Project Engineer or Resident Engineer. In any event, corrections must be made prior to the next rain event.

Corrective actions will be implemented within 72 hours for deficiencies identified during inspections. SWPPP amendments will be prepared by a qualified SWPPP practitioner if warranted by the problem encountered and corrective action required.

At a minimum, erosion and sediment controls will be cleaned, repaired, or replaced under these conditions:

• In advance of the rainy season and prior to a storm event

• When sediment or other debris has accumulated to greater than one-third the height of the barrier

• When sediment accumulation reaches one-third of the trap capacity

• When more than one-third of the cross section of a conveyance structure, such as a drainage swale or ditch, is plugged or blocked

Figure 16 provides a BMP implementation and maintenance schedule. The selection of BMPs can potentially change during Project construction, and Table 7 will be amended accordingly.

**Figure 16: BMP Implementation and Maintenance Schedule**

| Best Management Practices | Implementation | Inspection Frequency | Maintenance |
|---|---|---|---|
| Silt fence | Prior to construction and in sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Replace torn sections; repair up-rooted sections; clean out collected sediment when greater than 1/3 height of fence |
| Fiber rolls; coir logs; compost socks; biofilter bags | Prior to construction and in sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Replace crushed sections; replace rotted sections; clean out collected sediment when greater than 1/3 height of roll |
| Sediment basin; Sediment trap | Prior to construction and in sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Repair damage and remove obstructions as needed; stabilize eroded areas; clean out collected sediment when 1/2 of designated storage volume of basin or 1/3 of trap capacity; dewater within 72 hours |
| Check dams; velocity dissipation devices | Prior to construction and in sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Replace degraded or missing rock, bags, etc.; clean out when collected soil greater than 1/3 of barrier height |
| Dikes and drainage swales; slope drains | Prior to construction and in sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during | Repair as needed |

**Figure 16: BMP Implementation and Maintenance Schedule**

| Best Management Practices | Implementation | Inspection Frequency | Maintenance |
|---|---|---|---|
| Non-stormwater and materials management | Planned prior to construction | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Dispose of waste materials weekly; contract with outside vendors as needed; keep material storage areas clean and orderly; train all employees on correct use of materials and spill response |
| Erosion control blankets (geotextiles); non-vegetative stabilization; compost blankets | In sequence with construction activities; prior to forecasted rain event | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Repair eroded areas; replace and repair geotextiles and mats as needed |
| Sandbags | Prior to construction and in sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Repair, reshape, replace bags as necessary; replace bags exposed to sunlight every 2 to 3 months; clean out collected sediment when greater than 1/3 barrier height |
| Gravel bags | Prior to construction and in sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Repair, reshape, replace bags as necessary; replace bags exposed to sunlight every 2 to 3 months; clean out collected sediment when greater than 1/3 barrier height |

**Figure 16: BMP Implementation and Maintenance Schedule**

| Best Management Practices | Implementation | Inspection Frequency | Maintenance |
|---|---|---|---|
| Storm drain inlet protection | Prior to construction | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Clean and repair filters or fabric fence as needed; clean out collected sediment when greater than 1/3 barrier height |
| Hydraulic mulch | In sequence with construction activities; prior to forecasted rain event | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Repair eroded areas; reapply on bare areas as needed |
| Mulch (straw, wood, organic); soil binders | In sequence with construction activities; prior to forecasted rain event | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Repair eroded areas; reapply on bare areas as needed |
| Hydroseeding; seeding (if applicable) | As soon as possible after disturbance has permanently or temporarily ceased, but in no case more than 14 days after the construction activity in an area has ceased (except when construction activity will resume on that portion of the site within 21 days) | Inspect before and after storm events (and once each 24-hour period during extended storm events), weekly; monitored every May for the first 3 years following Project completion | Reseed areas that do not meet revegetation criteria |
| Streambank stabilization | In sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Repair eroded areas; replace BMP measure as needed |

**Figure 16: BMP Implementation and Maintenance Schedule**

| Best Management Practices | Implementation | Inspection Frequency | Maintenance |
|---|---|---|---|
| Straw bale barrier | In sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Replace rotted sections; clean out collected sediment when greater than 1/3 height of barrier |
| Active treatment system | In sequence with construction activities | Follow guidelines of the Construction General Permit | Follow guidelines of the Construction General Permit |
| Concrete washout | In sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Clean out, or construct new facility, once the washout is 75 percent full |
| Aggregate surfacing | Completion of grading activities | Weekly | Keep all temporary roadway ditches clear; periodically apply additional aggregate as needed |
| Stabilized construction entrance/exit | Prior to grading/earth disturbance | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Remove aggregate, separate and dispose of sediment when construction entrance/exit is clogged with sediment; keep all temporary roadway ditches clear; check for damage and repair as needed; replace gravel material when surface voids are visible |

**Figure 16: BMP Implementation and Maintenance Schedule**

| Best Management Practices | Implementation | Inspection Frequency | Maintenance |
|---|---|---|---|
| Stabilized construction roadway | Prior to start of associated construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Keep all temporary roadway ditches clear; periodically apply additional aggregate on gravel roads |
| Stockpile management | In sequence with construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Repair or replace perimeter controls and covers as needed |
| Street sweeping and vacuuming | Start of construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); when actively in use, inspect points of ingress and egress daily, otherwise weekly | Remove tracked or spilled sediment outside the construction limits at a minimum daily |
| Tire wash | Prior to start of associated construction activities | Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly | Remove accumulated sediment in wash rack to maintain system performance; repair as needed |

## 4.2 Rain Event Action Plans

The Rain Event Action Plans (REAP) is written document designed to be used as a planning tool by a qualified stormwater professional (QSP) to protect disturbed portions of the construction site and to ensure that adequate materials and staff are available to implement erosion and sediment control measures. It is the responsibility of the QSP to be aware of precipitation forecast and to obtain and print copies of forecasted precipitation from NOAA's National Weather Service Forecast Office (http://www.prh.noaa.gov/hnl/).

The QSP shall customize these templates for each rain event and project phase when the project is under construction. The QSP shall maintain a paper copy of completed REAPs in compliance with the record retention requirements of the SWPPP/ IWPPP. Completed REAPs shall be maintained on the project site with the SWPPP throughout the duration of construction.

The QSP will develop the event-specific REAP 48 hours prior to precipitation event forecast to have a 50% or greater chance of producing precipitation in the project area. The REAP will be maintained onsite and be implemented 24 hours in advance of the predicted precipitation event.

At a minimum, the REAP will include the following site and phase-specific information:

- Site Address;
- Site Stormwater Manager Information including the name, company and 24-hour emergency telephone number;
- Erosion and Sediment Control Provider information including the name, company and 24-hour emergency telephone number;
- Stormwater Sampling/Inspector Agent information including the name, company, and 24-hour emergency telephone number;
- Activities associated with each construction phase;
- Trades active on the construction site during each construction phase;
- Trade Contractor information; and
- Recommended actions for each project phase.

### 4.2.1 RAIN EVENT TRIGGERED OBSERVATIONS AND INSPECTIONS

Visual observations of the site and inspections of BMPs are required prior to a qualifying rain event, following a qualifying rain event, and every 24-hour period during a qualifying rain event. Pre-rain inspections will be conducted after consulting NOAA and determining that a precipitation event with a 50% or greater probability of precipitation has been predicted.

### 4.2.2 VISUAL OBSERVATIONS PRIOR TO A FORECASTED QUALIFYING RAIN EVENT

The REAP must be available onsite at least 48-hours prior to a qualifying forecast storm event. A stormwater visual monitoring site inspection and observations shall be conducted at the following locations:

- Potential pollutant sources are properly stored (i.e. sorted in covered areas, elevated off ground surfaces, etc.);

- Stormwater drainage areas to identify any spills, leaks, or uncontrolled pollutant sources;
- BMPs to identify if they have been properly implemented or require maintenance;
- Any stormwater storage and containment areas to detect leaks and ensure maintenance of adequate freeboard.

### 4.2.3 BMP Inspections During an Extended Storm Event

During an extended rain event BMP inspections will be conducted every 24 hours during normal business hours to identify and record:

- Stormwater drainage areas to identify any spills, leaks, or uncontrolled pollutant sources;
- Evidence of any spills, leaks, or uncontrolled pollutant sources that may have migrated offsite;
- BMPs that are properly installed;
- BMPs that need maintenance to operate effectively;
- BMPs that have failed; or
- BMPs that could fail to operate as intended.

If the construction site is not accessible during the rain event, the visual inspections shall be performed at all relevant outfalls, discharge points, and downstream locations. The inspections should record any projected maintenance activities.

### 4.2.4 Visual Observations Following a Qualifying Rain Event

Within 48 hours following a qualifying rain event (½ inch of rain) a stormwater visual monitoring site inspection is required to observe:

- Evidence of any spills, leaks, or uncontrolled pollutant sources that may have migrated offsite;
- BMPs to identify if they have been properly designed, implemented, and effective;
- Need for additional BMPs or BMP maintenance;
- Any stormwater storage and containment areas to detect leaks and ensure maintenance of adequate freeboard; and
- Discharge of stored or contained rain water.

If the QSP or the Project Engineer (PE) identifies a deficiency in the implementation of the accepted SWPPP, the deficiency must be corrected immediately unless the PE authorizes an agreed date for correction. The correction must occur before the onset of precipitation.

If failure to correct the deficiency by the scheduled date or by the onset of precipitation occurs, the project may correct the deficiency and deduct the cost of correcting the deficiency from payment. Failure to comply with the corrective action may result in the suspension of work by the PE until the project complies with the requirements of the SWPPP.

### 4.2.5 Post Construction Stabilization

The key to getting the post-project site to function (from a stormwater runoff standpoint) similar to a natural, undisturbed site is to restore the functionality that has been removed. In general, the successful and sustainable erosion control solution addresses:

1. Soil Cover:

   Bare soil requires the protective cover provided by a mulch product such as bark mulch, compost blanket, pine needles, straw, duff or hydraulically applied mulches. These products protect the soil surface from erosion due to raindrop impact and sheet flow.

2. Healthy Soil:

   Healthy soils maintain stormwater quality and control erosion by their open structure that facilitates infiltration of runoff, and by providing the nutrients and soil biota necessary to support long-term sustainable vegetative cover. To maintain stormwater quality, disturbed roadsides that feature highly compacted sterile soils typically require de-compaction and/or incorporation of organics such as compost to restore soil health.

3. Sustainable Vegetation:

   Sustainable vegetation is dependent upon selecting the proper mixture of plant types (grass, annual, perennial, forb, cutting, sod, liner, woody shrub) and species for specific site environmental conditions (geographic location, elevation, exposure, soil type). The short-term goal is to quickly establish vegetative cover to provide protection from raindrop impact and sheet-flow erosive forces. The long-term goal is to establish healthy mature vegetation that requires minimal replanting, supplemental water, or maintenance.

An erosion control solution that ensures that well drained soil including organic material and healthy soil biota, a surface mulch layer of duff/mulch, together with regionally appropriate plant material mimics the functionality of the natural environment, and with time should perform in a similar manner - protecting water quality and managing the runoff rate and volume.

## 4.3 Construction Operations and Applicable Best Management Practices Matrix

Prior to any ground disturbing activities, the physical condition of the construction site and adjacent areas should be reviewed by members of the Project Delivery Team (PDT) and Contractor Construction Staff. A project design package showing what is being constructed, limits of construction, avoidance areas/ sensitive areas, project schedule, and contract requirements will be provided to contractor. Site characteristics including drainage patterns, soils, vegetation, surface water bodies, and steep or unstable slopes should be noted. If available, the hydrology/ hydraulics report, soils report, and a grading/drainage plan should also be consulted. Physical conditions at the site will change as construction progresses; BMP application should change accordingly to ensure effective protection is maintained throughout construction milestones.

To meet regulatory requirements and protect the site resources, every project requiring coverage by a Construction General Permit (CGP) must include an effective combination of erosion and sediment control measures within the Storm Water Pollution Prevention Plan (SWPPP) and or an Erosion and Sediment Control Plan (ESCP). These measures must be selected from all of the BMP categories presented in this section: soil stabilization practices, sediment control practices, tracking control practices, and wind erosion control practices. Additionally, the project plan must include non-storm water controls, waste management and material pollution controls.

The SWPPP is more than just and erosion control plan. A SWPPP is a tool that aids in managing pollution during construction. A SWPPP is a written document that describe the pollution prevention practices and activities that will be implemented on the site. It includes descriptions of the site and of each major phase of the planned activity, the roles and responsibilities of contractors and subcontractors, procedures that will be implemented to comply with the terms and conditions of the construction general permit and the inspection schedule and logs. It is also a place to document changes and modifications to the construction plans and associated stormwater pollution prevention activities.

SWPPPs are designed to be amended whenever there is a change in design, construction, operation, or maintenance, which has a significant effect on the potential for discharge of pollutants to surface waters of the US, state, or to a MS4. The SWPPP is also amended if BMPs prove to be ineffective in managing pollutants of concern (POC) from sources identified during inspection, or when any new contractor and/or subcontractor will implement any measure of the SWPPP. All amendments are signed, dated, and kept as attachments to the original SWPPP. This ensures that SWPPPs are kept up to date with changes on the construction site.

However, historically many key construction permit applications (including the 404 and 401-water quality certifications) have required that a list of appropriate BMPs proposed for a specific project, along with the required site plan, description, and location of those BMPs be provided. A common issue with this approach for linear transportation projects is that the construction contractor has not been selected yet and how they plan to phase the project, or where they plan to locate their material storage and staging sites, is not available. The project designer may provide preliminary layout sheets showing the suggested locations of temporary BMPs, staging, and material storage. Typically, these layouts are not highly detailed drawings and are commonly drawn on l:200 and l:500 scale. Where multiple phases of construction are anticipated, the designer attempts to show the various stages and how the deployment of the BMPs is expected to change over time. These locations and layouts will be, in most cases, subject to the contractor’s phasing of the work and timing of operations. As a result, the locations are immediately modified by the contractor in the SWPPP as construction phasing is identified.

Contractors and designers need to carefully think through many factors to choose the most appropriate, effective and feasible practice(s) at a construction site that will best meet Federal, state and local stormwater and water quality objectives. Due to site constraints, there are situations where specific BMPs are identified to be used.

Proper BMP selection requires that a stormwater manager select those BMPs most able to address an identified pollutant source. Selecting an inappropriate BMP could lead to adverse resource impacts, friction with regulators, misperceptions about stormwater control success, and wasted time and money. Careful selection of BMPs will prevent negative impacts from installing the wrong BMP at the wrong location.

The number, location and type of applicable BMPs is variable and depends on project design and generally must be determined on a case by-case basis. There is no minimum number of practices that are appropriate to various projects. Following permit approval, it is common that BMPs need to be modified as a contractor develops their methods and means of construction on the project. This commonly requires that BMPs be modified, moved, or substituted to ensure they continue to meet project goals. The SWPPP is a living document and must be developed or amended to address conditions as activities change at the site. The utilization of preferred construction BMPs from six control categories allows improved coordination with the contractor during the development of the SWPPP and adaptive management of BMPs during construction as one preferred construction BMPs is substituted for another in the SWPPP rather than being static.

The goal of the below matrices is to allow a suite of preferred construction BMPs to be identified during the permitting process. Following permit approvals, the PDT and contractors can then use the project design specifications to refine the BMP list in the project site plan of the SWPPP. This approach allows projects to adaptively manage project BMPs as site conditions change, construction phasing changes or construction milestones are reached.

The BMP Matrices in this section cross-reference individual BMPs with the most common construction activities that can release pollutants. Therefore, in Table X the horizontal axis of the matrix (across the top) lists typical highway construction activities. The BMPs appropriate for those construction activities are listed on the vertical axis (down the left-hand side of the page). This table groups BMPs with major construction operations which will assist with BMP management during construction phasing.

The matrix in Table X further refines the construction BMPs by grouping BMPs into BMP categories including: soil stabilization practices, sediment control practices, tracking control practices, and wind erosion control practices, non-storm water controls, waste management and material pollution controls. These BMP categories are cross referenced against typical highway construction activities.

Detailed descriptions and guidance regarding implementation of these BMPs are in Chapter 4 or the Clear Water Diversion and Isolation Techniques (Chapter 5) which summarizes additional BMPs suitable for construction activities in, over or adjacent to water or when water diversion and isolation techniques are required to complete the necessary construction activities.

The BMP Matrix includes the best information available to the FHWA at this time regarding practices known to be appropriate for transportation projects. It is anticipated that this manual will be revised and supplemented in subsequent reviews of available BMP technologies. The list of BMPs provided in the matrix is not intended to be exhaustive. Rather, it is intended that members of the PDT and contractors may select BMPs other than those included in the BMP Matrix, so long as they treat the same POC and are an appropriate BMP for the particular construction activity.

The matrix format in Figure 18 and 19 reflects the fact that there are a variety of BMPs that may be appropriate for a given project and that each project's circumstances are unique. The matrix identifies the most likely BMPs appropriate for different types of projects and for different types of pollutant scenarios. It also assists the PDT in determining if a specific BMP is not appropriate to a specific scenario. The individual BMPs designated by an "X" in Table 5 have been identified as applicable to a particular typical construction activity, but will not necessarily be appropriate for all projects involving the noted activity. For example, not all projects will have on-site vehicle fueling and maintenance operations; however, those that do will be required to conduct those operations in a manner consistent with the intent of the BMP description. These tables can assist construction staff to determine if a proposed practice is actually applicable to the desired pollution prevention or environmental protection outcome. It is intended to be a flexible tool.

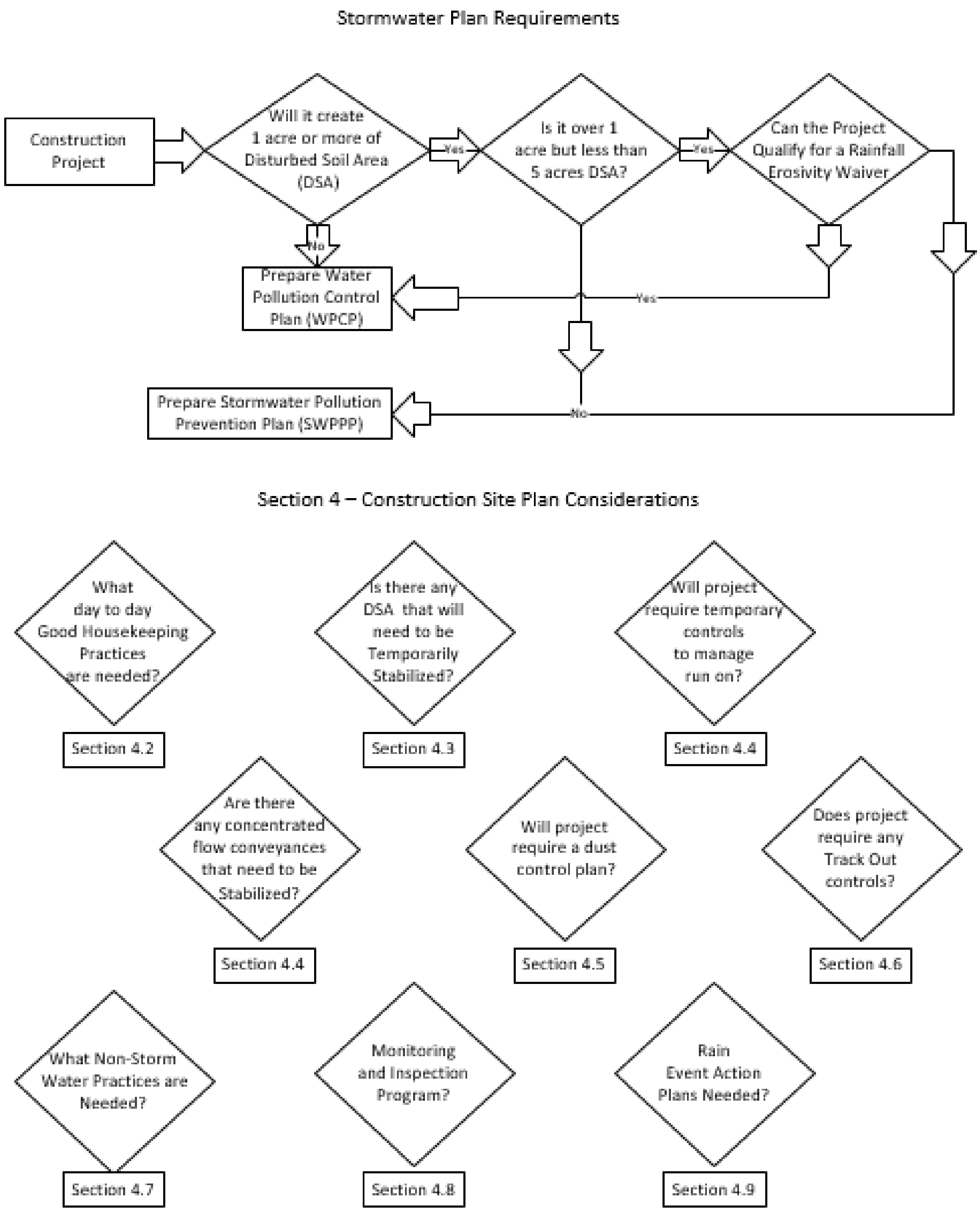
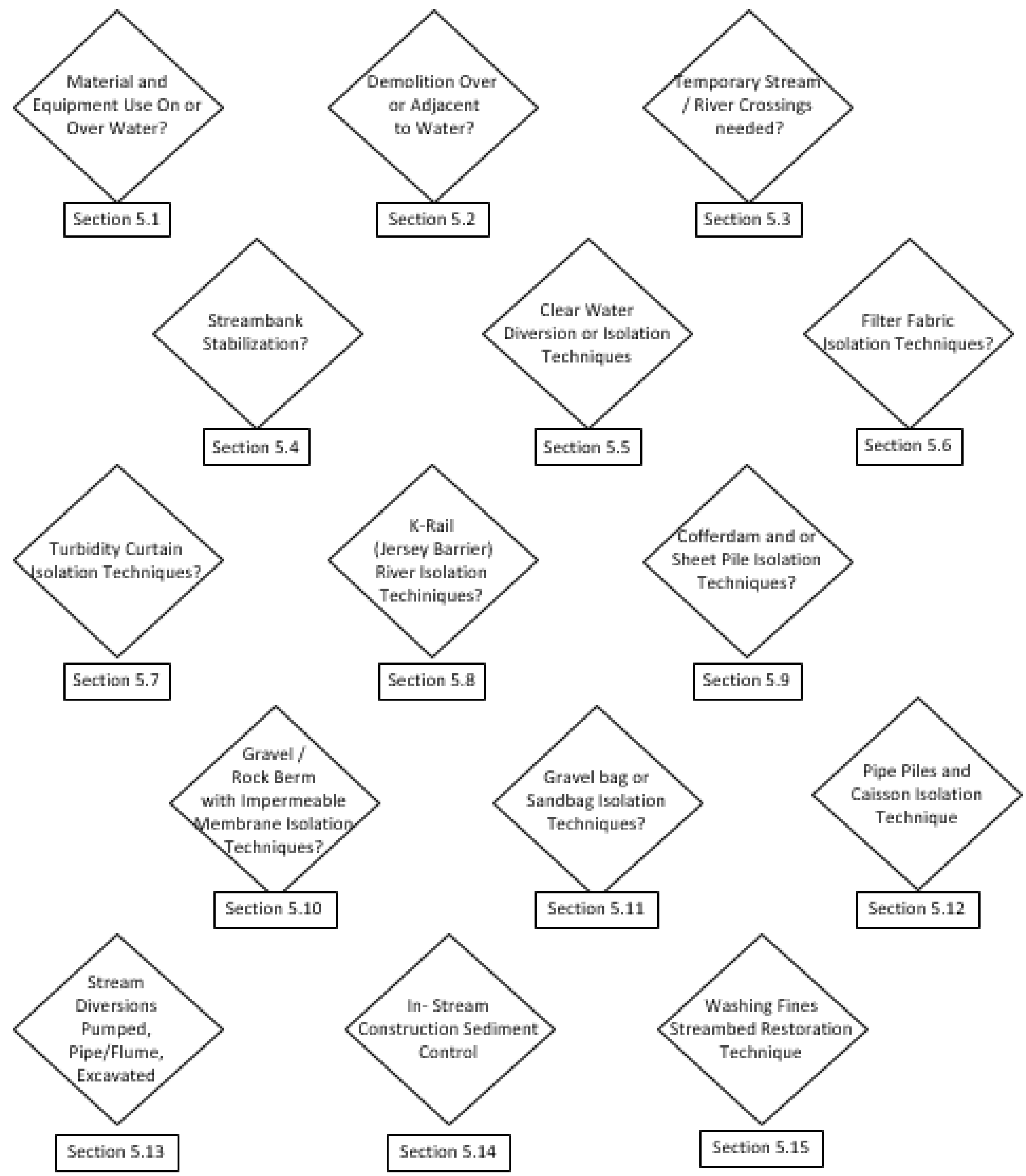



**Figure 17: Stormwater Plan Requirements**

Section 5 -Additional Working In, Adjacent, or Over Water Considerations



| Figure 18: Storm Water BMPs for Construction Operations | | | | |
|---|---|---|---|---|
| **Construction Operation** | **BMP Category** | **BMP Info** | **BMP Description** | **FP-14 Section Reference or SCR Location.** |
| Mobilization | Sediment Control | 4.4.7 | Street Sweeping and Vacuuming | |
| | Tracking Control | 4.5.1 | Stabilized Construction Entrance/Exit | |
| | | 4.5.2 | Stabilized Construction Roadway | |
| | | 4.5.3 | Entrance/Outlet Tire Wash | |
| | Non-Stormwater Control | 4.7.8 | Illicit Connection / Illegal Discharge Detection and Reporting | |
| | Waste Management and Materials Pollution Control | 4.2.2.1 | Material Delivery and Storage | |
| | | 4.2.2.2 | Material Use | |
| | | 4.2.3.7 | Spill Prevention and Control | |
| | | 4.2.3.2 | Solid Waste Management | |
| | | 4.2.3.5 | Hazardous Waste Management | |
| | | 4.2.3.3 | Sanitary/Septic Waste Management | |
| Clearing/Grubbing | Soil Stabilization and Erosion Control | 4.2.5.1 | Scheduling | FP Section 156 |
| | | 4.2.5.2 | Preservation of Existing Vegetation | |
| | | 4.3.1 | Slope Roughening, Terracing, and Rounding | FP Section 204, Section 624 |
| | | 4.3.2.1.1.1 | Hydraulic Mulch | FP Section 713.05 |
| | | 4.3.3 | Seeding | FP Section 713.04 |
| | | 4.3.4 | Chemical Stabilization with Soil Binders | |
| | | 4.3.2.1.1.2 | Straw Mulch | FP Section 713.05 |
| | | 4.3.5 | Geotextiles, Plastic Covers & Erosion Control Blankets/Mats | FP Section 714.01, Section 157 |
| | | 4.3.2.1.1.3 | Wood Mulching | |
| | | 4.3.6 | Earth Dikes/Drainage Swales & Lined Ditches | |
| | | 4.3.7 | Outlet Protection/Velocity Dissipation Devices | FP Section 251, Section 157, |
| | | 4.3.8 | Slope Drains | |
| | Sediment Control | 4.4.1 | Silt Fence | 713.01 |
| | | 4.4.2 | Sedimentation/Desilting Basin | |
| | | 4.4.3 | Sediment Trap/ Filter bags | |

**Figure 18: Storm Water BMPs for Construction Operations**

| Construction Operation | BMP Category | BMP Info | BMP Description | FP-14 Section Reference or SCR Location. |
|---|---|---|---|---|
| | | 4.4.4 | Check Dam | |
| | | 4.4.5 | Fiber Rolls | |
| | | 4.4.6 | Gravel Bag / Earthen Berm | |
| | | 4.4.7 | Street Sweeping and Vacuuming | |
| | | 4.4.8 | Sand bag Barrier | |
| | | 4.4.9 | Straw Bale Barrier | |
| | | 4.4.10 | Storm Drain Inlet Protection | |
| | Wind Erosion Control | 4.6 | Wind Erosion Control | |
| | Non-Stormwater Management | 4.7.5 | Water Conservation Practices | |
| | | 4.2.4.1 | Vehicle and Equipment Cleaning | |
| | | 4.2.4.3 | Vehicle and Equipment Refueling | |
| | | 4.2.4.2 | Vehicle and Equipment Maintenance | |
| | Waste Management and Materials Pollution Control | 4.2.2.3 | Stockpile Management | |
| | | 4.2.3.2 | Solid Waste Management | |
| | | 4.2.3.4 | Contaminated Soil Management | |
| Earthwork | Soil Stabilization | 4.2.5.1 | Scheduling | |
| | | 4.2.5.2 | Preservation of Existing Vegetation | |
| | | 4.3.1 | Slope Roughening, Terracing, and Rounding | Section 204, Section 624 |
| | | 4.3.2.1.1.1 | Hydraulic Mulch | |
| | | 4.3.3 | Seeding | |
| | | 4.3.4 | Chemical Stabilization with Soil Binders | |
| | | 4.3.2.1.1.2 | Straw Mulch | |
| | | 4.3.5 | Geotextiles, Plastic Covers & Erosion Control Blankets/Mats | |
| | | 4.3.2.1.1.3 | Wood Mulching | |
| | | 4.3.6 | Earth Dikes/Drainage Swales & Lined Ditches | |
| | | 4.3.7 | Outlet Protection/Velocity Dissipation Devices | |
| | | 4.3.8 | Slope Drains | |

| Figure 18: Storm Water BMPs for Construction Operations | | | | |
|---|---|---|---|---|
| **Construction Operation** | **BMP Category** | **BMP Info** | **BMP Description** | **FP-14 Section Reference or SCR Location.** |
| | Sediment Control | 4.4.1 | Silt Fence | |
| | | 4.4.2 | Sedimentation/Desilting Basin | |
| | | 4.4.3 | Sediment Trap / Filter bags | |
| | | 4.4.4 | Check Dam | |
| | | 4.4.5 | Fiber Rolls | |
| | | 4.4.6 | Gravel Bag / Earthen Berm | |
| | | 4.4.7 | Street Sweeping and Vacuuming | |
| | | 4.4.8 | Sandbag Barrier | |
| | | 4.4.9 | Straw Bale Barrier | |
| | | 4.4.10 | Storm Drain Inlet Protection | |
| | Tracking Control | 4.5.1 | Stabilized Construction Entrance/Exit | |
| | Wind Erosion Control | 4.6 | Wind Erosion Control | |
| | Non-Stormwater Management | 4.7.1 | Temporary Stream/River Crossing | |
| | | 4.2.4.1 | Vehicle and Equipment Cleaning | |
| | | 4.2.4.3 | Vehicle and Equipment Refueling | |
| | | 4.2.4.2 | Vehicle and Equipment Maintenance | |
| | Waste Management and Materials Pollution Control | 4.2.3.4 | Contaminated Soil Management | |
| Portland Cement Concrete and Asphalt / Concrete Operations | Sediment Control | 4.4.7 | Street Sweeping and Vacuuming | |
| | Tracking Control | 4.5.1 | Stabilized Construction Entrance/Exit | |
| | Non-Stormwater Management | 4.7.7 | Paving, Sealing, Sawcutting, and Grinding Operations | |
| | Waste Management and Materials Pollution Control | 4.2.2.1 | Material Delivery and Storage | |
| | | 4.2.2.2 | Material Use | |
| | | 4.2.2.3 | Stockpile Management | |
| | | 4.2.3.2 | Solid Waste Management | |
| | | 4.2.3.1 | Concrete Waste Management | |
| Drainage Work | Sediment Control | 4.4.2 | Sediment/Desilting Basin | |
| | | 4.4.3 | Sediment Trap / Filter bags | |
| | | 4.4.4 | Check Dam | |

**Figure 18: Storm Water BMPs for Construction Operations**

| Construction Operation | BMP Category | BMP Info | BMP Description | FP-14 Section Reference or SCR Location. |
|---|---|---|---|---|
| | | 4.4.10 | Storm Drain Inlet Protection | |
| | Soil Stabilization | 4.3.6 | Earth Dikes/Drainage Swales & Lined Ditches | |
| | | 4.3.7 | Outlet Protection/Velocity Dissipation Devices | |
| Dewatering Operations | Non-Stormwater Management | 4.7.6 | Dewatering Operations | |
| Bridge Construction | Non-Stormwater Management | 4.7.5 | Water Conservation Practices | |
| | | 4.7.7 | Paving, Sealing, Sawcutting, and Grinding Operations | |
| | | 4.7.1 | Temporary Stream/River Crossing | |
| | | 4.7.2 | Clear Water Diversion and Isolation Techniques | |
| | | 4.2.4.1 | Vehicle and Equipment Cleaning | |
| | | 4.2.4.3 | Vehicle and Equipment Refueling | |
| | | 4.2.4.2 | Vehicle and Equipment Maintenance | |
| | Waste Management and Materials Pollution Control | 4.2.2.1 | Material Delivery and Storage | |
| | | 4.2.2.2 | Material Use | |
| | | 4.2.2.3 | Stockpile Management | |
| | | 4.2.3.7 | Spill Prevention and Control | |
| | | 4.2.3.2 | Solid Waste Management | |
| | | 4.2.3.5 | Hazardous Waste Management | |
| | | 4.2.3.1 | Concrete Waste Management | |
| | | 4.2.3.6 | Liquid Waste Management | |
| | Non-Stormwater Control | 4.7.7 | Paving, Sealing, Sawcutting, and Grinding Operations | |
| | | 4.7.1 | Temporary Stream/River Crossing | |
| | | 4.7.2 | Clear Water Diversion and Isolation Techniques | |
| Roadway Construction | Waste Management and Materials Pollution Control | 4.2.2.1 | Material Delivery and Storage | |
| | | 4.2.2.2 | Material Use | |
| | | 4.2.2.3 | Stockpile Management | |

| Figure 18: Storm Water BMPs for Construction Operations | | | | |
|---|---|---|---|---|
| **Construction Operation** | **BMP Category** | **BMP Info** | **BMP Description** | **FP-14 Section Reference or SCR Location.** |
| | | 4.2.3.2 | Solid Waste Management | |
| | | 4.2.3.5 | Hazardous Waste Management | |
| | | 4.2.3.1 | Concrete Waste Management | |
| | | 4.2.3.6 | Liquid Waste Management | |
| Mobile Operations | Sediment Control | 4.4.7 | Street Sweeping and Vacuuming | |
| | | 4.4.10 | Storm Drain Inlet Protection | |
| | Tracking Control | 4.5.1 | Stabilized Construction Entrance/Exit | |
| | Non-Stormwater Control | 4.2.4.1 | Vehicle and Equipment Cleaning | |
| | | 4.2.4.3 | Vehicle and Equipment Refueling | |
| | | 4.2.4.2 | Vehicle and Equipment Maintenance | |
| | Waste Management and Materials Pollution Control | 4.2.2.1 | Material Delivery and Storage | |
| | | 4.2.2.2 | Material Use | |
| | | 4.2.2.3 | Stockpile Management | |
| | | 4.2.3.2 | Solid Waste Management | |
| | | 4.2.3.5 | Hazardous Waste Management | |
| | | 4.2.3.1 | Concrete Waste Management | |
| Trenching Operations | Sediment Control | 4.4.7 | Street Sweeping and Vacuuming | |
| | | 4.4.10 | Storm Drain Inlet Protection | |
| | Waste Management and Materials Pollution Control | 4.2.2.3 | Stockpile Management | |
| Erosion Control, Highway Planting and Landscaping | Soil Stabilization | 4.2.5.1 | Scheduling | |
| | | 4.2.5.2 | Preservation of Existing Vegetation | |
| | | 4.3.2.1.1.1 | Hydraulic Mulch | |
| | | 4.3.3.2.2 | Hydroseeding | |
| | | 4.3.4 | Chemical Stabilization with Soil Binders | |
| | | 4.3.2.1.1.2 | Straw Mulch | |
| | | 4.3.5 | Geotextiles, Plastic Covers & Erosion Control Blankets/Mats | |
| | | 4.3.2.1.1.3 | Wood Mulching | |

| Figure 18: Storm Water BMPs for Construction Operations | | | | |
|---|---|---|---|---|
| **Construction Operation** | **BMP Category** | **BMP Info** | **BMP Description** | **FP-14 Section Reference or SCR Location.** |
| | | 4.3.6 | Earth Dikes/Drainage Swales & Lined Ditches | |
| | | 4.3.7 | Outlet Protection/Velocity Dissipation Devices | |
| | Sediment Control | 4.4.1 | Silt Fence | |
| | | 4.4.7 | Street Sweeping and Vacuuming | |
| | | 4.4.8 | Sandbag Barrier | |
| | | 4.4.9 | Straw Bale Barrier | |
| | | 4.4.10 | Storm Drain Inlet Protection | |
| | Wind Erosion Control | 4.6 | Wind Erosion Control | |
| | Non-Stormwater Control | 4.7.9 | Potable Water/Irrigation | |
| | | 4.2.4.1 | Vehicle and Equipment Cleaning | |
| | Waste Management and Materials Pollution Control | 4.2.2.1 | Material Delivery and Storage | |
| | | 4.2.2.2 | Material Use | |

**Figure 19: Construction Site BMPs By Construction Activity**

| | *Typical Highway Construction Activities* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Demolish Pavement/Structure | Clear and Grub | Construct Access Roads | Grading (including cut and fill slopes) | Channel Excavation | Channel Paving | Trenching/ Underground Drainage | Underground Drainage Facility Installation | Drainage Inlet Modification | Utility Trenching | Utility Installation | Subgrade Preparation | Base Paving | Asphalt Concrete Paving | Concrete Paving | Saw Cutting | Joint Sealing | Grind/Groove | Structure Excavation | Erect Falsework | Bridge/Structure Construction | Remove Falsework | Striping | Miscellaneous Concrete Work | Sound Walls/Retaining Walls | Planting and Irrigation | Contractor Activities | Treatment BMP Construction |
| ***Best Management Practices*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Temporary Sediment Control* | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Silt Fence | X | X | X | X | X | | X | | | X | | X | | | | | | | X | | X | | | | | X | | X |
| Sandbag Barrier | X | X | X | X | X | | X | | | X | | X | | | | | | | X | | X | | | | | X | | X |
| Straw Bale Barrier | X | X | X | X | X | | X | | | X | | X | | | | | | | X | | X | | | | | X | | X |
| Fiber Rolls | X | X | X | X | X | | X | | | X | | | | | | | | | | | X | | | | | X | | X |
| Gravel Bag Berm | X | X | X | X | X | | X | | | X | | | | | | | | | | | X | | | | | X | | X |
| Check Dam | X | X | | X | X | | X | | | | | | | | | | | | | | | | | | | | | X |
| Desilting Basin | X | X | X | X | X | | | | | | | | | | | | | | | | X | | | | | X | | X |
| Sediment Trap / Filter Bags | X | X | X | X | X | | X | | | X | | X | | | | | | | X | | X | | | | | X | | X |
| Sediment Basin | | X | | X | X | | | | | | | | | | | | | | | | X | | | | | X | | X |
| *Temporary Soil Stabilization* | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydraulic Mulch | X | X | | X | X | | | | | | | | | | | | | | | | X | | | | | X | | X |
| Hydroseeding | X | X | | X | X | | | | | | | | | | | | | | | | X | | | | | X | | X |
| Soil Binders | X | X | | X | X | | | | | | | | | | | | | | X | | X | | | | | X | | X |
| Straw Mulch | X | X | X | X | X | | X | X | | X | | X | | | | | | | X | | X | | | | | X | | X |
| Geotextiles, Mats/Plastic Covers and Erosion Control | X | X | X | X | X | | X | X | | X | | X | | | | | | | X | | X | | | | | X | | X |

**Figure 19: Construction Site BMPs By Construction Activity**

| | *Typical Highway Construction Activities* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Demolish Pavement/Structure | Clear and Grub | Construct Access Roads | Grading (including cut and fill slopes) | Channel Excavation | Channel Paving | Trenching/ Underground Drainage | Underground Drainage Facility Installation | Drainage Inlet Modification | Utility Trenching | Utility Installation | Subgrade Preparation | Base Paving | Asphalt Concrete Paving | Concrete Paving | Saw Cutting | Joint Sealing | Grind/Groove | Structure Excavation | Erect Falsework | Bridge/Structure Construction | Remove Falsework | Striping | Miscellaneous Concrete Work | Sound Walls/Retaining Walls | Planting and Irrigation | Contractor Activities | Treatment BMP Construction |
| ***Best Management Practices*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Scheduling*** | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | X | | X | X | X | X | X | X |
| ***Preservation of Existing Vegetation*** | | X | X | X | | | X | X | | X | | | | | | | | | X | X | | X | | | X | | | |
| ***Temporary Concentrated Flow Conveyance Controls*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Earth Dikes/Drainage Swales & Lined Ditches* | | X | X | X | | | | | | | | | | | | | | | | | X | | | | | | | |
| *Outlet Protection/Velocity Dissipation Devices* | | X | X | X | | | | | | | | | | | | | | | | | X | | | | | | | |
| *Slope Drains* | | | | X | | | | | | | | | | | | | | | | | X | | | | | | | |
| ***Temporary Stream Crossing*** | | | X | | | | X | X | | X | X | | | | | | | | | X | X | X | | X | | | | |
| ***Clear Water Diversion and Isolation Techniques*** | X | | X | | X | X | | | | | | | | | | | | | | X | X | X | | | X | | | X |
| ***Wind Erosion Control*** | | X | X | X | X | | X | | | X | | X | X | X | X | | | | | | | | | | | X | | X |
| ***Sediment Tracking Control*** | X | X | X | X | X | | X | X | | X | X | X | X | X | X | X | | X | X | | X | | | | X | X | X | X |

**Figure 19: Construction Site BMPs By Construction Activity**

*Typical Highway Construction Activities*

| | Demolish Pavement/Structure | Clear and Grub | Construct Access Roads | Grading (including cut and fill slopes) | Channel Excavation | Channel Paving | Trenching/ Underground Drainage | Underground Drainage Facility Installation | Drainage Inlet Modification | Utility Trenching | Utility Installation | Subgrade Preparation | Base Paving | Asphalt Concrete Paving | Concrete Paving | Saw Cutting | Joint Sealing | Grind/Groove | Structure Excavation | Erect Falsework | Bridge/Structure Construction | Remove Falsework | Striping | Miscellaneous Concrete Work | Sound Walls/Retaining Walls | Planting and Irrigation | Contractor Activities | Treatment BMP Construction |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Best Management Practices*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Street Sweeping and Vacuuming* | X | X | X | X | X | | X | X | | X | X | X | X | X | X | X | | X | X | | X | | | | X | X | X | X |
| *Stabilized Construction Roadway* | | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | |
| *Entrance/Outlet Tire Wash* | | X | X | X | | | | | | | | | | | | | | | | | | | | | | X | X | |
| ***Waste Management*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Spill Prevention and Control* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| *Solid Waste Management* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| *Hazardous Waste Management* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| *Contaminated Soil Management* | X | X | | X | | | X | X | | X | X | | | | | | | | | X | | | | | | | | |
| *Concrete Waste Management* | X | | X | | | X | | X | | | X | | X | | X | X | | X | X | | X | | | X | X | X | X | X |
| *Sanitary/Septic Waste Management* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| *Liquid Waste Management* | | | | | | | | | | | | | | X | | X | X | | X | | X | | X | | | | X | X |

**Figure 19: Construction Site BMPs By Construction Activity**

| | *Typical Highway Construction Activities* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Demolish Pavement/Structure | Clear and Grub | Construct Access Roads | Grading (including cut and fill slopes) | Channel Excavation | Channel Paving | Trenching/ Underground Drainage | Underground Drainage Facility Installation | Drainage Inlet Modification | Utility Trenching | Utility Installation | Subgrade Preparation | Base Paving | Asphalt Concrete Paving | Concrete Paving | Saw Cutting | Joint Sealing | Grind/Groove | Structure Excavation | Erect Falsework | Bridge/Structure Construction | Remove Falsework | Striping | Miscellaneous Concrete Work | Sound Walls/Retaining Walls | Planting and Irrigation | Contractor Activities | Treatment BMP Construction |
| ***Best Management Practices*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ***Materials Handling*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Material Delivery, and Storage* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| *Material Use* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| ***Vehicle and Equipment Operations*** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Vehicle and Equipment Cleaning* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| *Vehicle and Equipment Fueling* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| *Vehicle and Equipment Maintenance* | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| ***Paving Operations*** | | | X | | | X | | | X | | | | X | X | X | X | X | X | | | X | | | | | | | |
| ***Stockpile Management*** | X | | X | | | | | X | | X | X | | X | X | X | | | X | | | | | | | | | | |
| ***Water Conservation Practices*** | X | X | X | X | X | X | X | X | X | X | | X | | | | X | X | X | X | | X | | | X | | X | X | X |

**Figure 19: Construction Site BMPs By Construction Activity**

| | *Typical Highway Construction Activities* | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Best Management Practices* | Demolish Pavement/Structure | Clear and Grub | Construct Access Roads | Grading (including cut and fill slopes) | Channel Excavation | Channel Paving | Trenching/ Underground Drainage | Underground Drainage Facility Installation | Drainage Inlet Modification | Utility Trenching | Utility Installation | Subgrade Preparation | Base Paving | Asphalt Concrete Paving | Concrete Paving | Saw Cutting | Joint Sealing | Grind/Groove | Structure Excavation | Erect Falsework | Bridge/Structure Construction | Remove Falsework | Striping | Miscellaneous Concrete Work | Sound Walls/Retaining Walls | Planting and Irrigation | Contractor Activities | Treatment BMP Construction |
| *Potable Water/Irrigation* | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dewatering Operations* | X | | | X | X | X | X | X | X | X | X | | | | | | | | X | | X | | | X | X | X | | X |
| *Illicit Connection/Illegal Discharge Detection and* | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Storm Drain Inlet Protection* | X | X | X | X | X | | X | X | X | X | | X | X | | | X | X | X | X | | | | | | | | X | X |
| *Stabilized Construction Entrance/Exit* | | X | X | X | | | | | | | | | | | | | | | | | | | | | | X | | X |

**X** BMP may be applicable to activity

# 4.4 SITE MANAGEMENT BMPS

Site Management BMPs are used on every project and in every organization that deals with stormwater management. Site management BMPs go beyond erosion and sediment control, and deal with other pollutants than sediment. To comply with the regulations and permits, all of these things also need to be considered during design and construction.

**Site Planning and General Practices**

- Scheduling;
- Location of Potential Sources of Sediment;
- Preservation of Existing Vegetation;
- Dewatering Operations;
- Dust Control;
- Paving Operations;
- Structure Construction and Painting;
- Topsoil Management

**Training and Communication**

- Employee Training;

**Material Management**

- Material Delivery and Storage;
- Material Use;
- Protection of Stockpiles;

**Waste Management**

- Concrete Waste Management;
- Solid Waste Management;
- Sanitary/Septic Waste Management;
- Contaminated Soil Management;
- Hazardous Waste Management;
- Liquid Waste Management;
- Spill Prevention and Control;

**Vehicle and Equipment Management**

- Vehicle and Equipment Cleaning;
- Vehicle and Equipment Maintenance;
- Vehicle and Equipment Refueling;

# 4.4.1 Training and Communication

## Communication

### *Definition and Purpose*

Communication is the key component to having a successful project.

Communication between internal parties during the engineering and design phase allows the project team to know the requirements for a compliant final product. Each member of the cross functional team should be informed how the different permits may affect what they can or can't do and how the design can avoid, minimize or mitigate for impacts to water quality on the project.

## Employee Training

### *Definition and Purpose*

Training programs ensure that all employees understand the requirements of the Storm Water Management Program Plan as applicable to their responsibilities. Training topics include but are not limited to storm water management, potential contamination sources, and BMPs.

Training programs should be designed to teach staff about potential sources of stormwater contamination and ways to minimize the water quality impact from transportation construction, operation and maintenance. Training programs should include a general stormwater awareness message, pollution prevention/good housekeeping measures, Spill Response and Prevention, and information about the operation and maintenance of structural best management practices (BMPs). Training programs also should include information on stormwater pollution prevention plans (SWPPPs) and BMPs recommended for use in the field to prevent contaminated discharges. Finally, field staff should be trained to recognize, track, and report illicit discharges.

One of the most important factors determining whether erosion and sediment control BMPs are properly installed and maintained is the knowledge and experience of the on-site contractor who is implementing and inspecting the BMPs. To ensure a high level of expertise, many states require formal certification for on-site contractors. These certified private contractors can then be used to lessen the community's inspection burden.

### *Appropriate Applications*

Training is appropriate for employees involved in the planning, design, or construction phase of construction, repair, or maintenance activities on FHWA projects.

Training can be accomplished through sponsored training courses, through informal, mandatory pre-construction or pre-wintering meetings, and during regular and final inspection visits to transfer information to contractors. At a minimum, training and certification programs help to ensure that plans are properly implemented and that BMPs are properly installed and maintained.

### *Limitations*

Training performance depends on the degree of employee motivation and incentive to learn about BMP implementation. It is also affected by the availability of staff time to coordinate and conduct training.

### *Standards and Specifications*

Employees can be educated about stormwater issues in a number of ways: in-house training programs, on-the-job reinforcement, general awareness and educational materials, and workshops or conferences.

Most agencies have established training programs for field maintenance staff to address safety, materials handling, waste disposal, or other issues. Typically, in-house training formats include formal, classroom style programs that are usually held on an annual basis, and more frequent, informal "tailgate" meetings. Tailgate meetings are usually held weekly to update staff on current issues and tasks, but they often incorporate short training sessions as well. More comprehensive training is usually conducted when new employees are hired or existing employees are looking to be promoted.

Basic stormwater information and details about pollution prevention and BMPs can be incorporated into these existing formats. Whenever possible, additional in-field training should be provided to demonstrate proper implementation of operation and maintenance of BMPs and housekeeping measures at municipal facilities.

### *Implementation*

- Provide storm water management training through courses, seminars, workshops, product demonstrations, employee meetings, posters, and bulletin boards.
- Provide field training programs conducted by trained personnel.
- Maintain commitment and request input from senior DOT and Highways Division management.
- Promote open communication between employees involved in various stages of the projects.
- Improve storm water quality management based on past experience involving water quality problems at construction sites. Implement revised practices and procedures in training.
- Increase employee awareness of requirements and procedures for BMP monitoring and reporting.
- Develop standard operating procedures for storm water quality management.
- Conduct spill drills.

### *Inspection and Maintenance*

Provide annual training on construction BMP implementation for all employees involved with construction activities.

### *Typical Details*

- Not Applicable.

### *Conditions for Removal*

- Not Applicable.

# 4.4.2 Material Delivery and Storage

## Definition and Purpose

Practices and procedures that promote proper handling and storage of construction materials to prevent or reduce storm water pollution, injury to workers or visitors, groundwater pollution, and soil contamination.

Responsible management of common chemicals, such as fertilizers, solvents, paints, cleaners, and automotive products, can significantly reduce polluted runoff. Such products must be handled properly in all stages of development, use, and disposal. Materials management entails the selection of the individual product, the correct use and storage of the product, and the responsible disposal of associated waste(s).

## Appropriate Applications

Storage and handling activities on construction sites involving delivery and storage of the following:

- Soil;
- Soil stabilizers and binders;
- Fertilizers;
- Pesticides and herbicides;
- Detergents;
- Plaster;
- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds;
- Petroleum products such as fuel, oil, and grease;
- Asphalt and concrete products; and
- Other materials that may be detrimental if released to the environment.

## Limitations

- Space limitation may preclude indoor storage.
- Comply with building and fire code requirements for storage sheds. Storage sheds should be leak free.

## Standards and Specifications

**General Requirements**

- Must comply with FHWA Standard Specifications and CGP.
- Train employees and subcontractors on the proper material delivery and storage practices.
- Located temporary storage areas away from vehicular traffic.

  Supply Safety Data Sheets (SDS) to the CO for all materials stored, if requested.

**Material Storage Areas and Practices**

- Store liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 in approved containers and drums and place in temporary containment facilities for proper storage.

- Provide each temporary containment facility with a permanent cover and side wind protection or cover during non-working days and whenever a storm event is forecasted.
- Provide a temporary containment facility for a spill containment volume, able to contain precipitation from a 24-hour, 25-year storm event, plus the greater of ten percent of the aggregate volume of all containers or 100 percent of the capacity of the largest container within its boundary, whichever is greater.
- Provide a temporary containment facility that is impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, collect accumulated rainwater and spills and place into drums. Handle these liquids as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids shall be sent to an approved disposal site.
- Provide sufficient separation between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, shall not be stored in the same temporary containment facility.
- Store materials in their original containers and maintain the original product labels in place in a legible condition. Replace damaged or otherwise illegible labels immediately.
- Store bagged and boxed materials on pallets and are not be allowed to accumulate on the ground. To provide protection from wind and rain, cover bagged and boxed materials during non-working days and prior to rain events.
- Manage stockpiles according to "Stockpile Management."
- Have proper storage instructions posted at all times in an open and conspicuous location and include it as an informal training component of the tailgates and ongoing WPC training.
- Do not store hazardous chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet, under cover in secondary containment.
- Keep ample supply of appropriate spill cleanup material near storage areas and replace spill materials used.
- Also, see "Hazardous Waste Management," for storing of hazardous materials.

**Material Delivery Practices**

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Ensure employees trained in emergency spill clean-up procedures are present when dangerous materials or liquid chemicals are unloaded.

**Spill Clean-up**

- Contain and clean up any spill immediately.

- If significant residual materials remain on the ground after construction is complete, properly remove and dispose any hazardous materials or contaminated soil.

  See "Spill Prevention and Control," for spills of chemicals and/or hazardous materials.

**Implementation**

Proper management reduces the likelihood of accidental spills or releases of hazardous materials during storm events.

- Identify all hazardous and nonhazardous substances present on the project. This can be accomplished by reviewing all purchase orders for the project and walking through the material storage area itself. Compile a list of all chemicals present and obtain a Material Safety Data Sheet (MSDS) for each one.
- Label all containers with the name of the chemical, unit number, expiration date, handling instructions, and health or environmental hazards. Much of this information will be found on the MSDS. Often, insufficient labeling leads to improper handling or disposal of hazardous substances.
- Make special note on the inventory of hazardous chemicals that require special handling, storage, or disposal.

### 4.4.2.1 Inspection and Maintenance

- Keep storage areas clean, organized, and equipped with ample clean-up supplies as appropriate for the materials being stored.
- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.
- Inspect storage areas before, during and after rainfall events, and at permit inspection intervals during other times. Collect and place into drums any spills or accumulated rainwater and dispose of properly.

  Material Delivery and Storage areas must be shown on the site map and reflect current site conditions.

#### 4.4.2.1.1 *Typical Details*

Some different types of secondary containment

Containment berm around tanks

Containment pallets

**Figure 20: Secondary containment for maintenance and fueling and clean-up operations**

### *Conditions for Removal*

- Ensure that all material that will not be used has been removed from the job site and disposed of properly.
- Remove all secondary containment materials once equipment, materials, and tanks inside have been removed. If soil was used for secondary containment, ensure that it has not been contaminated by the material it was containing, or remove contaminated components and dispose of properly.

## 4.4.3 MATERIAL USE

### Definition and Purpose

Practices and procedures for use of construction materials in a manner that minimizes or eliminates the discharge of these materials to the storm drain system or to receiving waters by reducing hazardous material use on-site, using alternative products, and training employees in proper handling and use of construction materials.

### Appropriate Applications

Activities involving use of one of the following materials:

- Soil stabilizers and binders;
- Fertilizers;
- Pesticides and herbicides;
- Detergents;
- Plaster;
- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds;
- Petroleum products such as fuel, oil, and grease;
- Asphalt and concrete products; and
- Other materials that may be detrimental if released to the environment.

### Limitations

- Safer alternative building and construction products may not be available or suitable in every instance.

### Standards and Specifications

<u>**General Requirements**</u>

- Must comply with FHWA Standard Specifications and CGP.
- Safety Data Sheets (SDS) shall be supplied to the CO if requested, for all materials.
- Latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, may be disposed of with other construction debris.
- Do not remove the original product label, it contains important safety and disposal information. Use the entire product before disposing of the container.
- Mix paint indoors, or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm into a concrete washout pit. For oil-based paints, clean brushes to the extent practical and filter and reuse thinners and solvents.
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials.

- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible.
- Do not over-apply fertilizers and pesticides. Prepare only the amount needed. Strictly follow the recommended usage instructions.
- Application of herbicides and pesticides shall be performed by a licensed applicator. Document the location, chemicals applied, applicants name and qualifications.
- Contractors are required to complete the "Report of Chemical Spray Forms" when spraying herbicides and pesticides.
- Keep an ample supply of spill cleanup material near use areas. Train employees in spill cleanup procedures.
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry

**Spill Clean-up**

- Contain and clean up any spill immediately.
- If significant residual materials remain on the ground after construction is complete, properly remove and dispose any hazardous materials or contaminated soil.
- See "Spill Prevention and Control," for spills of chemicals and/or hazardous materials.
- For water-based paint, clean brushes to the extent practical, and rinse to a drain leading to a sanitary sewer where permitted, or

**Implementation**

Proper management reduces the likelihood of accidental spills or releases of hazardous materials during storm events.

- Provide employee training on proper material use.
- Identify all hazardous and nonhazardous substances present on the project. This can be accomplished by reviewing all purchase orders for the project and walking through the material storage area itself. Compile a list of all chemicals present and obtain a Material Safety Data Sheet (MSDS) for each one.
- Label all containers with the name of the chemical, unit number, expiration date, handling instructions, and health or environmental hazards. Much of this information will be found on the MSDS. Often,
- Make special note on the inventory of hazardous chemicals that require special handling, storage, or disposal.
- Dispose container only after all of the product has been used.

## Inspection and Maintenance

- Inspect storage areas before, during and after rainfall events, and at least weekly during other times. Collect and place into drums any spills or accumulated rainwater and dispose of properly.
- Provide training to all new employees at the beginning of their employment.
- Provide periodic training to all employees involved in handling construction materials.
- Spot check employees and subcontractors throughout the job, include appropriate practices as part of the informal tailgate training.

### *Typical Details*

- Not Applicable.

### *Conditions for Removal*

- When materials are no longer needed to complete construction, remove them from the jobsite and recycle or dispose of properly.

# 4.4.4 STOCKPILE MANAGEMENT

## Definition and Purpose

Stockpile management procedures and practices are designed to reduce or eliminate air and storm water pollution from stockpiles of soil, and paving materials such as Portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate subbase or pre-mixed aggregate, asphalt binder (so called "cold mix" asphalt) and pressure treated wood.

## Appropriate Applications

Implemented in all projects that stockpile soil and other materials.

## Limitations

Use of plastic cover might be restricted depending on the location of the site and regulatory permits

## Standards and Specifications

**General Requirement**

- Must comply with FHWA Standard Specifications and CGP.
- Protection of stockpiles is a year-round requirement.
- Locate stockpiles a minimum of 50 ft. away from concentrated flows of storm water, drainage courses, and inlets.
- Utilize run-on and run-off BMPs to ensure stockpile materials are protected and do not have the potential to discharge material.
- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information see WE-1, "Wind Erosion Control."
- Stockpiles of contaminated soil shall be managed in accordance with WM-7, "Contaminated Soil Management."
- Bagged materials should be placed on pallets and under cover.

**Protection of Inactive Stockpiles**

- Inactive stockpiles of the identified materials shall be protected further as follows:
- Soil stockpiles:
    - Soil stockpiles shall be covered or protected with soil stabilization measures and a temporary perimeter sediment barrier at all times. If no longer needed, they should be removed and disposed of properly.
- Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate subbase:
    - The stockpiles shall be covered or protected with a temporary perimeter sediment barrier at all times. If no longer needed, they should be removed and disposed of properly.
- Stockpiles of "cold mix":

  - Cold mix stockpiles shall be placed on and covered with plastic or comparable material at all times and surround by a berm.

- Stockpiles/Storage of pressure treated wood with copper, chromium, and arsenic or ammonia, copper, zinc, and arsenate:
  - Treated wood shall be covered with plastic or comparable material and placed on pallets.
- Stockpile of rebar, metal,
  - Cover

**Protection of Active Stockpiles**

- Active stockpiles shall be protected further as follows:
  - All stockpiles shall be covered, stabilized, or protected with a temporary linear sediment barrier prior to the onset of precipitation.
  - Stockpiles of "cold mix" shall be placed on and covered with plastic or comparable material prior to the onset of precipitation.
  - All Stockpiles should be removed from the site and disposed of properly.

## Implementation

Proper stockpile management reduces the likelihood of accidental material release during storm events.

- Update stockpile protections as construction progresses and stockpile needs change.

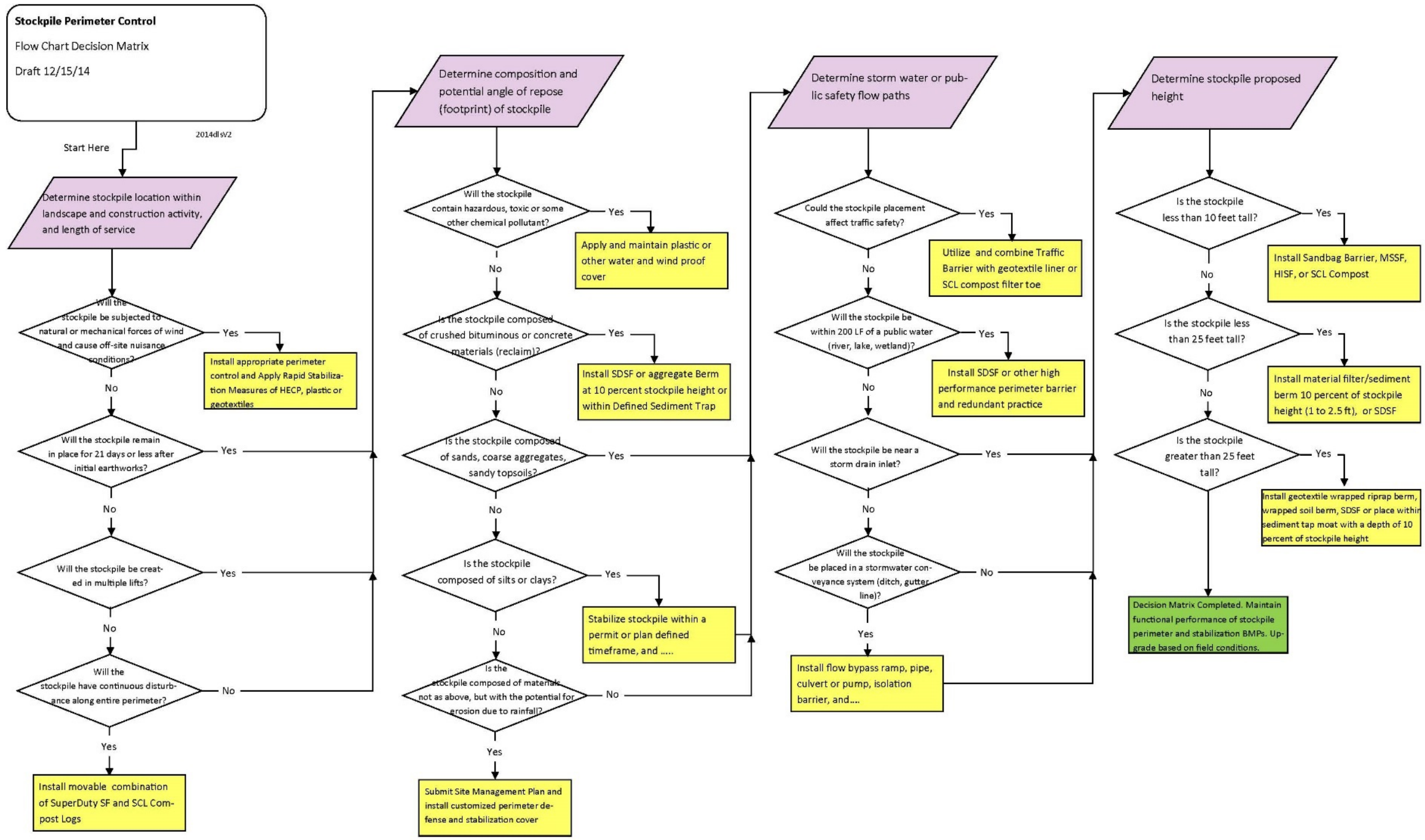
## Inspection and Maintenance

- Inspect Stockpile Management areas before, during and after rainfall events, and at least weekly during other times.
- Repair and/or replace perimeter controls and covers to keep Stockpile Management functioning properly.
- Stockpile Management areas must be shown on the site map and reflect site conditions.

## Conditions for Removal

When stockpile is no longer needed, remove excess material and dispose properly. Remove perimeter controls and cover materials and dispose.

## *Selection Matrix*



## *Typical Details*

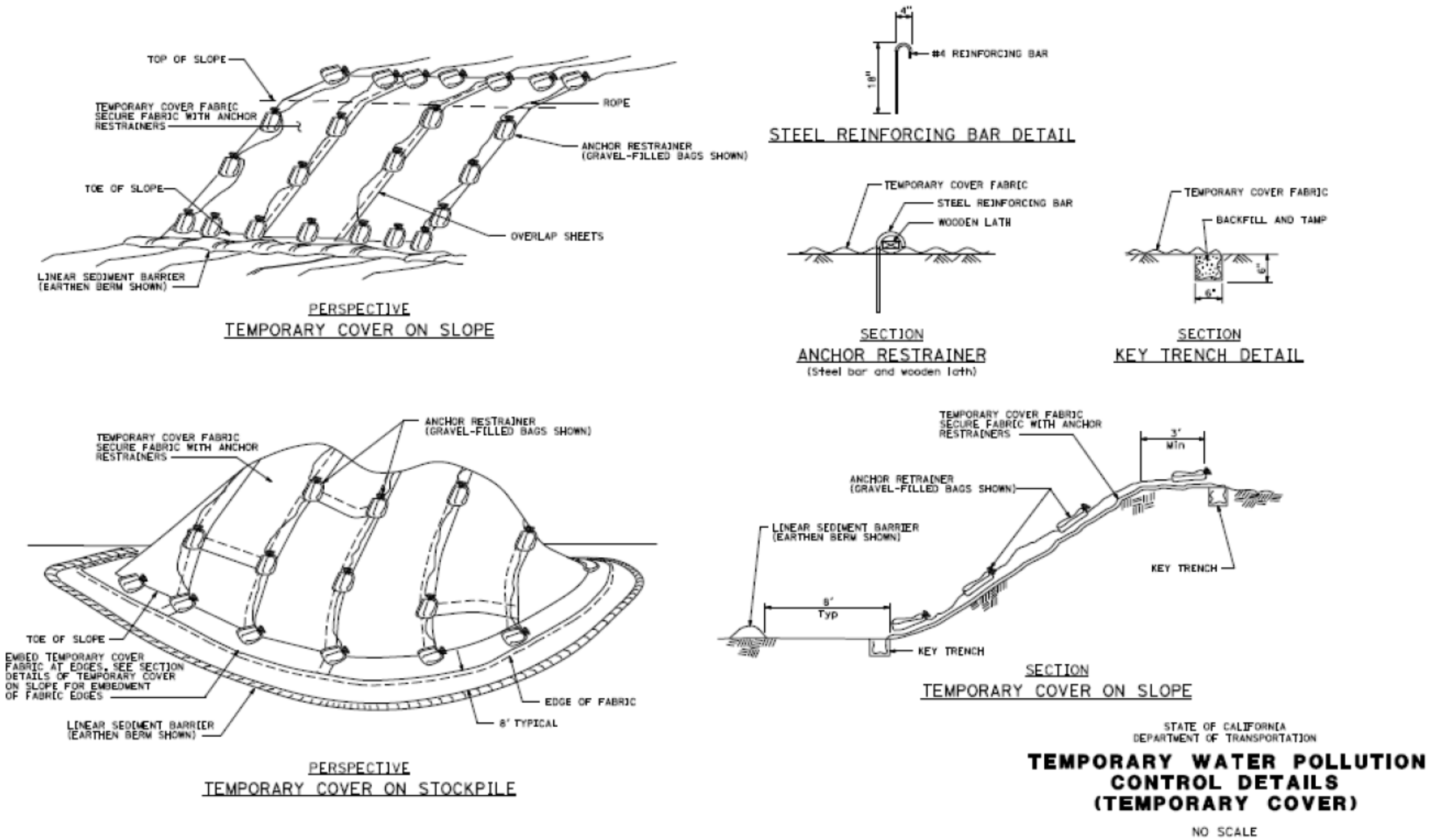



**Figure 21: Stockpile Management Details.**

## 4.5 WASTE MANAGEMENT

The NPDES storm water regulations for construction sites also require that BMPs be included in the project plans for waste management. As with the non-storm water management measures, it is important to provide the contractor with flexibility, but to identify in the plans, that specific BMPs will be implemented for certain activities regardless of where on the site those activities are performed. These are source control BMPs that prevent pollution by reducing pollutants at their source, and require a clean, well-kept site. The measures include:

- Concrete Waste Management;
- Solid Waste Management;
- Sanitary/Septic Waste Management;
- Contaminated Soil Management;
- Hazardous Waste Management;
- Liquid Waste Management;
- Spill Prevention and Control;

# 4.5.1 CONCRETE WASTE MANAGEMENT

### Definition and Purpose

Practices and procedures that are designed to minimize or eliminate the discharge of concrete waste materials to the storm drain systems or watercourses.

### Appropriate Applications

Concrete waste management procedures and practices are implemented on construction projects where concrete is used as a construction material or where concrete dust and debris result from demolition activities.

- Where slurries containing Portland cement concrete (PCC) or asphalt concrete (AC) are generated, such as from saw-cutting, coring, grinding, grooving, and hydro-concrete demolition.
- Where concrete trucks and other concrete-coated equipment are washed on site, when approved by the Project Engineer (PE). See also "Vehicle and Equipment Cleaning."
- Where mortar-mixing stations exist.

### Limitations

Off-site concrete wash areas may be impracticable.

### Standards and Specifications

**Education**

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.
- The contractors SWPPP Manager shall oversee and enforce concrete waste management procedures.

**Concrete Demolition Wastes**

- Stockpile concrete demolition wastes in accordance with BMP "Stockpile Management."

**Concrete Slurry Waste Management and Disposal**

- PCC and AC waste shall not be allowed to enter storm drainage systems or watercourses.
- A sign shall be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.
- The PE or Stormwater specialist must ensure that onsite concrete working tasks are being monitored, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.
- Residue from saw cutting, coring, grooving and grinding operations shall be picked up by means of a vacuum device. Residue shall not be allowed to flow across the pavement and shall not be left on the surface of the pavement. See also "Paving and Grinding Operations."

- Vacuumed slurry residue shall be disposed in accordance local, state and Federal laws. Slurry residue shall be temporarily stored in a facility as described in "Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures" (below), or within an impermeable containment vessel or bin.

**Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures**

- Locate temporary concrete washout facilities a minimum of 50 ft. from storm drain inlets, open drainage facilities, and watercourses, unless determined infeasible by the PE. Locate each facility away from construction traffic or access areas to prevent disturbance or tracking.
- Install a sign adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- Construct temporary concrete washout facilities above grade or below grade at the option of the Contractor. Maintain in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- Install temporary washout facilities with a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- Perform washout of concrete mixers, delivery trucks, and other delivery systems in designated areas only.
- Wash concrete only from mixer chutes into approved concrete washout facility. Washout may be collected in an impermeable bag or other impermeable containment devices for disposal.
- Pump excess concrete in concrete pump bin back into concrete mixer truck.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete shall be broken up, removed, and disposed of in conformance local, state, and Federal laws and ordinances.
- Construct temporary concrete washout facility Type "Above Grade" as shown in typical details below, with a recommended minimum length and minimum width of 10 feet, but with sufficient volume to contain all liquid and concrete waste generated by washout operations. The length and width of a facility may be increased to provide appropriate volume or multiple locations may be provided.
- Conform to project specifications for straw bales, wood stakes, and sandbag materials to ensure compliance.
- Provide plastic lining material that is a minimum of 10-mil polyethylene sheeting and is free of holes, tears or other defects that compromise the impermeability of the material. Install liner seams according to with manufacturers' recommendations.
- Provide portable delineators according to the provisions in the Standard Specifications. Cement the delineator bases to the pavement in the same manner as provided for cementing pavement markers to pavement. Apply only to a clean, dry surface.

**Temporary Concrete Washout Facility (Type Below Grade)**

- Construct temporary concrete washout facility Type “Below Grade” as shown in the typical details below, with a recommended minimum length and width of 10 feet each way. Size the basin to contain all liquid and concrete waste generated by washout operations or provide multiple basins.
- Use plastic lining material that is a minimum of 10-mil polyethylene sheeting and is free of holes, tears or other defects that compromise the impermeability of the material. Install liner seams according to with manufacturers’ recommendations.
- Prepare the soil base to be free of rocks or other debris that may cause tears or holes in the plastic lining material.
- Use other appropriate BMP’s at washout facilities to prevent run-on and run-off from the facility.

**Removal of Temporary Concrete Washout Facilities**

- When temporary concrete washout facilities are no longer required for the work, remove and dispose of the hardened concrete. Dispose of PCC dried residues, slurries or liquid waste offsite of the project in conformance with Federal, state, and local laws and ordinances. Remove and dispose of materials used to construct temporary concrete washout facilities properly.
- Backfill holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities and repair in conformance with the provisions in Standard Specifications for embankment construction. Remove and dispose

## Inspection and Maintenance

- Inspect Concrete Waste Management areas before, during and after rainfall events and during concrete operations, and at least weekly during other times.
- Monitor concrete working tasks, such as sawcutting, coring, grinding and grooving daily to ensure proper methods are employed.
- Maintain temporary concrete washout facilities to provide adequate holding capacity with a minimum freeboard of 4 inches for above grade facilities and 12 inches for below grade facilities.
- Maintaining temporary concrete washout facilities includes removing and disposing of hardened concrete and returning the facilities to a functional condition.
- Remove and dispose of hardened concrete materials in conformance with Federal, state, and local laws and ordinances.
- Existing facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.
- Inspect concrete washout facilities for damage (i.e. tears in polyethylene liner, missing sandbags, etc.). and repair or replace damaged facilities.
- Inspection and maintenance of these areas must be documented. Ensure no potential for discharges occur from these areas as part of the nonvisible monitoring requirements.

### 4.5.1.1 Typical Details

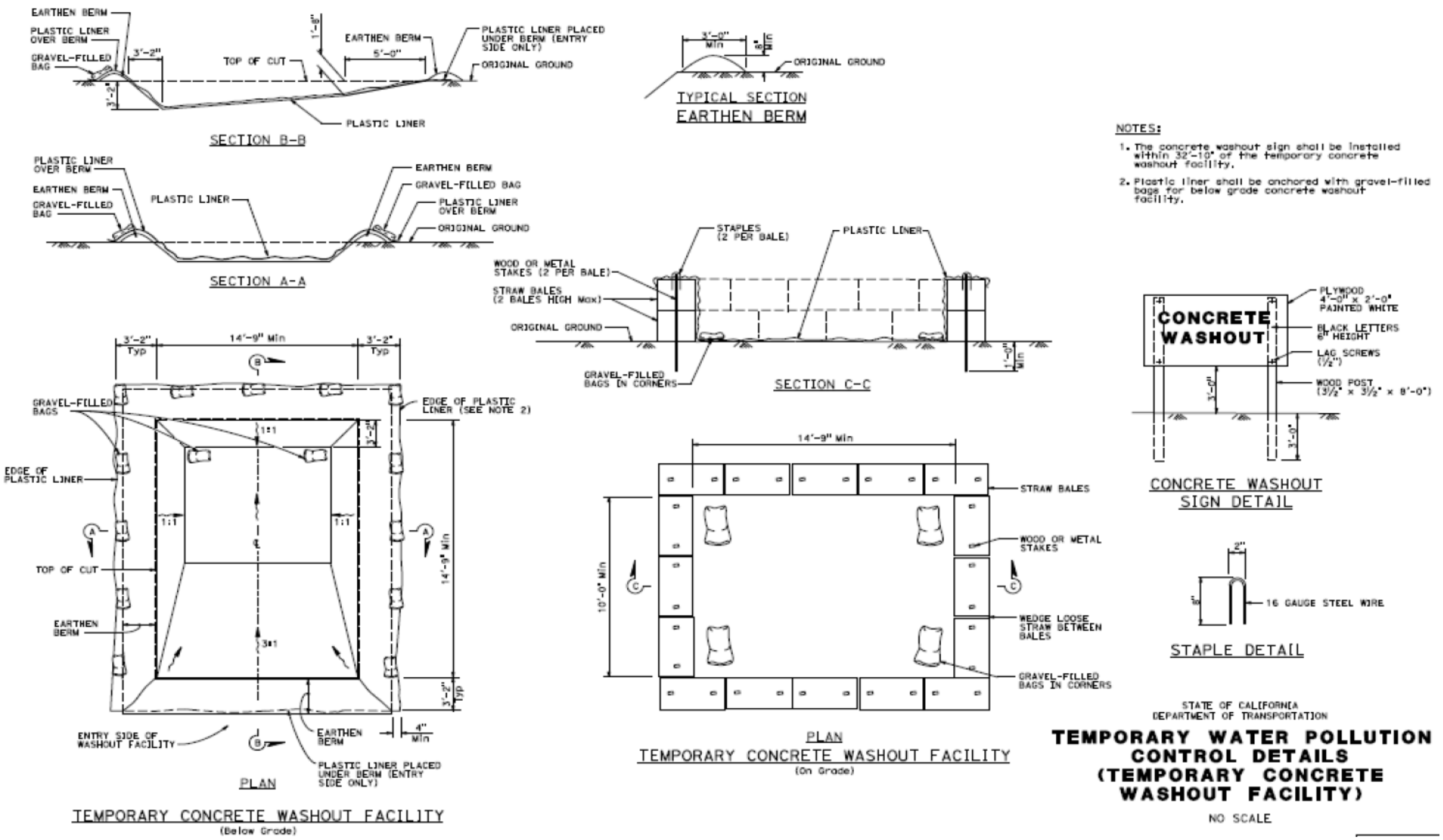
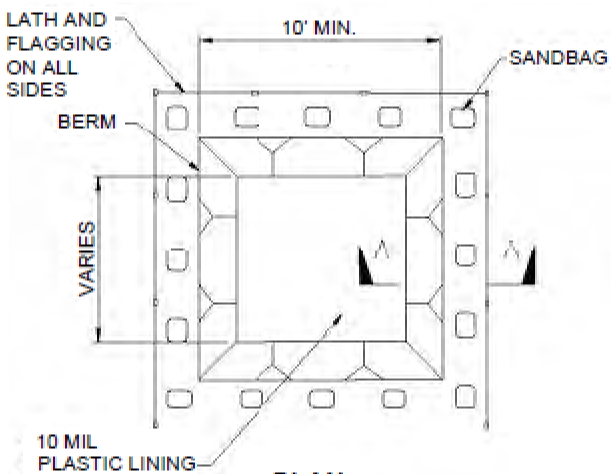
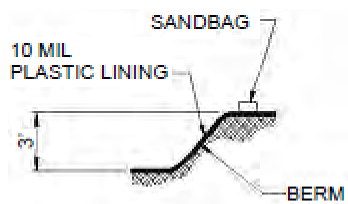



**Figure 22: Concrete Washout Details.**




PLAN
NTS

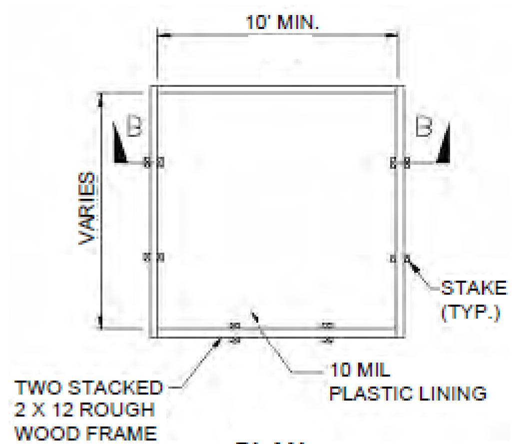



SECTION A-A
NTS

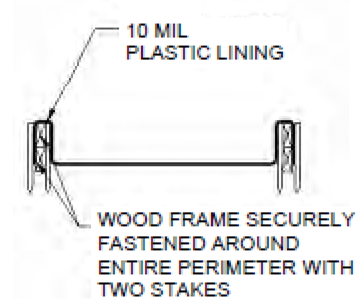
NOTES:

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FEET OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

**WASH AREA (BELOW GRADE)**




PLAN
NTS



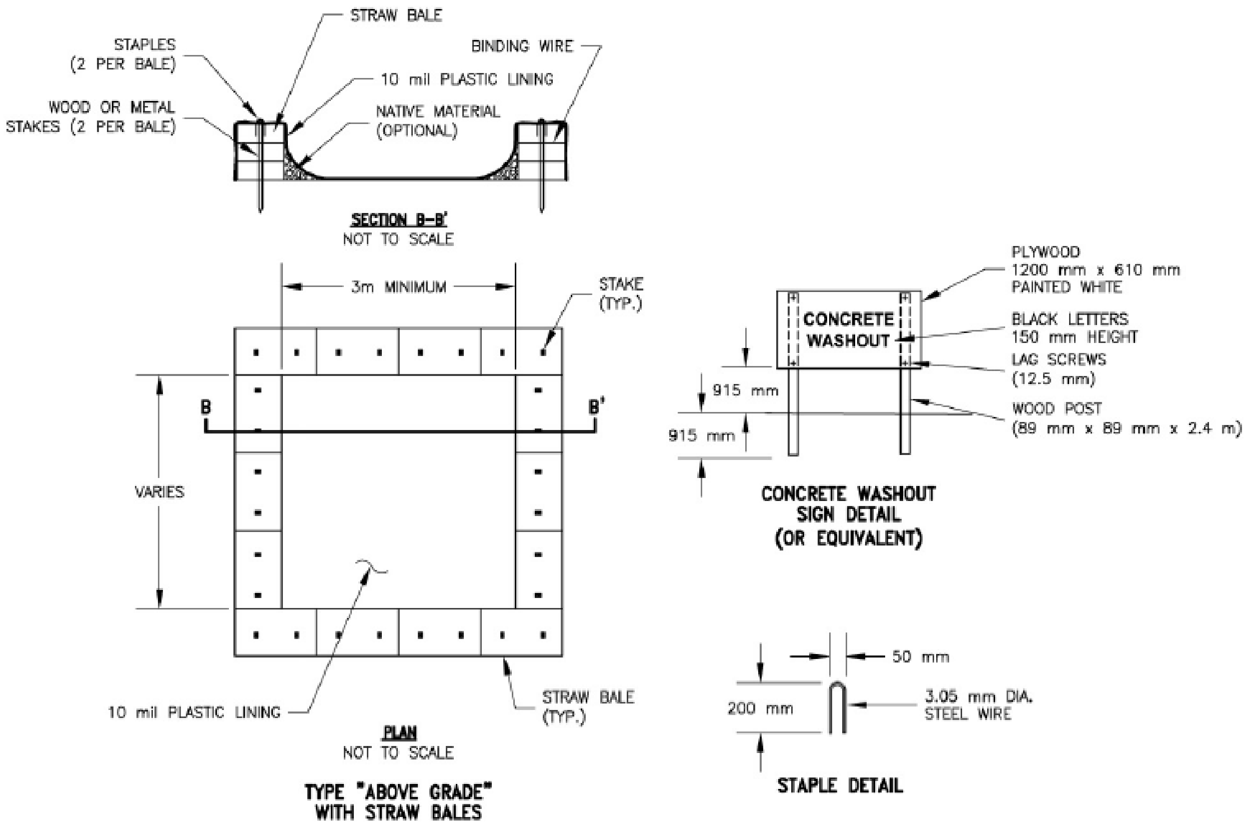

SECTION A-A
NTS

NOTES:

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FEET OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

**WASH AREA (ABOVE GRADE)**

**Figure 23: Concrete Washout Details (Continued).**

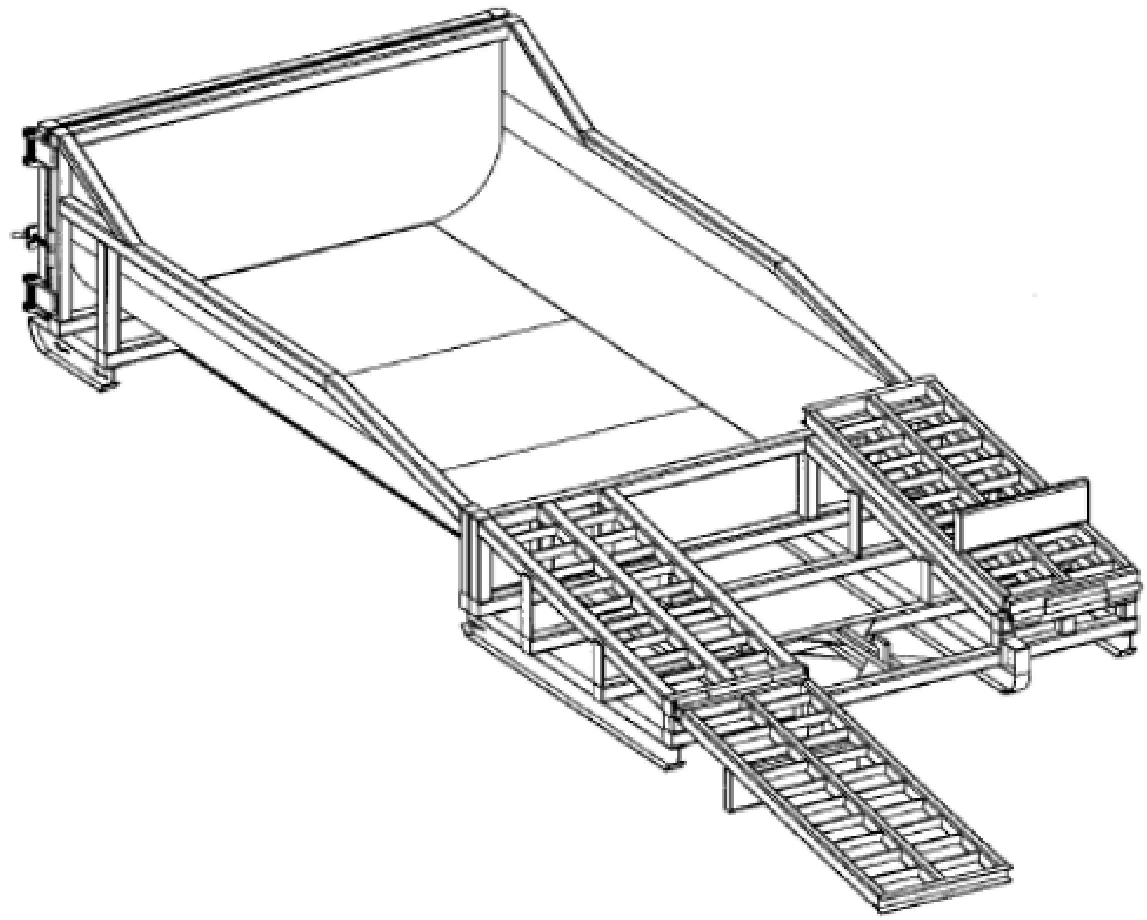



NOTES:

1. ACTUAL LAYOUT DETERMINED IN THE FIELD.
2. THE CONCRETE WASHOUT SIGN (SEE FIG. 4-15) SHALL BE INSTALLED WITHIN 10 m OF THE TEMPORARY CONCRETE WASHOUT FACILITIY.

CALTRANS/FIG4-14.DWG SAC 8-14-02

**Figure 24: Concrete Washout Details (Continued).**



Prefabricated Concrete Washout Container w/Ramp

**Figure 25: Concrete Washout Details (Continued).**

# 4.5.2 Solid Waste Management

## Definition and Purpose

Solid waste management procedures and practices are designed to minimize or eliminate the discharge of pollutants to the drainage system or to water bodies as a result of the creation, stockpiling, or removal of construction site wastes.

## Appropriate Applications

Solid waste management procedures and practices are implemented on all construction projects that generate solid wastes. Solid wastes include but are not limited to:

- Construction wastes including brick, mortar, timber, steel and metal scraps, sawdust, pipe and electrical cuttings, non-hazardous equipment parts, Styrofoam and other materials used to transport and package construction materials.
- Highway planting wastes, including vegetative material, plant containers, and packaging materials.
- Litter, including food containers, beverage cans, coffee cups, paper bags, plastic wrappers, and smoking materials, including litter generated by the public.

Inert fill materials are wastes that are not contaminated with hazardous materials such as asbestos or lead-based paint. Inert fill materials do not decompose or produce leachate or other products harmful to the environment. Inert fill materials include earth, soil, rock, cured asphalt, brick, and clean concrete (no exposed steel-reinforcing rod) with no dimension greater than eight inches.

Recycled/reused materials include but are not limited to: asphalt pavement, cardboard, concrete aggregate (no LBP, asbestos-free), electronic equipment, excavated rock, soil (uncontaminated), Freon from appliances, glass, green waste, metals, ferrous/non-ferrous, used tires, wood and lumbers, furniture, etc.

## Limitations

None identified.

## Standards and Specifications

<u>**Education**</u>

- The WPC Manager shall oversee and enforce proper solid waste procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings and tailgate sessions).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.

- Wherever possible, minimize production of solid waste materials.

**Collection, Storage, and Disposal**

- Provide dumpsters of sufficient size and number to contain the solid waste generated by the project and be properly serviced. Provide containers that are watertight and have a cover.
- Littering on the project site is prohibited.
- To prevent clogging of the storm drainage system make litter and debris removal a priority from drainage grates, trash racks, and ditch lines.
- Provide trash receptacles in the Contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Collect construction debris and litter from work areas within the construction limits of the project site and place in watertight dumpsters at least weekly regardless of whether the litter was generated by the Contractor, the public, or others. Do not place collected litter and debris in or next to drain inlets, storm water drainage systems or watercourses.
- Remove full dumpsters contents from the project site and dispose of as required by federal, state, and local laws and ordinances.
- Retain a waste management company to remove litter stored in collection areas and containers and dispose of properly
- Prevent stormwater run-on from contacting stored solid waste by berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Locate solid waste storage areas at least 50 ft. from drainage facilities and watercourses and do not locate in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters shall be securely covered from wind and rain by covering the waste with tarps or plastic sheeting.
- Notify trash hauling contractors that only watertight dumpsters are acceptable for use on-site.
- Plan for additional containers during the demolition phase of construction.
- Plan for more frequent pickup during the demolition phase of construction.
- Store construction waste in a designated area and show designated area on the site maps.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Keep the site clean of litter debris.
- Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.

- Dispose of non-hazardous waste in accordance with federal, state, and local laws and ordinances.
- For disposal of hazardous waste, see BMP "Hazardous Waste Management." Have hazardous waste hauled
- Salvage or recycle useful vegetation debris, packaging and/or surplus building materials when practical. For example, trees and shrubs from land clearing can be converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

### Inspection and Maintenance

- Monitor onsite solid waste storage and disposal procedures.
- Specific locations for Solid Waste Storage or Containment must be shown in the WPCDs and must be inspected and maintained regularly.

## Typical Details

Figure 26: Construction Waste Management Examples

# 4.5.3 Sanitary and Septic Waste Management

## Definition and Purpose

Procedures and practices to minimize or eliminate the discharge of construction site sanitary and septic waste materials to the storm drain system or to receiving waters.

## Appropriate Applications

Sanitary/septic waste management practices are implemented on all construction sites that use temporary or portable sanitary and septic waste systems.

## Limitations

None identified.

## Standards and Specifications

**Education**

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary/septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary/septic waste.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings and tailgates).
- Establish a continuing education program to indoctrinate new employees

**Storage and Disposal Procedures**

- Locate temporary sanitary facilities away from drainage facilities, receiving waters, and from traffic circulation.
- When subjected to high winds or risk for overtopping, temporary systems must be properly secured.
- Do not discharge or bury wastewater on the project site.
- If using an on-site disposal system, such as a septic system, comply with local health agency requirements.
- Ensure that sanitary and septic facilities are maintained in good working order by a licensed service.
- Use only reputable, licensed sanitary/septic waste haulers.

## Inspection and Maintenance

- Inspect onsite sanitary and septic waste storage and disposal procedures at least weekly, prior to a forecasted rain event, daily during extended rain events and post-storm events.
- Locations for portable Sanitary Systems must be shown on the WPCDs and reflect current site conditions.

### Typical Details

None specified to date for this manual.

# 4.5.4 Contaminated Soil Management

## Definition and Purpose

These are procedures and practices to minimize or eliminate the discharges of pollutants to the drainage system or to receiving waters from contaminated soil.

## Appropriate Applications

Projects in urbanized or industrial areas where previous site usage, undetected spills or leaks, illicit discharges, or underground storage tank leaks may have contributed to soil contamination.

It may also apply to highway widening projects in older areas where median and shoulder soils may have been contaminated by aerially deposited lead (ADL).

## Limitations

The procedures and practices presented in this best management practice (BMP) are general. The contractor shall identify appropriate practices and procedures consistent with the plans and specifications for the specific contaminants known to exist or discovered on site.

## Standards and Specifications

**Identifying Contaminated Areas**

- Contaminated soils are often identified during project planning and development with known locations identified in the plans and specifications. Review applicable reports and examine applicable callouts in the plans and specifications.
- The contractor may discover contaminated soils not identified in the plans and specifications by observing:
    - Spills and leaks, discoloration, odors or abandoned underground tanks or pipes.
    - Spills and leaks caused by the contractor are the contractor's responsibility for removal, testing, and disposal.
- If unanticipated asbestos or hazardous substances are discovered, stop work in that area immediately and

**Education**

- Prior to performing any excavation work at the locations containing material classified as hazardous, employees and subcontractors shall complete a safety training program which meets 29 CFR 1910.120 and 8 CCR 5192 covering the potential hazards as identified.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling, containment and disposal procedures.

**Handling Procedures for Material with Aerially Deposited Lead (ADL)**

- Materials from areas designated as containing (ADL) may, if allowed by the contract SCRs, be excavated, transported, and used in the construction of embankments and/or backfill.

- Must comply with the federal, state, or local requirements regarding handling, stockpiling and hauling of lead containing material.
- Excavation, transportation, and placement operations shall result in no visible dust.
- Use caution to prevent spillage of lead containing material during transport.
- Monitor the air quality during excavation of soils contaminated with lead.

**Handling Procedures for Contaminated Soils**

- Dispose of Contaminated soil properly in compliance with the specifications and all applicable regulations.
- If soil contamination is suspected, test contaminated soils at a certified laboratory.
- If the soil is contaminated, work with the local regulatory agencies to develop options for treatment and/or disposal.
- Avoid temporary stockpiling of contaminated soils or hazardous material if possible
- If temporary stockpiling is allowed by the specifications:
    - Place plastic sheeting or tarps underneath material and cover the stockpile with plastic sheeting or tarps according to the specifications.
    - Install a berm around the stockpile to prevent run-on or run-off from leaving the area.
    - Do not stockpile in or near storm drains or receiving water.
- Install berms or run-on controls to prevent stormwater from commingling with contaminated areas.
- Contaminated material and hazardous material on exteriors of transport vehicles shall be removed and placed either into the current transport vehicle or the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality during excavation operations as required for the contaminant.
- Collect water from decontamination procedures and treat and/or dispose of it at an appropriate disposal site.
- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavation, transport, and disposal of contaminated material and hazardous material shall be in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
    - United States Department of Transportation (USDOT).
    - United States Environmental Protection Agency (USEPA).
    - State regulatory agencies

  - Local regulatory agencies.

**Procedures for Underground Storage Tank Removals**

- If an unknown underground storage tank is discovered stop work immediately in that area and notify the CO. Do not resume work in the area until directed to do so.
- If tank removal operations are required by the contract, follow the contract requirements for obtaining permits and approval from the federal, state, and local agencies, which have jurisdiction over such work.
- If tank removal operations are required by the contract, the underground storage tank, any liquid and/or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal shall be transported to disposal facilities as required by the contract specifications.

**Water Control**

- Take all necessary precautions and preventive measures to prevent the flow of water, including ground water, from mixing with contaminated or hazardous materials or entering contaminated soil excavations. Such preventative measures may consist of, but are not limited to: berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, dewater the area consistent with "Dewatering Operations", and in compliance with the specifications.

## Inspection and Maintenance

- Monitor on-site contaminated soil storage and disposal procedures.
- Monitor the air quality during excavation operations, if required
- Manage contaminated soils and hazardous substances/waste under the appropriate federal, state, and local requirements.
- Inspect stockpiles, hazardous waste receptacles and storage areas regularly.

## Typical Details

None specified to date for this manual.

## 4.5.5 Hazardous Waste Management

### Definition and Purpose

Practices and procedures to minimize or eliminate the discharge of pollutants from construction site hazardous waste to the storm drain systems or to watercourses.

### Appropriate Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products
- Asphalt Products
- Concrete Curing Compounds
- Pesticides
- Palliatives
- Acids
- Paints
- Stains
- Solvents
- Septic Wastes
- Wood Preservatives
- Roofing Tar, or
- Any materials deemed a hazardous waste.

Hazardous waste management shall also be implemented for wastes from existing structures including:

- Sandblasted material such as grit or chips containing lead, cadmium, or chromium-based paints;
- Asbestos; and Polychlorinated Biphenyls (PCBs). Older transformers are a common source of PCBs.

### Limitations

- Nothing in this BMP relieves the Contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to Contaminated Soil Management," and the project special contract requirements

## Standards and Specifications

**Education**

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings and tailgate sessions).
- The WPC Manager must oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.

**Recognize potentially hazardous waste by implementing the following:**

- Review product label and shipping papers;
- Identify key words such as flammable or ignitable (able to catch fire); carcinogenic (causes cancer); toxic or poisonous (injures or harms people or animals); and hazardous, danger, caustic or corrosive (burns through chemical action); and
- Review material safety data sheets (MSDS) from the manufacturer and supplier of the product
- Wastes shall be stored in sealed containers constructed of a suitable material and shall be labeled as required by 49 CFR Parts 172,173, 177 and 178, 179.
- All hazardous waste shall be stored, transported, and disposed as required in 49 CFR 261-263.
- Waste containers shall be stored in temporary containment facilities that shall comply with the following requirements:
    - Temporary containment facility shall provide for a spill containment volume able to contain precipitation from a 24-hour, 25-year storm event, plus the greater of ten percent of the aggregate volume of all containers or 100 percent of the capacity of the largest tank within its boundary, whichever is greater.
    - Install temporary containment facilities impervious to the materials stored there for a minimum contact time of 72 hours.
    - Handle these liquids as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids shall be sent to an approved disposal site.

  - Provide sufficient separation between stored containers to allow for spill cleanup and emergency response access.
  - Do not store incompatible materials, such as chlorine and ammonia, in the same temporary containment facility.
  - Cover Temporary containment facilities during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs. A storage facility having a solid cover and sides is preferred to a temporary tarp. Equip storage facilities with adequate ventilation.
- Do not overfill drums and do not mix wastes.
- Unless watertight, store containers of dry waste on pallets.
- Clean paint brushes and equipment for water and oil based within a contained area and do not allow to contaminate site soils, watercourses or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused shall be disposed of as hazardous waste. When thoroughly dry, dispose of latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths as solid waste.
- Ensure that adequate hazardous waste storage volume is available.
- Ensure that hazardous waste collection containers are conveniently located.
- Designate hazardous waste storage areas on site away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
- Minimize production or generation of hazardous materials and hazardous waste on the job site.
- Use containment berms in fueling and maintenance areas and where the potential for spills is high.
- Segregate potentially hazardous waste from non-hazardous construction site debris.
- Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.
- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.

**Disposal Procedures**

- Dispose of waste properly within 90 days of being generated, and according to federal, state, and local laws and ordinances.
- Dispose waste by use of a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.

- Use an Environmental Laboratory Accreditation Program (ELAP) accredited laboratory to sample waste and analyze it to determine the appropriate disposal facility.
- Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for solid waste construction debris.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Recycle any useful material such as used oil or water-based paint when practical.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

## Inspection and Maintenance

- Monitor on-site hazardous waste storage and disposal procedures.
- Keep waste storage areas clean, well-organized, and equipped with ample clean-up supplies as appropriate for the materials being stored.
- Inspect storage areas according to the provisions in the contract documents. At a minimum, storage areas must be inspected before, daily during extended storm event, after every storm event and weekly year-round. Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.
- Cleaned up hazardous spills and file reports in conformance with the applicable Safety Data Sheet (SDS) and the instructions posted at the project site.
- Notify the National Response Center, at (800) 424-8802, of spills of Federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302.
- Copy of the hazardous waste manifests shall be provided to the PE, when requested.

## Typical Details

None specified to date for this manual.

# 4.5.6 LIQUID WASTE MANAGEMENT

## Definition and Purpose

Practices and procedures to prevent discharge of pollutants to the storm drain system or to receiving waters as a result of the creation, collection, and disposal of non-hazardous liquid wastes.

## Appropriate Applications

Liquid waste management is applicable to construction projects that generate any of the following non-hazardous byproducts, residuals, or wastes:

- Drilling slurries and drilling fluids.
- Grease-free and oil-free wastewater and rinse water.
- Dredging materials.
- Other non-storm water liquid discharges not permitted by separate permits.

## Limitations

- Disposal of some liquid wastes may be subject to specific laws and regulations, or to requirements of other permits secured for the construction project (e.g., NPDES permits, Army Corps permits, Coastal Zone permits, etc.).
- Does not apply to dewatering operations (see "Dewatering Operations"), solid waste management (see "Solid Waste Management"), hazardous wastes (see "Hazardous Waste Management"), or concrete slurry residue (see "Concrete Waste Management").
- Does not apply to non-stormwater discharges permitted by any NPDES permit, unless the discharge is determined by FHWA to be a source of pollutants. Typical permitted non-stormwater discharges can include: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated pumped ground water; discharges from potable water sources; foundation drains; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; flows from riparian habitats and wetlands; and, discharges or flows from emergency firefighting activities. Refer to the applicable Stormwater Construction General Permit for a complete list of permitted non-stormwater discharges.

## Standards and Specifications

**General Requirements**

- Oversee and enforce proper liquid waste management procedures and practices.
- Instruct employees and subcontractors how to safely differentiate between non-hazardous liquid waste and potential or known hazardous liquid waste.
- Instruct employees, subcontractors, and suppliers that it is unacceptable for any liquid waste to enter any storm drainage structure, waterway, or receiving water.
- Educate employees and subcontractors on liquid waste generating activities, and liquid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings and tailgates).
- Verify which non-stormwater discharges are permitted by the NPDES permit; different regions might have different requirements not outlined in this document. Some listed discharges may be prohibited if FHWA determines the discharge to be a source of pollutants.
- Apply the "Vehicle and Equipment Cleaning" BMP for managing wash water and rinse water from vehicle and equipment cleaning operations.

**Containing Liquid Wastes**

- Do not allow drilling residue and drilling fluids to enter storm drains and receiving waters. Dispose of offsite in conformance with the provisions in Standard Specifications.
- If an appropriate location is available, and it is allowed by Federal, state or local laws or ordinances, drilling residue and drilling fluids that are exempt may be dried by infiltration and evaporation in a containment facility constructed in conformance with the provisions concerning the Temporary Concrete Washout Facilities detailed in "Concrete Waste Management."
- Contain liquid wastes generated as part of an operational procedure, such as water-laden dredged material and drilling mud. Do not allow to flow into drainage channels or receiving waters prior to treatment.
- Containment devices must be structurally sound and leak free.
- Containment devices must be of sufficient quantity or volume to completely contain the liquid wastes generated.
- Take precautions to avoid spills or accidental releases of contained liquid wastes. Apply the education measures and spill response procedures outlined in "Spill Prevention and Control."

**Capturing Liquid Wastes**

- Do not allow liquid wastes to flow or discharge uncontrolled. Use temporary dikes or berms to intercept flows and direct them to a containment area or device for capture.
- If the liquid waste is sediment laden, use a sediment trap "Sediment trap/Curb Cutback" for capturing and treating the liquid waste stream, or capture in a containment device and allow sediment to settle.

**Disposing of Liquid Wastes**

- Typical method is to dewater the contained liquid waste, using procedures such as described in "Dewatering Operations", and "Sediment/Desilting Basin"; and dispose of resulting solids per "Solid Waste Management."
- Method of disposal for some liquid wastes may be prescribed in Water Quality Reports, NPDES permits, NEPA documentation, 401 Water Quality Certifications or 404 permits, local agency discharge permits, etc., and may be defined elsewhere in the special contract requirements.
- Liquid wastes, such as from dredged material, may require testing and certification whether it is hazardous or not before a disposal method can be determined.
- For disposal of hazardous waste, see the "Hazardous Waste Management" table above.

- If necessary, further treat liquid wastes prior to disposal. Treatment may include, though is not limited to, sedimentation, filtration, and chemical neutralization.

## Implementation

Proper management reduces the likelihood of accidental spills or releases of hazardous materials during storm events.

- Provide employee training on proper material use.

## Inspection and Maintenance

- Spot check employees and subcontractors at least monthly throughout the job to ensure appropriate practices are being employed. At a minimum, liquid waste containment areas must be inspected before, during and after rain events, findings must be properly documented and any deficiencies timely corrected.
- Remove deposited solids in containment areas and capturing devices as needed, and at the completion of the task. Dispose of any solids as described in "Solid Waste Management."
- Inspect containment areas and capturing devices frequently for damage, and repair as needed.
- Improper storage, containment or disposal might trigger additional sampling requirements of the SWPPP.
- Locations for Liquid Waste Management must be shown on the Site map and reflect current site conditions.

## Typical Details

None specified to date for this manual.

# 4.5.7 Spill Prevention and Control

## Definition and Purpose

Practices and procedures are implemented to prevent and control spills in a manner that minimizes or prevents the discharge of spilled material to the drainage system or watercourses.

## Appropriate Applications

This best management practice (BMP) applies to all construction projects. Spill control procedures are implemented anytime chemicals and/or hazardous substances are stored. Substances may include, but are not limited to:

- Soil stabilizers/binders.
- Dust Palliatives.
- Herbicides.
- Growth inhibitors.
- Fertilizers.
- Deicing/anti-icing chemicals.
- Fuels.
- Lubricants.
- Other petroleum distillates.

To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110, 117, and 302, and sanitary and septic wastes shall be contained and cleaned up immediately.

## Limitations

- This BMP only applies to spills caused by the contractor. Other spills or discharges observed or discovered must be reported to the PE.
- Procedures and practices presented in this BMP are general. Contractor shall identify appropriate practices for the specific materials used or stored on-site and follow the appropriate Safety Data Sheets (SDS).

## Standards and Specifications

<u>General Requirements</u>

- Must comply with FHWA Standard Specification 107.10 (b), Oil and hazardous substances.
- To the extent that it doesn't compromise cleanup activities, spills shall be covered and protected from stormwater run-on.
- Spills shall not be buried or washed with water. Potable water has chlorine and therefore should not be allowed to be discharged off the project site.

- Used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose shall be stored and properly disposed of.
- Water used for cleaning and decontamination shall not be allowed to enter storm drains or watercourses and shall be collected and disposed of in accordance with "Liquid Waste Management."
- Water overflow or minor water spillage shall be contained and shall not be allowed to discharge into drainage facilities or watercourses.
- Proper storage, clean-up and spill reporting instruction for hazardous materials stored or used on the project site shall be posted at all times in an open, conspicuous and accessible location.
- Waste storage areas shall be kept clean, organized, and equipped with ample clean-up supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers and liners shall be repaired or replaced as needed to maintain proper function.

**Education**

- Educate employees and subcontractors on what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- The Stormwater Manager shall oversee and enforce proper spill prevention and control measures.
- The list of reportable quantities can be found at https://www.bnl.gov/esh/env/compliance/docs/SaraTitleList.pdf

**Cleanup and Storage Procedures**

- Minor Spills
  - Minor spills typically involve small quantities of oil, gasoline, paint, etc., which can be controlled by the first responder at the discovery of the spill.
  - Use absorbent materials on small spills rather than hosing down or burying the spill.
  - Remove the absorbent materials promptly and dispose of properly.
  - The practice commonly followed for a minor spill is:
    - Contain the spread of the spill.
    - Recover spilled materials.
    - Clean the area and/or properly dispose of contaminated materials.

- Semi-Significant Spills:
  - Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.
- Clean-up spills immediately:
  - Notify the WPC Manager immediately. The WPC Manager shall notify the CO and prepare the proper notifications as required.
- Contain spread of the spill.
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials.
  - If the spill occurs in dirt areas, immediately contain the spill. Dig up and properly dispose of contaminated soil.
  - If the spill occurs during rain, cover spill with tarps to prevent contaminating runoff.
- Significant/Hazardous Spills:
  - For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps shall be taken:
  - Notify the CO immediately and follow up with a written report.

## Inspection and Maintenance

- Verify weekly that spill control clean-up materials are located near material storage, unloading, and use areas.
- Update spill prevention and control plans and stock appropriate clean-up materials when changes occur in the types of chemicals used or stored onsite.
- Improper clean-up might trigger need for water quality or soil testing. The WPC Manager should be proactive in ensuring controls are in place and adequate to contain and prevent further issues.

## Typical Details

None specified to date for this manual.

# 4.6 VEHICLE AND EQUIPMENT MANAGEMENT

Vehicle and Equipment Management

- Vehicle and Equipment Cleaning;
- Vehicle and Equipment Maintenance;
- Vehicle and Equipment Refueling;

## 4.6.1 VEHICLE AND EQUIPMENT CLEANING

### Definition and Purpose

Vehicle and equipment cleaning procedures and practices are used to minimize or eliminate the discharge of pollutants from vehicle and equipment cleaning operations to storm drain systems or to watercourses

### Appropriate Applications

These procedures are applied on all construction sites where vehicle and equipment cleaning is performed.

### Limitations

- This BMP may be limited or disallowed under regulatory agency permits, particularly near Environmentally Sensitive Areas (ESAs).
- Generates non-stormwater that requires management, and, in some cases, the disposal of hazardous waste.

### Standards and Specifications

**General Requirements**

- Limit vehicle and equipment cleaning or washing at the job site except for the safety and protection of the equipment and as needed to comply with regulatory agency permits and approvals.
- Cleaning of vehicles and equipment with soap, solvents or steam shall not occur on the job site unless the CO has been notified in advance and the resulting wastes are fully contained in accordance with federal, state, and local laws and ordinances. Do not use diesel to clean vehicles and minimize the use of solvents.
- Vehicle and equipment wash water shall be contained for percolation or evaporative drying away from storm drain inlets or receiving waters and should not be discharged within the highway right-of-way. Apply other appropriate BMPs as applicable.
- All vehicles/equipment that regularly enter and leave the construction site must be cleaned off-site.
- Resulting wastes and by-products shall not be discharged or buried within the highway right-of-way, and must be captured and recycled or disposed according to the requirements of "Liquid Waste Management" or "Hazardous Waste Management," depending on the waste characteristics.

## Implementation

When vehicle/equipment washing/cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area shall have the following characteristics, and shall be arranged with the PE as well as the Construction Storm Water Coordinator:

- Located away from storm drain inlets, drainage facilities, or watercourses.
- Paved with concrete or asphalt and bermed to contain wash waters and to prevent run-on and runoff.
- Configured with a sump to allow collection and disposal of wash water.
- Wash waters shall not be discharged to storm drains or watercourses.
- Used only when necessary.
- When cleaning vehicles/equipment with water:
    - Use as little water as possible. High pressure sprayers may use less water than a hose, and shall be considered.
    - Use positive shutoff valve to minimize water usage.

Facility wash racks shall discharge to a sanitary sewer, recycle system or other approved discharge system and shall not discharge to the storm drainage system or watercourses.

## Inspection and Maintenance

- The control measure shall be inspected at least weekly, prior to a forecasted rain event, daily during extended rain events and post-storm events.
- Inspect wash area and sump regularly. Remove liquids and sediment as needed.

## Typical Details

None specified to date for this manual.

# 4.6.2 Vehicle and Equipment Maintenance

## Definition and Purpose

Practices and procedures to minimize or eliminate the discharge of pollutants to the storm drain systems or to receiving waters from vehicle and equipment maintenance activities.

## Appropriate Applications

These procedures apply on all construction projects where an uncovered yard area is necessary for storage and maintenance of heavy equipment and vehicles.

## Limitations

- This BMP may be limited or disallowed under regulatory agency permits, particularly near Environmentally Sensitive Areas (ESAs).
- Onsite vehicle and equipment maintenance should only be used where it's impractical to send vehicles and equipment off-site for maintenance.

## Standards and Specifications

<u>**General Requirements**</u>

- When maintenance must occur onsite, select and designate an area to be used, subject to approval of the PE and implement appropriate controls for the activities to be performed.
- Dedicated maintenance areas shall be on level ground and protected from storm water run-on and runoff, and shall be located at least 50 ft from downstream drainage facilities and receiving waters.
- Protect maintenance areas with berms or dikes to prevent run-on, runoff, and to contain spills.
- For long-term projects, consider constructing roofs or using portable tents over maintenance areas.
- Absorbent spill clean-up materials and spill kits shall be available in maintenance areas and used on small spills instead of hosing down or burying techniques. Affected absorbent material and spill kits should be removed promptly and disposed of properly after use.
- Drip pans or plastic sheeting shall be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than one hour.
- Properly dispose or recycle used batteries and tires as well as any other vehicle or equipment parts.
- Substances used to coat asphalt transport trucks and asphalt-spreading equipment shall be non-toxic.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not dump fuels and lubricants onto the ground.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.

- Do not bury used tires.
- Repair fluid and oil leaks immediately.
- Provide spill containment dikes or secondary containment around stored oil and chemical drums. Refer to "Material Delivery and Storage" for details

## Inspection and Maintenance

- Vehicles and equipment shall be inspected on each day of use for leaks. Leaks shall be repaired immediately or removed from the project site.
- Maintenance areas and storage tanks shall be inspected regularly.
- Maintain waste fluid containers in leak proof condition.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.
- Inspection and Maintenance of these areas must be properly documented and the WPC Manager must ensure no potential for discharges occur from these areas as part of the non-visible monitoring requirements.

## Typical Details

None specified to date for this manual.

# 4.6.3 VEHICLE AND EQUIPMENT REFUELING

## Definition and Purpose

Practices and procedures for Vehicle and equipment fueling are designed to minimize or eliminate the discharge of fuel spills and leaks into storm drain systems or to receiving waters.

## Appropriate Applications

These procedures are applied on all construction sites where vehicle and equipment fueling takes place.

## Limitations

- This BMP may be limited or disallowed under regulatory agency permits, particularly near Environmentally Sensitive Areas (ESAs).
- Onsite vehicle and equipment fueling should only be used where it's impractical to send vehicles and equipment off-site for fueling.

## Standards and Specifications

**General Requirements**

- When fueling must occur onsite, the contractor shall select and designate an area or areas to be used, subject to approval of the PE.
- Dedicated fueling areas shall be protected from stormwater run-on and runoff, and shall be located at least 50 feet from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms or dikes to prevent run-on, runoff, and to contain spills.
- For long-term projects, consider constructing roofs or using portable tents over maintenance and fueling areas.
- Absorbent spill clean-up materials and spill kits shall be available in fueling areas and on fueling trucks and used on small spills instead of hosing down or burying techniques. Affected absorbent material and spill kits should be removed promptly and disposed of properly after use. Spill kits shall be re-stocked when materials are used from them.
- Drip pans or absorbent pads shall be readily available during vehicle and equipment fueling.
- Nozzles used in vehicle and equipment fueling shall be equipped with an automatic shut-off to control drips.
- Use vapor recovery nozzles to help control drips as well as air pollution where required.
- Ensure the nozzle is secured upright when not in use.
- Fuel tanks shall not be "topped-off."
- Federal, state, and local requirements shall be observed for any stationary above ground storage tanks. Refer to the “Material Delivery and Storage” BMP for specifics as to what needs to be included for BMP protection and documented in the SWPPP.

- Portable fuel canisters should be kept in a flammable cabinet when not in use.

## Inspection and Maintenance

- Vehicles and equipment shall be inspected on each day of use for leaks. Leaks shall be repaired immediately or problem vehicles or equipment shall be removed from the project site.
- Fueling areas and storage tanks shall be inspected at least weekly, prior to a forecasted rain event, daily during extended rain events and post-storm events.
- Immediately cleanup spills and properly dispose of contaminated soil and cleanup materials.

## Typical Details

- Some examples of spill kits. Contents of spill kits need to appropriate for the materials that are present on the job site.


**Figure 27: Example of Spill Pad Materials in use for maintenance or fueling**

### 4.6.4 SITE PLANNING AND GENERAL PRACTICES

Site Planning and General Practices

- Scheduling;
- Location of Potential Sources of Sediment;
- Preservation of Existing Vegetation;
- Dewatering Operations;
- Dust Control;
- Paving Operations;
- Structure Construction and Painting;
- Topsoil Management

# 4.6.5 SCHEDULING

### Definition and Purpose

This BMP involves developing, for every project, a schedule that includes sequencing of construction activities with the implementation of Construction Site BMPs such as temporary soil stabilization (erosion control) and temporary sediment control measures. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

### Appropriate Applications

- Construction sequencing should be used to minimize land disturbance for all projects.
- Land disturbing activities should be scheduled to allow the project to progress, but also minimize the time that areas are not stabilized.

### Limitations

- Scheduling considerations should take place during the planning stages of the project and construction schedules updated and revised as the project progresses.
- Scheduling discussions should continue during construction stages of the project once a contractor has been selected and contractor means and methods are developed.

### Standards and Specifications

- Developing a schedule and planning the project are the very first steps in an effective storm water program. The construction schedule shall be incorporated into the SWPPP. Develop the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, pouring foundations, installing utilities, etc., to minimize the active construction area during the rainy season. Schedule major grading operations for the non-rainy season when practical. Try to incorporate phasing of the project into the schedule to reduce the amount of land disturbed at any one time. Incorporate staged seeding and re-vegetation of graded slopes as work progresses. Consider scheduling when establishing permanent and temporary vegetation. Some schedule activities may be allowed to move, but other activities may need to be in a certain time frame for successful installation.

### Implementation

- Schedule should be followed throughout the life of the project.
- Schedule should be updated as construction progresses and or new information becomes available.

### Inspection and Maintenance

- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions. Amend the schedule when changes are warranted. Temporary BMPs should be installed prior to activities they are meant to protect. Other BMPs are installed as construction progresses.

### *Typical Details*

None specified to date for this manual.

# 4.6.6 Preservation of Existing Vegetation

## Definition and Purpose

Preservation of existing vegetation is the identification and protection of desirable vegetation that provides erosion and sediment control benefits. Whenever practical, existing ground cover, including vegetation should be left in place until active construction begins on the immediate area. Clearing and grubbing an entire site that will be built in phases leads to additional stabilization costs and unnecessary risk of stormwater discharges.

Plants and trees act as effective soil stabilization and sediment control devices, particularly around the perimeter of construction sites. Areas that will not be disturbed as part of construction activities should be clearly marked on plans and protected in the field with fencing or some other method of marking prior to clearing and grubbing. Permanent preservation of existing vegetation and topsoil minimizes the area of disturbance, reducing the need for erosion and sediment control BMPs and the potential for violations. It also provides a financial benefit by reducing the cost of grading, BMPs, topsoil, and seeding. Preserved areas can provide long-term stormwater benefits through increased absorption of rainfall compared to turf grass areas with compacted soil.

Access limitations should also be shown on the plans and described in the Special Contract Requirements (SCR). Any damage to preservation areas should be repaired immediately.

Items to consider when preserving existing vegetation include:

- Preserve existing vegetation to provide effective erosion control;
- Consider the age, life expectancy, health, aesthetic value, and habitat benefits of vegetation to be preserved;
- Areas containing vegetation to be preserved must be shown on the plans; and
- Preserve native plants on the site wherever possible.

## Appropriate Applications

- Preservation of existing vegetation requires planning and should be the first step in the design process. The site should be surveyed to identify high quality soils, trees, vegetation, and steep slopes to be preserved. The site improvements, including any temporary roadways, should be designed around these features and follow existing contours to reduce cutting and filling. Sediment control BMPs such as compost filter sock or silt fence may be desirable to protect the preservation area from significant sediment accumulation.

## Limitations

The following limitations may apply:

- Specific permit requirements, buffer areas, or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS may mandate protection of specific vegetation areas and supersede the guidance in this BMP. If these areas are identified ensure protection is maintained throughout the duration of construction.

- Improper protection BMPs may disturb vegetation.
- May limit work zone size and timing of construction in sensitive areas.

## Standards and Specifications

- Delineate Environmentally Sensitive Areas (ESAs)
- Delineate areas where no construction activities are planned.
- Delineate areas where construction activities will occur at a later date.
- Delineate areas outside the project right-of-way or boundary.
- Protection of preservation areas with temporary construction fencing and any sediment control BMPs shall be provided prior to the commencement of clearing and grubbing operations or other soil-disturbing activities.
- Construction materials, equipment storage, and parking areas should be located outside of protected areas where they will not cause root compaction.

## Inspection and Maintenance

- During weekly and rain event inspections, verify that temporary construction fencing and any sediment control BMPs to protect preservation areas are still in place and operational. If the area to be preserved is adjusted during construction, update the site plan and document the update in the SWPPP Amendment Log.
- Temporary fencing and any sediment control BMPs shall be removed after final stabilization of the site has occurred.

## Other Considerations

| Field Condition: | Common solutions are: |
|---|---|
| Vehicles and equipment run into or over vegetation that is to be preserved. | Clearly mark areas of preservation, and instruct workers to honor those areas. |
| | |
| Existing vegetation dies from lack of watering. | Maintain existing irrigation systems and ensure that they function properly. |
| Preserved trees are damaged. | Keep equipment and vehicles away from trees to prevent trunk and root damage. Severely damaged trees should be attended to by an arborist. Fence tree at drip line. |
| ESAs or areas where construction is not to occur or can occur at a later date are not delineated for protection. | Verify vegetation that requires preservation. Stop work if necessary. Delineate area as needed. |

## Typical Details

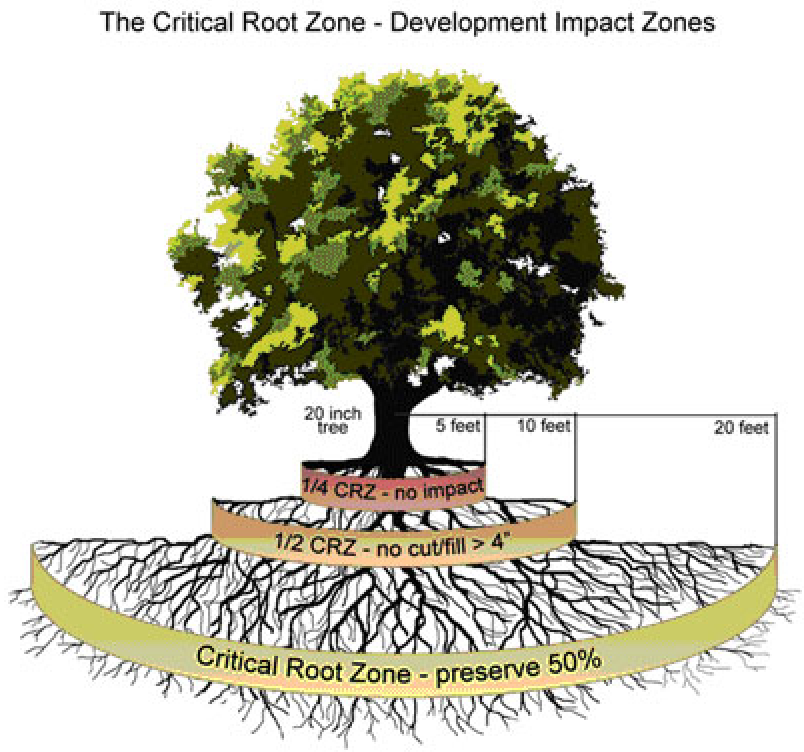
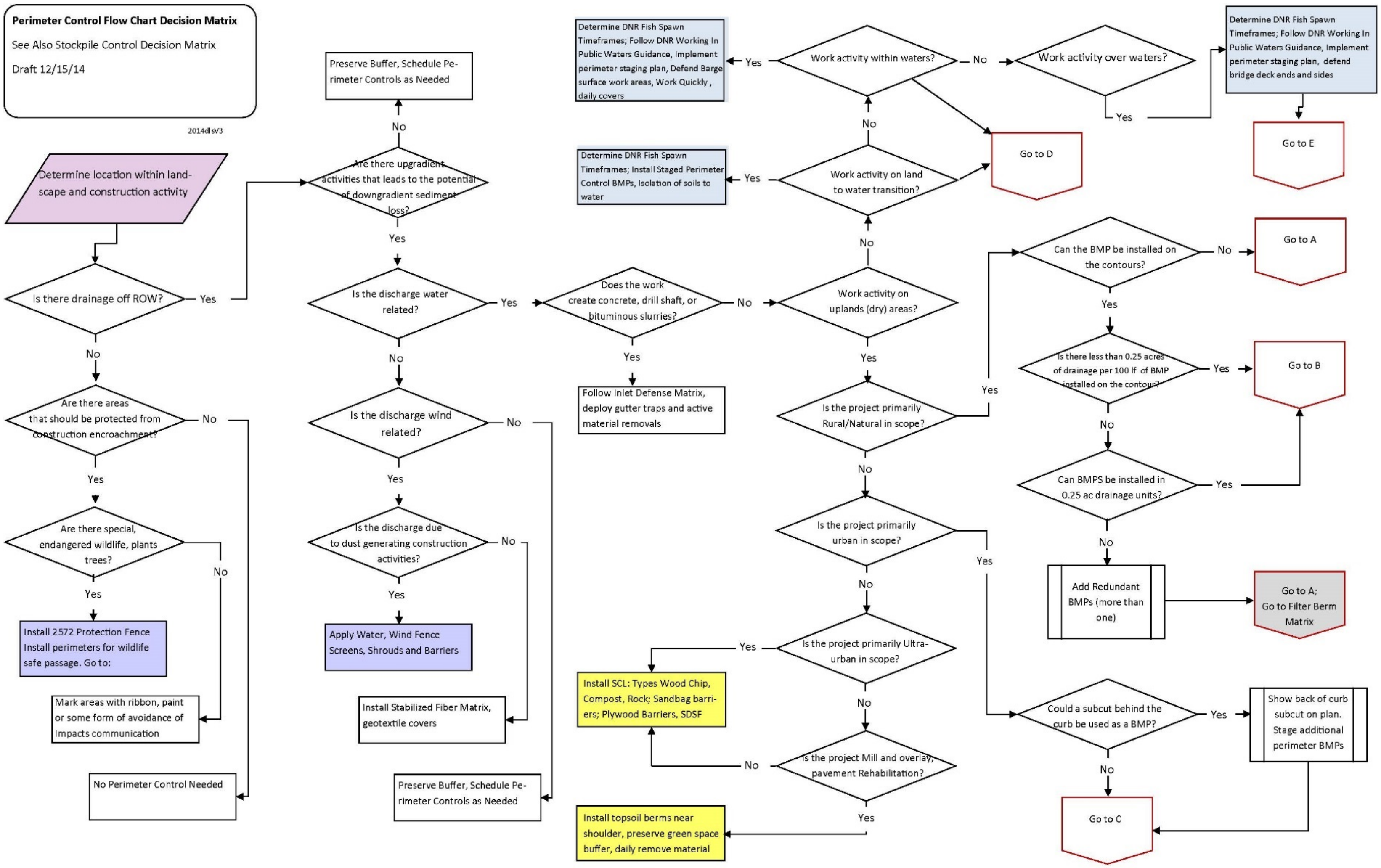


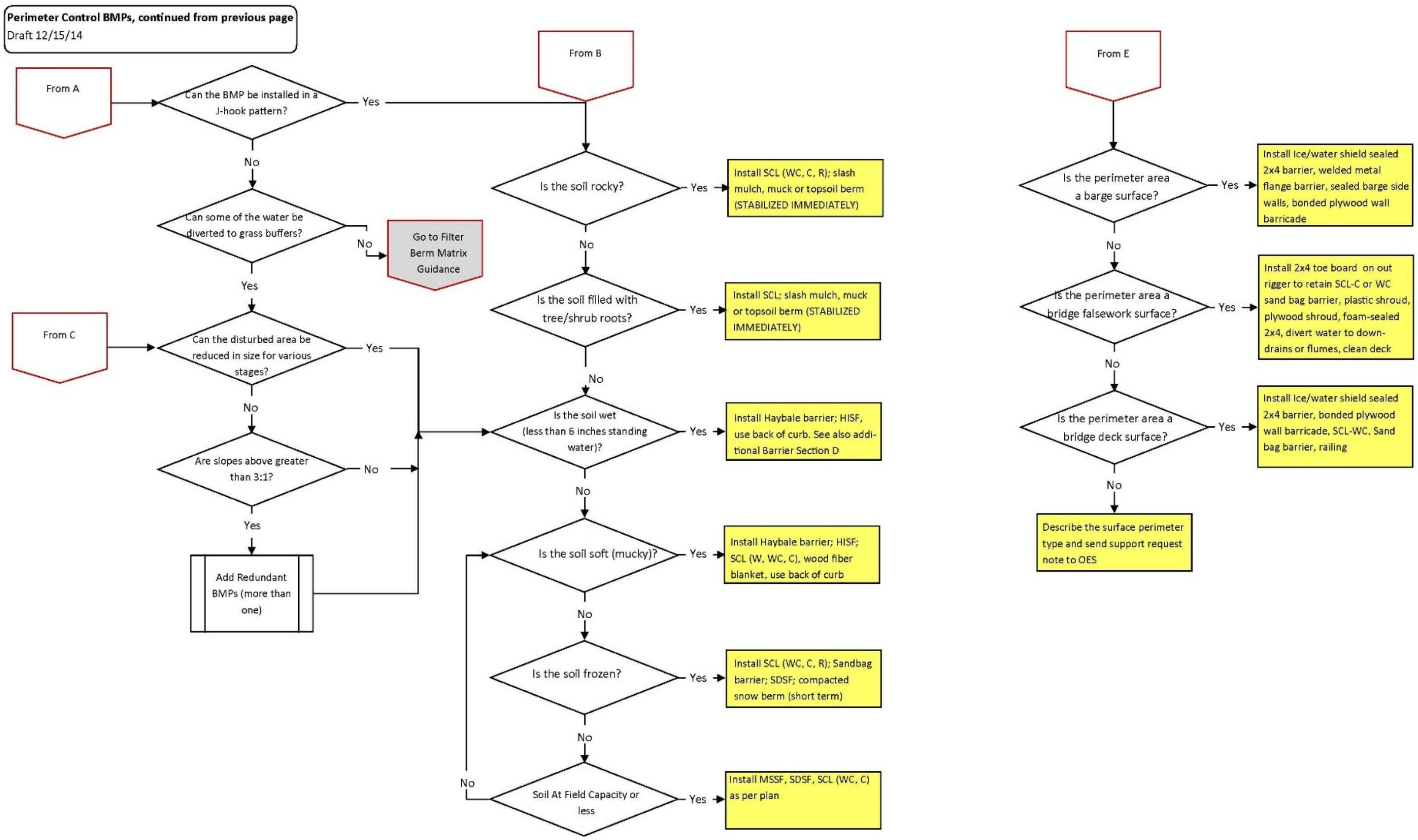

**Figure 28: Tree Critical Root Zones**

## Conditions for Removal

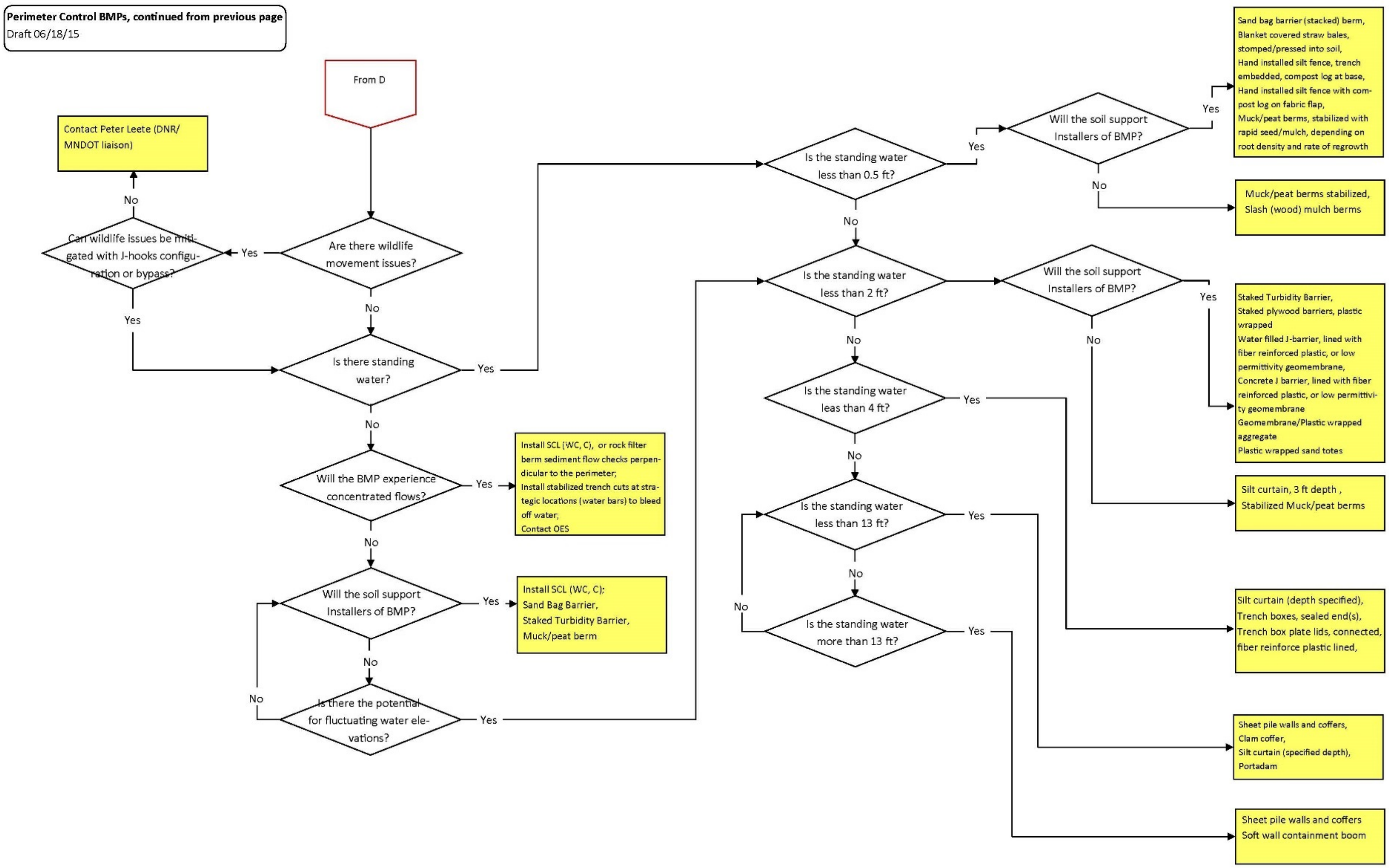
- Remove construction fencing at the end of construction once final stabilization products have been installed, prior to leaving construction site.
- Remove combination sediment control/perimeter control when the likelihood of sediment release has been minimized with permanent control measures. Removal is preferred for all non-biodegradable measures prior to contractor leaving the site unless it is meant to be permanent features.

## Selection Matrix





Perimeter Control BMPs, continued from previous page
Draft 12/15/14
From A
Can the BMP be installed in a J-hook pattern?
Yes
No
Can some of the water be diverted to grass buffers?
No
Go to Filter Berm Matrix Guidance
Yes
From C
Can the disturbed area be reduced in size for various stages?
Yes
No
Are slopes above greater than 3:1?
No
Yes
Add Redundant BMPs (more than one)
From B
Is the soil rocky?
Yes
Install SCL (WC, C, R); slash mulch, muck or topsoil berm (STABILIZED IMMEDIATELY)
No
Is the soil filled with tree/shrub roots?
Yes
Install SCL; slash mulch, muck or topsoil berm (STABILIZED IMMEDIATELY)
No
Is the soil wet (less than 6 inches standing water)?
Yes
Install Haybale barrier; HISF, use back of curb. See also additional Barrier Section D
No
Is the soil soft (mucky)?
Yes
Install Haybale barrier; HISF; SCL (W, WC, C), wood fiber blanket, use back of curb
No
Is the soil frozen?
Yes
Install SCL (WC, C, R); Sandbag barrier; SDSF; compacted snow berm (short term)
No
Soil At Field Capacity or less
Yes
Install MSSF, SDSF, SCL (WC, C) as per plan
No
From E
Is the perimeter area a barge surface?
Yes
Install Ice/water shield sealed 2x4 barrier, welded metal flange barrier, sealed barge side walls, bonded plywood wall barricade
No
Is the perimeter area a bridge falsework surface?
Yes
Install 2x4 toe board on out rigger to retain SCL-C or WC sand bag barrier, plastic shroud, plywood shroud, foam-sealed 2x4, divert water to down-drains or flumes, clean deck
No
Is the perimeter area a bridge deck surface?
Yes
Install Ice/water shield sealed 2x4 barrier, bonded plywood wall barricade, SCL-WC, Sand bag barrier, railing
No
Describe the surface perimeter type and send support request note to OES



Perimeter Control BMPs, continued from previous page
Draft 06/18/15
From D
Are there wildlife movement issues?
Yes
Can wildlife issues be mitigated with J-hooks configuration or bypass?
No
Contact Peter Leete (DNR/MNDOT liaison)
Yes
No
Is there standing water?
Yes
No
Will the BMP experience concentrated flows?
Yes
Install SCL (WC, C), or rock filter berm sediment flow checks perpendicular to the perimeter;
Install stabilized trench cuts at strategic locations (water bars) to bleed off water;
Contact OES
No
Will the soil support Installers of BMP?
Yes
Install SCL (WC, C);
Sand Bag Barrier,
Staked Turbidity Barrier,
Muck/peat berm
No
Is there the potential for fluctuating water elevations?
No
Yes
Is the standing water less than 0.5 ft?
Yes
Will the soil support Installers of BMP?
Yes
Sand bag barrier (stacked) berm,
Blanket covered straw bales, stomped/pressed into soil,
Hand installed silt fence, trench embedded, compost log at base,
Hand installed silt fence with compost log on fabric flap,
Muck/peat berms, stabilized with rapid seed/mulch, depending on root density and rate of regrowth
No
Muck/peat berms stabilized,
Slash (wood) mulch berms
No
Is the standing water less than 2 ft?
Will the soil support Installers of BMP?
Yes
Staked Turbidity Barrier,
Staked plywood barriers, plastic wrapped
Water filled J-barrier, lined with fiber reinforced plastic, or low permittivity geomembrane,
Concrete J barrier, lined with fiber reinforced plastic, or low permittivity geomembrane
Geomembrane/Plastic wrapped aggregate
Plastic wrapped sand totes
No
Silt curtain, 3 ft depth ,
Stabilized Muck/peat berms
No
Is the standing water leas than 4 ft?
Yes
Silt curtain (depth specified),
Trench boxes, sealed end(s),
Trench box plate lids, connected,
fiber reinforce plastic lined,
No
Is the standing water less than 13 ft?
Yes
Sheet pile walls and coffers,
Clam coffer,
Silt curtain (specified depth),
Portadam
No
Is the standing water more than 13 ft?
No
Yes
Sheet pile walls and coffers
Soft wall containment boom

## 4.7 Soil Stabilization and Erosion Control BMPs

Temporary soil stabilization consists of preparing the soil surface and applying a combination of BMPs, to stabilize disturbed soil areas. Temporary soil stabilization must be applied to disturbed soil areas of construction projects in conformance with contract documents and this Manual.

Examples of Temporary Soil Stabilization BMPs include:

- Hydraulic Mulch;
- Hydroseeding;
- Soil Binders;
- Straw Mulch;
- Geotextiles, Plastic Covers;
- Erosion Control Blankets;
- Wood Mulching;

Temporary concentrated flow conveyance controls consist of a system of measures or BMPs that are used alone or in combination to intercept, divert, convey and discharge concentrated flows with a minimum of soil erosion, both on-site and downstream (off-site). Temporary concentrated flow conveyance controls may be required to direct run-on around or through the project in a non-erodible fashion.

Temporary concentrated flow conveyance controls include the following BMPs:

- Earth Dikes/Drainage Swales and Ditches;
- Outlet Protection/Velocity Dissipation Devices; and
- Slope Drains.

Provided on Table 6 are selection criteria information and ratings for temporary soil stabilization BMPs. The BMPs are described in detail following Table 6.

# 4.7.1 SLOPE ROUGHENING, TERRACING, AND ROUNDING

## Definition and Purpose

Soil roughening is a temporary erosion control practice often used in conjunction with grading. Soil roughening involves increasing the relief of a bare soil surface with horizontal grooves by either stair-stepping (running parallel to the contour of the land) or using construction equipment to track the surface. Slopes that are not fine graded and left in a roughened condition can also reduce erosion. Soil roughening reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares the soil for seeding and planting by giving seed an opportunity to take hold and grow.

Methods of slope grading to reduce potential erosion by decreasing runoff velocities, trapping sediment, shortening slope length, and increasing infiltration into the soil.

## Appropriate Applications

Soil roughening is appropriate for all slopes, but works especially well on slopes greater than 3:1, on piles of excavated soil, and in areas with highly erodible soils. This technique is especially appropriate for soils that are frequently disturbed, because roughening is relatively easy. To slow erosion, roughen the soil as soon as possible after the vegetation has been removed from the slope or immediately after grading activities have ceased (temporarily or permanently). Use this practice in conjunction with seeding, planting, and temporary mulching to stabilize an area. A combination of surface roughening and vegetation is appropriate for steeper slopes and slopes that will be left bare for longer periods of time. Ideal areas for applying slope roughening, terracing and rounding include:

- Areas where seeding, planting, and mulching erosion control measures may be enhanced by roughening of the soil surface.
- Graded areas with smooth, hard surfaces.
- Areas requiring terracing to shorten the slope length.

## Limitations

The following limitations may apply:

- Soil roughening is not appropriate for rocky slopes.
- Tracked machinery can excessively compact the soil.
- Since terracing is permanent, design and approval shall be under the direction of a licensed, qualified engineer.
- Design of terraces shall provide adequate drainage and stabilized outlets.
- Roughening may result in increased grading costs and sloughing in soil.
- Stair-step grading may not be applicable to sandy, steep, or shallow soils.
- During intense rainfall events, roughening may not be an effective temporary erosion control measure. Typically, soil roughening is effective only for gentle or shallow depth rains. If roughening is washed away in a heavy storm, re-roughen the surface and reseed.

## Standards and Specifications

Roughened slope surfaces help establish vegetation, improve infiltration, and decrease runoff velocity. A rough soil surface allows surface ponding that protects lime, fertilizer, and seed and decreases erosion potential. Grooves in the soil are cooler and provide more favorable moisture conditions than hard, smooth surfaces. These conditions promote seed germination and vegetative growth.

Avoid excessive soil compacting, because this inhibits vegetation growth and causes higher runoff velocity. Limit roughening with tracked machinery to sandy soils that do not compact easily; also, avoid tracking on heavy clay soils, especially when wet. Seed roughened areas as quickly as possible, and follow proper dust control procedures.

Depending on the type of slope and the available equipment, use different methods for roughening soil on a slope. These include stair-step grading, grooving, and tracking. When choosing a method, consider factors such as slope steepness, mowing requirements, whether the slope is formed by cutting or filling, and available equipment. Choose from the following methods for surface roughening:

- ***Cut slope roughening for areas that will not be mowed.*** Use stair-step grades or groove-cut slopes for gradients steeper than 3h:1v when allowed or required in contract documents. Use stair-step grading on any erodible material that is soft enough to be ripped with a bulldozer. Also, it is well suited for slopes consisting of soft rock with some subsoil. Make the vertical cut distance less than the horizontal distance, and slope the horizontal portion of the step slightly toward the vertical wall (Drain towards the slope). Keep individual vertical cuts less than 2 feet deep in soft materials and less than 3 feet deep in rocky materials. Create ridges and depressions along the slope contours using machinery.
- ***Grooving.*** This technique uses machinery to create a series of ridges and depressions that run across the slope along the contour. Make grooves using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth on a front-end loader bucket. Make the grooves less than 3 inches deep and less than 15 inches apart.
- ***Fill slope roughening for areas that will not be mowed.*** Fill slopes with a gradient steeper than 3h:1v should be placed in lifts less than 12 inches, and properly compact each lift. The face of the slope should consist of loose, un-compacted fill 4 to 6 inches deep. If necessary, roughen the face of the slopes by grooving the surface as described above. Do not blade or scrape the final slope face. Apply seed, fertilizer, and mulch. Track or punch in the mulch. Refer to Mulching and Seeding in this manual for additional information.
- ***Cuts, fills, and graded areas that will be mowed.*** Make mowed slopes no steeper than 3:1. Roughen these areas with shallow grooves less than 10 inches apart and deeper than 1 inch using normal tilling, disking, or harrowing equipment (a cultipacker-seeder can also be used). Excessive roughness is undesirable where mowing is planned.
- ***Roughening with tracked machinery.*** To avoid undue compaction of the soil surface, roughening with tracked machinery should be done with smaller equipment. Operate

tracked machinery perpendicularly to the slope to leave horizontal depressions in the soil. Tracking is generally not as effective as other roughening methods.

- ***Terracing.*** Slope grades of 5:1 (H:V) could include terraces or benches when slope heights exceed 30 feet. Steeper slope or highly erosive soil conditions may warrant terraces or benches for slope heights of 15 feet of higher. Runoff collected along terraces and benches shall be routed to lined diversion ditches. Install lined diversion ditches at the intersection of the terrace and slope. Terracing should be shown in the design plans if required or desired to be installed. Due to limited right-of-way, terracing is not used on most CFLHD projects
- ***Rounding.*** All slopes shall be rounded with no sharp breaks in plan or profile according to Section 204 of the FP-14.

## Inspection and Maintenance

Inspect seeded and planted slopes for rills and gullies weekly during dry periods as well as within 24 hours of any rainfall of 0.5 inch or greater which occurs in a 24-hour period and daily during periods of prolonged rainfall.

## Typical Details

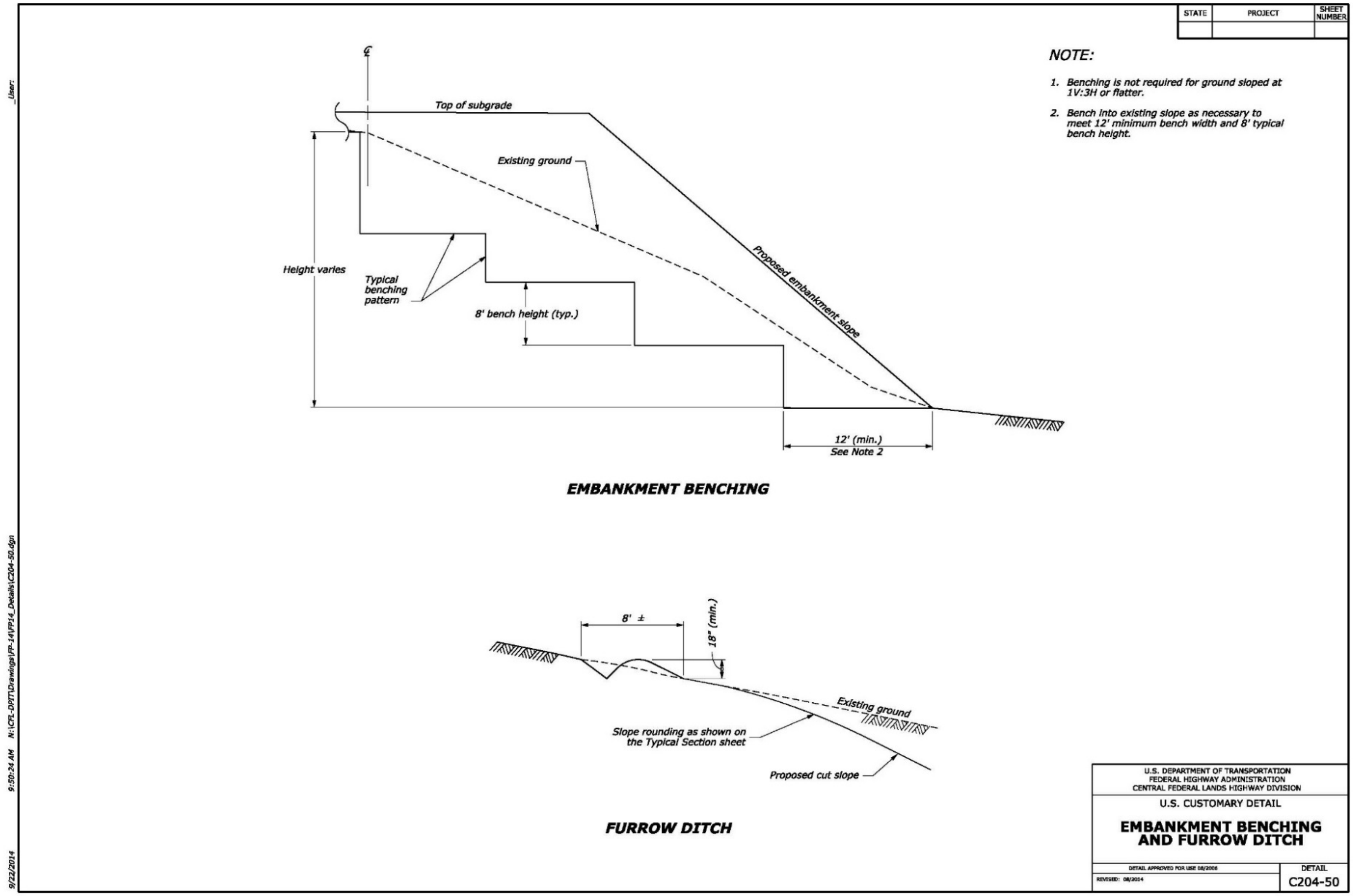



**Figure 29: Embankment Benching and Furrow Ditch**

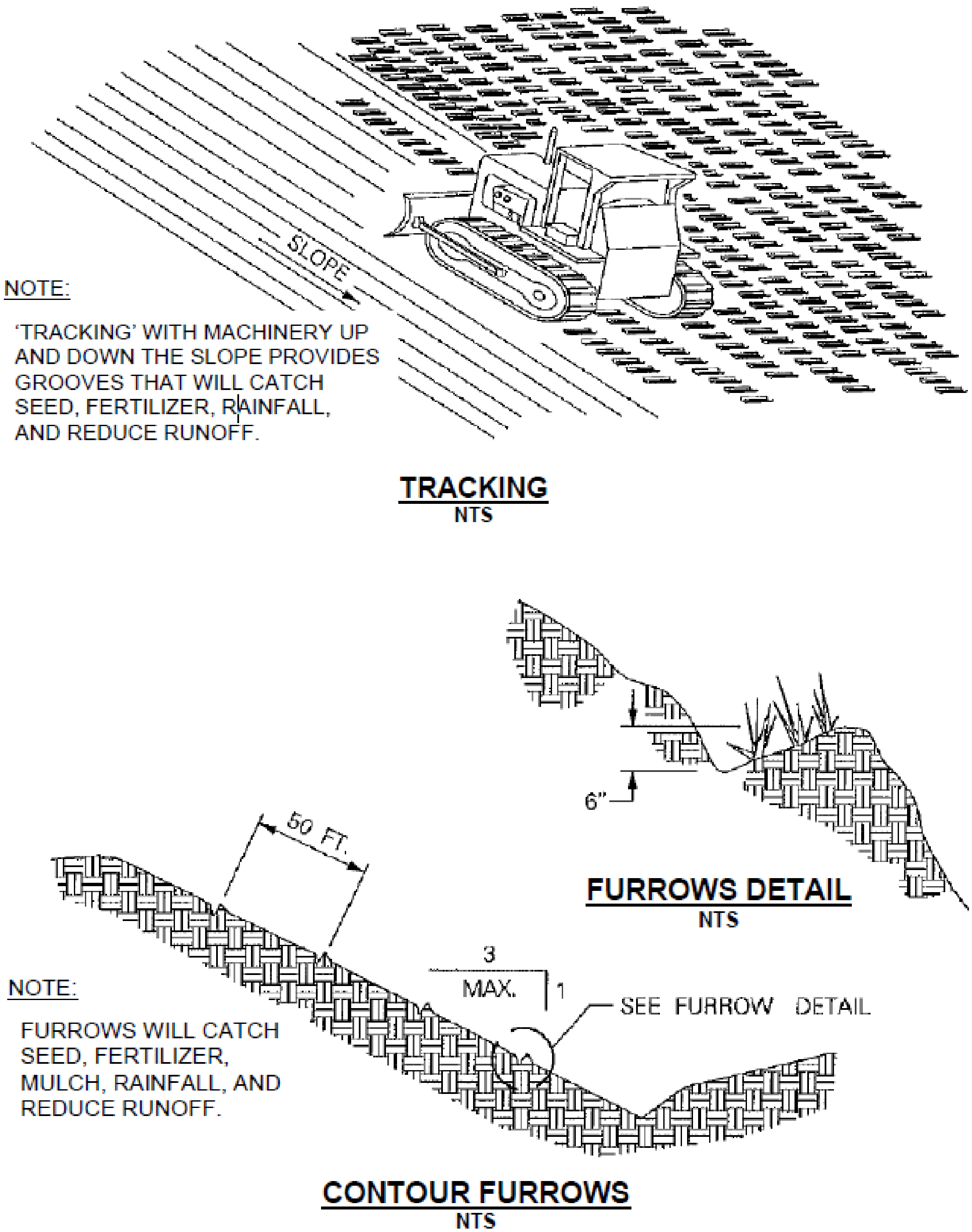



**Figure 30: Slope Roughening**

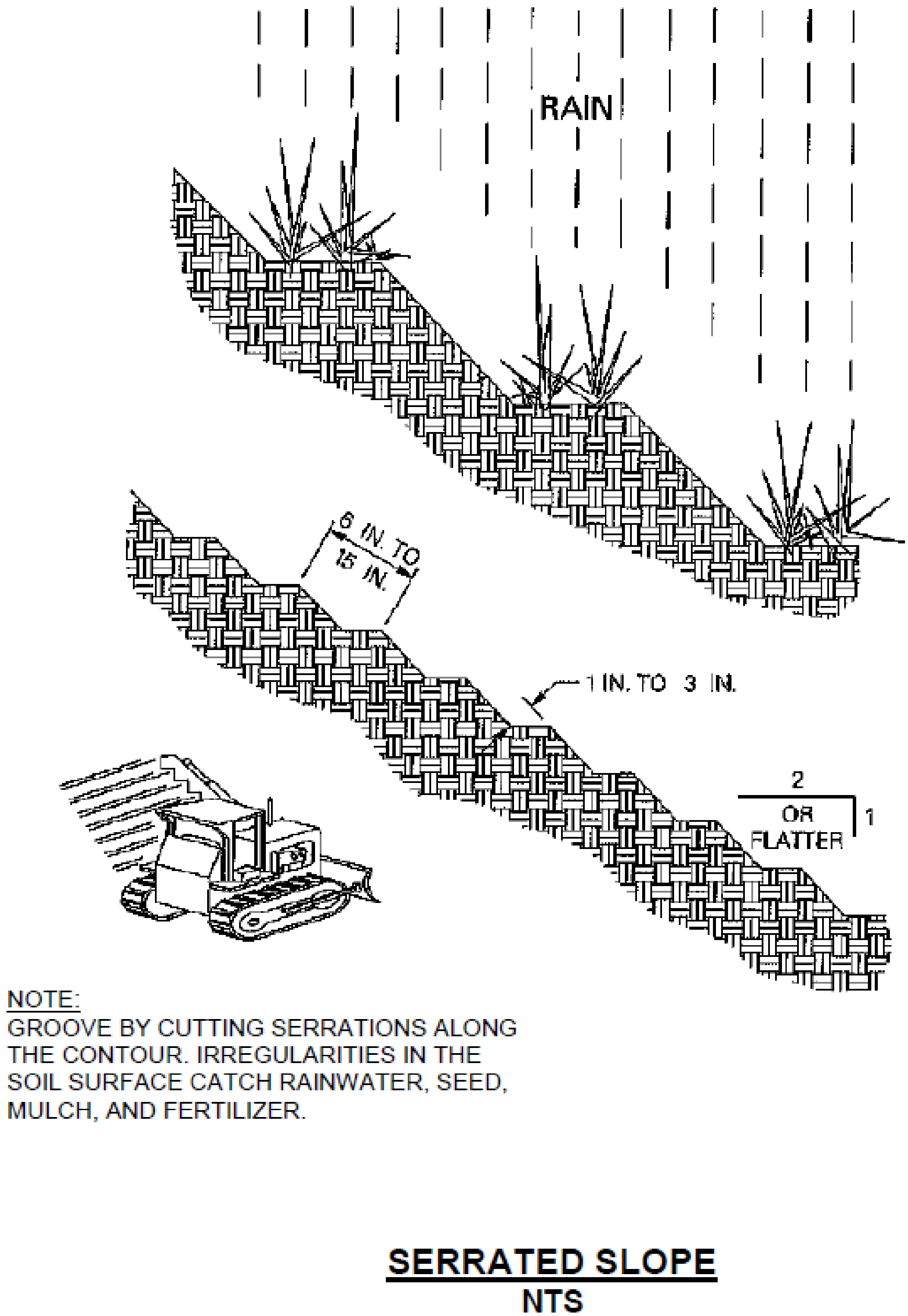
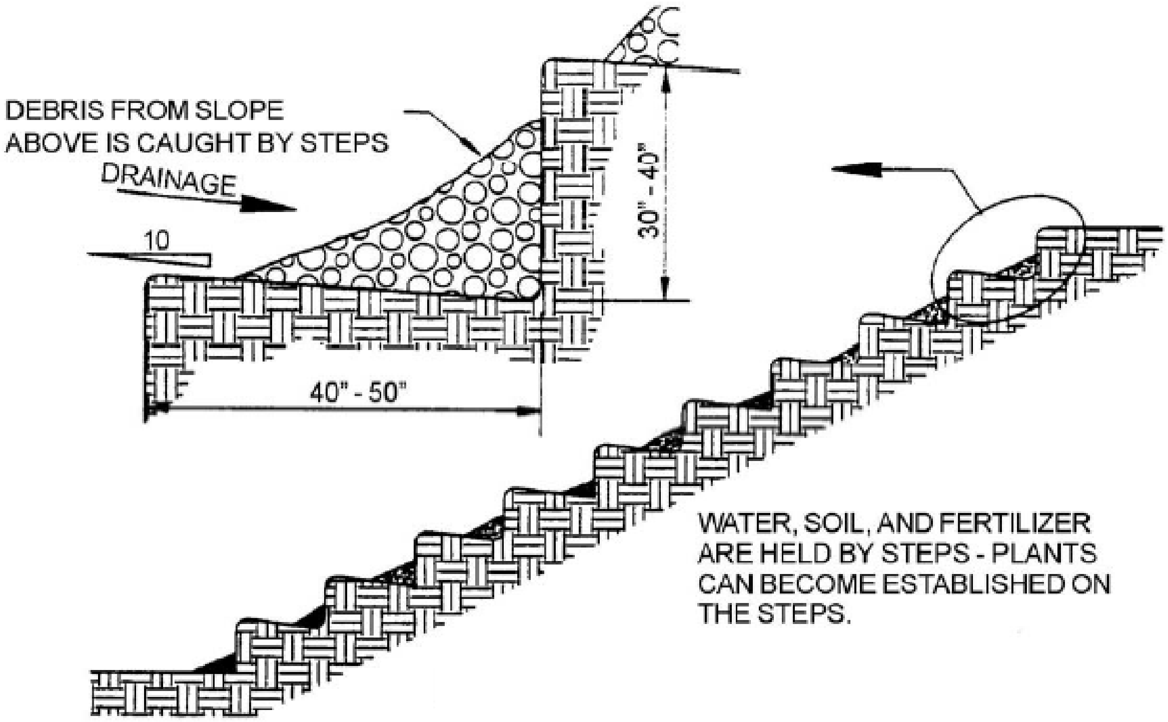



**Figure 31: Slope Serrating**




STAIR STEPPING CUT SLOPES
NTS

**Figure 32: Stair Stepping Cut Slopes**

# 4.7.2 MULCH

## Definition and Purpose

Mulching is an erosion control practice that uses materials such as grass, hay, wood chips, wood fibers, straw, or gravel to stabilize exposed or recently planted soil surfaces. Mulching is highly recommended and is most effective when used in conjunction with vegetation. In addition to stabilizing soils, mulching can reduce raindrop impact, stormwater velocity, and improve the infiltration of runoff. Mulching can also aid plant growth by holding seeds, fertilizers, and topsoil in place, preventing birds from eating seeds, retaining moisture, and insulating plant roots against extreme temperatures.

Mulch matting is made from materials such as jute or other wood fibers that are formed into sheets and are more stable than loose mulch. Use jute and other wood fibers, plastic, paper, or cotton individually or combine them into mats to hold mulch to the ground. Use netting to stabilize soils while plants are growing; although, netting does not retain moisture or insulate against extreme temperatures. Mulch tackifiers made of asphalt or synthetic materials are sometimes used instead of netting to bind loose mulches.

## Mulch Types

### *Hydraulic Mulch*

Hydraulic mulch consists of applying a water-based mixture of wood or paper fiber and stabilizing emulsion or tackifier with hydro-mulching equipment. Applied hydraulic mulch will help protect disturbed soil from water and wind erosion. Bonded Fiber Matrix (BFM) is another soil stabilizer alternative to hydraulic mulch. Common hydraulic mulch types include:

***Type: Wood Fiber***

Wood fiber mulch is generally used as a component of hydraulic applications. It is usually used in combination with seed, fertilizer and other materials, and is typically applied at the rate of 4,960 to 9,920 pounds per hectare (lbs/ha).

Wood fiber mulch can be specified with or without a tackifier. Data shows that wood fiber mulches with tackifiers have better erosion control performance.

***Type: Recycled Paper***

Recycled paper mulch is generally used in hydraulic applications. It is usually used in combination with seed and fertilizer and is typically applied at the rate of 4,960 to 9,920 lbs/ha.

***Type: Cellulose Fiber***

Cellulose fiber mulch contains fibers of shorter length than wood fiber mulches and is typically made from recycled newsprint, magazine, or other waste paper sources. It can be specified with or without a tackifier.

***Type: Bonded Fiber Matrix***

A bonded fiber matrix (BFM) is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion-resistant blanket that promotes vegetation, and prevents soil erosion. BFMs are typically applied at rates from 7,500 to 9,920 lbs/ha based on the manufacturer's recommendation.

The biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should not dissolve or disperse upon re-wetting. Typically, biodegradable BFMs should not be applied immediately before, during or immediately after rainfall so that the matrix will have an opportunity to dry for 24 hours after application.

### *Straw Mulch*

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller, or anchoring it with a tackifier. Straw mulch is used for soil stabilization, as a temporary surface cover, on disturbed areas until soils can be prepared for re-vegetation. It is also used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

Loose straw is the most common mulch material used in conjunction with direct seeding of soil. Straw mulching is generally the second part of multi-step process where seed and fertilizer are first applied, then straw mulch is applied as the second step. The final step of the process involves holding the loose straw in place by a) using netting, b) applying a liquid tackifier, or c) punching it into the soil by a process known as “crimping” or “incorporating.”

***Type: Wheat or Rice Straw***

Straw can be hand applied or machine applied. The fiber length of the straw should be typically greater than 6 inches [in].

### *Wood Mulch*

Wood mulching consists of applying shredded wood, bark, or green material. The primary function of wood mulching is to reduce erosion by protecting bare soil from raindrop impact and reducing runoff. Use is limited to slopes that are less than 1:3 and depth of the mulch blanket is typically 3 – 4 inches. The material is typically spread by hand, although pneumatic methods are available. Wood mulching is primarily applicable for landscape projects.

## Appropriate Applications

Mulching is often used in areas where vegetation cannot be established. Mulching can provide immediate and inexpensive erosion control. On steep slopes and critical areas, such as those near waterways, use mulch matting with netting or anchoring to hold it in place (Refer to 4.2.1.7 Geotextiles, Mats/Plastic Covers and Erosion Control Blankets). Use mulches on seeded and planted areas where slopes are steeper than 2:1 or where sensitive seedlings require insulation from extreme temperatures or moisture retention.

Mulching can be used in areas of sheet flow for temporary soil stabilization on disturbed areas and applied to seeded areas to protect the seed and retain moisture for plant establishment. It is essential to seeding success in most conditions. In landscape areas, mulch is installed for permanent use. Mulches are suitable for the following applications:

- Temporary protection for DSAs until permanent vegetation is established
- Temporary protection for DSAs that will be re-disturbed following an extended period (1 to 3 months) of inactivity

## Limitations

Mulching, matting, and netting might delay seed germination because the cover changes soil surface temperatures. The mulches themselves are subject to erosion and may be washed away in a large storm. Maintenance is necessary to ensure that mulches provide effective erosion control.

## Standards and Specifications

Material specifications for mulch can be found in FHWA Standard Specifications, Section 713.05.

When possible, natural mulches should be used for erosion control and plant material establishment. Suggested materials include loose straw, netting, wood cellulose, or agricultural silage. All materials must be certified weed free. Anchor loose hay or straw by applying tackifier, or crimping with a mulch crimping tool. Materials that are heavy enough to stay in place (for example, gravel or bark or wood chips on flat slopes) do not need anchoring. Other examples of organic mulches include hydraulic mulch products with 100 percent post-consumer paper content, yard trimming composts, and wood mulch from recycled stumps and tree parts. Use inorganic mulches such as pea gravel or crushed granite in unvegetated areas.

Mulches may or may not require a binder or tacking. To ensure effective use of netting and matting material, keep firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material. Grading is not necessary before mulching. Use biodegradable netting, if possible.

There must be adequate coverage to prevent erosion, washout, and poor plant establishment. If an appropriate tacking agent is not applied, or is applied in insufficient amounts, mulch will be lost to wind and runoff. The channel grade and liner must be appropriate for the amount of runoff, or the channel bottom will erode. Also, apply hydromulch in spring, summer, or fall to prevent deterioration of mulch before plants can become established. The table below presents some guidelines for installing mulches.

## Preventive Measures and Troubleshooting Guide

| Field Condition: | Common solutions are: |
|---|---|
| Slope was improperly dressed before application. | Roughen embankment and fill areas first by rolling with crimping or punching type roller or by track walking. |
| Coverage is inadequate. | Follow recommended application rates. Count the number of bags of the product to ensure the correct amount of material is used. |
| Allowed inadequate drying time. | Allow at least 24 hours for the material to dry before a rain event. Follow manufacturer’s recommendations. Reapply where necessary. |
| Portions of the mulch have been disturbed. | Keep workers and equipment off the mulched areas and repair areas that have been damaged. |
| Excess water flows across stabilized surface. | Use other BMPs to limit flow onto stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows. |

## Conditions for Removal

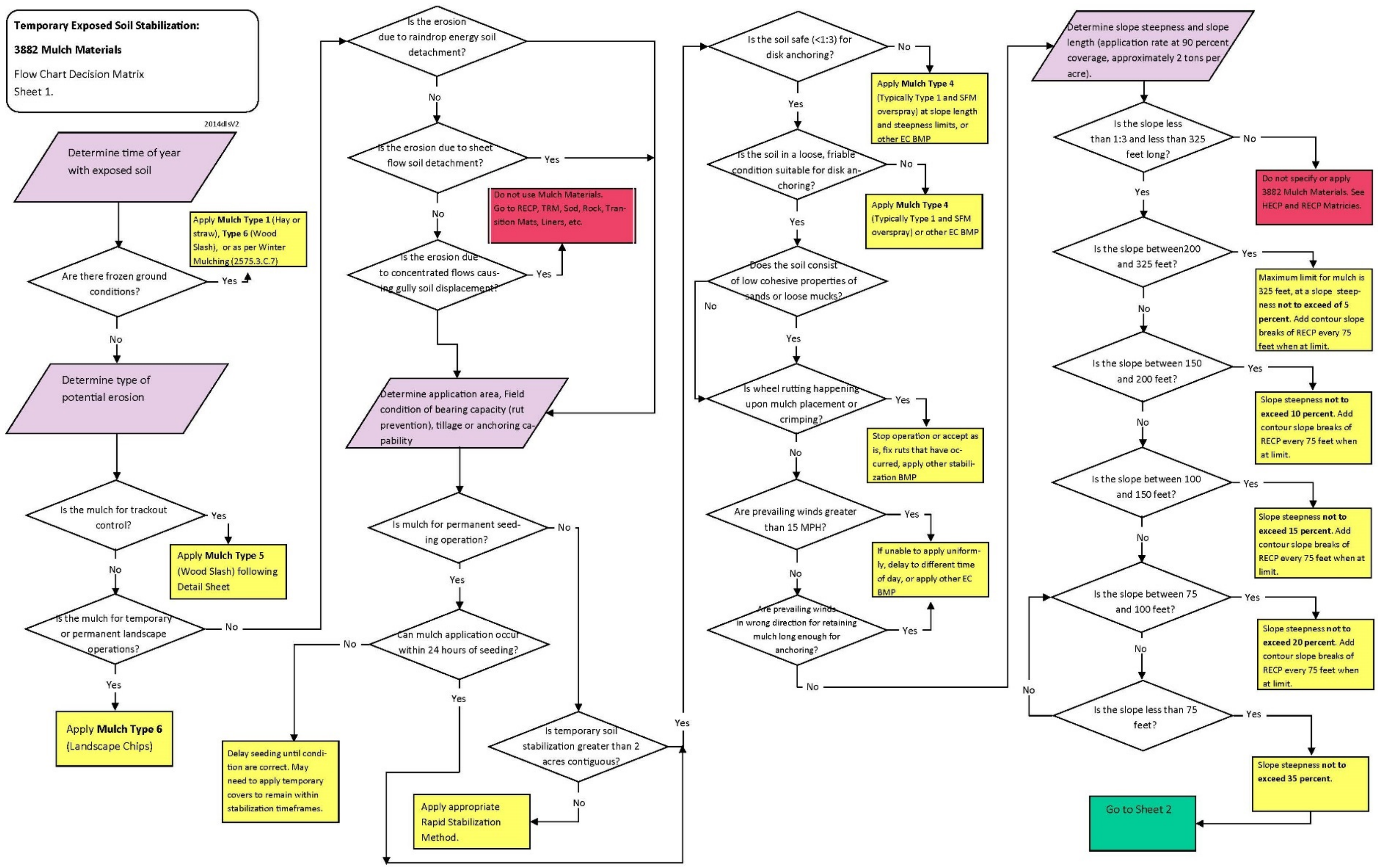
Mulching is biodegradable and will remain in place.

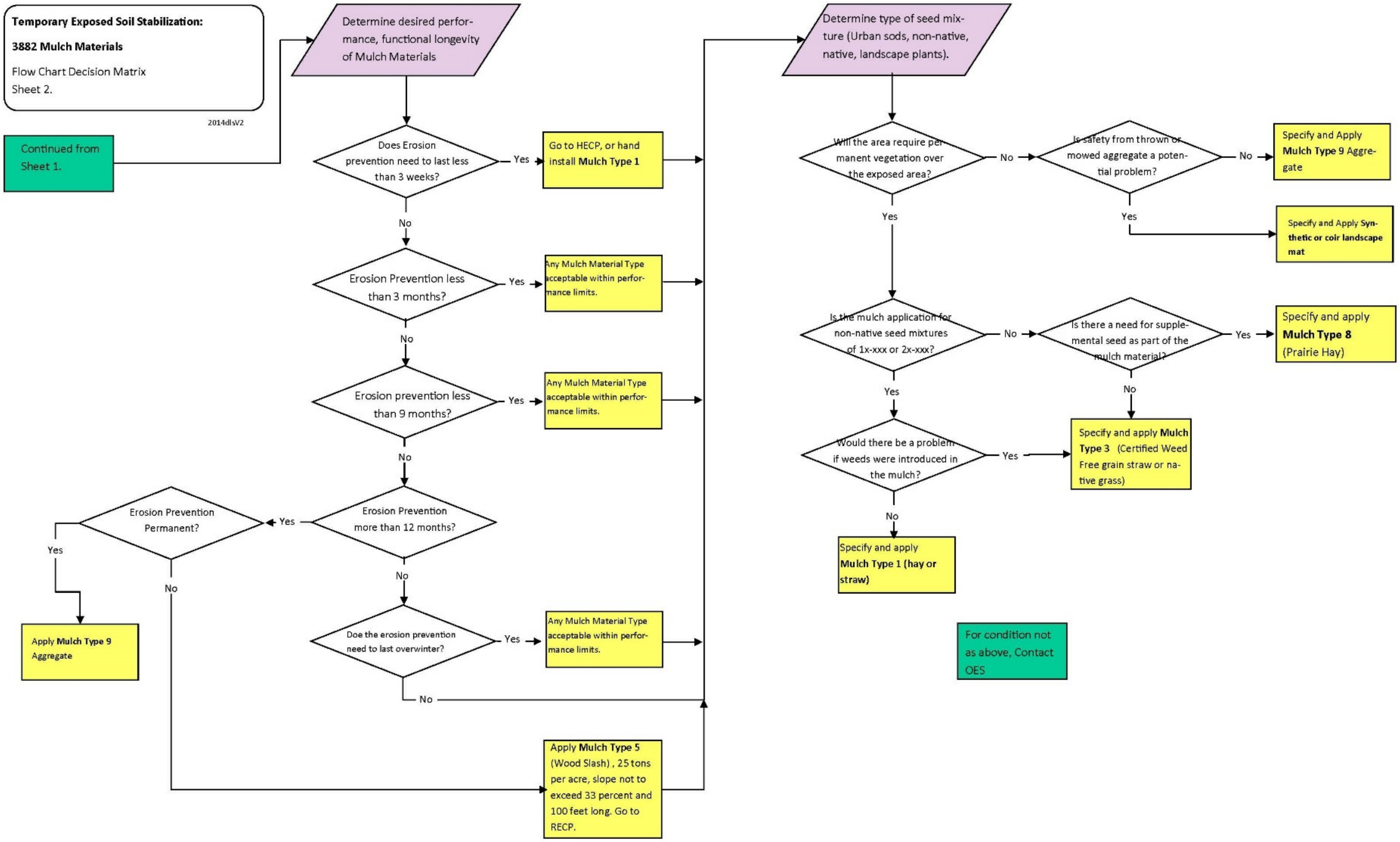
## Typical Details

None specified to date for this manual.

**Figure 33: Wood Slash/chips blown on slope for temporary or permanent mulch.**

## Selection Matrix




Temporary Exposed Soil Stabilization:
3882 Mulch Materials
Flow Chart Decision Matrix
Sheet 2.
2014dlsV2
Continued from Sheet 1.
Determine desired performance, functional longevity of Mulch Materials
Does Erosion prevention need to last less than 3 weeks?
Yes
Go to HECP, or hand install Mulch Type 1
No
Erosion Prevention less than 3 months?
Yes
Any Mulch Material Type acceptable within performance limits.
No
Erosion prevention less than 9 months?
Yes
Any Mulch Material Type acceptable within performance limits.
No
Erosion Prevention more than 12 months?
Yes
Erosion Prevention Permanent?
Yes
Apply Mulch Type 9 Aggregate
No
No
Doe the erosion prevention need to last overwinter?
Yes
Any Mulch Material Type acceptable within performance limits.
No
Apply Mulch Type 5 (Wood Slash), 25 tons per acre, slope not to exceed 33 percent and 100 feet long. Go to RECP.
Determine type of seed mixture (Urban sods, non-native, native, landscape plants).
Will the area require permanent vegetation over the exposed area?
No
Is safety from thrown or mowed aggregate a potential problem?
No
Specify and Apply Mulch Type 9 Aggregate
Yes
Specify and Apply Synthetic or coir landscape mat
Yes
Is the mulch application for non-native seed mixtures of 1x-xxx or 2x-xxx?
No
Is there a need for supplemental seed as part of the mulch material?
Yes
Specify and apply Mulch Type 8 (Prairie Hay)
No
Specify and apply Mulch Type 3 (Certified Weed Free grain straw or native grass)
Yes
Would there be a problem if weeds were introduced in the mulch?
Yes
No
Specify and apply Mulch Type 1 (hay or straw)
For condition not as above, Contact OES

## 4.7.3 SEEDING

### Definition and Purpose

Seeding is used to control runoff and erosion on disturbed areas by establishing perennial vegetative cover from seed. It reduces erosion and sediment loss and provides permanent stabilization. This practice is economical, adaptable to different site conditions, and allows selection of a variety of plant materials.

### Seeding Methods

#### *Method 1. Dry Seeding*

This is the "standard" method for seeding on prepared sites such as those on construction projects.

1. Site Preparation - The site should be prepared by loosening topsoil to a minimum depth of 3 inches.
2. Fertilizer – Use a fertilizer analysis based on a soil tests
3. Seed Installation - Seed should be installed with a drop seeder that will accurately meter the types of seed to be planted, keep all seeds uniformly mixed during the seeding and contain drop seed tubes for seed placement (Brillion-type). The drop seeder should be equipped with a cultipacker assembly to ensure seed-to-soil contact.
4. Seeding Rates - Rates are specified in the mixture tabulation for the specified mix.
5. Packing – If the drop seeder is not equipped with a cultipacker, the site should be cultipacked following the seeding to ensure seed-to-soil contact.
6. Mulch - The site should be mulched and disc-anchored following cultipacking. Also see temporary erosion control for additional information regarding mulch installation.

#### *Method 2. Hydroseeding*

Hydro seeding consists of applying a water-based mixture of wood or paper fiber, stabilizing emulsion, and seed with hydro-mulching equipment. This is usually a multi-step process with a layer of straw. Often fertilizer and compost are added to the hydraulic mixture. This will protect disturbed soil from erosion by raindrop impact or wind. Hydraulic mulches are typically combined with a seed mixture for achieving longer term temporary soil stabilization than by hydraulic mulching alone. The selection of plant materials to be included in the seed mixture can be based, in part, on the length of time temporary stabilization is required.

Hydroseeding is an acceptable method for establishing the general mixtures when it is done correctly. However, it is imperative that the site is prepared and finished properly. The FHWA generally uses hydroseeding on steep slopes or other areas inaccessible to a drop seeder such as wetland edges and ponds. Hydroseeding is not recommended if the extended weather patterns are hot and dry and the soil surface is dry and dusty. The seed-water slurry should be applied within one hour after the seed is added to the hydroseeder tank. Below are the steps in hydroseeding applications:

1. Site Preparation - The site should be prepared by loosening topsoil to a minimum depth of 3 inches. It is critical that the seedbed be loosened to a point that there are a lot of spaces for seed to filter into cracks and crevices otherwise it may end up on the surface and wash away with the first heavy rain.
2. Fertilizer – Apply a fertilizer if warranted to match soil needs after analysis through a soil test.
3. Seed Installation - Seed should be installed by hydro-seeding it evenly over the entire site. A fan-type nozzle should be used with approximately 500 gallons of water per acre. It is recommended to add approximately 75 pounds of hydromulch per 500 gallons of water for a visual tracer to ensure uniform coverage.
4. Seeding Rates - Rates are specified in the mixture tabulation for the specified mix.
5. Harrowing - The site should be harrowed, cultipacked or raked following seeding.
6. Mulch - The site should be mulched following harrowing using one of the following mulch methods (as per plans or special contract requirements).

NOTE: When seeding in conjunction with a hydraulic soil stabilizer (bonded fiber matrixes (BFM's), hydro-mulches, etc., it is recommended that a two-step operation be used. Seed should be placed first and the hydraulic soil stabilizer be applied afterwards. This is to ensure that seed comes into direct contact with the soil.

### *Method 3. Broadcast Seeding*

Broadcast seeding is performed either with mechanical "cyclone" seeders, by hand seeding or by any other method that scatters seed over the soil surface. It is essential that steps be taken to ensure good seed to soil contact when broadcast seeding is used.

1. Site Preparation - The site should be prepared by loosening topsoil to a minimum depth of 3 inches. It is critical that the seedbed be loosened to a point that there are spaces for seed to filter into cracks and crevices otherwise it may end up on the surface and wash away with the first heavy rain.
2. Fertilizer - Apply a fertilizer if warranted to match soil needs after analysis through a soil test.
3. Seed Installation - Seed should be installed by broadcasting it evenly over the entire site. Several types and sizes of broadcast seeders are available for use, ranging from fertilizer-type spreaders to power spreaders mounted on all-terrain vehicles. Seed should be mixed thoroughly prior to seeding and should be mixed occasionally in the spreader to prevent separation and settling.
4. Seeding Rates - Rates are specified in the mixture tabulation for the specified mix.
5. Harrowing - The site should be harrowed or raked following seeding.
6. Packing - The site should be cultipacked following harrowing.
7. Mulch - The site should be mulched following using an approved mulching method.

### *Method 4. Interseeding Into Existing Vegetation or Mulch*

This method is generally used for sites that did not establish well or if a temporary mulch was applied to the site. An interseeder drill can be used to plant the seed without removing or tilling the existing vegetation or mulch.

1. Site Preparation for Existing Vegetation- The site should be prepared by mowing existing vegetation to a height of 4-6 inches. The area can then be directly planted using an interseeding drill.

   NOTE: Sites that contain significant weed infestations may require weed control measures before planting.

2. Fertilizer – Apply a fertilizer if warranted to match soil needs after analysis through a soil test.
3. Seed Installation - The seed mixture should be installed with a seed drill that will accurately meter the seed to be planted and keep all seeds uniformly mixed during the drilling. The drill should contain a legume box for small seeds, and it should be equipped with disc furrow openers and packer assembly to compact the soil directly over the drill rows. Maximum row spacing should be 8 inches. The inter-seeder drill must be out-fitted with trash rippers that will slice through the vegetative mat and make a furrow into the underlying soil approximately 1 inch wide by 1/2 to 1 inch deep. These furrows shall be directly in line with the drill seed disc openers. Fine seed should be drop-seeded onto the ground surface from the fine seed box drill seeding should be done whenever possible at a right angle to surface drainage.
4. Seeding Rates - Rates are specified in Section 713.01 of the project specific Special Contract Requirements (SCR's) along with the mixture tabulation for the specified mix.
5. Harrowing - Harrowing is not required when using this seeding method.
6. Packing - Cultipacking the site is recommended to ensure seed-to-soil contact.
7. Mulch - Mulch is not required when using this seeding method unless a 90% soil coverage rate is not maintained.

## Appropriate Applications

Seeding is well-suited in areas where permanent, long-lived vegetative cover is the most practical or most effective method of stabilizing the soil. Use temporary seeding on roughly graded areas where operations are suspended and that vegetation will establish. Vegetation controls erosion by protecting bare soil surfaces from displacement by raindrop impacts and by reducing the velocity and quantity of overland flow. Seeding's advantages over other means of establishing plants include lower initial costs and labor needs. Soil stabilization during or after the construction phase applies to the following site conditions:

- Graded/cleared areas without on-going construction activity;
- Open space and fill areas;
- Steep slopes;
- Spoil piles or temporary stockpile of fill material;
- Vegetated swales;
- Landscape corridors; and
- Stream banks.

## Limitations

Requirements for each seeding/planting application shall be considered and include:

- Type of vegetation;
- Site and seedbed preparation;
- Seasonal planting times;
- Fertilization; and
- Water.

The effectiveness of seeding can be limited by:

- high erosion during establishment,
- the need to reseed areas that fail to establish,
- limited seeding times, or
- unstable soil temperature and soil moisture content during germination and early growth.

Seeding does not immediately stabilize soils; therefore, use temporary erosion and sediment control measures to prevent pollutants from disturbed areas from being transported off the site. Below are limitations and implementation requirements for vegetation classes:

### *Grasses*

- Ground preparation may require fertilization and mechanical stabilization of the soil.
- Short-term temperature extremes and waterlogged soil conditions tolerable.
- Appropriate soil conditions include a shallow soil base, good drainage, and 2:1 or flatter slope.
- Quickly develops from seeds.
- Vigorous grass growth dependent on mowing, irrigating, and fertilizing.

### *Trees and Shrubs*

- Selection dependent on vigor, species, size, shape, and potential wildlife food source.
- Consider wind/exposure and irrigation requirements.
- Use indigenous species where possible.

### *Vines and Ground Cover*

- Lime and fertilizer required for ground preparation.
- Use appropriate seeding rates.
- Consider requirements for drainage, acidity, and ground slope.
- Use indigenous species where possible.
- Avoid species which require irrigation.

## Standards and Specifications

Seed or plant permanent vegetation in areas 1 to 4 months after the final grade is achieved unless temporary stabilization measures are in place. Maximize successful plant establishment with planning; considering soil characteristics; selecting plant materials that are suitable for the site; preparing, liming, and fertilizing the seedbed adequately; planting timely; and maintaining regularly. Major factors that dictate the suitability of plants for a site include climate, soils, and topography. Prepare and amend the soil on a disturbed site to provide sufficient nutrients for seed germination and seedling growth. Loosen the soil surface enough for water infiltration and root penetration. If soils are too acidic, increase the pH to between 6.0 and 6.5 with liming or choose plants that are appropriate for the soil characteristics at your site. Protect seeds with mulch to retain moisture, regulate soil temperatures, and prevent erosion during seedling establishment.

## Inspection and Maintenance

Maintenance for seeded areas will vary depending on the level of use expected. Use long-lived grass perennials that form a tight sod and are fine-leaved for areas that receive extensive use, such as homes, industrial parks, schools, churches, and recreational areas. Whenever possible, choose native species that are adapted to local weather and soil conditions to reduce water and fertilizer inputs and lower maintenance overall. In arid areas, consider seeding with non-grass species that are adapted to drought conditions, called xeriscaping, to reduce the need for watering.

Low-maintenance areas are mowed infrequently or not at all and do not receive lime or fertilizer regularly. Plants must be able to persist with minimal maintenance over long periods of time. Use grass and legume mixtures for these sites because legumes fix nitrogen from the atmosphere. Sites suitable for low-maintenance vegetation include steep slopes, stream or channel banks, some commercial properties, and "utility" turf areas such as road banks.

Grasses should emerge within 4-28 days and legumes 5-28 days after seeding, with legumes following grasses. A successful stand has the following characteristics:

- Vigorous dark green or bluish green (not yellow) seedlings
- Uniform density, with nurse plants, legumes, and grasses well intermixed
- Green leaves that remain green throughout the summer--at least at the plant bases

Inspect seeded areas for failure and, if needed, reseed and repair them as soon as possible. If a stand has inadequate cover, reevaluate the choice of plant materials and quantities of lime and fertilizer. Depending on the condition of the stand, repair by over-seeding or reseeding after complete seedbed preparation. If timing is bad, over-seed with rye grain or German millet to thicken the stand until a suitable time for seeding perennials. Consider seeding temporary, annual species if the season is not appropriate for permanent seeding. If vegetation fails to grow, test the soil to determine if low pH or nutrient imbalances are responsible.

On a typical disturbed site, full plant establishment usually requires re-fertilization in the second growing season. Use soil tests to determine if more fertilizer needs to be added. Do not fertilize cool season grasses in late May through July. Grass that looks yellow might be nitrogen deficient. Do not use nitrogen fertilizer if the stand contains more than 20 percent legumes.

### Typical Details

None specified to date for this manual.

### Conditions for Removal

Seeding is a permanent stabilization measure and will remain in place.

# 4.7.4 Chemical Stabilization with Soil Binders

## Definition and Purpose

Chemical stabilizers, also known as soil binders or soil palliatives, provide temporary soil stabilization. Compounds are sprayed onto the surface of exposed soils to hold the soil in place and minimize erosion from runoff and wind. These materials are easily applied to the surface of the soil, can stabilize areas where vegetation cannot be established, and provide immediate protection. Soil binders are adhesives that stabilize soil by binding soil particles together. This will protect disturbed soil from erosion by raindrop impact or wind. Soil binders can also be used in combination with hydraulic mulches to improve their erosion control effectiveness.

There are five types of soil binders:

- Plant Material-Based (Short-Term);
- Plant Material-Based (Long-Term);
- Polymeric Emulsion Blends;
- Petroleum or Resin-Based Emulsions; and
- Cementitious-Based Binders.

## Type: Plant-Material Based (Short-Term)

### *Guar*

Guar is a non-toxic, biodegradable, natural galactomannan-based hydrocolloid treated with dispersant agents for easy field mixing. It should be applied at the rate of 2.6 lbs to 4 lbs per 264 gallons of water, depending on application machine capacity. Recommended minimum application rates are as follows:

**Application Rates for Guar Soil Stabilizer**

| | | | | | |
|---|---|---|---|---|---|
| Slope (V:H): | Flat | 1:4 | 1:3 | 1:2 | 1:1 |
| lbs/ha: | 100 | 110 | 123 | 147 | 171 |

### *Psyllium*

Psyllium is composed of the finely ground muciloid coating of plantago seeds that is applied as a dry powder or in a wet slurry to the surface of the soil. It dries to form a firm but re-wettable membrane that binds soil particles together but permits germination and growth of seed. Psyllium requires 12 to 18 hours drying time. Application rates are generally 200 to 500 lbs/ha, with enough water in solution to allow for a uniform slurry flow.

### *Starch*

Starch is non-ionic, cold-water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 374 lbs/ha. Approximate drying time is 9 to 12 hours.

## Type: Plant-Material Based (Long-Term)

### *Pitch and Rosin Emulsion*

Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin should be a minimum of 26% of the total solids content. The soil stabilizer should be non-corrosive, water-dilutable emulsion that upon application cures to a water insoluble binding and cementing agent. For soil erosion control applications, the emulsion is diluted as follows:

- For clayey soil: 5 parts water to 1 part emulsion
- For sandy soil:10 parts water to 1 part emulsion

Application can be by water truck or hydraulic seeder with the emulsion/product mixture applied at the rate specified by the manufacturer.

## Type: Polymeric Emulsion Blends

### *Acrylic Copolymers and Polymers*

Polymeric soil stabilizers should consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound should be handled and mixed in a manner that will not cause foaming or should contain an anti-foaming agent. The polymeric emulsion should have a minimum shelf life of one year. Polymeric soil stabilizer should be readily miscible in water, non-injurious to seed or animal life, non-flammable, should provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and should not re-emulsify when cured. The applied compound should air cure within a maximum of 36 to 48 hours. Liquid copolymer should be diluted at a rate of 10 parts water to 1 part polymer and applied to soil at a rate of 2,905 gallons/hectare.

### *Liquid Polymers of Methacrylates and Acrylates*

This material consists of a tackifier/sealer that is a liquid polymer of methacrylates and acrylates. It is an aqueous 100% acrylic emulsion blend of 40% solids by volume that is free from styrene, acetate, vinyl, ethoxylated surfactants or silicates. For soil stabilization applications, it is diluted with water and applied with a hydraulic seeder at the rate of 50 gallons per hectare. Drying time is 12 to 18 hours after application.

### *Copolymers of Sodium Acrylates and Acrylamides*

These materials are non-toxic, dry powders that are copolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient:

| Slope Gradient (V:H) | lbs/ha |
|---|---|
| Flat to 1:5 | 7.5 to 12.4 |
| 1:5 to 1:3 | 12.4 – 24.7 |
| 1:2 to 1:1 | 24.7 – 49.4 |

### *Poly-Acrylamide and Copolymer of Acrylamide*

Linear copolymer poly-acrylamide is packaged as a dry-flowable solid. When used as a stand-alone stabilizer, it is diluted at a rate of 2.64 lbs/264 gallons of water and applied at the rate of 12.34 lbs/ha.

### *Hydro-Colloid Polymers*

Hydro-colloid polymers are various combinations of dry-flowable poly-acrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 132 to 154 lbs/ha. Drying times are 0 to 4 hours.

## Type: Petroleum or Resin-Based Emulsions

### *Emulsified Petroleum Resin*

This material is a concentrated petroleum hydrocarbon emulsion that is mixed with water and applied to the soil surface at a rate of 6,075 gallons per hectare. Dilution rates vary with the type of soil and other site conditions, and should be provided by the manufacturer. They typically range from 12:1 to 20:1 parts water to emulsion.

## Type: Cementitious-Based Binders

### *Gypsum*

This is a formulated gypsum-based product that readily mixes with water and mulch to form a thin protective crust on the soil surface. It is composed of high purity gypsum that is ground, calcined and processed into calcium sulfate hemihydrate with a minimum purity of 86 percent. It is mixed in a hydraulic seeder and applied at rates 9,920 to 29,762 lbs/ha. Drying time is 4 to 8 hours.

## Appropriate Applications

- Use chemical stabilizers alone in areas where other methods of stabilization are not effective because of environmental constraints, or use them in combination with vegetative or perimeter practices to enhance erosion and sediment control.

## Limitations

- Chemical stabilizers, if improperly applied, can create impervious surfaces where water cannot infiltrate and could increase stormwater runoff. In addition, chemical stabilization is usually more expensive than vegetative practices.

## Standards and Specifications

- Closely follow the manufacturer's recommended application procedures to prevent the products from pooling and creating impervious areas where stormwater cannot infiltrate.

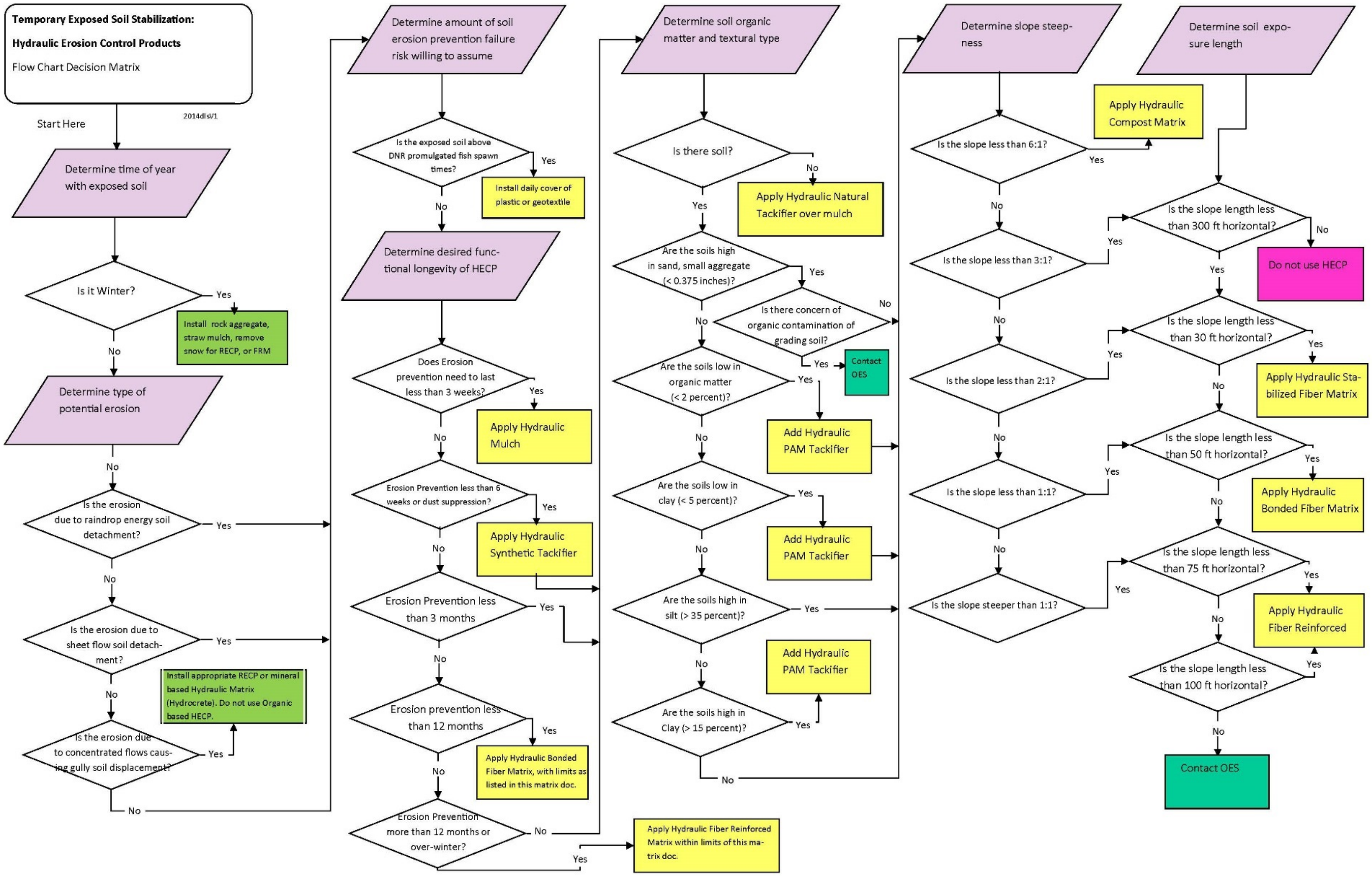
## Inspection and Maintenance

- Inspect chemically stabilized areas regularly for signs of erosion, and if necessary, reapply the stabilizer.

## Typical Details

None specified to date for this manual.

## Selection Matrix



# 4.7.5 Temporary Cover, Geotextiles, Mats/Plastic Covers and Rolled Erosion Control Products

## Definition and Purpose

This BMP involves the placement of geotextiles, plastic covers, or erosion control blankets/mats to stabilize DSAs and protect soil from erosion by wind or water. These measures are typically used when DSAs are particularly difficult to stabilize, around Environmentally Sensitive Areas (ESAs), and as a temporary quick stopgap measure.

Geotextiles are porous fabrics also known as filter fabrics, road rugs, synthetic fabrics, construction fabrics, or simply fabrics. Geotextiles are manufactured by weaving or bonding fibers that are often made of synthetic materials such as polypropylene, polyester, polyethylene, nylon, polyvinyl chloride, glass, and various mixtures of these materials. As a synthetic construction material, geotextiles are used for a variety of purposes such as separators, reinforcement, filtration and drainage, and erosion control. Some geotextiles are made of biodegradable materials such as mulch matting and netting. Mulch mattings are jute or other wood fibers that have been formed into sheets and are more stable than normal mulch. Netting is typically made from jute, wood fiber, plastic, paper, or cotton and can be used to hold the mulching and matting to the ground. Netting can also be used alone to stabilize soils while the plants are growing; however, it does not retain moisture or temperature well. Mulch binders (either asphalt or synthetic) are sometimes used instead of netting to hold loose mulches together. Geotextiles can aid in plant growth by holding seeds, fertilizers, and topsoil in place. Fabrics come in a wide variety to match the specific needs of the site and are relatively inexpensive for certain applications. Soil stabilization BMP types included within this category are summarized below.

## Type: Biodegradable Rolled Erosion Control Products

Biodegradable Rolled Erosion Control Products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. For an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that hold the biodegradable mulch fibers together must also be biodegradable.

### *Jute Mesh*

Jute is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

### *Curled Wood Fiber*

Excelsior (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80% of the fiber 6 in (150 mm) or longer. The excelsior blanket should be of consistent thickness. The wood fiber should be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and shall be non-toxic and non-injurious to plant and animal life. Excelsior blanket should be furnished in rolled strips, a minimum of 48 inches (1,220 mm) wide, and should have an average weight of 0.7 to 1 pound per square yard (lb/yd$^2$) +/-10 percent depending on longevity needed, at the time of manufacture. Excelsior blankets should be secured in place with wire staples. Staples should be made of 0.12 in (3.05-mm ) steel wire and should be U-shaped with 8 inch legs and 2 in crown or larger.

### Straw

Straw blanket should be machine-produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket.

The straw blanket should be furnished in rolled strips a minimum of 6 ft (2 m) wide, a minimum of 82 ft (25 m) long and a minimum of (0.27 kg/m2). Straw blankets should be secured in place with wire staples.

### Wood Fiber

Wood fiber blanket is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance revegetation. The material is furnished in rolled strips, which should be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

### Coconut Fiber

The coconut fiber blanket should be machine-produced mats of 100% coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. The coconut fiber blanket should be furnished in rolled strips with a minimum of 6 ft (2 m) wide, a minimum of 82 Ft (25 m) long and a minimum of 0.59 lbs/3 foot. Coconut fiber blankets should be secured in place with wire staples.

### Coconut Fiber Mesh

Coconut fiber mesh is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which should be secured to the soil with U- shaped staples or stakes in accordance with manufacturers' recommendations.

### Straw Coconut Fiber

The straw coconut fiber blanket should be machine-produced mats of 70% straw and 30% coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. The straw coconut fiber blanket should be furnished in rolled strips a minimum of 6 ft wide (2 m), and a minimum of 80 ft (25m) long. Straw coconut fiber blankets should be secured in place with wire staples.

## Type: Non-Biodegradable Rolled Erosion Control Products

Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

### *Plastic Netting*

Plastic netting is a lightweight bi-axially-oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

### *Plastic Mesh*

Plastic mesh is an open-weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than 0.2 in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

### *Synthetic Fiber with Netting*

Synthetic fiber with netting is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three-dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

### *Bonded Synthetic Fibers*

This type of product consists of a three-dimensional, geomatrix nylon (or other synthetic) matting. Typically it has more than 90% open area, which facilitates root growth. It's tough root-reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

### *Combination Synthetic and Biodegradable*

Combination synthetic and biodegradable RECPs consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high-strength continuous-filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

### *Rolled Plastic Sheeting*

Plastic sheeting should have a minimum thickness of 0.24 in (6 mm), and should be firmly held in place with sandbags or other weights placed no more than 3 m (9.8 ft) apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in (300 mm) to 24 in (600 mm) overlap of all seams. Edges should be embedded a minimum of 6 in (150 mm) in native soil.

All sheeting should be inspected periodically after installation and after significant rainstorms to check for erosion and undermining. Any failures shall be repaired immediately. If washout or breakages occurs, the material should be re-installed after repairing the damage to the slope.

### *Geotextile (Woven)*

Woven geotextile material should be a woven polypropylene fabric with a minimum thickness of 0.6 in (15 mm), a minimum of 12 ft (3.7 m) wide and should have a minimum tensile strength of 0.67 KN (warp) 0.36 KN (fill) in conformance with the requirements in American Society of Testing and Materials (ASTM) Designation: D 4632. The permittivity of the fabric shall be approximately 0.07 sec –1 in conformance with the requirements in ASTM Designation: D 4491. The fabric should have an ultraviolet (UV) stability of 70% in conformance with the requirements in ASTM designation: D 4355. Geotextile blankets should be secured in place with wire staples or sandbags and by keying into tops of slopes and edges to prevent infiltration of surface waters under geotextile. Staples should be made of 0.12 in (3.05-mm) steel wire and shall be U-shaped with 200-mm (7.9 in) legs and 50-mm (2 in) crown.

### *Geotextile (Non-Woven)*

Non-woven geotextile shall be manufactured from polyester, nylon, or polypropylene material, or any combination thereof. The fabric shall be permeable, non-woven, shall not act as a wicking agent. The fabric shall weigh a minimum of 135 grams per square meter (per ASTM Designation: D 3776), have a minimum grab tensile strength of 0.22 KN in each direction (per ASTM Designation: D 4632), have a minimum elongation at break of 10% (per ASTM Designation: D 4632), have a minimum toughness of 13 KN (percent elongation x grab tensile strength), and a minimum permittivity of 0.5 sec-1 (per ASTM Designation: D 4491).

## 4.7.5.1 Appropriate Applications

These measures can be used in various ways for erosion control on construction sites. They are usually employed when disturbed soils may be particularly difficult to stabilize including the following situations:

- Steep slopes, generally steeper than 3:1 (H:V).
- Slopes where the erosion potential is high.
- Slopes and disturbed soils where mulch must be anchored.
- Disturbed areas where plants are slow to develop.
- Channels with flows exceeding 3 ft/s.
- Channels to be vegetated.
- Slopes adjacent to receiving waters or Environmentally Sensitive Areas.
- Geotextiles can be used to protect exposed soils immediately and temporarily, such as when active piles of soil are left overnight.
- They can also be used as a separator between riprap and soil, which prevents the soil from being eroded from beneath the riprap and maintains the riprap's base.

## 4.7.5.2 Limitations

- Geotextiles (primarily synthetic types) have the potential disadvantage of disintegrating when exposed to light. Consider this before installing them.

- Some geotextiles might increase runoff or blow away if not firmly anchored.
- Depending on the type of material used, geotextiles might need to be disposed of in a landfill, making them less desirable than vegetative stabilization. If the geotextile fabric is not properly selected, designed, or installed, its effectiveness may be reduced drastically.
- Blankets and mats are typically more expensive than other erosion control measures, due to labor and material costs. This usually limits their application to areas inaccessible to hydraulic equipment, or where other measures are not applicable, such as channels.
- May delay seed germination due to reduction in soil temperature.
- Plastic netting should not be used when regulatory permits prohibit their use or if there is a potential for plastic netting to endanger wildlife.
- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Blankets and mats should be removed and disposed of prior to application of permanent soil stabilization measures as required by the contract plans. Long-term erosion control blankets must be Class 8 Rock Slope Protection fabric.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill and requires extensive inspection and maintenance.
- Plastic results in 100 percent runoff, which may cause serious erosion problems in the downstream areas receiving the increased flow.
- The use of plastic should be limited to covering stockpiles, or very small graded areas for short periods of time (such as through one imminent storm event), until alternative measures, such as seeding and mulching, can be installed.
- Geosynthetics, mats, plastic covers, and RECPs have maximum flow rate limitations; consult the manufacturer for proper selection.

## Standards and Specifications

There are many types of temporary cover, geotextiles, and RECPs available; therefore, the selected fabric should match its purpose. To ensure the effective use of geotextiles, keep firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil, and erosion will occur underneath the material. Selection of the appropriate type is based on the specific type of application and site conditions. Selection(s) made by the Contractor must be approved by the CO.

### *Temporary Cover - Geosynthetics*

- Material shall be a woven polypropylene fabric with minimum thickness of 0.06 inch, minimum width of 12 feet and meet all requirements of contract specifications. Material shall have a minimum tensile strength of 150 lb (warp) and 80 lbs (fill) in conformance with the requirements in ASTM Designation: D 4632. The permittivity of the fabric must be approximately 0.07 sec –1 in conformance with the requirements in ASTM Designation: D4491. The fabric must have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets should be secured in place with wire staples or sandbags and by keying into tops of slopes and edges to prevent infiltration of surface water. Staples should be made of minimum 16 gauge steel wire and be U-shaped with 8-inch legs and 2-inch crown.

- Geotextiles may be reused if, in the opinion of the PE, they are suitable for the use intended.
- Submit a certificate of compliance for each type of geosynthetic material used.

### *Temporary Cover – Plastic Sheeting*

- Plastic sheeting shall comply with Standard Specification Section 13-5 and 96-1 which requires a minimum thickness of 0.39 inches, and be keyed in at the top of slope and firmly held in place with gravel-filled bags placed no more than 6 feet apart or other weights authorized by the PE. Seams are typically taped or weighted down their entire length, and there should be at least 12 to 24 inches overlap of all seams. Edges must be embedded a minimum of 6 inches in soil.
- All sheeting must be inspected periodically after installation and after rain events to check for erosion, undermining, and anchorage failure. Any failures must be repaired immediately. If washout or breakages occurs, the material should be re-installed after repairing the damage to the slope or area.

### *Rolled Erosion Control Products*

- RECPs are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. For an RECP to be considered 100 percent biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable.
    - Jute mesh is made from a natural fiber that is spun into a yarn, then loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips that are secured to the soil with steel U-shaped staples.
    - Erosion control blanket is a machine-produced mat made of processed natural fibers that are bound together to form a continuous matrix surrounded by two natural nets. The processed natural fibers comprising the matrix of the blanket may be a mixture of straw (70 percent) and coconut (30 percent), woven coir (100 percent), or excelsior (curled wood fiber) (80 percent). Erosion control blankets must be furnished in rolled strips a minimum of 72 inches wide, and secured in place with steel U-shaped staples. Erosion control blankets must also comply with Section 629 and 713.17 of the FP 14.
    - Netting consists of pure coconut fibers, or coir, woven into a matrix. Coir netting must be furnished in rolled strips a minimum of 72 to 158 inches in width and 0.3 inches thick. There are three classes of coir netting: Type A, Type B, and Type C. for the minimum requirements for each type of netting.
- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well. Check contract SCRs to determine whether non-

biodegradable products cannot be used based on regulatory or land management agency requirements.

- Turf reinforcement mat is a nondegradable, open-weave textile made of synthetic fibers, filaments, nets, wire mesh, or other elements processed into a permanent three-dimensional matrix. Turf reinforcement mats must be a minimum of 72 inches in width and 0.25 inches thick. There are three classes of turf reinforcement mat: Type A, Type B, and Type C. See FP-14 Section 713.18 for the minimum requirements for each type of product.
- Plastic netting is a lightweight biaxially-oriented netting designed for securing loose mulches like straw to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Plastic mesh is an open-weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than 0.25 inch. It is used with revegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Synthetic fiber with netting is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three-dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be revegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Bonded synthetic fibers consist of a three-dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. Its tough root-reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Combination synthetic and biodegradable RECPs consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high-strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance revegetation. The material is furnished in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

### *Site Preparation*

- Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil.
- Grade and shape the area of installation.

- Remove all rocks, clods, vegetation or other obstructions larger than 1 inch in size. Fill voids or depressions.
- Proper site preparation ensures that the products and covers will have complete, direct contact with the soil.

### Seeding

- If applicable, seed the area before RECP installation for erosion control and revegetation.
- Check all slots and other areas disturbed during installation must be reseeded.
- For turf reinforcement mats, seeding is often specified to occur after installation.

### Anchoring

- U-shaped wire staples, metal stake pins, triangular wooden stakes, or fasteners recommended by manufacturers can be used to anchor mats and blankets to the ground surface in conformance with RECP manufacturer recommendations or contract specifications.
- Staples should be made of minimum 16 gauge steel wire and be U-shaped with 8-inch legs and 2-inch crown.
- Metal stake pins should be 0.188 inch diameter steel with a 1.5 inch steel washer at the head of the pin, and 8 inch in length.
- Wire staples and metal stakes should be driven flush to the soil surface.
- All anchors should be have sufficient ground penetration to resist pullout. Longer anchors may be required for loose soils.

### Installation on Slopes

- Refer to typical details below and manufacturers recommendations for installation.

### Installation in Channels

- Typical details below for installation in channels.
- Installation shall be in accordance with the manufacturer's recommendations. In general, these will be as follows:
  - Dig initial anchor trench 12 in deep and 6 in wide across the channel at the lower end of the project area.
  - Excavate intermittent check slots, 6 in deep and 6 in wide across the channel at 25 ft to 30 ft intervals along the channels.
  - Cut longitudinal channel anchor slots 4 in deep and 4 in wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 in to 3 in above the crest of the channel side slopes.
  - Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in intervals. Note: matting will initially be upside down in anchor trench.
  - In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in.

- Secure these initial ends of mats with anchors at 12 in intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in overlap.
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations: Place two rows of anchors on 6 in centers at 25 ft to 30 ft intervals in lieu of excavated check slots.
- Shingle-lap spliced ends by a minimum of 12 in apart on 12 in intervals.
- Place edges of outside mats in previously excavated longitudinal slots, anchor using prescribed staple pattern, backfill and compact soil.
- Anchor, fill and compact upstream end of mat in a 12 in by 6 in terminal trench.
- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

#### *Soil Filling (if specified for turf reinforcement)*

- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes or brooms for fine grading and touch up.
- Smooth out soil filling, just exposing top netting of mat.

#### *Temporary Soil Stabilization Removal*

- When no longer required for the work, temporary soil stabilization becomes the property of the Contractor.

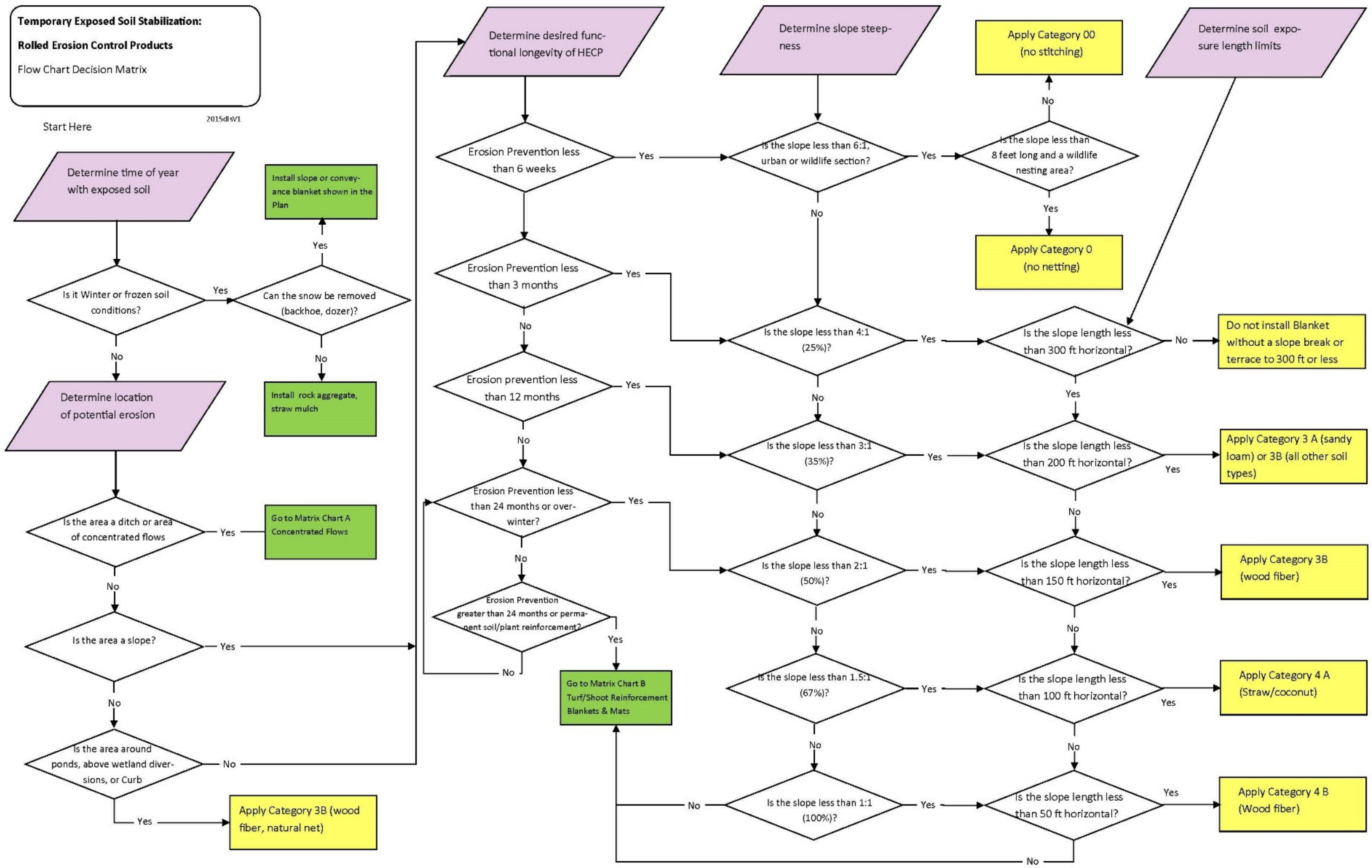
### Inspection and Maintenance

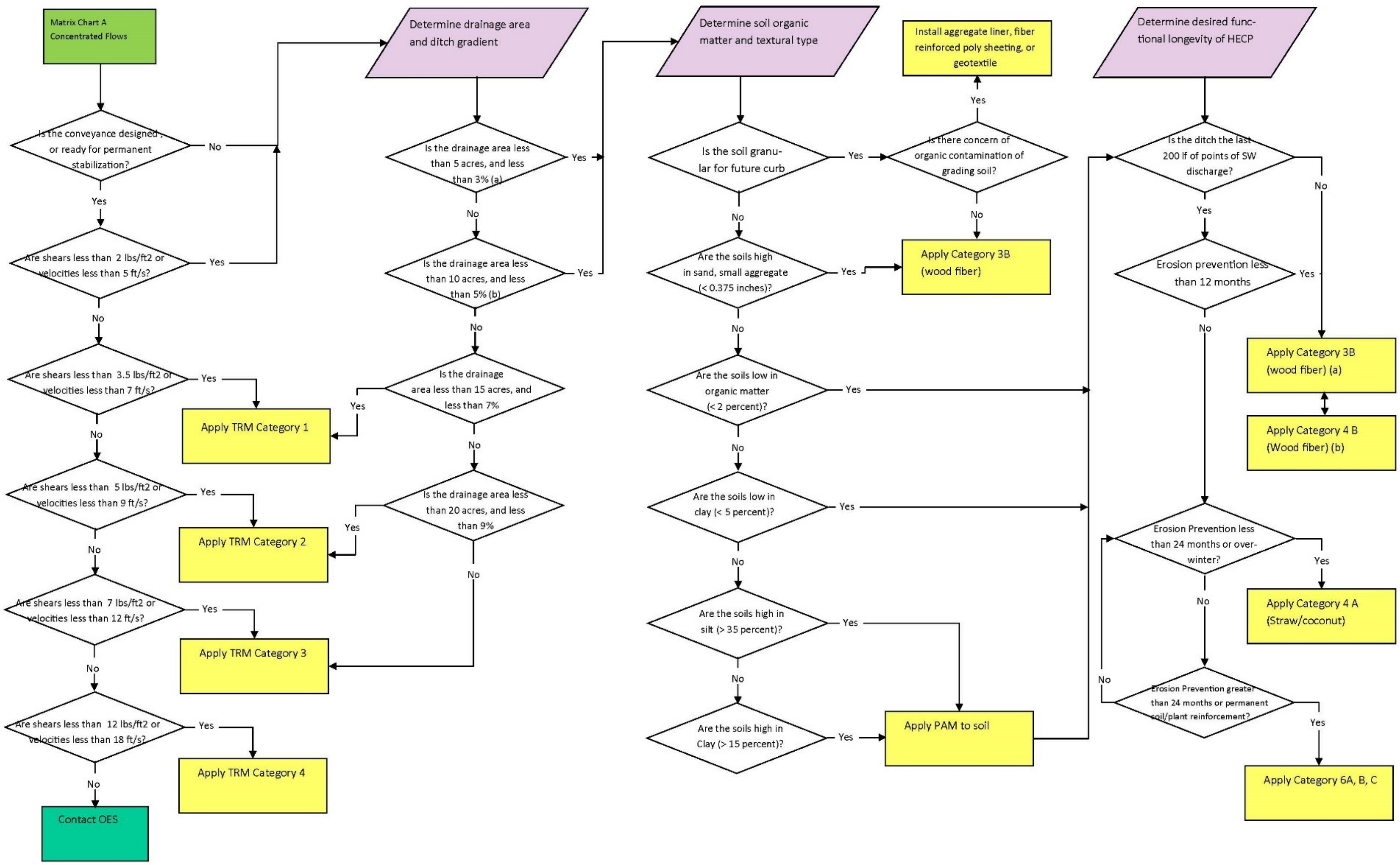
Areas treated with temporary soil stabilization must be inspected as specified in the Standard Specifications and SCRs. Areas treated with temporary soil stabilization must be maintained to provide adequate erosion control. Temporary soil stabilization should be reapplied or replaced on exposed soils when area becomes exposed or exhibits visible erosion.

- All blankets and mats must be inspected periodically after installation to determine if cracks, tears, or breaches have formed in the fabric; if so, repair or replace the fabric immediately. It is necessary to maintain contact between the ground and the geotextile at all times. Remove trapped sediment after each storm event.
- Installation should be inspected after significant rain events to check for erosion and undermining. Any failures must be repaired immediately.

- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.

## Selection Matrix




Matrix Chart A
Concentrated Flows
Is the conveyance designed or ready for permanent stabilization?
No
Yes
Are shears less than 2 lbs/ft2 or velocities less than 5 ft/s?
Yes
No
Are shears less than 3.5 lbs/ft2 or velocities less than 7 ft/s?
Yes
Apply TRM Category 1
No
Are shears less than 5 lbs/ft2 or velocities less than 9 ft/s?
Yes
Apply TRM Category 2
No
Are shears less than 7 lbs/ft2 or velocities less than 12 ft/s?
Yes
Apply TRM Category 3
No
Are shears less than 12 lbs/ft2 or velocities less than 18 ft/s?
Yes
Apply TRM Category 4
No
Contact OES
Determine drainage area and ditch gradient
Is the drainage area less than 5 acres, and less than 3% (a)
Yes
No
Is the drainage area less than 10 acres, and less than 5% (b)
Yes
No
Is the drainage area less than 15 acres, and less than 7%
Yes
No
Is the drainage area less than 20 acres, and less than 9%
Yes
No
Determine soil organic matter and textural type
Is the soil granular for future curb
Yes
Is there concern of organic contamination of grading soil?
Yes
Install aggregate liner, fiber reinforced poly sheeting, or geotextile
No
Apply Category 3B (wood fiber)
No
Are the soils high in sand, small aggregate (< 0.375 inches)?
Yes
No
Are the soils low in organic matter (< 2 percent)?
Yes
No
Are the soils low in clay (< 5 percent)?
Yes
No
Are the soils high in silt (> 35 percent)?
Yes
No
Are the soils high in Clay (> 15 percent)?
Yes
Apply PAM to soil
Determine desired functional longevity of HECP
Is the ditch the last 200 lf of points of SW discharge?
No
Yes
Erosion prevention less than 12 months
Yes
Apply Category 3B (wood fiber) (a)
Apply Category 4 B (Wood fiber) (b)
No
Erosion Prevention less than 24 months or overwinter?
Yes
Apply Category 4 A (Straw/coconut)
No
Erosion Prevention greater than 24 months or permanent soil/plant reinforcement?
Yes
Apply Category 6A, B, C
No

## Typical Details

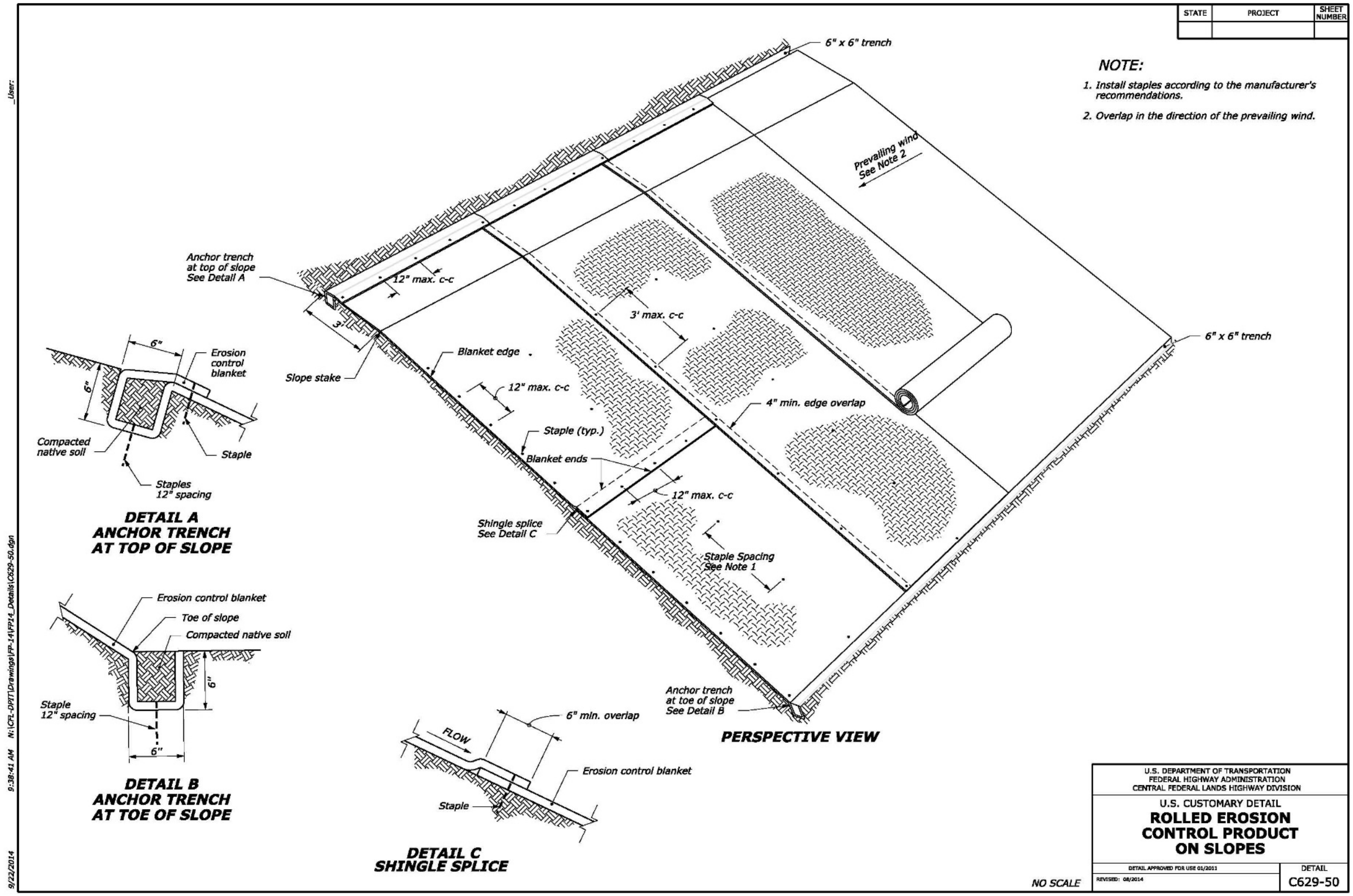



**Figure 34: Rolled Erosion Control Product on Slope Detail**

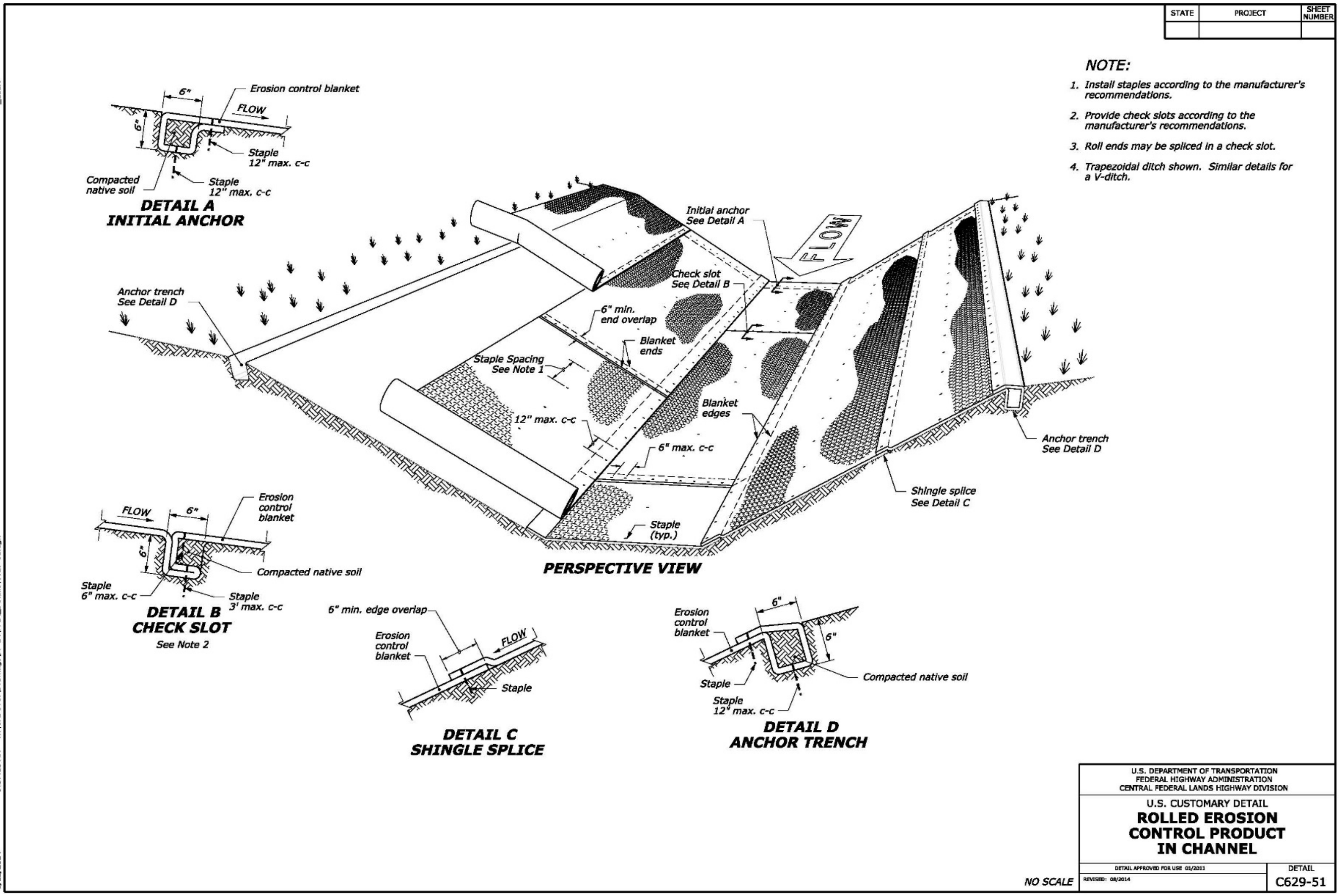



**Figure 35: Rolled Erosion Control Product in Channel Detail**

# 4.7.6 EARTH DIKES/DRAINAGE SWALES AND DITCHES

## Definition and Purpose

These are structures that intercept, divert and convey surface run-on, generally sheet flow, to prevent erosion. The primary function of earth dikes, drainage swales and ditches is to prevent erosion and reduce pollutant loading. They are structures that intercept, divert, and convey surface runoff in a controlled, non-erosive manner. Top, toe, and mid-slope diversion ditches, berms, dikes, and swales should be used to intercept runoff and direct it away from critical slopes without allowing it to reach the roadway.

An earthen perimeter control usually consists of a dike or a combination dike and channel constructed along the perimeter of and within the disturbed part of a site. An earthen perimeter control is a ridge of compacted soil, often accompanied by a ditch or swale with a vegetated lining, at the top or base of a sloping disturbed area. Depending on its location and the topography of the landscape, an earthen perimeter control can achieve one of two goals.

When on the upslope side of a site, earthen perimeter controls help to prevent surface runoff from entering a disturbed construction site. An earthen structure located upslope can improve working conditions on a construction site. It can prevent an increase in the total amount of sheet flow runoff traveling across the disturbed area and thereby lessen erosion on the site.

Earthen perimeter control structures also can be located on the downslope side of a site. They divert sediment-laden runoff created onsite to onsite sediment-trapping devices, preventing soil loss from the disturbed area.

These control practices are called temporary diversion dikes, earth dikes, and interceptor dikes. No matter what they are called, all earthen perimeter controls are constructed in a similar way with a similar objective--to control the velocity or route (or both) of sediment-laden stormwater runoff.

Typically, mid-slope diversion ditches should have a cross-slope of at least 2%, and should be concrete or rock-lined. Top of slope diversions should be paved along cut slopes where the slope length above the cut is greater than 12.2 m (40 ft). Earthen diversion ditches, berms, dikes, and swales channelize flow and should be stabilized with vegetation or other materials to prevent erosion.

Alternatively, drop structures can be placed along the diversion to maintain a grade sufficiently mild to prevent erosive velocities, or a paved chute can be placed down the side of the fill before the accumulated runoff in the diversion is sufficient to cause erosive velocities.

Design guidelines include:

- Select design flow and safety factor based on careful evaluation of the risk due to erosion of the measure, over topping, flow backups, or wash out;
- Examine the site for run-on from off-site sources. These off-site flows should be diverted from the right-of-way;
- Select flow velocity limit of unlined conveyance systems based on soil types and drainage flow patterns for each project site. Establish a maximum flow velocity for using earth dikes and swales, above which a lined ditch must be used. Consider use of rip-rap, engineering fabric, vegetation or concrete lining;

- Consider outlet protection where localized scour is anticipated;
- Consider order of work provisions early in the construction process to effectively install and use the permanent ditches, berms, dikes, and swales; and
- A sediment-trapping device should be used in conjunction with conveyances where sediment-laden water is expected.

## Appropriate Applications

Earth dikes/drainage swales and lined ditches may be used to:

- Convey surface runoff down sloping land.
- Intercept and divert runoff to avoid sheet flow over sloped surfaces.
- Divert and direct runoff towards a stabilized watercourse, drainage pipe or channel.
- Intercept runoff from paved surfaces.

Earth dikes/drainage swales and lined ditches also may be used:

- Below steep grades where runoff begins to concentrate.
- Along roadways and facility improvements subject to flood drainage.
- At the top of slopes to divert run-on from adjacent or undisturbed slopes.
- At bottom and mid-slope locations to intercept sheet flow and convey concentrated flows.

## Limitations

The following limitations may apply:

- Earth dikes/drainage swales and lined ditches are not suitable as sediment trapping devices.
- May be necessary to use other soil stabilization and sediment controls, such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales and ditches.
- Temporary swales and ditches should not or any other runoff diversion device should not adversely impact upstream or downstream properties.

## Standards and Specifications

- There Standard Specification Section 19-6 "Embankment Construction," which covers allowable materials and construction procedures for dikes.
- Standard Specification Section 72-5 "Concrete Slope Protection, Gutter, Ditch and Channel Lining" covers ditch and channel lining materials and construction procedures.
- Care must be applied to correctly size and locate earth dikes, drainage swales and lined ditches. Excessively steep, unlined dikes and swales are subject to erosion and gully formation.
- Must complete a careful evaluation of the risks due to erosion of the selected measure based on flow velocity, soil types, potential for over topping, flow backups, washouts, and drainage patterns for each BMP location.

- Conveyances shall be stabilized. Consider using a lined ditch for high flow velocities to prevent scour. Compact any fills or backfills to prevent unequal settlement.
- Do not divert runoff from the highway right-of-way onto other property.
- When possible, install and utilize permanent dikes, swales and ditches early in the construction process.
- Earthen berms should be 8 inches tall and 36 inches wide at a minimum. Earthen berms must be compacted either by hand or mechanical methods.
- Provide stabilized outlets. Refer to, "Outlet Protection/Velocity/ Dissipation Devices."

## Inspection and Maintenance

- Inspect temporary measures prior to, daily during extended rain events post-storm and weekly year-round.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment.
- Remove debris and sediment, and repair linings and embankments to ensure they function as intended.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

# 4.7.7 Outlet Protection/Velocity Dissipation Devices

### Definition and Purpose

Outlet protection/velocity dissipation devices are rock, riprap, or other materials placed at pipe outlets to reduce flow velocity and the energy of exiting storm water flows and to prevent scour. They are used where localized scouring is anticipated, such as outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels. They are also used where lined channels or ditches discharge to unlined conveyances.

### Appropriate Applications

Appropriate applications include:

- Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels;
- Outlets located at the bottom of mild to steep slopes;
- Discharge outlets that carry continuous flows of water;
- Outlets subject to short, intense flows of water, such as from flash floods; and
- Points where lined conveyances discharge to unlined conveyances.

### Limitations

The following limitations may apply:

- Loose rock may have stones washed away during high flows.
- Grouted rock slope protection may break up in areas of freeze and thaw.
- If there is not adequate drainage, and water builds up behind grouted rock slope protection, it may cause the grouted rock slope protection to break up due to the resulting hydrostatic pressure.
- Outlet protection may negatively impact the channel habitat.

### Standards and Specifications

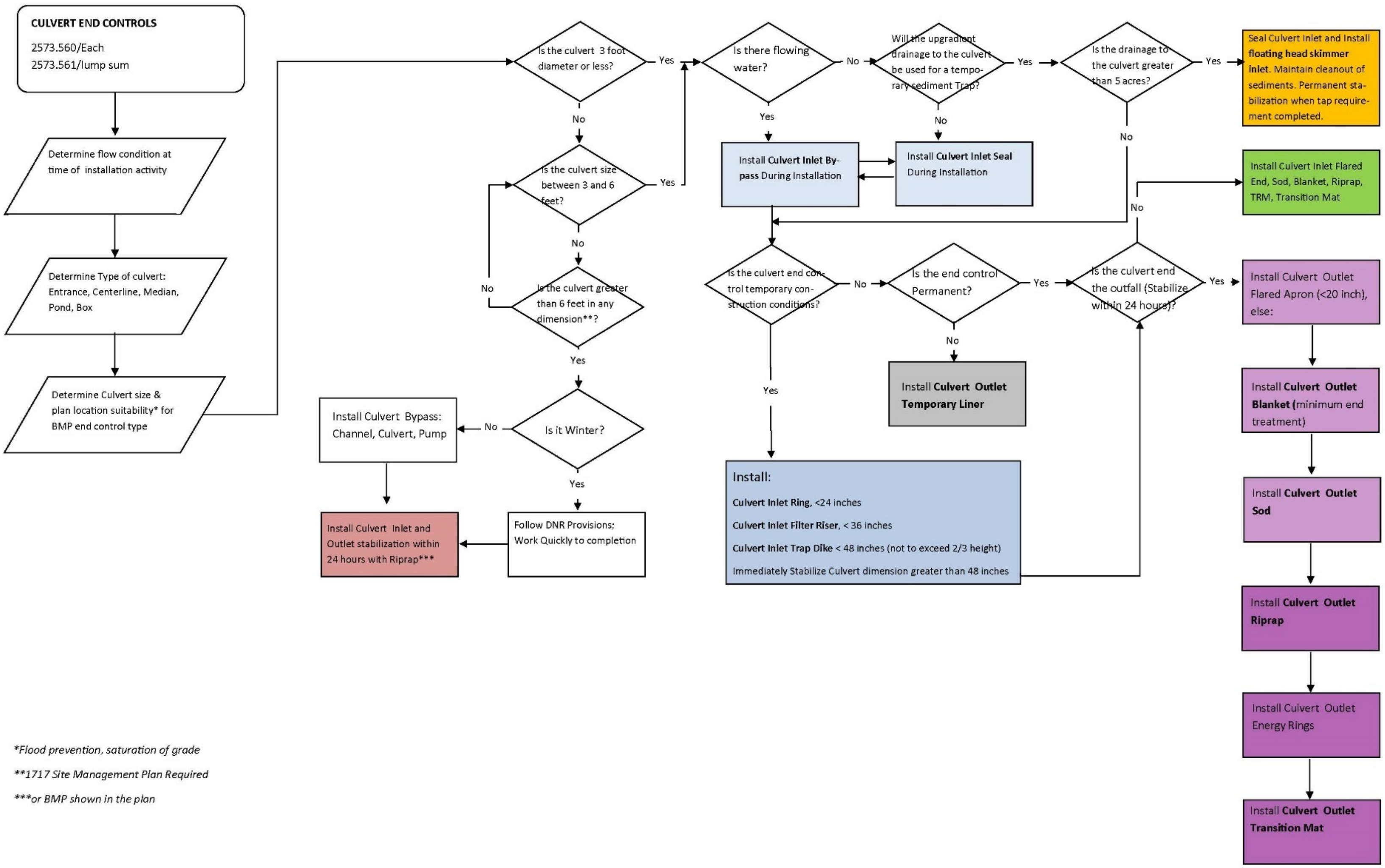
- All slopes shall be rounded with no sharp breaks in plan or profile.
- There are many types of energy dissipaters; a flared end section and rock slope protection is shown in the figure on the previous page. Please note that this is only one example and the PE may approve other types of devices proposed by the contractor.
- Flared end sections must comply with Standard Specification Section 602.
- Rock slope protection must comply with Standard Specification Section 251.
- Install rock slope protection, grouted rock slope protection, or concrete apron at selected outlet. Rock slope protection aprons are best suited for temporary use during construction.
- Carefully place rock slope protection to avoid damaging the filter fabric.

- For proper operation of apron:
  - Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, consider placing it in upper section of apron.
  - If size of apron rock slope protection is large, consider protecting underlying filter fabric with a gravel blanket.
- Outlets on slopes steeper than 10% should have additional protection.

## Inspection and Maintenance

- At a minimum, perform inspections weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Minimize areas of standing water by removing sediment blockages and filling scour depressions. If persistent, it might be necessary to have licensed professional re-evaluate size and type of device implemented.
- Inspect apron for displacement of the rock slope protection and/or damage to the underlying fabric. Repair fabric and replace rock slope protection that has washed away.
- Inspect for scour beneath the rock slope protection and around the outlet. Repair damage to slopes or underlying filter fabric immediately.
- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

## Selection Matrix

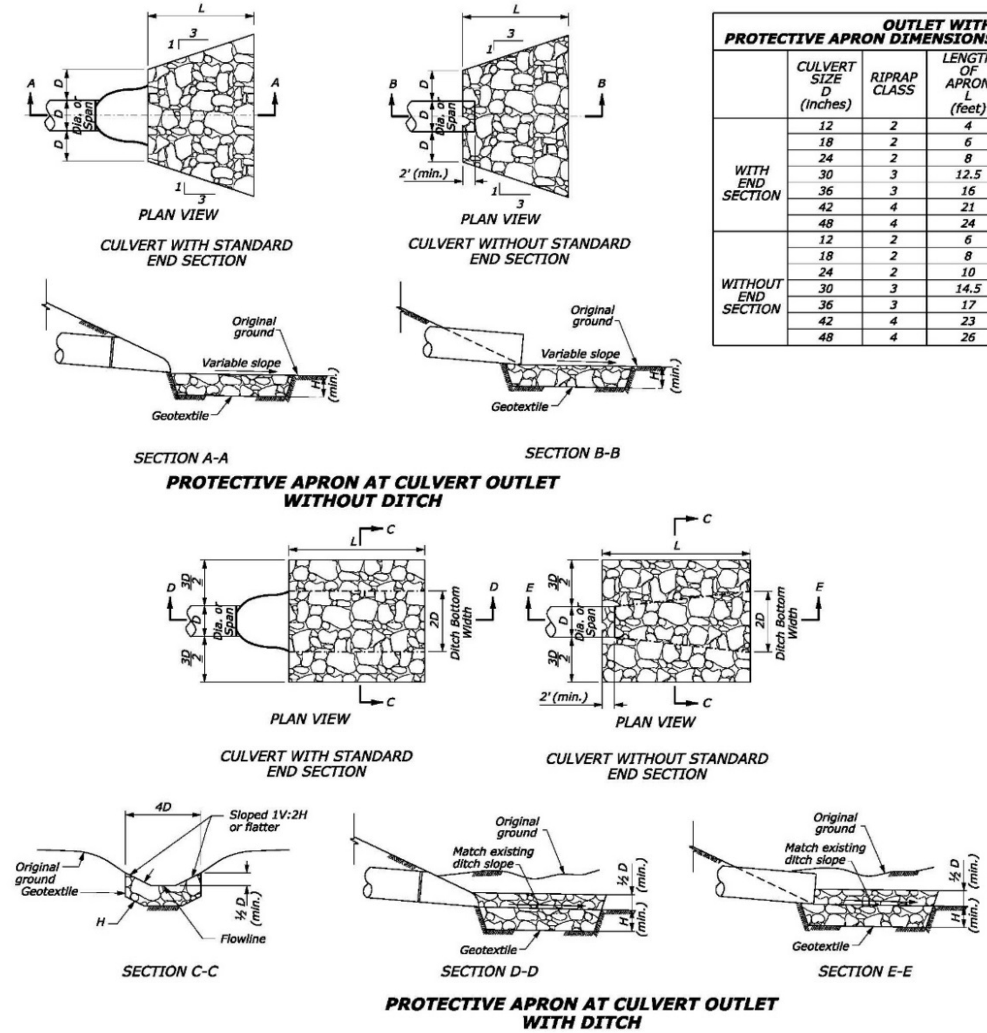



*Flood prevention, saturation of grade

**1717 Site Management Plan Required

***or BMP shown in the plan

## Typical Details




**OUTLET WITHOUT DITCH**
**PROTECTIVE APRON DIMENSIONS AND ESTIMATED QUANTITIES**

| | CULVERT SIZE D (Inches) | RIPRAP CLASS | LENGTH OF APRON L (feet) | DEPTH OF APRON H (feet) | ESTIMATED RIPRAP QUANTITY (CY) | ESTIMATED GEOTEXTILE QUANTITY (SY) |
|---|---|---|---|---|---|---|
| WITH END SECTION | 12 | 2 | 4 | 1.5 | 1 | 5 |
| | 18 | 2 | 6 | 1.5 | 2.2 | 9 |
| | 24 | 2 | 8 | 1.5 | 3.9 | 14 |
| | 30 | 3 | 12.5 | 2 | 10.9 | 28 |
| | 36 | 3 | 16 | 2 | 15.6 | 37 |
| | 42 | 4 | 21 | 2.5 | 34.1 | 63 |
| | 48 | 4 | 24 | 2.5 | 44.5 | 79 |
| WITHOUT END SECTION | 12 | 2 | 6 | 1.5 | 1.7 | 8 |
| | 18 | 2 | 8 | 1.5 | 3.2 | 12 |
| | 24 | 2 | 10 | 1.5 | 5.2 | 17 |
| | 30 | 3 | 14.5 | 2 | 13.3 | 33 |
| | 36 | 3 | 17 | 2 | 18.5 | 43 |
| | 42 | 4 | 23 | 2.5 | 38.7 | 70 |
| | 48 | 4 | 26 | 2.5 | 49.8 | 87 |

**NOTE:**

1. Use for aprons serving culverts with slopes of less than 10%.
2. Furnish geotextile conforming to Subsection 714.01(a).
3. Excavation for placement of riprap will not be measured for payment.

**OUTLET WITH DITCH**
**PROTECTIVE APRON DIMENSIONS AND ESTIMATED QUANTITIES**

| | CULVERT SIZE D (Inches) | RIPRAP CLASS | LENGTH OF APRON L (feet) | DEPTH OF APRON H (feet) | ESTIMATED RIPRAP QUANTITY (CY) | ESTIMATED GEOTEXTILE QUANTITY (SY) |
|---|---|---|---|---|---|---|
| WITH END SECTION | 12 | 2 | 4 | 1.5 | 0.9 | 5 |
| | 18 | 2 | 6 | 1.5 | 2 | 8 |
| | 24 | 2 | 8 | 1.5 | 3.6 | 13 |
| | 30 | 3 | 12.5 | 2 | 9.3 | 24 |
| | 36 | 3 | 15 | 2 | 13.4 | 32 |
| | 42 | 4 | 21 | 2.5 | 27.3 | 53 |
| | 48 | 4 | 24 | 2.5 | 35.6 | 65 |
| WITHOUT END SECTION | 12 | 2 | 6 | 1.5 | 1.4 | 6 |
| | 18 | 2 | 8 | 1.5 | 2.7 | 10 |
| | 24 | 2 | 10 | 1.5 | 4.5 | 15 |
| | 30 | 3 | 14.5 | 2 | 10.8 | 27 |
| | 36 | 3 | 17 | 2 | 15.2 | 36 |
| | 42 | 4 | 23 | 2.5 | 29.9 | 57 |
| | 48 | 4 | 26 | 2.5 | 38.6 | 70 |

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
CENTRAL FEDERAL LANDS HIGHWAY DIVISION

U.S. CUSTOMARY DETAIL

**PLACED RIPRAP AT CULVERT OUTLETS**

DETAIL APPROVED FOR USE
REVISED: 08/2014
DETAIL C251-50

**Figure 36: Outlet Protection Details**

# 4.7.8 SLOPE DRAINS

## Definition and Purpose

A slope drain is a pipe used to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device, or stabilized area. Slope drains are used with lined ditches to intercept and direct surface flow away from slope areas to protect cut or fill slopes.

Slope drains should be sized to convey large, infrequent storms down or around the slope. Design the top and toe of slope diversion ditches/berms/dikes/swales to direct flow into the drain. Provide for outlet protection/velocity dissipation devices at the outlet of the drain, as needed

## Appropriate Applications

- Slope drains may be used on construction sites where slopes may be eroded by surface runoff.
- Drainage for top of slope dikes or swales.
- Drainage for top of cut and fill slopes where water can accumulate.
- Emergency spillway for a sediment basin.

## Limitations

The following limitations may apply:

- Severe erosion may result when slope drains fail by overtopping, piping, or pipe separation.
- Sediment accumulation, scour depressions, and/or persistent non-stormwater discharges in energy dissipaters associated with slope drain outlets can result in suitable areas for vector production.

## Standards and Specifications

- All slopes shall be rounded with no sharp breaks in plan or profile.
- Maximum slope generally limited to 2:1 (H:V), as energy dissipation below steeper slopes is difficult.
- Direct surface runoff to slope drains with interceptor dikes. See BMP “Earth Dikes/Drainage Swales, and Lined Ditches.”
- Slope drains can be placed on or buried underneath the slope surface.
- Recommended materials are plastic or corrugated metal, or comparable pipe.
- When installing slope drains:
    - Install slope drains perpendicular to slope contours.
    - Compact soil around and under entrance, outlet, and along length of pipe.
    - Securely anchor and stabilize pipe and appurtenances into soil.

- Check to ensure that pipe connections are water tight.
- Protect area around inlet with filter cloth. Protect outlet with rock slope protection or other energy dissipation device. For high energy discharges, reinforce rock slope protection with concrete or use reinforced concrete device.
- Protect inlet and outlet of slope drains; use standard flared end section at entrance and exit for pipe slope drains 12 in and larger.

### Inspection and Maintenance

Inspect before, daily during and after each rain event, and weekly during the duration of the construction project. Inspect outlet for erosion and downstream scour.

- If eroded, repair damage and install additional energy dissipation measures. If downstream scour is occurring, it may be necessary to reduce flows being discharged into the channel.
- Inspect slope drainage for accumulations of debris and sediment.
- Remove built-up sediment from entrances, outlets, and within drains as required.
- Make sure stormwater is not ponding onto inappropriate areas (e.g., active traffic lanes, material storage areas, etc.).

## Typical Details

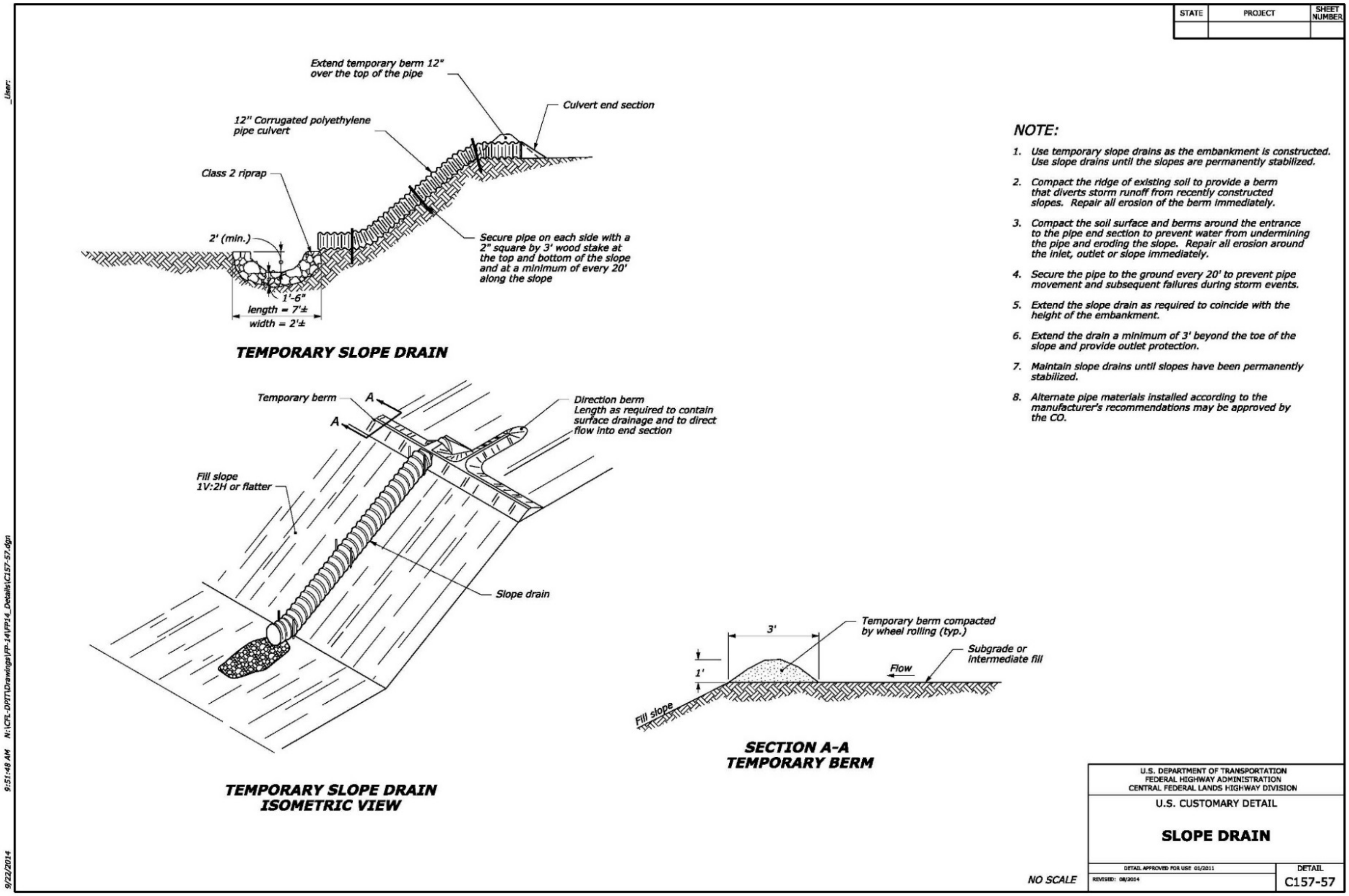



**Figure 37: Slope Drain Detail**

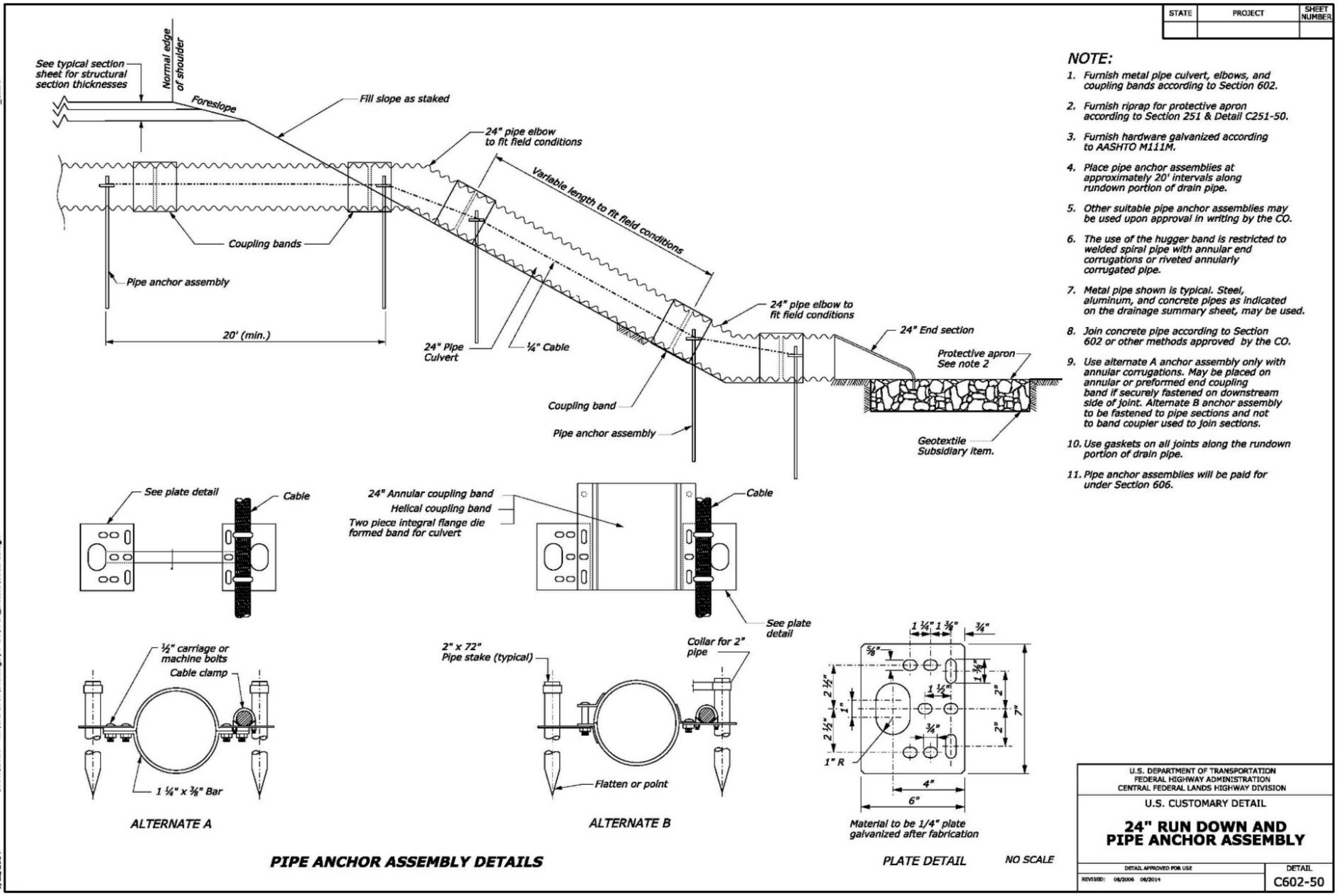



**Figure 38: Slope Drain Detail**

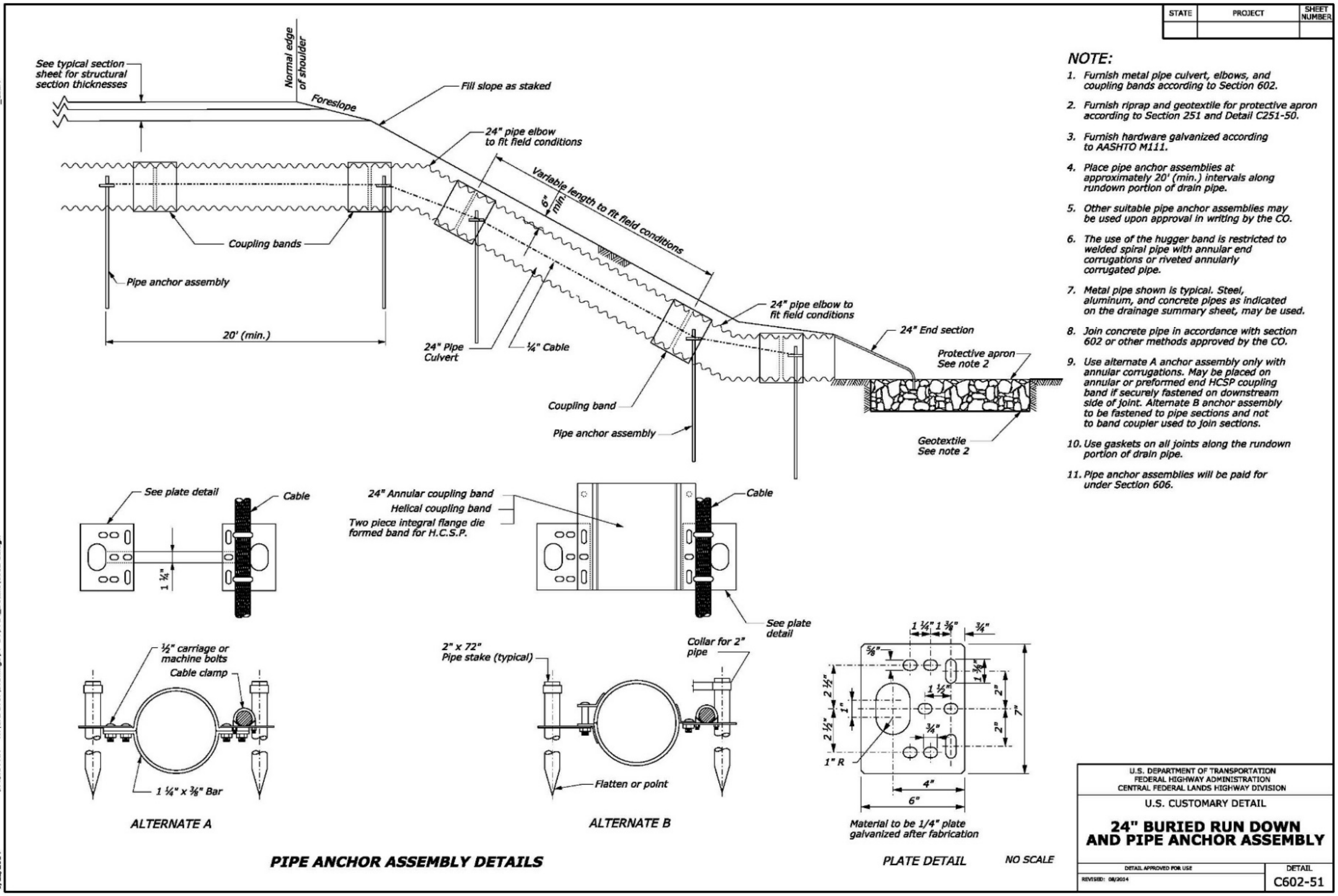



**Figure 39: Buried Slope Drain Detail**

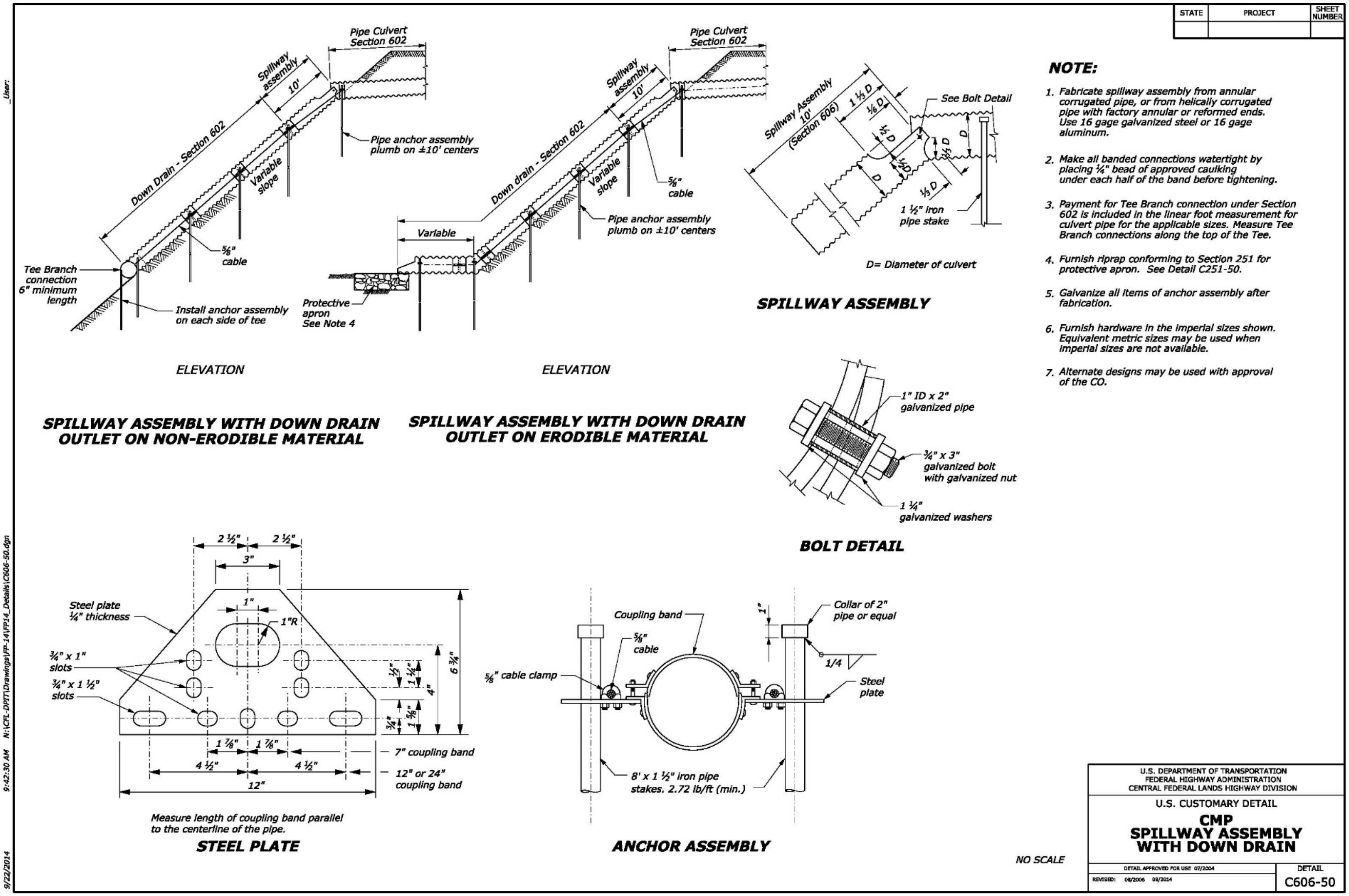



Figure 40: CMP Down Drain Detail

# 4.8 SEDIMENT CONTROL PRACTICES

Temporary sediment control practices include those practices that intercept and slow or detain the flow of stormwater to allow sediment to settle and be trapped. These practices can consist of installing temporary linear sediment barriers (such as silt fences, sandbag barriers, and straw bale barriers); providing fiber rolls, gravel bag berms, or check dams to break up slope length or flow; or constructing a temporary sediment/desilting basin on sediment trap. Linear sediment barriers are typically placed below the toe of exposed and erodible slopes, downslope of exposed soil areas, around temporary stockpiles, and at other appropriate locations along the site perimeter.

Temporary sediment control practices must be implemented in conformance with the criteria presented in Chapter 2 of this Manual. Sediment control is required along the site perimeter at all operational internal inlets and at all times during the rainy season.

Sediment control devices function by:

- Slowing water velocities, thereby allowing soil particles to settle out; and
- Attenuating the flood peak by detaining flow and releasing water at a slower rate.

All sediment control devices require continued maintenance to function properly. Excess sediment not removed reduces capacity and efficiency.

Examples of sediment control practices include:

- Silt Fence
- Sediment / Desilting Basin
- Sediment Trap / Filter Bags
- Check Dam
- Fiber Rolls
- Gravel Bag Berm / Earthen Berm
- Street Sweeping and Vacuuming
- Sand Bag Barrier
- Straw Bale Barrier
- Storm Drain Inlet Protection
- Compost Sock
- Flexible Sediment Barrier

The remainder of this Section describe the working details for each of the temporary sediment control BMPs.

# 4.8.1 SILT FENCE

## Definition and Purpose

A silt fence is a temporary linear sediment barrier of permeable fabric designed to intercept and slow the flow of sediment-laden sheet flow runoff. Silt fences allow sediment to settle from runoff before water leaves the construction site.

Silt fences are placed below the toe of exposed and erodible slopes, downslope of exposed soil areas, around temporary stockpiles and along streams and channels. Silt fences should not be used to divert flow or in streams, channels or anywhere flow is concentrated.

## Appropriate Applications

- Below the toe of exposed and erodible slopes.
- Down-slope of exposed soil areas.
- Around temporary stockpiles.
- Along streams and channels.
- Along the perimeter of a project.

## Limitations

- Not effective unless trenched and keyed in.
- Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
- Must be maintained.
- Must be removed and disposed of.
- Silt fence is used only in sheet flow conditions, not in concentrated flow areas.
- Silt fence is typically installed along the contour (constant elevation), not on slopes, to avoid channelizing water
- Don't use below slopes subject to creep, slumping, or landslides.
- Don't use in streams, channels, drain inlets, or anywhere flow is concentrated.
- Don't use silt fences to divert flow.
- Don't use in locations where ponded water may cause a flooding hazard.

## Standards and Specifications

<u>**Design and Layout**</u>

- The drainage area above any fence should not exceed a quarter of an acre, (100-feet of silt fence per 10,000 square feet of DSA).
- Slope of area draining to silt fence should be less than 1:1 (H:V).
- Silt fences must be placed parallel to the slope contour.
- Silt fences rely on temporary ponding to encourage sediment deposition and achieve water quality benefits. Limit application to areas where ponding and deposition may occur on the uphill side of the silt fence.
- Temporary silt fence fabrics generally have life spans ranging between five and eight months. Projects with longer durations may require replacing silt fence fabric.
- Silt fences constructed across concentrated flows are susceptible to washout. Silt fences shall not be installed across concentrated flows.
- For slopes adjacent to water bodies or Environmentally Sensitive Areas (ESAs), additional temporary soil stabilization BMPs should be used.

**Reinforced Silt Fence**

- Temporary reinforced silt fence is typically used in areas affected by high winds. They are also often used on slopes steeper than 2:1 (H:V) that contain a high number of rocks or large dirt clods that tend to dislodge, or where area draining fence contains moderate sediment loads.
- Temporary reinforced silt fence (type 2) may also be used to provide sediment control and delineate ESAs.
- For any 50 foot section of silt fence, the elevation of the base of the fence may not vary by more than 1/3 of the fence height.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- Join separate sections to form reaches not more than 500 feet without openings. Ensure there are no gaps between posts.

**Materials**

- Silt fence fabric should be a woven or unwoven geosynthetic textile that complies with Section 713 of the FP14. The Contractor must submit a certificate of compliance for silt fence fabric in accordance with Standard Specifications Section 106.
- Wood posts should be untreated fir, redwood, cedar, or pine lumber. Each silt fence post should be at least 4 feet long, except reinforced silt fence posts should be at least 6 feet for Type 1 and 5 feet for Type 2 installations. Posts should be free from decay, splits or cracks longer than the thickness of the post or other defects that would weaken the posts and cause the posts to be structurally unsuitable. Steel posts may be used as well. Posts should comply with the requirements in Section 713 of the FP-14.
- Anchors may be used. Anchors consist of a number 4 steel reinforcing bar. End protection shall be provided for any exposed bar reinforcement.
- Staples used to fasten the fence fabric to the posts and to join adjacent silt fence sections shall be U-shaped and have 1/2-inch legs and a 1-inch crown. Staples should be 1/16-inch in diameter. At least four staples should be installed on each silt fence post for adequate fastening, with a maximum of 8- inches between each staple.

**Installation**

- Install in accordance with Pages 5 and 6 of this BMP or to manufacturers recommendation.
- Generally, silt fences should be used in conjunction with soil stabilization source controls up slope to provide effective erosion and sediment control.
- Excavate a trench that is 6-inches deep and 6-inches wide with a length consistent with the project design plans. Place the bottom of the silt fence fabric in the trench so that the trench is on the up-slope side of the fence. Backfill the trench with soil over the base of the silt fence fabric. Compact the backfill soil by hand or mechanical methods.
- Construct the length of each reach so that the change in base elevation along any 50-foot reach does not exceed 1/3 the height of the barrier; in no case should any reach of temporary silt fence exceed 500 feet in length.
- Construct silt fences with a set-back of at least 3 feet from the toe of a slope. Where a silt fence is determined to be not practical with a 3-foot set-back from the toe due to specific site conditions, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practical.

### Inspection and Maintenance

- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric.
- Inspect silt fence when rain is forecast. Perform necessary maintenance.
- Inspect silt fence following rain events. Perform maintenance as necessary.
- Maintain silt fences to provide an adequate sediment holding capacity. Sediment should be removed when the sediment accumulation reaches one third (1/3) of the barrier height.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed of outside the highway right-of-way in conformance with the Standard Specifications, and replaced with new silt fence barriers.
- Holes, depressions or other ground disturbance caused by the removal of the temporary silt fences should be backfilled and repaired in conformance with the Standard Specifications.
- Remove silt fence when no longer needed. Fill and compact post holes and anchorage trench, remove sediment accumulation, and grade fence alignment to blend with adjacent ground.
- Silt Fence placement is to be shown in the WPCDs along with other BMPs.

## Typical Details

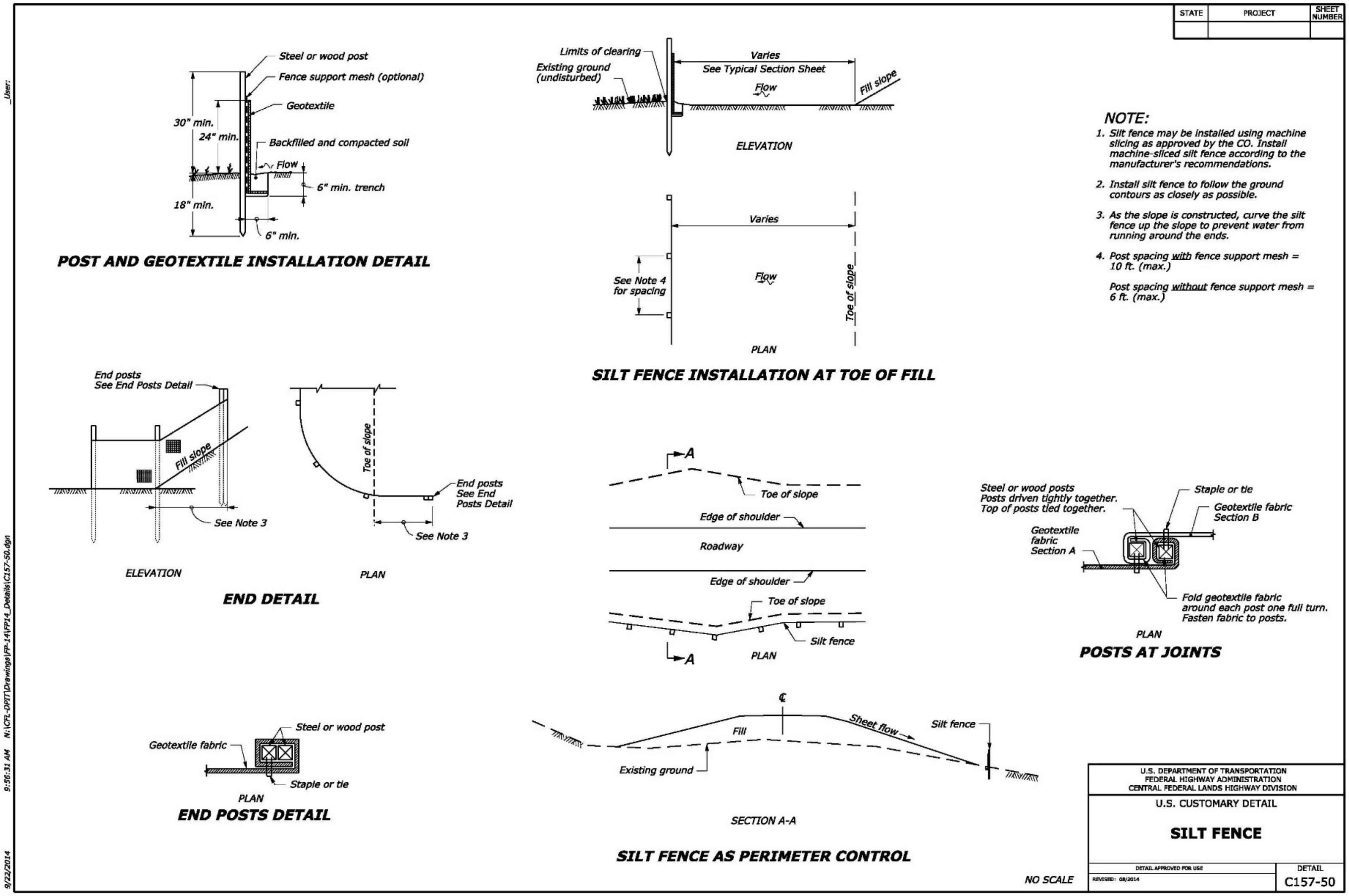



**Figure 41: Silt Fence Detail**

# 4.8.2 Sedimentation / De-silting Basin

## Definition and Purpose

A sedimentation / de-silting basin is a temporary basin formed by excavation and/or constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

## Appropriate Applications

De-silting basins shall be considered for use:

- On construction projects with disturbed areas during the rainy season, typically October through May;
- Where sediment-laden water may enter the drainage system or water courses; and
- At outlets of disturbed soil areas between 2 ha and 4 ha (5 acres and 10 acres).

## Limitations

- Alternative BMPs must be thoroughly investigated for erosion control before selecting temporary sediment/desilting basins.
- Requires large surface areas to permit settling of sediment.
- Size may be limited by availability of right-of-way.
- Not appropriate for drainage areas greater than 75 ac.
- Not to be located in live streams.
- For safety reasons, basins should have protective fencing.
- Not to be used as a standalone BMP, requires proper BMP implementation upstream and downstream of its location.

## Standards and Specifications

### General Requirements

- Sediment basins should be designed in accordance with the methods referenced in the State NPDES General Permit for Storm Water Discharges Associated with Construction Activities (CGP).
- Areas under embankments, structural works, and sediment basin must be cleared, stripped of vegetation in accordance with Standard Specifications Section 16 – "Temporary Facilities."
- Earthwork should be in accordance with Standard Specifications Section 19 – "Earthwork." Contractor is specifically directed to Standard Specifications Sections 19-5, "Compaction," and 19-6, "Embankment Construction."
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern. Fencing should be in accordance with Standard Specifications Section 80 – "Fences."
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the RE.
- The outflow from the basins must have outlet protection to prevent erosion and scouring of the embankment and channel. See BMP SS-10, "Outlet Protection/Velocity Dissipation Devices."
- Avoid dewatering of groundwater to the sediment basin during the wetter months. Insignificant quantities of accumulated precipitation may be dewatered to the sediment

basin unless precipitation is forecasted within 24 hours. Refer to NS-2 "Dewatering Operations."

**Other Considerations**

- Basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, (3) where failure would not cause loss of life or property damage, (4) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.
- Construct sediment basins prior to the rainy season and construction activities.
- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event. The calculated basin volume and proposed location should be submitted to the RE for approval at least 3 days prior to the basin construction.
- Construct an emergency spillway to accommodate flows not carried by the principal spillway. Spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a nonerodable rock slope protection.
- The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.
- Limit the contributing area to the sediment basin to only the runoff from disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- A forebay, constructed upstream of the basin may be provided to allow debris and larger particles to settle out of suspension before entering the basin.
- Basin inlets should be located to maximize travel distance to the basin outlet and resulting sediment deposition benefits.
- Rock or vegetation should be used to protect the basin inlet and slopes against erosion.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Discharge from the basin should be accomplished through a water quality outlet. An example is shown in Figure 3. The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen, although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The water quality outlet should be designed to drain the basin within 24 to 96 hours (also referred to as "drawdown time"). (The 24-hour limit is specified to provide adequate settling time; the 96-hour limit is specified to avoid vector control concerns). Local agencies may have more stringent drawdown time requirements.
- The two most common outlet problems that occur are: (1) the capacity of the outlet is too great resulting in only partial filling of the basin and drawdown time less than designed for; and (2) the outlet clogs because it is not adequately protected against trash and debris. To

avoid these problems, the following outlet types are recommended for use: (1) a single orifice outlet with or without the protection of a riser pipe, and (2) perforated riser. Design guidance for single orifice and perforated riser outlets are as follows:

**Flow Control Using a Single Orifice at the Bottom of the Basin**

(Figure 1). The outlet control orifice should be sized using the following equation:

$$a = \frac{2A(H - Ho)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7x10^{-5})A(H - Ho)^{0.5}}{CT} \qquad \text{(Eq. 2)}$$

Where:

a = area of orifice (ft2) (1 ft2 =0.0929m2)

A = surface area of the basin at mid elevation (ft2)

C = orifice coefficient
T = drawdown time of full basin (hrs)
G = gravity (32.2 ft/s2)
H = elevation when the basin is full (ft)
Ho = final elevation when basin is empty (ft)

With a drawdown time of 40 hours, the equation becomes:

$$a = \frac{(1.75x10^{-6})A(H - Ho)^{0.5}}{C} \qquad \text{(Eq. 3)}$$

**Flow Control Using Multiple Orifices**

$$a_t = \frac{2A(h_{\max})}{CT(2g[h_{\max} - h_{centroid\ of\ orifices}])^{0.5}} \qquad \text{(Eq. 4)}$$

With terms as described above except:

at = total area of orifices

hmax = maximum height from lowest orifice to the maximum water surface (ft)

hcentroid of orifices = height from the lowest orifice to the centroid of the orifice configuration (ft)

Allocate the orifices evenly on two rows; separate the holes by 3x hole diameter vertically, and by 120 degrees horizontally (refer to Figure 3).

Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

Care must be taken in the selection of "C"; 0.60 is most often recommended and used. However, based on actual tests, GKY (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:

C = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or

C = 0.80 when the material is thicker than the orifice diameter

- The Contractor should verify that the outlet is properly designed to handle the design and peak flows.
- If rock is used for energy dissipation or to prevent erosion, it must comply with Highway Design Manual Chapter 860.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel), which extends through the embankment to toe of fill. Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.
- Basins with an impounding levee greater than 5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,300 cubic feet, should be designed by a professional Civil. The design must be submitted to the PE for approval at least 7 days prior to the basin construction.
- The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.

### Inspection and Maintenance

- Inspect sediment basins before and after rainfall events and weekly year-round. During extended rainfall events, inspect at least every 24 hours.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Remove standing water from the basin within 72 hours after accumulation.
- Check inlet and outlet area for erosion and stabilize if required.
- Remove accumulated sediment when its volume reaches one-third the volume of the sediment storage. Properly dispose of sediment and debris removed from the basin.
- Check fencing for damage and repair.

### 4.8.2.1 Typical Details

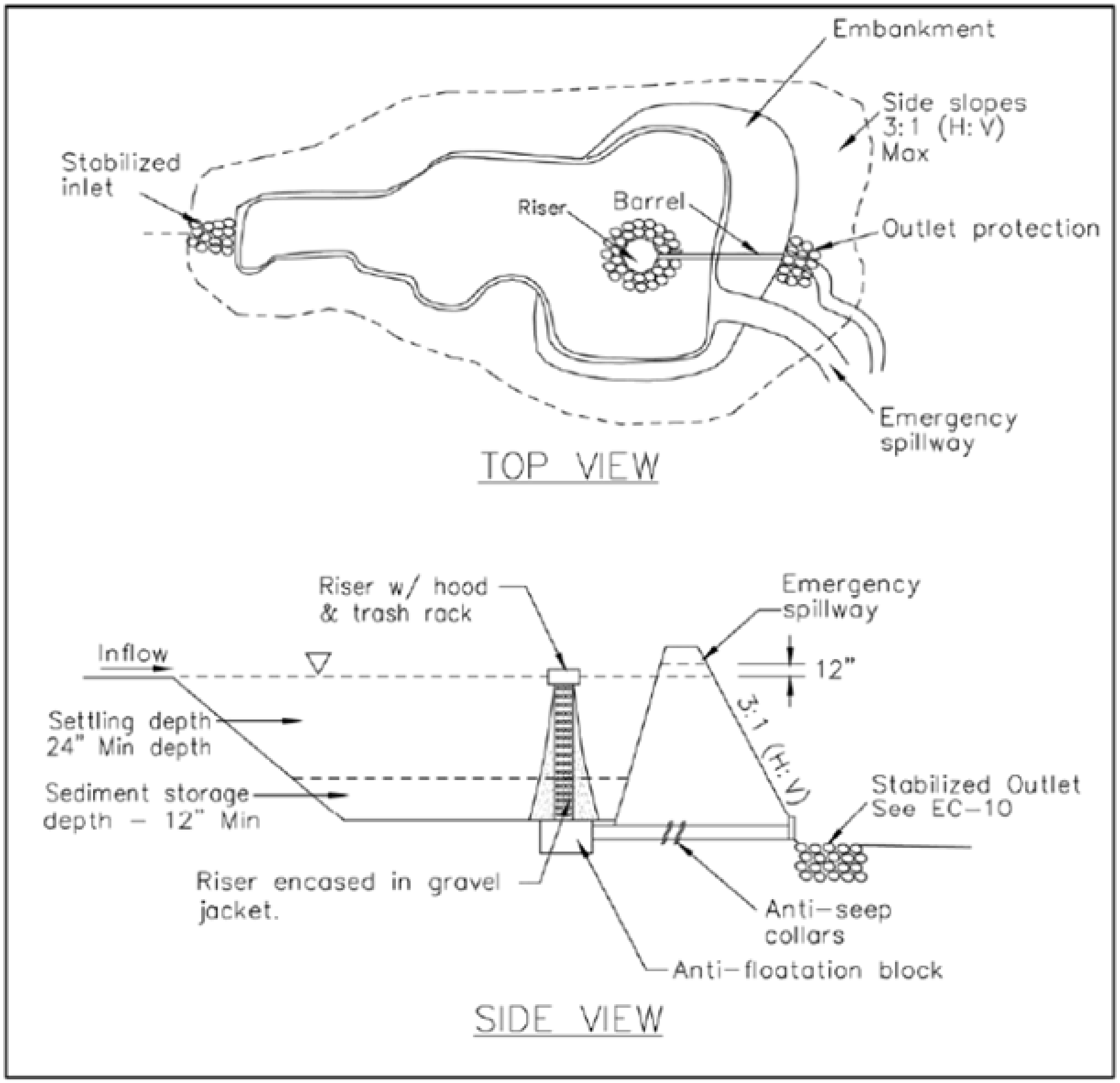



**Figure 42: Temporary Sediment Basin Detail**

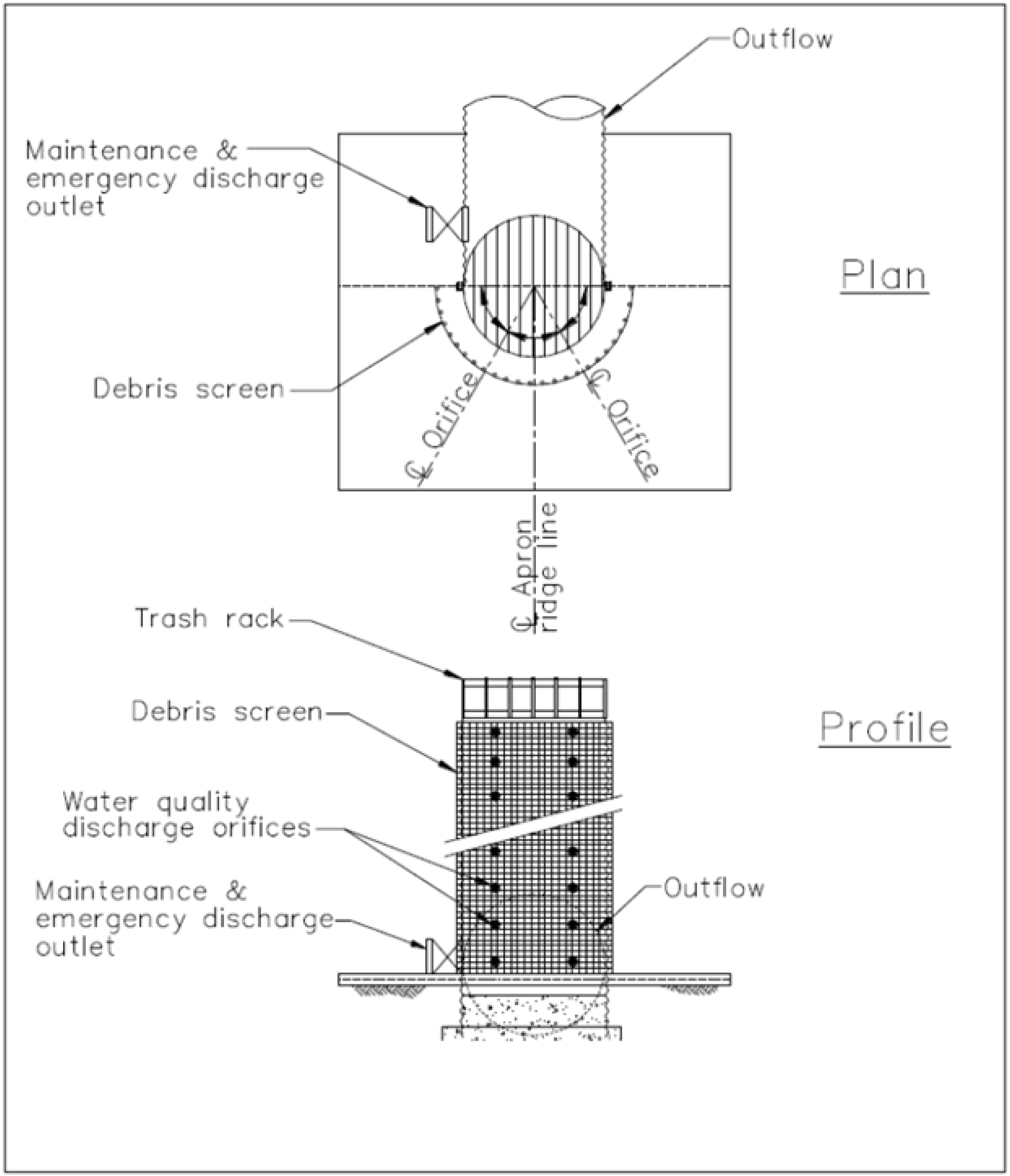



**Figure 43: Multiple Orifice Outlet Riser**

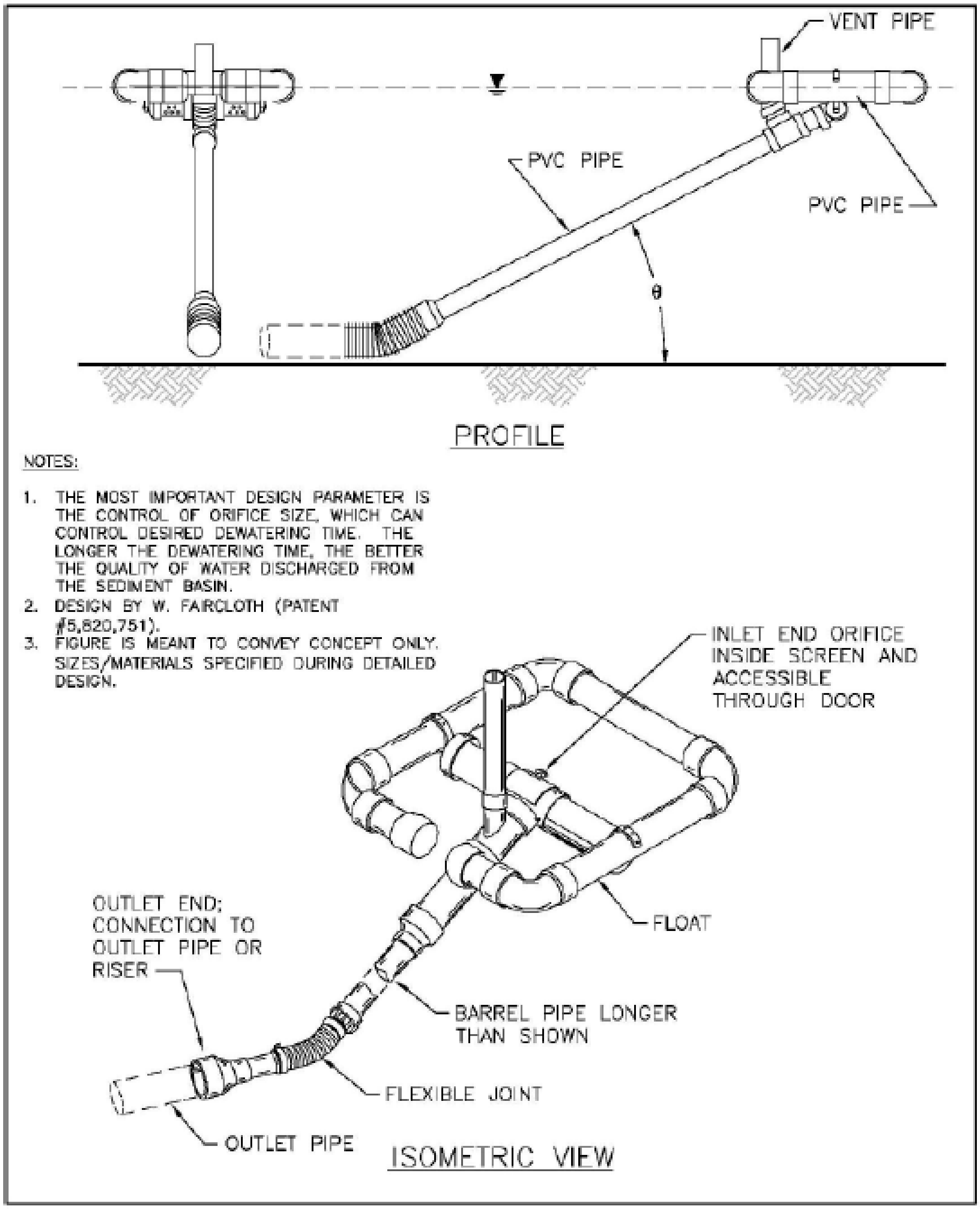



**Figure 44: Skimmer Detail**

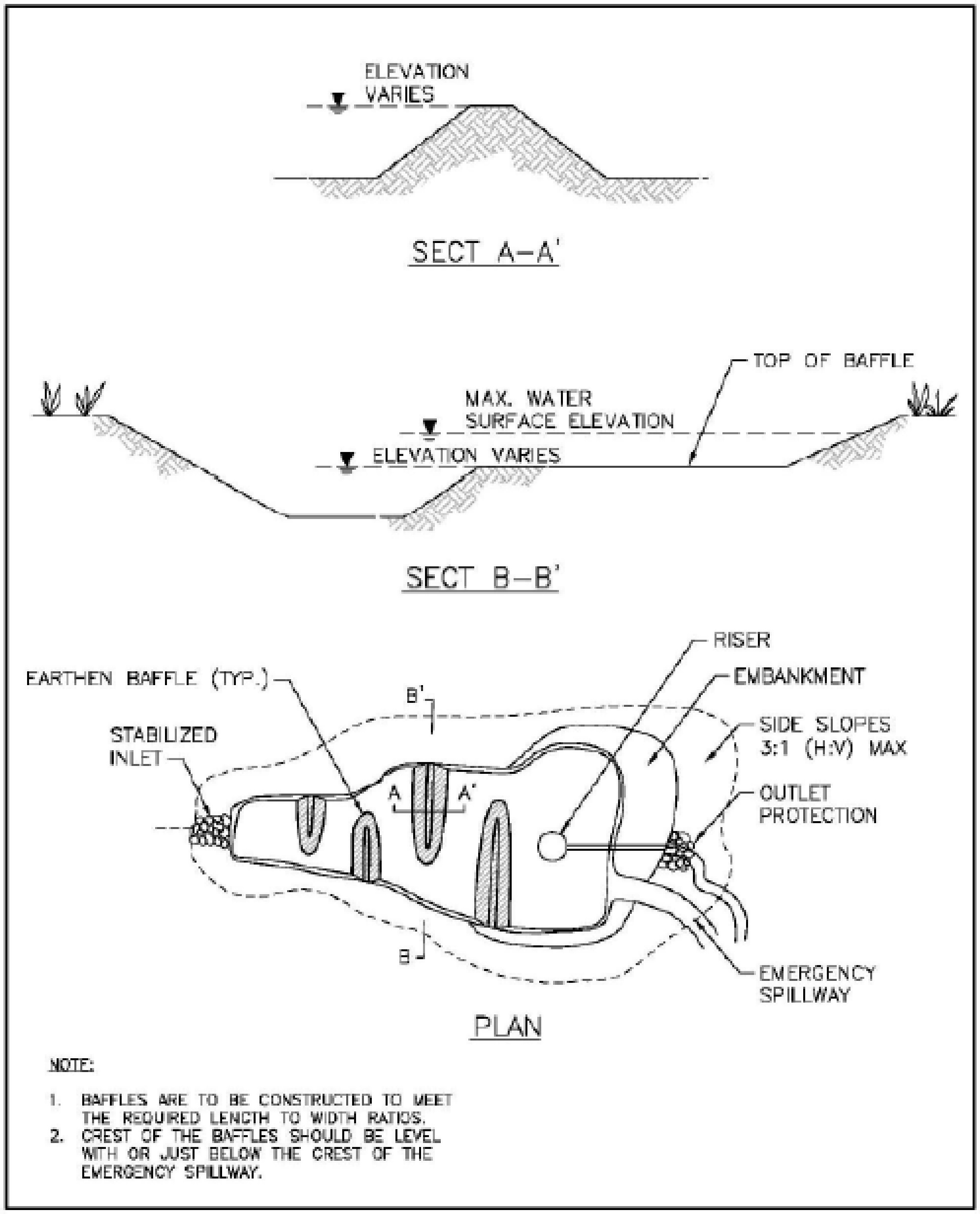



**Figure 45: Temporary Sediment Basin with Baffles**

# 4.8.3 SEDIMENT TRAP / FILTER BAGS / CURB CUTBACK

## Definition and Purpose

A sediment trap is a temporary basin with a controlled release structure, formed by excavating or constructing an earthen embankment across a waterway or low drainage area. As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Sediment traps may be used on construction projects during the rainy season when the contributing drainage area is less than 2 ha (5 acres). Traps would be placed where sediment laden storm water may enter a storm drain or watercourse, and around and/or up-slope from storm drain inlet protection measures.

Curb cutback is implemented when the construction project utilizes the removed section of pavement and uses the depression of the curb as a temporary containment to collect sediment before reaching a storm drain.

Filter bags may be used in place of sediment traps. Sediment filter bags consist of a non-woven geotextile fabric that can catch and contain sediment during dewatering and pumping operations.

## Appropriate Applications

- Sediment traps may be used on construction projects where the drainage area is less than 5 ac. Traps should be placed where sediment-laden stormwater enters a storm drain or watercourse.
- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

## Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Size may be limited by availability of right-of-way.
- Not appropriate for drainage areas greater than 5 ac.
- Only removes large and medium sized particles and requires upstream erosion control.
- Sediment traps may appear attractive and dangerous to children, requiring protective fencing.
- Sediment traps should not to be located in live streams.
- Curb cutback typically does not allow for a large storage area and therefore requires frequent maintenance to prevent sediment laden discharges.

## Standards and Specifications

### General Requirements

- Areas under embankments, structural works, and sediment traps must be cleared and stripped of vegetation in accordance with Standard Specifications Section 201 – "Clearing and Grubbing."
- Earthwork must be in accordance with Standard Specifications Section 204 – "Earthwork". Contractor is specifically directed to Standard Specifications Sections 204.xx entitled, "Compaction" and "Embankment Construction," respectively.

- Fencing, in accordance with Standard Specifications Section 80 – "Fences," should be provided to prevent unauthorized entry.
- Remove and dispose of deposited solids from sediment traps under Standard Specifications Section 14-10 – "Solid Waste Disposal and Recycling," unless another method is authorized.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the RE.
- The outflow from sediment traps may be provided with outlet protection to prevent erosion and scouring of the embankment and channel. See BMP SS- 10, "Outlet Protection/Velocity Dissipation Devices."
- For curb cutback, excavate soil from behind the curb, sidewalk, or roadway at least 3-4 inches down from the top of the hardscape and bring the soil back at a minimum 3-4 feet back from the hardscape. Site conditions might allow for  increase in capacity.

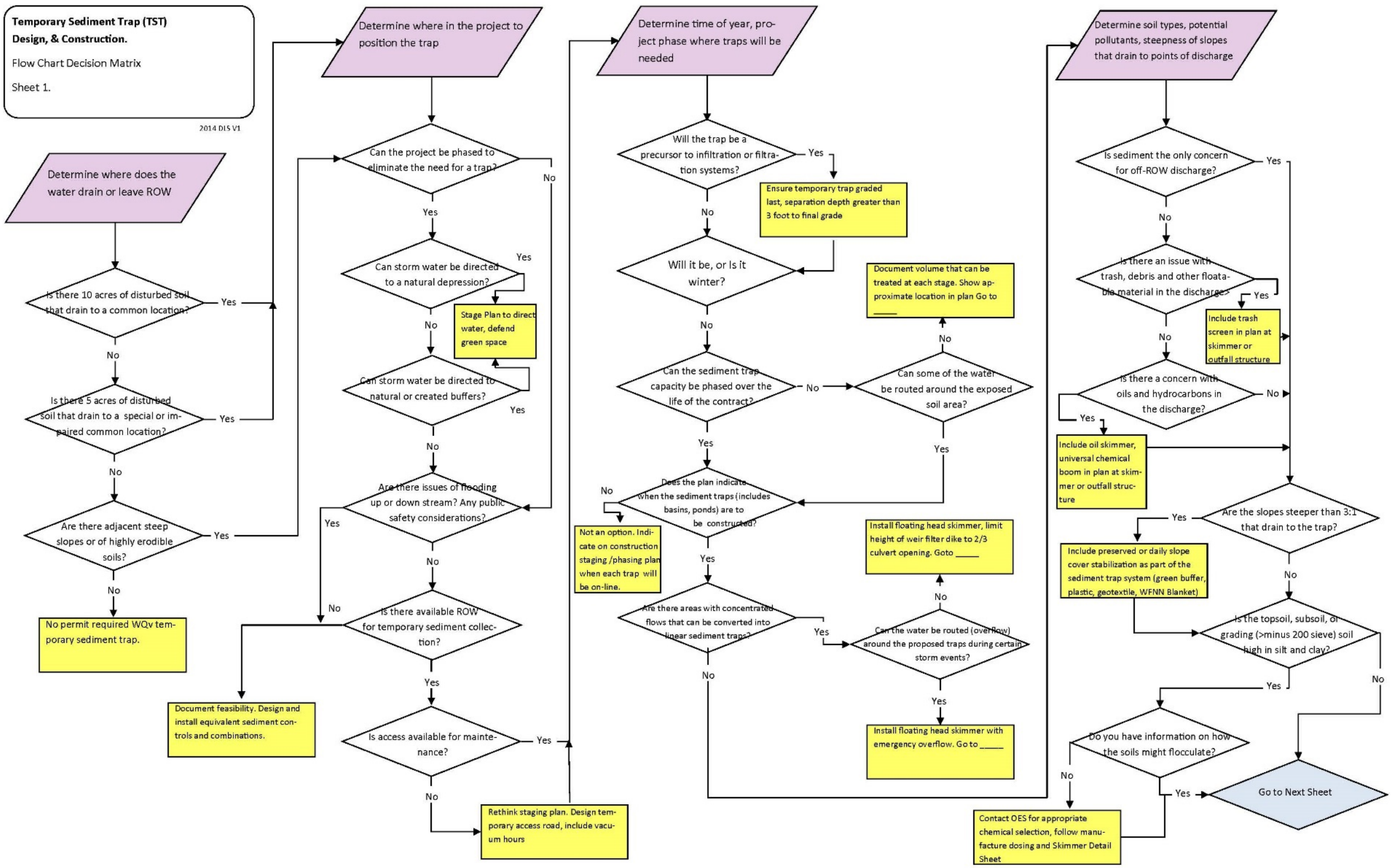
**Other Considerations**

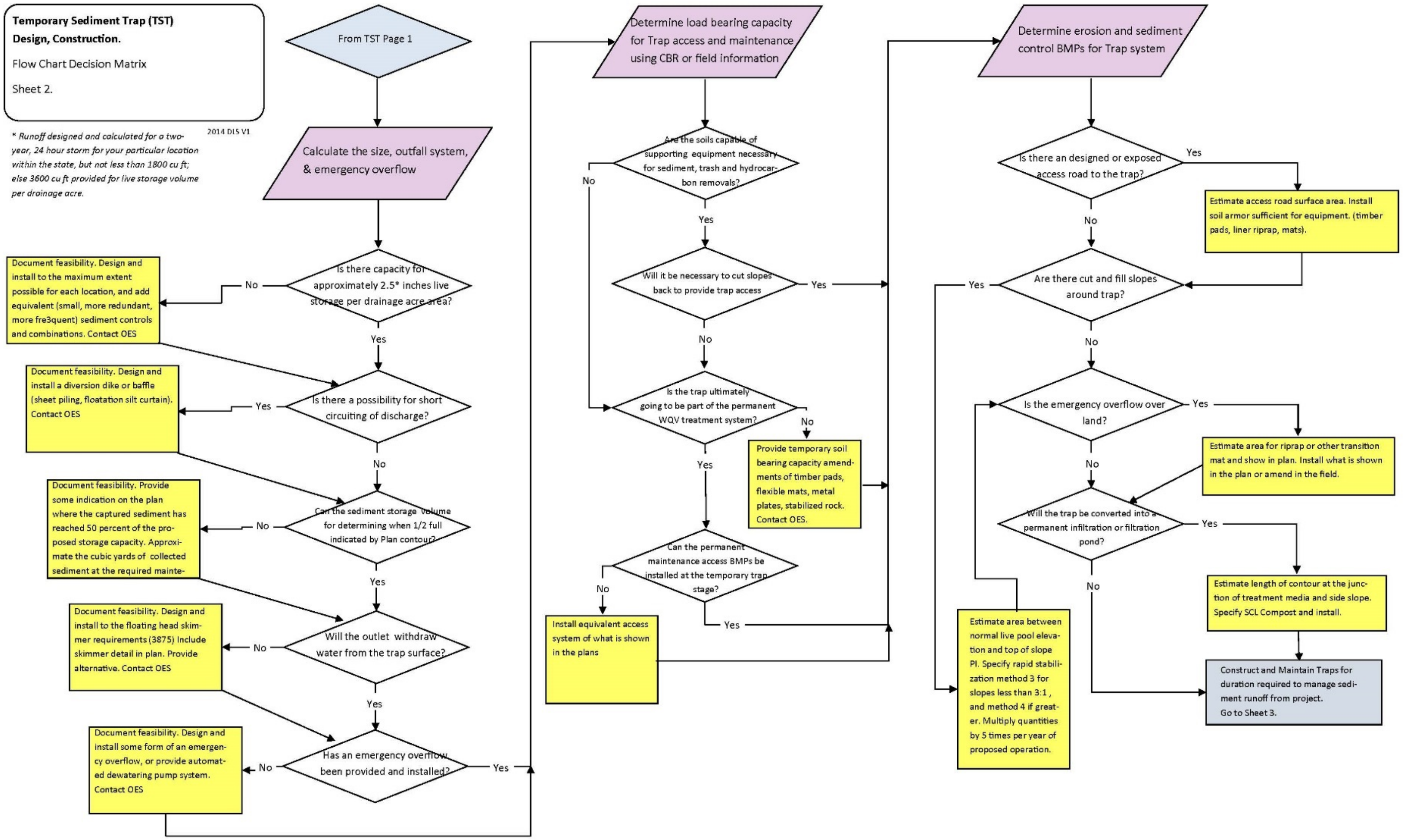
- The sediment trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
- Sediment traps should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67 yd3/ac and 33 yd3/ac of contributing drainage area, respectively, based on 0.5 inch of runoff volume over a 24-hour period. Multiple traps and/or additional volume may be required to accommodate site specific rainfall and soil conditions.
- Use rock or vegetation to protect the trap outlets against erosion.
- Traps with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 cubic feet, must be designed by a Civil Engineer registered. The design must be submitted to the RE for approval at least 7 days prior to the basin construction. The design should include maintenance requirements to ensure continuous function of the trap outlet and bypass structures.

## Inspection and Maintenance

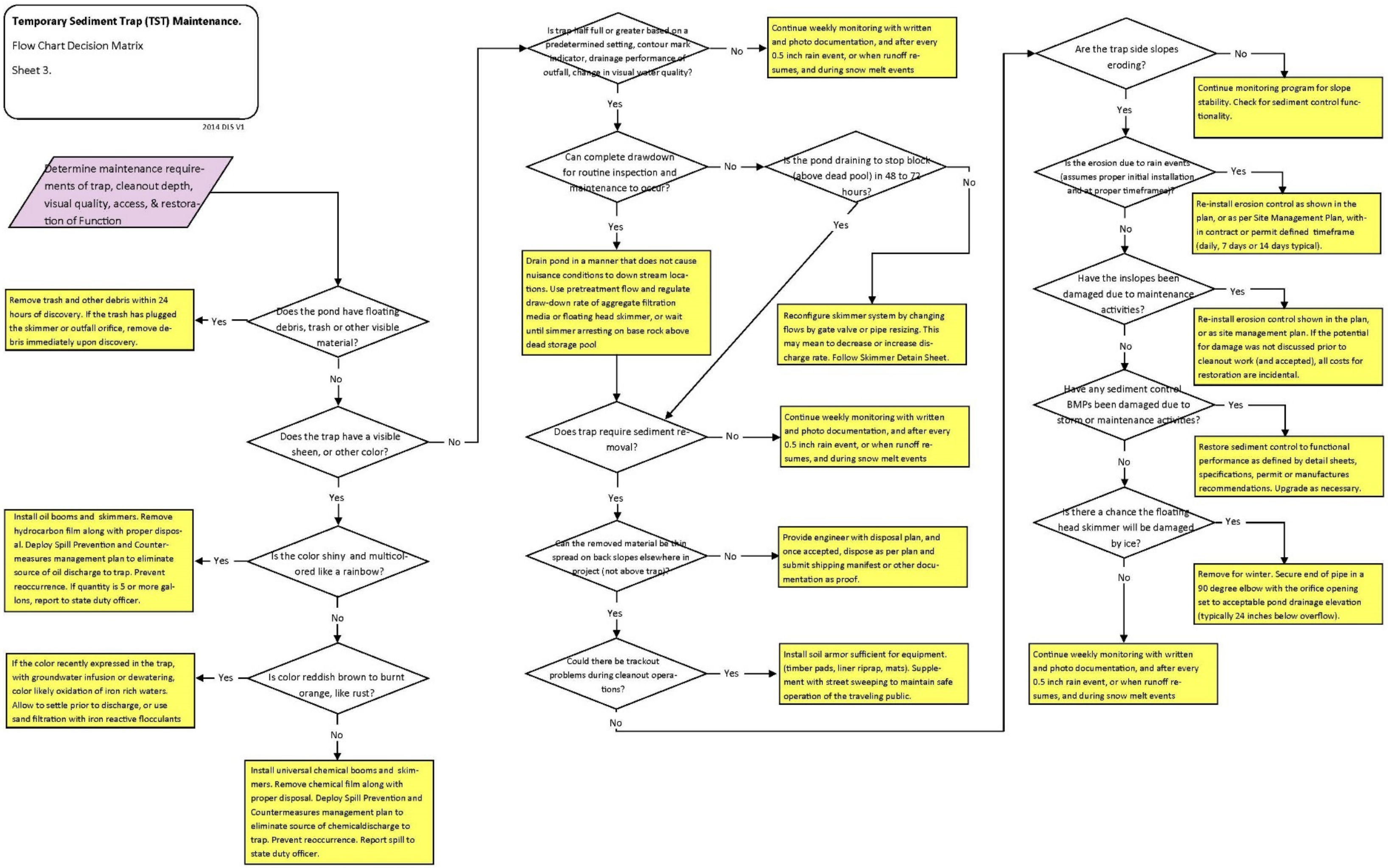
- Inspect sediment traps/curbs before, during and after rainfall events and weekly year-round. During extended rainfall events, inspect sediment traps at least every 24 hours.
- If captured runoff has not completely infiltrated within 96 hours, then the sediment trap must be dewatered.
- Inspect trap banks for embankment seepage and structural soundness.
- Inspect outlet structure and rock spillway for any damage or obstructions. Repair damage and remove obstructions as needed or as directed by the PE.
- Inspect outlet area for erosion and stabilize if required, or as directed by the PE.
- Remove accumulated sediment when the volume has reached one-third the original trap volume.
- Inspect fencing for damage and repair as needed or as directed by the PE.
- Temporary Sediment Trap/ Curb Cutback locations must be shown in the SWPPP and site map along with other BMPs.

## Selection Matrix





Temporary Sediment Trap (TST) Design, Construction.
Flow Chart Decision Matrix
Sheet 2.
2014 DIS V1
* Runoff designed and calculated for a two-year, 24 hour storm for your particular location within the state, but not less than 1800 cu ft; else 3600 cu ft provided for live storage volume per drainage acre.
From TST Page 1
Calculate the size, outfall system, & emergency overflow
Is there capacity for approximately 2.5* inches live storage per drainage acre area?
No
Document feasibility. Design and install to the maximum extent possible for each location, and add equivalent (small, more redundant, more fre3quent) sediment controls and combinations. Contact OES
Yes
Is there a possibility for short circuiting of discharge?
Yes
Document feasibility. Design and install a diversion dike or baffle (sheet piling, floatation silt curtain). Contact OES
No
Can the sediment storage volume for determining when 1/2 full indicated by Plan contour?
No
Document feasibility. Provide some indication on the plan where the captured sediment has reached 50 percent of the proposed storage capacity. Approximate the cubic yards of collected sediment at the required mainte-
Yes
Will the outlet withdraw water from the trap surface?
No
Document feasibility. Design and install to the floating head skimmer requirements (3875) Include skimmer detail in plan. Provide alternative. Contact OES
Yes
Has an emergency overflow been provided and installed?
No
Document feasibility. Design and install some form of an emergency overflow, or provide automated dewatering pump system. Contact OES
Yes
Determine load bearing capacity for Trap access and maintenance using CBR or field information
Are the soils capable of supporting equipment necessary for sediment, trash and hydrocarbon removals?
No
Yes
Will it be necessary to cut slopes back to provide trap access
Yes
No
Is the trap ultimately going to be part of the permanent WQV treatment system?
No
Provide temporary soil bearing capacity amendments of timber pads, flexible mats, metal plates, stabilized rock. Contact OES.
Yes
Can the permanent maintenance access BMPs be installed at the temporary trap stage?
No
Install equivalent access system of what is shown in the plans
Yes
Determine erosion and sediment control BMPs for Trap system
Is there an designed or exposed access road to the trap?
Yes
Estimate access road surface area. Install soil armor sufficient for equipment. (timber pads, liner riprap, mats).
No
Are there cut and fill slopes around trap?
Yes
Estimate area between normal live pool elevation and top of slope PI. Specify rapid stabilization method 3 for slopes less than 3:1, and method 4 if greater. Multiply quantities by 5 times per year of proposed operation.
No
Is the emergency overflow over land?
Yes
Estimate area for riprap or other transition mat and show in plan. Install what is shown in the plan or amend in the field.
No
Will the trap be converted into a permanent infiltration or filtration pond?
Yes
Estimate length of contour at the junction of treatment media and side slope. Specify SCL Compost and install.
No
Construct and Maintain Traps for duration required to manage sediment runoff from project. Go to Sheet 3.


Temporary Sediment Trap (TST) Maintenance.
Flow Chart Decision Matrix
Sheet 3.
2014 DLS V1
Determine maintenance requirements of trap, cleanout depth, visual quality, access, & restoration of Function
Does the pond have floating debris, trash or other visible material?
Remove trash and other debris within 24 hours of discovery. If the trash has plugged the skimmer or outfall orifice, remove debris immediately upon discovery.
Does the trap have a visible sheen, or other color?
Is the color shiny and multicolored like a rainbow?
Install oil booms and skimmers. Remove hydrocarbon film along with proper disposal. Deploy Spill Prevention and Countermeasures management plan to eliminate source of oil discharge to trap. Prevent reoccurrence. If quantity is 5 or more gallons, report to state duty officer.
Is color reddish brown to burnt orange, like rust?
If the color recently expressed in the trap, with groundwater infusion or dewatering, color likely oxidation of iron rich waters. Allow to settle prior to discharge, or use sand filtration with iron reactive flocculants
Install universal chemical booms and skimmers. Remove chemical film along with proper disposal. Deploy Spill Prevention and Countermeasures management plan to eliminate source of chemicaldischarge to trap. Prevent reoccurrence. Report spill to state duty officer.
Is trap half full or greater based on a predetermined setting, contour mark indicator, drainage performance of outfall, change in visual water quality?
Continue weekly monitoring with written and photo documentation, and after every 0.5 inch rain event, or when runoff resumes, and during snow melt events
Can complete drawdown for routine inspection and maintenance to occur?
Is the pond draining to stop block (above dead pool) in 48 to 72 hours?
Drain pond in a manner that does not cause nuisance conditions to down stream locations. Use pretreatment flow and regulate draw-down rate of aggregate filtration media or floating head skimmer, or wait until simmer arresting on base rock above dead storage pool
Reconfigure skimmer system by changing flows by gate valve or pipe resizing. This may mean to decrease or increase discharge rate. Follow Skimmer Detain Sheet.
Does trap require sediment removal?
Continue weekly monitoring with written and photo documentation, and after every 0.5 inch rain event, or when runoff resumes, and during snow melt events
Can the removed material be thin spread on back slopes elsewhere in project (not above trap)?
Provide engineer with disposal plan, and once accepted, dispose as per plan and submit shipping manifest or other documentation as proof.
Could there be trackout problems during cleanout operations?
Install soil armor sufficient for equipment. (timber pads, liner riprap, mats). Supplement with street sweeping to maintain safe operation of the traveling public.
Are the trap side slopes eroding?
Continue monitoring program for slope stability. Check for sediment control functionality.
Is the erosion due to rain events (assumes proper initial installation and at proper timeframes)?
Re-install erosion control as shown in the plan, or as per Site Management Plan, within contract or permit defined timeframe (daily, 7 days or 14 days typical).
Have the inslopes been damaged due to maintenance activities?
Re-install erosion control shown in the plan, or as site management plan. If the potential for damage was not discussed prior to cleanout work (and accepted), all costs for restoration are incidental.
Have any sediment control BMPs been damaged due to storm or maintenance activities?
Restore sediment control to functional performance as defined by detail sheets, specifications, permit or manufactures recommendations. Upgrade as necessary.
Is there a chance the floating head skimmer will be damaged by ice?
Remove for winter. Secure end of pipe in a 90 degree elbow with the orifice opening set to acceptable pond drainage elevation (typically 24 inches below overflow).
Continue weekly monitoring with written and photo documentation, and after every 0.5 inch rain event, or when runoff resumes, and during snow melt events

## Typical Details

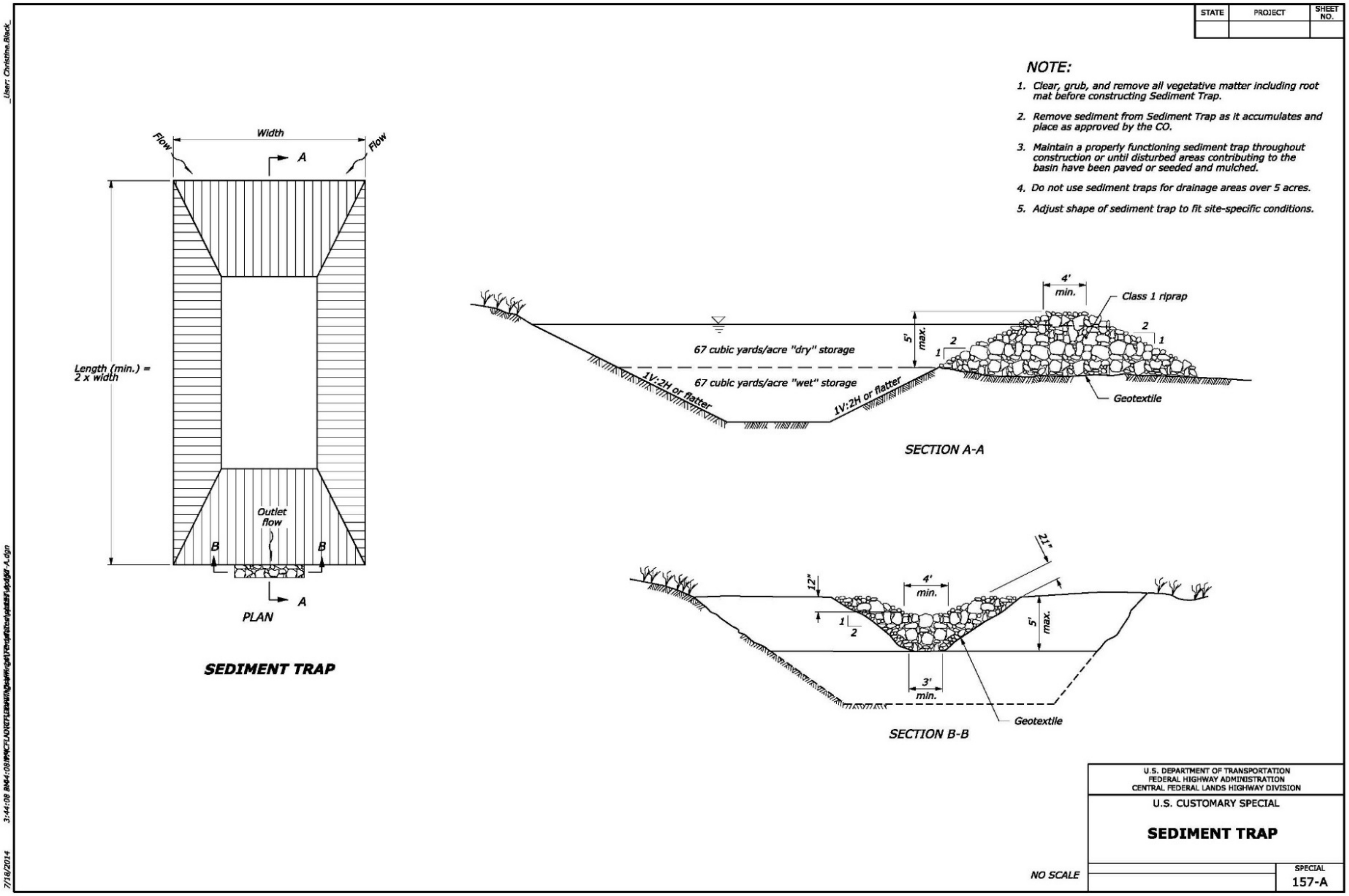



**Figure 46: Sediment Trap Detail**

# 4.8.4 CHECK DAM

## Definition and Purpose

A check dam is a small device constructed of rock, sand bags, or fiber rolls, placed across a natural or man-made channel or drainage ditch. Check dams reduce scour and channel erosion by reducing flow velocity and encouraging sediment dropout.

## Appropriate Applications

Check dams may be installed:

- In small open channels that drain 10 acres or less;
- In steep channels where storm water runoff velocities exceed 5 feet per second [ft/s];
- During the establishment of grass linings in drainage ditches or channels; and
- In temporary ditches where a short length of services does not warrant establishment of erosion-resistant linings.

This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the PE.

## Limitations

- Not to be used in live streams.
- Not appropriate in channels that drain areas greater than 10 ac.
- Not to be placed in channels that are already grass lined unless erosion is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping, which can be re-suspended during subsequent storms or removal of the check dam.
- Not to be constructed from straw bales or silt fence.

## Standards and Specifications

**General Requirements**

- Remove obstructions, rocks, clods, and debris greater than 1 inch in diameter from the ground before installing temporary check dams.
- If check dams are used in combination with Rolled Erosion Control Product (RECP) or blanket, install the RECP or blanket first.
- Place a temporary check dam perpendicular to the centerline of the ditch or drainage line.
- Install the check dam with enough spillway depth to prevent flanking of a concentrated flow around its ends.
- Fiber Roll, Gravel Filled Bags, and Riprap check dams are appropriate for unlined ditches. Gravel Filled Bags and Riprap check dams are appropriate if the ditch is concrete lined.

**Fiber Roll Check Dam**

Refer to "Fiber Rolls." For more details

- Secure the fiber rolls with rope and notched wood stakes.
- Drive the stakes into the soil until the notch is even with the top of the fiber roll.
- Lace rope between the stakes and over the fiber roll. Knot the rope at each stake.

- Tighten by driving the stakes further into the soil.

**Gravel-Filled Bag Check Dam**

Refer to "Gravel Bag Berm." For more details

- Bag Material: Bags are a geosynthetic material, either polypropylene, polyethylene or polyamide woven fabric, minimum unit weight 4 ounces per yd2, mullen burst strength exceeding 300 psi in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.
- Bag Size: Each gravel-filled bag shave a length of 24 in to 32 in, width of 16 in to 20 in, and thickness of 3 in. Alternative bag sizes must be submitted to the RE for approval prior to deployment.
- Gravel: Fill material is between 3/8 and 3/4 inch in diameter, and must be clean and free from clay balls, organic matter, and other deleterious materials. The opening of gravel-filled bags should be secured such that gravel does not escape. Gravel-filled bags are between 30 and 50 lb in weight. Fill material is subject to approval by the RE.
    - Place a Type 2 temporary check dam as a single layer of gravel-filled bags, placed end-to-end to eliminate gaps.
    - If you need to increase the height of the dam, add more layers of gravel-filled bags. Stack the bags in the upper row to overlap the joints in the lower row. Stabilize the rows by adding more rows of bags in the lower layers.
    - Tightly abut bags and stack gravel bags using a pyramid approach. Gravel bags should not be stacked any higher than 3 ft.
- Upper rows of gravel bags should overlap joints in lower rows.

**Riprap Check Dam**

Refer to "Fiber Rolls." For more details

- Secure the fiber rolls with rope and notched wood stakes.
- Drive the stakes into the soil until the notch is even with the top of the fiber roll.
- Lace rope between the stakes and over the fiber roll. Knot the rope at each stake.
- Tighten by driving the stakes further into the soil.

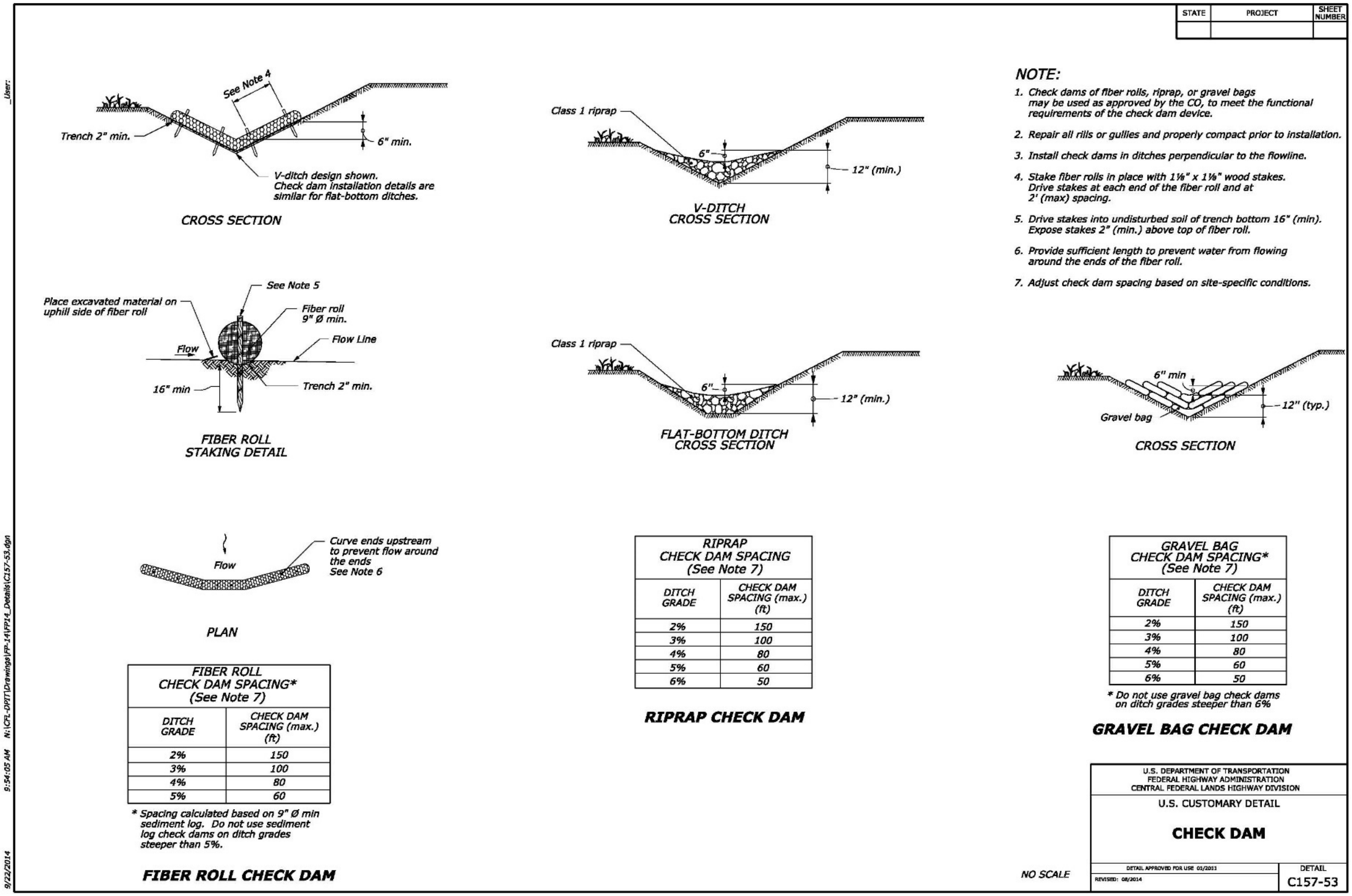
**Other Considerations**

- Check dams should be placed at a distance and height to allow small pools to form behind them. Install the first check dam approximately 15 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- For multiple check dam installation, backwater from downstream check dam should reach the toe of the upstream dam.
- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale from erosion.
- Check dam materials should consist of biodegradable materials whenever feasible.
- Rock check dams might be more applicable if concentrated flows might be a potential.

### Inspection and Maintenance

- Check dams must be inspected at a minimum weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Replace missing rock, bags, fiber rolls, etc. that have degraded or become damaged.
- Remove sediment when depth reaches one-third of the check dam height.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed or when directed by the PE.
- Removed sediment can be incorporated in the project at locations designated by the PE or disposed of outside the highway right-of-way in conformance with the Standard Specifications.

## Typical Details




**FIBER ROLL CHECK DAM SPACING* (See Note 7)**

| DITCH GRADE | CHECK DAM SPACING (max.) (ft) |
|---|---|
| 2% | 150 |
| 3% | 100 |
| 4% | 80 |
| 5% | 60 |

* Spacing calculated based on 9" Ø min sediment log. Do not use sediment log check dams on ditch grades steeper than 5%.

**RIPRAP CHECK DAM SPACING (See Note 7)**

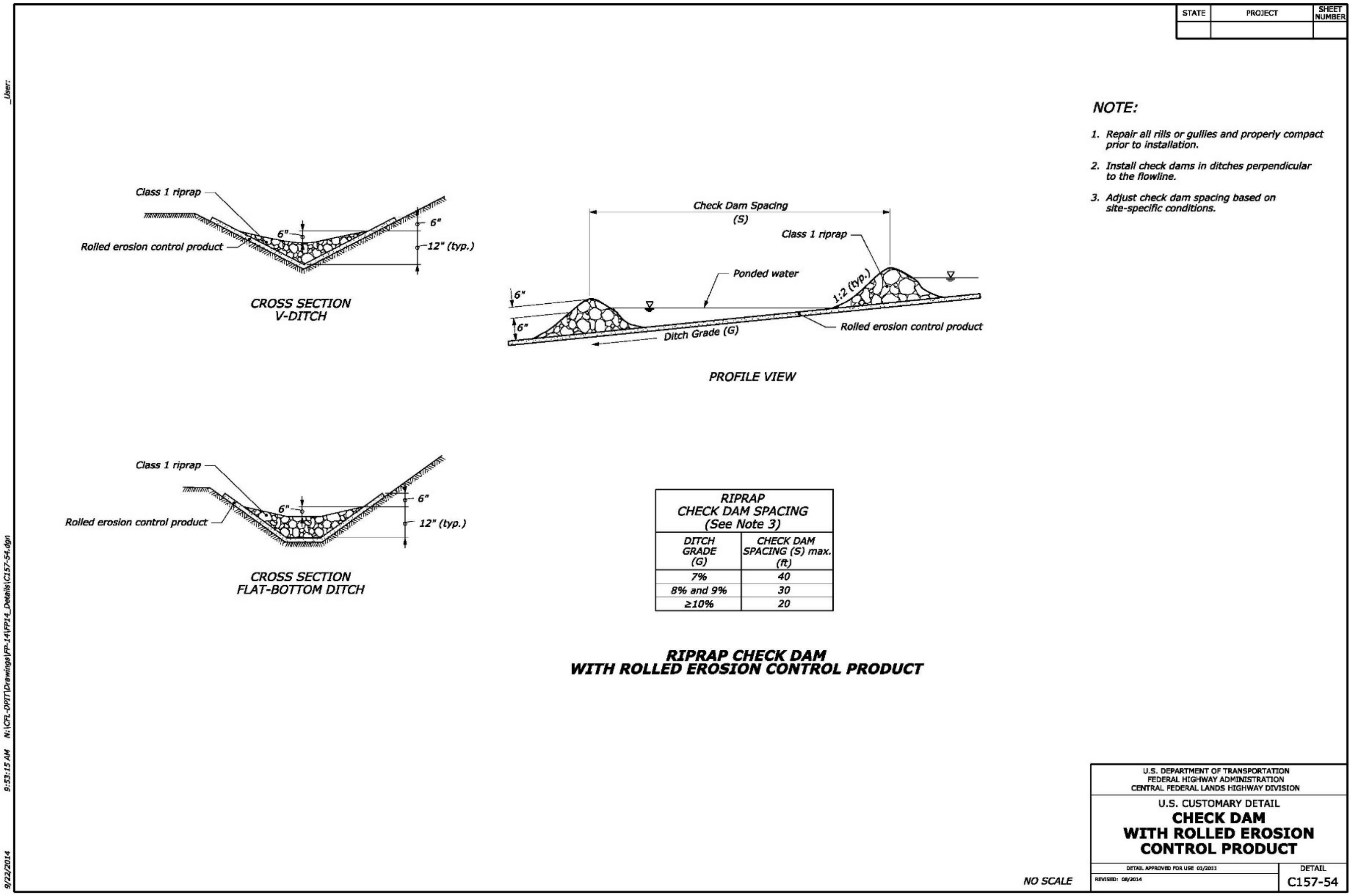
| DITCH GRADE | CHECK DAM SPACING (max.) (ft) |
|---|---|
| 2% | 150 |
| 3% | 100 |
| 4% | 80 |
| 5% | 60 |
| 6% | 50 |

**GRAVEL BAG CHECK DAM SPACING* (See Note 7)**

| DITCH GRADE | CHECK DAM SPACING (max.) (ft) |
|---|---|
| 2% | 150 |
| 3% | 100 |
| 4% | 80 |
| 5% | 60 |
| 6% | 50 |

* Do not use gravel bag check dams on ditch grades steeper than 6%

**Figure 47: Check Dam Detail**




**RIPRAP CHECK DAM SPACING (See Note 3)**

| DITCH GRADE (G) | CHECK DAM SPACING (S) max. (ft) |
|---|---|
| 7% | 40 |
| 8% and 9% | 30 |
| ≥10% | 20 |

**Figure 48: Check Dam with RECP Detail**

# 4.8.5 FIBER ROLLS

## Definition and Purpose

A fiber roll consists of straw, flax or other similar materials inserted into a tube of netting. Fiber rolls are placed on the face of slopes at regular intervals and/or at the toe of slopes to intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide some removal of sediment from the runoff. Fiber rolls may be used along the top, face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow

## Appropriate Applications

- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the designer.
- Fiber rolls may be applied as both temporary and permanent sediment controls.
- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- Below the toe of exposed and erodible slopes.
- Fiber rolls may be used as check dams in unlined ditches or as temporary drainage inlet protection Down-slope of exposed soil areas.
- Around temporary stockpiles.
- Along the perimeter of a project.

## Limitations

- Runoff and erosion may occur if fiber roll is not adequately trenched in.
- Fiber rolls at the toe of slopes greater than 5:1 (H:V) may require the use of a large sediment barrier as specified in Standard Specifications Section 13- 10.03D Temporary Large Sediment Barrier or installations achieving the same protection (i.e., stacked smaller diameter fiber rolls, etc.).
- Difficult to move once saturated.
- Fiber rolls could be transported by high flows if not properly staked and trenched in.
- Fiber rolls have limited sediment capture zone.
- Do not use fiber rolls on slopes subject to creep, slumping, or landslide.
- Plastic netting should not be used when regulatory permits prohibit their use or if there is a potential for plastic netting to endanger wildlife.
- Plastic netting is only allowed where fiber rolls will be for short duration and will be removed.

## Standards and Specifications

<u>**Materials**</u>

- Fiber rolls must be premanufactured and filled with weed-free rice or wheat straw, wood excelsior, or coconut fiber. Fiber roll must be covered with biodegradable jute, sisal, or coir fiber netting secured tightly at each end.
- Fiber rolls must have a minimum functional longevity of 1 year.
- Fiber rolls must be:
  - 8 to 10 inches in diameter and at least 1.1 lb/ft
  - 10 to 12 inches in diameter and at least 3 lb/ft
- Large sediment barriers are a subset of fiber rolls. Large sediment barriers must be:

    - 18 to 22 inches in diameter
    - At least 8 ft in length
    - At least 6.5 lb/ft
- Some jurisdictions require that fiber rolls must be made entirely of biodegradable materials if the project is near an Environmentally Sensitive Area, they are intended to be left in place after construction is completed or there are regulatory permits prohibiting the use of non-photo/biodegradable fiber rolls.
- Submit a Certificate of Compliance for fiber rolls.
- Rope to fasten fiber rolls must be 1/4 inch in diameter and biodegradable, such as sisal or manila.
- Wood stakes must be untreated fir, redwood, cedar, or pine and cut from sound timber. The ends must be pointed for driving into the ground. Notched stakes must be at least 1 by 2 by 24 inches in size. Stakes without notches must be at least 1 by 1 by 24 inches.

**Typical Fiber Roll Installation**

- Before installing fiber roll, remove obstructions from the ground, including rocks, clods, and debris greater than 1 inch in diameter.
- For any 20-foot section of fiber roll, prevent the fiber roll from varying more than 5 percent from level.
- Use the following spacing unless otherwise noted on the project plans or SCRs:
    - 10 feet apart for slopes steeper than 2:1 (H:V)
    - 15 feet apart for slopes from 2:1 to 4:1 (H:V)
    - 20 feet apart for slopes from 4:1 to 10:1 (H:V)
    - 50 feet apart for slopes flatter than 10:1 (H:V)
- For Type 1 installations:
    - Place in a furrow that is from 2 to 4 inches deep.
    - Fasten with wood stakes every 4 feet along the length of the fiber roll.
    - Fasten the ends of the fiber roll by placing a stake 6 inches from the end of the roll.
    - Drive the stakes into the soil so the top of the stake is less than 2 inches above the top of the fiber roll.
- For Type 2 installations:
    - Fasten with notched wood stakes and rope.
    - Drive stakes into the soil until the notch is even with the top of the fiber roll.
    - Lace the rope between stakes and over the fiber roll. Knot the rope at each stake.
    - Tighten the fiber roll to the surface of the slope by driving the stakes further into the soil.
    - If more than one fiber roll is placed in a row, the rolls should be overlapped; not abutted. Stagger overlapping joints in adjacent rows by 5 to 10 feet.
    -

**Typical Large Sediment Barrier Installation**

- Place a single row of fiber rolls end-to-end, approximately parallel with the slope contour. For any 20-foot section of fiber roll, do not allow the fiber roll to vary by more than 5 percent from level.
- Place the fiber rolls in a furrow that is from 6 to 8 inches deep.
- Secure the fiber rolls with wood stakes 4 feet apart.
- Place a stake 18 inches from each end of each fiber roll.

- Drive the stakes into the soil such that the top of the stakes are less than 2 inches above the top of the fiber rolls.
- 
- Angle the last 6 feet upslope at the downhill end of the run.

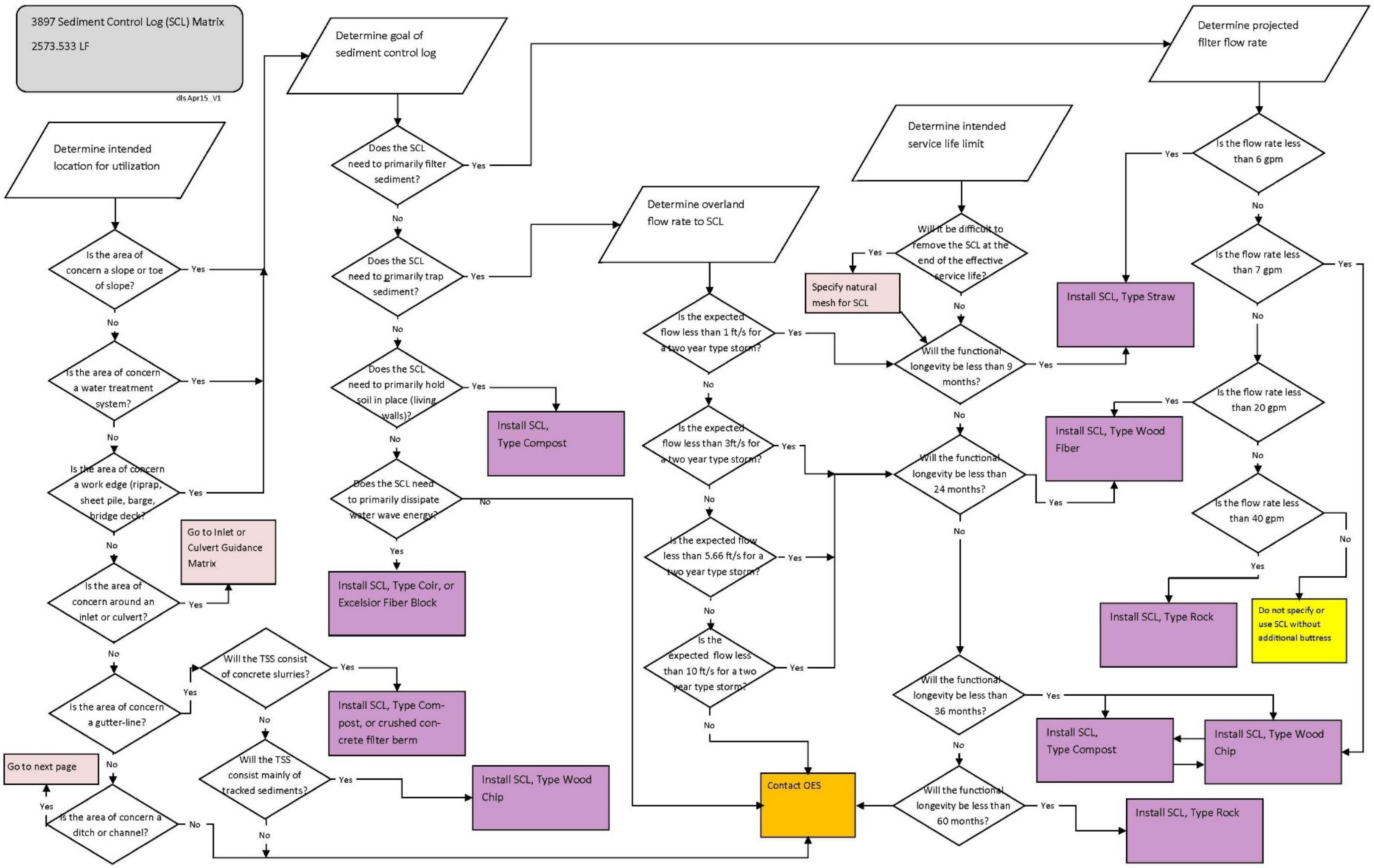
**<u>Removal</u>**

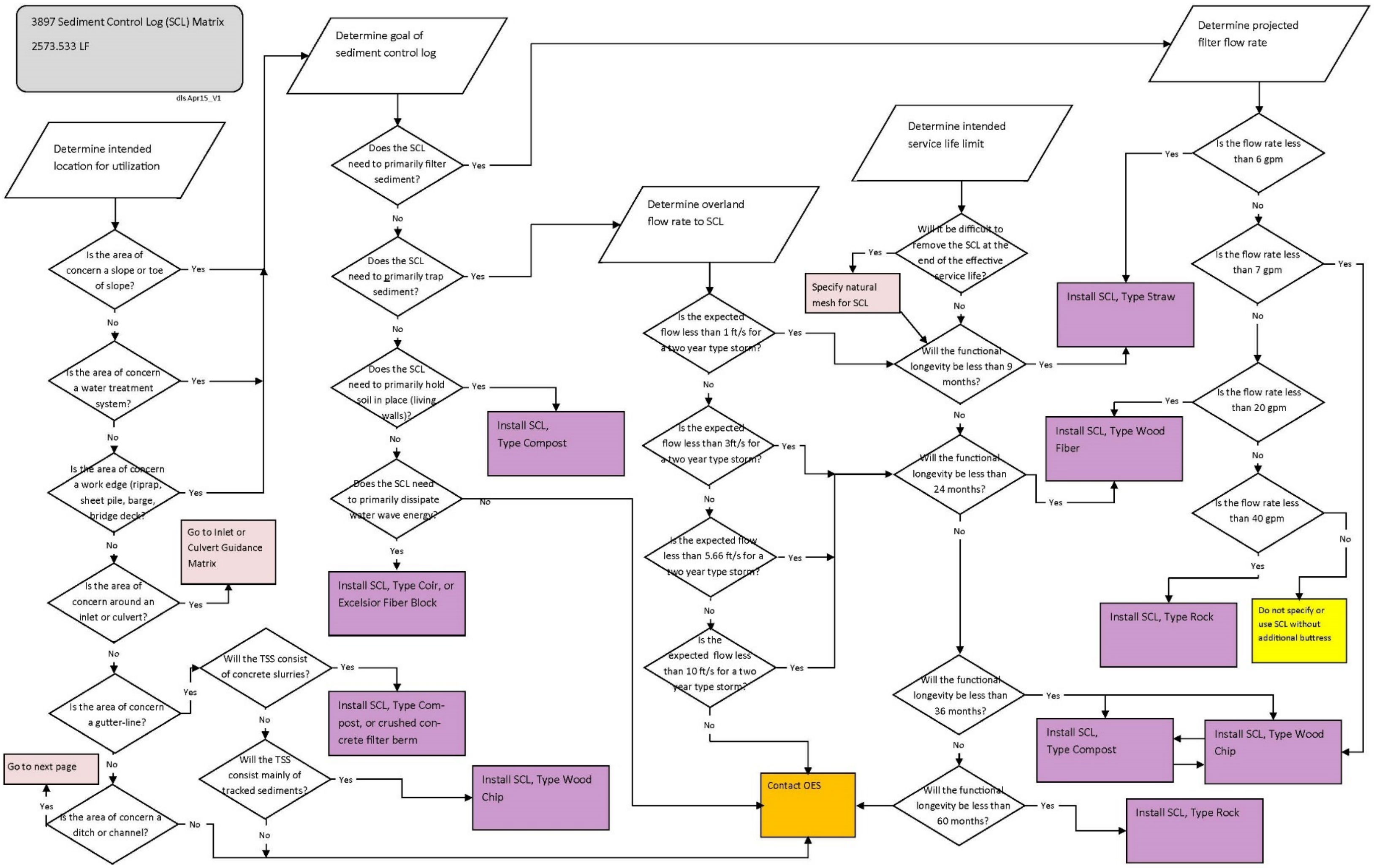
- For permanent installations, do not remove fiber rolls. Fiber rolls will degrade over time, while underlying soils are stabilized by other BMPs.
- 
- For temporary installations, remove fiber rolls, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

## Inspection and Maintenance

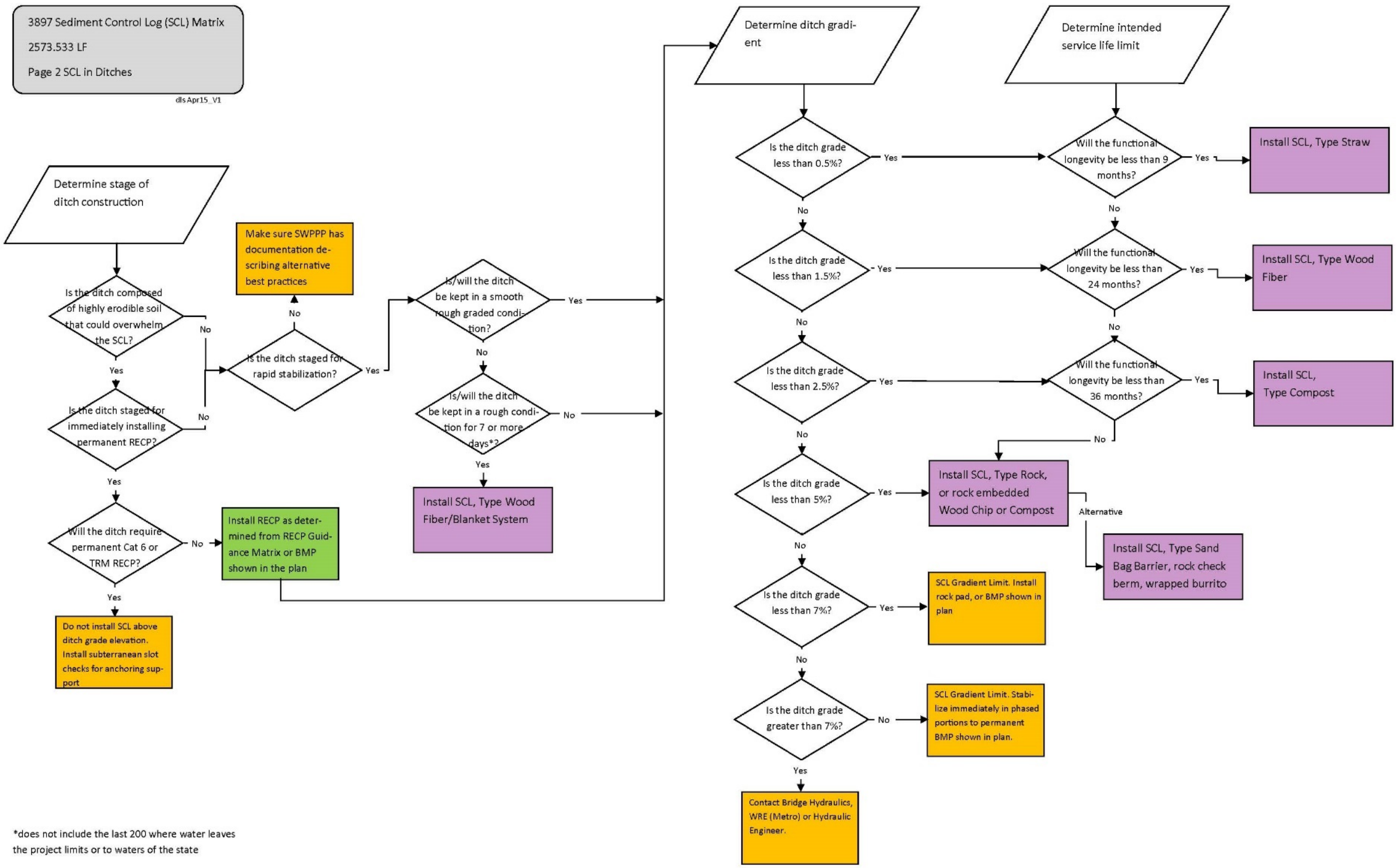
- Remove sediment from behind the fiber roll if sediment is 1/3 of fiber roll height above ground.
- Repair or adjust the fiber roll if rills or other evidence of concentrated runoff occur beneath the fiber roll.
- Repair or replace the fiber roll if they become split, torn, or unraveled.
- Add stakes if the fiber roll slumps or sags.
- Replace broken or split wood stakes.
- Remove sediment deposits, trash, and debris from fiber roll as needed. If removed sediment is deposited within project limits, it must be stabilized and not exposed to erosion by wind or water.
- Perform maintenance as needed or as required by the RE or CGP or requirements.
- Inspect fiber rolls before and following rainfall events and a least daily during prolonged rainfall. Perform maintenance as needed or as required by the RE.
- Maintain fiber rolls to provide an adequate sediment holding capacity and runoff velocity reduction.
- Fiber roll placement must be shown on the WPCDs

## Selection matrix





3897 Sediment Control Log (SCL) Matrix
2573.533 LF
dls Apr15_V1
Determine intended location for utilization
Is the area of concern a slope or toe of slope?
Is the area of concern a water treatment system?
Is the area of concern a work edge (riprap, sheet pile, barge, bridge deck)?
Is the area of concern around an inlet or culvert?
Go to Inlet or Culvert Guidance Matrix
Is the area of concern a gutter-line?
Is the area of concern a ditch or channel?
Go to next page
Determine goal of sediment control log
Does the SCL need to primarily filter sediment?
Does the SCL need to primarily trap sediment?
Does the SCL need to primarily hold soil in place (living walls)?
Install SCL, Type Compost
Does the SCL need to primarily dissipate water wave energy?
Install SCL, Type Coir, or Excelsior Fiber Block
Will the TSS consist of concrete slurries?
Install SCL, Type Compost, or crushed concrete filter berm
Will the TSS consist mainly of tracked sediments?
Install SCL, Type Wood Chip
Determine overland flow rate to SCL
Is the expected flow less than 1 ft/s for a two year type storm?
Is the expected flow less than 3ft/s for a two year type storm?
Is the expected flow less than 5.66 ft/s for a two year type storm?
Is the expected flow less than 10 ft/s for a two year type storm?
Contact OES
Determine intended service life limit
Will it be difficult to remove the SCL at the end of the effective service life?
Specify natural mesh for SCL
Will the functional longevity be less than 9 months?
Will the functional longevity be less than 24 months?
Will the functional longevity be less than 36 months?
Will the functional longevity be less than 60 months?
Install SCL, Type Straw
Install SCL, Type Wood Fiber
Install SCL, Type Compost
Install SCL, Type Wood Chip
Install SCL, Type Rock
Determine projected filter flow rate
Is the flow rate less than 6 gpm
Is the flow rate less than 7 gpm
Is the flow rate less than 20 gpm
Is the flow rate less than 40 gpm
Install SCL, Type Rock
Do not specify or use SCL without additional buttress
Yes
No


3897 Sediment Control Log (SCL) Matrix
2573.533 LF
Page 2 SCL in Ditches
dls Apr15_V1
Determine stage of ditch construction
Is the ditch composed of highly erodible soil that could overwhelm the SCL?
Yes
No
Is the ditch staged for immediately installing permanent RECP?
Yes
No
Will the ditch require permanent Cat 6 or TRM RECP?
Yes
No
Do not install SCL above ditch grade elevation. Install subterranean slot checks for anchoring support
Install RECP as determined from RECP Guidance Matrix or BMP shown in the plan
Is the ditch staged for rapid stabilization?
No
Yes
Make sure SWPPP has documentation describing alternative best practices
Is/will the ditch be kept in a smooth rough graded condition?
Yes
No
Is/will the ditch be kept in a rough condition for 7 or more days*?
No
Yes
Install SCL, Type Wood Fiber/Blanket System
Determine ditch gradient
Is the ditch grade less than 0.5%?
Is the ditch grade less than 1.5%?
Is the ditch grade less than 2.5%?
Is the ditch grade less than 5%?
Is the ditch grade less than 7%?
Is the ditch grade greater than 7%?
Yes
No
Contact Bridge Hydraulics, WRE (Metro) or Hydraulic Engineer.
SCL Gradient Limit. Install rock pad, or BMP shown in plan
SCL Gradient Limit. Stabilize immediately in phased portions to permanent BMP shown in plan.
Install SCL, Type Rock, or rock embedded Wood Chip or Compost
Alternative
Install SCL, Type Sand Bag Barrier, rock check berm, wrapped burrito
Determine intended service life limit
Will the functional longevity be less than 9 months?
Will the functional longevity be less than 24 months?
Will the functional longevity be less than 36 months?
Install SCL, Type Straw
Install SCL, Type Wood Fiber
Install SCL, Type Compost
*does not include the last 200 where water leaves the project limits or to waters of the state

## Typical Details

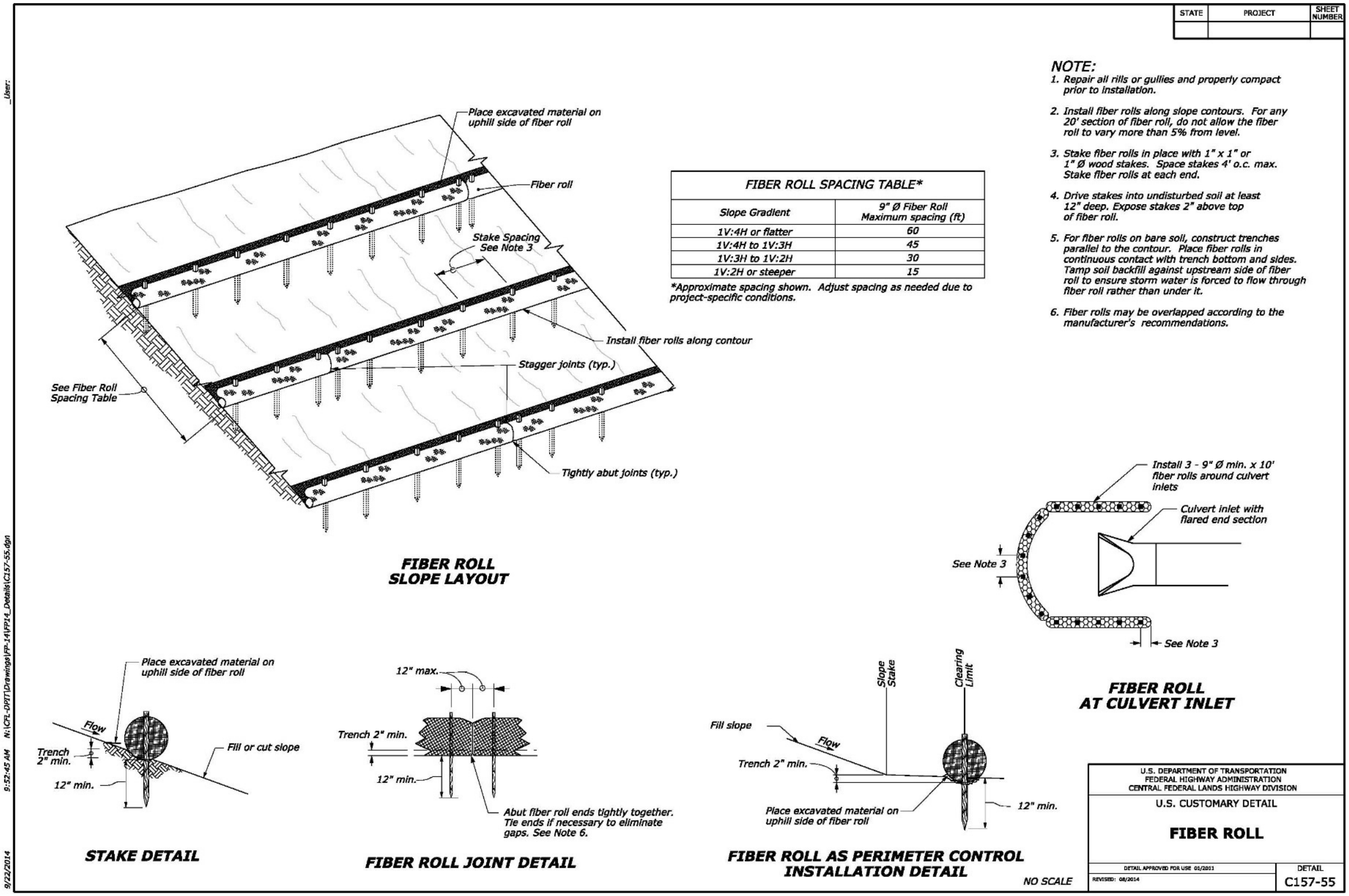



**Figure 49: Fiber Roll Detail**

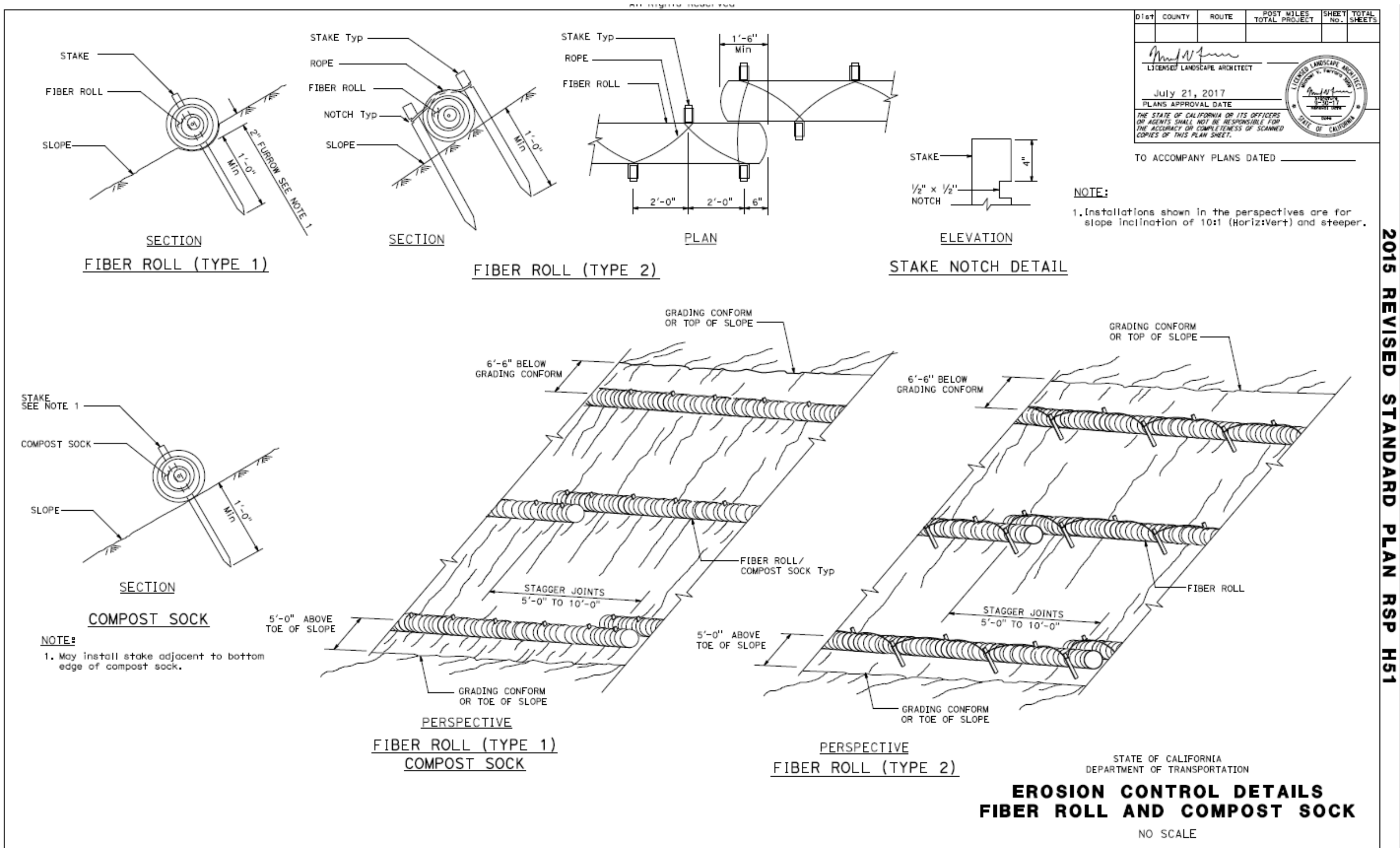



**Figure 50: Fiber Roll Alternate Staking Patterns Detail**

# 4.8.6 Gravel Bag / Earthen Berm

## Definition and Purpose

A gravel bag berm consists of a single row of gravel bags that are installed end-to-end to form a barrier across a slope to intercept runoff, reduce runoff velocity, release runoff as sheet flow and provide some sediment removal. The gravel bag berm should be installed along a level contour with the bags tightly abutted. Gravel bags can be used where flows are moderately concentrated, such as ditches, swales, and storm drain inlets (see SC-10 "Drainage Inlet Protection") to divert and/or detain flows.

Earthen berms are linear sediment barriers designed to intercept sheet flows. Water gets impounded upstream of the earthen berm, allowing sediment to settle out and releasing runoff as sheet flow, preventing erosion.

## Appropriate Applications

- BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the RE.
- Along streams and channels.
- Below the toe of exposed and erodible slopes.
- Down slope of exposed soil areas.
- Around stockpiles.
- Across channels to serve as a barrier for utility trenches or provide a temporary channel crossing for construction equipment, to reduce stream impacts.
- Parallel to a roadway to keep sediment off paved areas.
- At the top of slopes to divert roadway runoff away from disturbed slopes.
- Along the perimeter of a site.
- To divert or direct flow or create a temporary sediment basin.
- During construction activities in stream beds when the contributing drainage area is less than 5 ac.
- When extended construction period limits the use of either silt fences or straw bale barriers.
- When site conditions or construction sequencing require adjustments or relocation of the barrier to meet changing field conditions and needs during construction.
- At grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

## Limitations

- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Limited durability for long term projects.
- When used to detain concentrated flows, maintenance requirements increase.
- Earthen berms should not be used to intercept flows with moderate to high velocities that may erode the earthen berm.
- Earthen berms are susceptible to erosion from concentrated flows.

## Standards and Specifications

### Materials

- **Bag Material:** Bags must be a geosynthetic material, either polypropylene, polyethylene or polyamide woven fabric, minimum unit weight 4 ounces per yard$^2$, mullen burst strength exceeding 300 psi in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.
- Bag Size: Each gravel-filled bag should have a length of 24 to 32 inches, width of 16 to 20 inches, and thickness of 3 inches. Alternative bag sizes must be submitted to the RE for approval prior to deployment.
- Gravel: Fill material should be between 3/8 and 3/4 inch in diameter, and be clean and free from clay balls, organic matter, and other deleterious materials. The opening of gravel-filled bags must be secured such that gravel does not escape. Gravel-filled bags are between 30 and 50 lb in weight. Fill material is subject to approval by the PE.
- Earthen Berms should be made with native soil or selected material.

### Installation

- When used as a linear control for sediment removal:
  - Install along a level contour.
  - Place gravel-filled bags end-to-end to eliminate gaps in a gravel bag berm.
  - Angle the last 6 feet upslope at the downhill end of the run.
  - Stack the bags such that the upper row overlaps the joints in the lower row.
  - Add layers of gravel-filled bags to increase the height of a temporary gravel bag berm if needed. Stack the bags in the upper row to overlap the joints in the lower row. Stabilize the rows by adding rows of bags in the lower layers.
- Generally, gravel bag barriers can be used in conjunction with temporary soil stabilization controls up slope.
- Construct gravel bag barriers with a set-back from the toe of a slope. Where it is determined to be not practicable due to specific site conditions, the gravel bag barrier may be constructed at the toe of the slope, but be constructed as far from the toe of the slope as practicable.
- Refer to SC-4 “Check Dams” when used for concentrated flows.
- Submit a certificate of compliance for gravel-filled bag material.
- Earthen berms are constructed with either native soil or an alternative selected material.
- Earthen berms must be at least 8 inches in height and 36 inches in width
- Earthen berms must be compacted by manual or mechanical methods.

## Inspection and Maintenance

- Gravel bag/earthen berms must be inspected in accordance with CGP requirements for the associated project type and risk level or with LTCGP. At a minimum, BMPs must be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Reshape or replace gravel bags as needed, or as directed by the PE.
- Repair washouts or other damages as needed, or as directed by the PE.
- Inspect gravel bag/earthen berms for sediment accumulations and remove sediment when accumulation reaches one-third of the berm height. Removed sediment can be incorporated

in the project at locations designated by the PE or disposed of outside the highway right-of-way in conformance with the Standard Specifications.

- Remove gravel bag berms when no longer needed. Remove sediment accumulations and clean, re-grade, and stabilize the area.
- If using earthen berm, ensure soil remains compacted through the duration of the berm
- Maintain earthen berms to provide sediment-holding capacity and to reduce concentrated flow velocities.
- Repair the berm if rills or other evidence of concentrated runoff over it.
- Gravel Bag/Earthen Berm placement must be shown in the SWPPP and Site Maps as reflected in site conditions.

## Typical Details

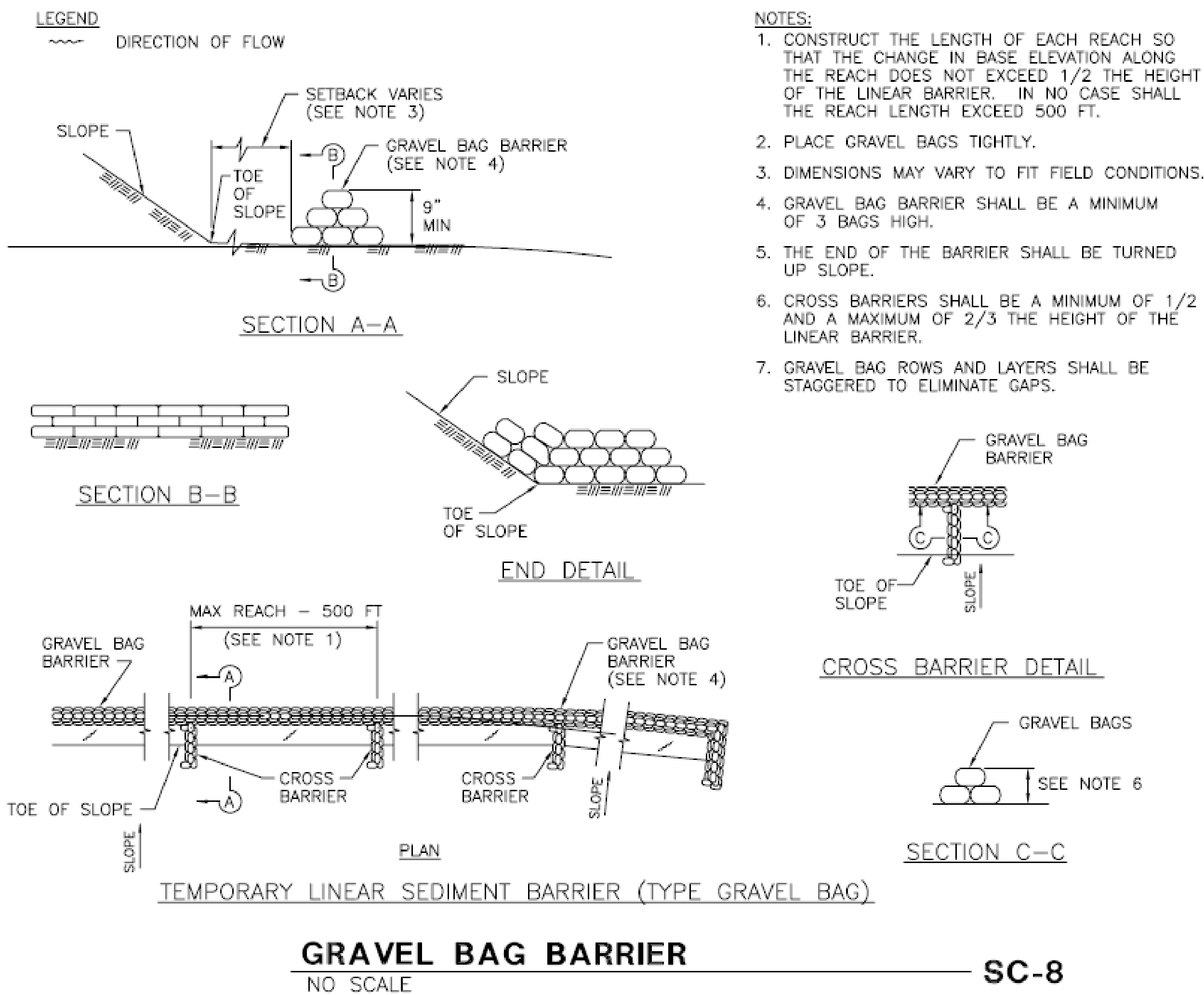



**Figure 51: Gravel Bag Barrier Detail**

# 4.8.7 STREET SWEEPING AND VACUUMING

## Definition and Purpose

Street sweeping and vacuuming are practices to remove tracked soil particles from paved roads to prevent the sediment from entering a storm drain or watercourse. Street sweeping and vacuuming are implemented anywhere sediment is tracked from the project site onto public or private paved roads, typically at points of egress.

## Appropriate Applications

These practices are implemented anywhere sediment is tracked from the project site onto public or private paved roads, typically at jobsite entrances and exits.

### 4.8.7.1 Limitations

Sweeping and vacuuming may not be effective when soil is wet or muddy.

## Standards and Specifications

**General Requirements**

- Sweep by hand or mechanical methods, such as vacuuming. Kick brooms or sweeper attachments may not be used.
- At least one street sweeper in good working order must be at the job site at all times when street sweeping work is required.
- Use one of the following types of street sweepers:
  - Mechanical sweeper followed by a vacuum-assisted sweeper;
  - Vacuum-assisted, dry, waterless, sweeper; or
  - Regenerative-air sweeper.
- Submit the number and type of street sweepers that will be used on the project for each activity at least 5 business days before starting the activities listed above. Keep and submit street sweeping activity records including sweeping times, locations, and the quantity of material collected.
- Sweep paved roads at construction entrance and exit locations and onsite paved areas:
  - During clearing and grubbing, earthwork, trenching, and pavement-structure construction activities.
  - When vehicles are entering and leaving the job site.
  - After soil-disturbing activities.
  - After observing off-site tracking of material.
- Sweep within 1 hour if sediment or debris is observed during the activities described above that require sweeping.
- Sweep within 24 hours if sediment or debris is observed during activities that do not require sweeping.
- Keep dust to a minimum during street sweeping activities. Use water for dust control or a vacuum whenever dust generation is excessive or sediment pickup is ineffective. Refer to "Wind Erosion Control" BMPs.
- Remove collected material, including sediment, from paved shoulders, drainage inlets, curbs and dikes, and other drainage areas.
- After sweeping is finished, collected material may be stockpiled. If not mixed with debris, trash or potentially hazardous objects, consider incorporating the removed sediment back

into the project if approved by the PE. Otherwise, dispose of stockpiled material at least once per week.

- Street sweeping does not void the requirements for residue collection included in other work activities, such as grooving, grinding, or asphalt concrete planning.

## Inspection and Maintenance

- Inspect potential sediment tracking locations daily.
- Monitor and inspect tracking control BMPs such as TC-1, "Temporary Construction Entrance/Exit," to reduce sediment accumulation on roads.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- Sweeper material must be disposed in compliance with waste regulations.

## Typical Details

None specified to date for this manual.

# 4.8.8 SAND BAG BARRIER

## Definition and Purpose

A sand bag barrier is a temporary linear sediment barrier consisting of stacked sand bags, designed to intercept and slow the flow of sediment-laden sheet flow runoff. Sand bag barriers allow sediment to settle from runoff before water leaves the construction site.

## Appropriate Applications

Sand bags can also be used:

- Where flows are moderately concentrated to divert and/or detain flows;
- Along the perimeter of a site;
- Along streams and channels;
- Below the toe of exposed and erodible slopes; and
- Around stockpiles.
- Across channels to serve as a barrier for utility trenches or provide a temporary channel crossing for construction equipment, to reduce stream impacts.
- Parallel to a roadway to keep sediment off paved areas.
- At the top of slopes to divert roadway runoff away from disturbed slopes.
- To divert or direct flow or create a temporary sediment/desilting basin.
- During construction activities in stream beds when the contributing drainage area is less than 5 ac.
- When extended construction, period limits the use of either silt fences or straw bale barriers.
- Along the perimeter of vehicle and equipment fueling and maintenance areas or chemical storage areas.
- To capture and detain non-stormwater flows until proper cleaning operations occur.
- When site conditions or construction sequencing require adjustments or relocation of the barrier to meet changing field conditions and needs during construction.
- To temporarily close or continue broken, damaged or incomplete curbs.

## Limitations

- Limit the drainage area upstream of the barrier to 5 ac.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor intensive.
- Limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.
- Consider using gravel bags whenever possible since they often do not require as much maintenance or impact wildlife when used near Environmentally Sensitive Areas.

## Standards and Specifications

<u>Materials</u>

- **Sandbag Material:** Sandbag can be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight four ounces per square yard, mullen burst strength exceeding 300 psi in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap is not acceptable.

- **Sandbag Size:** Each sand-filled bag should have a length of 18 in, width of 12 in, thickness of 3 in, and mass of approximately 33 lb. Bag dimensions are nominal, and may vary based on locally available materials. Alternative bag sizes must be submitted to the RE for approval prior to deployment.
- **Fill Material:** All sandbag fill material can be non-cohesive, Class 1 or Class 2 permeable material free from clay and deleterious material, conforming to the provisions in Standard Specifications Section 47-2.02D "Permeable Material". The requirements for the Durability Index and Sand Equivalent do not apply. Fill material is subject to approval by the PE.

**Installation**

- When used as a linear sediment control:
    - Install along a level contour.
    - Turn ends of sandbag row up slope to prevent flow around the ends.
    - Generally, sandbag barriers may be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Construct sandbag barriers with a set-back of at least 3 ft from the toe of a slope. Where it is determined to be not practical due to specific site conditions, the sandbag barrier may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable.

## Inspection and Maintenance

- Inspect sandbag barriers before and after each rainfall event, and weekly year round.
- Reshape or replace sandbags as needed, or as directed by the RE.
- Repair washouts or other damages as needed, or as directed by the RE.
- Inspect sandbag barriers for sediment accumulations and remove sediments when accumulation reaches one-third the barrier height. Removed sediment can be incorporated in the project at locations designated by the PE or disposed of outside the highway right-of-way.

Remove sandbags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilized the area.

## Typical Details

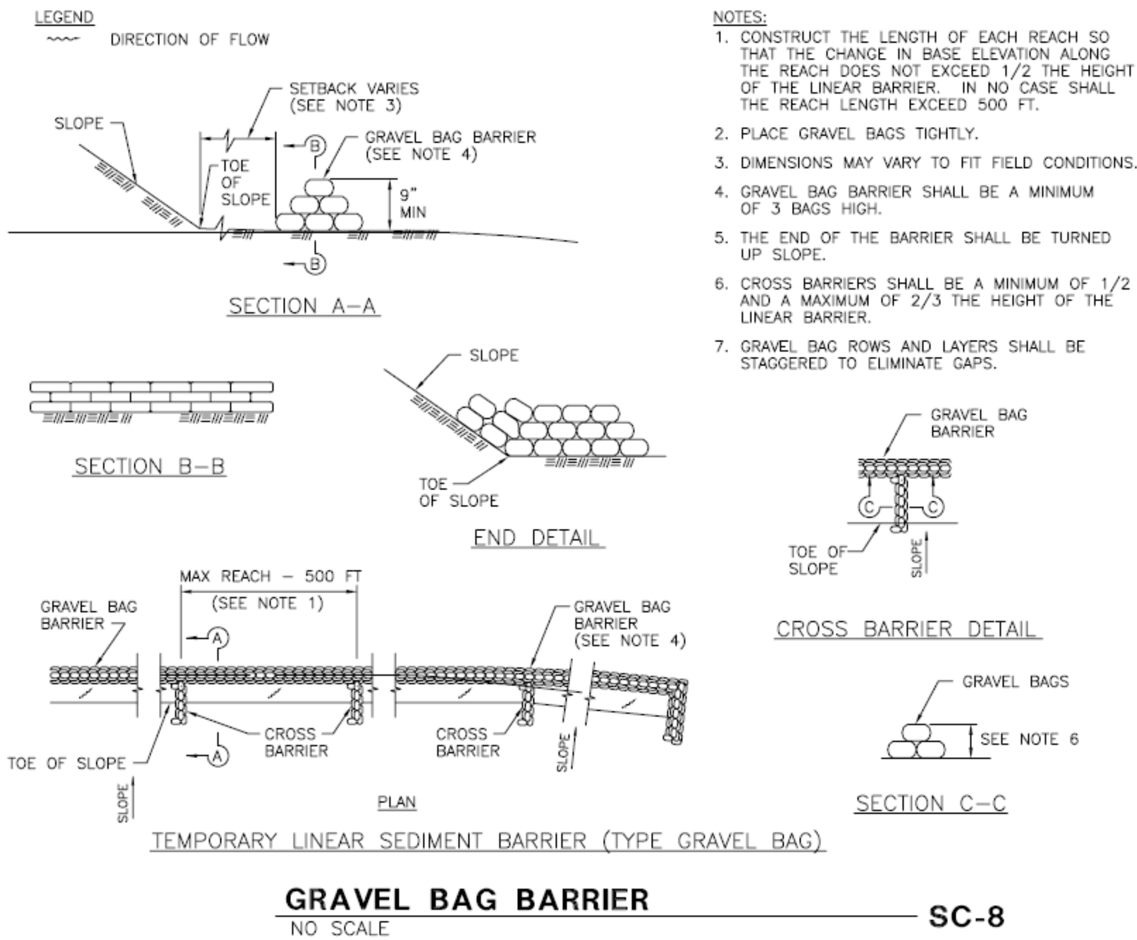



**Figure 52: Gravel Bag Barrier Detail**

# 4.8.9 STRAW BALE BARRIER

## Definition and Purpose

A straw bale barrier is a temporary linear sediment barrier consisting of straw bales, designed to intercept and slow sediment-laden sheet flow runoff. Straw bale barriers allow sediment to settle from runoff before water leaves the construction site.

## Appropriate Applications

Typical applications for straw bale barriers include:

- Along the perimeter of a site;
- Along streams and channels;
- Below the toe of exposed and erodible slopes;
- Downslope of exposed soil areas; and
- Around stockpiles.
- Across minor swales or ditches with small catchments.
- Around above grade type temporary concrete washouts (see "Concrete Waste Management").
- Parallel to a roadway to keep sediment off paved areas.

## Limitations

- Installation can be labor intensive.
- Straw bale barriers are maintenance intensive.
- Degraded straw bales may fall apart when removed or left in place for extended periods.
- Can't be used on paved surfaces.
- Not to be used for drain inlet protection.
- Not to be used in areas of concentrated flow.
- Can be an attractive food source for some animals.
- May introduce undesirable non-native plants to the area.

## Standards and Specifications

<u>Materials</u>

- Straw must conform to the provisions in Section 713.
- Each straw bale should be a minimum of 14 in wide, 18 in high, 36 in long and shave a minimum weight of 50 lb.
- The straw bale must be composed entirely of vegetative matter, except for the binding material.
- Bales can be bound by either wire, nylon, or polypropylene string placed horizontally. Jute and cotton binding may not be used. Baling wire should be at least 16 gauge. Nylon or polypropylene string should have a diameter of approximately 0.08 in with a breaking strength of 80 lbs.
- Wood or metal posts should be used as stakes. Posts for straw bale barriers must comply with Section 713

<u>Installation</u>

- Place a single row of straw bales end-to-end and parallel with the slope contour. For any 20-foot section of straw bale barrier, do not allow it to vary by more than 5% from level.

- Place straw bales in a trench or key them into the slope. Place the bales such that the binding wire or string does not come in contact with the soil. Use wood or metal posts as stakes.
- Secure each straw bale with two posts. The first post in each bale must be driven toward the previously laid bale to force the bales together. Drive the posts into the soil such that the top of the post is less than 2 in. above the top of the straw bale. The post must extend a minimum of 2 ft in the ground below the bottom of the straw bales.
- Angle the last 6 feet upslope at the downhill end of the run.

See page 5 of this BMP for installation detail.

**Other Considerations**

- Construct straw bale barriers with a set-back of at least 3 ft from the toe of a slope. Where it is determined to be not practical due to specific site conditions, the straw bale barrier may be constructed at the toe of the slope, but be constructed as far from the toe of the slope as practical.
- This BMP may be implemented on a project-by-project basis in addition to other BMPs when determined necessary and feasible by the PE.
- Straw bale barriers may be used in combination with a silt fence (see "Silt Fence") for additional sediment control.

### Inspection and Maintenance

- At a minimum, BMPs must be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect straw bale barriers for sediment accumulations and remove sediment when depth reaches one-third the barrier height. Removed sediment should be disposed of outside the highway right-of-way in conformance with the Standard Specifications.
- Replace or repair damaged bales as needed or as directed by the PE.
- Repair washouts or other damages as needed or as directed by the PE.
- Remove straw bales when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilized the area.

Straw Bale Barrier placement must be shown on the WPCDs and reflect current site conditions.

## Typical Details

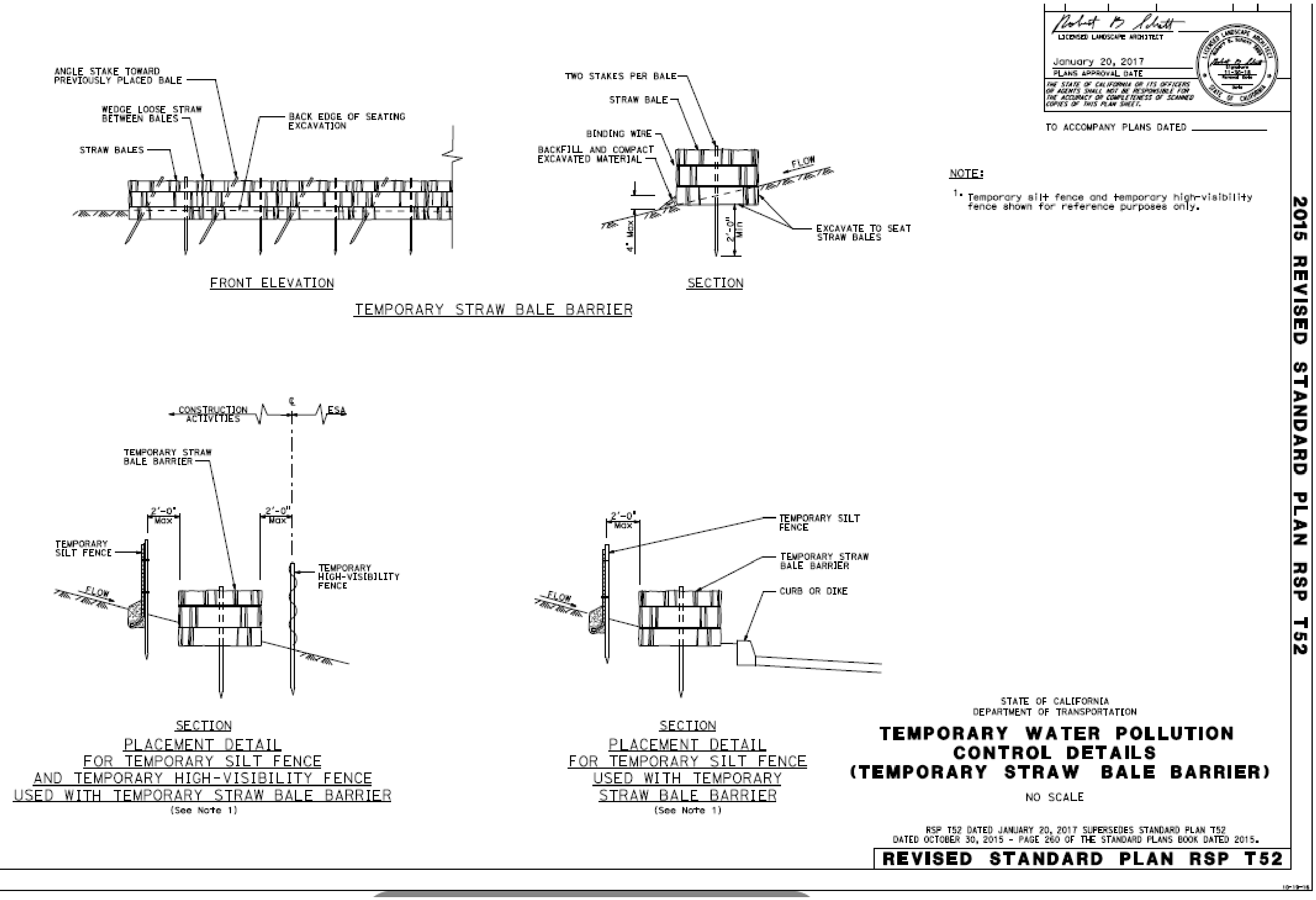



**Figure 53: Straw Bale Barrier Detail**

# 4.8.10 Storm Drain Inlet Protection

## Definition and Purpose

Storm drain inlet protection is a practice to reduce sediment from storm water runoff discharging from the construction site prior to entering the storm drainage system. Effective storm drain inlet protection allows sediment to settle out of water or filters sediment from the water before it enters the drain inlet. Storm drain inlet protection is the last line of sediment control defense prior to storm water leaving the construction site.

## Appropriate Applications

Storm drain inlet protection is used:

- Where ponding will not encroach into highway traffic;
- Where sediment-laden surface runoff may enter an inlet;
- Where disturbed drainage areas have not yet been permanently stabilized; and
- Where the drainage area is 0.4 ha (1 acre) or less.
- Used year-round.

## Limitations

- Requires an adequate area for water to pond without encroaching upon traveled way and should not present an obstacle to oncoming traffic.
- May require other methods of temporary protection to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.
- 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, such as SC-4 “Check Dams,” in conjunction with temporary drainage inlet protection.
- Frequent maintenance is required.
- Silt fence inlet protection is appropriate in open areas that are subject to sheet flow and for flows not exceeding 0.5 cfs.
- Gravel bag barriers for inlet protection are applicable when sheet flows or concentrated flows exceed 0.5 cfs, and it is necessary to allow for overtopping to prevent flooding.
- Fiber rolls and foam barriers are not appropriate for locations where they cannot be properly anchored to the surface.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected and overflow capability is needed.
- For drainage areas larger than 1 ac, runoff should be routed to a sediment trapping device designed for larger flows. See BMPs “Sediment/Desilting Basin,” and “Sediment Trap/Curb Cutback.”
- 

## Standards and Specifications

<u>General Requirements</u>

- Identify existing and/or planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed, and which method or combination of methods to use. Update inlet protection as site conditions change.

- Use a linear sediment barrier to redirect runoff and control ponding in order to prevent ponding from encroaching on the traveled way or overtopping the curb or dike.
- Prior to installation, clear the area around each inlet of obstructions, including rocks, clods, and debris greater than 1-in. in diameter.
- Install linear sediment barriers upstream of the inlet and parallel with the curb, dike, or flow line to keep sediment from entering the inlet.

Remove accumulated sediment according to Maintenance and Inspection recommendations. Accumulated sediment may be disposed of outside the highway right-of-way in conformance with the Standard Specifications Section 14-10.

**Silt Fence**

This method should be used for drain inlets requiring protection in areas where finished grade is established and erosion control seeding has been applied or is pending. The silt fence (Type 1) protection is illustrated in the typical section below. Do not place filter fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced.

**Excavated Drop Inlet Sediment Trap**

This method may be used for drainage inlets requiring protection in areas that have been cleared and grubbed, and where exposed soil areas are subject to grading. The excavated drop inlet sediment trap (Type 2) is illustrated in the Typical Sections below. Similar to constructing a temporary silt fence; see BMP "Silt Fence." Size the excavated trap to provide a minimum storage capacity calculated at the rate of 67 yd3/ac of drainage area.

**Gravel Bag Berm for Grate Inlets**

This method may be used for drainage inlets surrounded by AC or paved surfaces. The gravel bag berm for grate inlets (Type 3B) is illustrated in the Typical Sections below. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Place gravel bags in accordance with BMP "Gravel Bag Berm." Gravel bags are used due to their high permeability.

**Flexible Sediment Barrier for Grate Inlets**

This method may be used for drainage inlets requiring protection in areas that have been cleared and grubbed, and where exposed soil areas subject to grading. Flexible Sediment Barrier for Grate Inlets is placed around the inlet and keyed and anchored to the surface. Flexible Sediment Barriers are intended for use as inlet protection where the area around the inlet is unpaved and the foam barrier or fiber roll can be secured to the surface. Place fiber rolls over the erosion control blanket. PE or appropriate licensed professional approval is required.

**Flexible Sediment Barrier for Combined Inlets**

This method may be used for drainage inlets requiring protection in areas that have been cleared and grubbed, and where exposed soil areas subject to grading. Flexible Sediment Barrier for Combined Inlets is placed in rows upstream of the inlet and along the curb or dike. The barriers are keyed and anchored to the surface. Flexible Sediment Barriers are intended for use as inlet protection where the area around the inlet is unpaved and the foam barrier or fiber roll can be secured to the surface. Place the barrier to provide a tight joint with the curb or dike. Cut the cover fabric or jacket to ensure a tight fit. PE approval is required.

**Sediment Filter Bag**

- This method may be used in areas with vehicle and equipment traffic that could damage aboveground inlet protection devices. The Sediment Filter Bags are installed as follows: (1) Remove the drainage inlet grate, (2) Place the sediment filter bag in the opening, and (3) Replace the grate to secure the sediment filter bag in place.

**Catch Basin with Grate**

- Catch Basin with Grate (Type 6A) is shown on page 16. Cover grate inlet with rigid plastic barrier and secure on each end with gravel-filled bags. If using a rigid sediment barrier and the grated inlet does not have a curb opening, placed the barrier using a gasket to prevent runoff from flowing under the barrier. Secure the barrier to the pavement with nails and adhesive, gavel-filled bags, or a combination of both.

**Curb Inlet without Grate**

- Curb Inlet without Grate (Type 6B) is shown on page 16. Place the flexible sediment barrier across the curb inlet opening and secure with gravel-filled bags.

## Inspection and Maintenance

**General Requirements**

- Inspect all drainage inlet protection devices before and after every rainfall event and weekly year round. During extended rainfall events, inspect inlet protection devices at least once every 24 hours.
- Inspect the storm drain inlet after severe storms to check for bypassed material.
- Remove all drainage inlet protection devices within thirty days after the site is stabilized, or when the inlet protection is no longer needed.
    - Bring the disturbed area to final grade and smooth and compact it. Appropriately stabilize all bare areas around the inlet.

Clean and re-grade area around the inlet and clean the inside of the storm drain inlet as it must be free of sediment and

**Filter Fabric Fence**

- Make sure the stakes are securely driven in the ground and are structurally sound (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes.
- Replace or clean the fabric when the fabric becomes clogged with sediment. Make sure the fabric does not have any holes or tears. Repair or replace fabric as needed or as directed by the RE.
- At a minimum, remove the sediment behind the fabric fence when accumulation reaches one-third the height of the fence or barrier height at the time of final inspection.

**Excavated Drop Inlet Sediment Trap**

- Remove sediment from basin when the volume of the basin has been reduced by one-half.

**Gravel Bag Berm for Combined Inlets**

- Inspect bags for holes, gashes, and snags.
- Check gravel bags for proper arrangement and displacement. Remove the sediment behind the barrier when it reaches one-third the height of the barrier.

**Gravel Bag Berm for Grate Inlets**

- Inspect bags for holes, gashes, and snags.
- Check gravel bags for proper arrangement and displacement. Remove the sediment behind the barrier when it reaches one-third the height of the barrier.

**Flexible Sediment Barrier for Grate Inlets**

- Check flexible sediment barrier for proper arrangement and displacement.
- Remove the sediment behind the barrier when it reaches one-third the height of the barrier.

**Flexible Sediment Barrier for Combined Inlets**

- Check flexible sediment barrier for proper arrangement and displacement.
- Remove the sediment behind the barrier when it reaches one-third the height of the barrier.

**Sediment Filter Bag**

- ■ Change sediment filter bag carefully ensuring not to spill captured sediment into the drainage inlet.

**Catch Basin with Grate**

- Check barrier and gravel-filled bags for proper arrangement and displacement. Routinely remove accumulated sediment

**Curb Inlet without Grate**

- Check barrier and gravel-filled bags for proper arrangement and displacement.
- Remove the sediment behind the barrier when it reaches one-third the height of the barrier.

## Selection Matrix

**INLET RINGS**

Typical Uses: Part of inlet staging program. Standard inlet protection for field and pre-curb and gutter

Field inlets,

pre-curb/gutter,

Slot drains

bridge scupper filter plugs,

Enhancing performance with other inlet BMPs

Ranking of performance:

SCL Wood Fiber Ring (must be staked)

SCL Wood Chip Ring

SCL Compost Ring

SCL Rock Ring

Silt Fence Ring

SuperDuty SF Ring

**Strengths**

Customizable for flow rate, safety overflows

Can be combined with sediment trap rings for improved length of sediment collection service

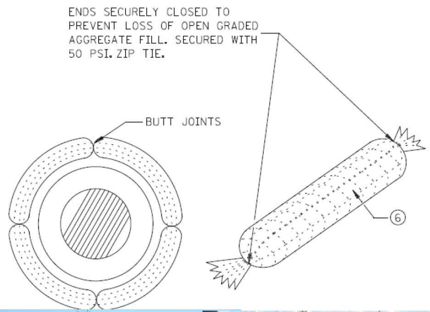
Rapid installation

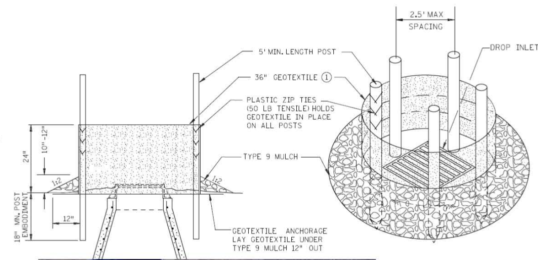
Some rings easily mobilized out of way

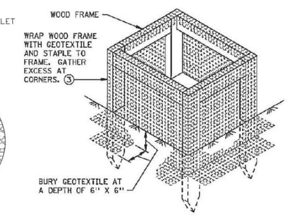
Increases sediment capture capacity

**Weakness**

Devices vary in height with various sediment collec-
















**INLET INSERTS**

Standard storm drain inlet for urban curb and gutter. Minimum requirement of emergency overflow to limit localized flooding

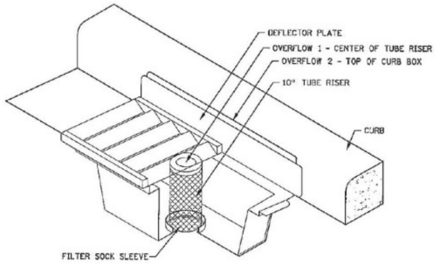
**Strengths**

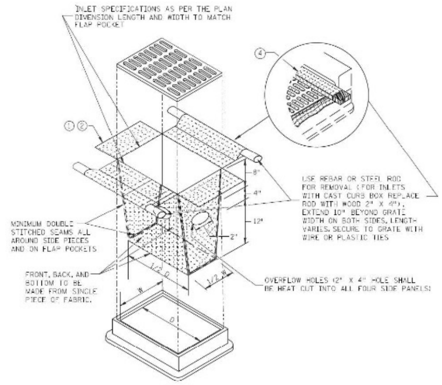
Safety overflow

Visual determination for maintenance

**Weakness**

Some version can be dropped into structure below




**INLET SEALS**

Typical usage: Field, precurb, curb, and Bridge scuppers

1. Geotextile semi-seal: bituminous milling, bituminous placement
2. Plug seal: isolation of non-stormwater discharges from concrete saw cutting, planning, refueling, structure cleaning, and sediment entry prevention
3. Diversion of storm water from multiple interconnected inlets to one downgrade with appropriate controls

Typical materials: low flow geotextile, plastic, tape, foam, ramneck

**Strengths**

Nothing lost to storm drain

Reduces number inlets from routine inspection and documentation

Allow focus on limited areas of controlled drainage locations

**Weakness**

High maintenance

Can increase localized flooding

Can saturate the grade

Can increase sediment transport along proposed conveyance


**INLET GRATE OVERLAY**

Typical usage: areas nearing completion of land disturbance where 1 acre or less remains exposed or project access over BMP

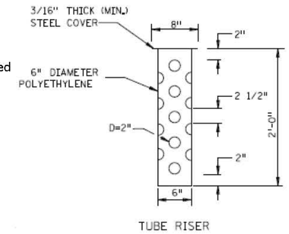
**Strength**

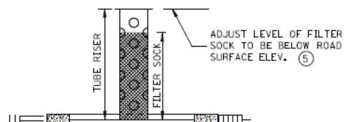
Quick

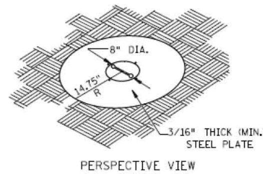
**Weakness**

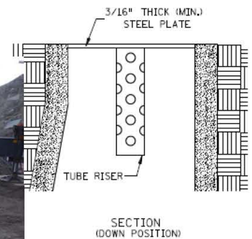
High maintenance

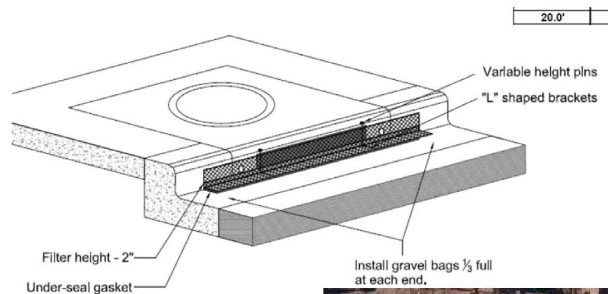
Unable to see structure below




**INLET RISERS**

Typical usage: Areas where the ditch, future gutter or existing pavements can be temporarily used for increased sediment trapping with adjustments to overflow elevation controls

**Strengths**

Increases sedimentation capacity

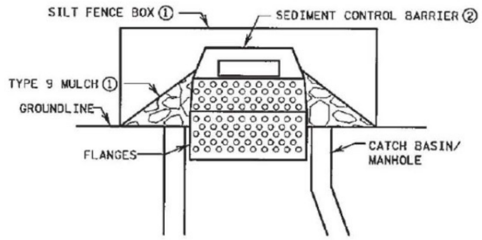
**Weakness**

Unsafe for public use of road

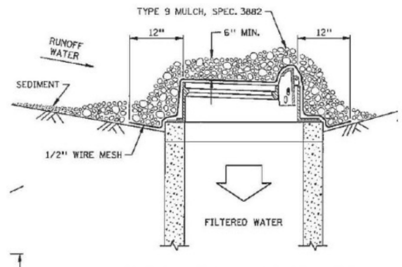
Overflow elevation can cause localized flooding

High maintenance

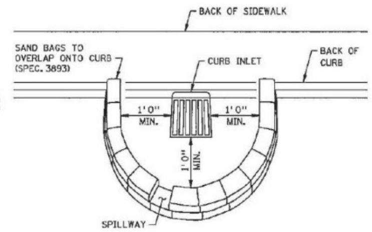
Can be difficult to properly install



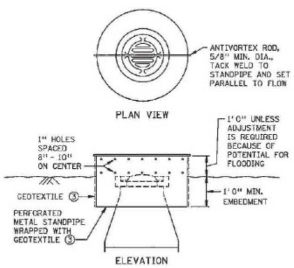

SEDIMENT CONTROL BARRIER ②




AGGREGATE FILTER AT CURB INLET
(TYPE B WITHOUT CURB SPEC. 3891)
(TYPE C WITH CURB SPEC. 3891)




SANDBAG BARRIER AT STREET INLET
THIS INLET PROTECTION IS USED DURING ROUGH GRADING ONLY. USE BEFORE ROAD IS OPEN TO TRAFFIC OR IS PAVED. (SPEC. 3893)




RISER STANDPIPE
TO PROTECT DROP INLET

**INLET TRAP**: converted into sediment/material traps

Typical usage: large scale pollution generating activity within storm water conveyance systems. Slurry, debris or equipment washoff is directed to shuttered storm drain inlet for vacuum truck or pump lift station slurry/material removals and treatment elsewhere.

Example Construction Operations

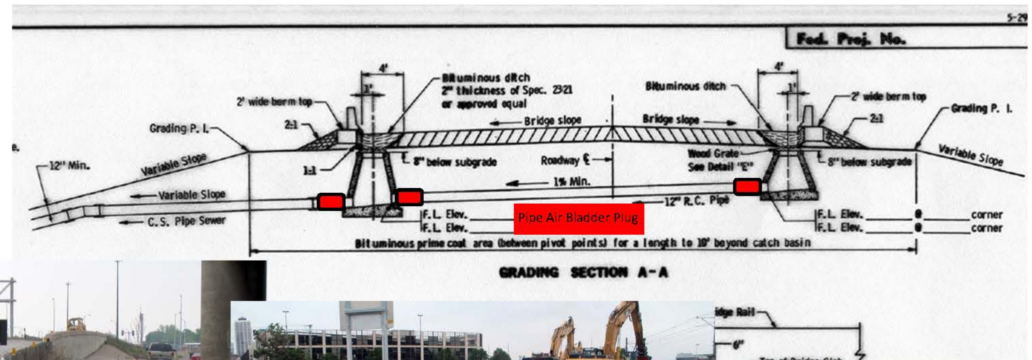
Pavement saw cutting
High volume dust suppression Demolitions
Concrete equipment washoff
Structure cleaning
Structure surface blasting

**Strengths**

Prevents loss to reciveing waters, allows urban pavement rehabilitation, concrete paving and slip forming machine washoff method when every grade base surface is not available.

**Weakness**

Prone to overflow if not regularly vacuumed




**INLET SKIMMER**

Typical usage: surface pond inlet skimmer for sediment trap controlled discharge for maximum effective sedimentation.

**Strengths**

NPDES permit requirement for temporary sediment traps with 10/5 acres of upgradient exposed soil drainage

Prepares sediment trap for next storm event

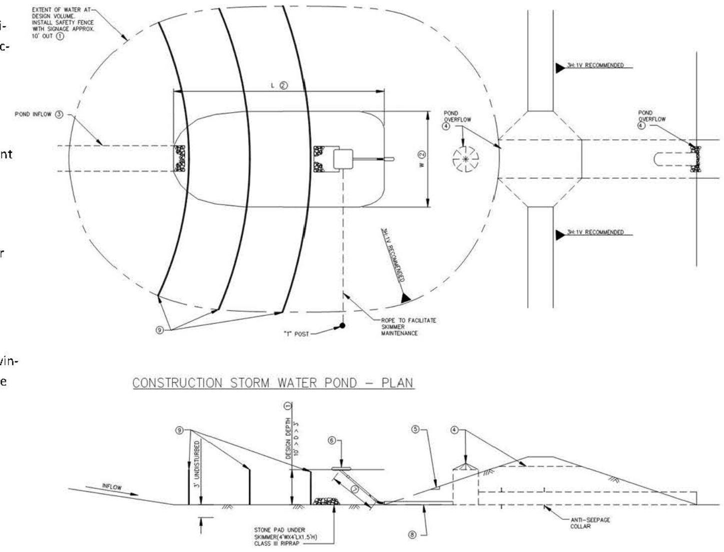
Allows visual inspection of collected sediments for appropriate cleanout

**Weakness**

Difficult to install in myriad of outfall structures, winter freeze-up, initial surfaced water extraction rate determination

3875 Water Treatment

2573.511 Water Treatment Type Floating Head Skimmer




CONSTRUCTION STORM WATER POND – PLAN

CONSTRUCTION STORM WATER POND – SECTION

NOTES:

① DESIGN POND VOLUME AT THE DESIGN DEPTH (D) TO HOLD 2.5-INCHES OF WATER OVER THE INFLOW DRAINAGE AREA (SEE POND SIZING CHART BELOW). INSTALL SAFETY FENCE AROUND OUTER EXTENT AND WARNING SIGNS AT ALL FOUR SIDES STATING DROWNING HAZARD .

② POND WIDTH (W) SHALL BE APPROXIMATLY HALF THE LENGTH (L).

③ POND INFLOW MUST BE CONVEYED TO PREVENT EROSION.

④ POND OVERFLOW MUST BE PROPERLY DESIGNED TO CONVEY STORM WATER IN EXCESS OF THE POND VOLUME TO THE RECEIVING WATERWAY WITHOUT CAUSING EROSION. THIS MAY INCLUDE A RISER PIPE DROP STRUCTURE WITH PIPE THROUGH THE EMBANKMENT WITH SEEPAGE COLLARS AND/OR A POND OVERFLOW SPILLWAY.

⑤ POND SIDE SLOPES SHALL BE LINED TO PREVENT EROSION.

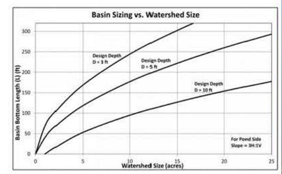
⑥ THE POND SKIMMER DEVICE SHALL BE DESIGNED TO SKIM WATER FROM WITHIN 6-INCHES OF THE POND SURFACE AND DRAIN THE DESIGN POND VOLUME OVER A PERIOD OF 72 HOURS WITH A CONSTANT FLOW RATE. SEE SPECIAL PROVISIONS FOR MATERIALS. INSTALL OIL ABSORBENT BOOM AROUND EXTIRE PREIMETER OF SKIMMER.

⑦ THE ARM PIPE TO THE SKIMMER SHALL HAVE A LENGTH OF 1.4 TIMES THE DESIGN POND DEPTH (A MINIMUM OF 6 FEET) OR AS RECOMMENED BY MANUFACTURE.

⑧ THE BOTTOM OF THE ARM PIPE SHALL BE ATTACHED TO THE RISER STRUCTURE OR DIRECTLY TO A PIPE THROUGH THE EMBANKMENT TO CONVEY SKIMMER WATER DOWNSTREAM. SEE SHEET XX FOR CONNECTION EXAMPLES.

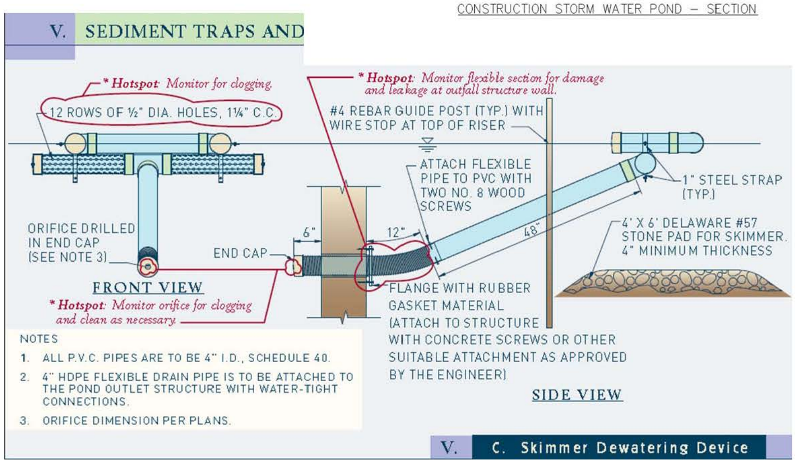
⑨ INSTALL THREE POND FIBER BAFFLES IN THE POND FROM THE INFLOW TO THE SKIMMER DEVICE WITH A SPACING OF ONE QUARTER THE BASIN LENGTH (L). TWO POND FIBER BAFFLES MAY BE INSTALLED IN PONDS LESS THAN 20-FEET IN LENGTH WITH A SPACING OF ONE THIRD THE BASIN LENGTHI. SEE POND BAFFLE DETAIL.

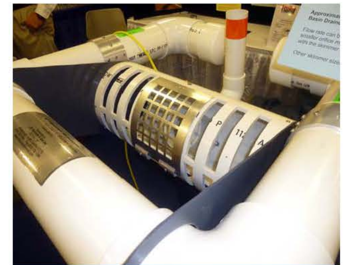
⑩ [redacted]

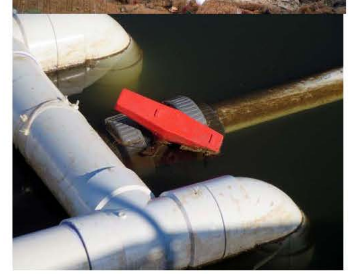



POND SIZING CHART

| STANDARD SHEET NO. XXX | TITLE: XXX | |
|---|---|---|
| STANDARD APPROVED: XXX | XXX | |
| STATE PROJ. NO. | (TH ) | SHEET NO. OF SHEETS |



## Typical Details

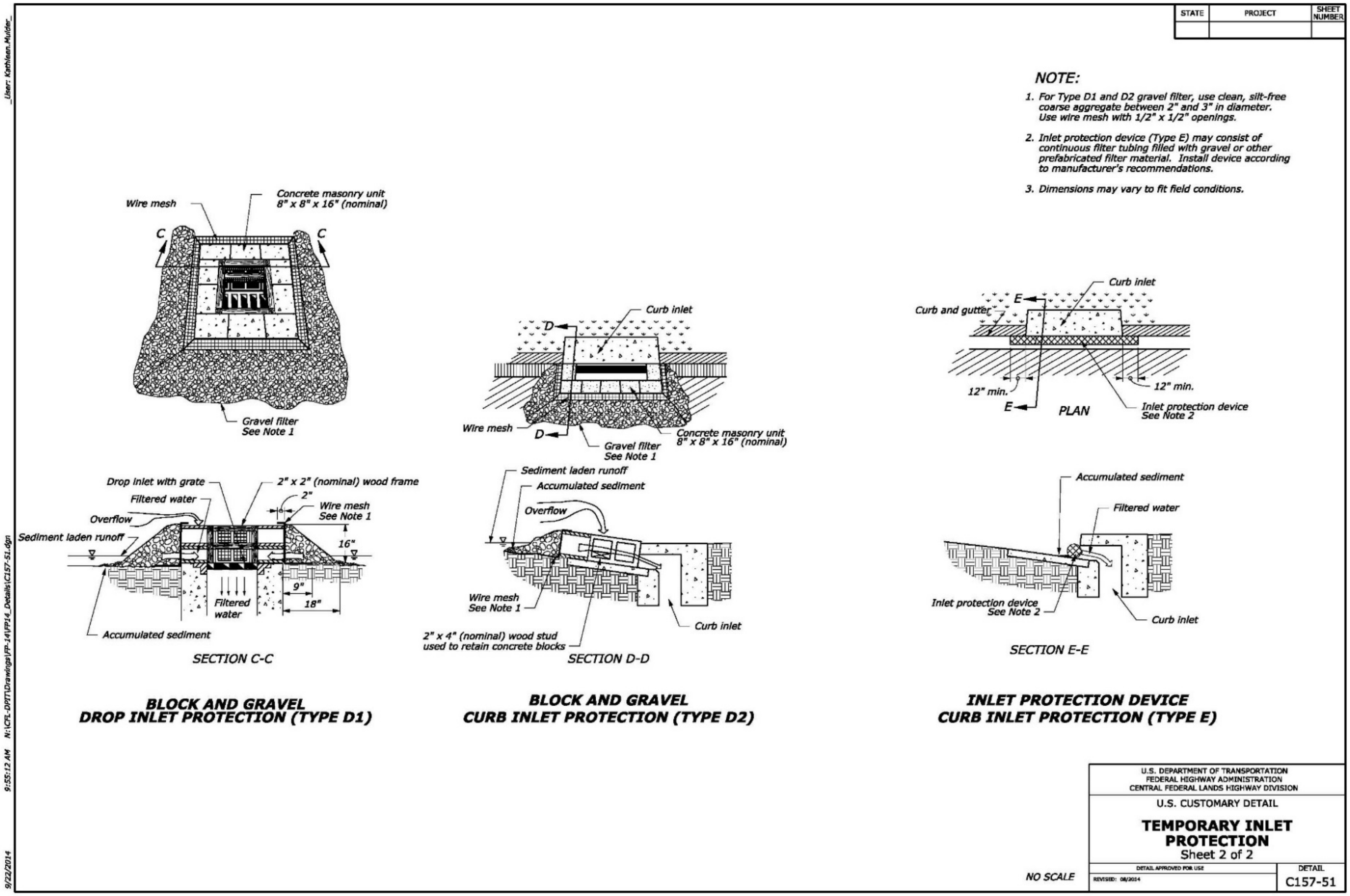



**Figure 54: Temporary Inlet Detail**

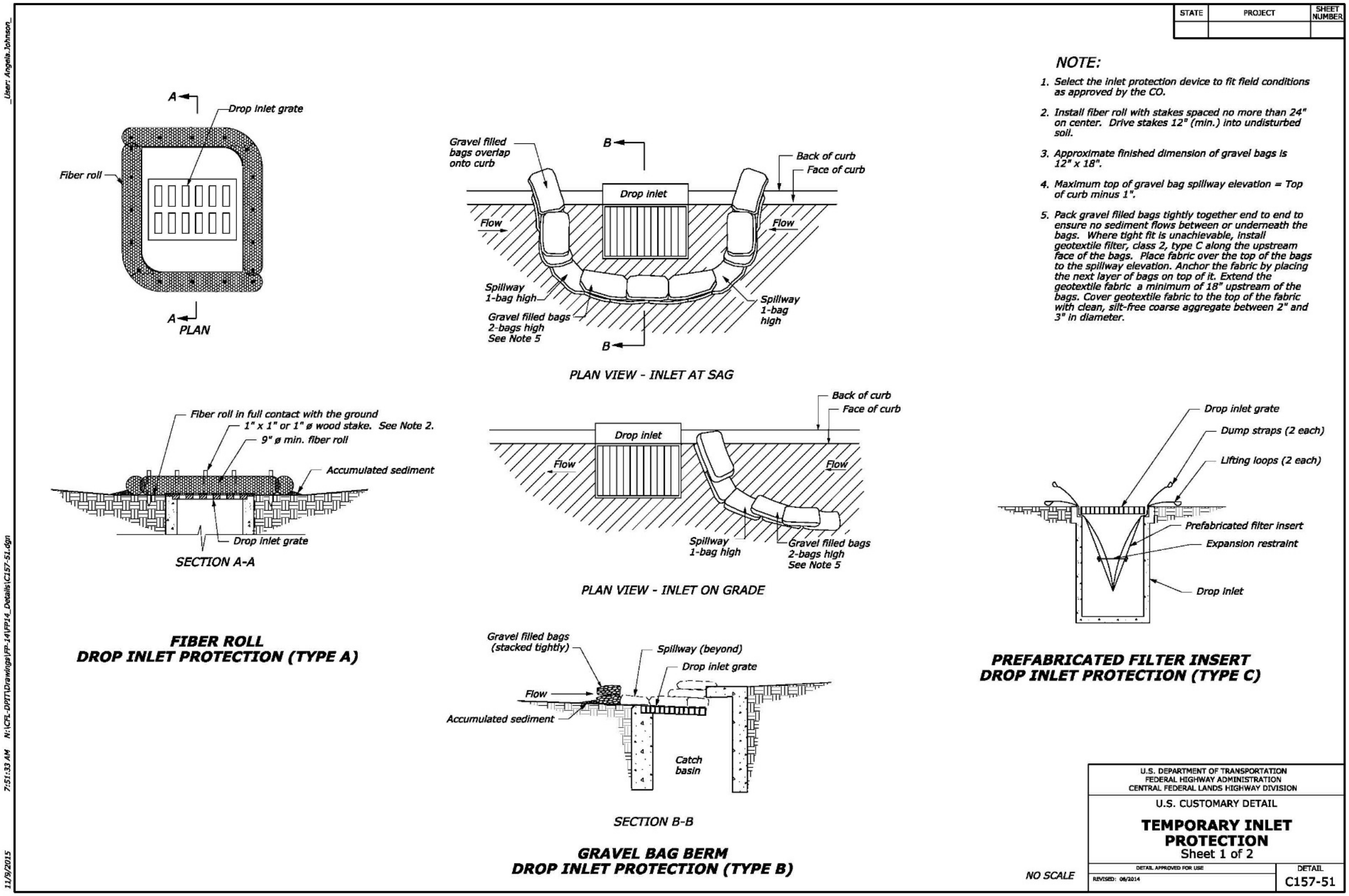



**Figure 55: Temporary Inlet Protection Detail**

# 4.8.11 Compost Socks

## Definition and Purpose

Compost socks are a mesh sock containing compost that act as three dimensional, biodegradable structures that intercept and filter sheet flow. Compost socks can filter runoff, retain sediment, and reduce sheet flow velocities. Compost socks may be used as either a temporary or permanent sediment control measure.

## Appropriate Applications

Compost Socks can also be used:

- Compost socks may be applied as both temporary and permanent sediment controls.
- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- Along the perimeter of a project.
- As check dams in unlined ditches.
- Down-slope of exposed soil areas.
- At operational storm drains as a form of inlet protection.
- Around temporary stockpiles.

## Limitations

- Compost can potentially leach nutrients into runoff and negatively affect water quality. Compost should not be used directly upstream from a nutrient impaired water body.
- Compost socks are susceptible to damage by traffic. Compost socks may be used around heavy machinery, but frequent disturbance decreases sock performance.

## Standards and Specifications

**General Requirements**

- Compost sock installation is illustrated in Typical Section Below.
- Compost socks consist of a 12-inch diameter mesh tube that is filled with compost. The mesh tube must be composed of a natural biodegradable product such as cotton, jute, sisal, burlap, or coir. The mesh tube must be clean, evenly woven, and free of encrusted concrete or other contaminating materials, cuts, tears, broken or missing yarns, and thin, open, or weak places.
- Compost socks must have a functional longevity of one year.

**Installation**

- Before installing compost sock, remove obstructions from the ground including rocks, clods, and debris greater than 1 inch in diameter.
- For any 20-foot section of compost sock, prevent the compost sock from varying more than 5 percent from level.
- Use the following spacing unless otherwise noted on the project plans or SCRs:
    - 10 feet apart for slopes steeper than 2:1 (H:V)
    - 15 feet apart for slopes from 2:1 to 4:1 (H:V)
    - 20 feet apart for slopes from 4:1 to 10:1 (H:V)
    - 50 feet apart for slopes flatter than 10:1 (H:V)
- Place mesh tube, secure the end, and fill uniformly with compost. Secure the remaining end.

- For Type 1 installations:
  - Place in a furrow that is from 2 to 4 inches deep.
  - Fasten with wood stakes every 4 feet along the length of the compost sock.
  - Fasten the ends of the compost sock by placing a stake 6 inches from the end of the sock.
  - Drive the stakes into the soil so the top of the stake is less than 2 inches above the top of the compost sock.
- For Type 2 installations:
  - Fasten with notched wood stakes and rope.
  - Drive stakes into the soil until the notch is even with the top of the compost sock.
  - Lace the rope between stakes and over the compost sock. Knot the rope at each stake.
  - Tighten the fiber roll to the surface of the slope by driving the stakes further into the soil.
  - If more than one compost sock is placed in a row, the socks should be overlapped; not abutted. Stagger overlapping joints in adjacent rows by 5 to 10 feet.

**Removal**

- For permanent installations: do not remove compost socks. Compost socks will degrade over time.
  - For temporary installations: remove sock, rope and stakes if ordered by the PE. Cut sock and empty contents in place.

**Other Considerations**

- Compost may be pre-seeded before placement into the mesh tube to assist in establishing vegetation. Once established, vegetation root systems provide additional soil stability and runoff filtration.
- Permanent compost sock applications are particularly advantageous below embankments, especially adjacent streams, by limiting re-entry and the disturbance to sensitive areas.
  - Organic material in compost is important for pollutant removal and vegetation establishment. Organic content of the compost should range from 30 to 65% depending on site conditions.

## Inspection and Maintenance

- Inspect compost socks before and after each rainfall event, and weekly year round.
- Remove sediment from behind the compost sock if sediment is 1/3 of compost sock height above ground.
- Repair or adjust the compost sock if rills or other evidence of concentrated runoff occur beneath the sock.
- Repair or replace compost socks if they become split, torn, or unraveled.
- Add stakes if the compost sock slumps or sags.
- Replace broken or split wood stakes.
  - Maintain compost socks to provide an adequate sediment holding capacity and runoff velocity reduction.

## Typical Details

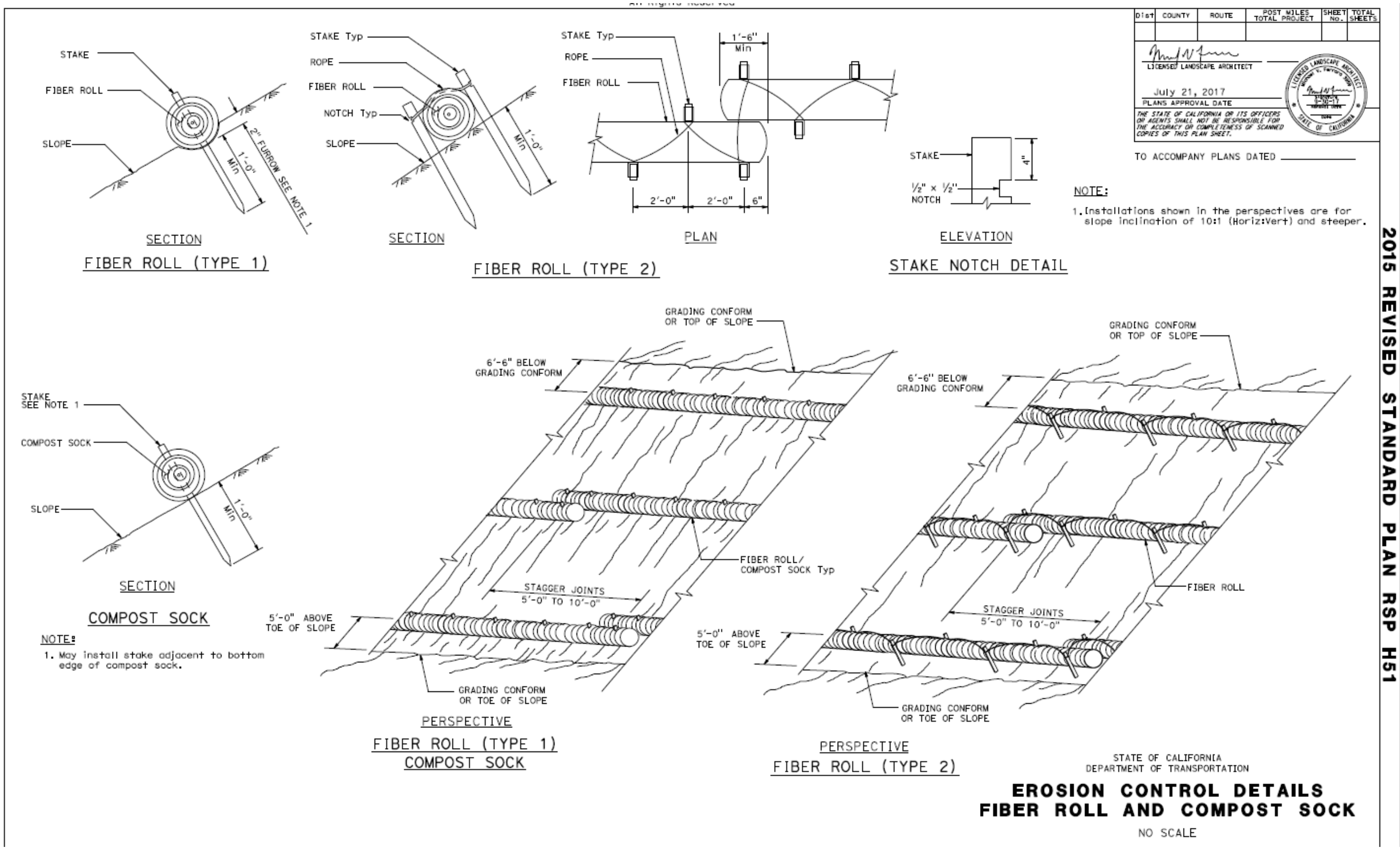



**Figure 56: Compost Sock Staking Detail**

# 4.8.12 FLEXIBLE SEDIMENT BARRIER

### Definition and Purpose

Flexible sediment barriers are synthetic alternatives to fiber rolls, compost socks, and straw bale barriers. Flexible sediment barriers consist of a geosynthetic fabric with a urethane foam-filled core and a fabric apron that helps to prevent undermining and scour. These synthetic linear sediment barriers are generally more robust sediment controls than standard fiber rolls, and may be appropriate for continuous use in stormwater collection areas.

### Appropriate Applications

Flexible Sediment Barriers can be used:

- Along the perimeter of a project.
- As check dams in ditches, channels, or other stormwater collection areas.
- Down-slope of exposed soil areas.
- At operational storm drains as a form of inlet protection.
- Around temporary stockpiles.
- On either paved surfaces or soil.
- As a linear sediment control for "Temporary Drain Inlet Protection."

### Limitations

- Frequent maintenance is required if sediment-laden discharges are upstream of the BMP to maintain it operational.

### Standards and Specifications

<u>**General Requirements**</u>

- Flexible sediment barriers consist of:
    - A urethane foam-filled core.
    - Geosynthetic fabric cover and flap.
    - Triangular, circular, or square cross section.
    - Vertical height of at least 5 inches after installation.
    - Horizontal flap at least 8 inches in width.
    - Length of at least 4 feet per unit.
    - Ability to interlock separate units into a long barrier such that water will not flow between units.
- Geosynthetic fabric for flexible sediment barriers covers must have:
    - Minimum grab break load of 200 lbs., per ASTM D4632.
    - Minimum apparent elongation of 15%, per ASTM D4632.
    - Average water flow rate of 100-150 gallons per minute per square foot, per ASTM D4491.
    - Minimum permittivity of 0.05 1/sec, per ASTM D4491.
    - Maximum apparent opening size of the 40 U.S. standard sieve size, per ASTM D4751.
    - Minimum ultraviolet radiation resistance of 70% retained grab breaking load at 500 hours of exposure, per ASTM D4355.
- Submit a certificate of compliance for flexible sediment barriers.

**Installation**

- Remove obstructions, including rocks, clods, and debris greater than 1 inch in diameter, from the ground.
- Secure flexible sediment barriers to pavement with:
  - 1-inch concrete nails, 1-inch washers, and solvent-free adhesive,
  - Gravel-filled bags, or
  - A combination of both of the above methods.
- Secure flexible sediment barriers to soil with 6-inch nails and 1-inch washers.
- Secure connection points of two adjacent sections of flexible sediment barriers with 2 nails.
- Do not pierce the foam core of the barrier with nails.

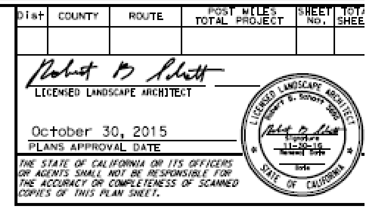
## Inspection and Maintenance

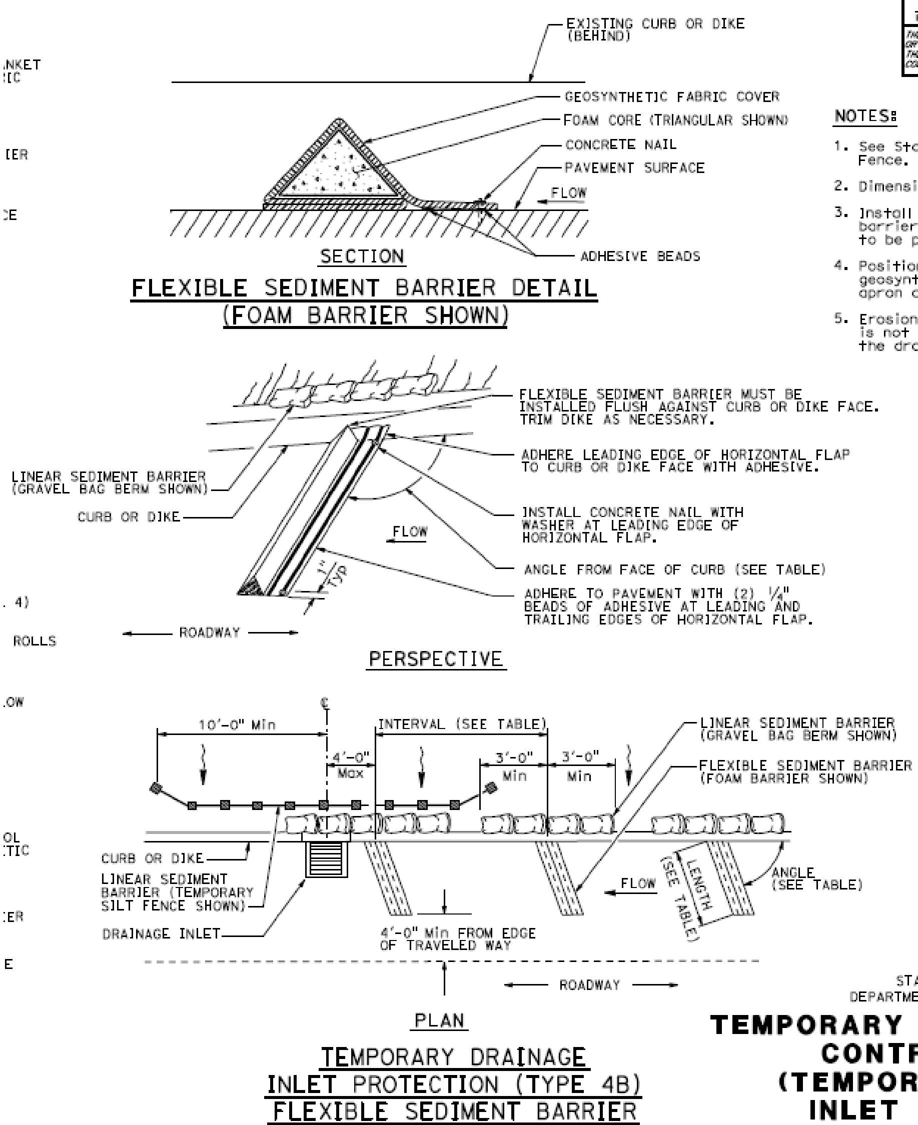
- Inspect flexible sediment barriers before and after each rainfall event, and weekly year-round.
- Maintain a flexible sediment barriers to provide sediment-holding capacity and to reduce concentrated flow velocities.
- Repair or adjust the flexible sediment barriers if rills or other evidence of concentrated runoff occur beneath it.
- Repair or replace split, torn, or unraveled material. Add or replace posts, stakes, or fasteners as needed to prevent sagging or slumping.
- Reattach any flexible sediment barriers that detaches from the pavement.
- Remove sediment deposits if the sediment exceeds 1/3 of the height above the ground behind a foam barrier.

## Typical Details

FLEXIBLE SEDIMENT BARRIER SPACING TABLE

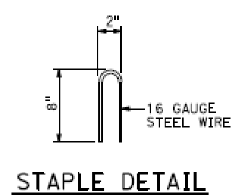
| SLOPE OF ROADWAY (PERCENT) | 0 TO 0.9 | 1 TO 1.9 | 2 TO 2.9 | 3 TO 4 | 5+ |
|---|---|---|---|---|---|
| INTERVAL BETWEEN BARRIERS | 50′ | 35′ | 30′ | 25′ | 20′ |
| ANGLE FROM FACE OF CURB | 70° | 70° | 70° | 45° | 45° |
| SUGGESTED BARRIER LENGTH | 6′ | 6′ | 6′ | 6′ | 6′ |




NOTES:

1. See Standard Plan T51 for Temporary Silt Fence.
2. Dimensions may vary to fit field conditions.
3. Install a minimum of 3 flexible sediment barriers upstream of each drainage inlet to be protected.
4. Position erosion control blanket or geosynthetic fabric at edge of concrete apron and secure in trench.
5. Erosion control blanket or geosynthetic fabric is not required if the area adjacent to the drainage inlet is vegetated.




STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

**TEMPORARY WATER POLLUTION CONTROL DETAILS (TEMPORARY DRAINAGE INLET PROTECTION)**

**Figure 57: Flexible Sediment Barrier**

## 4.9 Tracking Control Practices

Tracking control practices prevent or reduce off-site tracking of sediment by vehicles. Tracking is a common source of complaints, and can result the discharge of sediment to storm drains or watercourses. These measures include:

- Stabilized Construction Entrance/ Exit;
- Stabilized Construction Roadway; and
- Entrance/Outlet Tire Wash.

Tracking controls shall be implemented, as needed, to reduce the tracking of sediment and debris from the construction site. At a minimum, entrances and exits shall be inspected daily, and controls implemented as needed.

# 4.9.1 STABILIZED CONSTRUCTION ENTRANCE AND EXIT

## Definition and Purpose

A stabilized construction entrance is a designated point of access (ingress and egress) to a construction site that is stabilized to reduce tracking of sediment (mud and dirt) onto public roads by construction vehicles. Stabilized construction entrances are an effective method to limit the migration of sediment from the construction site, especially when combined with street sweeping and vacuuming. The stabilized entrance is typically composed of a crushed aggregate layer over a geotextile fabric or constructed of steel plates with ribs.

## Appropriate Applications

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

## Limitations

- Site conditions will dictate design and need.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.

## Standards and Specifications

**General Requirements**

- Maintain a temporary construction entrance or roadway to minimize the generation of dust and tracking of soil and sediment onto public roads. Whenever dust or sediment tracking increases, place additional rock unless the PE authorizes another method.
- When the temporary construction entrance or roadway is being used, do not allow soil, sediment, and other debris that is tracked onto the pavement to enter storm drains, open drainage facilities, and watercourses. When material is tracked onto the pavement, remove it within 6 hours, unless the Engineer authorizes a longer period.
- Submit details for alternative construction entrances at least 5 business days before installation.

**Installation**

- Prepare the location for a temporary construction entrance or roadway as follows:
    - Remove vegetation to ground level and clear away debris
    - Grade the ground to a uniform plane
    - Grade the ground surface to drain
    - Remove sharp objects that could damage the fabric
    - Compact the top 1.5 feet of the soil to at least 90 percent relative compaction
- Construct a temporary construction entrance or roadway as follows:
    - Position the fabric along the length of the entrance or roadway
    - Overlap the sides and ends of the fabric by at least 12 inches
    - Spread rock over the fabric in the direction of traffic

 - Cover the fabric with rock within 24 hours
 - Keep a 6-inch layer of rock over the fabric to prevent damage from spreading equipment
- Do not drive on the fabric until the rock is spread.
- Repair fabric damaged during rock spreading by placing new fabric over the damaged area. The new fabric must be large enough to cover the damaged area and provide at least an 18-inch overlap on all edges.

**Other Considerations**

- Implement BMP "Street Sweeping" as required.
- Require all employees, subcontractors, and suppliers to utilize the temporary construction entrance/exit. If the construction entrance/exit has metal plates as part of the BMP, all vehicles must be required to utilize them.
- Route runoff from temporary construction entrances/exits through a sediment trapping device before discharge.
- Design a temporary construction entrance/exit to support the heaviest vehicles and equipment that will use it.
- The use of asphalt concrete (AC) grindings is not allowed (high potential for leaching hydrocarbons).
- Designate combination or single purpose entrances and exits to the construction site to maintain smooth flow of traffic.

## Inspection and Maintenance

- Inspect before and after each rainfall event, and weekly year round.
- Inspect immediate site access roads daily, implement "Street Sweeping" as needed.
- Remove aggregate, separate, and dispose of sediment if temporary construction entrance is clogged with sediment.
- Keep all temporary construction entrance/exit ditches clear.
- Repair a temporary construction entrance or roadway if:
  - Fabric is exposed
  - Depressions in the surface develop
- Rock is displaced

## Selection Matrix

**CONSTRUCTION EXIT CONTROLS** (2573.3K)

The following list of construction exit controls are ranked from lowest performing to highest protection, but are subject to construction activity, vehicle type, soil type, bearing capacity, weather events, time of year, and amount of use. Some exit control methods are specific to load bearing capacity of the parent soils. All construction exit controls require high maintenance actions for functional performance and public safety. All construction exit controls require pavement cleaning operations that may include rapid and daily street sweeping.

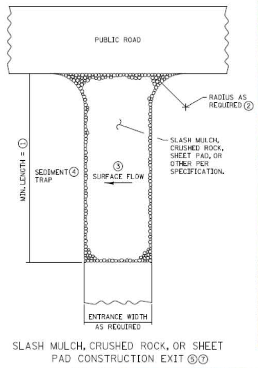
Typical Minimum Lengths are 5 times the circumference of the largest tire using the construction exit [C=3.14xD].

1. Slash Mulch (3882.2E Type 5)
2. Crushed Aggregates (Rock, concrete, bituminous)
3. Temporary Paving
4. Reinforced geotextile
5. Steel Sheet Pads
6. Floating Road
7. Timber Pad
8. Rumble Pad
9. Wash-off
10. Combinations

Payment methods include incidental, lump sum, and (number 9) each. Payment methods require proper installation of the various BMPs, maintenance and removals over the life of the contract, regardless of types used or quantities deployed.

2573.535 Stabilized Construction Exit: lump sum

2573.536 Wheel Wash Off: each




Slash Mulch Exit Control

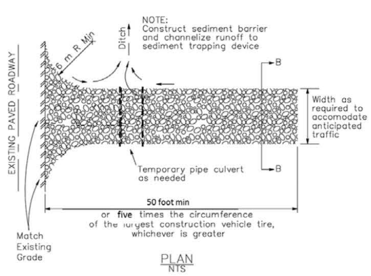

Crushed Aggregate Exit Control

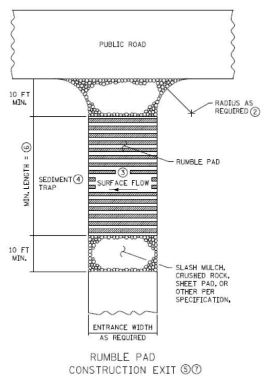
Temporary Paving Exit Control

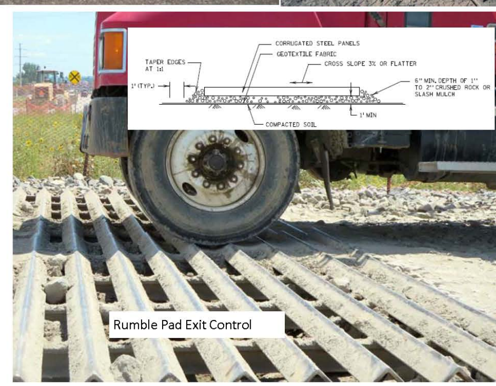
Reinforced Geotextile Exit Control

Floating Road Exit Control

Timber Pad Exit Control



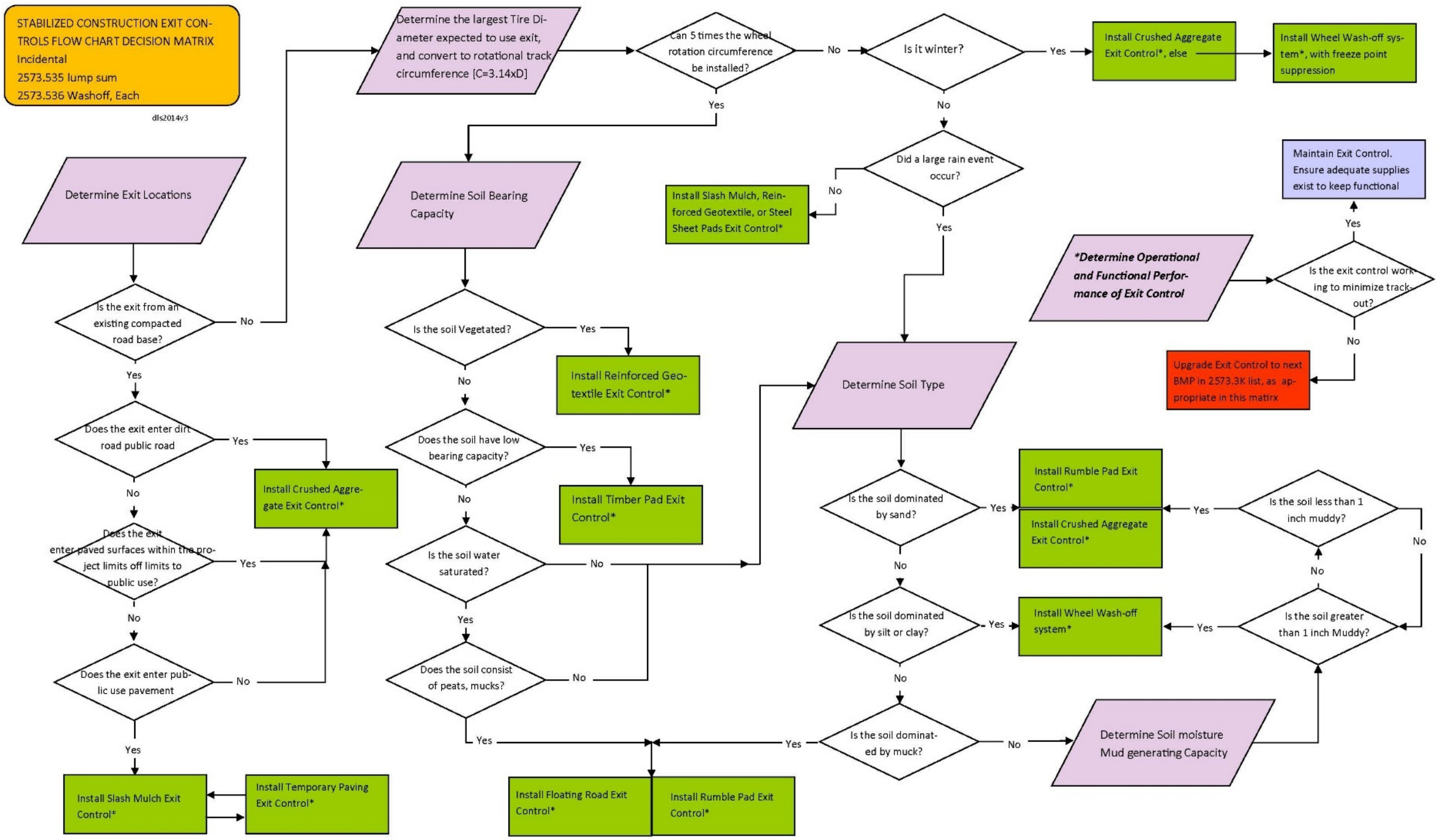




Rumble Pad Exit Control

Wash-off Exit Control System

Example shows tilt-grading of crushed aggregate draining to plastic lined sump and operator pressure hoses connected to water supply truck


STABILIZED CONSTRUCTION EXIT CONTROLS FLOW CHART DECISION MATRIX
Incidental
2573.535 lump sum
2573.536 Washoff, Each
dls2014v3
Determine Exit Locations
Is the exit from an existing compacted road base?
Does the exit enter dirt road public road
Does the exit enter paved surfaces within the project limits off limits to public use?
Does the exit enter public use pavement
Install Crushed Aggregate Exit Control*
Install Slash Mulch Exit Control*
Install Temporary Paving Exit Control*
Determine the largest Tire Diameter expected to use exit, and convert to rotational track circumference [C=3.14xD]
Can 5 times the wheel rotation circumference be installed?
Determine Soil Bearing Capacity
Is the soil Vegetated?
Install Reinforced Geotextile Exit Control*
Does the soil have low bearing capacity?
Install Timber Pad Exit Control*
Is the soil water saturated?
Does the soil consist of peats, mucks?
Install Floating Road Exit Control*
Install Rumble Pad Exit Control*
Is it winter?
Install Crushed Aggregate Exit Control*, else
Install Wheel Wash-off system*, with freeze point suppression
Did a large rain event occur?
Install Slash Mulch, Reinforced Geotextile, or Steel Sheet Pads Exit Control*
Determine Soil Type
Is the soil dominated by sand?
Is the soil dominated by silt or clay?
Is the soil dominated by muck?
Install Rumble Pad Exit Control*
Install Crushed Aggregate Exit Control*
Install Wheel Wash-off system*
Determine Soil moisture Mud generating Capacity
Is the soil less than 1 inch muddy?
Is the soil greater than 1 inch Muddy?
*Determine Operational and Functional Performance of Exit Control
Is the exit control working to minimize trackout?
Maintain Exit Control. Ensure adequate supplies exist to keep functional
Upgrade Exit Control to next BMP in 2573.3K list, as appropriate in this matrix
Yes
No

### 4.9.1.1 Typical Details

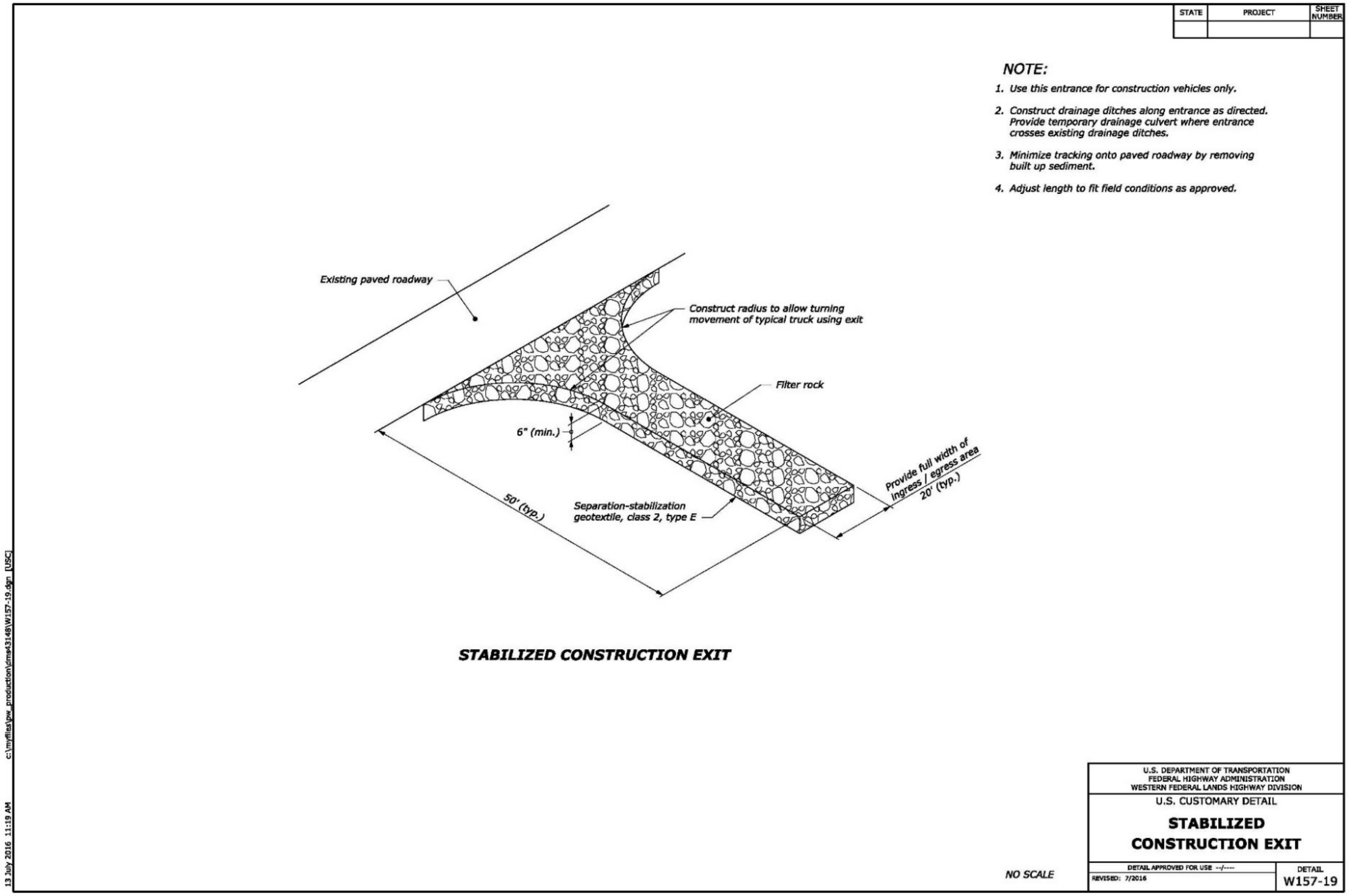



**Figure 58: Stabilized Construction Exit**

# 4.9.2 STABILIZED CONSTRUCTION ROADWAY

## Definition and Purpose

A stabilized construction roadway is a temporary access road connecting existing public roads to a remote construction area. It is designed for the control of a dust and erosion created by vehicular traffic. A stabilized construction roadway may be constructed of aggregate, asphalt concrete, or concrete based on the desired longevity.

## Appropriate Applications

Use construction roadways and short-term detour roads:

- Where mud tracking is a problem during wet weather.
- Where dust is a problem during dry weather.
- When road is adjacent to water bodies.
- Where poor soils are encountered.
- Where there are steep grades and additional traction is needed.

## Limitations

- Materials will likely need to be removed prior to final grading and stabilization.
- Site conditions will dictate design and need.
- May not be applicable to very short duration projects.
- Limit speed of vehicles to control dust.

## Standards and Specifications

### General Requirements

- Design stabilized access to support the heaviest vehicles and equipment that will use it.
- Implement "Temporary Construction Entrance/Exit" and "Entrance/Outlet Tire Wash" in combination with temporary construction roadway for maximum tracking control.

### Installation

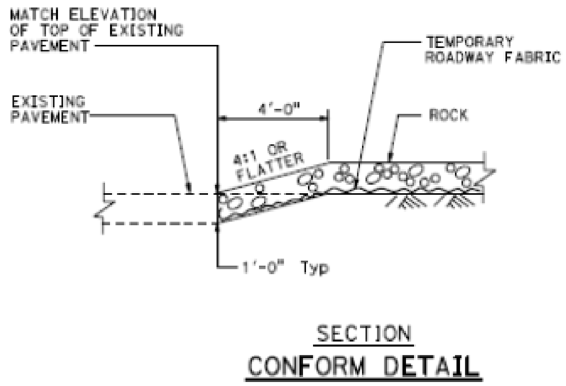
- Prepare the location for the temporary roadway as follows:
    - Remove vegetation and clear debris.
    - Grade the ground to a uniform plane.
    - Grade the ground surface to drain in a way that prevents runoff from leaving the construction site.
    - Remove sharp objects that could damage the fabric.
    - Compact the top 1.5 feet of soil to at least 90% relative compaction.
- Construct the temporary construction roadway as follows:
    - Place the fabric along the length of the roadway.
    - Overlap fabric ends by at least 12 inches.
    - Cover the fabric with rock within 24 hours.
    - Spread rock over the fabric in the direction of traffic.
- Keep a 6-inch layer of rock over the fabric to prevent damage from the spreading equipment.

## Inspection and Maintenance

- Inspect before and after each rainfall event, and weekly year round.

- Inspect immediate site access roads daily, implement “Street Sweeping” as needed.
- Keep all temporary roadway ditches clear.
- When no longer required, remove stabilized construction roadway and regrade, re-vegetate and repair slopes.

## Typical Details



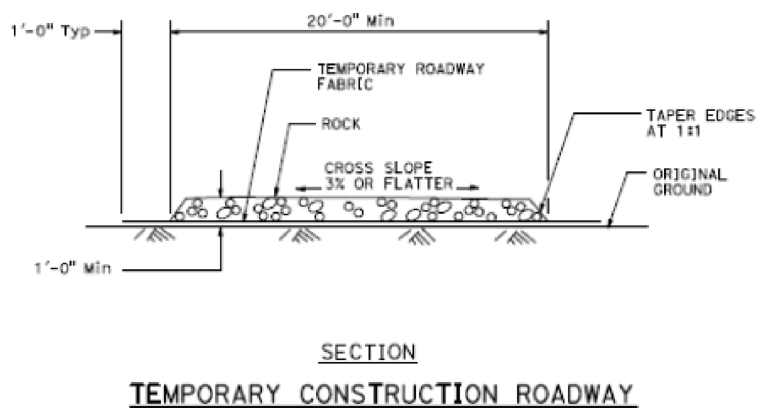




**Figure 59: Temporary Construction Roadway Detail**

# 4.9.3 ENTRANCE/OUTLET TIRE WASH

## Definition and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and undercarriages, and to prevent tracking of sediment onto public roads. The tire wash typically includes a wash rack on a pad of coarse aggregate. The runoff water from the wash area must be conveyed to a sediment trap or basin.

## Appropriate Applications

- Tire washes may be used on construction sites where construction vehicles may track dirt and mud onto public roads.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the PE.

## Limitations

- Requires a supply of wash water and way to collect or capture tire wash area runoff.
- Requires a turnout or doublewide exit to prevent entering vehicles from driving through the wash area.

## Standards and Specifications

<u>General Requirements</u>

- Require all employees, subcontractors, and others that leave the site with mud-caked tires and/or undercarriages to use the wash facility.
- Incorporate with a temporary construction entrance/exit. See "Temporary Construction Entrance/Exit."
- Construct on level ground when possible, on a pad of Type A or Type B rock. Either Class 8 or 10 RSP fabric should be placed below the rock.
- Wash rack must be designed and constructed/manufactured for anticipated traffic loads.
- Vehicle wash water is non-stormwater that requires management and disposal. See "Vehicle and Equipment Cleaning."
- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device or similar device. The drainage ditch should be of sufficient grade, width, and depth to carry the wash runoff.
- Implement BMP "Street Sweeping" as needed.
- Refer to "Temporary Construction Entrance/Exit," for details regarding design and installation of construction entrance and exits to the project site.

## Inspection and Maintenance

- Inspect before, daily during extended rain events, after each rain event, and weekly year round.
- Inspect immediate site access roads daily, implement "Street Sweeping" as needed.
- Remove accumulated sediment in wash rack and/or sediment trap to maintain system capacity and performance.
- Inspect routinely for damage and repair as needed. Document non-stormwater (sediment trapping device or similar device) in appropriate inspection form.

## Typical Details

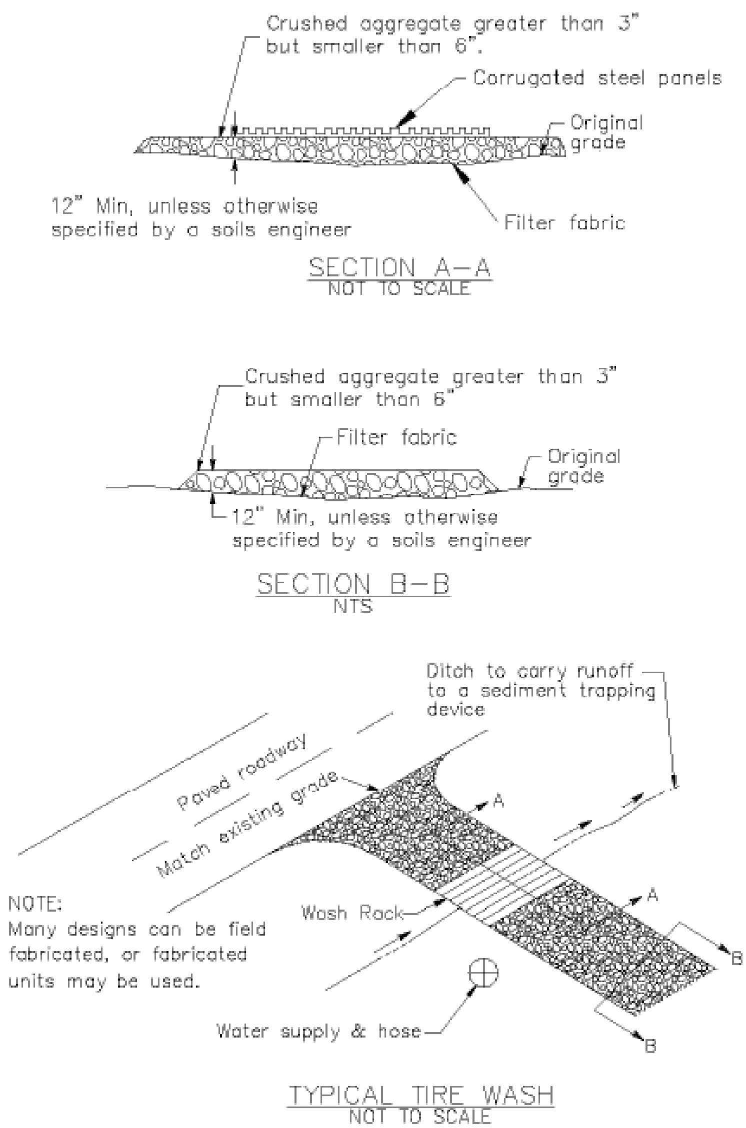



**Figure 60: Tire Wash Detail**

# 4.6 WIND EROSION CONTROL

## Definition and Purpose

Wind erosion controls shall be considered for all disturbed soil areas on the project site that are subject to wind erosion and when significant wind and dry conditions are anticipated during construction of the project. Wind erosion control consists of applying water or other dust palliatives as necessary to prevent or alleviate wind-blown dust. Dust control must be applied in accordance with FHWA standard practices. Water or dust palliatives should be applied so no runoff occurs.

The General Construction Permit requires that special attention be paid to stockpiles. Stockpiles may be covered with plastic, mats, blankets, mulches, or sprayed with water or soil binders. It may also be prudent to surround the base of a stockpile with a row of fiber rolls, silt fence, or other sediment barrier.

Another means to reduce the potential for wind erosion of stockpiles is to keep the height of stockpiles low, and to adjust the shape and orientation of the stockpiles to reduce the area of exposure to the prevailing wind.

## Appropriate Applications

This practice is generally implemented on all exposed soils subject to wind erosion.

## Limitations

- Effectiveness depends on soil, temperature, humidity and wind velocity.
- Chemically treated subgrades could cause soil to become water repellant, preventing infiltration or the long-term re-vegetation of the site.

## Standards and Specifications

### General Requirements

- Effective dust control is accomplished by applying dust palliatives, temporary Soil Stabilization BMPs, Tracking Controls and managing stockpiles.
- "Dust Palliatives" are covered under Section 18 of the Standard Specifications. Acceptable dust palliatives include water, dust control binders, and dust suppressants. Dust control binders must comply with specifications for tackifier. Dust suppressants include petroleum-based organic product, nonpetroleum-based organic product, hygroscopic product, and synthetic polymer emulsion.
- If a dust suppressant or tackifier is used, submit a Dust Treatment Plan. Submit a certificate of compliance for dust suppressants, tackifiers, and fibers.
- Identify and stabilize key access points with the use of Tracking Control BMPs.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Temporary soil stabilization BMPs, such as "Hydraulic Mulch", "Hydroseed", "Soil Binders", also provide wind erosion control benefits.
- Ensure proper implementation of BMPs "Stockpile Management,"and "Street Sweeping," as these BMPs provide wind erosion control benefits.
- Ensure that water is applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles to ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.

- Chemical dust suppression products could have environmental water quality impacts. Depending on the product and the time of application, water quality sampling for non-visible pollutants should be assessed when a storm even is forecasted.
- For chemical or petroleum based organics stabilization, there are many products available. These products should not create any adverse effects on stormwater, plant life, groundwater and should meet all applicable regulatory requirements including inspection, documentation, monitoring and reporting requirements.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.
- If reclaimed water is used, the sources and discharge must meet Federal, State, and local water reclamation requirements. Non-potable water must not be conveyed in tanks or drain pipes that will be used to convey potable water and there must be no connection between potable and non-potable supplies. Non-potable tanks, pipes and other conveyances must be marked "NON-POTABLE WATER - DO NOT DRINK."

### Inspection and Maintenance

- Check areas where wind erosion controls have been implemented daily for erosion and visible dust.
- Most water-based dust control measures require frequent application. Obtain vendor or independent information on longevity of chemical dust suppression.

### Typical Details

Refer to typical details for referenced BMPs utilize as Wind Erosion BMPs.

## 4.7 NON-STORM WATER CONTROLS

The objective of the construction site management (non-stormwater and waste management and materials pollution controls) is to reduce the discharge of materials other than stormwater to the stormwater drainage system or to receiving waters. These controls shall be implemented year-round for all applicable activities, material usage, and site conditions.

The National Pollutant Discharge Elimination System (NPDES) storm water regulations for construction sites also require that BMPs be included in the project plans for control of non-storm water discharges. Non-storm water management measures are source controls that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with storm water. These BMPs are also known as "good housekeeping practices." These BMPs must be in place throughout the grading and construction phases. The measures include:

- Water Conservation Practices
- Dewatering Operations
- Paving and Grinding Operations
- Temporary Stream Crossing
- Clear Water Diversion
- Illicit Connection/Illegal Discharge Detection and Reporting
- Potable Water/Irrigation

During preparation of the project plans, it is not always possible to know where a contractor will be performing certain activities. To provide the contractor with flexibility, but to assure that proper control measures are implemented, it is appropriate to identify in the project plans that specific BMPs will be implemented for certain activities regardless of where on the site those activities are performed.

### 4.7.1 Temporary Stream Crossing (Discussed further in Chapter 5)

A temporary stream crossing is a structure placed across a waterway that allows vehicles to cross the waterway during construction without contacting the water, thus reducing erosion and the transport of pollutants into the waterway. Temporary stream crossings are typically conditions of regulatory permits for work near live streams. Installation may require dewatering or temporary diversion of the stream. Types of temporary stream crossings include culverts, fords, and bridges. Their design requires knowledge of stream flows, soils, and wildlife.

### 4.7.2 Clear Water Diversion (Discussed further in Chapter 5)

Clear water diversion consists of a system of structures and measures that intercept clear surface water runoff upstream of a construction site, transport it around the site, and discharge it downstream with minimal water quality impact. A common example is a temporary creek diversion system that consists of a sandbag cofferdam and a flexible plastic pipe to divert the water around the construction site. Structures commonly used as part of this system include diversion ditches, berms, dikes, slope drains, drainage, and interceptor swales.

### 4.7.3 Material and Equipment Use Over Water (Discussed Further in Chapter 5)

This BMP consists of procedures for the proper use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads, or similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse. These procedures shall be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may be detrimental if released and apply where equipment is used over or adjacent to a watercourse.

### 4.7.4 Structure Demolition/Removal Over Water (Discussed Further in Section Chapter 5)

This BMP consists of procedures to protect water bodies from debris and wastes associated with structure demolition or removal over or adjacent to watercourses. These procedures shall be implemented for full bridge demolition and removal, partial bridge removal (i.e., barrier rail, edge of deck) associated with bridge widening projects, concrete channel removal, or any other structure removal that could potentially affect water quality.

The remainder of this Section describe the working details for each of the temporary sediment control BMPs.

# 4.7.5 WATER CONSERVATION PRACTICES

## Definition and Purpose

Water conservation practices are activities that use water during the construction of a project in a manner that avoids erosion caused by runoff and the transport of pollutants off the site. If less water is used, the potential for erosion decreases and the transport of construction-related pollutants off site is less likely. Water conservation practices must be implemented on all construction sites wherever water is used. It includes preventing water leaks, avoid vehicle washing on site, sweeping in lieu of hosing areas, and applying water for dust control to minimize runoff.

## Appropriate Applications

Water conservation practices are implemented on all construction sites wherever water is used.

## Limitations

If not implemented correctly, discharges may trigger reporting and monitoring requirements and delay construction work.

## Standards and Specifications

**General Requirements**

- Keep water equipment in good working condition.
- Ensure tracking controls are implemented in, near and around water truck filling areas.
- Repair water leaks promptly.
- Authorization is required for activities that could potentially discharge water into a storm drain system or receiving waters.
- Avoid using water to clean construction areas. Do not wash paved areas with water. Paved areas and roadways should be swept and vacuumed in accordance with "Street Sweeping."
- Apply water for dust control in accordance with Standard Specifications Section 158 Watering for Dust Control and BMP "Wind Erosion Control."
- Direct construction water runoff to areas where it can infiltrate into the ground or be collected and reused.
- Manage run-on to minimize contact with job site.
- Retain water spilled while filling water trucks within the designated water truck filling areas. Prevent tracking from water trucks and other equipment.
- Report discharges to the PE and the WPC Manager immediately.

## Inspection and Maintenance

- Inspect water equipment areas at least weekly, prior to a forecasted rain event, daily during extended rain events and post-storm events.
- Inspect non-stormwater BMPs daily when non-stormwater operations are ongoing.
- Repair water equipment as needed.

## Typical Details

None specified to date for this manual.

# 4.7.6 DEWATERING OPERATIONS

## Definition and Purpose

This BMP is intended to prevent the discharge of pollutants from construction site dewatering operations associated with storm water (accumulated rain) and non-storm water (groundwater, water from a diversion or cofferdam, etc.). Dewatering effluent that is discharged from the construction site to a storm drain or receiving water is subject to the requirements of the applicable NPDES permit.

## Appropriate Applications

- These practices are implemented for the collection and discharge of non-stormwater and stormwater (accumulated rain water) from excavations or temporary containment facilities. Non-stormwater includes, but is not limited to, groundwater, dewatering of piles, water from cofferdams, water diversions, and water used during construction activities that must be removed from a work area.
- Practices identified in this section are also appropriate for implementation when managing the removal of accumulated precipitation (stormwater) from depressed areas at a construction site.
- Stormwater mixed with non-stormwater should be managed as non-stormwater.

## Limitations

- Dewatering operations for non-stormwater will require, and must comply with, applicable local permits, project-specific permits, and regulations.
- Site conditions will dictate design and use of dewatering operations.
- Avoid dewatering discharges where possible by infiltrating, reusing the water for dust control, etc.

## Standards and Specifications

<u>General Requirements</u>

- Dewatering shall be conducted in accordance with Standard Specifications and applicable permits.
- A dewatering and discharge work plan shall be submitted at least 15 days before the start of dewatering activities detailing the location of dewatering and discharge activities, quantity of water, equipment, and discharge point.
- Dewatering discharges must not cause erosion, scour, or sedimentation that could impact natural bedding materials.
- Discharge the water within the project limits. Dispose of the water if it cannot be discharged within project limits due to site constraints or contamination.
- Do not discharge stormwater or non-stormwater that has an odor, discoloration other than sediment, an oily sheen, or foam on the surface. Immediately notify the PE upon discovering any such condition.
- Some states may require a separate NPDES permit for a dewatering operation. These permits will have specific testing, monitoring, and discharge requirements.
- Discharges must comply with regional and watershed-specific discharge requirements.
- Additional permits or permissions from other agencies may be required for dewatering cofferdams or diversions.

- Dewatering records shall be kept with the SWPPP and maintained for a minimum of 3 years after the construction project is terminated.
- The controls discussed in this BMP address sediment only. If the presence of polluted water with hazardous substances is identified in the contract, the contractor shall implement dewatering pollution controls as required by the contract documents. If the quality of water to be removed by dewatering is not identified as polluted in the contract documents, but is later determined by observation or testing to be polluted, the contractor shall notify the PE.

**Sediment Treatment**

- A variety of methods can be used to treat water during dewatering operations from the construction site. The size of particles present in the sediment and/or Dewatering Permit or receiving water limitations on sediment are key considerations for selecting sediment treatment option(s); in some cases, the use of multiple devices may be appropriate.
- Refer to the applicable project dewatering and/or stormwater permit for monitoring and sampling forms and requirements

## Inspection and Maintenance

- Inspect dewatering operation areas at least weekly, prior to a forecasted rain event, daily during extended rain events and post-storm events.
- Accumulated sediment removed during the maintenance of a dewatering device may be disposed of outside the project limits.
- Accumulated sediment that is commingled with other pollutants must be disposed of in accordance with all applicable laws and regulations.
- The SW Manager must take immediate action to prevent non-stormwater discharges from being discharged.

## Typical Details

None specified to date for this manual.

# 4.7.7 PAVING, SEALING, SAWCUTTING, AND GRINDING OPERATIONS

### Definition and Purpose

Procedures that minimize pollution of storm water runoff during paving operations include new paving and preparation of existing paved surfaces for overlays. Paving, sealing, sawcutting and grinding operations include handling materials, wastes and equipment associated with pavement removal, paving, surfacing, resurfacing, pavement preparation, thermoplastic striping and placing pavement markers.

### Appropriate Applications

These procedures are implemented where operations such as paving, surfacing, resurfacing, grinding, coring, grooving, sealing and sawcutting generate spoils, residue, or process water that may pollute storm water runoff or discharge to the storm drain system or receiving water body.

### Limitations

- Activities related to paving, sealing, sawcutting, grooving, and grinding operations should be limited when precipitation is forecasted to prevent the triggering for visible and non-visible pollutant monitoring.
- Discharges of freshly paved surfaces can raise pH and trigger permit violations.

### Standards and Specifications

**General Requirements**

- Refer to Standard Specifications Section 13-4.03E (7) Paving, Sealing, Sawcutting, Grooving, and Grinding Activities.
- Do not allow the following materials to enter storm drain system and receiving waters: cementitious material, asphaltic material, aggregate or screenings, sawcutting, grooving, and grinding residue, pavement chunks, shoulder backing, methacrylate resin, and sandblasting residue. This list is not exhaustive.
- Drainage inlets shall be protected and linear sediment barriers (such as silt fences, gravel bag berms, or fiber rolls) shall be used to protect receiving waters during operations related to paving, sealing, sawcutting, or grinding.
- Drainage inlets and manholes shall be protected during application of seal coat, tack coat, slurry seal, and/or fog seal. Refer to "Temporary Drainage Inlet Protection."
- Whenever precipitation is forecasted, limit paving, sawcutting, and grinding to places where runoff can be captured. Grinding or grooving of pavement shall not be conducted when precipitation is forecasted unless runoff can be captured.
- Seal coat, tack coat, slurry seal, or fog seal shall not be applied when precipitation is forecasted during the application or curing period.
- Slurry shall be removed with a vacuum immediately after it is produced and shall be prevented from running off the pavement or into lanes open to traffic.
- The residue from grooving and grinding activities shall be collected with a vacuum attachment on the grinding machine and shall be prevented from flowing across the pavement. See "Concrete Waste Management," and "Liquid Waste Management."

- Material removed from existing roadways may be stockpiled, if allowed, away from drainage inlets and receiving waters in accordance with BMP "Stockpile Management".
- Drip pans or absorbent materials shall be placed under paving equipment when not in use. Refer to "Spill Prevention and Control." Equipment shall be cleaned in accordance with "Vehicle and Equipment Cleaning."
- Do not coat asphalt trucks and equipment with substances that contain soap, foaming agents, or toxic chemicals.

**Asphalt Concrete and Concrete Pavement Handling**

- Prevent sand and gravel from entering streets, storm drains, and receiving waters.
- Substances used to coat asphalt transport trucks, asphalt trucks, and asphalt spreading equipment shall not contain soap, foaming agents, or toxic chemicals.
- Asphalt spoils must be recycled or disposed of in accordance with "Solid Waste Management," and/or "Hazardous Waste Management."
- AC and PCC grindings, pieces, or chunks approved by the PE for reuse in embankments or shoulder backing shall not be at risk of entering storm drain systems or receiving waters.
- Temporarily protect inlets and receiving waters until the structure is stabilized or permanent controls are in place.
- The reuse of AC or PCC grindings, pieces, or chunks as road base must be placed at least five feet above the seasonal high groundwater elevation with the approval of the PE. Shoulder backing containing Recycled Asphalt Pavement (RAP) shall not be placed within 100 feet measured horizontally from a culvert, watercourse, or bridge.
- During chip seal application and sweeping operations, petroleum or petroleum covered aggregate must not be allowed to enter storm drains or receiving waters. Temporarily protect inlets and receiving waters until stabilized.
- Clean asphalt-coated equipment off-site whenever possible. When cleaning dry, hardened asphalt from equipment, manage hardened asphalt debris in accordance with "Solid Waste Management," and/or "Hazardous Waste Management," and "Vehicle and Equipment Cleaning" whichever is applicable.
- Allow aggregate rinse to settle. Then, either allow rinse water to dry in a temporary pit as described in "Concrete Waste Management," or dispose in accordance with "Solid Waste Management."

**Thermoplastic Striping and Pavement Markers**

- Contractor shall not pre-heat, transfer, or load thermoplastic within 50 feet of drainage inlets or receiving waters.
- Do not unload, transfer, or load bituminous material for pavement markers within 50 feet of drainage inlets or receiving waters.
- All thermoplastic striper and pre-heater equipment shutoff valves shall be inspected to ensure that they are working properly to prevent thermoplastic from leaking.
- The pre-heater shall be filled carefully to prevent splashing or spilling of hot thermoplastic. Leave six inches of space at the top of the pre-heater container when filling thermoplastic to allow room for material to move when the vehicle is deadheaded.
- Melting tanks shall be loaded with care, a minimum of six inches of freeboard in case of splashing when vehicle is deadheaded. When servicing or filling melting tanks, ensure all pressure is released before removing lids to avoid spills.

- Immediately remove drips, overspray, improper markings, paint, and thermoplastic tracked by traffic with an authorized method.
- Collect and dispose of bituminous material from the roadway after removal of markers in accordance with “Solid Waste Management.”
- Clean truck beds daily of loose debris and melted thermoplastic. When possible, recycle thermoplastic material. Thermoplastic waste shall be disposed of in accordance with BMP “Solid Waste Management” and/or “Hazardous Waste Management, as applicable.

### 4.7.7.1 Inspection and Maintenance

- Inspect and maintain machinery and BMPs regularly to minimize leaks and drips.
- Ensure that employees and subcontractors are implementing appropriate measures during paving operations.

### 4.7.7.2 Typical Details

None specified to date for this manual.

# 4.7.8 Illicit Connection/Illegal Discharge Detection and Reporting

## Definition and Purpose

These procedures and practices are designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents to the Project Engineer (PE).

## Appropriate Applications

- Illicit connection and illegal discharge detection and reporting is applicable anytime an illicit connection or discharge is discovered or illegally dumped material is found on the construction site.
- This BMP applies to all construction projects.

## Limitations

- Illicit connections and illegal discharges or dumping, for the purposes of this BMP, refer to discharges and dumping caused by parties other than the contractor.
- Procedures and practices presented in this BMP are general. Contractor shall use extreme caution, immediately notify the PE when illicit connections or illegal dumping or discharges are discovered, and take no further action unless directed by the PE.
- If pre-existing hazardous materials or wastes are known to exist onsite, the contractor's responsibility will be detailed in separate SCRs. Onsite area should be clearly marked and described in the SWPPP.

## Standards and Specifications

**Inspection**

- Areas Inspect site before beginning the job for evidence of illicit connections or illegal dumping or discharges.

**Illicit Connection and Illegal Discharge Detection and Reporting**

- Solids - Look for debris or trash piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- Liquids – signs of illegal liquid dumping or discharge can include:
  - Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils.
  - Pungent odors coming from the drainage systems.
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes.
  - Abnormal water flow during the dry weather season.
- Urban Areas - Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:
  - Abnormal water flow during the dry weather season.
  - Unusual flows in subdrain systems used for dewatering.
  - Pungent odors coming from the drainage systems.

    - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes.
    - Excessive sediment deposits, particularly adjacent to or near active offsite construction projects.
- Rural Areas - Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:
    - Abnormal water flow during the dry weather season.
    - Non-standard drainage junction structures.
- Broken concrete or other disturbances at or near junction structures.

**Reporting**

- Notify the RE of any illicit connections and illegal dumping or discharge incidents at the time of discovery. Do not take further action unless ordered.
- The PE will notify the CO for reporting.

## Inspection and Maintenance

- Notify the PE of any illicit connections and illegal dumping or discharge incidents at the time of discovery. Do not take further action unless ordered.
- The contractor is not responsible for investigation and clean up of illicit or illegal dumping or discharges not generated by the contractor. FHWA may direct contractor to clean up non-hazardous dumped or discharged material on the construction site following proper contracting actions or modification. Assume that unlabeled or unidentifiable material is hazardous.
- Inspect the entire project site at least weekly to check for illicit connection or illegal discharges.

## Typical Details

None specified to date for this manual.

# 4.7.9 Potable Water/Irrigation

### Definition and Purpose

Potable water/irrigation consists of practices and procedures to reduce the discharge of potential pollutants generated from irrigation water lines, landscape irrigation, lawn or garden watering, potable water sources, water line flushing, and hydrant flushing. These practices include reusing discharges for landscaping, automatic shut-off valves, prevention of impacts to downstream drainage systems, leak detection, inspection of equipment and lines, and repair of broken pipes.

### Appropriate Applications

Implement this BMP whenever the above activities or discharges occur at or enter a construction site.

### Limitations

None identified

### Standards and Specifications

**General Requirements**

- Inspect irrigated areas within the construction limits for excess watering.
- Adjust watering times and schedules to ensure that the appropriate amount of water is being used and to minimize runoff. Consider factors such as soil structure, grade, relative compaction, time of year, and type of plant material in determining the proper amounts of water for a specific area.
- Take precautions to prevent irrigation water from eroding soil, wetting vehicles and pavement, or otherwise causing sediment, hydrocarbons, and other non-visible pollutants that accumulate on those surfaces to discharge into a storm drain system or receiving waterbody.
- When possible, discharges from water line flushing or temporary Active Treatment Systems should be reused for landscaping purposes.
- Project Engineer (PE) approval is required prior to commencing any washing activities that could discharge to the storm drain or receiving waterbody.
- Where possible, direct water from off-site sources around or through a construction site in a way that minimizes contact with the construction site.
- Perform pressure tests on the irrigation system supply lines to test for leaks, which could result in erosion or runoff if breached.
- Shut off the water source to broken lines, sprinklers, or valves as soon as possible to prevent excess water flow.
- Protect downstream storm water drainage systems and receiving waters from water pumped or bailed from trenches excavated to repair water lines.

### Inspection and Maintenance

- Repair broken water lines as soon as possible or as directed by the PE.
- Inspect irrigated areas regularly for signs of erosion and/or discharge.

### Typical Details

None specified to date for this manual.

# 4.7.10 Pile Driving Operations

## Definition and Purpose

The construction of bridges and retaining walls often includes driving piles for foundation support. Piles are typically constructed of cast in place concrete, steel, or timber. Driven sheet piles are also used for shoring and cofferdam construction. Proper control and use of equipment, materials, and waste products from pile driving operations will reduce the discharge of potential pollutants to the storm drain system or watercourses. These procedures apply to all construction sites where permanent and temporary pile driving operations take place.

## Appropriate Applications

These procedures apply to construction sites near or adjacent to surface waters or groundwater where permanent and temporary pile driving operations (impact and vibratory) take place, including operations using pile shells for construction of cast-in-steel-shell and cast-in-drilled-hole piles.

## Limitations

None Identified

## Standards and Specifications

<u>**General Requirements**</u>

- Have spill kits and cleanup materials available at all locations of pile driving. Refer to "Spill Prevention and Control."
- Place drip pans, absorbent pads, or plastic sheeting with absorbent material under vehicles and equipment performing pile driving activities. Refer to "Vehicle and Equipment Fueling" and "Vehicle and Equipment Maintenance."
- Protect pile driving equipment, including hammers and other hydraulic attachments, by parking them on plywood and covering it with plastic sheeting when precipitation is forecasted.
- When not in use, store pile driving equipment on level ground away from concentrated flows of storm water, drainage courses, and inlets.
- Use less hazardous vegetable oil instead of hydraulic fluid, when practicable.
- Keep equipment that is in use in streambeds; or on docks, barges, or other structures over water bodies, leak free. The storage or use of equipment in streambeds or other bodies of water shall comply with all applicable regulatory permits. Refer to "Material and Equipment Use Over Water."
- Implement other BMPs as applicable, such as "Dewatering Operations," "Solid Waste Management," "Hazardous Waste Management," and "Liquid Waste Management."

## Inspection and Maintenance

- Inspect pile driving areas and equipment for leaks and spills daily when they are in operation or within or next to water.
- Inspect pile driving areas and equipment for leaks and spills at least weekly, prior to a forecasted rain event, daily during extended rain events and post-storm events.
- Inspect equipment routinely and repair equipment as needed (e.g., worn or damaged hoses, fittings, gaskets).

- Inspection and Maintenance of these areas must be properly documented and the stormwater Manager must ensure no potential for discharges occur from these areas as part of the non-visible monitoring requirements.

### Typical Details

None specified to date for this manual.

# 4.7.11 CONCRETE CURING

## Definition and Purpose

This BMP consists of procedures that minimize pollution of storm water runoff during concrete curing. Concrete curing includes the use of both chemical and water methods. Concrete curing is used for the construction of structures such as bridges, retaining walls, and pump houses. Any element of the structure (i.e., footings, columns, abutments, stem and soffit, decks) may be subject to curing requirements. Proper procedures to minimize any potential for runoff during concrete curing must take place.

## Appropriate Applications

All concrete elements of a structure (e.g., footings, columns, abutments, stems, soffit, deck) are subject to curing requirements.

## Limitations

None Identified

## Standards and Specifications

**Chemical Curing**

- Avoid over-spray of curing compounds.
- Minimize the drift of chemical cure as much as possible by applying the curing compound close to the concrete surface. Apply an amount of compound that covers the surface, but does not allow any runoff of the compound.
- Use proper storage and handling techniques for concrete curing compounds. Refer to "Material Delivery and Storage."
- Protect drain inlets prior to the application of curing compounds. Refer to "Temporary Drainage Inlet Protection."
- Implement "Spill Prevention and Control" BMPs.

**Water Curing for Bridge Decks, Retaining Walls, and Other Structures**

- Direct cure water away from inlets and receiving waters to collection areas for removal as approved by the RE and in accordance with all applicable permits.
- Collect cure water and transport or dispose of water in accordance with all applicable permits
- Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

## Inspection and Maintenance

- Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- Inspect any temporary diversion devices, lined channels, or swales for washouts, erosion, runoff or debris. Replace lining and remove debris as necessary.
- Inspect cure containers and spraying equipment for leaks. Also, inspect concrete curing areas daily when there are ongoing operations.
- The stormwater Manager must ensure no concrete curing activities occur when rain is forecasted that could lead to a discharge.

#### 4.7.11.1 Typical Details

None specified to date for this manual.

# 4.7.12 CONCRETE FINISHING

## Definition and Purpose

This BMP consists of procedures to minimize the impact that concrete finishing methods may have on storm water runoff. Methods include sand blasting, lead shot blasting, grinding, or high pressure water blasting. Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances.

## Appropriate Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

## Limitations

Specific permit requirements may be included in the contract documents for certain concrete finishing operations.

## Standards and Specifications

**General Requirements**

- Follow containment requirements stated in the project SCRs.
- Collect and properly dispose of water and solid waste from high-pressure water blasting operations.
- Collect and properly dispose of water from water blasting operations, sand and solid waste from sandblasting operations.
- Protect drainage inlets within 50 feet of the sandblasting prior to beginning sandblasting operations. Refer to “Temporary Drainage Inlet Protection.”
- Implement “Street Sweeping” within the sand blasting and surrounding area.
- Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.
- Discharges to waterways shall be reported to the PE by SWPPP manager immediately upon discovery.

**Other Considerations**

- Direct water from blasting operations away from inlets and receiving waters to collection areas for removal (e.g., dewatering) as approved in advance by the PE and in accordance with applicable permits.
- When blast residue contains a potentially hazardous waste, refer to “Hazardous Waste Management.”
- Implement “Concrete Waste Management” in combination with this BMP.

## Inspection and Maintenance

- At a minimum, inspect containment structures, if any, for damage or voids prior to use each day and prior to a likely forecasted rain event.
- At the end of each work shift, remove and contain the liquid and solid wastes from containment structures, if any, and from the general work area.
- Inspect concrete finishing areas at least weekly, prior to a forecasted rain event, daily during extended rain events and post-storm events.

- Inspection and Maintenance of these areas must be properly documented and ensure no potential for discharges occur from these areas as part of the nonvisible monitoring requirements.

### 4.7.12.1 Typical Details

None specified to date for this manual.

# CHAPTER 5:

# CONSTRUCTION BMPS FOR WORKING IN, OVER OR ADJACENT TO WATERS OF THE U.S.:

# 5 CONSTRUCTION BMPS FOR WORKING IN, OVER OR ADJACENT TO WATERS OF THE U.S.:

A critical area in transportation construction is working in, over, or adjacent to surface waters. These areas have limited space to capture pollutants before it reaches these receiving waters. Much of the work in this area involves demolition or construction of temporary or permanent bridges, culverts, or low water crossings. This section is focused on BMPs that help protect this sensitive work zone that occurs within the aquatic environment but is a critical part of roadway construction activities. Most of these BMPs in this section fall into the non stormwater category as they focus on isolating and containment of in water work zones rather than management of upland areas.

## 5.1 ISOLATION AND CONFINEMENT BMPS

These BMPs are largely required for CWA compliance with section 404 and 401 permitted activities, though NPDES storm water regulations for construction sites also apply. As with the non-storm water management measures, it is important to provide the contractor with flexibility, but to identify in the plans, that specific BMPs will be implemented for certain activities regardless of where on the site those activities are performed. These are source control BMPs that prevent pollution by reducing pollutants at their source, and require a clean, well-kept site. The measures include:

- Working On or Over Water;
- Demolition Over or Adjacent to Water;
- Temporary Stream/River Crossing;
- Streambank Stabilization;
- Clearwater Diversion and Isolation Techniques;
- Filter Fabric Isolation Technique;
- Turbidity Curtain Isolation Technique;
- K-Rail River Isolation Technique;
- Cofferdam and/or Sheet Pile Isolation Technique;
- Gravel/Rock Berm with Impermeable Membrane Isolation Technique;
- Gravel Bag or Sandbag Isolation Technique;
- Pipe Piles and Caisson Isolation Technique;
- In-stream Construction Sediment Control; and
- Washing Fines (Streambed Restoration Technique

## 5.1.1 Working On or Over Water; Including Material and Equipment Use on Water:

### Description and Purpose

Procedures for the proper use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads, or similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse.

### Appropriate Applications

Applies where materials and equipment are used on barges, boats, docks, and other platforms over or adjacent to a watercourse including waters of the United States. These procedures should be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may be detrimental if released.

### Limitations

Dredge and fill activities are regulated by the USACE and states under Section 404/401 of the CWA and Section 10 of RHA. Ensure all appropriate permits are obtained prior to construction activities.

### Standards and Specifications

- Refer to BMPs for Material Delivery and Storage and Spill Prevention and Control.
- Use drip pans and absorbent materials for equipment and vehicles and ensure that an adequate supply of spill clean-up materials is available.
- The exterior of vehicles and equipment that will encroach on a water body within the project should be maintained free of grease, oil, fuel, and residues and may require vegetable based hydraulic oil.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle is expected to be idle for more than 1 hour.
- Maintain equipment in accordance with BMPs for Vehicle and Equipment Maintenance. If a leaking line cannot be repaired, remove equipment from over the water
- Provide watertight curbs or toe boards to contain spills and prevent materials, tools, and debris from leaving the barge, platform, dock, etc.
- Secure all material to prevent discharge to receiving waters via wind.
- Identify types of spill control measures to be employed, including the storage of such materials and equipment. Ensure that staff is trained regarding the use of the materials, deployment and access control measures, and reporting measures.
- In case of spills, contact the PE who will contact the USACE and State water quality division as soon as possible but within 48 hours.
- Refer to BMPs for Solid Waste Management (non-hazardous) and Hazardous Waste Management. Ensure the timely and proper removal of accumulated wastes.

- Comply with all necessary permits required for construction within or near the watercourse, such as State 401 WQC, USACE 404 permit
- Discharges to waterways should be reported to the USACE and State WQC immediately upon discover. A written discharge notification must follow within 7 days. Follow the spill reporting procedures contained in the SWPPP.

## Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Ensure that employees and subcontractors implement the appropriate measures for storage and use of materials and equipment.
- Inspect and maintain all associated BMPs and perimeter controls to ensure continuous protection of the water courses, including waters of the United States.

## Typical Details

None specified to date for this manual.

# 5.1.2 Demolition Over or Adjacent to Water

### Description and Purpose

Procedures to protect water bodies from debris and wastes associated with structure demolition or removal over or adjacent to watercourses.

### Appropriate Applications

Full bridge demolition and removal, partial bridge removal (barrier rail, edge of deck) associated with bridge widening projects, concrete channel removal, or any other structure removal that could potentially affect water quality.

### Limitations

Specific permit requirements may be included in the contract documents.

### Standards and Specifications

- Refer to Clear Water Diversion and Isolation Techniques, to direct water away from work areas.
- Use attachments on construction equipment such as backhoes to catch debris from small demolition operations.
- Use covers or platforms to collect debris.
- Platforms and covers are to be approved by the PE.
- Stockpile accumulated debris and waste generated during demolition away from watercourses and in accordance with Stockpile Management.
- Ensure safe passage of fish and wildlife.
- Discharges to waterways shall be reported to the State WQB immediately upon discovery. A written discharge notification must follow within 7 days. Follow the spill reporting procedures in the SWPPP.
- For structures containing hazardous materials, i.e., lead paint or asbestos, refer to Hazardous Waste Management procedures. For demolition work involving soil excavation around lead-painted structures, refer to Contaminated Soil Management procedures.

### Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Any debris-catching devices shall be emptied regularly. Collected debris shall be removed and stored away from the watercourse and protected from runon and runoff.

### Typical Details

None specified to date for this manual.

## 5.1.3 Temporary Stream/River Crossing

### Description and Purpose

A temporary stream crossing is a temporary culvert, ford or bridge placed across a waterway to provide access for construction purposes for a period of less than one year. Temporary access crossings are not intended to maintain traffic for the public. The temporary access will eliminate erosion and downstream sedimentation caused by vehicles.

### Appropriate Applications

Temporary stream crossings should be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels that may be significantly eroded by construction traffic.

Temporary streams crossings are installed at sites:

- Where appropriate permits have been secured for the temporary crossing (404 Permits, and 401 Certifications)
- Where construction equipment or vehicles need to frequently cross a waterway
- When alternate access routes impose significant constraints
- When crossing perennial streams or waterways causes significant erosion
- Where construction activities will not last longer than one year

### Limitations

The following limitations may apply:

- Specific permit requirements or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS supersede the guidance in this BMP. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.
- Installation and removal will usually disturb the waterway.
- Installation may require dewatering or temporary diversion of the stream. See , Dewatering Operations and Clear Water Diversion BMPs.
- Installation may cause a constriction in the waterway, which can obstruct flood flow and cause flow backups or washouts. If improperly designed, flow backups can increase the pollutant load through washouts and scouring.
- Use of natural or other gravel in the stream for construction of Cellular Confinement System (CCS) ford crossing will be contingent upon approval by fisheries agencies.
- Ford crossings may degrade water quality due to contact with vehicles and equipment.
- May be expensive for a temporary improvement.
- Requires other BMPs to minimize soil disturbance during installation and removal.
- Fords should only be used in dry weather.

## Standards and Specifications

### General

The purpose of this BMP is to provide a safe, erosion-free access across a stream for construction equipment. Minimum standards and specifications for the design, construction, maintenance, and removal of the structure should be established by an professional engineer. Temporary stream crossings may be necessary to prevent construction equipment from causing erosion of the stream and tracking sediment and other pollutants into the stream.

Temporary stream crossings are used as access points to construction sites when other detour routes may be too long or burdensome for the construction equipment. Often heavy construction equipment must cross streams or creeks, and detour routes may impose too many constraints such as being too narrow or poor soil strength for the equipment loadings. Additionally, the contractor may find a temporary stream crossing more economical for light–duty vehicles to use for frequent crossings, and may have less environmental impact than construction of a temporary access road.

Location of the temporary stream crossing should address:

- Site selection where erosion potential is low.
- Areas where the side slopes from site runoff will not spill into the side slopes of the crossing.

The following types of temporary stream crossings should be considered:

- **Culverts –** A temporary culvert is effective in controlling erosion but will cause erosion during installation and removal. A temporary culvert can be easily constructed and allows for heavy equipment loads.
- **Fords -** Appropriate during the dry season in arid areas. Used on dry washes and ephemeral streams, and low-flow perennial streams. A temporary ford provides little sediment and erosion control and is ineffective in controlling erosion in the stream channel. A temporary ford is the least expensive stream crossing and allows for maximum load limits. It also offers very low maintenance. Fords are more appropriate for ephemeral drainages in drier areas.
- **Bridges -** Appropriate for streams with high flow velocities, steep gradients and where temporary restrictions in the channel are not allowed.

### Design

For short duration work in ephemeral drainages, a temporary ford may be sufficient. However, a ford is not appropriate if construction will continue through the rainy season, if summer thunderstorms are likely, or if the stream flows during most of the year. Temporary culverts and bridges should then be considered and, if used, should be sized to pass a design storm (i.e., at least a 2 to 5-year storm). The temporary stream crossing should be protected against erosion, both to prevent excessive sedimentation in the stream and to prevent washout of the crossing.

Design and installation requires knowledge of stream flows and soil strength. Designs should be prepared under direction of, and approved by, a registered civil engineer and for bridges, a registered structural engineer. Both hydraulic and construction loading requirements should be considered with the following:

- Comply with any special requirements for culvert and bridge crossings, particularly if the temporary stream crossing will remain through the rainy season.
- Provide stability in the crossing and adjacent areas to withstand the design flow. The design flow and safety factor should be selected based on careful evaluation of the risks due to over topping, flow backups, or washout.
- Install sediment traps immediately downstream of crossings to capture sediments. See BMP Summary for Sediment Trap.
- Avoid oil or other potentially hazardous materials for surface treatment.
- Culverts are relatively easy to construct and able to support heavy equipment loads.
- Fords are the least expensive of the crossings, with maximum load limits.
- CCS crossing structures consist of clean, washed gravel and CCS blocks. These systems are appropriate for streams that would benefit from an influx of gravel; for example, streams or rivers below reservoirs, and urban, channelized streams. Many urban stream systems are gravel-deprived due to human influences, such as dams, gravel mines, and concrete channels.
- The CCS allows designers to use either angular or naturally occurring rounded gravel, because the cells provide the necessary structure and stability. In fact, natural gravel is optimal for this technique, because of the habitat improvement it will provide after removal of the CCS.
- A gravel depth of 6 to 12 in. for a CCS structure is sufficient to support most construction equipment.
- An advantage of a CCS crossing structure is that relatively little rock or gravel is needed, because the CCS provides the stability.
- Bridges are generally more expensive to design and construct, but provide the least disturbance of the streambed and constriction of the waterway flows.

**Construction and Use**

- Stabilize construction roadways, adjacent work area, and stream bottom against erosion.
- Construct during dry periods to minimize stream disturbance and reduce costs.
- Construct at or near the natural elevation of the streambed to prevent potential flooding upstream of the crossing.
- Install temporary erosion control BMPs in accordance with erosion control BMP fact sheets to minimize erosion of embankment into flow lines.
- Any temporary artificial obstruction placed within flowing water should only be built from material, such as clean gravel or sandbags, that will not introduce sediment or silt into the watercourse.

- Temporary water body crossings and encroachments should be constructed to minimize scour. Cobbles used for temporary water body crossings or encroachments should be clean, rounded river cobble.
- Vehicles and equipment should not be driven, operated, fueled, cleaned, maintained, or stored in the wet or dry portions of a water body where wetland vegetation, riparian vegetation, or aquatic organisms may be destroyed.
- The exterior of vehicles and equipment that will encroach on the water body within the project should be maintained free of grease, oil, fuel, and residues.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than one hour.
- Disturbance or removal of vegetation should not exceed the minimum necessary to complete operations. Precautions should be taken to avoid damage to vegetation by people or equipment. Disturbed vegetation should be replaced with the appropriate soil stabilization measures.
- Riparian vegetation, when removed pursuant to the provisions of the work, should be cut off no lower than ground level to promote rapid re-growth. Access roads and work areas built over riparian vegetation should be covered by a sufficient layer of clean river run cobble to prevent damage to the underlying soil and root structure. The cobble must be removed upon completion of project activities.

### Inspection and Maintenance

The following limitations may apply:

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two week intervals in the non-rainy season to verify continued BMP implementation.
- Check for blockage in the channel, sediment buildup or trapped debris in culverts, blockage behind fords or under bridges
- Check for erosion of abutments, channel scour, riprap displacement, or piping in the soil
- Check for structural weakening of the temporary crossings, such as cracks, and undermining of foundations and abutments
- Remove sediment that collects behind fords, in culverts, and under bridges periodically
- Replace lost or displaced aggregate from inlets and outlets of culverts and cellular confinement systems
- Remove temporary crossing promptly when it is no longer needed.

### Typical Details

None specified to date for this manual

# 5.1.4 STREAMBANK STABILIZATION

## Description and Purpose

Stream channels, stream banks, and associated riparian areas are dynamic and sensitive ecosystems that respond to changes in land use activity. Streambank and channel disturbance resulting from construction activities can increase the stream's sediment load, which can cause channel erosion or sedimentation and have adverse effects on the biotic system. BMPs can reduce the discharge of sediment and other pollutants to minimize the impact of construction activities on watercourses. Proper planning and procedures for work in and around streams and channels can reduce the potential for discharge of sediment and other pollutants and minimize the impacts of construction activities on watercourses and habitat. Streams on the 303(d) list and listed for sediment may require numerous measures to prevent any increases in sediment load to the stream.

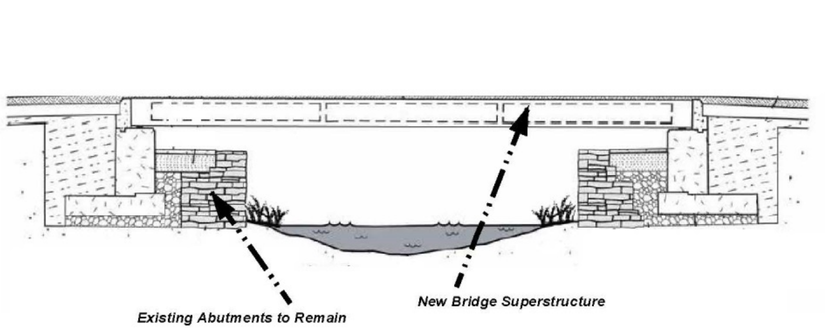
## Suitable Applications

These procedures typically apply to all construction projects that disturb or occur within stream channels and their associated riparian areas. The site-specific stream bank practices used will be partially dependent upon the types of soils present, the slope of the bank, gradient of the river, flow, and uses of the watercourse. Streambank stabilization typically consists of a combination of several BMPs to prevent destabilization and enhance stability of eroding streambanks.

## Limitations

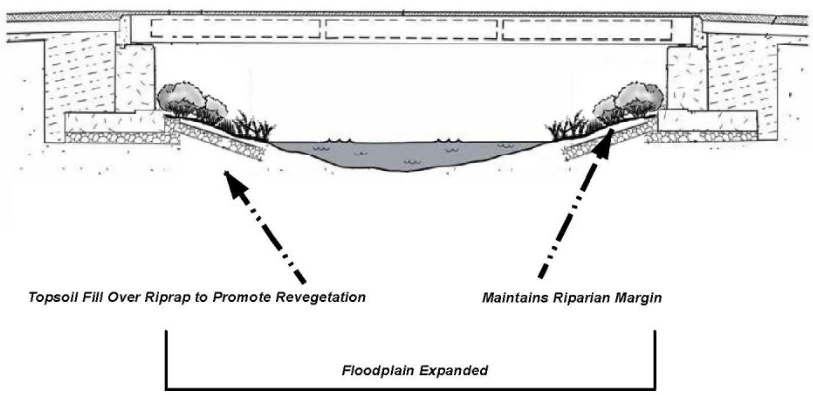
- The appropriate time to apply stream bank erosion controls is dependent upon the method used.
- Specific permit requirements or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS supersede the guidance in this BMP. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.

## Retain Existing Bridge Abutment Cross-Section:




**Notes:**
1) Minimizes new disturbance during the short term.
2) Previous active channel and floodplain widths are maintained.
3) Does not support a riparian margin.
4) Does not allow for any bioengineering features to be Integrated into Design

## Remove Existing Bridge Abutment with Channel Improvement Cross-Section:




**Notes:**
1) Supports Riparian Functions
2) Provides Scour Protection Through Buried Riprap
3) Maintains a Riparian Margin Adjacent to Roadway.
4) Allows Bioengineering Features to be Integrated into Design

Federal Highway Administration-Central Federal Lands Highway Division

**Figure 61. Example of streambank stabilization options during bridge replacement.**

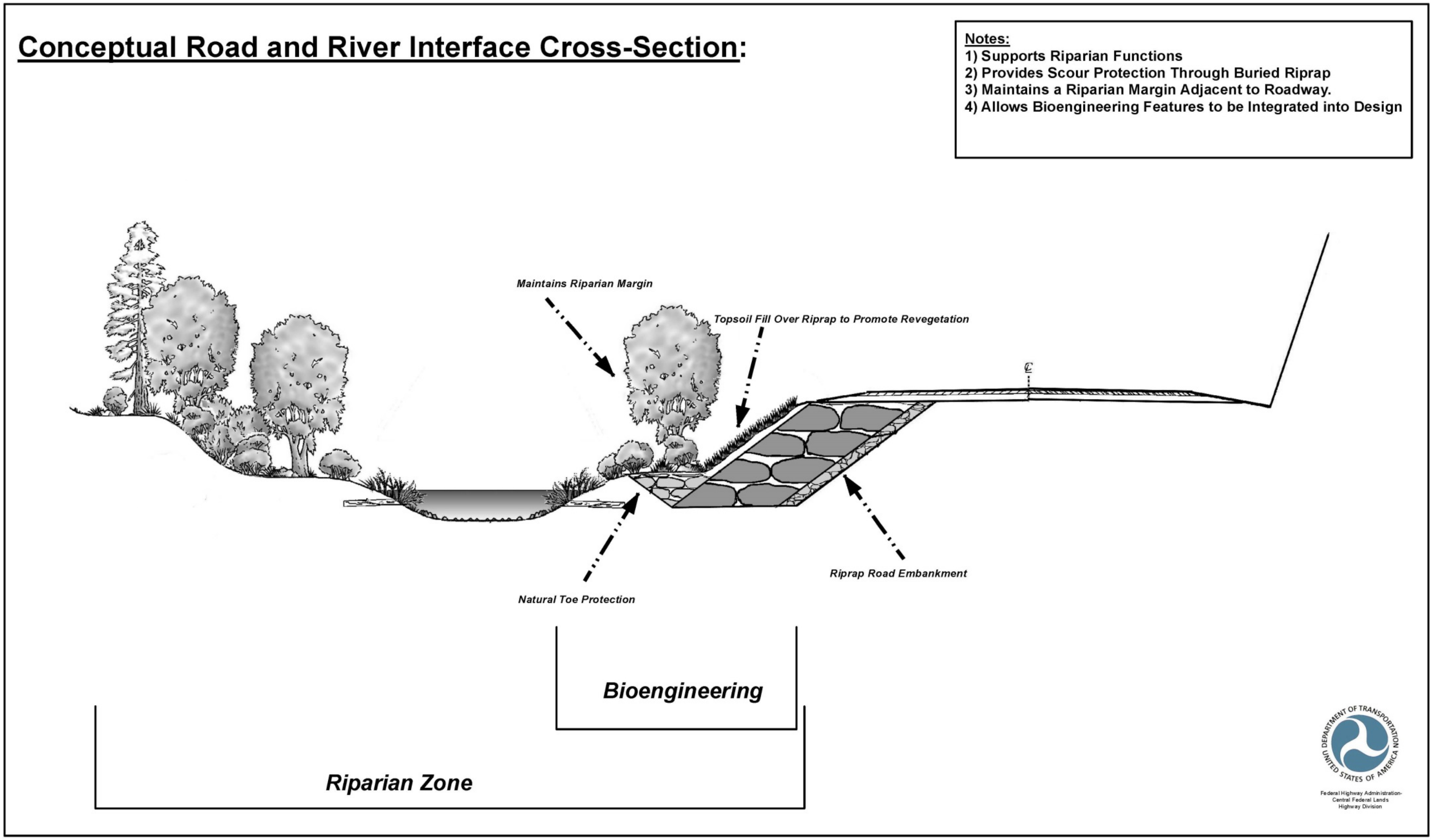



**Figure 62. Example of roadway with riprap and bioengineering features.**

## Implementation

### Planning

Proper planning, design, and construction techniques can minimize impacts normally associated with streambank construction activities. Poor planning can adversely affect soil, fish, wildlife resources, land uses, or land users. Planning should take into account: scheduling; avoidance/minimization of in-stream construction; minimizing disturbance area and construction time period; using pre-disturbed areas; selecting crossing location; selecting equipment; and proper stabilization techniques once the activity is completed.

It is important to remember that streams are dynamic. Even without human influence streams may meander, and in the process, cause banks to erode. Therefore, not all eroding banks are "bad" and in need of repair. In fact, the wrong system of BMPs installed in the wrong place may cause more damage downstream (and therefore to the entire stream system) than leaving the stream in its natural state. For example, "hard structures" like large riprap or gabions, placed on one eroding bank, can displace the stream's energy downstream to a previously stable bank, causing the downstream bank to erode. If this downstream bank is also stabilized with a hard structure, the stream's energy may be moved further downstream to another previously stable bank, and so on.

So before stabilizing stream banks, consider the cause of the stream bank erosion. If the banks are eroding due to a natural meander, then it may be best to leave the bank alone. If the banks are eroding due to fluctuations in hydrology, the hydrologic fluctuations should be addressed before the banks are stabilized.

Once the cause of erosion is identified and addressed (If possible), determine the goal in stabilizing the stream banks. Some banks are stabilized to protect buildings, land and infrastructure. Others are stabilized to keep soil from entering the stream and to allow recreational or angler access to the stream. The purpose for stabilizing the banks and the users of the stream will help determine the type of structures needed.

Once the above concerns have been addressed, then it is important to work with agencies with expertise in stream bank erosion techniques to address stream bank erosion at the watershed level. Looking at the entire watershed will help prioritize bank stabilization efforts. This is especially important in dynamic watersheds where restoration options must account for more extreme hydrology (steep slopes and intense rainfall regime), extreme channel hydraulics (velocities, shear stress), flood control requirements, and limited space. Design considerations for streambank stabilization techniques should include:

- Channel Grade
- Discharge Frequency
- Discharge Velocities
- Freeboard
- Alignment
- Stream Type and Hydraulic Geometry
- Sediment Load and Bed Material
- Protection Against Failure
- Undermining
- Ends of Revetment
- Debris Removal
- Vegetative Systems

**Scheduling**

Construction activities should be scheduled according to the relative sensitivity of the environmental concerns and in accordance with the Scheduling BMP. Scheduling considerations will be different when working near perennial streams vs. ephemeral streams and are as follows:

- When in-stream construction is conducted in a perennial stream, work should optimally be performed during the rainy season. This is because in the summer, any sediment-containing water that is discharged into the watercourse will cause a large change in both water clarity and water chemistry. During the rainy season, there is typically more and faster flowing water in the stream so discharges are diluted faster. However, should in-stream work be scheduled for summer, establishing an isolation area, or diverting the stream, will significantly decrease the amount of sediment stirred up by construction work. For perennial streams, clear water diversion (see "Clear Water Diversion"), dewatering (see "Dewatering Operations"), and water quality monitoring may be required. Construction work near perennial streams should optimally be performed during the dry season (see below).
- When working in or near ephemeral streams, work should be performed during the dry season. By their very nature, ephemeral streams are usually dry in the summer, and therefore, in-stream construction activities will not cause significant water quality problems. However, when tying up the site at the end of the project, wash any fines (see Washing Fines) that accumulated in the channel back into the bed material, to decrease pollution from the first rainstorm of the season.
- When working near streams, erosion and sediment controls (see Chapter 4) should be implemented to keep sediment out of stream channel.
- Regulatory permits might require or allow for the stockpiling of native bed material to be backfilled during stabilization.

**Minimize Disturbance**

Minimize disturbance through: selection of the narrowest crossing location; limiting the number of equipment trips across a stream during construction; and, minimizing the number and size of work areas (equipment staging areas and spoil storage areas). Place non-water dependent work areas at least 50 feet (ft) from stream channel to minimize impacts to stream. Field reconnaissance should be conducted during the planning stage to identify work areas.

**Use of Pre-Disturbed Areas**

Locate project sites and work areas in areas disturbed by prior construction or other activity when possible. If not possible, select access and staging areas that minimizes disturbance to aquatic species, riparian vegetation, and habitat.

**Selection of Project Site**

Select project site that minimizes disturbance to aquatic species or habitat. Try to avoid steep and unstable banks, highly erodible or saturated soils, or highly fractured rock, wherever possible.

**Equipment Selection**

Select equipment that reduces the amount of pressure exerted on the ground surface, and therefore, reduces erosion potential and/ or use overhead or aerial access for transporting equipment across drainage channels. Use equipment that exerts ground pressures of less than 5 or 6 lb/in, where possible. Low ground pressure equipment includes: wide or high flotation tires (34 to 72 in. wide); dual tires; bogie axle systems; tracked machines; lightweight equipment; and, central tire inflation systems.

## Streambank Stabilization Methods

Streambanks should be temporarily stabilized using approved soil stabilization and sediment control methods identified in Chapter 4 including but not limited to: preservation of existing vegetation, hydraulic mulch, hydroseeding, soil binders, straw mulch, geotextiles or mats, silt fence, straw bale barriers, fiber rolls, velocity dissipation devices, slope drains and/or other appropriate erosion and sediment control methods.

There are numerous methods available to permanently stabilize stream banks. Rather than discuss all of them in detail, below is a discussion of the most common practices.

**Bioengineering**

Bioengineering is a method of using vegetation to stabilize a site with or without structural controls. Some refer to bioengineering as softening the traditional rock-the-bank approach because non-invasive vegetation is used to blend the site into its surrounding landscape. Bioengineering techniques may be as simple as installing erosion control blankets, then seeding exposed soil to help prevent soil movement, to full stream restoration plans. Common techniques utilized included:

**Figure 63: Streambank and Shoreline Stabilization Measures**

| | *Type of Protection and Where Applicable* | | | | | | | | | | *Problems Addressed* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Best Management Practices*** | Decrease Force | Increase Resistance | Immediate Protection | Protection Below or at Waterline | Streambank | Shoreline | Flat Banks (<2:1) | Steep Banks (>2:1) | Holes, Slumps | Natural Materials Present | Toe Erosioin, Undercutting | Wildlife Habitat | Aquatic Habitat | Water Quality/ Sediment Trap | Saturated Soil | Bare Bank | Overbank Erosion |
| ***Bioengineering*** | | | | | | | | | | | | | | | | | |
| Fiber Rolls and Fiberschines, Coir Logs | | X | X | X | X | X | | | | | X | X | X | X | | | |
| Brush Mattress | | X | X | | X | X | | | | X | | X | | X | X | X | X |
| Brush Layering or Branch Packing | X | X | X | | X | X | X | | X | X | | X | X | X | X | X | |
| Brush/Tree Revetment | X | X | X | X | X | | X | X | | | | | | | | | |
| Brush Trench | X | X | X | | X | X | X | X | X | X | | X | | | | X | |
| Stake Plantings | | X | | | X | X | X | | X | | | X | | X | X | X | X |
| Vertical Bundles | | X | | | X | X | X | | X | | | X | | X | X | X | X |
| Live Wattles or Fascines | | X | | | X | X | X | | X | X | | X | | X | X | X | X |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Branchpacking | X | X | X | | X | X | X | | X | X | | | | | | | |
| Live Cribwall | | X | X | X | X | X | | X | | | X | X | X | X | X | X | X |
| Brushmattress | | X | X | | X | X | | | | X | | X | | X | X | X | X |
| ***Structural*** | | | | | | | | | | | | | | | | | |
| Rock Riffle | X | X | X | X | X | | X | X | | | X | | X | X | | | |
| Engineered Log Jams and Tree Revetments | X | X | X | X | X | | | | | X | X | X | X | | | | |
| Log, Rootwad, Boulder Revetment | X | X | X | X | X | | | | | X | | X | X | X | | | |
| Post/Pole Planting | X | X | X | X | X | | | | | X | X | X | | | X | X | X |
| Rock Riprap | | X | X | X | X | X | X | | | | X | | | | X | X | X |
| Rock Gabions | | | X | X | X | X | X | X | | | X | | X | | X | X | |
| Vanes, Weirs, Barbs | X | | X | X | X | | X | | | | X | | X | X | | | |

**Notes:**
**X = BMP may be applicable to activity**

Preserve existing vegetation in accordance with "Preservation of Existing Vegetation." In a stream bank and shoreline environment, bioengineering and preservation of existing vegetation provides the following benefits:

**<u>Riparian Habitat and Water Quality Protection</u>**

Vegetated buffers on slopes trap sediment and promote groundwater recharge. The buffer width needed to maintain water quality ranges from 15 to 100 ft. On gradual slopes, most of the filtering occurs within the first 30ft. Steeper slopes require a greater width of vegetative buffer to provide water quality benefits. As a general rule, the width of a buffer strip between a road and the stream is recommended to be 50 ft plus four times the percent slope of the land, measured between the road and the top of stream bank.

Additionally, these the vegetative buffers surrounding riverine systems are composed of diverse riparian vegetation which provide food and shelter for riparian and aquatic organisms. Minimizing impacts to fisheries habitat is a major concern when working near streams and rivers. Riparian vegetation provides shade, shelter, organic matter (leaf detritus and large woody debris), and other nutrients that are necessary for fish and other aquatic organisms. Buffer widths for habitat concerns are typically wider than those recommended for water quality concerns (100 to 1,500 ft).

Additionally, the root system of riparian vegetation stabilizes stream banks by increasing tensile strength in the soil. The presence of vegetation modifies the moisture condition of slopes (infiltration, evapotranspiration, interception) and increases bank stability.

When working near watercourses, it is important to understand the work site's placement in the watershed. Riparian vegetation in headwater streams has a greater impact on overall water quality than vegetation in downstream reaches. Preserving existing vegetation upstream is necessary to maintain water quality, minimize bank failure, and maximize riparian habitat, downstream of the work site.

### *Riprap*

Riprap is one of the more commonly used stream bank stabilization techniques. It is a permanent cover of rock used to stabilize stream banks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows. It is generally used on stream banks at the toe (bottom) of the slope, with other structures placed up-slope to prevent soil movement. It is often a component of many soil bioengineering techniques listed above.

- Riprap stabilization designs should include appropriate bank slope and rock size to protect the bank from wave and current action and to prolong the life of the embankment. A final slope ratio of at least 1:2 (vertical to horizontal) is recommended, and a more stable 1:3 slope should be used where possible. However, steeper slopes may be appropriate.
- A layer of gravel, small stone, or filter cloth placed under and/or behind the rock helps prevent failure. In many cases, only the toe of the slope may need rock reinforcement; the remainder can be planted with native vegetation.

### *Hydraulic Mulch, Hydroseeding, and Soil Binders*

- Apply hydraulic mulch, hydroseed, or soil binders on disturbed streambanks above the mean high water level to provide temporary soil stabilization.
- Do not place hydraulic mulch, tackifiers, fertilizers, or soil binders below the mean high water level, as these materials could wash into the channel and impact water quality or possibly cause eutrophication.

### *Straw Mulch*

- Apply straw mulch to disturbed streambanks in accordance with “Straw Mulch.”
- Do not place straw mulch or tackifiers below the mean high water level, as this material could wash into the channel and impact water quality.

### *Temporary Cover and Rolled Erosion Control Products*

- Install geosynthetics, rolled erosion control product, and plastic as described in “Temporary Cover and Rolled Erosion Control Products” to stabilize disturbed channels and streambanks.
- Not all applications of temporary cover and RECP should be installed in a channel, for example, certain geotextile netting may snag fish gills and are not appropriate in fishbearing streams. Geotextile fabrics that are not biodegradable are not appropriate for in-stream use. Additionally, geotextile fabric or blankets placed in channels must be adequate to sustain anticipated hydraulic forces.

### *Earth Dikes/Drainage Swales, and Lined Ditches*

- Convey, intercept, or divert runoff from disturbed streambanks using “Earth Dikes/Drainage Swales, and Lined Ditches.”
- Do not place earth dikes in watercourses, as these structures are only suited for intercepting sheet flow, and should not be used to intercept concentrated flow.

### *Outlet Protection/Velocity Dissipation Devices*

- Place outlet protection or velocity dissipation devices at outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits or channels in accordance with device specifications.

### *Slope Drains*

- Use slope drains to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device or stabilized area in accordance with SS-11, "Slope Drains." The use of slope drains minimizes potential streambank erosion from overland flows.

## Streambank Sediment Control Methods

Work along streambanks should minimize to the greatest extent possible the introduction of sediment to the aquatic environment. Temporarily sediment control methods are identified in Chapter 4. Below are requirements for those sediment control BMPs when applied to the streambank environment:

### *Silt Fences*

- Install silt fences in accordance with SC-1, "Silt Fence" to control sediment. Silt fences should only be installed where sediment-laden water can pond, thus allowing the sediment to settle out.

### *Fiber Rolls*

- Install fiber rolls in accordance with SC-5, "Fiber Rolls" along slope contour above the high water level to intercept runoff, reduce flow velocity, release the runoff as sheet flow and provide removal of sediment from the runoff. In a stream environment, fiber rolls should be used in conjunction with other sediment control methods such as SC-1, "Silt Fence" or SC-9, "Straw Bale Barrier." Install silt fence, straw bale barrier, or other erosion control methods along the toe of slope above the high water level. Typical fiber roll installation is illustrated at the end of this Section.

### *Gravel Bag Berm*

- A gravel bag berm or barrier can be utilized to intercept and slow the flow of sediment-laden sheet flow runoff in accordance with SC-6, "Gravel Bag Berm." In a stream environment gravel bag barriers can allow sediment to settle from runoff before water leaves the construction site and can be used to isolate the work area from the stream. Gravel bag barriers are not recommended as a perimeter sediment control practice around streams.

### *Straw Bale Barrier*

- Install straw bale barriers in accordance with SC-9, "Straw Bale Barrier" to control sediment. Straw bale barriers should only be installed where sediment-laden water can pond, thus allowing the sediment to settle out. Install a silt fence in accordance with SC-1, "Silt Fence" on the down-slope side of the straw bale barrier closest to stream channel to provide added sediment control.

### *Compost Sock*

- Compost socks are a mesh sock containing compost that act as three dimensional, biodegradable structures that intercept and filter sheet flow.

- Compost socks can filter runoff, retain sediment, and reduce sheet flow velocities. Compost may be pre-seeded to assist in the establishment of vegetation. Compost socks may be used as either a temporary or permanent sediment control measure.

## Inspection and Maintenance

- Inspect BMPs daily during construction.
- Maintain and repair BMPs.
- Remove accumulated sediment as necessary.

## Typical Details

None specified to date for this manual

# 5.1.5 Clear Water Diversion and Isolation Techniques

## Description and Purpose

Clean water diversions are used to minimize water quality degradation by keeping clean water away from active construction sites. These diversions temporarily intercept and reroute water to 1) isolate surface waters from a construction area that is in or adjacent to water, or 2) divert upslope runoff around an active construction site or one that is newly constructed, unstable, unprotected, or recently seeded, and discharge downstream or down gradient to a protected outlet. They will divert surface waters until the construction is completed, BMPs are installed, and/or slopes are stabilized with vegetation and mulch.

Clear water diversion consists of a system of structures and measures that intercept clear surface water runoff upstream of a project, transport it around the work area, and discharge it downstream with minimal water quality degradation from either the project construction operations or the construction of the diversion. Clear water diversions are used in a waterway to isolate and confine construction area and reduce sediment pollution from construction work occurring in or adjacent to water. Structures commonly used as part of this system include diversion ditches, berms, dikes, slope drains, rock, gravel bags, wood, aqua barriers, cofferdams, filter fabric or turbidity curtains, drainage and interceptor swales, pipes, or flumes.  This guidance will summarize these common practices as well as; identify suitable applications, limitations, standards and specifications, and inspection and maintenance of these practices.

## Design Considerations

### *Construction Sites:*

- Plan in advance for stable discharge of runoff collected in diversions. Discharge points must have outlet protection or energy dissipaters.
- Reduce diversion gradient to reduce water velocity.
- Size clean water diverters adequately for the catchment drainage size.
- Ensure that all diversion pipe connections are completely sealed and conduits are staked securely to the slope. Pipes are preferred to flumes for spill control.
- Ensure that any substance used to assemble or maintain diversion structures (e.g. form oil) or used to minimize seepage beneath these structures (e.g. grout) are non-toxic, non-hazardous, and neutral pH to minimize contamination of clean water.

### *Streams*

- Schedule construction for periods of low flows, or when the stream is dry if possible. Consider seasonal releases of water from dams, fish migration and spawning seasons, and water demands due to vegetation irrigation.
- Always allow sufficient flow to pass to maintain aquatic life downstream. Never completely dam stream flow during isolation of a stream reach for construction.

- Never harm or remove riparian vegetation, unless approved by the permitting authority.
- Consider potential impacts to the stream channel or water body before installing diverters. Select less intrusive methods.
- Do not park equipment below the high water mark of a water body, unless approved by the permitting authority.
- Stabilize embankment slopes and diversion ditches with liners such as geotextiles, erosion control blanket systems, rock slope protection, or other slope stabilization materials in areas where erosion is anticipated.
- Avoid disturbing aquatic species during installation, dewatering, maintenance, or removal of clean water diverters. Maintain adequate flow downstream to support aquatic life.

## Suitable Applications

A clear water diversion is typically implemented where appropriate permits (Section 10, Section 404, and Section 401 WQC) have been secured and work must be performed in a flowing stream or water body.

- Clear water diversions are appropriate for isolating construction activities occurring within or near a water body such as streambank stabilization, or culvert, bridge, pier or abutment installation. They may also be used in combination with other methods, such as clear water bypasses and/or pumps.
- Temporarily intercept and divert upslope runoff around construction areas and discharge to stable point downslope.
- Suitable for conveying runoff down steep slopes, particularly cut-and-fill slopes.
- Useful for diverting, removing, and treating sediment-laden water encountered during construction.
- Pumped diversions are suitable for intermittent and low flow streams.
- Excavation of a temporary bypass channel, or passing the flow through a heavy pipe (called a "flume") with a trench excavated under it, is appropriate for the diversion of streams less than 20 ft wide, with flow rates less than 100 cubic feet per second (cfs).

## Limitations

- Diversion and encroachment activities will usually disturb the waterway during installation and removal of diversion structures.
- Specific permit requirements or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS supersede the guidance in this BMP. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.
- Special permits or mitigation measures may be required.

- Diversion and encroachment activities may constrict the waterway, which can obstruct flood flows and cause flooding or washouts. Diversion structures should not be installed without identifying potential impacts to the stream channel.
- Diversion or isolation activities are not appropriate in channels where there is insufficient stream flow to support aquatic species in the area dewatered as a result of the diversion.
- Diversion or isolation activities are inappropriate in deep water unless designed or reviewed by a hydraulic engineer.
- Diversion or isolation activities should not completely dam stream flow.
- Dewatering and removal may require additional sediment control or water treatment. See SM-17, Dewatering Operations.
- Not appropriate if installation, maintenance, and removal of the structures will disturb sensitive aquatic species of concern.

## Standards and Specifications

There are two types of clean water diversions: (1) The diversion method involves intercepting clean runoff water from upslope, diverting it around a construction area, and conveying it by various means to a stable discharge point down slope. (2) The isolation method, on the other hand, uses various techniques to isolate and dewater a construction area that exists in a stream, lake, or other water environment.

**General**

- Implement the streambank stabilization guidelines to minimize impacts to streambanks.
- Divert clear water to clear water. This means that a diversion should be of sufficient length to completely bypass the area impacted by construction. If clear water is returned to a waterway too soon, it will exacerbate the sediment control problem rather than mitigating it by increasing the volume of sediment laden water on the job site.
- Where working areas encroach on flowing streams, barriers adequate to prevent the flow of muddy water into streams should be constructed and maintained between working areas and streams. During construction of the barriers, muddying of streams should be held to a minimum.
- Where possible, diversion/encroachment impacts should be avoided or minimized by scheduling construction during periods of low-flow or when the stream is dry (see also the project SCRs for scheduling requirements). Scheduling should also consider seasonal releases of water from dams, fish migration and spawning seasons, and water demands due to crop irrigation.
- Diversion structures must be adequately designed to accommodate fluctuations in water depth or flow volume due to tides, storms, flash floods, etc.
- Heavy equipment driven in wet portions of a water body to accomplish work should be completely clean of petroleum residue, and water levels should be below the fuel tanks, gearboxes, and axles of the equipment unless lubricants and fuels are sealed such that inundation by water will not result in discharges of fuels, oils, greases, or hydraulic fluids.

- Excavation equipment buckets may reach out into the water for the purpose of removing or placing fill materials. Only the bucket of the crane/ excavator/backhoe may operate in a water body. The main body of the crane/excavator/backhoe should not enter the water body except as necessary to cross the stream to access the work site.
- Stationary equipment such as motors and pumps located within or adjacent to a water body should be positioned over drip pans.
- When any artificial obstruction is being constructed, maintained, or placed in operation, sufficient water should, at all times, be allowed to pass downstream to maintain aquatic life.
- The exterior of vehicles and equipment that will encroach on a water body within the project should be maintained free of grease, oil, fuel, and residues and may require vegetable based hydraulic oil.
- Equipment should not be parked below the high water mark unless allowed by a permit.
- Disturbance or removal of vegetation should not exceed the minimum necessary to complete operations, and as shown on the project plan sheets (i.e. construction limits). Precautions should be taken to avoid damage to vegetation by people or equipment. Disturbed vegetation should be replaced with the appropriate erosion control/soil stabilization measures.
- Riparian vegetation approved for trimming as part of the project should be cut off no lower than ground level to promote rapid re-growth. Access roads and work areas built over riparian vegetation should be covered by a sufficient layer of clean river run cobble to prevent damage to the underlying soil and root structure. The cobble should be removed upon completion of project activities.
- Drip pans should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- Where possible, avoid or minimize diversion and encroachment impacts by scheduling construction during periods of low flow or when the stream is dry. Scheduling should also consider seasonal releases of water from dams, fish migration and spawning seasons, and water demands due to crop irrigation.
- Construct diversion structures with materials free of potential pollutants such as soil, silt, sand, clay, grease, oil or other petroleum products.
- • A “Diversion Plan” should be submitted to the Project Engineer for review prior to commencing any clear water diversion activities. This plan should include, at a minimum, the following:
    - Predicted diversion flow rates
    - Pump capacities (if required)
    - Material to be used (i.e., piping, plastic sheeting)
    - Appropriate permits and approvals (as required)

- Contingency plans
- Additional BMP(s) (as required)
- Removal and restoration plan

## Stream Isolation Techniques (Temporary Dry Construction Areas)

Isolation techniques are methods that isolate near shore work from a waterbody. Techniques include sheet pile enclosures, water-filled geotextile (Aqua Dam), gravel berm with impermeable membrane, gravel bags, coffer dams, and K-rail.

The selection of which stream diversion or Isolation technique to use will depend upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project. Costs of clear water diversion vary considerably and can be very high. Manufactured diversion structures should be installed following manufacturer's specifications.

### *Filter Fabric*

A relatively inexpensive isolation method is filter fabric isolation. This method involves placement of gravel bags or continuous berms to 'key-in' the fabric, and subsequently staking the fabric in place. This method should be used in relatively calm water, and can be used in smaller streams. Note that this is not a dewatering method, but rather a sediment isolation method.

### *Turbidity Curtain:*

A turbidity curtain is a fabric barrier used to isolate the near shore work area. The barriers are intended to confine the suspended sediment. The curtain is a floating barrier, and thus does not prevent water from entering the isolated area; rather, it prevents suspended sediment from getting out. Turbidity curtains should be used where sediment discharge to a stream is unavoidable.

### *K-rail River Isolation:*

K-rails are shaped concrete barriers that can be used to isolate an in-stream or near bank construction area or to form a sediment deposition area. The method can be used in streams with higher water velocities than allowable with many other isolation techniques, but it does not allow for full dewatering.

### *Sheet Pile Enclosures:*

Sheet metal piles are installed in water to provide a waterproof area for full dewatering. This technique is useful in large streams and lakes. This technique is relatively expensive and staging and heavy equipment access areas are necessary.

### *Water-Filled Geotextile::*

This technique allows for partial dewatering of in-stream/lake or near bank construction areas and can be used for small streams to large rivers. An aqua dam consists of a geotextile bag with two separate sections that is placed in water. Each section is then filled with water to reach above the high water level, preventing movement of the bag. Aqua dams are lightweight, easy to transport, reusable, and easy to install.

### *Gravel Berm with Impermeable Membrane:*

This technique, designed for small streams, allows for partial dewatering of in-stream/lake or near bank construction areas. At the upstream end of the project area, clean washed gravel is placed into the stream to hold in place an impermeable membrane. The area can then be dewatered.

Gravel Bag Berms used in conjunction with an impermeable membrane are cost effective, and can be dewatered relatively easily. If spawning gravel is used, the impermeable membrane can be removed from the stream, and the gravel can be spread out and left as gravel in water habitat if approved in the permit. Only clean, washed gravel should be used for both the gravel bag and gravel berm techniques.

#### *Gravel Bag:*

Overlapping clean and washed gravel filled bags are placed into the water until they reach the height of the high water level. The work area downstream of the gravel bags can then be dewatered. Installation and removal of the gravel bags is labor intensive. Leaks between the gravel bags can also make dewatering an area difficult.

#### *Coffer dams:*

Coffer dams are watertight structures of steel, timber, earth, or other materials built in place to block off the construction area which is normally submerged. These dams are used in a variety of settings, including small to large streams, lakes, and coastal areas. Also, many options are now available and are relatively easy to install.

### Isolation Technique Considerations

- When dewatering behind temporary structures to create a temporary dry construction area, such as cofferdams, pass pumped water through a sediment-settling device, such as a portable tank or settling basin, before returning water to the water body.
- Isolation structures must be in place for life of in-water work. Structures should be installed before work starts and removed after stabilization of in-water work area is complete to avoid impacts to aquatic environment.
- Any substance used to assemble or maintain diversion structures, such as form oil, should be inert, non-toxic and non-hazardous.
- Any material used to minimize seepage underneath diversion structures, such as grout, should be non-toxic, non-hazardous, and as close to a neutral pH as possible.

### Stream Diversion Techniques

In conjunction with isolating and dewatering the work area in a stream reach, surface water upstream may be diverted around the work area and discharged downstream. There are three types of stream diversions. The stream diversion technique to use depends upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project. The three stream diversion techniques are:

#### *Pumped diversions:*

Effective for de-watering in relatively flat terrain. Pump capacity must be sufficient for design flow. Pumps require frequent monitoring.

#### *Pipe/Flume diversions:*

Requires moderate slope to generate adequate stream velocity to move water through the pipe/flume to the discharge area.

### *Dam-type or excavated diversions:*

Water is diverted by temporary dams constructed above and below the work site. Dams must be constructed of erosion resistant materials such as steel plate, sheet pile, washed gravel bags, continuous berms, inflatable water bladders, and similar.

## Diversion Technique Considerations

- When constructing a diversion channel, begin excavation of the channel at the downstream end and work upstream. Once the watercourse to be diverted is reached, and the excavated channel is stable, breach the upstream end, and allow water to flow down the new channel. Once flow has been established in the diversion channel, install the diversion weir in the main channel; this will force all water to be diverted from the main channel.
- All stream diversions will need to have a barrier installed to block the water and force it into the diversion (Refer to Stream Isolation Techniques above). Carefully evaluate site conditions to select type of diversion to use and installation specifications. Size diversions to convey design flood flows. Provide adequate energy dissipation at the outlet to minimize erosion.
- In high flow velocity areas, stabilize slopes of embankments and diversion ditches using an appropriate liner, in accordance with standard specifications for Geotextiles and Mats, or use rock slope protection.
- Where appropriate, use natural streambed materials such as large cobbles and boulders for temporary embankment and slope protection, or other temporary soil stabilization methods.
- Provide for velocity dissipation at transitions in the diversion, such as the point where the stream is diverted to the channel and the point where the diverted stream is returned to its natural channel. See standard specifications for Velocity Dissipation Devices.

# 5.1.6 FILTER FABRIC ISOLATION TECHNIQUE

## Definition and Purpose

A filter fabric isolation structure is a temporary structure built into a waterway to enclose a construction area and reduce sediment pollution from construction work in or adjacent to water. This structure is composed of filter fabric, gravel bags, and steel t-posts.

## Appropriate Applications

- Filter fabric may be used for construction activities such as streambank stabilization, or culvert, bridge, pier or abutment installation. It may also be used in combination with other methods, such as clean water bypasses and/or pumps.
- Filter fabric isolation is relatively inexpensive. This method involves placement of gravel bags or continuous berms to 'key-in' the fabric, and subsequently staking the fabric in place.
- If spawning gravel is used, all other components of the isolation can be removed from the stream, and the gravel may be spread out and left as gravel stream habitat if approved in the permit. Whether spawning gravel or other types of gravel are used, only clean washed gravel should be used as infill for the gravel bags or continuous berm.
- This method should be used in relatively calm water, and can be used in smaller streams.
- This is not a dewatering method, but rather a sediment isolation method.
- Water levels inside and outside the fabric curtain must be about the same, as differential heads will cause the curtain to collapse.

## Limitations

- Do not use if the installation, maintenance and removal of the structures will disturb sensitive aquatic species of concern.
- Filter fabrics are not appropriate for projects where dewatering is necessary.
- Filter fabrics are not appropriate to completely dam stream flow.

## Standards and Specifications

- For the filter fabric isolation method, a non-woven or heavy-duty fabric (refer to Standard Specification FP-14, Section 713) is required over standard silt fence. Using rolled geotextiles allows non-standard widths to be used.
- Anchor filter fabric with gravel bags filled with clean, washed gravel. Do not use sand. If a bag should split open, the gravel can be left in the stream, where it can provide aquatic habitat benefits. If a sandbag splits open in a watercourse, the sand could cause a decrease in water quality, and could bury sensitive aquatic habitat. Exceptions may apply if streambed is composed of sand and similar sand material is used to fill bags.
- Another anchor alternative is a continuous berm, made with the Continuous Berm Machine. This is a gravel-filled bag that can be made in very long segments. The length

of the berms is usually limited to 20 ft for ease of handling (otherwise, it gets too heavy to move).

## Installation

- Place the fabric on the bottom of the stream, and place either a bag of clean, washed gravel or a continuous berm over the bottom of the silt fence fabric, such that a bag-width of fabric lies on the stream bottom. The bag should be placed on what will be the outside of the isolation area.
- Pull the fabric up, and place a metal t-post immediately behind the fabric, on the inside of the isolation area; attach the silt fence to the post with three diagonal nylon ties.
- Continue placing fabric as described above until the entire work area has been isolated, staking the fabric at least every 6 ft.

## Inspection and Maintenance

- Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications. At a minimum, during construction inspect daily during the workweek.
- Schedule additional inspections during and after storm events.
- Immediately repair any gaps, holes or scour.
- Remove and properly dispose of sediment buildup.
- Remove BMP upon completion of construction activity. Recycle or reuse if applicable.
- Revegetate areas disturbed by BMP removal if needed.

## Typical Details

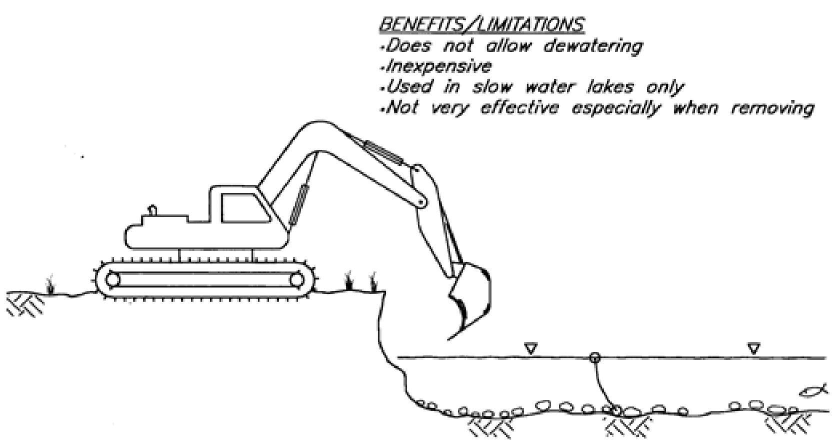



**Figure 64: Geotextiles, Silt Barriers, Curtain Enclosure Method.**

# 5.1.7 TURBIDITY CURTAIN ISOLATION TECHNIQUE

## Definition and Purpose

A turbidity curtain is a fabric barrier used to isolate the near shore work area. The barriers are intended to confine the suspended sediment. The curtain is a floating barrier, and thus does not prevent water from entering the isolated area; rather, it prevents suspended sediment from getting out.

## Appropriate Applications

- Turbidity curtains should be used where sediment discharge to a stream is unavoidable. They are used when construction activities adjoin quiescent waters, such as lakes, ponds, and slow flowing rivers. The curtains are designed to deflect and contain sediment within a limited area and provide sufficient retention time so that the sediment particles will fall out of suspension.
- These BMPs are designed and selected for specific flow conditions. For sites with flow velocities or currents greater than 5 feet per second, a qualified engineer and product manufacturer shall approve of the use.

## Limitations

- May be insufficient as a primary isolation technique and may be better suited for use in conjunction with other isolation or confinement techniques
- Turbidity curtains should not be used in flowing water; they are best suited for use in ponds, lakes, and very slow-moving rivers.
- Turbidity curtains should not be placed across the width of a channel unless they are specifically engineered to withstand expected flows and approved by project engineer.
- Removing sediment that has been deflected and settled out by the curtain may create a discharge problem through the re-suspension of particles and by accidental dumping by the removal equipment.

## Standards and Specifications

- Turbidity curtains shall be installed parallel to the flow of the watercourse, allowing for 10 to 20 percent variance in the straight-line measurements. Allow for at least 50 feet between joints in the curtain and no more than 100 feet between anchor or stake locations.
- The curtain should extend the entire depth of the watercourse in calm-water situations.
- In wave conditions, the curtain should extend to within 1 ft of the bottom of the watercourse, such that the curtain does not stir up sediment by hitting the bottom repeatedly. If it is desirable for the curtain to reach the bottom in an active-water situation, a pervious filter fabric may be used for the bottom 1 ft.
- Multiple concentric curtains, in some cases both top-down and bottom-up, may be necessary to fully contain sediment during in-water work.
- Turbidity monitoring shall be conducted to evaluate curtain effectiveness, and contingency measures shall be implemented immediately if suspended sediment escapes in excess of allowable limits.

- Turbidity curtains shall extend the entire depth of the watercourse. In significant wind, wave, or tidal action areas, a 10- to 12-foot depth is the most practical because of fabric and mooring anchor strain from the heavy water and sediment loads.
- For tidal situations or in areas heavily impacted by wind-generated wave action, turbidity curtains shall have slack to follow the rise and fall of the water level without submerging. Curtains shall also maintain adequate flow-through, usually by using heavier woven fabric for the bottom sections of the curtain.
- Materials shall be of strong, heavyweight materials that have UV inhibitors. The tensile strength shall be sufficient to withstand predicted flows. All material seams and line attachments shall be sewn or vulcanized welded into place. Materials shall be of bright colors, when applicable, to attract attention of boaters or swimmers using areas near the worksite. Flotation devices for turbidity curtains shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain. Flotation devices shall be secured to prevent shifting and ensure proper flotation along the entire length of the curtain.
- Turbidity curtains shall be anchored by vinyl-sheathed steel cable at the top, with a breaking strength as per engineer specifications, but 10,000 pounds at the minimum. At the bottom, a load line with chain incorporated into the bottom hem of the curtain shall be used for ballast to hold the curtain vertical.
- Shoreline turbidity curtain anchors and instream sediment mats shall be anchored by chains, 2x4-foot wood, or 1.33 pounds/linear foot metal stakes. Bottom anchors for turbidity curtains shall hold the curtain in position and may be any of the following anchor types: plow, fluke, mushroom, or grappling hook. All instream anchors shall have a floating anchor buoy or other identifying mark.
- Best installation is achieved by setting the upstream anchor points first, then unfurling the fabric, letting the flow carry the fabric downstream or to a vertical position for turbidity curtains.
- The anchors should first be placed, and then the fabric should be towed out in a furled condition and connected to the anchors. The anchors should be connected to the flotation devices, not to the bottom of the curtain. Once in place, the furling lines should be cut, and the bottom of the curtain should be allowed to sink.
- Sediment shall be allowed to settle for a minimum of 6 to 12 hours before BMP removal or cleaning. All cleaning operations shall also use good sediment control practices. However, consideration must be given to the potential for re-suspension of the particles or by accidental dumping of material during removal. It is recommended that the soil particles trapped by the turbidity curtain be removed only if there has been a significant change in the original contours of the affected area in the watercourse.
- Consider sizing materials adequately to allow maintenance to occur only before removal and not throughout the project.

### Removal Specifications

- Particles should always be allowed to settle for a minimum of 6 to 12 hours prior to their removal or prior to removal of the turbidity curtain.

- All materials shall be removed at low flows and in a way that scoops and traps sediments within the fabric. The removal area shall be clear of any obstructions that could tear the fabric.
- For curtains, consider pulling the bottom line and top lines in together like a parachute to pull soils ashore.
- Spoils shall be reused and controlled for erosion on a nearby bank or upland area needing stabilization.

## Inspection and Maintenance

- Inspect turbidity curtains as least daily during in-water work. Immediately repair floats, fabric, or seams to maintain a fully intact barrier. Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications.
- The curtain should be inspected for holes or other problems, and any repairs needed should be made promptly. Follow the manufacturer's instructions for fabric and material repair.
- Allow sediment to settle for 6 to 12 hours prior to removal of sediment or curtain. This means that after removing sediment, wait an additional 6 to 12 hours before removing the curtain.
- To remove, install furling lines along the curtain, detach from anchors, and tow out of the water.

### *Signs of Failure*

| Symptoms | Cause | Solution |
|---|---|---|
| Turbid water releasing from curtain. | • Bottom anchor is loose or gone.<br>• Joints/overlaps are loose.<br>• Floatation is gone/ diminished.<br>• Curtain material is torn. | • Repair/replace parts as needed.<br>• Reevaluate curtain strength versus strength of water flows. |

## Typical Details

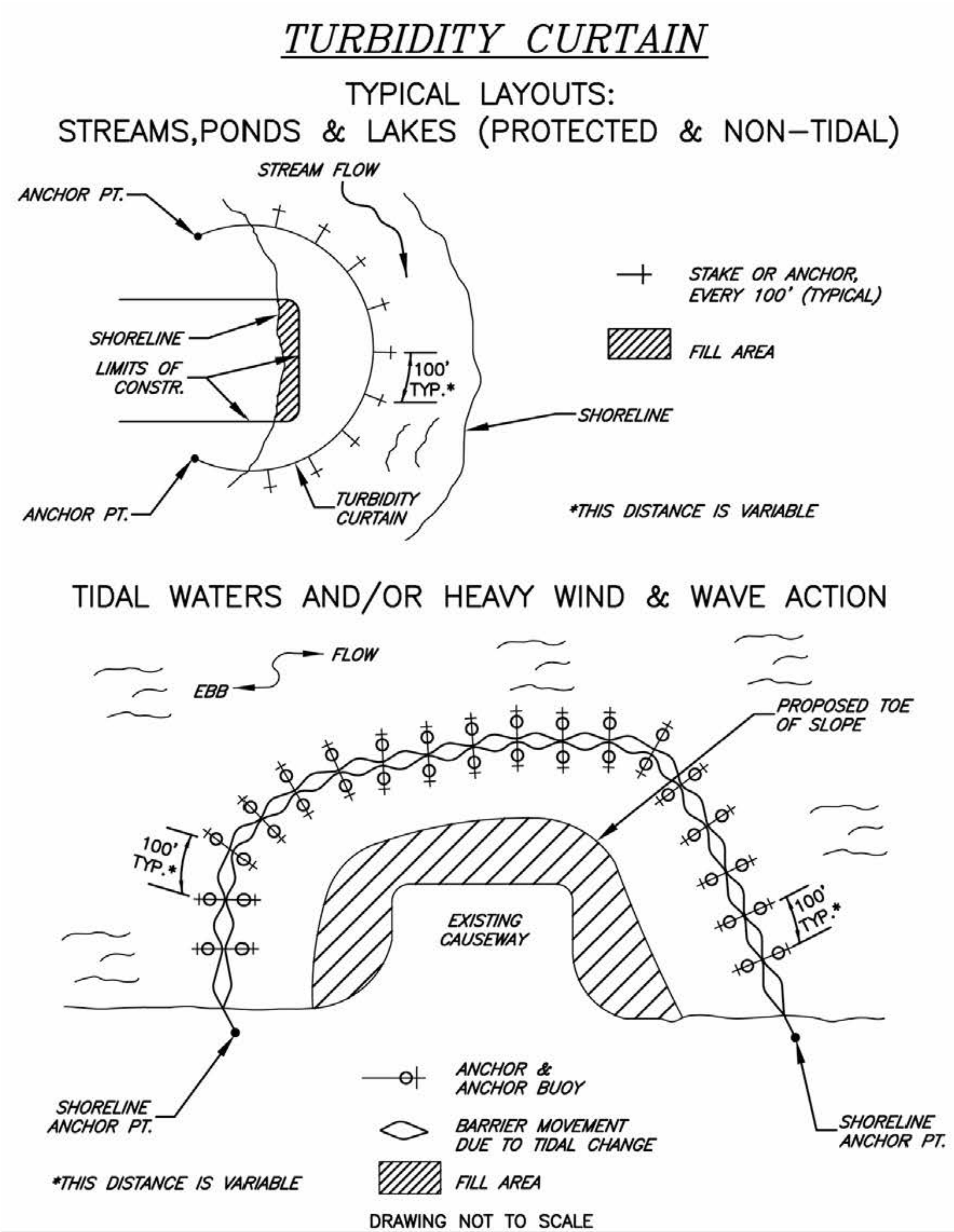



**Figure 65: Turbidity Curtain Enclosure Method.**

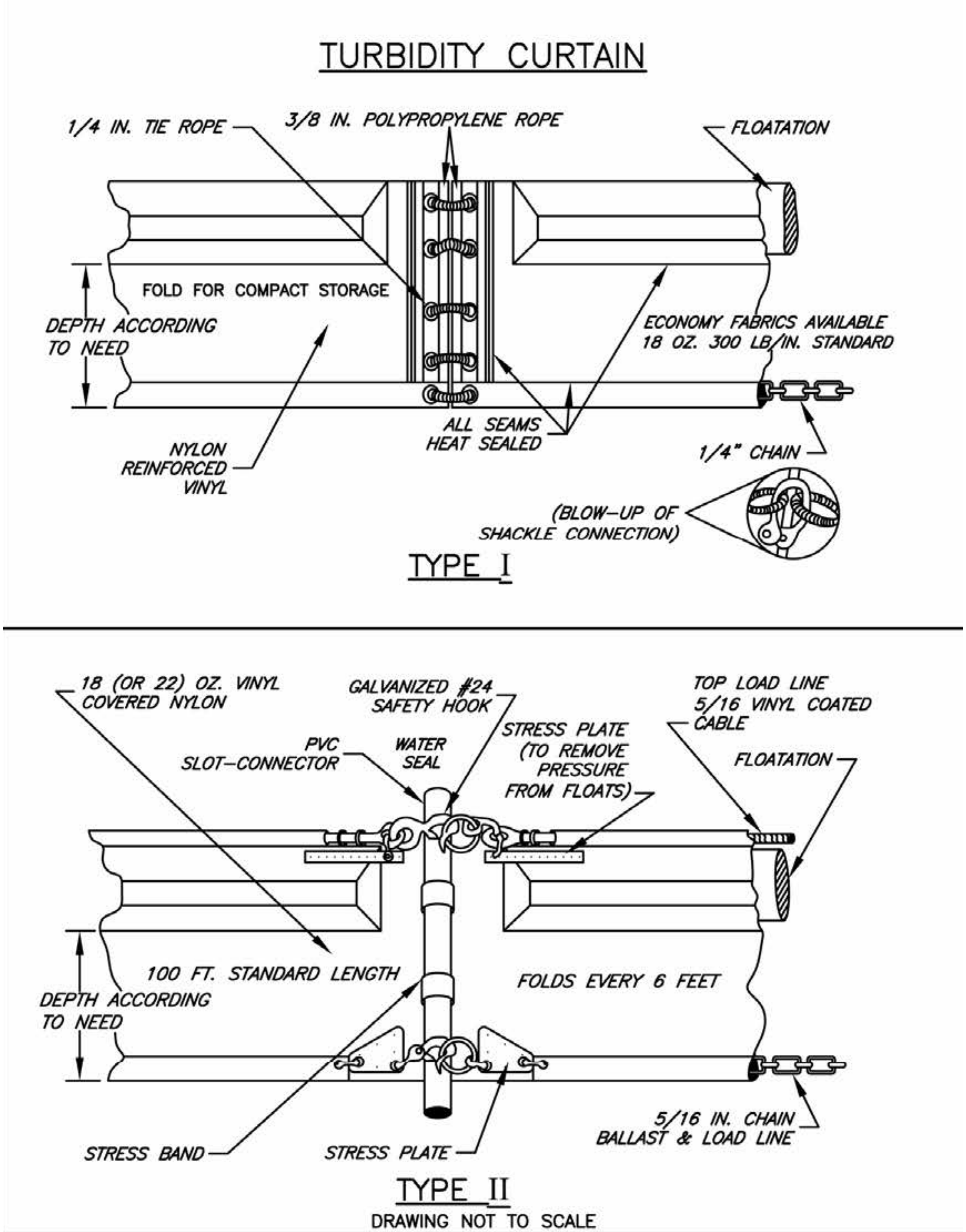



**Figure 66: Turbidity Curtain Enclosure Method.**

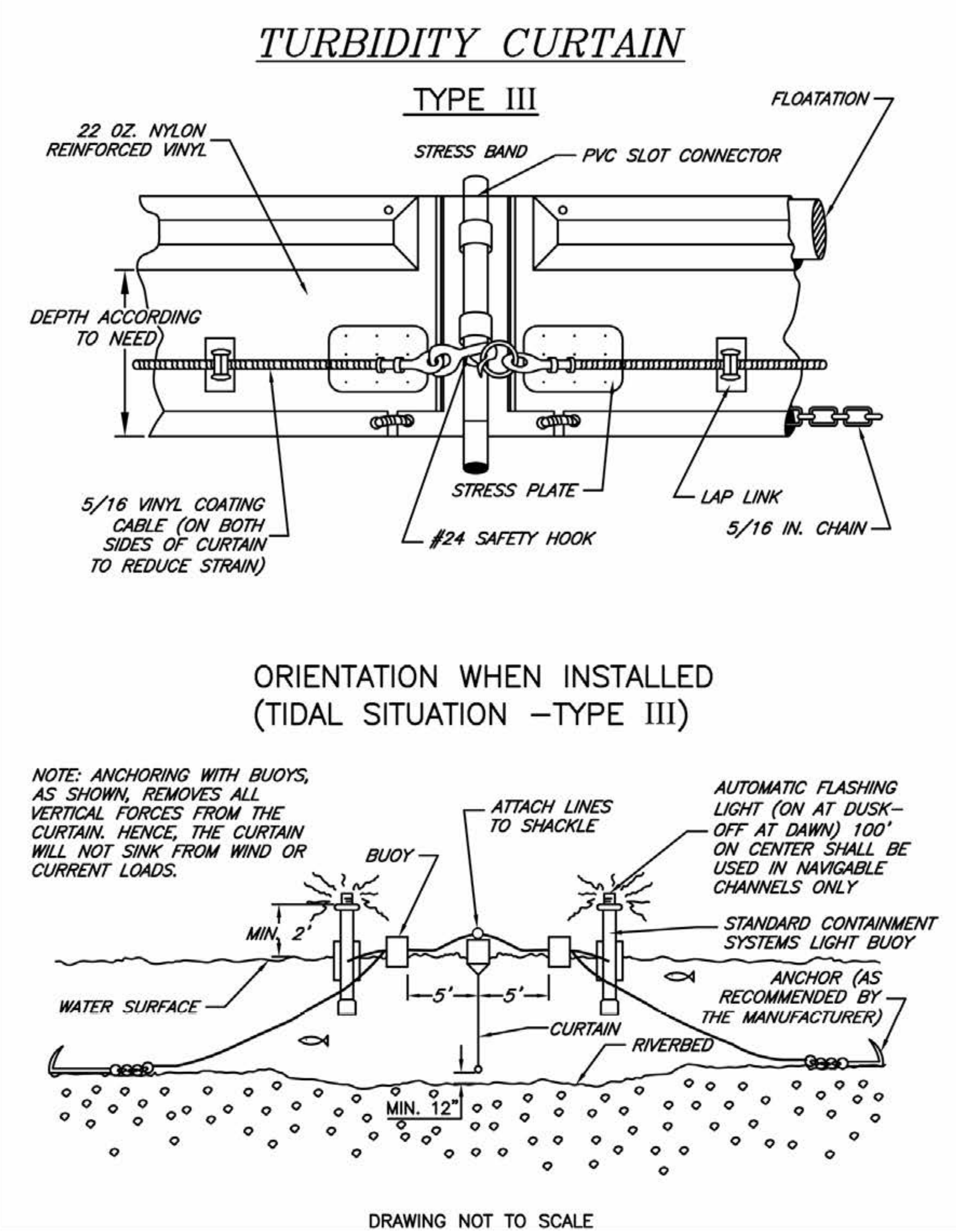



**Figure 67: Turbidity Curtain Enclosure Method.**

# 5.1.8 K-RAIL (JERSEY BARRIER) RIVER ISOLATION TECHNIQUE

### Definition and Purpose

This temporary sediment control or stream isolation method uses K-rails to form the sediment deposition area, or to isolate the in-stream or near-bank construction area.

Barriers are placed end-to-end in a pre-designed configuration and gravel-filled bags are used at the toe of the barrier and at their abutting ends to seal and prevent movement of sediment beneath or through the barrier walls.

### Appropriate Applications

- The K-rail isolation can be used in streams with higher water velocities than many other isolation techniques.
- This technique is also useful at the toe of embankments, and cut or fill slopes.

### Limitations

- The K-rail method should not be used to dewater a project site, as the barrier is not watertight. Refer to standard specifications for construction dewatering techniques.

### Standards and Specifications

- To create a floor for the K-rail, move large rocks and obstructions. Place washed gravel and gravel-filled bags to create a level surface for K-rails to sit. Washed gravel should always be used.
- Place the bottom two K-rails adjacent to each other, and parallel to the direction of flow; fill the center portion with gravel bags. Then place the third K-rail on top of the bottom two (See Figure 15). There should be sufficient gravel bags between the bottom K-rails such that the top rail is supported by the gravel. Place plastic sheeting around the K-rails, and secure at the bottom with gravel bags.
- Further support can be added by pinning and cabling the K-rails together. Also, large riprap and boulders can be used to support either side of the K-rail, especially where there is strong current.

### Inspection and Maintenance

- Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications.
- The barrier should be inspected and any leaks, holes, or other problems should be addressed immediately.
- Sediment should be allowed to settle for at least 6 to 12 hours prior to removal of sediment, and for 6 to 12 hours prior to removal of the barrier.

## Typical Details

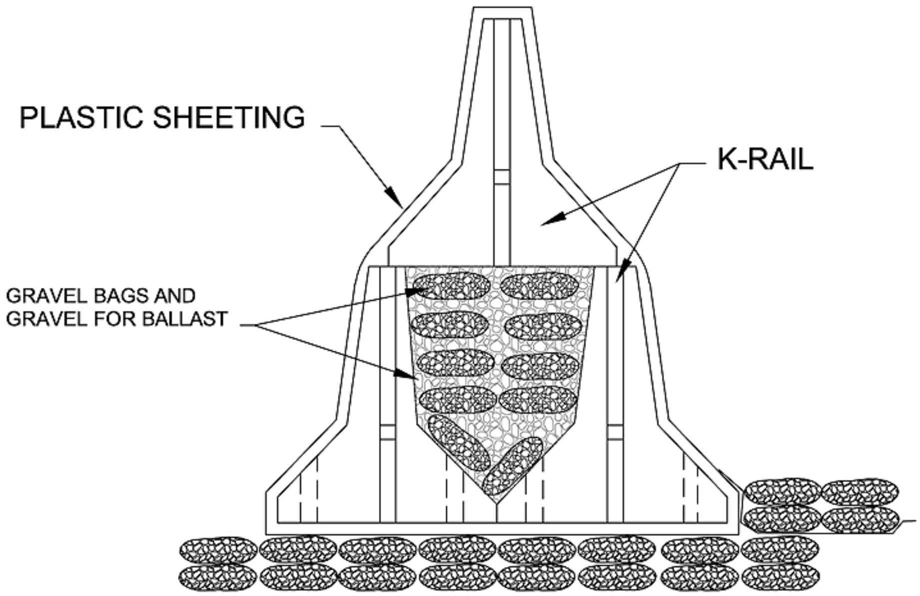



**Figure 68: K-Rail Isolation Method.**

## 5.1.9 Cofferdam and/or Sheet Pile Isolation Technique

### Definition and Purpose

Coffer dams and Sheetpile walls are temporary structures built into a waterway to contain or divert movement of water and to provide a reasonably dry construction area. Coffer dams are commonly made of steel sheet pile, rock, gabions, concrete jersey barriers, vinyl tubes filled with water, or wood and may be lined with geotextile, plastic sheeting, or other materials to prevent water from entering the construction area.

### Appropriate Applications

- Where dewatering is necessary.
- Work areas that require isolation from flows.
- Often used in conjunction with stream diversion techniques.

### Limitations

- Under some conditions, the design must be developed or approved by a qualified licensed engineer.
- The coffer dam should be sturdy enough to withstand anticipated water pressure, shear stresses and scouring.

### Standards and Specifications

- Site specific design is required for a coffer dam.
- Coffer dams should be designed to withstand currents and scour conditions expected under normal stream flow and annual high water. The functional life expectancy is generally 6 months or less.
- Construction materials commonly include steel sheet piles, rock, vinyl tubes, or wood. Piling could consist of standard steel sheet interlocked and driven into the soil or anchored to bedrock. Wooden structures may consist of planks or wood timbers. Concrete jersey barriers may be used, depending on the anticipated water flow, depth and appropriate fit and contact with the stream bed.
- The water side of the coffer dam may be lined with plastic sheeting or some other suitable material that would prevent water passage into the construction area.
- The coffer dam should be built as shown on the plans. Field adjustments should be made as necessary. Water-filled Geotextile (bladder dams) should be installed following manufacturer's recommendations and guidelines. Rocks or sharp objects should be removed prior to installation.
- If dewatering is required while utilizing a coffer dam, meet dewatering requirements of the NPDES permit and/or 404 permits.

### Inspection and Maintenance

- Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications.

- Remove accumulated sediment and debris regularly and just prior to removing the coffer dam.
- Conduct required dewatering operations such that all permitting requirements are met.
- Upon removal of the coffer dam, stabilize the area and streambed and restore to as near-natural condition as possible. This may require some form of rock riprap and permanent revegetation if the stream bank has been disturbed.

## Typical Details

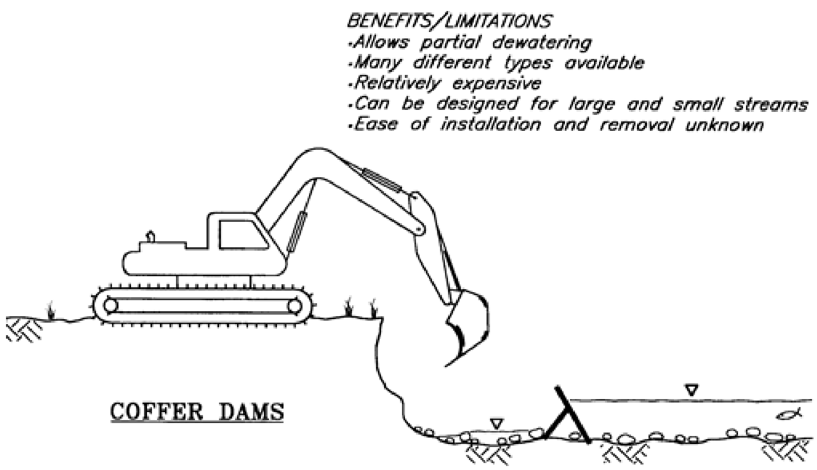



**Figure 69: Coffer Dam Isolation Method.**

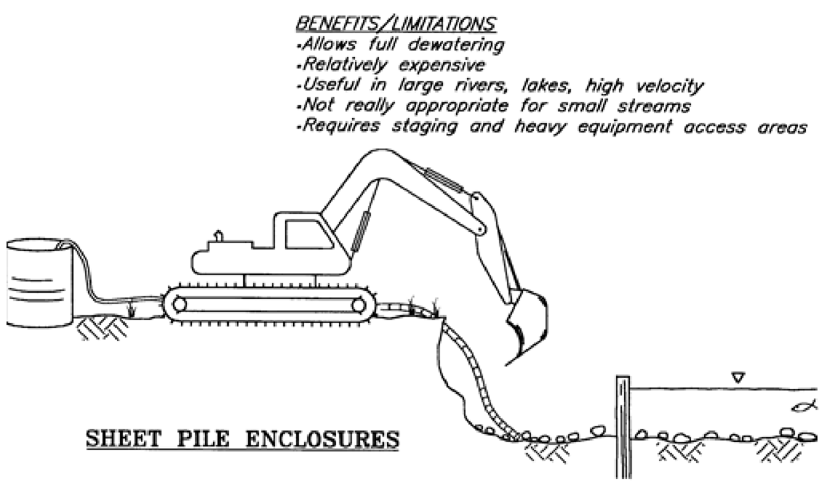



**Figure 70: Sheet Pile Isolation Method.**

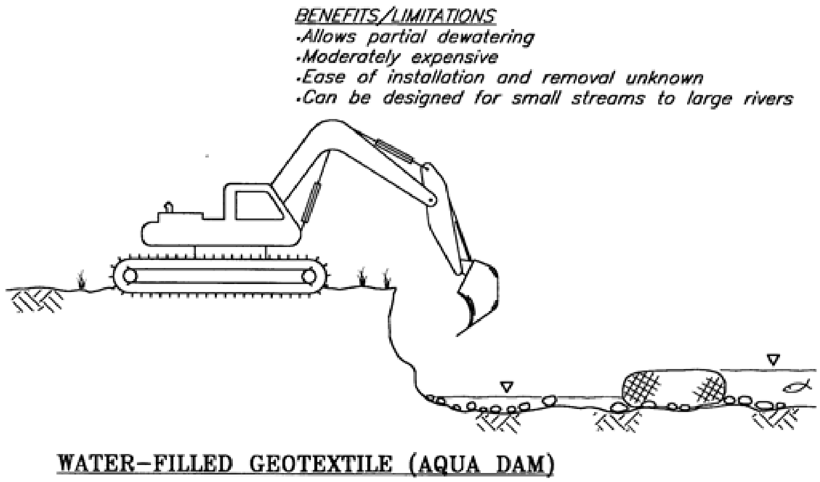



**Figure 71: Water-Filled Geotextile (Bladder Dam).**

## 5.1.10 GRAVEL/ROCK BERM WITH IMPERMEABLE MEMBRANE ISOLATION TECHNIQUE

### Definition and Purpose

This temporary sediment control or stream isolation method uses a gravel or rock berm with an impermeable membrane to isolate the in-stream or near-bank construction area. Appropriate Applications

- Where dewatering is necessary.
- Work areas that require isolation from flows.

### Limitations

- Under some conditions, the design must be developed or approved by a qualified licensed engineer.
- The gravel/rock size should be sturdy enough to withstand anticipated water pressure, shear stresses and scouring.

### Standards and Specifications

- Installation guidelines will vary based on existing site conditions and type of diversion used.
- Gravel berm should be designed to withstand currents and scour conditions expected under normal stream flow and annual high water.
- The impermeable barrier imbedded within the berm should be made of plastic sheeting or some other suitable material that would prevent water passage into the construction area.

### Inspection and Maintenance

- Conduct inspections as required by the NPDES, 404 permit, 401 WQC or contract specifications.
- Conduct required dewatering operations such that all permitting requirements are met.
- Check for any erosion and/or undercutting around the inlet and outlet structures, repair as needed.
- Remove accumulated sediment and debris regularly and just prior to removing the coffer dam.
- Upon decommissioning of the gravel/rock berm, stabilize the area and streambed and restore to as near-natural condition as possible. This may require some form of rock riprap and permanent revegetation if the stream bank has been disturbed.
- Inspect berm before and after large storms, and inspect daily during construction. Visually inspect for clogging, damage to linings, accumulation of debris, and adequacy of slope protection. Remove debris and repair linings and slope protection as required. Repair holes, gaps, or scour.

- Upon completion of work, remove the diversion or isolation structure and redirect flow back into the original stream channel.

## Typical Details

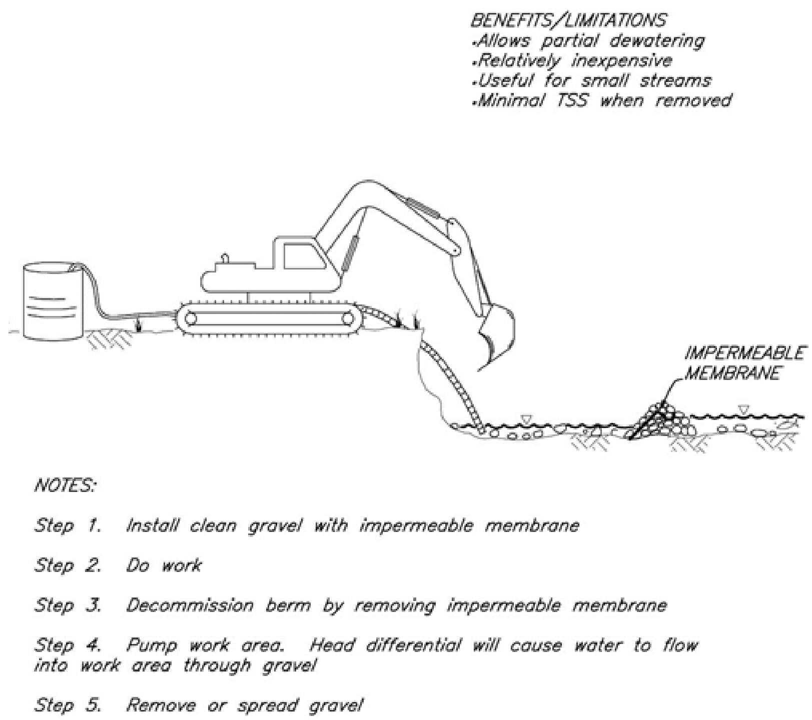



**Figure 72: Gravel/Rock Berm with Impermeable Membrane.**

# 5.1.11 Gravel bag or Sandbag Isolation Technique

## Definition and Purpose

A sandbag barrier is a temporary linear sediment barrier consisting of stacked gravel bag/sandbags, designed to intercept and slow the flow of sediment-laden sheet flow runoff. Gravel bag / Sandbag barriers allow sediments to settle from runoff before water leaves the construction site. Large gravel bag / sandbag barriers can also be used for in-water work and/or water diversions if site conditions allow.

## Appropriate Applications

- To divert or direct flow or create a temporary sediment/de-silting basin.
- During construction activities in stream beds when the contributing drainage area is typically less than 5 acres.
- To capture and detain non-stormwater flows until proper cleaning operations occur.
- When site conditions or construction sequencing require adjustments or relocation of the barrier to meet changing field conditions and needs during construction.
- To temporarily close or continue broken, damaged, or incomplete curbs.

## Limitations

- The drainage area upstream of the barrier should be limited to 5 acres.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor-intensive.
- Limited durability of bag material.
- When used to detain concentrated flows, maintenance may increase.

## Standards and Specifications

- Installation guidelines will vary based on existing site conditions and type of diversion used.
- **Bag Material:** Bags should be woven canvas, geotextile, or burlap material that is UV-resistant and impermeable. Minimum unit weight 4 ounces per square yard; Mullen burst strength exceeding 300 psi in conformance with the requirements in ASTM designation D3786; minimum water flow rating of 145 gallons per minute per foot in conformance with the requirements in ASTM D4491; and ultraviolet stability exceeding 70 percent in conformance with the requirements in ASTM designation D4355.
- **Fill Material:** Use clean gravel or sand (if more suitable based on site conditions) to fill bags Fill material should be inert and easily recoverable if spilled (minimum 3" aggregate for gravel). Fill should be inert clean and free from clay balls, organic matter, and other deleterious materials that could leach from the bag. Fill material is subject to approval by the Engineer.
- Place bags in a manner that causes the least amount of disturbance to the stream bed. Applicable in waters with smooth bed surfaces where bag can create seal along bottom.

## Inspection and Maintenance

- The barrier should be inspected and any leaks, holes, or other problems should be addressed immediately.
- Conduct inspections as required by any applicable permit or contract specifications.
- Reshape or replace sandbags as needed, or as directed by the Engineer.
- Repair washouts or other damages as needed, or as directed by the Engineer.
- Removed sediment should be incorporated in the project at locations designated by and approved by the Engineer or if deemed contaminated (i.e. hazardous waste) should be disposed of in accordance with federal and state laws.
- Remove sandbags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

## Typical Details

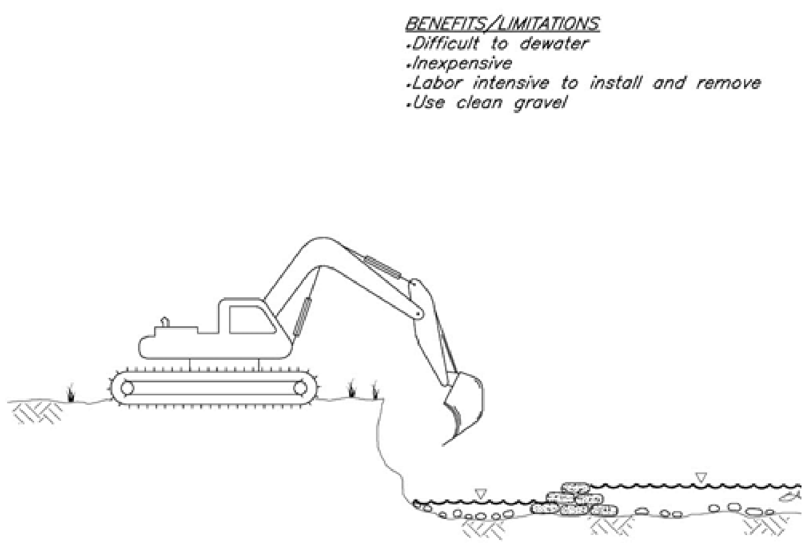



**Figure 73: Gravel Bag / Sand Bag Method**

## 5.1.12 Pipe Piles and Caisson Isolation Technique

### Definition and Purpose

Piles and Caissons come in many different forms and are commonly used during construction of transportation structures, including bridges. Driven piles are typically constructed of precast concrete, steel, or timber. Driven sheet piles are also used for shoring and cofferdam construction.

#### *Piles*

Piled foundations are usually the first alternative considered when it is impractical, uneconomical or unsafe to found conventional structure footings at shallow or intermediate depths below ground. There is a sufficiently wide range of piling systems available from which to select appropriate foundation solutions in most types of ground conditions for road bridges which often require deep founding.

Piles are commonly used to construct bridge or other structural foundations. In this use they are able to transmit the applicable combinations of permanent and transient loads which are applied at the top of the piles, through weak compressible soil or fill materials onto stiff or dense soil strata or rock at lower levels, in such a manner as to prevent excessive settlement, horizontal displacement or rotation of the supported structure.

Driven piles are usually slender, 'column like' structural members (usually acting in groups) which are installed vertically or at a slope in the ground by various techniques, to sufficient depth to achieve the necessary load bearing capacity through frictional resistance along their sides, end bearing resistance at their bases, or combinations of both.

#### *Caissons*

Caissons provide an alternative means to achieve adequate founding at intermediate to significant depths in both land and water environments. This system has been frequently as a practical means to found major bridges in deep water conditions.

Caissons provide a watertight space for underwater construction. The function of caissons is essentially the same as for piles, they transmit the applicable combination of permanent and transient loads applied at the top of the caisson through weak compressive soil or fill materials onto stiff or dense soil strata or rock at lower levels, in such a manner as to prevent excessive settlement, horizontal displacement or rotation of the supported structure at the caisson cap level.

Caissons for bridge foundations are usually cellular reinforced concrete structures, with circular, rectangular or more streamlined plan cross sections comprising one or more excavation compartments, and which are wholly or partly constructed at higher level and sunk in stages to the desired founding level. Sinking of Caisson usually occurs by internal excavation (bucket or crane excavation) sometimes assisted by the application of weights.

Small diameter concrete shafts comprising single open cells and constructed in the same manner as caissons are usually called cylinders. The distinction between cylinders and caissons is merely one of size. Because of their smaller size (usually up to about 8 foot diameter), cylinders lend themselves readily to precast concrete ring elements in their construction. This form of caisson construction can be very economical down to intermediate depths but are not well suited to sinking through ground containing large boulders or with high water tables. Cylinders constructed with precast concrete rings are usually filled with reinforced concrete.

## Appropriate Applications

All construction sites near or adjacent to a watercourse or groundwater where permanent and temporary pile driving (impact and vibratory) takes place.

## Limitations

Proper control and use of equipment, materials, and waste products from pile driving operations will reduce or eliminate the discharge of potential pollutants to the storm drain system, watercourses, and waters of the United States.

- Piles and Caissons are required to be founded at sufficient depth to prevent instability due to scour arising from major floods, when located in riverine environments.
- Specific permit requirements or mitigation measures such as 401 Water Quality Certification, U.S. Army Corps of Engineers Section 404 or Section 10 permits, U.S. Coast Guard Section 9 or General Bridge Act Permits and approval by USFWS and NMFS supersede the guidance in this BMP. If numerical-based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required.

## Standards and Specifications

- Use drip pans or absorbent pads during vehicle and equipment operation, maintenance, cleaning, fueling, and storage. Refer BMPs for Vehicle and Equipment Cleaning, Vehicle and Equipment Fueling, and Vehicle and Equipment Maintenance.
- Have spill kits and cleanup materials available at all locations of pile driving. Refer to BMP for Spill Prevention and Control.
- Equipment that is stored or in use in streambeds, or on docks, barges, or other structures over water bodies should be kept leak free.
- Park equipment over plastic sheeting or equivalent where possible. Plastic is not a substitute for drip pans or absorbent pads. The storage or use of equipment in streambeds or other bodies of water must comply with all applicable permits.
- Implement other BMPs as applicable, such as Dewatering Operations, Solid Waste Management, Hazardous Waste Management, and Liquid Waste Management.
- When not in use, store pile-driving equipment away from concentrated flows of stormwater, drainage courses, and inlets. Protect hammers and other hydraulic attachments from run-on and runoff by placing them on plywood and covering them with plastic when rain is forecast.
- Use less hazardous products, e.g., vegetable oil, when practicable.

## Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect equipment every day at startup and repair equipment as needed (i.e., worn or damaged hoses, fittings, and gaskets). Recheck equipment at shift changes or at the end of the day and scheduled repairs as needed.
- Inspect entire pile driving areas and equipment for leaks and spills on a daily basis. Inspect equipment routinely for damage and repair equipment as needed.

### Typical Details

None specified to date for this manual

# 5.1.13 Stream Diversion Techniques: Pumped, Pipe/Flume, and Excavated

## Definition and Purpose

Stream diversions consists of a system of structures and measures that intercept an existing stream upstream of the project, transports it around the work area, and discharges it downstream. The selection of which stream diversion technique to use depends upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project.

## Appropriate Applications

- Where Dewatering of the work area is necessary.
- Work areas that require isolation from flows.

## Advantages

- Downstream sediment transport can be nearly eliminated.
- Pipes can be moved around to allow construction operation sequencing.
- The dams can also serve as temporary access to the site.
- Increased flows can be managed by adding more pumping capacity.
- Excavated channels isolate work from water flow and allow dewatering.
- Excavated channels can handle larger flows than pumps.

## Limitations

- Flow volume is limited by pump capacity.
- A pumped diversion requires frequent monitoring of pumps.
- Large flows during storm events can overtop dams.
- Erosion at the outlet can occur.
- Flow diversion and re-direction with small dams involves in-stream disturbance and mobilization of sediment during installation and removal.
- Bypass channel or flume must be sized to handle flows, including possible floods.
- Channels must be protected from erosion.
- Flow diversion and re-direction with small dams involves in-stream disturbance and mobilization of sediment.
- Flow volume is limited by temporary channel/flume capacity.
- Sudden rain could overtop excavated channels/flumes.
- Minor in-stream disturbance is required to install and remove dams to detour water into temporary channels/flumes.

## Standards and Specifications

- Any type of water diversion requires special permitting.
- Water diversions are custom designed for unique site specific conditions. Contact system suppliers or design engineers for assistance.
- Installation guidelines will vary based on existing site conditions and type of diversion used.
- Diversions should be sized to convey design flood flows.
- Pump capacity must be sufficient for design flow; the upper limit is approximately 10 cfs (0.3 $m^3$/sec) (the capacity of two 8 inch pumps).
- Adequate energy dissipation must be provided at the outlet to minimize erosion.
- Materials used to create dams upstream and downstream of the diversion should be erosion-resistant. Materials such as steel plates, sheet piles, sandbags, continuous berms, inflatable water bladders, etc., would be acceptable.
- Construction of a diversion channel should begin with excavation of the channel at the proposed downstream end, with work proceeding upstream. Once the watercourse to be diverted is reached, and the excavated channel is stable, the upstream end should be breached, and water should be allowed to flow down the new channel. Once flow has been established in the diversion channel, the diversion weir should be installed in the main channel; this will force all water to be diverted from the main channel.
- Installation guidelines will vary based on existing site conditions and type of diversion used.
- Pump capacity must be sufficient for design flow.
- A standby pump is required in case a primary pump fails.
- Dam materials used to create dams upstream and downstream of diversion should be erosion resistant; materials such as steel plate, sheet pile, sandbags, continuous berms, inflatable water bladders, etc., would be acceptable.
- When constructing a diversion channel, begin excavation of the channel at the proposed downstream end, and work upstream. Once the watercourse to be diverted is reached and the excavated channel is stable, breach the upstream end and allow water to flow down the new channel. Once flow has been established in the diversion channel, install the diversion weir in the main channel; this will force all water to be diverted from the main channel.

## Inspection and Maintenance

- Conduct inspections as required by the NPDES permit or contract specifications.
- Pumped diversions require frequent monitoring of pumps.
- Monitor pumps, which may be required frequently for pumped diversions.
- Remove debris and repair linings and slope protection as required.

- The barrier should be inspected and any leaks, holes, gaps, scour or other problems should be addressed immediately.
- Upon completion of work, remove the diversion or isolation structure and redirect flow through the new culvert or back into the original stream channel. Recycle or re-use if applicable.
- Re-vegetate areas disturbed by BMP removal, if needed.
- Inspect embankments and diversion channels for damage to the linings, accumulating debris, sediment buildup, and adequacy of the slope protection. Remove debris and repair linings and slope protection as required. Remove holes, gaps, or scour.

## Typical Details

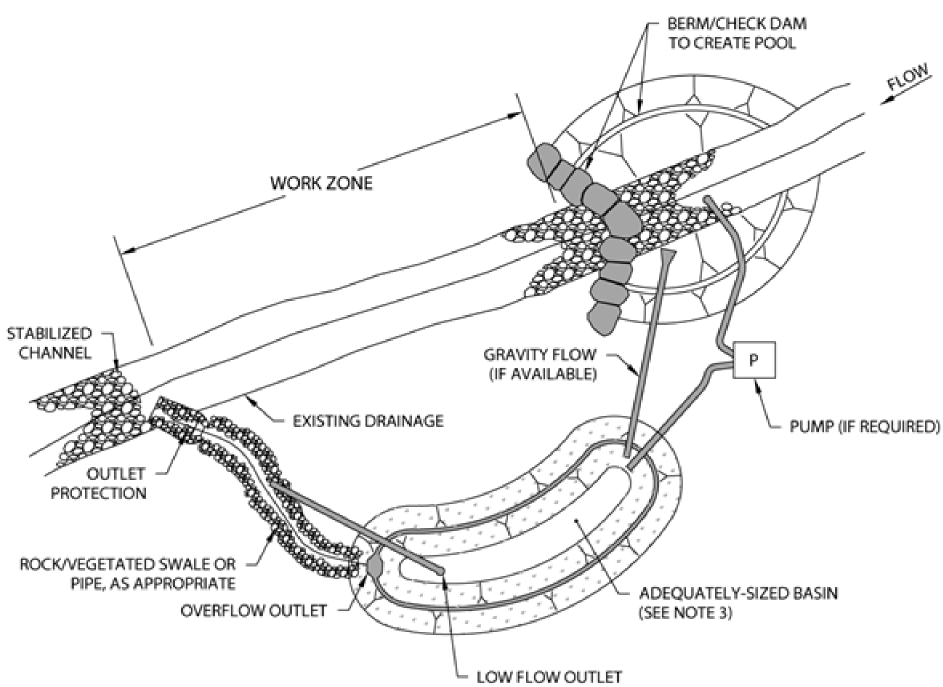



**Figure 74: Diversion Method**

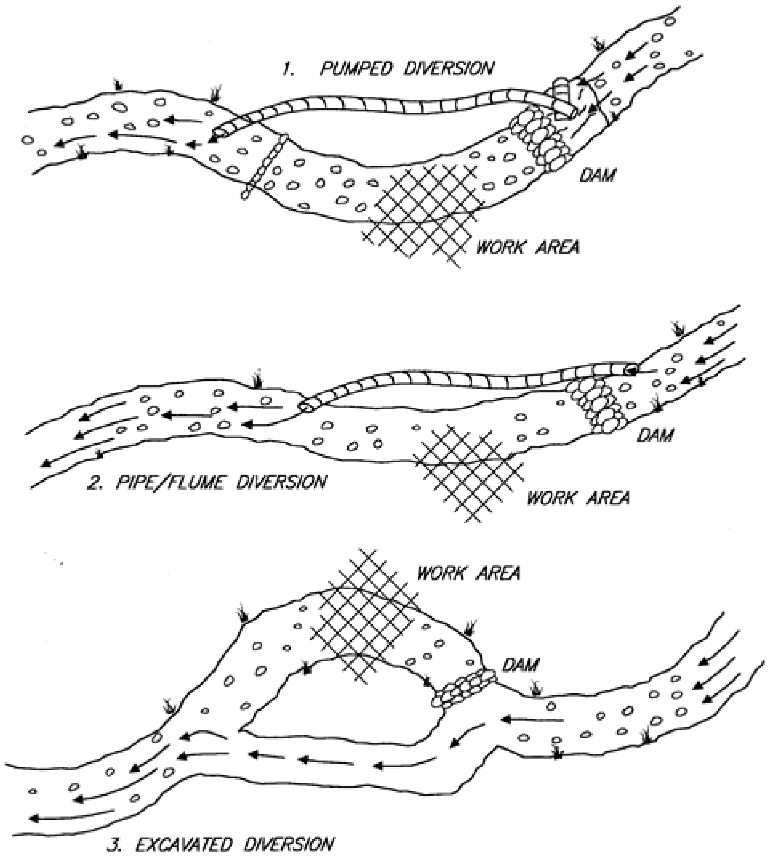



**Figure 75: Diversion Methods.**

## 5.1.14 IN-STREAM CONSTRUCTION SEDIMENT CONTROL

### Definition and Purpose

Instream sediment control BMPs are designed to provide sediment trapping for projects that must take place within the waterway. Projects that cross or otherwise work within the waterway shall strive to limit the amount of work that occurs within the water flow line. Measures that can reduce the amount of instream work include working from bank areas, diverting the stream around work areas, or scheduling for seasons of no or limited flows.

Instream sediment trapping devices include both floating materials (turbidity curtains described above) anchored to the watercourse bottom, instream sediment collection mats that run along the watercourse bottom and constructed sediment traps within a water coarse. These materials are specifically designed to limit sediment transport impacts within a body of water.

Coarse sediment traps are excavations in the bed or structures across a watercourse designed to limit the downstream movement of sand and gravel from upstream sediment sources. Depending on trap design and stream characteristics, lesser amounts of fine sediments (the fine sand, silts and clays that move in the flow rather than along the bed) can be trapped.

Sediment traps confine sediment deposition to a small reach of channel and reduce excavation costs: Sediment traps are relatively wide, short and deep excavations in the bed. Trapped sediment does not progress downstream where deposition would reduce channel capacity. The trap itself has to be episodically excavated (after major storms) rather than a much greater length of the stream.

### Appropriate Applications

These devices provide sedimentation protection for instream, bank, or upslope ground disturbance, dredging, or filling within a waterway. There are three different options currently available for reducing turbidity while working in a stream or river. The stream can be; (1) isolated from the area in which work is occurring by means of a water barrier, (2) the stream can be diverted around the work site through a pipe or temporary channel, or (3) one can employ construction practices that minimize sediment suspension.

### Limitations

Instream sediment traps are used in conjunction with other sediment control measures to reduce excessive sediment in watercourses: For upland sediment sources, the most desirable strategy is to implement land management practices that reduce erosion and transport of sediment and associated contaminants. The second strategy is to retain sediments on the land before they get to aquatic resources (e.g. filter strips, sediment retention ponds). For channel sources, streamflow should be retarded to protect the channel (e.g. vegetated banks); eroding banks should be repaired (e.g. contour and vegetate); and livestock that cause erosion should be removed from the channel and banks. If these measures are not undertaken, then continuous in-channel sediment problems will occur. In some cases, an in channel sediment trap can be the first line of defense (e.g. multiple, uncontrollable sediment sources).

### Standards and Specifications

The highest hazard for sedimentation from in-stream construction generally occurs when the sediment control structure is being installed and when it is being removed. Generally the best time to install the stream isolation or diversion structure is when the stream is low. Conversely, the optimum time to remove in-stream diversion or isolation structures may be during the rising limb of a storm hydrograph aka the rapid increase in flow resulting from rainfall causing increased surface runoff and stream flow. A probable "worst time" to release high TSS into a stream system with diminishing aquatic habitat might be when the stream is very low; summer low flow, for example. During these times, the flow may be low while the biological activity in the stream is very high. On the other hand, the addition of short-term spike in TSS or sediment during a big storm discharge might have a relatively low impact on the aquatic habitat or turbidity because the stream is already turbid, and the stream energy is capable of transporting both suspended solids, and large quantities of bedload through the system.

- All embankments and structures must be constructed in accordance with accepted engineering practice, and with appropriate materials.
- Determine the design flow for the channel where the sediment trap is to be located and establish the viability of creating a trap (see location).
- Determine the target size of material to be trapped, and the trapping efficiency required. Fine sand (i.e. sediment ≥0.125 mm) and 90% trapping are often used.
- Determine the surface area of the sediment trap.
- Check the depth required to prevent re-suspension of the trapped sediment.
- These BMPs are designed and selected for specific flow conditions. For sites with flow velocities or currents greater than 5 feet per second, a qualified engineer and product manufacturer shall approve of the use.
- Instream sediment mats can be aligned either direction along the watercourse bottom, as long as the upstream mat overlaps the downstream mat (like a drainage ditch erosion control blanket installation). Ensure that the upstream edge is firmly trenched in to prevent flows from going under the mat. Mats shall cross the entire stream and be staked or use stones to keep them in place. Follow the manufacturer's specifications for the length of mat needed for the site's flow rate.

## Techniques to minimize Total Suspended Solids

- **Padding -** Padding laid in the stream below the work site may trap some solids that are deposited in the stream during construction. After work is done, the padding is removed from the stream, and placed on the bank to assist in revegetation.
- **Clean, washed gravel -** Using clean, washed gravel as fill decreases solid suspension, as there are fewer small particles deposited in the stream.
- **Excavation using a large bucket -**Each time a bucket of soil is placed in the stream, a portion is suspended. Approximately the same amount is suspended whether a small amount of soil is placed in the stream, or a large amount. Therefore, using a large excavator bucket instead of a small one will reduce the total amount of soil that washes downstream.
- **Use of dozer for backfilling -** Using a dozer for backfilling instead of a backhoe follows the same principles – the fewer times soil is deposited in the stream, the less soil will be suspended.

- **Partial dewatering with a pump -** Partially dewatering a stream with a pump reduces the amount of water, and thus the amount of water that can suspend sediment

## Inspection and Maintenance

- The design depth of the sediment trap should be marked in the sediment trap (e.g. a stage gauge board). Once the effective capacity of the sediment trap is reached, the trap effectiveness declines, and the sediment trap should be re-excavated.

## Typical Details

None specified to date for this manual

# 5.1.15 WASHING FINES (STREAMBED RESTORATION TECHNIQUE)

## Definition and Purpose

Washing fines is an "in-channel" sediment control method, which uses water, either from a water truck or hydrant, to wash any stream fines that were brought to the surface of the channel bed during restoration, back into the interstitial spaces of the gravel and cobbles. This technique is useful in both intermittent or ephemeral stream channels with gravelly to cobbely substrate and may be useful in perennial streams just prior to removing isolation structures.

The purpose of this technique is to reduce or eliminate the discharge of sediment from the channel bottom during the first seasonal flows, or "first flush." Sediment should not be allowed into stream channels; however, occasionally in-channel restoration work will involve moving or otherwise disturbing fines (sand and silt-sized particles) that are already in the stream, usually below bankfull discharge elevation. Subsequent re-watering (resumption of flows) of the channel can result in a plume of turbidity and sedimentation.

This technique washes the fines back into the channel bed. Bedload materials, including gravel cobbles, boulders and those fines, are naturally mobilized during higher storm flows. This technique is intended to delay the discharge until the fines would naturally be mobilized.

## Appropriate Applications

- This technique should be used when construction work is required in channels. It is especially useful in intermittent or ephemeral streams in which work is performed "in the dry", and which subsequently become re-watered.

## Limitations

- The stream must have sufficient gravel and cobble substrate composition.
- The use of this technique requires consideration of time of year and timing of expected stream flows.
- The optimum time for the use of this technique is in the fall, prior to winter flows.
- Consultation with, and approval from the wildlife and water quality regulating agencies is required.

## Standards and Specifications

- Apply sufficient water to wash fines, but not cause further erosion or runoff.
- Apply water slowly and evenly to prevent runoff and erosion.
- Consult with appropriate Federal and State agencies (i.e. USACE, DEQ, WQB, USFWS, NMFS and Department of Land and Natural Resources (DLNR)) for specific water quality requirements of applied water (e.g. chlorine)

# CHAPTER 6:

# 6 GLOSSARY

**Acute.** Acute effects refer to physiological effects observed following limited duration exposure to contaminants.

**Adsorption.** Adsorption is the process by which dissolved pollutants adhere to suspended particulates, bottom sediments, vegetation surfaces, or other media (such as activated carbon). Some filtration media help remove charged pollutant particles, such as metal cations, by adsorption.

**Aquatic or Riparian Problems:** means construction or development sites where control practices are needed to protect aquatic or riparian environments or conditions (e.g., bank habitat, associated vegetative cover, preservation of habitat, life cycle impacts to plants and animals, water quality limitations that affect fish and wildlife).

**Avulsion (avulsing).** The rapid migration of the primary stream channel from its previous course, usually during flood events.

**Backwater.** The accumulation of water and slowing of flow behind (upstream of) an obstruction or constriction in a stream or floodplain.

**Bank erosion.** The carrying away or displacement of solids (sediment, soil, rock, and other particles) along a stream bank usually by the agents of streamflow or by downward or down-slope movement in response to gravity or by living organisms. Bank erosion is distinguished from weathering, which is the process of chemical or physical breakdown of the minerals in the rocks, although the two processes may be concurrent.

**Bed load.** The portion of the total sediment load of a river or stream that is in intermittent contact with the streambed.

**Bedrock.** The native, contiguous, consolidated rock underlying the surface of the Earth. Above bedrock is usually an area of broken and weathered unconsolidated rock, usually called sediment. Occasionally bedrock is exposed on the surface indicating that sediment has been removed by streamflow or some other sediment transport process (e.g., landsliding).

**Best Management Practices (BMPs):** means structural and non-structural methods, measures or practices implemented to prevent, reduce or mitigate adverse water quality impacts resulting from construction and operation of a project.

**Better site design:** includes a series of techniques that reduce impervious cover, conserve natural areas, and use pervious areas to more effectively treat stormwater runoff and promote the treatment train approach to runoff management.

**Bioavailable.** Able to interact with an organism in a physiologically meaningful (e.g., tissue uptake, bioaccumulation in tissue, metabolism) way.

**Biochemical oxygen demand.** A measure of the amount of oxygen needed by aquatic organisms to break down solids and other readily degradable organic matter present in water. Also called biological oxygen demand.

**Biofiltration.** The process of reducing pollutant concentrations in water by filtering the polluted water through biological materials, such as vegetation.

**Bioinfiltration.** The process of reducing pollutant concentrations in water by infiltrating the polluted water through grassy vegetation and soils into the ground. Biological oxygen demand. A measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter. Frequently used as an indicator of water quality.

**Bypass.** An alternate flow path, such as an emergency overflow spillway, provided as part of a BMP. Designed to prevent facility failure when the primary mode of discharge is blocked.

**Catch basin.** A structure, typically concrete, that collects surface runoff through a metal grate. Catch basins typically include a sump where sediment can settle out.

**Channel aggradation.** The accumulation of sediment in a channel. It occurs when sediment supply exceeds the ability of a river to transport the sediment.

**Channel incision.** The deepening of the channel of a stream by erosion.

**Channel migration.** The movement of the horizontal position of a channel over time. Channel migration is often associated with the movement of a meander.

**Chemical oxygen demand (COD).** COD is a measure the amount of organic compounds in water. In natural surface waters, such as lakes and rivers, it indicates the presence of organic pollutants and is therefore a useful indicator of water quality. It is expressed in milligrams [of oxygen] per liter [of water, or other solution].

**Chronic.** Chronic effects refer to physiological effects observed following prolonged duration exposure to contaminants.

**Colloidal.** Remaining suspended without forming an ionic or dissolved solution.

**Complexing.** Bonding between a dissolved metal and another chemical (ligand) that keeps a dissolved metal in solution.

**Composite sample.** Composite samples involve a collection and mixing of multiple subsamples throughout a sampling period (usually an individual storm event) to provide water quality data that is more representative of the overall sampling period.

**Contributing impervious area (CIA).** All impervious surface within the project limits, plus impervious surface owned or operated by ODOT outside the project limits, that drains to the project via direct flow or discrete conveyance.

**Cut bank.** An erosional feature of streams. Cut banks are found in abundance along mature or meandering streams, they are located on the outside of a stream bend, known as a meander. They are shaped much like a small cliff, and are formed by the erosion of soil as the stream collides with the river bank. As opposed to a point bar, it is an area of erosion rather than deposition.

**Detention.** The temporary storage of stormwater runoff in a facility (typically a pond, vault, or large pipe) which is used to control the peak discharge rates. The entire stormwater volume is ultimately released, but at a lower discharge rate.

**Dispersion.** Release of surface water and stormwater runoff in such a way that the flow spreads over a wide area and is located so as not to allow flow to concentrate. Dispersion areas should be gently sloped, vegetated, and with underlying soils suitable for infiltration.

**Dissolution.** Dissolving a solid substance into a solvent to yield a solution.

**Dissolved Metals.** Metals bound to another chemical (ligand) through complexing that are in solution.

**Dissolved Oxygen.** The amount of oxygen dissolved in water. This term also refers to a measure of the amount of oxygen available for biochemical activity in a waterbody, an indicator of water quality.

**Disturbed Soil Area:** Disturbed soil areas (DSAs) are areas of exposed, erodible soil that are within the construction limits and that result from construction activities. The following are not considered DSAs:

- Areas where soil stabilization, erosion control, highway planting, or slope protection are applied and associated drainage facilities are in place and functional.
- Roadways, construction roads, access roads or contractor's yards that have been stabilized by the placement of compacted subbase or base material or paved surfacing.
- Areas where construction has been completed in conformance with the contract plans and permanent erosion control is in place and functional.

**Durations.** The cumulative amount of time that a receiving water experiences higher flows during and after storm events.

**Effluent:** The U.S. EPA defines effluent as wastewater, treated or untreated, that flows out of a treatment plant, sewer, or industrial outfall.

**Emergency Overflow Spillway.** An armored surface outlet from detention pond or other surface BMP to allow stormwater to discharge even in the event of outlet plugging or higher than design flows.

**Ephemeral stream:** An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

**Erosion and sediment control (ESC) measures.** Erosion control is the process of minimizing the amount of soil that runs off of a site (such as during construction). Sediment control is the process of retaining eroded soil on site, preventing damage to watercourses and infrastructure.

**Eutrophication.** A process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth. Under eutrophic conditions, dissolved oxygen levels may be depleted by the respiring algae and by microorganisms that feed on dead algae, threatening salmon and other marine animals.

**Evapotranspiration.** The sum of evaporation (movement of water to the air through tree canopy interception, soil, and water bodies) and transpiration (water loss as vapor through plant activity).

**Event Mean Concentration (EMC).** Mean concentration of pollutants in runoff from a storm event.

**Federal nexus.** A project receiving federal funding (e.g., a highway construction project) is subject to federal laws and regulations. For example, ESA issues must be addressed either in a no-effect memorandum or in a BA.

**Filter strip.** A grassy area with gentle slopes that treats stormwater runoff from adjacent paved areas before it can concentrate into a discrete channel.

**Filtration:** Physical trapping of suspended pollutants. Filtration can encompass a wide range of physical and chemical mechanisms, depending on the filtering media, typically some sand media, natural soil, grassy vegetation, or mixes of chemically active ingredients such as perlite, zeolite, and granular activated carbon. Filtration removes particulate matter either on the surface of the filter or within the pore space of the filter. Filtration such as a sand filter can provide the added benefit of removing stormwater constituents that may be attached to solids such as metals and bacteria. Filtration can also provide opportunities for sorption processes to occur, reducing dissolved and fine suspended constituents. Filtration can often be an effective preliminary treatment for stormwater, by increasing the longevity of downstream BMPs and reducing maintenance frequency.

**Floodplain.** A floodplain is an area adjacent to a river or stream channel that is usually fairly flat and experiences occasional or periodic inundation during floods. The floodplain includes the floodway and other areas sometimes referred to as the flood fringe, which are inundated during floods but do not contribute significantly to flood flow conveyance and do not experience significant flow velocities.

**Floodway.** A floodway is an area that includes that channel of a river, stream, or other watercourse and adjacent lands that conveys floodwaters. The floodway is composed of the active river channel and those parts of the floodplain which experience flows of significant velocity and convey flow during flood events. The floodway concept has regulatory significance, imposing boundaries on developable area.

**Flow concentration.** The result of large flows in association with developed (impervious surface) areas, where infiltration is prevented. In these areas, flow becomes concentrated and channelized much more quickly than in undeveloped settings.

**Flow regime.** Generally referring to type of flow present in a stream. This has impacts on the position of hydraulic control in a stream. Fast moving, or supercritical flows, are controlled from upstream conditions; while slow moving, or subcritical flows, are controlled from downstream conditions.

**Flow-through.** Facilities such as grass swales that convey stormwater, or store it temporarily, prior to release through surface runoff or enclosed (piped) drainage systems. Flow-through facilities are in contrast to infiltration facilities.

**Grab sample.** A single sample of stormwater collected for analysis. Grab samples provide a snapshot of water quality conditions, and may be useful if collected during the rising limb or at the peak of a storm hydrograph when higher concentrations might be expected.

**Gutter**. A depressed concrete channel that conveys stormwater along the edge of a street.

**Hardness.** Water hardness measures the presence of multivalent cations dissolved in water; particularly calcium and magnesium divalent cations (ions with a charge of +2).

**Headcut.** An active eroding bank or channel that moves further upstream as it continues to erode material.

**Hydraulic gradient.** Difference in hydraulic head between two or more hydraulic head measurements divided by the length of the flow path.

**Hydraulic head.** Measure of water pressure above a datum. Typically expressed as an elevation, in feet.

**Hydrologic attenuation:** Hydrologic attenuation achieves pollutant reduction through runoff volume reduction. Infiltration is the primary means of hydrologic attenuation for the purposes of the types of BMPs used in stormwater management. Attenuation reduces the pollutant load discharged to surface waters, but does not necessarily reduce pollutant concentrations. Infiltration includes several different treatment mechanisms. Processes such as sorption, filtration, and microbial degradation occur as runoff infiltrates through the soil matrix.

**Hydrologic soil groups.** A soil characteristic classification system defined by the Natural Resources Conservation Service in which a soil may be categorized into one of four soil groups (A, B, C, or D) based on infiltration rate and other properties.

**Impervious surface.** A hard surface area that either prevents or slows the entry of water into the ground as compared with natural conditions (prior to development), and from which water runs off at an increased rate of flow or in increased volumes. Common impervious surfaces include but are not limited to rooftops, walkways, roads, and other concrete or asphalt surfaces.

**Incised, incision.** See channel incision.

**Inert.** Not chemically active. Inert filtration media would rely only on physical properties, rather than chemical treatment mechanisms such as sorption, for pollutant removal.

**Infiltration rate.** The rate, usually expressed in inches per hour, at which water moves downward (percolates) through the soil profile.

**Infiltration.** The downward movement of rainwater or surface water through the soil.

**Inlet.** A structure, typically concrete, that collects surface runoff through a metal grate. Inlets may include a sump where sediment can settle out.

**Inundate.** To cover with water, usually associated with flooding.

**Jurisdictional wetland.** A wetland that is connected to a Water of the United States (WOUS) using the Corps definition of WOUS (Section 404 Clean Water Act).

**Large woody debris (LWD).** The accumulation of trees and large branches that have fallen into a stream. LWD serves many purposes in a stream that are vital to life history of many native species of fish, plants and animals.

**Levee.** A natural or artificial slope or wall, usually earthen and often parallel to the course of a stream, to protect adjacent areas (usually development) from flooding.

**Log jams.** These features are large accumulations of large woody debris (LWD) in particular places along a stream bank or in the middle of a stream. Log jams have traditionally been removed from streams. However, increased awareness of these features has shown to provide key hydraulic and geomorphic function necessary for a healthy stream ecosystem.

**Low Impact Development (LID):** A comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds. LID is a stormwater management design approach that attempts to mimic a site's predevelopment hydrology by using design practices and techniques that reduce impervious areas, and preserve native vegetation and soils. LID stormwater management techniques capture, filter, store, evaporate and infiltrate runoff near its source.

**Meander(ing).** A bend in a stream, also known as an oxbow loop, or simply an oxbow. A stream of any volume may assume a meandering course, alternatively eroding sediments from the outside of a bend and depositing them on the inside. The result is a "snaking" pattern as the stream meanders back and forth across its down-valley axis.

**Microbially mediated transformation:** Microbial activity promotes or catalyzes redox reactions and transformations including degradation of organic and inorganic pollutants and immobilization of metals. Bacteria, algae, and fungi present in the soil or water column are primarily responsible for the transformations. Stormwater treatment that incorporates vegetation or permanent water pools usually has a diverse microbial population. These transformations can remove dissolved nitrogen species, metals, and simple and complex organic compounds. Soils may be inoculated with desirable microbes to promote specific reactions.

**Municipal Separate Storm Sewer Systems:** is defined as any conveyance or system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, human-made channels, and storm drains) owned or operated by a state, city, town, county, or other public body having jurisdiction over storm water, that is designed or used for collecting or conveying storm water.

**Non-Point Source:** a source of pollution that issues from widely distributed or pervasive environmental elements.

**Nonstructural BMPs:** include pollution prevention practices and source control activities, designed to minimize or eliminate a problem before it occurs. Source control BMPs are sometimes referred to as "good housekeeping" measures because a clean site will produce less pollutants than will a dirty one. Site planning and design of BMPs may, in and of itself, be considered a nonstructural BMP.

**Outfall.** Any location where concentrated stormwater runoff leaves the right if way as concentrated runoff. Outfalls may discharge to surface waters or groundwater.

**Outlet protection.** A protective barrier of rock, erosion control blankets, vegetation, or sod constructed at a conveyance outlet.

**Overflow Spillway.** See Emergency Overflow Spillway.

**Particulates.** A minute separate particle, such as a granular substance or powder.

**Peak flow.** Maximum discharge of stormwater associated with a particular design storm, e.g. 2-year, 24-hour design storm.

**Perennial stream:** A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow.

**Pipe cover.** Vertical separation between pavement subgrade and the top of a pipe.

**Planimeter.** An instrument that measures the area of a plane figure as a mechanically coupled pointer traverses the perimeter of the figure.

**Plug flow.** A laminar flow regime where water flows as if in a full pipe, the unit that enters first, exits first and there is no mixing between different units of water, designing for this type of flow prevents "short circuiting".

**Point bar.** A depositional feature of streams. Point bars are found in abundance in mature or meandering streams. They are crescent-shaped and located on the inside of a stream bend.

**Pollutant load.** Mass of a pollutant that a waterbody receives.

**Polycyclic aromatic hydrocarbons (PAHs).** PAHs are hydrocarbon compounds with multiple benzene rings. PAHs are typical components of asphalts, fuels, oils, and greases.

**Pour point.** The point at which smaller stream or river basins meet larger stream or river basins.

**Pretreatment.** The removal of material such as solids, grit, and grease from flows to improve treatability prior to biological or physical treatment processes; may include screening, settling, oil/water separation, or application of a basic treatment BMP prior to infiltration.

**Primary Treatment Mechanisms:** the first stage of wastewater treatment, including removal of floating debris and solids by screening, skimming and sedimentation.

**Project Types:** means general categories and types of construction or development projects (e.g., bridges, crossing structures, channel work, utility construction, site development, roads and highways, instream mining, dams and reservoirs, specialty activities such as go f courses and driveways) that are likely to require federal or state permits (e.g. 404 permit, 401 certification).

**Point Source:** A point source is any discrete conveyance such as a pipe or a man-made ditch.

**Pollutant load:** refer to the mass of pollutants, or the total amount delivered to the storm system or receiving waters independent of the volume of stormwater.

**Rain Event:** A qualifying rain event is any storm event that produces precipitation of ½ inch or more at the time of discharge. In conformance with the USEPA definition, a minimum of 72 hours of dry weather will be used to distinguish between separate qualifying rain events.

**Reference Types:** means categories that refer to structural or source controls, permanent best management practices, and specialty practices used by Federal, State or local agencies (e.g. National Park Service). Reference types are applicable to construction or development sites.

**Release rate.** The design peak discharge rate, typically expressed in cubic feet per second (cfs) from a detention facility. When detention is required, design standards often stipulate that post development release rates must match pre-pre-development peak discharge rates.

**Riparian Area:** Vegetated ecosystems along a waterbody through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent waterbody. These systems encompass wetlands, uplands, or some combination of these two land forms. They will not in all cases have all of the characteristics necessary for them to be classified as wetlands.

**Runoff:** Rainwater or snowmelt that directly leaves an area as surface drainage.

**Salinity:** The dissolved salts content of a body of water.

**Sand filter:** A manmade depression or basin with a layer of sand that treats stormwater as it percolates through the sand and is discharged via a central collector pipe.

**Saturated hydraulic conductivity:** The rate of movement of water through a saturated porous medium.

**Sediment Problems:** means construction or development sites where sediment and erosion controls are necessary to prevent sediment pollution (e.g., sediment deposits and loading, steep slopes, stream bank instability, runoff or velocity controls, wind erosion).

**Sedimentation/density separation:** Density separation refers to the unit processes of sedimentation and flotation that are dependent on the density differences between the pollutant and the water to effect removal. Sedimentation is the gravitational settling of particles having a density greater than water. Flotation is similar to gravitational sedimentation except in the opposite direction. Typically, floatable materials such as trash, debris, and hydrocarbons are removed through treatment processes that utilize the location of these pollutants on the water surface for removal. Stormwater treatment that incorporates vegetation and or permanent water bodies usually has a diverse microbial population, and it is not possible to optimize conditions for all beneficial species.

**Sediment supply:** The amount of sediment made available to a stream from the surrounding landscape and its runoff.

**Sediment transport:** The movement of solid particles ("sediments") due to the movement of the fluid in which they are immersed. In streams, the particles are rocks (sand, gravel, boulders, etc.) or clay, and the fluid is water.

**Sheet flow:** Runoff that flows over the ground surface as a thin, even layer, not concentrated in a channel.

**Short Circuiting:** the passage of runoff through a BMP in less than the design treatment time

**Sorption:** Sorption refers to the individual unit processes of both absorption and adsorption. Absorption is a physical process whereby a substance of one state is incorporated into another substance of a different state (e.g., liquids being absorbed by a solid or gases being absorbed by water). Adsorption is the physiochemical adherence or bonding of ions and molecules (ion exchange) onto the surface of another molecule. In stormwater treatment application, particularly for highway runoff, the primary pollutant types targeted with absorption unit processes are petroleum hydrocarbons, while adsorption processes typically target dissolved metals, nutrients, and organic toxicants such as pesticides and polycyclic aromatic hydrocarbons (PAHs). Different types of filter media may provide either or both of these unit processes.

**Source Control BMP:** Appropriate operational or structural measures that prevent or reduce pollutants from entering storm water. Examples of operational source control BMPs include good housekeeping practices, spill prevention, and employee training. Structural source control BMPs consist of enclosures or roofs for working areas where pollutants are present or installing devices that direct contaminated storm water to appropriate treatment BMPs.

**Soil amendments.** Materials that improve soil fertility for establishing vegetation or permeability for infiltrating runoff.

**Soil texture.** The proportion of sand, silt and clay in a soil. Many properties of soil are heavily dependent on texture including infiltration rate, resistance to erosion, and water-holding capacity.

**Sorptive.** A substance capable of taking up water or dissolved compounds.

**Stormwater Management Plan.** A document that describes the condition of receiving waters including water quality issues, channel conditions, watershed size and characteristics, and climate. It also describes the proposed drainage and stormwater management systems and estimates project impacts.

**Stormwater treatment BMP.** A BMP specifically designed for pollutant removal.

**Swale.** A wide natural channel with relatively gentle side slopes, generally with flow depths less than 1 foot, used to filter runoff.

**Structural BMPs:** are facilities constructed to passively treat runoff before it enters the receiving waters. Such BMPs (sometimes called "dirt moving" practices) used on a construction or development site can be either temporary or permanent, depending on the duration of their application, and are designed to reduce sediment pollution and other pollutants in runoff. Additionally, they can provide for the protection of aquatic or riparian areas. A limited number of special use practices requiring additional demonstration under the semi-arid or mountainous conditions are also listed in the matrix and can be used on a case-by-case basis. Special use practices have been developed for golf course projects, driveways and high-altitude construction. Some construction BMPs result in permanent sediment and erosion control structures, which are designed to work beyond the construction period.

**Total Dissolved Solids:** The dissolved matter found in water comprised of minerals salts and small amount of other inorganic and organic substances.

**Total Kjeldahl Nitrogen:** The sum of organic nitrogen and ammonia in a water body, measured in milligrams per liter (mg/L). High measurements typically result from sewage and manure discharges to water bodies.

**Total Maximum Daily Load (TMDL):** the maximum amount of a pollutant that can be discharged into a water body from all sources (point and non-point) and still maintain water quality standards. Under Clean Water Act section 303(d), TMDLs must be developed for all water bodies that do not meet water quality standards after application of technology-based controls.

**Total Nitrogen:** A measure of all forms of nitrogen (e.g., nitrate, nitrite, ammonia-N, and organic forms) that are found in a water sample.

**Total Phosphorus:** the total concentration of phosphorus found in the water. Phosphorus is a nutrient and acts as a fertilizer, increasing the growth of plant life such as algae.

**Total Suspended Solids (TSS):** solids suspended in water including a wide variety of material such as silt and decaying plant matter.

**Toxicity.** Adverse effects on living organisms resulting from chemical exposure.

**Treatment train or system.** The combination of several treatment facilities with unique unit processes applied in a linear progression (also called "in series").

**Turbidity.** The cloudiness or haziness of a fluid caused by individual particles (suspended solids)) that are generally invisible to the naked eye. The measurement of turbidity is a key test of water quality.

**Underdrain.** Plastic pipes with holes drilled through the top, installed on the bottom of an infiltration facility, that are used to collect and remove excess runoff.

**Qualifying Rain Event:** Any rain event producing precipitation of 0.5 inch or more over the duration of the rain event.

**Intermittent stream:** An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.

**Ordinary High Water Mark:** that line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

**Unit Operations.** The treatment facilities in which the unit process occurs (i.e., wet pond or swale).

**Unit Process.** The specific mechanism of pollutant removal (i.e., sedimentation or vegetative uptake).

**Vegetated filter strip.** A facility designed to provide stormwater treatment of conventional pollutants (but not nutrients) through the process of biofiltration.

**Vegetative (or Biological) Uptake.** The processes by which nutrients and other dissolved chemicals are taken up by plants and algae. Chemicals may be metabolized or stored in plant tissues.

**Uptake/Storage:** Uptake and storage refer to the removal of organic and inorganic constituents by plants and microbes through nutrient uptake and bioaccumulation. Nutrient uptake converts required micro- and macro-nutrients into living tissue. In addition to nutrients, various algae and wetland and terrestrial plants accumulate organic and inorganic constituents in excess of their immediate needs (bioaccumulation). The ability of plants to accumulate and store metals varies greatly. Significant metal uptake by plants will not occur unless the appropriate species are selected.

**Watershed.** A geographic region within which water drains into a particular river, stream, or body of water.

**Wetlands:** are a subset of jurisdictional WUS and are jointly defined by the USACE and the U.S. Environmental Protection Agency (40 Code of Federal Regulations [CFR] 230.3) as those areas that are inundated or saturated by surface or groundwater 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.

# APPENDICES

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# APPENDIX A: STATE SPECIFIC NPDES REQUIREMENTS

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