

# CHAPTER 8. CONSTRUCTION SITE STORMWATER MANAGEMENT

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## 1.0 INTRODUCTION

This section of the *Manual* on construction best management practices was developed using several references including: Urban Storm Drainage Criteria Manual developed by Urban Drainage and Flood Control District in Denver, Colorado; Stormwater Management Manual for Western Washington developed by Washington State Department of Ecology Water Quality Program; and California Stormwater BMP Handbook developed by California Stormwater Quality Association.

### 1.1 Executive Summary

The purpose of this chapter of the *Manual* is to provide technical guidance for erosion, sediment, and runoff control for construction activity along with the implementation of Best Management Practices (BMPs) for the period of time from initial earth disturbance until the final landscaping and permanent stormwater measures are accepted by the City of Rogers and coverage under the Arkansas Department of Energy & Environment Division of Environmental Quality (DEQ) Construction General Permit has been terminated.

The City of Rogers requires that a Stormwater Pollution Prevention Plan (SWPPP) be developed for construction sites in accordance with the DEQ Construction General Permit prior to obtaining a Land Disturbance Permit. The City of Rogers has the right under the Federal Clean Water Act and the Arkansas Water and Air Pollution Control Act to require that BMPs for erosion, sediment, and runoff control be implemented at construction sites.

Two copies of the SWPPP shall be submitted for review and approval to the City of Rogers for sites with disturbed areas of five (5) acres or more.

For sites with disturbed areas greater than or equal to one (1) acre and less than five (5) acres, the City of Rogers will review the proposed BMPs based on the submitted erosion control plans. The SWPPP must be submitted to the City of Rogers.

### 1.2 Introduction

Surface runoff controls for construction sites and activities in Arkansas are mandated by the Clean Water Act of the Federal Government and the Arkansas Water and Air Pollution Control Act. All sites where construction will disturb soil or remove vegetation on one (1.0) or more acres of land in total for all phases of work during the life of the construction project must be covered under the DEQ Construction General Permit. This Construction General Permit provides authorization to discharge stormwater associated with construction activity under the National Pollutant Discharge Elimination System (NPDES) to all Arkansas receiving waters in accordance with effluent limitations, monitoring requirements, and other conditions set forth in the Construction General Permit. Coverage under the Construction General Permit does not relieve the site owner or operator from addressing and obtaining, as needed, other local, State and Federal permits (e.g., permit for work in a floodplain,

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Corps of Engineers 404 permit, building permit, local Land Disturbance Permit, etc.).

A Stormwater Pollution Prevention Plan (SWPPP) must be developed for construction sites in accordance with the Construction General Permit. The SWPPP shall be prepared in accordance with good engineering practices and shall identify potential sources of pollution which may reasonably be expected to affect the quality of stormwater discharges from the construction site. In addition, the SWPPP shall describe and ensure the implementation of Best Management Practices (BMPs) which are to be used to reduce pollutants in stormwater discharges and to assure compliance with the terms and conditions of the Construction General Permit. The initially developed SWPPP has to be viewed as a starting point that will be modified as the work progresses and its effectiveness is tested in the field.

The DEQ identifies two construction project sizes for the City of Rogers including: large construction sites (disturbance of five (5) or more acres of total land area) and small construction sites (greater than or equal to one (1) acre and less than five (5) acres of total land area). The owner or operator of large construction sites must submit a Notice of Intent (NOI) and permit fee to DEQ to be covered under the Construction General Permit. In addition, for large construction sites a copy of the SWPPP must be submitted to DEQ. For small construction sites, an NOI and a DEQ permit fee is not required; however, a Land Disturbance Permit fee is required through the City. Rather than an NOI, the owner or operator must complete and sign a Construction Site Notice and post it at the construction site. For small construction sites, a SWPPP must be developed but does not need to be submitted to DEQ unless requested.

DEQ requires qualified personnel (provided by the site owner or operator) to conduct inspections of all areas disturbed by construction activity and all storage areas that are exposed to precipitation. The inspectors must look for evidence of, or the potential for, pollutants to enter the stormwater system. Locations where vehicles enter or exit the site, discharge locations, and locations where erosion and sediment control measures are installed shall also be inspected. In addition, the City of Rogers, DEQ or EPA may conduct inspections at any time.

Issuance of a Notice of Violation (NOV) by the City, State or EPA sets the stage for enforcement action and fines. This is a regulatory program with many potential consequences and has to be taken seriously by site owners or operators. Conducting construction activities without coverage under the Construction General Permit when one is needed has the potential of criminal action enforcement being taken against the violating party, which not only can carry much higher fines, but has a potential for jail sentences.

### 1.3 Performance Objectives

The following are objectives for erosion and sediment control during construction:

1. Conduct all land disturbing activities in a manner that effectively reduces accelerated soil erosion and reduces sediment movement and deposition off site.
2. Schedule construction activities to minimize the total amount of soil exposed at any given time to reduce the period of accelerated soil erosion.
3. Establish temporary or permanent cover on areas that have been disturbed as soon as possible after grading is completed.
4. Design and construct all temporary or permanent facilities to limit the flow of water to non-erosive velocities around, through or from disturbed areas.
5. Remove sediment from surface runoff water before it leaves the site.
6. Stabilize the areas of land disturbance with permanent vegetative cover and stormwater quality control measures.

### 1.4 Stormwater Pollution Prevention Plan

The owner is responsible for providing the Stormwater Pollution Prevention Plan (SWPPP). It is recommended that the owner secure the services of a qualified professional knowledgeable in construction management practices to develop the SWPPP. The SWPPP must meet the requirements listed in the DEQ Construction General Permit No. ARR150000, "Authorization to Discharge under the National Pollutant Discharge Elimination System and the Arkansas Water and Air Pollution Control Act" available at [www.adeq.state.ar.us](http://www.adeq.state.ar.us).

Two copies of the SWPPP shall be submitted for review and approval to the City of Rogers for sites with disturbed areas of five (5) acres or more. The final SWPPP must be consistent with the Drainage Report accepted by the City of Rogers. However, approval of the SWPPP does not imply acceptance or approval of Drainage Plans, Street Plans, Design of Retaining Walls, or any other aspect of the site development.

The City of Rogers will review the SWPPP submitted for the site and will return either an approval of the SWPPP or a request for revisions. Construction activity, including any soil disturbance or removal of vegetation, shall not commence on the site until the City of Rogers and DEQ has issued an approval of the SWPPP.

For sites with disturbed areas greater than or equal to one (1) acre and less than five (5) acres, the City of Rogers will review the proposed BMPs based on the submitted erosion control plans. The SWPPP doesn't need to be submitted to the City of Rogers unless requested.

## 1.5 Land Disturbance Permit

Any person proposing to engage in clearing, filling, cutting, quarrying, construction, or similar activities on any piece of disturbed land of one-half (1/2) acre or larger shall apply for a Land Disturbance Permit with the City of Rogers.

For sites with disturbed areas of five (5) acres or more, the SWPPP must be approved by the City of Rogers prior to issuance of a Land Disturbance Permit.

For sites with disturbed areas greater than or equal to one-half (1/2) acre and less than five (5) acres, the erosion control plans must be approved by the City of Rogers prior to issuance of a Land Disturbance Permit.

## 1.6 Construction Phase

During the construction phase, the following sequence is recommended for the implementation of the project and the SWPPP:

1. The owner and/or the contractor shall designate a manager for the implementation of the SWPPP. This person shall be responsible for implementing all permit conditions and shall communicate with inspectors from the City of Rogers and other agencies.
2. Install all BMPs shown on the SWPPP that need to be installed in advance of proceeding with construction, such as construction entrances and exits, perimeter silt fences, etc.
3. Identify construction equipment and materials storage and maintenance areas. Install BMPs to prevent pollutant migration from these areas.
4. Install any additional BMPs that are called for in the SWPPP before overlot grading begins.
5. Strip off and stockpile topsoil for reuse.
6. Open areas not planned for immediate use shall be seeded or sodded. Soil which is exposed for more than fourteen (14) days with no construction activity shall be seeded, mulched, or re-vegetated.
7. Exposed soil within stormwater facilities, including but not limited to detention/retention ponds, swales and sedimentation basins, must be stabilized and sodded immediately, but no later than fourteen (14) days, following construction of the facility.
8. Insure that BMPs are installed and fully operational in advance of each construction phase as called for in the SWPPP.
9. After construction and revegetation is complete, permanent post-construction BMPs that were used as construction sediment controls shall be cleaned and restored.

## 1.7 Revegetation Phase

Once revegetation has been deemed acceptable by the City of Rogers, the owner shall request release of any surety, letters of credit or other financial guarantees that the City of Rogers may have required the permit holder to provide at the time the permit was issued. A closure of the Construction General Permit from DEQ shall also be pursued at this time.

The City of Rogers shall require a bond at the time of approval by the Planning Commission for revegetation of the site if construction halts. The value of the bond shall be set based on an estimate provided by the engineer of record.

## 2.0 FUNDAMENTALS FOR THE MANAGEMENT OF CONSTRUCTION SITES

### 2.1 Erosion and Sedimentation

#### 2.1.1 Erosion

Soil erosion is the process by which the land surface is worn away by the action of wind, water, ice and gravity. This section of the *Manual* addresses erosion caused by water and wind. The rate of soil erosion is increased greatly by many urban activities--especially construction activities. Any activity that disturbs the natural soil and vegetation increases the erosion potential since bare and loose soil is easily moved by wind or water.



**Photograph CS-1 – Example of Erosion during Construction**

Wind erosion is caused when winds of sufficient velocity create movement of soil particles. The potential for wind erosion is dependent upon soil cover, soil particle size, wind velocity, duration of wind and unsheltered distance. Wind erosion can begin at a wind velocity as low as ten (10) mph, and can even result from turbulence created by passing vehicles.

Water erosion has five primary mechanisms: raindrop erosion, sheet erosion, rill erosion, gully erosion, and channel erosion. Raindrops detach soil particles and splash them into the air. These detached particles are then vulnerable to be carried off by stormwater runoff or snowmelt.

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## 2.1.2 Sedimentation

During a typical rainstorm in urban areas, runoff normally builds up rapidly to a peak and then diminishes. The amount of sediment a watercourse can carry is dependent upon the velocity and volume of runoff. Sediment is deposited as runoff decreases. The deposited sediments may be resuspended when future runoff events occur. In this way, sediments are moved progressively downstream in the waterway system.

Windblown silt and sand particles are deposited whenever the force of the wind lessens. Much of the wind-eroded material is deposited behind fences, in landscaped areas or downwind of buildings or other obstructions to the wind. (Dust will form "drifts" just like snow.)

## 2.1.3 Factors Influencing Erosion

Physical properties of soils such as particle size, cohesiveness, and density affect its erodibility. Loose silt and sand-sized particles are more susceptible to erosion than "sticky" clay soils. Rocky soils are also less susceptible to wind erosion, but are often found on steep slopes that are subject to water erosion.

Vegetation plays an extremely important role in controlling erosion. Roots bind particles together and the leaves or blades of grass reduce raindrop impact forces on the soil. Grass, forest floor litter and other ground cover not only trap rain to promote infiltration but also reduce runoff velocity and shear stress at the surface. Vegetation reduces wind velocity at the ground surface, and provides a rougher surface which will trap particles moving along the ground. Once vegetation is removed, soils are no longer protected and erosion may increase.

When surface vegetative cover and soil structure are disturbed the soil's erodibility potential increases. Construction activities, such as excavating and grading, disrupt the soil structure and its vegetative cover.

## 2.2 Principles of Erosion and Sediment Control

Erosion controls limit the amount and rate of erosion occurring on disturbed areas. Sediment controls attempt to capture the soil that has been eroded before it leaves the construction site. Despite the use of both erosion control and sediment control measures (referred to as Best Management Practices (BMPs)), it is recognized that some amount of sediment will remain in runoff leaving a construction site.

The purpose of BMPs is to potentially minimize the sediment to the extent feasible. Construction activities management shall address six major elements:

1. The erosion control measures that will be used to limit erosion of soil from disturbed areas at a construction site;
2. The sediment and runoff control measures to limit transport of sediment off-site to downstream properties and receiving waters;

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3. The waterway protection measures to protect waterways located on or downstream of the construction site from erosion and sediment damages;
4. The construction practices management to limit pollutant movement off site resulting from construction equipment maintenance and storage and from materials storage and handling.
5. The stabilization practices to return the site to either a vegetative state or employ non-erosive surfaces where disturbances have occurred. Stabilization may include both temporary and permanent stabilization methods.
6. The onsite infiltration measures used to infiltrate stormwater runoff onsite where appropriate.

### 2.3 Stormwater Planning Process

Stormwater planning should occur early in the site development process. The planning process can be divided into five separate steps:

1. Gather information on topography, soils, drainage, vegetation and other predominant site features.
2. Analyze the information in order to anticipate erosion, sedimentation, and runoff problems.
3. Devise a plan which schedules construction activities and minimizes the amount of erosion created by development.
4. Develop a SWPPP which specifies effective erosion, sediment and runoff control measures as well as waste management and construction phasing.
5. Follow the SWPPP and revise it when necessary.
6. Remove temporary BMPs once the site has reached final stabilization and file a Notice of Termination (NOT) with DEQ.

#### 2.3.1 Guidelines for SWPPP Development

The following guidelines are recommended in developing the SWPPP:

1. Determine the limits of clearing and grading. If the entire site will not undergo excavation and grading, or excavation and grading will occur in stages, the boundaries of each cut-and-fill operation should be defined. Buffer strips of natural vegetation may be utilized as a control measure.
2. Define the layout of buildings and roads.
3. Determine permanent drainage features. The location of permanent channels and stormwater systems shall be defined. The SWPPP shall be consistent with the hydraulic features of the final drainage plan.

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4. Determine extent of temporary channel diversions. If improvements will be made to a permanent channel, the location, routing, sizing, lining, and type of temporary channel diversion should be determined.
5. Determine the boundaries of watersheds. The size of drainage areas will determine the types of sediment controls to be used. Areas located off the site that contribute overland flow runoff must be assessed. Measures to limit the size of upland overland flow areas, such as diversion dikes, may be initially considered at this stage.
6. Determine schedule of construction. The schedule of construction will determine what areas must be disturbed at various stages throughout the development plan. The opportunity for staging cut-and-fill operations to minimize the period of exposure of soils needs to be assessed and then incorporated into the final SWPPP.
7. Select Erosion, Sediment, and Runoff Controls. All areas of exposed soil will require a control measure be defined dependent on the duration of exposure. Select the controls needed for each phase of the construction project based on the different demands.
8. Identify locations of topsoil stockpiles. Areas for storing topsoil should be determined and then proper measures to control their erosion and sediment movement selected.
9. Identify location of temporary construction roads, vehicle tracking controls, and material storage areas.
10. Identify areas where stormwater could potentially be infiltrated onsite during construction. Onsite infiltration measures (such as detention ponds and grass swales) will reduce the runoff that will require treatment prior to leaving the site.

[Figures CS-1 through CS-3](#) illustrate how the implementation of a SWPPP may be done in phases (for example, overlot grading phase, road and utility construction phase, major site revegetation phase, home building phase, and final acceptance phase). Each phase needs to address erosion, sediment, and runoff controls and the construction activities management for that phase of the construction activities. Each needs to take into account the specific physical layout and site conditions that will exist during that phase. Some projects may need to show multiple phases to have an effective overall SWPPP.

### **Figure CS-1 – Example of Phase 1 Erosion Control**

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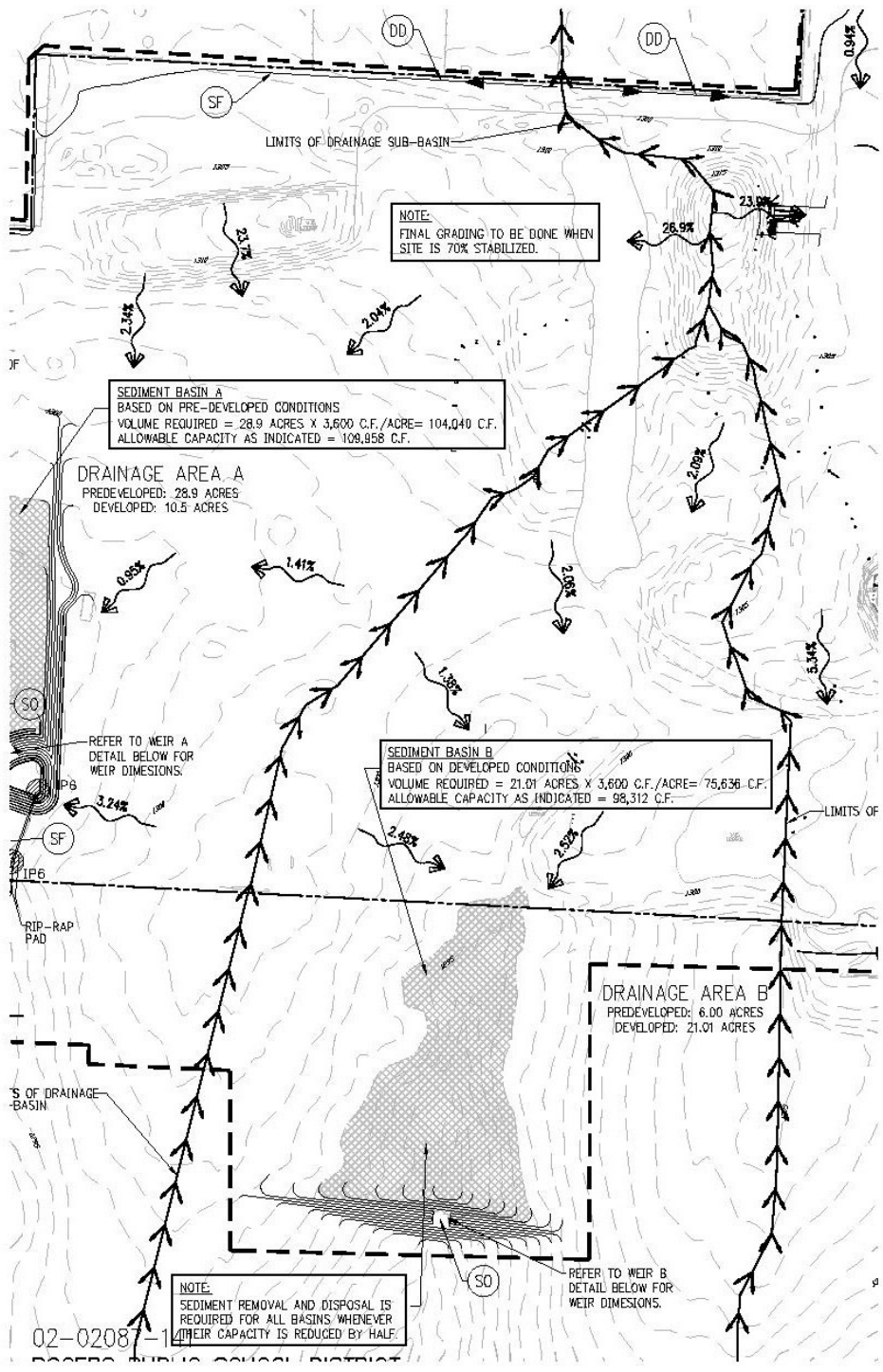


Figure CS-2 – Example of Phase 2 Erosion Control

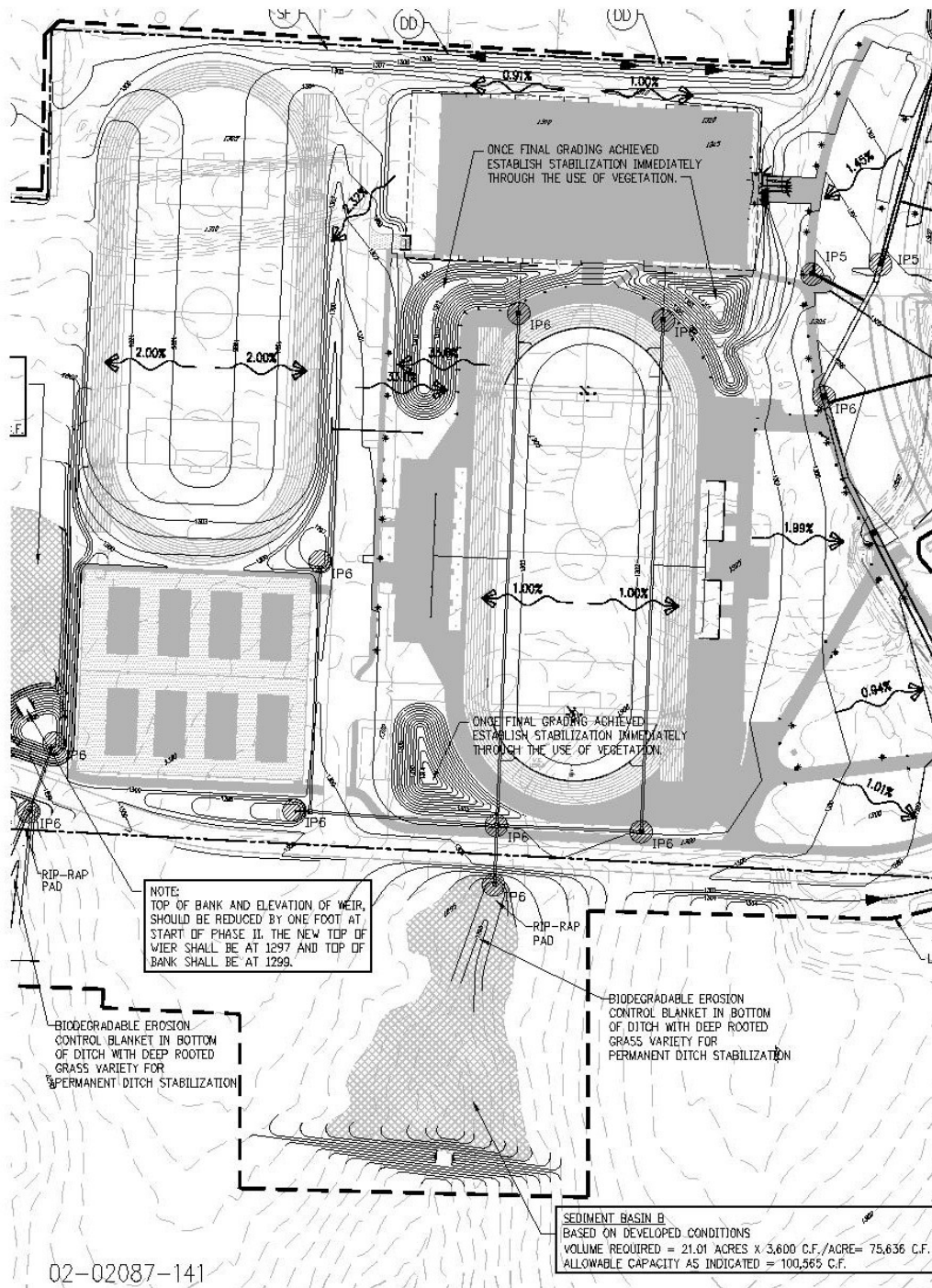
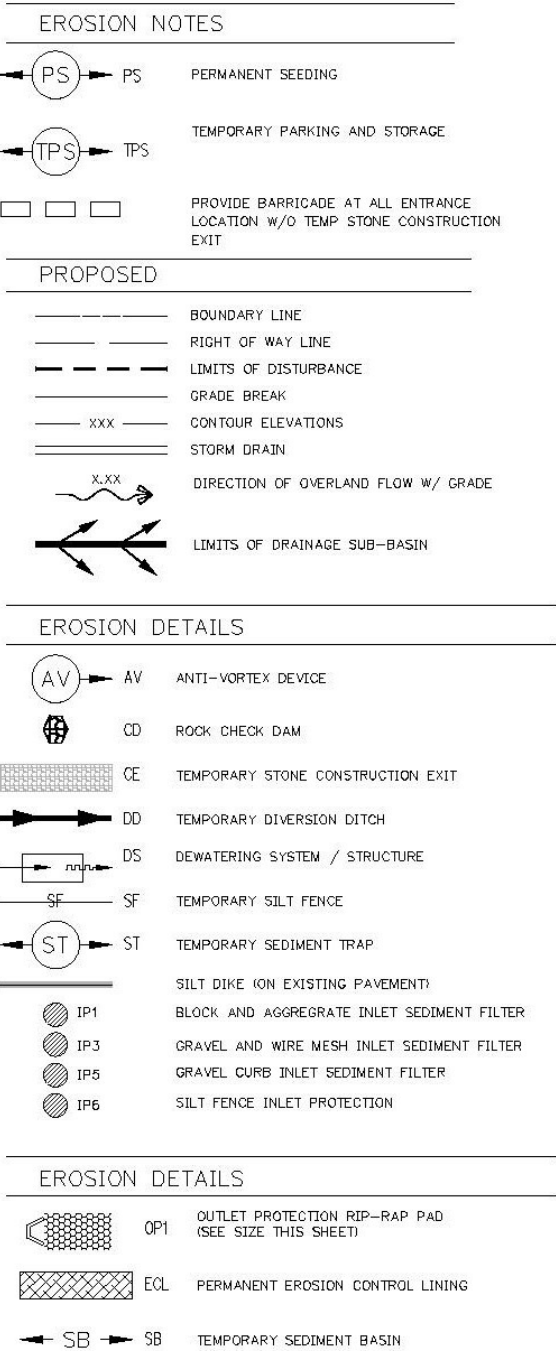


Figure CS-3 – Example of Erosion Control Legend

# CONSTRUCTION SITE STORMWATER MANAGEMENT



### 3.0 BEST MANAGEMENT PRACTICES FOR CONSTRUCTION SITES

Best Management Practices (BMPs) are used to reduce pollutants in stormwater discharges from construction sites and to assure compliance with the terms and conditions of the Construction General Permit.

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The impacts to water quality resulting from construction management facilities can be managed by controls on equipment and material storage.

Erosion controls limit the amount and rate of erosion occurring on disturbed areas. They are surface treatments and source controls that stabilize the soil exposed by excavation or grading.

Sediment controls capture soil that has been eroded before it leaves the construction site. They allow soil particles that have been suspended in runoff to be filtered through a porous media or to be deposited by slowing the flow and allowing the natural process of sedimentation to occur.

The planning for the installation of temporary or permanent erosion and sediment controls needs to begin in advance of all major soil disturbance activities on the construction site. Minimizing the area being disturbed at any given time is one of the most effective erosion control measures. This principle needs to be kept in mind whenever developing a SWPPP. All areas of exposed soil will require a control measure to be defined that is dependent on the duration of exposure.

The erosion potential associated with a construction site is reduced when stabilization techniques are employed. Existing vegetation shall be preserved where attainable. Stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased.

Maximizing onsite infiltration will reduce the runoff that will require treatment prior to leaving the site. Sediment basins, detention ponds, grass swales, and sediment traps are BMPs that will encourage onsite infiltration. Infiltration should not be promoted in areas next to building foundations or in soils that are not appropriate.

The erosion and sediment control measures will also be effective in controlling wind erosion. The surface stabilization measures identified for control of precipitation-induced erosion act also to prevent soils from becoming windborne. Although these guidelines were developed to control erosion by rainfall and snowmelt, they are consistent with design principles for wind erosion and will be effective for this purpose. Refer to DEQ Regulation 18: Arkansas Air Pollution Code at [www.adeg.state.ar.us](http://www.adeg.state.ar.us)

BMP Fact Sheets have been provided for each of the following construction management practices, erosion controls, and sediment controls. They are to be used as guidelines to select the controls needed for each phase of the construction project based on the different demands.

Construction management practices include the BMPs listed in [Table CS-1](#).

**Table CS-1 – List of BMPs for Construction Management Practices**

<b>BMP #</b>	<b>BMP Name</b>
CM-1	Construction sequencing/phasing
CM-2	Hazardous waste management and chemical storage
CM-3	Solid waste management
CM-4	Concrete washouts
CM-5	Construction staging and maintenance areas
CM-6	Construction dewatering

Erosion control practices include the BMPs listed in [Table CS-2](#).

**Table CS-2 – List of BMPs for Erosion Control Practices**

<b>BMP #</b>	<b>BMP Name</b>
EC-1	Chemical Stabilization
EC-2	Compost Blankets
EC-3	Geotextiles, Erosion Control Blankets and Mats
EC-4	Terraces
EC-5	Mulching
EC-6	Temporary Outlet Protection, Energy Dissipation Devices, Riprap Apron
EC-7	Temporary and Permanent Revegetation
EC-8	Wind erosion or dust control
EC-9	Hydroseeding and Hydromulching
EC-10	Surface Roughening
EC-11	Temporary Slope Drain
EC-12	Temporary Stream Crossings
EC-13	Level Spreader

Sediment Control and Runoff Control practices include the BMPs listed in [Table CS-3](#).

**Table CS-3 – List of BMPs for Sediment Control and  
Runoff Control Practices**

<b>BMP #</b>	<b>BMP Name</b>
SC-1	Stabilized construction entrance/exit
SC-2	Embedded Silt fence
SC-3	Inlet protection
SC-4	Chemical treatment
SC-5	Sediment trap
SC-6	Sediment basin
SC-7	Compost filter socks
SC-8	Fiber rolls/wattles
SC-9	Gravel bags
SC-10	Vegetative buffers
SC-11	Sediment filters and sediment chambers
RC-1	Check dams
RC-2	Triangular Silt Dike
RC-3	Grass-lined channels
RC-4	Interceptor and diversion dikes and swales
RC-5	Rough-cut street control
RC-6	Water bars

Many of the temporary controls used for sediment control can be modified into permanent structural controls. In addition, permanent stormwater quality controls can often be constructed at the initial stages of the project and modified to control sediment during construction phases. When that occurs, they will need to be modified and restored to the post-construction BMP configuration at the end of construction. Restoration of the post-construction BMPs may involve removing sediment that may have accumulated during construction.

#### **4.0 WATERWAY PROTECTION**

At times construction activities must occur within or immediately adjacent to a waterway (drainageway, creek, stream, river, lake, reservoir or wetland). Whenever this occurs, bottom

sediment and the soil will be disturbed and sediment movement will occur. The goal is to minimize the movement of sediments resulting from construction activities. This is accomplished by the use of erosion and sediment control practices described in this Manual.

#### **4.1 Working Within or Crossing a Waterway**

When working immediately adjacent to a waterway, the use of erosion and sediment control practices described earlier in this Manual is crucial. Activities such as minimizing disturbed areas adjacent to the waterways, timing construction during low flows, using surface roughening techniques, mulching disturbed areas as quickly as possible, using silt fence, and using temporary slope diversions to direct runoff to sediment basins before runoff enters the waterway. The inspection and maintenance of the erosion and sedimentation controls needs to be more aggressive.

When working within a waterway, steps must be taken to stabilize the work area during construction to control erosion. The channel banks and channel bed must be restabilized by the use of seeding, mulching, and/or erosion control matting, as quickly as possible. If it is not practical to do final seeding due to site conditions (e.g., frozen ground, prolonged wet weather, etc.), mulch shall be applied to the surface, and then seed and final mulch when conditions permit.

A permit is required for placement of fill in a waterway under Section 404 of the Clean Water Act. The U.S. Army Corps of Engineers has issued nationwide permit Number 14 for Linear Transportation Projects (roads, highways, railways, trails, airport runways, etc.) along with the placement of temporary fill associated with the construction. Appropriate measures must be taken to maintain normal downstream flows and floodplain capacity. The U.S. Army Corps of Engineers has issued nationwide permit Number 12 for Utility Line Activities for construction of utility lines within Waters of the United States provided there is no change in pre-construction contours. The local office of the Corps of Engineers should be contacted concerning the requirements for obtaining a 404 permit.

In addition, a permit from the U.S. Fish and Wildlife Service may be needed if endangered species are of concern in the work area. For a list of endangered or threatened species, contact the Arkansas Natural Heritage Commission at (501) 324-9619 or [www.naturalheritage.com](http://www.naturalheritage.com) or the U.S. Fish and Wildlife Services (USFWS) at (501) 324-5643 or [www.fws.gov](http://www.fws.gov). Typically the USFWS issues are addressed by a 404 permit if one is required. The City of Rogers should also be consulted and can provide assistance.

Applicants of a Corps of Engineers 404 permit shall also contact DEQ for a Short Term Activity Authorization (STAA) needs determination for activities that have the potential to violate water quality criteria.

Besides permitting with the U.S. Army Corps of Engineers and USFWS, it may be necessary to submit the proper map revision application [(C)LOMA, (C)LOMR-F, (C)LOMR] to FEMA depending on the type and level of work taking place within a waterway. Should any of the work occurring in

## DRAINAGE CRITERIA MANUAL

and around a waterway create a situation that permanently alters the future hydraulic characteristics of the waterway (e.g. by placement of fill in a waterway or realignment of the waterway) it will be necessary to coordinate such work with FEMA and the City's Floodplain Administrator to ensure all necessary maps and hydraulic information are revised/updated for the impacted area of the waterway.

Where an actively-flowing watercourse must be crossed regularly by construction vehicles, a temporary stream crossing shall be provided. Three primary methods are available: (1) a culvert crossing, (2) a stream ford, and (3) a bridge crossing. Refer to [Figures CS-4](#) through [CS-5](#) for examples of temporary stream crossings. Also refer to the Temporary Stream Crossing BMP fact sheet EC-12.

Construction vehicles shall be kept out of a waterway to the maximum extent practicable.

When working within a waterway, temporary facilities shall be installed to divert clean flowing water around the construction activities taking place within a waterway.

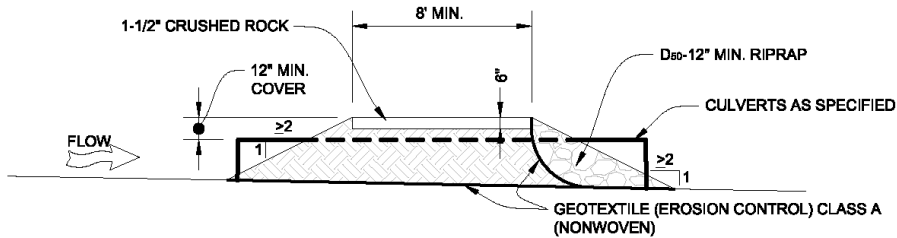
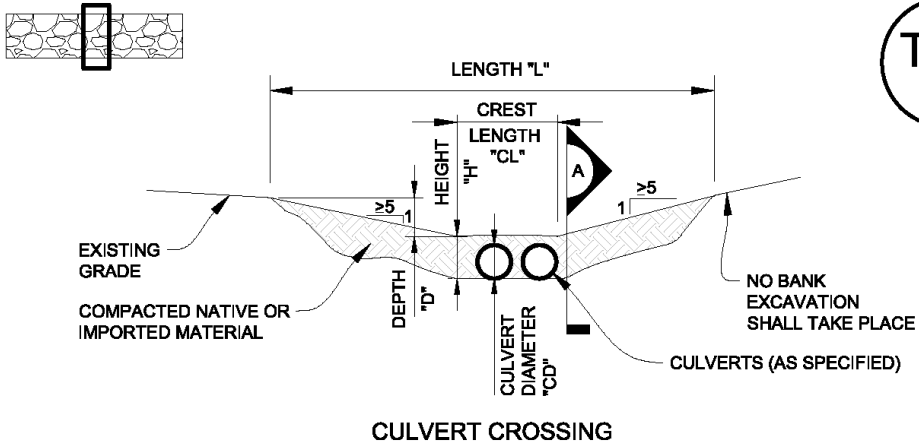
Whenever possible, construction in a waterway shall be sequenced to begin at the most downstream point and work progressively upstream installing required channel and grade control facilities.

Complete work in small segments, exposing as little of the channel at a time as possible.

Where feasible, it is best to perform all in-channel work during historically low stream flow periods. This is the period when the chances of flash floods and flows higher than the 2-year flood peak flows are least likely.

Some construction activities within a waterway are short lived, namely a few hours or days in duration, and are minor in nature. These are typically associated with maintenance of utilities and stream crossings and minor repairs to outfalls and eroded banks. In these cases, construction of temporary diversion facilities can often cause more soil disturbance and sediment movement than the maintenance activity itself. However, this determination will have to be made in conjunction with the Corps of Engineers, DEQ, the City and any other appropriate jurisdictions.

**Figure CS-4 – Temporary Culvert Stream Crossing**



**TEMPORARY STREAM CROSSING INSTALLATION NOTES**

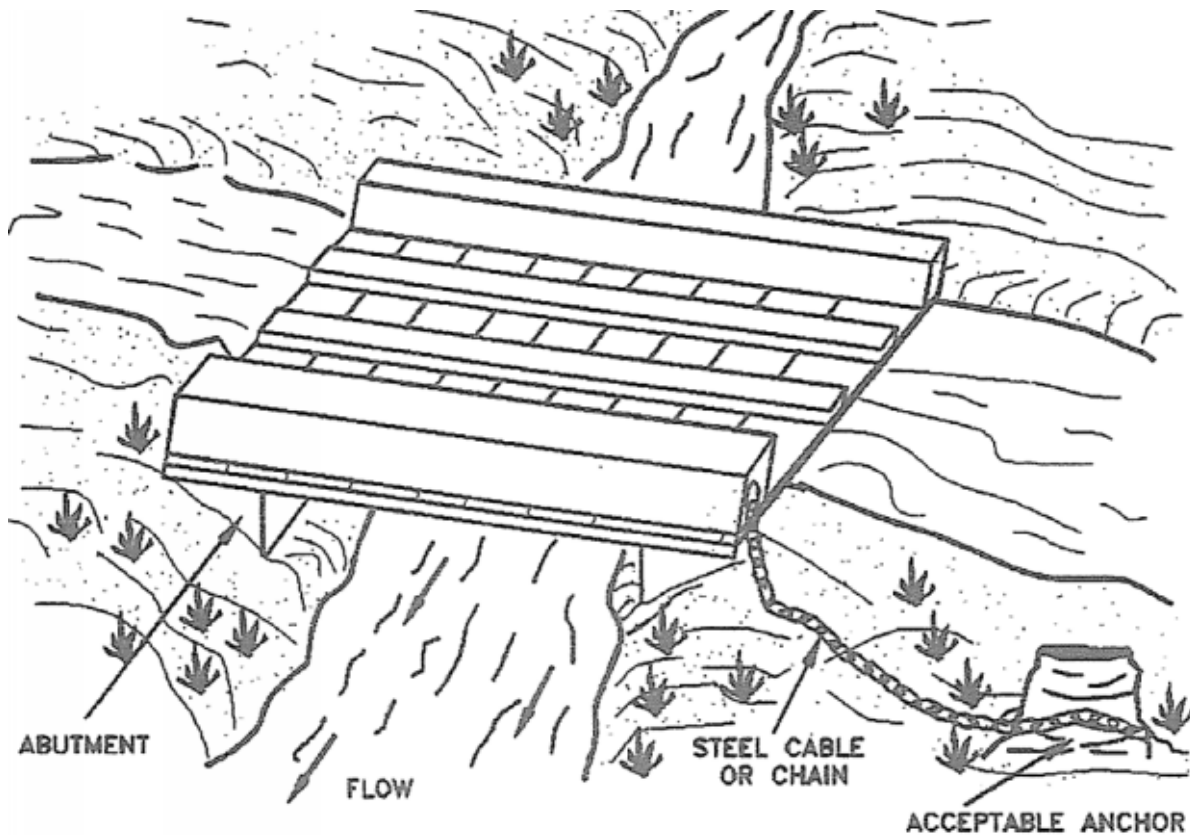
1. SEE PLAN VIEW FOR:
  - LOCATIONS OF TEMPORARY STREAM CROSSING.
  - STREAM CROSSING TYPE (FORD OR CULVERT).
  - FOR CULVERT CROSSING: LENGTH, "L", CREST LENGTH, "CL", CROSSING HEIGHT, "H", DEPTH, "D", CULVERT DIAMETER, "CD", AND NUMBER, TYPE AND CLASS OR GAUGE OF CULVERTS.
2. TEMPORARY STREAM CROSSING DIMENSIONS,  $D_{80}$ , AND NUMBER OF CULVERTS INDICATED (FOR CULVERT CROSSING) SHALL BE CONSIDERED MINIMUM DIMENSIONS; ENGINEER MAY ELECT TO INSTALL LARGER FACILITIES. ANY DAMAGE TO STREAM CROSSING OR EXISTING STREAM CHANNEL DURING BASE-FLOW OR FLOOD EVENTS SHALL BE THE CONTRACTOR'S RESPONSIBILITY.
3. SEE TABLE MD-7, MAJOR DRAINAGE, VOL. 1 FOR RIPRAP AND 1-1/2" CRUSHED ROCK GRADATIONS.
4. FOR A TEMPORARY STREAM CROSSING THAT WILL CARRY H-10 OR GREATER LOADS, THE TEMPORARY STREAM CROSSING MUST BE DESIGNED BY THE ENGINEER, STRUCTURAL.

**TEMPORARY STREAM CROSSING MAINTENANCE NOTES**

1. THE SWMP MANAGER SHALL INSPECT STREAM CROSSINGS WEEKLY, DURING AND AFTER ANY STORM EVENT AND MAKE REPAIRS OR CLEAN OUT UPSTREAM SEDIMENT AS NECESSARY.
2. SEDIMENT ACCUMULATED UPSTREAM OF STREAM CROSSINGS SHALL BE REMOVED WHEN THE SEDIMENT DEPTH UPSTREAM OF FORD CROSSINGS IS WITHIN 6-INCHES OF THE CREST AND FOR CULVERT CROSSINGS IS GREATER THAN AN AVERAGE OF 12-INCHES.
3. STREAM CROSSINGS ARE TO REMAIN IN PLACE UNTIL NO LONGER NEEDED AND SHALL BE REMOVED PRIOR TO THE END OF CONSTRUCTION.
4. WHEN STREAM CROSSINGS ARE REMOVED, THE DISTURBED AREA SHALL BE COVERED WITH TOP SOIL, DRILL SEEDED AND CRIMP MULCHED AND COVERED WITH EROSION CONTROL BLANKET OR OTHERWISE STABILIZED IN A MANNER APPROVED BY THE LOCAL JURISDICTION.

DETAIL BASED ON DETAILS PROVIDED BY DOUGLAS COUNTY, COLORADO

**Figure CS-5 – Graphical Illustration of a Temporary Bridge Stream Crossing**



## 4.2 Temporary Channel Diversions

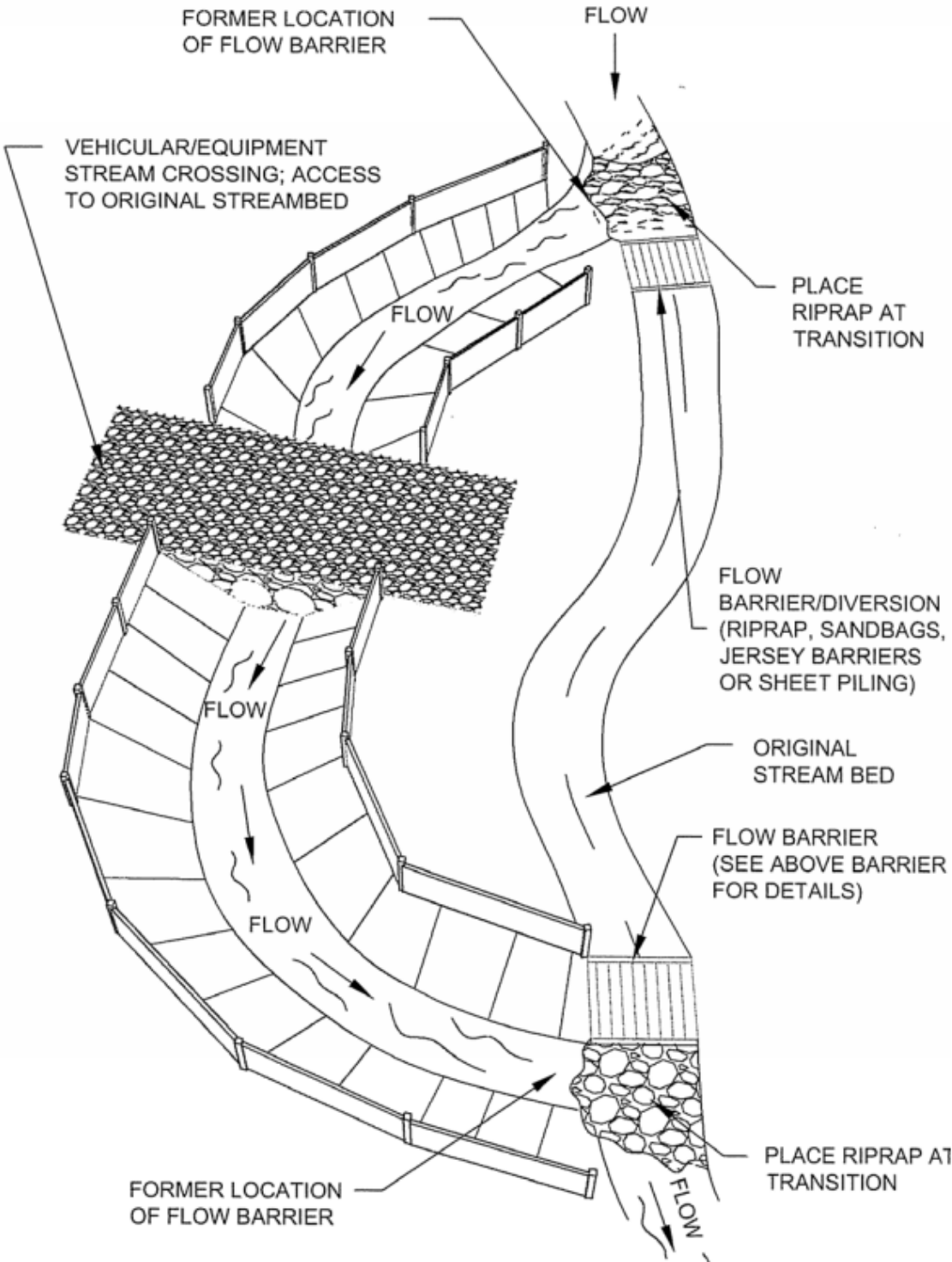
Limiting construction activities within a waterway will significantly reduce erosion and sediment movement downstream. Construction berms can be used on portions of large channels to carry water around construction activities. The berms shall be tall enough to contain at least the 2-year flood peak without being overtopped.

Temporary diversion channels that divert the entire waterway are appropriate for work in smaller waterways and for the construction of detention basins and dams located on waterways. Refer to [Figure CS-6](#) for an example of a temporary channel diversion.

Whenever the temporary diversion is around the construction site of a detention basin or a dam, the detention basin behind the dam should be considered for use as a temporary sediment basin. During construction such basins will need to be maintained as any other sediment basin. Once the construction site is stabilized, and before the temporary diversion is removed, all the accumulated sediment will need to be removed. The basin and its outlet facility will need to be configured to meet the requirements of the final design plans and specifications.

**Figure CS-6 – Illustration of a Temporary Diversion Channel**

CONSTRUCTION SITE  
STORMWATER MANAGEMENT



**4.2.1 Temporary Channel Diversion Sizing**

It is the responsibility of the designer and the contractor to assess their risk of having the temporary diversion be exceeded and to evaluate the damages such an event may cause to the project, adjacent properties, and to others. For larger waterways, including ones controlled by flood control

reservoirs, specific risk assessment may be appropriate to insure that the work and the waterways are protected. Risk assessment does not insure that the construction work will be 100 percent safe from high flows in the waterway. It merely provides a reasonable minimum level of flow for the design of temporary diversion channels.

The maximum depth of flow for temporary diversion channels is one (1) foot for flows less than 20 cfs, and a maximum depth of three (3) feet for flows less than 100 cfs. Flows in excess of 100 cfs shall be designed in accordance with Chapter 7 – Open Channel Flow Design of the manual. The steepest side slope allowable for a temporary channel is 2:1 (horizontal:vertical). It is required that the design for temporary diversion channels include a minimum of one-half (0.5) foot of freeboard.

### **4.2.2 Temporary Channel Stability Considerations**

Temporary channels are not likely to be in service long enough to establish adequate vegetative lining. Temporary channel diversions must be designed to be stable for the design flow for the channel lining material. Unlined channels shall not be used unless it can be demonstrated that an unlined channel will not erode during the design flow. [Table CS-4](#) gives allowable channel lining materials for a range of slope and flow depth. [Table CS-5](#) gives Manning's 'n' values for lining materials. Design procedures for temporary channels are described in detail in the Hydraulic Engineering Circular No. 15 published by the Federal Highway Administration.

**Table CS-4 – Lining Materials for Temporary  
Channels**

Slope Range	Maximum Flow Depth	
	1 ft	3 ft
0% - 0.005%	Jute Netting	Straw or Wood Fiber Erosion Control Netting or Plastic Membrane
0.005% - 1.0%	Straw or Wood Fiber Erosion Control Netting or Plastic Membrane	Straw or Wood Fiber Erosion Control Netting
1.0% - 2.0%	Geotextile with Overlay of Erosion Control Mat	D <sub>50</sub> = 4" Riprap to D <sub>50</sub> = 6" Riprap
2.0% - 3.0%	D <sub>50</sub> = 3" Riprap to D <sub>50</sub> = 6" Riprap	D <sub>50</sub> = 9" Riprap
3.0% - 4.0%	D <sub>50</sub> = 6" Riprap	D <sub>50</sub> = 12" Riprap

**Table CS-5 – Temporary Channel Design Criteria**

Lining Material	Manning's n for Flow Depth 0 ft to 1.0 ft	Manning's n for Flow Depth 1.0 ft to 3.0 ft	Manning's n for Flow Depth 3.0 ft to 5.0 ft
Plastic Membrane	0.011	0.010	0.009
Jute Netting	0.028	n/a	n/a
Straw or Curled Wo Mats	0.035	0.025	0.020
Riprap, D <sub>50</sub> = 6" Rip	0.070	0.045	0.035
Riprap, D <sub>50</sub> = 9" Rip	0.100	0.070	0.040
Riprap, D <sub>50</sub> = 12" Ri	0.125	0.075	0.045

Notes:

1. Maximum depth is one (1) foot for flows less than twenty (20) cfs
2. Maximum depth is three (3) feet for flows less than one hundred
3. For flows greater than 100 cfs, design temporary diversion chanr Chapter 7 – *Open Channel Flow Design* of the *Manual* except the steepness shall not exceed 2:1 (horizontal:vertical) unless struct
4. Determine the channel bottom width required using Manning's E given above.
5. Refer to Chapter 7 – *Open Channel Flow Design* of the *Manual* f
6. Erosion protection shall extend a minimum of 0.5 feet above the

**4.2.3 Example: Temporary Channel Diversion Design**

A simplified method for designing a non-erosive temporary diversion channel is given as follows:

Step One: Using the tributary area A (in acres) determine peak flow.

Step Two: Determine depth of flow, one (1) foot maximum for flows less than 20 cfs and three (3) feet maximum for flows less than 100 cfs. (Flows in excess of 100 cfs shall be designed in accordance with Chapter 7 – Open Channel Flow Design.)

Step Three: Determine channel slope based on existing and proposed site conditions.

Step Four: Pre-size the channel, determine maximum velocities and select lining material from [Table CS-4](#).

Step Five: Determine the channel geometry and check the capacity using Manning's Equation and the "n" value given in [Table CS-5](#). The steepest side slope allowable for a temporary channel is 2:1 (horizontal:vertical), unless vertical walls are installed using sheet piling, concrete

or stacked stone. It is required that the design for temporary bypass channels include a minimum of one-half (0.5) foot of freeboard.

## **5.0 UNDERGROUND UTILITY CONSTRUCTION – PLANNING AND IMPLEMENTATION**

The construction of underground utility lines will be subject to the following criteria:

- The City of Rogers has the right to limit the amount of trench excavated in advance of utility laying. In general, such trenching shall not exceed 400 feet.
- Where consistent with safety and space considerations, excavated material is to be placed on the uphill side of trenches.
- Trench dewatering devices must discharge in a manner that will not adversely affect flowing streams, wetlands, drainage systems, or off-site property. Dewatering that discharges water in a manner that may enter into waters of the State require a Construction General Permit from the Arkansas Department of Energy & Environment Division of Environmental Quality.
- Provide storm sewer inlet protection whenever soil erosion from the excavated material has the potential for entering the storm drainage system.
- City ordinance Article I. Section 14-1 requires that prior to digging or construction of a trench that the fire department shall be notified by email, telephone or internet submission. Further, it requires that all trenches comply with the Occupational and Safety Act of 1980.

Utility agencies shall develop and implement Best Management Practices (BMPs) to prevent the release of sediment and discharge of pollutants from utility construction sites. Disturbed areas shall be minimized and managed. Construction site entrances shall be managed to prevent sediment tracking. Excessive sediment tracked onto public streets shall be removed immediately. The City of Rogers may adopt and impose additional BMPs on utility construction activity.

Prior to entering a construction site or subdivision development, utility agencies shall have obtained from the owner a copy of any SWPPP for the project. Any disturbance to BMPs resulting from utility construction shall be repaired immediately by the utility company in compliance with the SWPPP.

It is the responsibility of the utility agency to obtain necessary permits for the construction of utility lines within Waters of the United States.

## **6.0 REMOVAL OF TEMPORARY MEASURES**

All temporary erosion and sediment control measures shall be removed and properly disposed of

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within thirty (30) days after final stabilization is achieved, after the temporary measures are no longer needed, or as authorized by the City of Rogers. It may be necessary to maintain some of the control measures for an extended period of time, until the upstream areas have been fully stabilized and vegetation has sufficiently matured to provide specified cover.

Trapped sediment and disturbed soil areas resulting from the removal of temporary measures must be returned to final plan grade and permanently stabilized to prevent further soil erosion.

The qualified professional preparing the SWPPP shall submit a schedule of removal dates for the temporary control measures. The schedule should be consistent with key construction phases such as street paving, final stabilization of disturbed areas, or installation of structural stormwater controls.

Permanent post-construction BMPs that were used as sediment controls during construction shall be refurbished to a fully operational form per the design plans and SWPPP. The final site work will not be accepted by the City of Rogers until these permanent post-construction BMPs are in a final and acceptable form.

### **7.0 MAINTENANCE**

All temporary and permanent erosion and sediment controls shall be inspected, maintained, and repaired by the owner during the construction phase to assure continued performance of their intended function. Refer to the individual BMP fact sheets for maintenance guidelines.

The qualified professional preparing the SWPPP shall submit a schedule of planned maintenance activities for the temporary and permanent erosion and sediment control measures.

### **8.0 STANDARDS AND SPECIFICATIONS FOR BMPS (FACT SHEETS)**

#### **8.1 BMP CM-1 Construction Sequencing/Phasing**

##### Description

Premature and/or excessive grading can increase the erosion potential and is therefore prohibited.

Construction Sequencing coordinates land disturbing activities with construction requirements to minimize the amount of soil exposed to erosion at any time.

##### Applicability

Projects on larger sites and on projects that land disturbing activities can be phased are best suited for Construction Sequencing.

### Design Criteria

The potential for erosion is reduced when construction is performed in stages and the entire construction site is not disturbed all at the same time.

Areas of the site to be preserved should be clearly marked on the plans and delineated on the site. The timing of clearing and access to different areas of the site should be indicated in the contract documents.

Only land needed for building activities and vehicular traffic should be cleared.

Another way to phase construction is to minimize the disturbed areas during times of the year that traditionally receive large precipitation events.

### Limitations

Sometimes, smaller projects do not lend themselves to sequencing of land disturbing activities.

### Maintenance Requirements

Maintenance of protective BMP as needed.

## **8.2 BMP CM-2 Hazardous Waste Management and Chemical Storage**

### Description

Often materials are used at a construction site that present a potential for contamination of stormwater runoff. Hazardous Waste Management is the proper staging, storage, handling, and disposal of construction material listed as hazardous by EPA and/or DEQ to prevent pollutants from being released from the site to receiving waters.

### Applications

All construction materials that are listed as hazardous by EPA and/or DEQ.

### Criteria

Guidelines published by EPA and OSHA for the types of materials to be used on the construction site should be incorporated into the SWPPP.

The types of materials that are generally considered hazardous are:

- Fuels (diesel, gas, etc.)
- Oils and greases (lubricating, cutting, etc.)
- Petroleum based materials (asphalt, emulsions, solvents)

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- Paints (including wood preservatives, stains, and lead based)
- Solvents (paint thinners, cleaners, etc.)
- Pesticides, herbicides, insecticides

Proper management of hazardous materials entails:

- Replace hazardous materials with non-hazardous materials
- Minimize the use of hazardous materials
- Reuse and recycle hazardous materials
- Proper use of hazardous materials
- Proper storage and handling of hazardous materials
- Proper disposal of hazardous materials

Employees must be trained in the use, storage, and disposal of hazardous wastes. Hazardous materials should be stored so only authorized personnel can use the material.

Areas at the construction site that are used for storage of toxic materials and petroleum products should be designed with an enclosure, under a roof if possible, with a container, or with a dike located around the perimeter of the storage area to prevent discharge of these materials in runoff from the construction site. These barriers will also function to contain spilled materials.

Measures to prevent spills or leaks of fuel, gear oil, lubricants, antifreeze, and other fluids from construction vehicles and heavy equipment should be considered to protect groundwater and runoff quality. All equipment maintenance should be performed in a designated area and measures, such as drip pans, used to contain petroleum products. Spills of construction-related materials, such as paints, solvents, or other fluids and chemicals, shall be cleaned up immediately and disposed of properly.

The following methods shall be followed for spill prevention and clean-up:

- The manufacturers recommended methods for spill clean-up shall be clearly posted and personnel shall be trained in the location of clean-up supplies and clean-up procedures.
- Clean-up supplies shall be kept in a secure area.
- Personnel shall wear proper protective clothing when cleaning up the spill.
- Spills shall be cleaned up immediately and the waste properly disposed of.
- Licensed hazardous waste haulers must be used to transport hazardous wastes to approved treatment and disposal sites.

- Additional measures for spill prevention, response, and material storage practices may be required.

### **8.3 BMP CM-3 Solid Waste Management**

#### Description

Solid wastes that are improperly disposed of can be blown or washed from construction sites causing others to pick up the wastes from their property. Solid Waste Management refers to the proper handling and disposal of all construction wastes.

#### Applications

All construction sites.

#### Criteria

Areas shall be designated for the storage and disposal of construction material waste (both solid and liquid) to prevent discharge or movement of these materials off of the construction site.

These sites shall be located away from all storm drainage facilities and waterways. Consider covering the waste storage areas and fencing them, if necessary, to contain windblown materials. Consider constructing a perimeter dike to exclude or to contain runoff. These measures may not be necessary if all waste is placed immediately in covered waste containers at the site and is otherwise controlled in an effective manner. Trash receptacles shall be placed in convenient locations throughout the job site.

All waste shall be disposed only at approved landfill sites.

#### Maintenance Requirements

Trash and waste construction materials shall be picked up and disposed of daily.

### **8.4 BMP CM-4 Concrete Washouts**

#### Description

Concrete waste from washout of ready mix trucks, concrete pumps, and other concrete equipment increases sediment and changes the pH of stormwater runoff.

Concrete Waste Management is the practice of providing a basin for disposing of concrete residue and to wash out concrete truck mixers.

#### Applications

All construction sites with concrete work.

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### Design Criteria

The concrete washout area shall have sufficient storage volume to accept the wash water and allow the suspended particles to settle out.

The concrete washout area shall provide a minimum of six (6) cubic feet of containment volume for every ten (10) cubic yards of concrete to be poured.

### Limitations

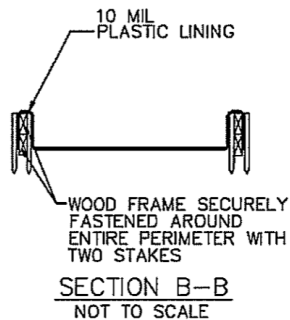
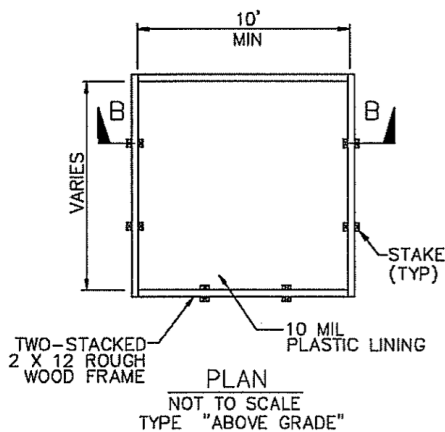
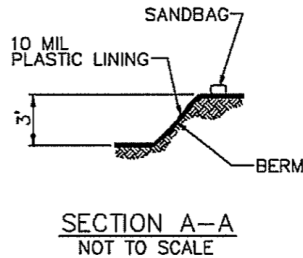
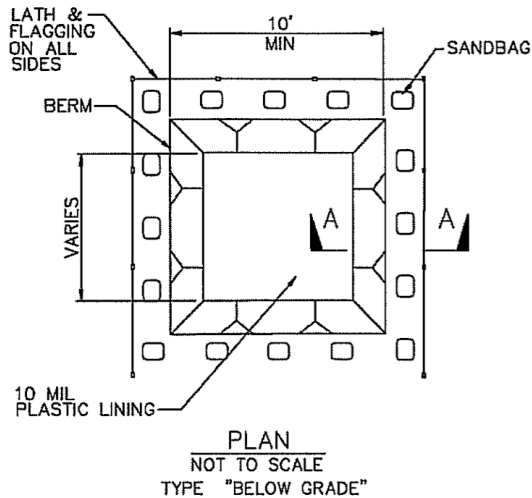
Improperly sized washout area can overflow and washout will not be contained.

### Maintenance Requirements

The washout pit shall be cleaned weekly, when two-thirds (2/3) full, or as necessary to maintain capacity for wasted concrete. The waste material shall be disposed of properly.

**Figure CS-7 – Concrete Washout Detail (EPA)**

**WM-8 Concrete Waste Management**



**NOTES**

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

### **8.5 BMP CM-5 Construction Staging and Maintenance Areas**

#### Description

Ideally, vehicle maintenance occurs in garages and wash facilities, not on active construction sites. However, if these activities must occur onsite, operators shall follow appropriate BMPs to prevent untreated nutrient-enriched wastewater or hazardous wastes from being discharged to surface or ground waters.

#### Applications

Vehicle maintenance and BMPs prevent construction site spills of wash water, fuel, or coolant from contaminating surface or ground water. They apply to all construction sites.

A covered, paved or gravel-lined area shall be dedicated to vehicle maintenance. A spill prevention and cleanup plan should be developed. Prevent hazardous chemical leaks by properly maintaining vehicles and equipment. Properly cover and provide secondary containment for fuel drums and toxic materials. Properly handle and dispose of vehicle wastes.

#### Implementation

Construction vehicles shall be inspected daily, and any leaks repaired immediately. All used oil, antifreeze, solvents and other automotive-related chemicals shall be disposed of according to manufacturer instructions. These wastes require special handling and disposal. Used oil, antifreeze, and some solvents can be recycled at designated facilities, but other chemicals must be disposed of at a hazardous waste disposal site. Local government agencies can help identify such facilities.

#### Limitations

There are construction costs for the enclosed maintenance area, along with labor costs for hazardous waste storage, handling, and disposal.

#### Maintenance

Vehicle maintenance operations produce substantial amounts of hazardous and other wastes that require regular disposal. Clean up spills and dispose of cleanup materials immediately. Inspect equipment and storage containers regularly to identify leaks or signs of deterioration.

(Source: EPA)

## 8.6 BMP CM-6 Construction Dewatering

### Description

Construction dewatering practices involve the removal of sediment from trench or groundwater prior to it being discharged from the construction site. It is also appropriate for the removal of stormwater from depressed areas at a construction site.

### Implementation

If trench or ground waters contain sediment, it must pass through a sediment settling pond or other equally effective sediment control device, prior to being discharged from the construction site. Sediment may be removed by settling in place or by dewatering into a sump pit, filter bag, or comparable practice.

Groundwater dewatering which does not contain sediment or other pollutants is not required to be treated prior to discharge. However, care must be taken when discharging groundwater to ensure that it does not become pollutant-laden by traversing over disturbed soils or other pollutant sources.

Dewatering discharges must not cause erosion at the discharge point.

### Limitations

Dewatering operations will require, and must comply with, applicable local permits. Dewatering that discharges water in a manner that may enter any waters of the State require a Construction General Permit from the Arkansas Department of Energy & Environment Division of Environmental Quality (DEQ). This permit will need to be obtained by the owner and all conditions stipulated in that permit strictly adhered to. It is the responsibility of the owner and their SWPPP manager to insure that this occurs.



**Photograph CS-2 – Example of Dewatering Bag**

### **8.7 BMP EC-1 Chemical Stabilization**

#### Description

Erosion is caused by rainfall impact detaching soil particles and runoff carrying the particles downslope. Chemical stabilization is the practice of spraying chemicals (tackifiers, soil binders) on the soil to hold the soil particles in place and protect against erosion.

#### Applicability

Areas that have been cleared of vegetation or do not have a protective cover on the soil. If temporary seeding cannot be used or would not be effective due to the time of year, steepness of slope, or other reasons; chemical stabilizers can be applied to protect against erosion. Chemical stabilization can be used in conjunction with seeding and mulching.

#### Design Criteria

The type of chemical used (asphalt emulsion, polyacrylamides (PAM), vinyl, or rubber), the application rate, and application method should meet the manufacturer's recommendations.

#### Limitations

Improper application methods or rates can result in over application which can diminish infiltration and cause additional runoff.

#### Maintenance Requirements

Chemically stabilized areas shall be inspected regularly and after one-half (1/2) inch or greater rainfalls and stabilizer reapplied as required.

### **8.8 BMP EC-2 Compost Blankets**

#### Description

A compost blanket is a layer of loosely applied compost or composted material that is placed on the soil in disturbed areas to control erosion and retain sediment resulting from sheet-flow runoff. It can be used in place of traditional sediment and erosion control tools such as mulch, netting, or chemical stabilization. When properly applied, the erosion control compost forms a blanket that completely covers the ground surface. This blanket prevents stormwater erosion by (1) presenting a more permeable surface to the oncoming sheet flow, thus facilitating infiltration; (2) filling in small rills and voids to limit channelized flow; and (3) promoting establishment of vegetation on the surface.

Compost blankets can be placed on any soil surface: rocky, frozen, flat, or steep. The method of application and the depth of the compost applied will vary depending upon slope and site conditions.

The compost blanket can be vegetated by incorporating seeds into the compost before it is placed on the disturbed area (recommended method) or the seed can be broadcast onto the surface after installation.

#### Applications

Compost blankets are most effective when applied on slopes between 4:1 (horizontal:vertical) and 2:1 (horizontal:vertical), such as stream banks, road embankments, and construction sites, where stormwater runoff occurs as sheet flow.

Compost blankets can be used on steeper slopes, such as 1:1 (horizontal:vertical), if netting or confinement systems are used in conjunction with the compost blanket to further stabilize the compost and the slope or if the compost particle size and compost depth are specially designed for the application.

#### Limitations

Compost blankets are not applicable for locations with concentrated flow.

Compost blankets are not generally used on slopes greater than 2:1

(Source: US Environmental Protection Agency)

## **8.9 BMP EC-3 Geotextiles, Erosion Control Blankets and Mats**

### Description

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 (USEPA, 1992).

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.

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### Applications

Geotextiles can be used in various ways for erosion control on construction sites. Use them as matting to stabilize the flow of channels or swales or to protect seedlings on recently planted slopes until they become established. Use matting on tidal or stream banks, where moving water is likely to wash out new plantings. 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. Geotextiles can also be used on stockpiles.

### Design Considerations

There are many types of geotextiles available; therefore, the selected fabric shall 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.

### 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.

### Maintenance

Inspect geotextiles regularly 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.

(Source: EPA)



**Photograph CS-3 – Example of Erosion Control Blanket**

## **8.10 BMP EC-4 Terraces**

### Description

Terraces are earthen embankments or ridge and channel systems that reduce erosion by slowing, collecting and redistributing surface runoff to stable outlets that increase the distance of overland runoff flow. Terraces hold moisture and help trap sediments, minimizing sediment-laden runoff.

Sediment can be controlled on slopes that are particularly steep by the use of terracing. During grading, relatively flat sections or terraces, are created and separated at intervals by steep slope segments. The steep slope segments are prone to erosion, however, and must be stabilized by mulching or other techniques. Retaining walls, gabions, cribbing, deadman anchors, rock-filled slope mattresses and other types of soil retention systems are available for use. These should be specified in the plan and installed according to manufacturer's instructions.

### Applications

Terraces perform most effectively in barren areas with an existing or expected water erosion problem. Gradient terraces are effective only if suitable runoff outlets are available. Do not build terraces on slopes comprised of rocky or sandy soil because these soil types may not adequately redirect flows.

### Implementation

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Terraces should be properly spaced and constructed with an adequate grade, and they should have adequate and appropriate outlets toward areas not susceptible to erosion or other damage. Whenever possible, use vegetative cover in the outlet.

Terraced (stair-stepping) slopes shall have the vertical cuts no more than two (2) feet deep and the horizontal steps shall be wider than the depth of the vertical cut. The horizontal step shall slope backward to the vertical cut upslope on the hill.

### Limitations

Terraces are inappropriate for use on sandy or shallow soils, or on steep slopes. If too much water permeates a terrace system's soils, sloughing could occur; potentially increasing cut and fill costs.

### Maintenance

Terraces shall be inspected after major storms and at least once annually to ensure that they are structurally sound and have not eroded.

(Source: US Environmental Protection Agency)

## **8.11 BMP EC-5 Mulching**

### Description

Erosion is caused by rainfall impact detaching soil particles and runoff carrying the particles downslope. Mulch can be applied to the area to hold the soil particles in place and protect against erosion.

Mulching is the practice of applying a layer of organic material (hay, straw, wood fiber, paper fiber, etc.) to protect the soil from impact of precipitation.

### Applicability

Areas that have been cleared of vegetation or do not have a protective cover on the soil. Mulches are typically used to protect areas that have been seeded. Mulching can be used in conjunction with chemical stabilization.

### Design Criteria

Mulch should be applied consisting of clean, weed-free and seed-free, long-stemmed grass hay (preferred) or cereal grain straw. Hay is preferred as it is less susceptible to removal by wind. At least 50 percent of the grass hay mulch, by weight, shall be ten (10) inches or more in length.

Straw mulch shall be evenly applied at a rate of two (2) tons of dry straw per acre. The mulch shall be attached to the soil immediately after application as an anchor and not merely placed on the

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surface. This can be accomplished mechanically by crimping or with the aid of tackifiers or nets. Anchoring with a crimping implement is preferred, and is the recommended method for all areas equal to or flatter than 3:1. Mechanical crimpers must be capable of tucking the long mulch fibers into the soil four (4) inches deep without cutting them.

Mulch is typically applied using a mulch blower, but it can be applied by hand in small or hard to reach areas.

Soil which is exposed for more than fourteen (14) days with no construction activity shall be seeded, mulched, or revegetated.

On small areas sheltered from the wind and from heavy runoff, spraying a tackifier on the mulch is satisfactory for holding it in place. Hydraulic mulching consisting of wood cellulose fibers must be mixed with water and a tackifying agent and applied at a rate of no less than 2,000 pounds per acre with a hydraulic mulcher.

Mats, blankets, and nets are required to help stabilize steep slopes (3:1 and steeper) and waterways. Depending on the product, these may be used alone or in conjunction with grass or straw mulch. Normally, use of these products will be restricted to relatively small areas. Mats made of straw and jute, straw-coconut, coconut fiber, or excelsior can be used instead of mulch. Whichever material is used, blankets need to be bio-degradable.

Some synthetic tackifiers or binders may be used to anchor mulch in order to limit erosion and, if approved by review agency, provide soil stabilization. Caution should be used to prevent the introduction of any potentially harmful and non-biodegradable materials into the environment. Manufacturer's recommendations should be followed at all times.

Rock (gravel, slag, crushed stone, river rock) can also be used as mulch. It provides protection of exposed soils to wind and water erosion and allows infiltration of precipitation. Rock of aggregate base-course size can be spread on disturbed areas for temporary or permanent stabilization. Rock must be removed from those areas to be planned for vegetation establishment.

### Limitations

Wind and concentrated water flows can blow or wash mulch from the application area. Mulch should not be applied in areas with concentrated flows.

For steep slopes and special situations where greater control is needed, blankets anchored with stakes should be required instead of mulch.

Road cuts, road fills, and parking lot areas shall be covered as early as possible with the appropriate aggregate base course where this is specified as part of the pavement in lieu of mulching.

### Maintenance Requirements

Mulched areas shall be inspected regularly and after one-half (1/2) inch or greater rainfalls and

mulch reapplied as required.

### **8.12 BMP EC-6 Temporary Outlet Protection, Energy Dissipation Devices, Riprap Apron**

#### Description

Water exiting a channel, swale, pipe, or culvert (any water carrying conduit) typically is in a concentrated stream with a relatively high velocity. This high energy stream of water erodes unprotected soil.

Energy Dissipation is a structural BMP placed at the exit of a water carrying conduit to slow the velocity and decrease the turbulence of the water. Permanent energy dissipation controls can be used as temporary devices during the construction phase of the project, and shall be designed according to methods described in Chapter 7 – Open Channel Flow Design. A riprap apron is considered the most cost effective type of temporary energy dissipation device; meaning that the energy dissipation device is only needed during construction and will be removed once construction is complete. However, should a permanent energy dissipation device be required at the outlet end of a conduit it may be more economical to install a permanent energy dissipation device early in construction as a structural BMP, making sure to maintain and service the device so it can be used permanently once construction is over. Other types of energy dissipation devices include: Plunge Pools, ScourStop© Mats, ShoreMax© Mats, Velocity Dissipaters, etc. The only type of temporary energy dissipation device that will be discussed in this *Manual* will be the riprap apron. The use of riprap as a permanent energy dissipation device is discouraged and its use requires city approval.

#### Applicability

All channels or pipes carrying runoff at velocities that will erode the soil in the discharge area.

#### Design Criteria

See Section 6.0 – Outlet Protection of Chapter 8 – Culvert and Bridge Hydraulic Design for additional design information on sizing riprap apron outlet protection.

Determine the required median size ( $d_{50}$ ) of riprap using graph in the “Riprap Apron Sizing” Figure(s) below for the condition at hand. Enter the graph on the X-axis with the discharge in cubic feet per second, move vertically to intersect either the appropriate depth of flow ( $d$ ) line or the velocity of flow ( $v$ ) line, and then read horizontally to the Y-axis on the right side to determine the required median diameter of riprap ( $d_{50}$ ).

Determine the minimum required apron length using the graph in the “Riprap Apron Sizing” Figure(s). Enter the graph on the X-axis with the discharge in cubic feet per second, move vertically to the

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second set of lines to intersect the appropriate depth of flow ( $d$ ), and then read horizontally to the left to determine the minimum required length of apron ( $L_a$ ) in feet.

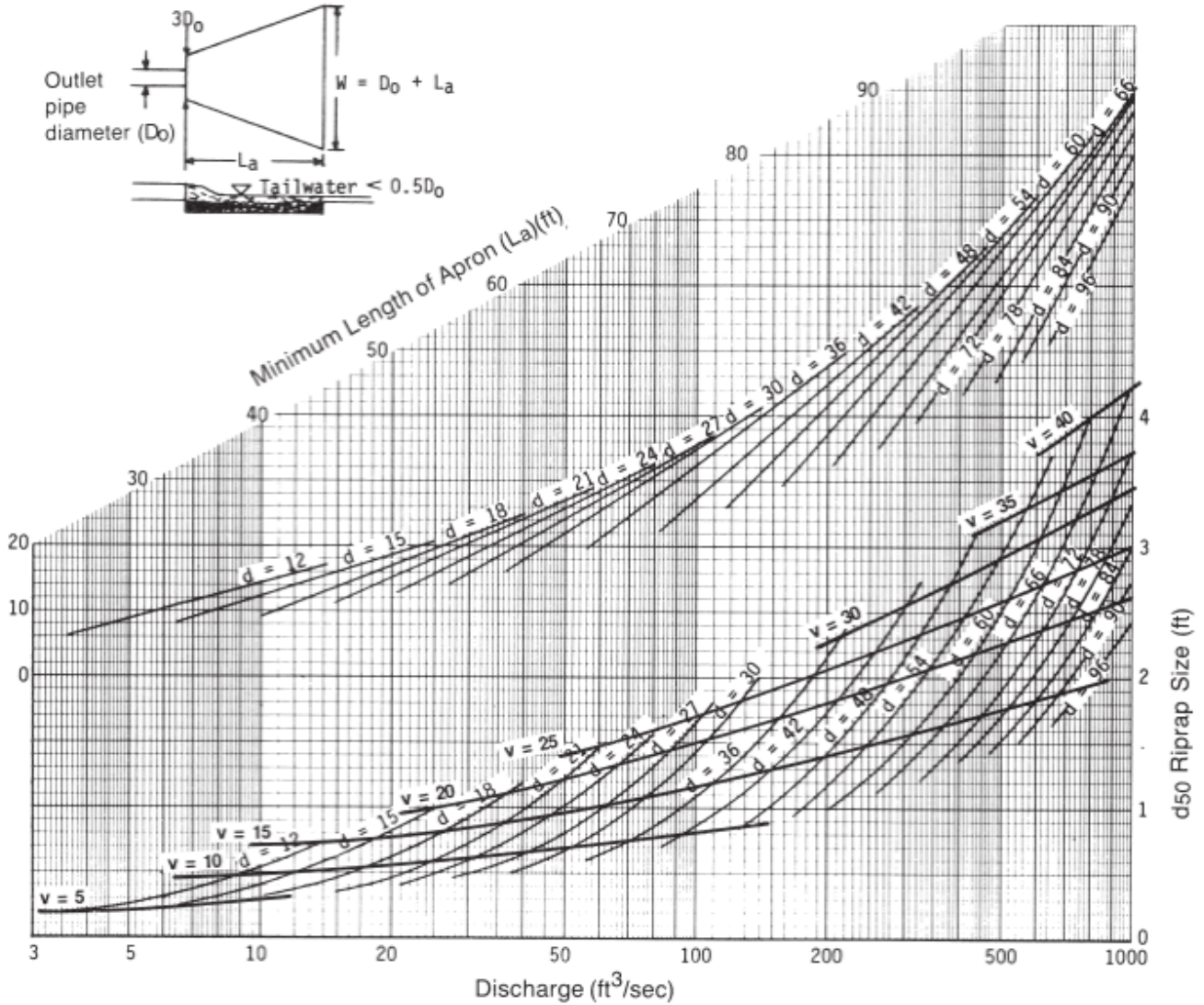
### Limitations

Riprap aprons are best suited for applications where the Froude Number at the conduit exit is less than 2.5.

### Maintenance Requirements

The apron should be inspected after large storms to ensure that the riprap is in place. Riprap should be replaced when it is dislodged or missing.

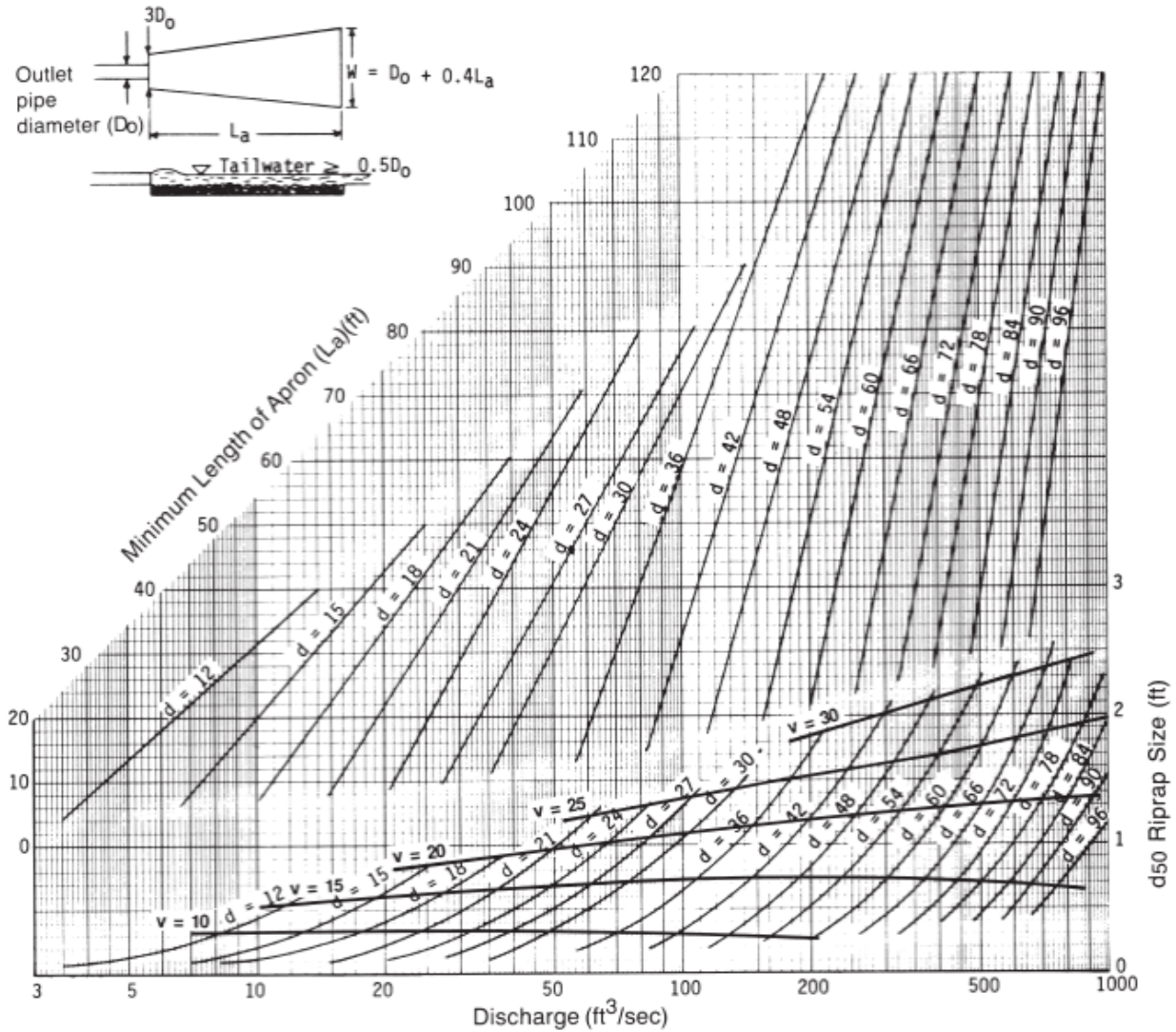
**Figure CS-8 – Riprap Apron Sizing for a Round Pipe Flowing Full,  
Minimum Tailwater Condition ( $T_w < 0.5$  diameter) (SCS, 1975)**



Curves may not be extrapolated.

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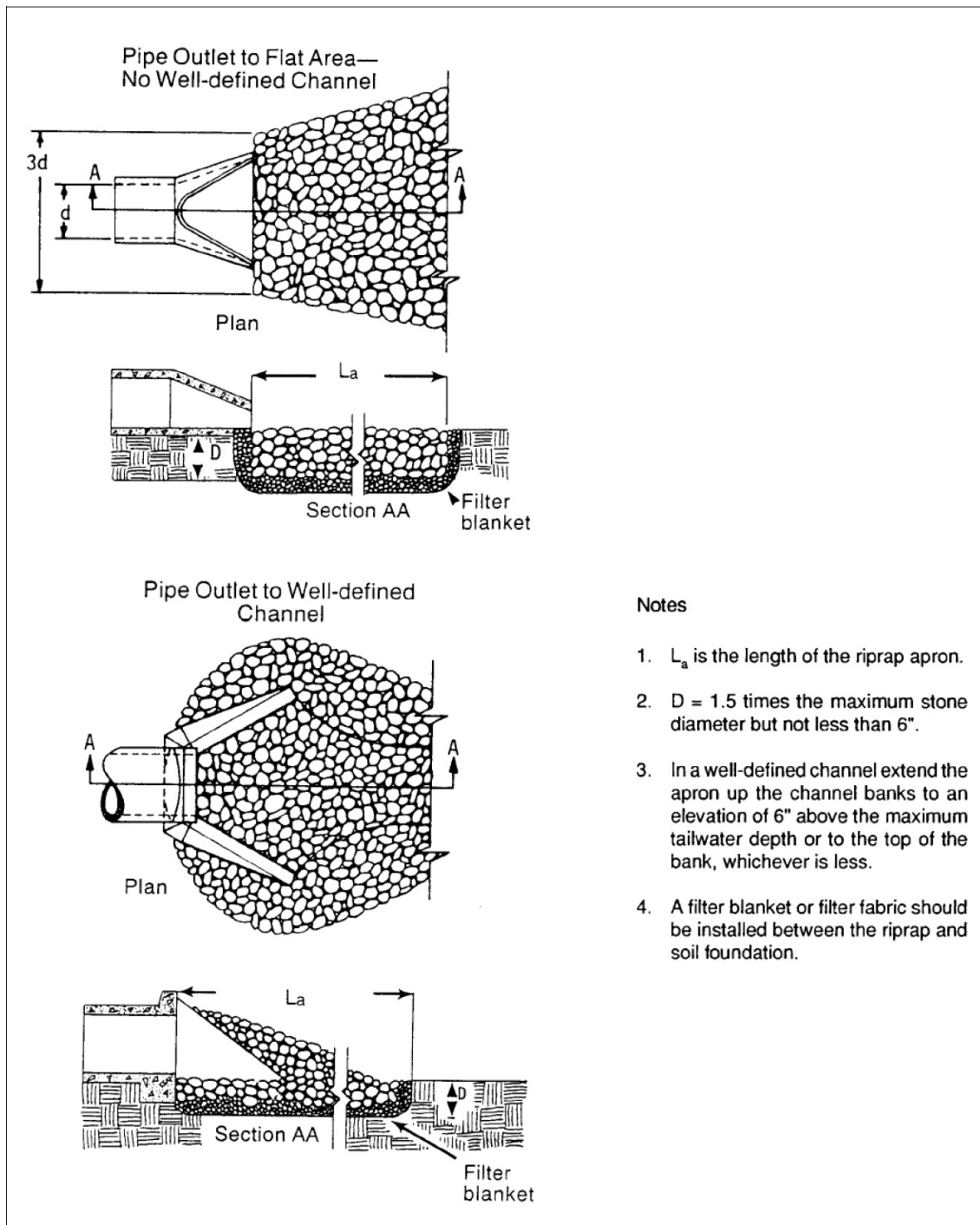
**Figure CS-9 – Riprap Apron Sizing for a Round Pipe Flowing Full,  
Maximum Tailwater Condition ( $T_w \geq 0.5$  diameter) (SCS, 1975)**



Curves may not be extrapolated.

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Figure CS-10 – Riprap Apron Detail (MESCG, 1996)



Notes

1.  $L_a$  is the length of the riprap apron.
2.  $D = 1.5$  times the maximum stone diameter but not less than 6".
3. In a well-defined channel extend the apron up the channel banks to an elevation of 6" above the maximum tailwater depth or to the top of the bank, whichever is less.
4. A filter blanket or filter fabric should be installed between the riprap and soil foundation.

### **8.13 BMP EC-7 Temporary and Permanent Revegetation**

#### Description

Erosion is caused by rainfall impact detaching soil particles and runoff carrying the particles downslope. Vegetation (seeded or sodded) can hold the soil particles in place and protect against erosion.

#### Applicability

Any area of a construction site that the natural vegetation has been removed. Seeding or sodding can be used as a temporary or a permanent erosion control measure.

#### Topsoil and Seedbed Preparation

Areas to be revegetated shall have soils capable of supporting vegetation. Overlot grading will oftentimes bring to the surface subsoils that have low nutrient value, little organic matter content, few soil microorganisms, rooting restrictions, and conditions less conducive to infiltration of precipitation. As a result, rototilling and adding topsoil, compost, and other soil amendments can be essential to achieve successful revegetation.

Topsoil should be salvaged during grading operations and used for spreading on areas to be revegetated later. Topsoil shall be viewed as an important resource to be utilized for vegetation establishment, primarily due to its water-holding capacity. Native topsoil located on a construction site also has good soil structure, organic matter content, biological activity, and nutrient supply that support vegetation.

At a minimum, the upper six (6) inches of topsoil can be stripped and stockpiled, and respread to a thicker depth on surfaces not planned for buildings or impervious areas. Stockpiled soils shall be seeded with a temporary or permanent grass cover. Mulching is recommended to ensure vegetation establishment. If stockpiles are located within one hundred (100) feet of a waterway, additional sediment controls, such as diversion dikes or embedded silt fences, should be provided.

If the soils have become compacted, they shall be loosened to a depth of at least six (6) inches.

Soil roughening will assist in placement of a stable topsoil layer on steeper slopes, and allow percolation and root penetration to greater depth. Soil roughening techniques shall be used for slopes greater than 3:1 (33%).

Where topsoil is not available or utilized, subsoils can be treated to provide a plant-growth medium. Organic matter, such as well digested compost, can be added to improve nutrient levels necessary for plant growth. Other treatments, such as liming, can be used to adjust soil pH conditions when needed. If the pH of the soil is less than 6, lime shall be added to the top six (6) inches of soil. Soil testing needs to be done to determine appropriate amendments required.

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Fertilizer (10-10-10) shall also be incorporated into the top six (6) inches of soil at a rate of 100 lb/acre.

A suitable seedbed will enhance the success of revegetation efforts. The surface should be rough and the seedbed should be firm, but neither too loose nor compacted. The seed bed should be loose, without large clods, and uniform before seeding. The upper layer of soil should be in a condition suitable for seeding at the proper depth and conducive to plant growth.

### Temporary Revegetation

The appropriate temporary vegetation for a site is dependent upon the time of year. Prior to application of seed, grading of the site shall be complete including all erosion and sediment control practices.

Soil which is exposed for more than fourteen (14) days with no construction activity shall be seeded, mulched, or re-vegetated. All temporary seeding shall be protected with mulch.

Typical broadcast rates for temporary vegetation are listed in [Table 8.1](#) below.

**Table CS-6 – Temporary Seeding Planting Materials**

Species	Planting Dates		Broadcast Rate (lb/acre)	Plant Characteristics
Oats	2/1 – 5/30	8/1 – 9/30	80	not cold tolerant
Rye/Wheat	1/1 – 5/31	7/15 – 11/15	90 / 120	cold tolerant
Millet/ Sudangrass	5/1 – 8/15	---	45 / 60	warm season
Annual Ryegrass	1/1 – 5/31	7/15 – 9/30	75	not heat tolerant
Annual Lespedeza plus Tall Fescue	5/1 – 8/15	---	15 / 45	warm season

(Adapted from MAACD, 1998)

### Permanent Revegetation

Permanent seeding is the process of establishing permanent vegetative cover through the use of perennial seed mix to control runoff and erosion on disturbed areas. Permanent revegetation protects bare soil surfaces from raindrop impact and reduces the velocity and volume of overland flow.

Permanent seeding should be considered for any disturbed area where all construction or maintenance activities have ceased for a period of one (1) year or longer, or for areas where all construction has been finalized and is now ready for permanent vegetative cover.

All permanent seeding shall be protected with mulch. Mulch is required to protect seeds from

heat, moisture loss, and transport due to runoff.

Vegetation is not considered established until a ground cover is achieved which is equivalent to at least 80% of the previously existing vegetation and is sufficiently mature to control soil erosion and can survive severe weather conditions.

Each site will have different characteristics, and a landscape professional should be contacted to determine the most suitable species or seed mix for a specific site. The recommended seed mix will depend on site specific information such as elevation, exposure, soils, water availability, and topography. Seeding shall be done at the proper time of year, and the proper application of fertilizers will contribute to the success of the seeding.

In lieu of a specific recommendation and for planning purposes, one of the perennial grass species appropriate for site conditions listed in Table 8.2 can be used. The seeding rates of application recommended in these tables are considered to be absolute minimum rates for seed applied using proper drill-seeding equipment. Appropriate seeding dates are also provided in Table 8.2.

**Table CS-7 – Seeding rates and timing for turfgrasses in Arkansas  
(Univ. of Arkansas Cooperative Extension Service FSA2113)**

Perennial Grass Species	Area of Adaptatio	Seeding Rate lbs/1,000 sq	Days to Germinat	Planting Time
Tall fescue + Kentucky bluegrass	North	5.0 to 7.0	5 to 21	September-October preferred
Tall fescue	Central, North	8.0 to 10.0	5 to 10	September-October preferred (or early spring)
Bermudagrass	Statewide	0.5 to 1.0	7 to 14	May-June
Centipedegrass	South	0.25 to 0.5	7 to 14	May-June
Zoysiagrass	Statewide	1.0 to 2.0	10 to 21	May-June
Annual or perennial ryegrass	Statewide	6.0 to 10.0	5 to 8	September-November

Limitations

Vegetation is not appropriate for heavily trafficked areas (vehicular and pedestrian) and is not appropriate for rocky, gravelly, or coarse grained soils. For these types of soils, apply six (6) inches of clean topsoil before seeding.

Permanent seeding may only be applied during planting season. Temporary cover is required until that time.

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## Maintenance Requirements

Vegetated areas shall be protected from runoff from adjacent areas and traffic (vehicular and pedestrian).

Permanent seeding is the last phase of reclaiming any disturbed soils. Inspect all seeded areas on a regular basis and after each major storm event to check for areas where corrective measures may have to be made. Indicate which areas need to be reseeded or where other remedial actions are necessary to assure establishment of permanent seeding. Continue monitoring the site until permanent vegetation is established. Until established, the vegetation will require fertilization and water.

## **8.14 BMP EC-8 Wind Erosion or Dust Control**

### Description

Wind erosion or dust control consists of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

### Applications

Wind erosion control BMPs are suitable for construction vehicle traffic on unpaved roads, for drilling and blasting activities, for sediment tracking onto paved roads, for soil and debris storage piles, for batch drops from front-end loaders, for areas with unstabilized soil, and for final grading and site stabilization.

### Limitations

Watering only prevents dust for a short period of time and should be applied daily (or more often) to be effective.

Over watering may cause erosion.

The effectiveness of wind erosion control depends on soil, temperature, humidity, and wind velocity.

### Implementation

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel or asphalt surfacing, temporary gravel construction entrances, equipment washout areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no

construction traffic. Preventative measures would include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to fifteen (15) mph, and controlling the number and activity of vehicles on a site at any given time.

#### Maintenance

Most dust control measures require frequent, often daily, or multiple times per day attention.

(Source: California Stormwater BMP Handbook, January 2003)

### **8.15 BMP EC-9 Hydroseeding / Hydromulching**

#### Description

Hydroseeding typically consists of applying a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydromulch equipment, to temporarily protect exposed soils from erosion by water and wind and provide an environment conducive to plant growth. Hydromulching is applying a slurry of water, wood fiber mulch, and often a tackifier, to prevent soil erosion. These terms are often used interchangeably. For our purposes we will refer to hydroseeding only in this section, but all information shared below can and should be applied to hydromulching if its application is warranted in a design.

#### Applications

Hydroseeding is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established. Hydroseeding is also suitable for disturbed areas that will be re-disturbed following an extended period of inactivity.

#### Implementation

In order to select the appropriate hydroseeding mixture, an evaluation of site conditions shall be performed with respect to soil conditions, site topography, season and climate, vegetation types, maintenance requirements, sensitive adjacent areas, water availability, and plans for permanent vegetation.

Prior to application, roughen the area to be seeded with the furrows trending along the contours.

Hydroseeding can be accomplished using a multiple step or one step process. The multiple step process ensures maximum direct contact of the seeds to soil. When the one step process is used to apply the mixture, the seed rate shall be increased to compensate for all seeds not having direct contact with the soil.

Follow up applications shall be made as needed to cover weak spots and to maintain adequate soil protection.

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Avoid over spray onto roads, sidewalks, drainage channels, and existing vegetation.

### Limitations

Hydroseeding may be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and coverage to provide adequate erosion control. Otherwise, hydroseeding must be used in conjunction with mulching.

Steep slopes are difficult to protect with temporary seeding.

Temporary vegetation may have to be removed before permanent vegetation is applied.

Temporary vegetation is not appropriate for short term inactivity.

### Maintenance

Hydroseeding BMPs, along with irrigation systems, shall be inspected prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

Where seeds fail to germinate, or they germinate and die, the area must be re-seeded, fertilized, and mulched within the planting season, using not less than half the original application rates.

(Source: California Stormwater BMP Handbook, January 2003)

## **8.16 BMP EC-10 Surface Roughening**

### Description

Water flowing down a bare slope will erode soil and transport soil to the bottom of the slope. Surface roughening provides temporary stabilization of disturbed areas from wind and water erosion.

Soil roughening is the practice of increasing the roughness of exposed soil by making grooves, tracks, or terraces (stair-steps) which run perpendicular to the flow path (parallel to slope) slowing flow and trapping sediment.

### Applications

Soil roughening can be used on a wide variety of slopes and in conjunction with seeding and mulching.

Soil roughening is particularly useful where temporary revegetation cannot be immediately established due to seasonal planting limitations.

### Design Criteria

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Surface roughening shall be performed after final grading. Fill slopes can be constructed with a roughened surface. Cut slopes that have been smooth graded can be roughened as a subsequent operation. Roughening ridges and depressions should follow along the contours of the slope.

Tracking with lugged tracked equipment is appropriate on sandy material so as to not excessively compact the soil.

Grooving can be accomplished using a plow with the furrows three (3) inches deep and less than fifteen (15) inches apart.

Terraced (stair-stepping) slopes shall have the vertical cuts no more than two (2) feet deep and the horizontal steps shall be wider than the depth of the vertical cut. The horizontal step shall slope backward to the vertical cut upslope on the hill.

The slope shall be seeded immediately after roughening and mulch or chemical stabilization should be utilized where appropriate.

### Limitations

Soil roughening should not be used on rocky soils or soils that are high in clay content. Tracking may cause excessive compaction which can lead to greater erosion.

Care should be taken not to drive vehicles or equipment over areas that have been roughened. Tire tracks will smooth the roughened surface and encourage runoff to collect into rills and gullies. As surface roughening is only a temporary control, additional treatments may be necessary to maintain the soil surface in a roughened condition.

### Maintenance Requirements

Roughened slopes shall be inspected after ½ inch and greater storms and problem areas noted. After a rain event, slopes may need reconstruction, re-roughening, re-seeding, and re-mulching.

## **8.17 BMP EC-11 Temporary Slope Drain**

### Description

Gullying and excessive erosion will take place on slopes subjected to concentrated flows of runoff.

Slope Drains are conduits (open or closed) used to direct water down a slope while protecting the slope from erosion.

### Applicability

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Slopes with the potential for intended or unintended concentrated flows.

### Design Criteria

Slope drains (rundowns, pipe slope drains, etc.) should be placed where runoff from uphill drainage areas will concentrate. Slope drains shall be sized to handle a 10-year storm from an area no greater than five (5) acres. Minimum size for a pipe slope drain is 18-inch diameter. Appropriate energy protection should be placed at the outlet of the pipe. Slope rundowns (stone or riprap lined channels) should be constructed with the middle sufficiently lower than the sides to ensure flow stays in the rundown. Slope drains operate best when used in conjunction with interceptor swales and dikes on the top of the slope. The discharge from all slope drains must be directed to a stabilized outlet, temporary or permanent channel, or sediment basin.

### Limitations

For larger storms, the slope drain may not operate properly and can cause excessive gullying and slope erosion as well as damage to the construction site. Slope drains that are improperly designed or constructed such that the flow does not stay in the drain will cause excessive erosion.

### Maintenance Requirements

Slope drains shall be inspected weekly and kept clear of trash, debris, and vegetation.

## **8.18 BMP EC-12 Temporary Stream Crossings**

### Description

A temporary stream crossing is a temporary culvert, ford, or bridge placed across a waterway to provide access for construction purposes. Temporary stream crossings are not intended to maintain traffic for the public. The temporary access will eliminate erosion and downstream sedimentation caused by vehicles.

### Applications

Temporary stream crossings shall 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 stream crossings shall be installed at sites when alternate access routes impose significant constraints, when crossing perennial streams or waterways causes significant erosion, and when appropriate permits have been obtained for the stream crossing (such as Corps of Engineers 404 permit).

### Implementation

Temporary stream crossings are used 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 shall be established by a professional engineer registered in the State of Arkansas. Design and installation requires knowledge of stream flows and soil strength. Both hydraulic and construction loading requirements should be considered.

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 – Fords are appropriate during the dry season and on 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.
- Bridges – Bridges are appropriate for streams and high flow velocities, steep gradients, and where temporary restrictions in the channel are not allowed.

The temporary stream crossing should be located where erosion potential is low. They should be constructed during dry periods to minimize stream disturbance and reduce costs.

Temporary stream crossings should be constructed at or near the natural elevation of the streambed to prevent potential flooding upstream of the crossing.

A culvert crossing should be designed to pass at least the 2-year design flow accounting for the headwater and tailwater controls to meet its design capacity.

When a ford needs to and can be used, namely a culvert is not practical or the best solution, it shall be lined with at least a twelve (12) inch thick layer of 6" riprap ( $D_{50}$ ) or 9" riprap ( $D_{50}$ ) with void spaces filled with 1-1/2 inch diameter rock.

### Limitations

Installation and removal of the temporary stream crossings usually disturb the waterway, therefore additional BMPs will be required to minimize soil disturbance.

Appropriate permits will need to be obtained for the fill associated with temporary stream crossings (such as a Corps of Engineers 404 permit).

Installation may require dewatering or temporary diversion of the stream.

Fords shall only be used in dry weather.

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Temporary stream crossings are not intended to maintain traffic for the public, only for construction purposes.

### 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.

Check for blockage in the channel, sediment buildup or trapped debris in culverts, and for blockage behind fords or under bridges. Remove sediment that collects behind fords, in culverts, and under bridges periodically.

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 temporary crossings promptly when they are no longer needed.

## **8.19 BMP EC-13 Level Spreader**

### Description

A level spreader receives concentrated flow from channels, outlet structures, or other conveyance structures and converts them to sheet flow. Although a level spreader by itself is not considered a pollutant reduction device, it improves the efficiency of other facilities, such as vegetated swales, filter strips, or infiltration devices, which are dependent on sheet flow to operate properly. The slight depression allows water to collect and then disperse uniformly over the surrounding vegetated area to reduce erosion and concentrated stormwater runoff.

### Applications

Level spreaders are used in wide, level areas where concentrated runoff occurs. The level spreader converts the concentrated runoff to sheet flow and releases it onto an area stabilized by vegetation. Flows to the spreader should be relatively free of sediment or the spreader will be quickly overwhelmed by sediment and lose its effectiveness.

### Implementations

The spreader should be constructed absolutely level. Height of the spreader is based on depth of design flow, allowing for sediment and debris deposition. The length of the spreader is based on the design flow for the site.

The slope leading to the level spreader shall be less than one (1%) percent for at least twenty (20) feet immediately upstream in order to keep velocities less than two (2) feet per second at the spreader during the 10-year storm event. Slope of the outlet from the spreader shall be six (6%) percent or less.

#### Limitations

If the spreader is not absolutely level, flows will concentrate at the low point and may cause more problems than if no level spreader were used.

The drainage area shall be limited to five (5) acres or forty (40) cubic feet per second (cfs).

#### Maintenance

Regular inspection and maintenance is essential to ensure sheet flow discharge and to avoid channeling across the crest of the depression. The level spreader shall be inspected regularly and after large rainfall events. Inspection shall note and repair any erosion and low spots in spreader. Sediment shall be removed from behind spreader.

### **8.20 BMP SC-1 Stabilized Construction Entrance/Exit**

#### Description

Mud and sediment carried off-site on the tires of equipment and vehicles will be deposited on the neighboring streets. This sediment will end up in the local streams if not swept up.

Construction Entrances are systems that clean vehicles of mud, sediment, and aggregate prior to leaving the site.

#### Applicability

Any entrance/exit of a construction site.

#### Design Criteria

A six (6) inch layer of B-stone (ranging in size from 1-1/2" minimum to 6" maximum, where the stone shall be uniformly graded and the amount passing the 1-1/2" sieve shall be not more than 10% by weight) can be used to stabilize construction site entrances. The stabilized construction entrance shall be a minimum length of twenty percent (20%) of the lot depth or fifty (50) feet, whichever is greater, up to a maximum of one hundred (100) feet and of adequate thickness to minimize tracking onto the city street. The stabilized construction entrance shall be at least 50 feet long. The entrance shall be as long as the longest vehicle that will enter the site. If larger volumes of traffic are expected, a two-lane entrance is appropriate.

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Construction access shall be limited to locations as approved by the City of Rogers.

A stabilized construction entrance and a dunk or mechanical wheel wash are required on all sites.

Other methods of removing mud from vehicles may be acceptable such as rumble strips (cattle guard, logs, etc.).

A dunk wheel wash is a water filled, stabilized (1 inch or greater gravel or stone) pit. The water depth shall be at least two feet deep and the pit shall be at least 20 foot long. The pit shall be two vehicle lengths from the construction site exit and the entrance and exit to the pit shall be stabilized. These shall be provided on all sites. If there is not enough room to install a dunk wheel wash, a hand-operated pressure wash may be used instead with the approval of the city.

### Limitations

In order to avoid puncturing tires, stabilized entrances shall not be constructed with sharp edge stones.

### Maintenance Requirements

Stabilized entrances require periodic cleaning or addition of stone as the voids in the stones fill with mud and sediment.

Wheel wash facilities and rumble strips will need to be cleaned as the pits fill in order to provide more room to store new mud and sediment.

The street in front of the entrance shall be cleaned as required to remove sediment that has been tracked off site.

Whenever sediment is transported onto a public road, regardless of the size of the site, the road shall be cleaned immediately. Sediment shall be removed from roads by shoveling and sweeping and be transported to a controlled sediment disposal area. Washing of the street with a water hose or flushing the water downstream shall not be allowed.

## **8.21 BMP SC-2 Embedded Silt Fence**

### Description

Water flowing in sheet or shallow flow will carry sediment down a slope and off-site.

An embedded silt fence is a barrier made of geotextile fabric placed along a contour to capture water, slow the flowrate, trap sediment, and allow water to filter through the fabric.

### Applications

Small drainage areas with sheet flow or shallow flow.

### Design Criteria

## CONSTRUCTION SITE STORMWATER MANAGEMENT

The embedded silt fence shall be placed on a contour and designed to hold runoff from the 10 year storm from an area of 100 sq. ft for each foot of fence. The maximum depth of retained water on the upstream side of the fence shall be two (2) feet. The maximum slope length above the fence shall be no more than one hundred (100) feet. The maximum slope above the fence is 3:1.

The fabric shall be buried in a trench that is at least eight inch deep and eight inches wide. The fabric shall be place on the upstream side of the posts.

Post shall be made of metal (T-post) or wood (2"x2") and placed no more than six feet apart.

All embedded silt fence shall be wire-backed except when used as inlet protection.

### Limitations

Silt fence must be embedded or it will not function properly and should not be installed in rocky soil where it cannot be properly embedded.

Silt fence is not designed to hold back concentrated flow and therefore shall not be placed across channels, gullies, or streams.

Silt fence shall not be run down slopes as it will concentrate flow causing gully erosion and causing downstream BMPs to fail.

### Maintenance Requirements

The embedded silt fence shall be inspected weekly and after one-half (1/2) inch or greater rainfalls for proper installation, defective fencing, erosion on the ends, and excessive sediment buildup behind the fence (half the fence height). Any sediment accumulated behind them must be removed and disposed of properly. Any defective measures shall be repaired or replaced within 24 hours.



**Photograph CS-4 – Example of Silt Fencing**

## **8.22 BMP SC-3 Inlet Protection**

### Description

Runoff from a construction site often carries sediment into the stormwater sewer system, which discharges into local streams. Besides the problems caused by sediment, other pollutants (e.g. oil, grease, and nutrients) are often attached to the sediment.

Inlet Protection is the practice of placing gravel, sand bags, silt fence or other proprietary systems around or in an inlet to allow runoff to pond and sediment to settle out prior to entering the stormwater sewer system.

### Applications

Any storm drain inlet that could receive runoff from the construction site.



**Photograph CS-5 – Example of Inlet Protection**

Design Criteria

If silt fence is used as the dam material, the post shall be driven at the edge of the inlet and shall be no greater than three (3) feet apart. The fence should be installed according to the Silt Fence Inlet Protection detail.

For inlets in paved areas, either gravel, sandbags, or wattles should be used as the dam material. If gravel is to be used as the dam material, the gravel shall be at least one (1) inch in diameter. The dam shall be no higher than one (1) foot high and the side shall have no greater than a 2:1 (horizontal:vertical) slope. If sandbags are used as the dam material, the bags shall be no heavier than fifty (50) pounds and shall be stacked no higher than three (3) bag diameters high, with the bags layered in a pyramid formation.

For inlets located in sump, it is important that the inlet continue to function while reducing the amount of sediment entering it. This can be accomplished for a curb opening or combination inlet in a sump by setting the maximum height of the protective barrier lower than the top of the curb opening. This allows overflow to occur during larger rainfall events even though sediment-laden runoff will enter the storm drainage system. If the inlet protection height is greater than the curb elevation, particularly if the filter is clogged from previous sediment deposits, runoff will not enter the inlet and can bypass it, possibly causing more downstream erosion and damage than would occur without inlet protection. Area inlets located in a sump setting can be protected through the use of geotextile, concrete block and gravel filter, sandbags, excavated sediment trap, or “rock socks” imbedded in the adjacent soil and stacked around the area inlet.

## DRAINAGE CRITERIA MANUAL

For inlets located along a slope, it is best not to use the details described above, since the flows in the gutter will merely bypass the inlet. A more effective approach is to control sediment along a sloping street by trapping it before it enters the inlet, which can be done fairly effectively, but not completely, through the use of gravel “socks”, triangular silt dikes, or other proprietary products placed upstream of the inlet.

### Limitations

Inlet protection control measures are not capable of handling large quantities of sediment and can require maintenance during rain events in order to protect nearby facilities and to eliminate flooding. Ponding can cause flooding problems for surrounding facilities.

If the flow entering the inlet is being directed to a sedimentation basin, no such inlet protection is needed. In those cases it is much more effective to drop out sediment at the sedimentation basin rather than creating a condition where the stormwater cannot enter the inlet and continues to move downstream, eventually overflowing into the waterway in an uncontrolled fashion.

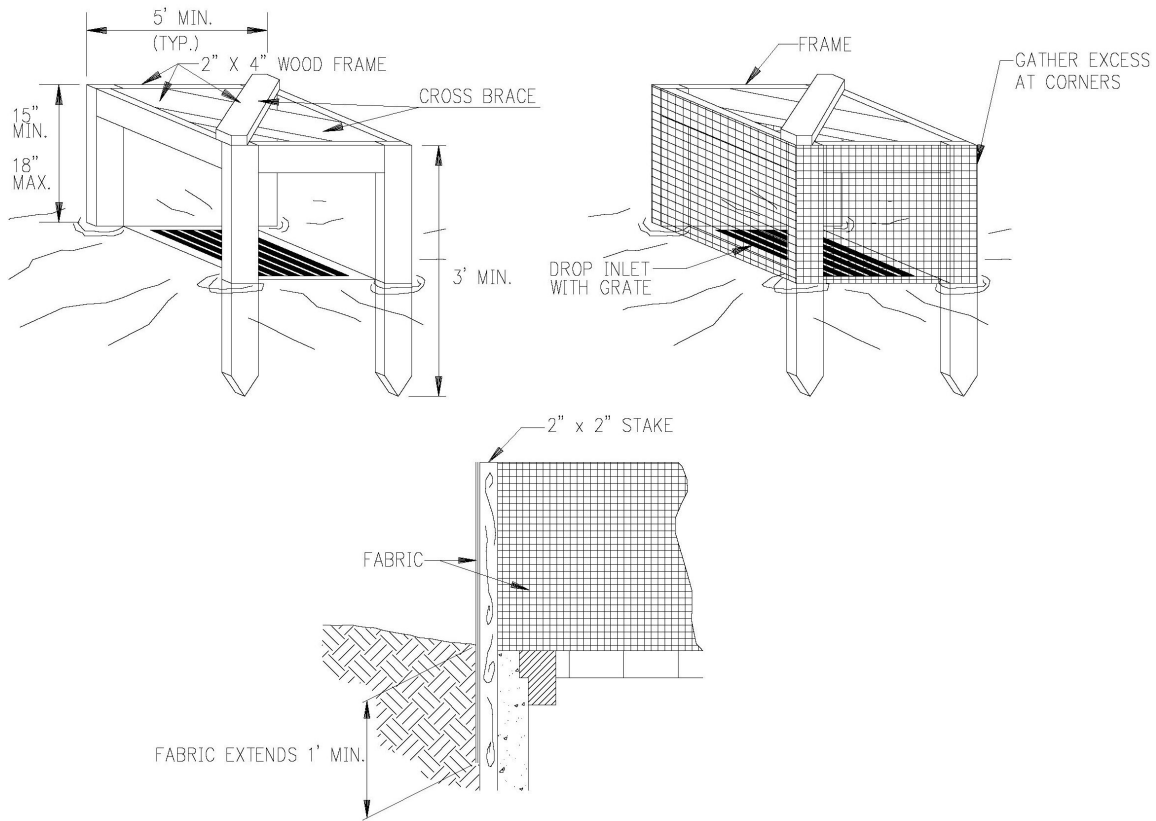
### Maintenance Requirements

Inlet protection measures should be inspected during storm events to ensure surrounding facilities are not flooded.

Inlet protection measures shall be inspected weekly and after one-half (1/2) inch or greater rainfalls for proper installation, defective fencing, erosion, and excessive sediment buildup and defective measures repaired or replaced within 24 hours.

**Figure CS-11 – Silt fence inlet protection detail**

# CONSTRUCTION SITE STORMWATER MANAGEMENT



## 8.23 BMP SC-4 Chemical Treatment

### Description

Chemical treatment includes the application of chemicals to stormwater to aid in the reduction of turbidity caused by fine suspended solids.

### Applications

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants and should be considered where turbid discharges to sensitive waters cannot be avoided using other BMPs. Typically, chemical use is limited to waters with numeric turbidity standards.

### Implementation

Turbidity is difficult to control once fine particles are suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are ineffective at removing smaller particulates such as clay and fine silt. Chemical treatment may be used to reduce the turbidity of stormwater runoff. Very high turbidities can be reduced to levels comparable to what is found in streams during dry weather.

## DRAINAGE CRITERIA MANUAL

Chemically treated stormwater discharged from construction sites must be non-toxic to aquatic organisms.

### Maintenance

Chemical treatment systems must be operated and maintained by individuals with expertise in their use. Chemical treatment systems should be monitored continuously while in use.

(Source: California Stormwater BMP Handbook, January 2003)

## **8.24 BMP SC-5 Sediment Trap**

### Description

Water carrying sediment off-site can cause damage to neighboring property and local streams. Sediment Traps provide an area for sediment to settle out of the runoff prior to discharge from the site.

### Applications

Sediment traps are well suited for sites that will be required to have a permanent stormwater control basin; but, should be used for any concentrated flow (culvert, pipe, swale, etc.) that could have sediment in the runoff leaving the site.

### Design Criteria

The removal efficiency of sediment traps is a function of the total surface area of the pond, the shape of the pond, the influent flow rate, and the type of soil in the runoff. The maximum drainage area for a sediment trap shall be three (3 acres), for larger areas a sediment basin shall be used.

The minimum bottom area and spillway width for sediment traps are given in the Table 8.4 below. The berm or levee shall curve upstream to hold the water; the berm shall have 3:1 side slopes (maximum) and have a maximum depth of three (3) feet. The outlet spillway shall be made of six (6) inches of stone (6 inch diameter minimum) and be placed on a geotextile fabric, or approved equal, in lieu of rip rap.

**Table CS-8 – Minimum Sediment Trap Dimensions**

<b>Drainage Area (acres)</b>	<b>Minimum Bottom Area (square feet)</b>	<b>Overflow Spillway Width (ft)</b>
<b>1 or less</b>	<b>250</b>	<b>6</b>
<b>1 to 2</b>	<b>675</b>	<b>12</b>
<b>2 to 3</b>	<b>1500</b>	<b>18</b>

Limitations

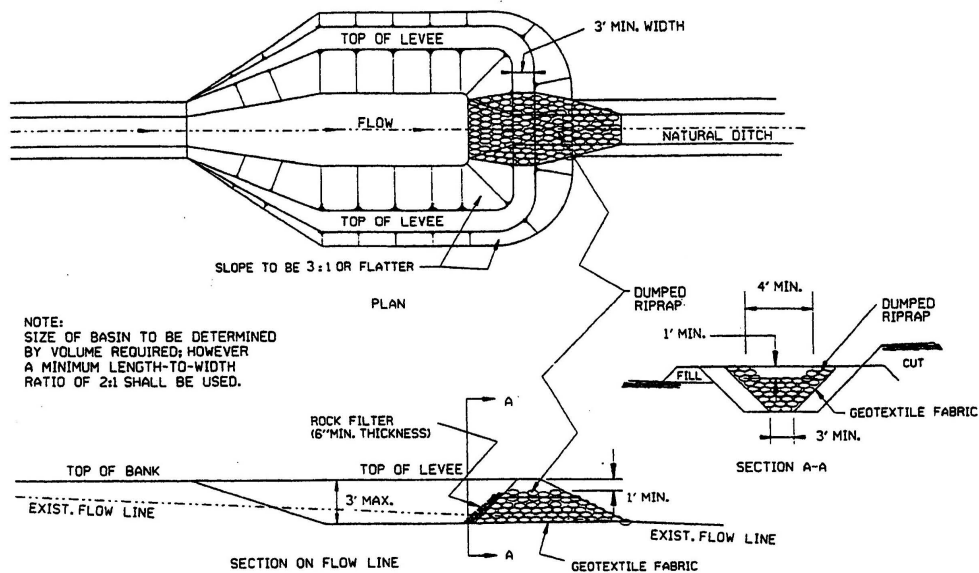
Sediment Traps do not have sufficient surface area to allow for settling of very small particles (e.g. clay, silt).

Sediment Traps are not appropriate for runoff from areas greater than three (3) acres.

Maintenance

Sediment Traps shall be inspected weekly and after one-half (1/2) inch or greater rainfalls for proper installation, erosion, and excessive sediment buildup and defective measures repaired or replaced within 24 hours.

**Figure CS-12 – Sediment trap detail (Adapted from: AHTD, 2001)**



**8.25 BMP SC-6 Sediment Basin**

Description

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before runoff is discharged.

Applications

Sediment basins should be considered for use when the drainage area is three (3) acres or more,

## DRAINAGE CRITERIA MANUAL

for smaller areas a sediment trap shall be used.

Sediment basins should be considered where post construction detention basins are required.

### Implementation

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins shall be located at the stormwater outlet from the site, but not in a natural or undisturbed stream.

Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.

The volume of the sediment basin shall be three-thousand (3,000) cubic feet per acre for property with average slope greater than five percent (5%), or fifteen-hundred (1,500) cubic feet per acre for property with an average slope less than five percent (5%). A properly sized sediment basin is required for each separate drainage area within the property being developed.

The outlet from a sediment basin shall be designed to empty its volume over an extended period of time. This is needed to permit the smaller sediment particles to settle to the bottom of the basin.

### Maintenance

Sediment basins shall be inspected weekly and after one-half (1/2) inch or greater rainfalls for proper installation, erosion, and excessive sediment buildup and defective measures repaired or replaced within 24 hours.

Check inlet and outlet structures for any damage, obstructions, or erosion. Repair damage and remove obstructions as needed. The sediment basin must be maintained until final stabilization of the site.



**Photograph CS-6 – Example of Sediment Basin with Stone Outlet**

## **8.26 BMP SC-7 Compost Filter Socks**

### Description

A compost filter sock is a type of contained compost filter berm. It is a mesh tube filled with composted material that is placed perpendicular to sheet flow runoff to control erosion and retain sediment in disturbed areas. The compost filter sock is oval to round in cross section, and it provides a three-dimensional filter that retains sediment and other pollutants while allowing the cleaned water to flow through. The filter sock can be used in place of a traditional sediment and erosion control tools, such as a silt fence.

### Applications

Compost filter socks can be used on disturbed sites where stormwater runoff occurs as sheet flow.

### Implementation

Compost filter socks are generally placed along the perimeter of a site, or at intervals along a slope, to capture and treat stormwater that runs off as sheet flow. They can be laid adjacent to each other, perpendicular to stormwater flow, to reduce flow velocity and soil erosion. They can be used on pavement as inlet protection.

No trenching is required; therefore, soil is not disturbed upon installation. Once the filter sock is filled and put in place, it shall be anchored to the slope. The preferred anchoring method is to

## DRAINAGE CRITERIA MANUAL

drive stakes through the center of the sock at regular intervals; alternatively, stakes can be placed on the downstream side of the sock. The ends of the filter sock shall be directed upslope, to prevent stormwater from running around the end of the sock. The filter sock may be vegetated by incorporating seed into the compost prior to placement in the filter sock. Since compost filter socks do not have to be trenched into the ground, they can be installed on frozen ground or even pavement.

### Limitations

The drainage areas for compost filter sock use shall not exceed 0.25 acre per 100 feet of device length and flow shall not exceed one (1) cubic foot per second. To ensure optimum performance for compost filter socks, heavy vegetation should be cut down or removed and extremely uneven surfaces should be leveled to ensure that the compost filter sock uniformly contacts the ground surface. Filter socks can be installed perpendicular to flow in areas where a large volume of stormwater runoff is likely, but should not be installed perpendicular to flow in perennial waterways and large streams.

### Maintenance

Compost filter socks shall be inspected regularly, as well as after each rainfall event, to ensure that they are intact and the area behind the sock is not filled with sediment.

If there is excessive ponding behind the filter sock or accumulated sediments reach the top of the sock, an additional sock shall be added on top or in front of the existing filter sock.

If the filter sock was overtopped during a storm event, the operator should consider installing an additional filter sock on top of the original, placing an additional filter sock further up the slope, or using an additional BMP, such as a compost blanket.

(Source: US Environmental Protection Agency)

## 8.27 BMP SC-8 Fiber Rolls/Wattles

### Description

Fiber rolls help reduce sediment loads to receiving waters by filtering runoff and capturing sediments.

Fiber rolls (also called fiber logs or straw wattles) are tube-shaped erosion control devices filled with straw, flax, rice or coconut fiber material. Each roll is wrapped with a UV-degradable polypropylene netting for longevity or with 100 percent biodegradable materials like burlap, jute, or coir. Fiber rolls also help to slow, filter, and spread overland flows. This helps to prevent erosion and minimizes rill and gully development. Fiber rolls also help reduce sediment loads to receiving waters by filtering runoff and capturing sediments.



**Photograph CS-7 – Example of Fiber Roll/Wattle**

### Applications

Fiber rolls can be used along the toe, top, face, and at-grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow. They can be used along the perimeter of a project, as check dams in unlined ditches, downslope of exposed soil areas, and around temporary stockpiles.

### Implementations

Fiber rolls should be prefabricated rolls or rolled tubes of geotextiles fabrics. When rolling the tubes, make sure each tube is at least eight (8) inches in diameter. Bind the rolls at each end and every four (4) feet along the length of the roll with jute-type twine.

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On slopes, install fiber rolls along the contour with a slight downward angle at the end of each row to prevent ponding at the midsection. Turn the ends of each fiber roll upslope to prevent runoff from flowing around the roll. Fiber rolls should be installed in shallow trenches.

### Limitations

Fiber rolls are not effective unless trenched.

If not properly staked and entrenched, fiber rolls can be transported by high flows.

Fiber rolls have a very limited sediment capture zone.

Fiber rolls can be difficult to move once saturated.

### Maintenance

Inspect fiber rolls to ensure that they remain firmly anchored in place and are not crushed or damaged by equipment traffic. Monitor fiber rolls daily during prolonged rain events. Repair or replace split, torn, unraveled, or slumping fiber rolls.

(Source: US Environmental Protection Agency)

## **8.28 BMP SC-9 Gravel Bag Berms**

### Description

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out. They also release runoff slowly to prevent erosion.

### Applications

Gravel bag berms are suitable for sediment control when placed down slope of exposed soil areas, as sediment traps at pipe outlets, along the perimeter of a site, around temporary stockpiles, parallel to a roadway to keep sediment off paved areas, and along streams and channels.

Gravel bag berms are suitable for erosion control when placed at the top of slopes to divert runoff away from disturbed slopes, when placed along the face and at grade breaks of exposed and erodible slopes to shorten length and spread runoff as sheet flow, and as check dams across mildly sloped construction roads.

### Implementations

Gravel bag berms are to be placed on level contours. For slopes between 20:1 and 2:1 (horizontal:vertical), gravel bags should be placed at a maximum interval of fifty (50) feet. For

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slopes 2:1 (horizontal:vertical) or steeper, gravel bags should be placed at a maximum interval of twenty-five (25) feet. Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm. Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage. Use a pyramid approach when stacking bags.

### Limitations

Gravel bag berms may not be appropriate for drainage areas greater than five (5) acres.

Runoff will pond upstream of the berm, possibly causing flooding if sufficient space does not exist.

Installation can be labor intensive.

### Maintenance

Gravel bag berms shall be inspected prior to forecasted rain, daily during extended rain events, after rain events, and at two (2) week intervals during the non-rainy season.

Gravel bags exposed to sunlight will need to be replaced every two (2) or three (3) months due to the degrading of the bags.

Sediment shall be removed when the sediment accumulation reaches one-third (1/3) of the barrier height.

Remove gravel bag berms when no longer needed.

(Source: California Stormwater BMP Handbook, January 2003)

## **8.29 BMP SC-10 Vegetative Buffers**

### Description

Vegetative buffers are areas of natural or established vegetation to protect the water quality of neighboring areas. Buffer zones slow stormwater runoff, provide an area where runoff can permeate the soil, contribute to ground water recharge, and filter sediment. Slowing runoff also helps to prevent soil erosion and stream bank collapse.

### Applications

Vegetated buffers can be used in any area able to support vegetation. They are most effective and beneficial on floodplains, near wetlands, along stream banks, and on unstable slopes.

### Implementations

Most vegetation will be removed from a construction site during clearing and grading operations. A perimeter buffer strip shall be temporarily maintained around disturbed areas for erosion control

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purposes and shall be kept undisturbed except for reasonable access for maintenance. The width of this strip shall be six percent (6%) of the lot width and depth. The minimum width shall be twenty-five (25) feet and the maximum shall be forty (40) feet. In no event shall these temporary buffer strips be less than the width of the permanent buffers required for the development.

Vegetative buffers shall be used along streams, creeks, rivers, lakes, and other water bodies. The stricter criteria should be used between the DEQ Construction General Permit buffer requirements and the following: A minimum strip twenty-five (25) feet wide, undisturbed except for reasonable access, shall be provided along each side of streams having a peak ten-year storm flow rate of greater than one hundred fifty (150) cubic feet per second. The twenty-five (25) foot strip shall be measured from the top of bank. An exception to this requirement is allowed where the only work being done on the site is public street construction.

### Limitations

Adequate land and soil must be available for a vegetative buffer.

### Maintenance

Once established, vegetated buffers do not require maintenance beyond the routine procedures and periodic inspections. Inspect them after heavy rainfall of 0.5-inch or greater and at least once every fourteen calendar days. Focus on encroachment, gully erosion, the density of the vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. If more than six (6) inches of sediment has accumulated, remove it and restore vegetative buffer.

(Source: US Environmental Protection Agency)

## **8.30 BMP SC-11 Sediment Filters and Sediment Chambers**

### Description

Sediment filters are sediment-trapping devices typically used to remove pollutants (mainly particulates) from stormwater runoff. Sediment filters have four components: (1) inflow regulation, (2) pretreatment, (3) filter bed, and (4) outflow mechanism. Sediment chambers are one component of a sediment filter system.

Inflow regulation is diverting stormwater runoff into the sediment-trapping device. After runoff enters the filter system, it enters a pretreatment sedimentation chamber. This chamber is used as a preliminary settling area for large debris and sediments. It is usually no more than a wet detention basin. As water reaches a predetermined level, it flows over a weir into a bed of some filter medium. The medium is typically sand, but it can consist of sand, soil, gravel, peat, compost,

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or a combination. The filter bed removes small sediments and other pollutants from the stormwater as it percolates through the filter medium. Finally, treated flow exits the sediment filter system via an outflow mechanism. It returns to the stormwater conveyance system.

Sediment filter systems can be confined or unconfined, on-line or off-line, and aboveground or belowground. Confined sediment filters are constructed with the filter medium contained in a structure, often a concrete vault. Unconfined sediment filters are made without a confining structure. For example, sand might be placed on the banks of a permanent wet pond detention system to create an unconfined filter. On-line systems retain stormwater in its original stream channel or storm drain system. Off-line systems divert stormwater.

### Applications

Sediment filters might be a good alternative for small construction sites where a wet pond is being considered as a sediment-trapping device. They are widely applicable, and they can be used in urban areas with large amounts of highly impervious area. Confined sand filters are man-made systems, so they can be applied to most development sites and have few constraining factors. However, for all sediment filter systems, the drainage area to be serviced shall be no more than ten (10) acres.

The available space is important to the design of sediment filters. Another important consideration is the amount of available head. Head is the vertical distance available between the inflow of the system and the outflow point. Because most filtering systems depend on gravity to move water through the system, if enough head is not available, the system will not be effective.

### Limitations

For sediment filter systems, the drainage area to be serviced shall be no more than ten (10) acres.

Sediment filters are usually limited to removing pollutants from stormwater runoff. To provide flood protection, they have to be used with other stormwater management practices.

Sediment filters are likely to lose effectiveness in cold regions because of freezing conditions.

(Source: US Environmental Protection Agency)

## **8.31 BMP RC-1 Check Dams**

### Description

Excessive velocity of water in swales or channels causes erosion and transports the sediment downstream to local streams.

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Check Dams (ditch check) slow water in channels and provide an area for sediment to settle out of the water before it flows over the dam.

### Applications

Any unlined channel or any channel that the vegetative protection has not developed. Steeper slopes are more subject to erosion than flatter slopes.

### Design Criteria

Place ditch checks such that the top of the downstream check is at the same elevation as the bottom of the next upstream check.

Checks must be constructed such that the top elevation of the center of the check is at least six (6) inches below the bottom elevation of both ends of the check. The dam must be excavated into the channel no less than six (6) inches as shown in the below figures.

### Limitations

If improperly constructed, water will flow around or through the check dam and erode the banks of the channel. Large flows (less frequent storms) can washout the check dams, erode the banks at the end of the check dams, or cause excessive scour at the outfall of the check dam.

### Maintenance Requirements

Sediment that collects behind a check dam shall be removed when the sediment reaches fifty percent (50%) of the depth to the spillway crest. Check Dams shall be inspected weekly and after one-half (1/2) inch or greater rainfalls for proper installation, erosion, and excessive sediment buildup and defects shall be repaired or replaced within 24 hours.

Check dams constructed in permanent swales shall be removed when perennial grasses have become established, or immediately prior to installation of a non-erodible lining. All of the rock and accumulated sediment shall be removed. The area shall be dressed to match surrounding grades, then seeded and mulched, or otherwise stabilized.

**Figure CS-13 – Sand bag check dam detail (Source: AHTD, 2001)**

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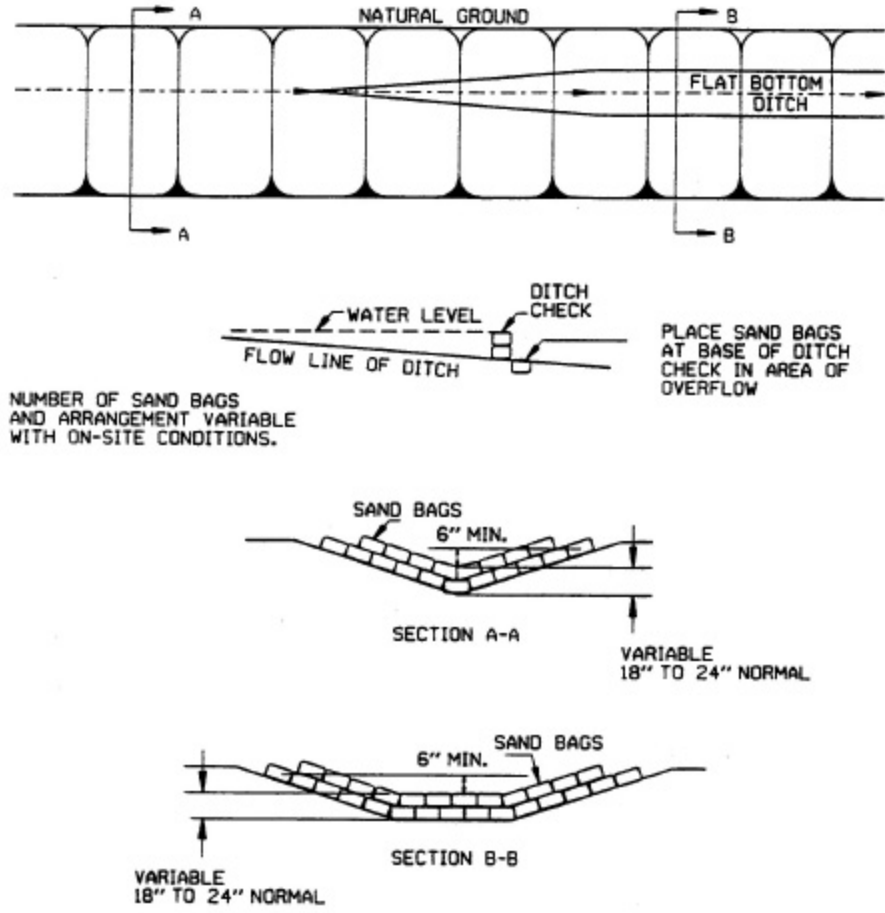
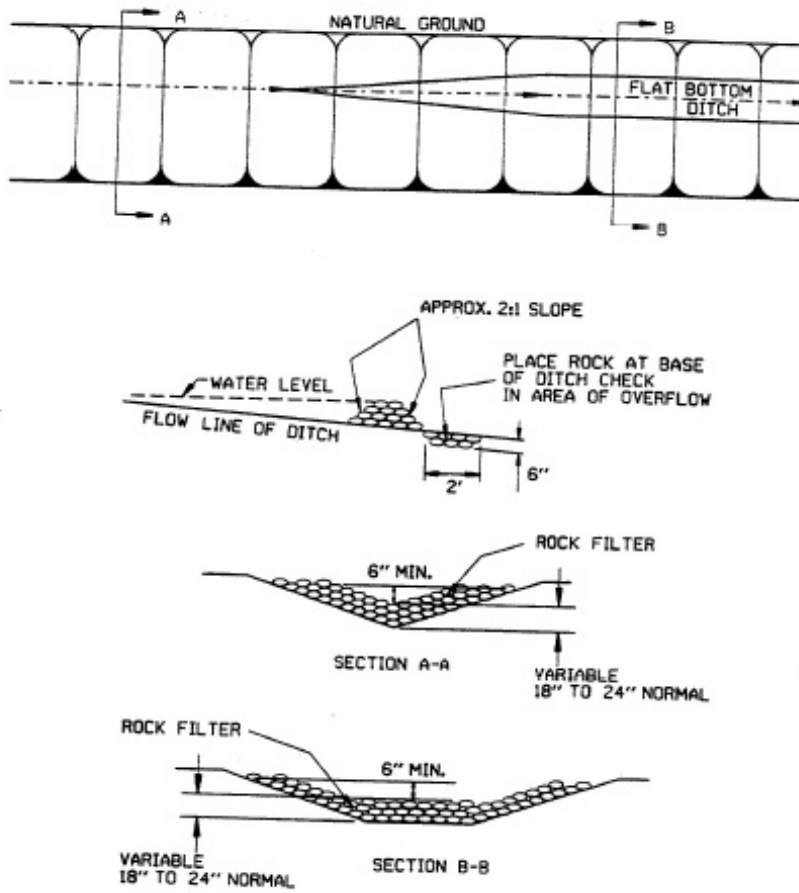


Figure CS-14 – Rock Check Dam Detail (Source: AHTD, 2001)

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Photograph CS-8 – Example of Rock Check Dam (Source: Delaware DOT)

## 8.32 BMP RC-2 Triangular Silt Dike

### Description

A triangular silt dike is a triangular-shaped foam block covered with geotextile fabric. When laid in a channel and placed perpendicular to the flow of water, it provides an area for sediment to settle out of the water. A triangular silt dike is a reusable alternative to rock check dams. It conforms to curves and rough terrain.

### Applications

Any channel where the vegetative protection has not developed. Steeper slopes are more subject to erosion than flatter slopes.

Triangular silt dikes can also be used as diversion dikes and as inlet protection.

### Design Criteria

Place ditch checks such that the top of the downstream check is at the same elevation as the bottom of the next upstream check.

A protective apron shall be installed on both sides of the dike to prevent erosion and failure and are secured using U-shaped wire staples.

A trench shall be excavated that is approximately three to six (3 to 6) inches deep on the upslope side of the dike. The trench shall then be backfilled and the soil compacted over the textile.

### Limitations

If improperly constructed, water will flow around or the triangular silt dike and erode the banks of the channel. Large flows (less frequent storms) can washout the triangular silt dike, erode the banks at the end of the check dams, or cause excessive scour at the outfall of the check dam.

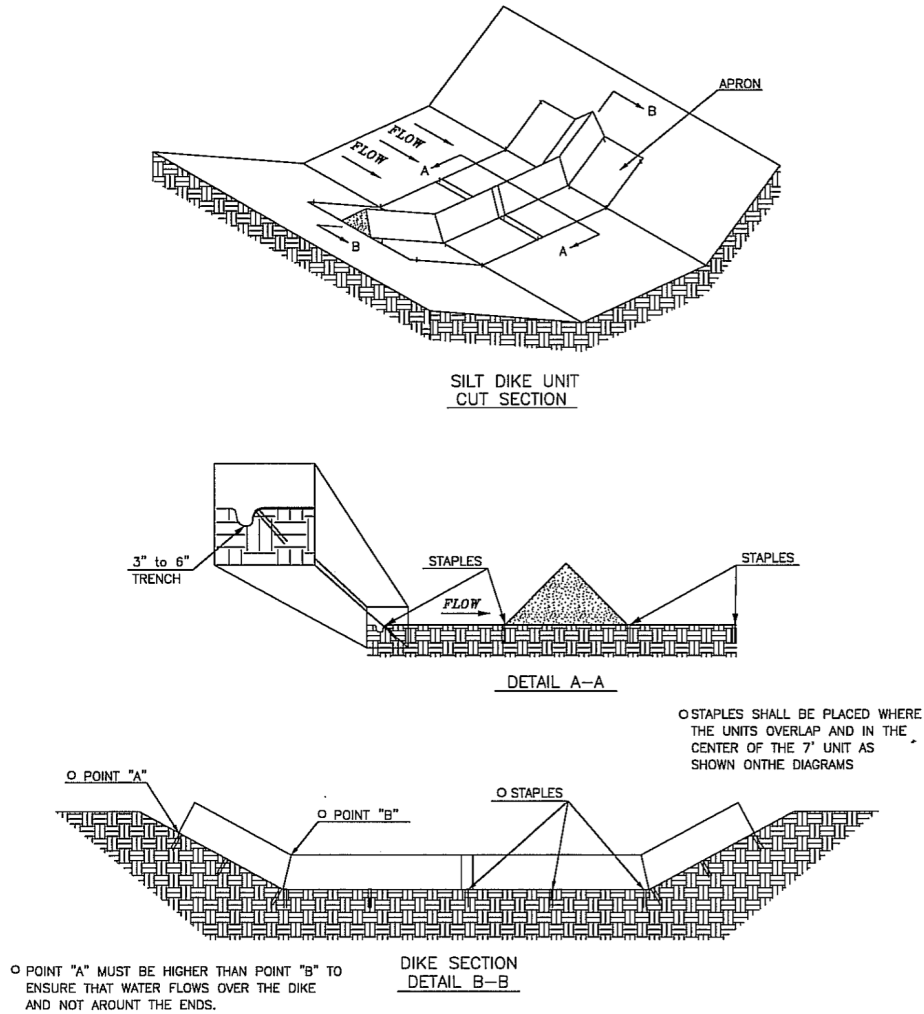
### Maintenance Requirements

Triangular silt dikes shall be inspected weekly and after one-half (1/2) inch or greater rainfalls for proper installation, erosion, and excessive sediment buildup. Any damage shall be repaired immediately. Sediment must be removed when it reaches six (6) inches high on the dike. If the geotextile has deteriorated due to ultraviolet breakdown, it shall be replaced.

Triangular silt dikes constructed in permanent swales shall be removed when perennial grasses have become established, or immediately prior to installation of a non-erodible lining. All of the accumulated sediment shall be removed. The area shall be dressed to match surrounding grades, then seeded and mulched, or otherwise stabilized.

Figure CS-15 – Triangular Silt Dike Detail (Source: ACF Environmental)

TRIANGULAR SILT DIKE INSTALLATION  
FOR  
ROADWAY DITCH OR DRAINAGE DITCH



### 8.33 BMP RC-3 Grass-Lined Channels

#### Description

A grass-lined or sod-lined channel conveys stormwater runoff through a stable conduit. Vegetation lining the channel reduces the velocity of concentrated runoff and provides water quality benefits through filtration and infiltration. Because grassed channels are not usually designed to control peak runoff loads by themselves, they are often used with other BMPs, such as subsurface drains and riprap stabilization.

Where moderately steep slopes require drainage, grassed channels can include excavated depressions or check dams to enhance runoff storage, decrease flow rates, and improve pollutant removal. Peak discharges can be reduced by temporarily holding them in the channel. Pollutants can be removed from stormwater by filtration through vegetation, by deposition, or in some cases by infiltration of soluble nutrients into the soil. The degree of pollutant removal in a channel depends on how long the water stays in the channel and the amount of contact with vegetation and the soil surface. Local conditions affect the removal efficiency.

#### Applications

The first choice of lining should be grass or sod because this reduces runoff velocity and provides water quality benefits through filtration and infiltration. If the velocity in the channel would erode the grass or sod, riprap, concrete, or gabions can be used. Geotextile materials can be used in conjunction with either grass or riprap linings to provide additional protection at the soil-lining interface.

Use grassed channels in areas where erosion-resistant conveyances are needed, including areas with highly erodible soils and moderately steep slopes (though less than five (5%) percent). Install them only where space is available for a relatively large cross section.

Grassed channels have a limited ability to control runoff from large storms, so do not use them in areas where flow rates exceed five (5) feet per second.

#### Implementations

Site grass-lined channels in accordance with the natural drainage system. The channel should not receive direct sedimentation from disturbed areas and should be sited only on the perimeter of a construction site to convey relatively clean stormwater runoff. To reduce sediment loads, separate channels from disturbed areas by using a vegetated buffer or another BMP.

Consider using geotextiles to stabilize vegetation until it is fully established. Consider covering the bare soil with sod, mulches with netting, or geotextiles to provide reinforced stormwater conveyance immediately.

Use triangular channels with low velocities and small quantities of runoff; use parabolic grass

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channels for larger flows and where space is available; use trapezoidal channels with large, low-velocity flows (low slope).

Install outlet stabilization structures if the runoff volume or velocity might exceed the capacity of the receiving area.

### Limitations

If grassed channels are not properly installed, they can change the natural flow of surface water and adversely affect downstream waters. And if the design capacity is exceeded by a large storm event, the vegetation might not be adequate to prevent erosion and the channel might be destroyed. Clogging with sediment and debris reduces the effectiveness of grass-lined channels for stormwater conveyance.

Grassed channels have a limited ability to control runoff from large storms, so do not use them in areas where flow rates exceed 5 feet per second.

### Maintenance

The maintenance requirements for grass channels are relatively minimal. While vegetation is being established, inspect the channels after every rainfall. After vegetation is established, mow it, remove litter, and perform spot vegetation repair. The most important objective in grassed channel maintenance is to maintain a dense and vigorous growth of turf.

Periodically clean the vegetation and soil buildup in curb cuts so that water flow into the channel is unobstructed.

During the growing season, cut the channel grass no shorter than the level of the design flow.

(Source: US Environmental Protection Agency)

## **8.34 BMP RC-4 Interceptor and Diversion Dikes and Swales**

### Description

Water running onto the site will increase erosion and be a nuisance to construction activities. Additionally, runoff from the construction site can have excessive amounts of sediment that can end up in local streams.

Interceptor and Diversion Swales and Dikes are diversion systems used to divert runoff around a site or to direct runoff from a site to a pond in order to settle out sediment prior to discharge from the site.

### Applicability

Any area that is subject to runoff from uphill drainage areas.

Design Criteria

There are two types of temporary slope diversion dikes:

1. A diversion dike located at the top of a slope to divert upland runoff away from the disturbed area. The runoff from undisturbed upland areas may be directed by such dikes to a permanent channel or temporary diversion channel.
2. A diversion dike located at the base or mid-slope of a disturbed area to divert sediment-laden water to a sediment basin. The discharge intercepted by these diversion dikes may be directed to a temporary slope drain and/or sediment basin.

Temporary diversion dikes **shall** be provided whenever:

$$S^2 L > 2.5 \quad \text{for } \mathbf{undisturbed} \text{ tributary areas:}$$

$$S^2 L > 1.0 \quad \text{for } \mathbf{disturbed} \text{ tributary areas:}$$

$$S^2 L > 0.25 \quad \text{for } \mathbf{paved} \text{ tributary areas:}$$

where:  $S$  = slope of the upstream tributary area (in feet/foot); and,  
 $L$  = length of the upstream slope (in feet).

and

**Undisturbed Tributary Area** = area tributary to the temporary diversion dike that is, and will remain, in a natural condition undisturbed by development activities.

**Disturbed Tributary Area** = area tributary to the temporary diversion dike that has been disturbed by development activities, including removal of native vegetation and/or compaction of native soils.

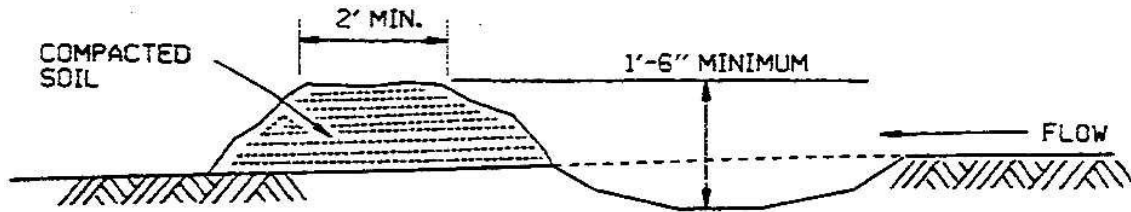
**Impervious Tributary Area** = area tributary to the temporary diversion dike that is largely comprised of impervious surfaces, such as buildings and pavement.

The swale (channel) and dike shall be situated to capture runoff uphill of the work area with a vegetative buffer uphill of the swale to remove sediment before it enters the swale. The stabilized swale and ditch shall be in-place prior to all other earth work on the project. The channel shall be designed to handle the 10-year storm, with the bottom and sides protected for the anticipated water velocity. Typically, the ditch will be two (2) foot wide at the bottom and six (6) foot wide at the top. Maximum water velocity in the swale shall not exceed four (4) feet per second. Side

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slopes shall be no steeper than 3:1 (horizontal:vertical). Energy dissipation shall be provided at the exit from the swale as needed.

**Figure CS-16 – Swale configuration detail (Source: AHTD, 2001)**



### Limitations

Excessive flow rates can cause scour in the swale; therefore requiring a sediment control pond at the end of the swale.

In the event that the dike over flows during larger storm events, the site can be damaged and excessive erosion and sediment transport can occur.

### Maintenance Requirements

The swale shall be cleared of debris and excessive vegetation as required.

## **8.35 BMP RC-5 Rough-Cut Street Control**

### Description

Rough-cut street controls are dirt berms, sandbag dikes, or gravel filled geotextiles socks used to prevent rill, channel and gully erosion on unpaved streets.

Rough cut street controls are runoff barriers that are constructed at intervals down an unpaved road. These barriers are installed perpendicular to the longitudinal slope from the outer edge of the roadside swale to the crown of the road. The barriers are positioned alternately from the right and left side of the road to allow construction traffic to pass in the lane not barred. Refer to the rough-cut street control detail below.

### Applicability

Rough-cut street controls shall be considered for roadways that are not paved for thirty (30) days

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of final grading and have not received an application of road base.

Maintenance

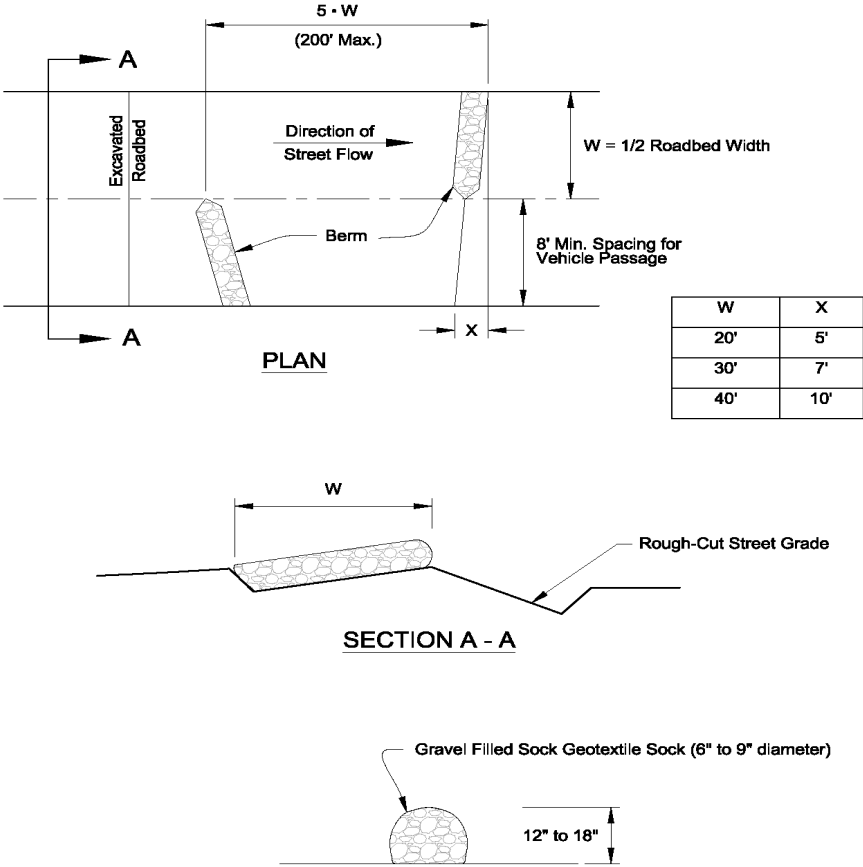
Rough-cut street controls shall be inspected immediately following the initial installation, once a week while the site is under active construction, and immediately following a rain event.

Accumulated sediment shall be removed when the sediment depth is a quarter (1/4) the height of the berm.

Rough-cut street control shall be repaired immediately following any sign of wear or alteration of the original shape and dimensions.

Rough-cut street control shall be kept in place and maintained until subgrade preparation begins for paving.

**Figure CS-17 – Rough-Cut Street Control (Source: Orange County, CA)**



**8.36 E**

**TYPICAL SECTION**

Description

A water bar is a ridge of compacted soil, loose rock, or gravel constructed diagonally across

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disturbed rights-of-way and similar sloping areas. The height and side slopes of the water bar are designed to divert water and allow vehicles to cross. Water bars are used to shorten the flow length within a long sloping right-of-way, thereby reducing the erosion potential by diverting storm runoff to a stabilized outlet or sediment trapping device.

### Applications

Water bars can be used in areas where earthen diversions are applicable and where there will be little or no construction traffic within the right-of-way. Gravel structures are more applicable to roads and rights-of-way which accommodate vehicular traffic.

### Implementations

Construction of utility lines and roads often requires the clearing of long strips of right-of-way over sloping terrain. The volume and velocity of stormwater runoff tend to increase in these cleared strips and the potential for erosion is much greater since the vegetative cover is diminished or removed. To compensate for the loss of vegetation, it is usually a good practice to break up the flow length within the cleared strip so that runoff does not have an opportunity to concentrate and cause erosion. At proper spacing intervals, water bars can significantly reduce the amount of erosion which will occur until the area is permanently stabilized.

### Limitations

Water bars shall not be used for drainage areas less than one (1) acre.

The water bar spacing must be close enough to dissipate water flow energy.

Water bars can be used where there will be little or no construction traffic within the right-of-way. Gravel structures are more applicable to roads and rights-of-way which accommodate vehicular traffic.

### Maintenance

Water bars shall be inspected after every rainfall and repairs made if necessary. Approximately once every week, whether a storm has occurred or not, the measure shall be inspected and repairs made if needed. Earth fill that is subject to damage by vehicular traffic shall be reshaped at the end of each working day.

(Source: NRCS Planning and Design Manual)

### **Figure CS-18 – Water Bar installation (Source: Minnesota – DNR 1998)**

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