FIELD WIDE
STORMWATER MANAGEMENT PLAN
FOR CONSTRUCTION ACTIVITIES

Southeastern Colorado

Bent County, Colorado

Prepared For:

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Petroleum Development Corporation Certification

Stormwater Management Plan for
Southeastern Colorado (SECO)
Bent County, Colorado

Petroleum Development Corporation (dba PDC Energy) has prepared this Field Wide Stormwater Management Plan for Construction Activities (SWMP) for Bent County in Southeastern Colorado (SECO).

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: _____

Name: _____

Title: _____

Date: _____

ADMINISTRATIVE LOG
PDC ENERGY
SOUTHEASTERN COLORADO

Date	Training, SWMP Revisions or Updates	Comments

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INTRODUCTION

This Field Wide Stormwater Management Plan for Construction Activities (SWMP) is written to comply with the Colorado Department of Public Health and Environment's (CDPHE) Permit No COR-030000, issued on July 1, 2007 and expires on June 30, 2012, and related U.S. Environmental Protection Agency (USEPA) National Pollutant Discharge Elimination System (NPDES) stormwater regulations. This SWMP addresses construction activities associated with Petroleum Development Corporation's (PDC) oil and gas activities in Southeastern Colorado (SECO). A copy of this permit can be found in **Appendix A**.

Stormwater Runoff Permitting Requirements

The Federal Clean Water Act [Section 402(p)] requires that discharges of pollutants to waters of the U.S. from any point source be regulated by NPDES permits. In November 1990 the EPA published final regulations that established application requirements for stormwater associated with construction activity for soil disturbances of 5 acres or more be regulated as an industrial activity and covered by an NPDES permit. In December 1999 the EPA published final Phase II NPDES regulations that established application requirements for stormwater associated with construction activity for soil disturbances to be regulated as an industrial activity and covered by an NPDES permit. These regulations became effective July 1, 2002.

On June 30, 2005, Colorado stormwater regulations went into effect to require Colorado Discharge Permit System (CDPS) permits for stormwater discharges from construction activities for (1 acre or greater) oil and gas activities. Federal permit coverage for these discharges was conditionally exempted from the Federal Clean Water Act by the 2005 Federal Energy Bill. On February 1, 2006, the CDPHE issued a letter clarifying that the CDPHE Water Quality Control Commission decided to maintain the existing requirements for stormwater permitting for oil and gas construction sites greater than 1 acre.

Project Description

SECO field wells will be located within Township 21S - Range 48W, Township 21S - Range 49W, and Township 22S – Range 49W of the 6th PM. The permitted area includes well pads, pipelines, and access roads within approximately 21,000 gross acres. Individual pad sites will range from ¾ acre to five acres. The town of Lamar, Colorado is the nearest population center. See **Figure 1** for area location map.

The current drilling and development plan includes pad construction, access road improvement and construction, reserve pit construction, well drilling, well testing, well completion, installation of associated facilities, and pipeline construction.

This SWMP is intended to be updated as necessary to address additional disturbances or construction. Anticipated updates include, but are not limited to, BMP details, site plans, and contact information. The SWMP administrator will be responsible to update the SWMP as necessary. These changes shall be documented in the Administrative Log located at the front of this document. In general, new development should be planned with consideration for stormwater quality (e.g. minimize disturbed area and maximize distance from surface water drainages, as practicable).

1. CONSTRUCTION SITE DESCRIPTION

The following section describes the site location and provides a description of the construction areas.

1.A Nature of Construction Activity

SECO field well pads will be constructed using conventional cut and fill earthmoving techniques. Individual pad sites will range from ¾ acre to 5 acres in size. Specific pad dimensions vary depending on the planned drill rig, number of wells to be drilled from each pad, and local terrain conditions. Reserve pits may be used during activities to contain drilling fluids and cuttings. The pits will be designed, constructed, and reclaimed according to Colorado Oil and Gas Conservation Commission (COGCC) requirements.

In areas that are disturbed by well construction, topsoil will be stripped and stockpiled near the site. Soil materials will be managed so that erosion and sediment transport are minimized. Nearby drainages will be protected by appropriate measures.

If the well is not productive, it will be plugged and abandoned according to COGCC rules and the pad area reclaimed to approximate pre-construction contours.

1.B Sequence of Construction Activities

For new disturbances in the SECO field that are covered by this plan, structural and non-structural best management practices (BMPs) will be installed prior to, during, and following construction activities, as practicable, with consideration given to safety, access, and ground conditions (e.g., frozen ground) at the time of construction.

The development of natural gas wells is generally accomplished in seven distinct work phases. They include Access Road and Pad Construction, Pipeline Installation, Well Drilling, Well Completion, Production, Interim Reclamation, and Final Reclamation. Each work phase and associated BMPs are briefly discussed below.

Access Road Construction

The drilling and development of natural gas wells requires the construction of access roads. Access road construction is generally accomplished by using traditional cut and fill techniques but may also require blasting and other techniques. Size and maintenance requirements for each road are based on road location and traffic level.

Pad Construction

The Pad Construction phase includes the construction of the well pad surface. Most work will be performed using traditional cut-and-fill construction. Reserve pits may be constructed at this time to store certain fluids and solids during later phases of drilling and completion operations. No fluids or solids, excluding any accumulated stormwater, will be stored in the reserve pits during this phase. In the event that a reserve pit is not required for drilling, the pad surface will still be graded to drain surface water onsite, and appropriate BMPs will be installed to control this surface water.

Basic construction activities that are conducted during this phase include clearing and grubbing, segregation of topsoil for use in reclamation, grading and excavation, compaction of well pad, final grading and contouring, and installation of gravel or other materials. Sediment discharge is the main potential pollutant of concern during this phase of construction. No chemicals or fuels will be stored on the pad during this phase; however, attention will be paid to the potential for leaks that might occur during the use of construction equipment.

To the extent possible, BMPs that will be utilized to control stormwater throughout the life of the wells that will be constructed during this phase.

Pipeline Installation

Development of natural gas wells also requires the installation of pipelines used to transmit natural gas and other related fluids. Pipeline installation is generally accomplished by trenching. The area of disturbance for each pipeline is determined by location and pipeline size.

Well Drilling

The Well Drilling phase includes the drilling of one or more wells at each location. Activities associated with the drilling phase include:

- Mobilization of the drilling rig and associated equipment, including generators and drilling-mud handling equipment – in some instances a smaller drilling rig may be used to drill the initial stages of each well prior to the larger drilling rig mobilizing to the location
- Installation of storage, office and housing trailers
- Storage of down hole chemicals, fuels and lubricants
- Installation of potable water tanks and sewage-handling equipment (e.g., portable toilets or sewage vaults)
- Well drilling activities including the installation and cementing of well casing
- Demobilization of the drilling rig and all other equipment at the completion of this phase

Sediment discharge, unused and used chemicals, and drilling water/mud are potential pollutants of concern during this phase of construction. Drilling mud and water will be used to maintain appropriate down hole pressures and lubrication. Unused fresh water and mud chemicals will be stored on the pad. Used materials will either be discharged to the reserve pit or captured in tanks during closed-loop drilling processes. Petroleum products are used for the duration of the drilling process to fuel or lubricate equipment and include: fuel, gear oil, hydraulic oil, brake fluid, and grease. Materials to be used to cement casing placed in the well may also be stored and prepared on location or may be transported to the site.

Procedures will also be implemented for prompt containment and remediation of any spills that may occur during the drilling phase.

As equipment is demobilized at the completion of this phase, the well pad and surrounding areas will be carefully inspected to identify any spills or leaks that may have occurred so that those areas can be remediated prior to initiation of the well completion phase.

Well Completion

The Well Completion phase may include hydraulic fracturing (fracing), cementing, and other processes that stimulate the well and prepare it for production. The basic activities that are conducted during this phase include:

- Mobilization of equipment required for well completion
- Storage of downhole chemicals, fuels and lubricants

- Installation of potable water tanks and sewage-handling equipment (e.g., portable toilets or sewage vaults) or continued maintenance of such equipment installed during the drilling phase
- Fracing and other well-stimulation processes
- Drill out of any plugs placed during well completion with a work-over rig
- Flowback of the well to remove frac water, sand and other impurities
- Demobilization of equipment when this phase has been completed

Several temporary facilities/structures will be placed on site during this phase. These will include: frac trucks, storage and office trailers, generators, and frac tanks. During completions, certain chemicals may be used to stimulate the formation for the extraction of natural gas. Unused water and chemicals will be stored on the pad. Used water will be stored in the reserve pit, recycled, or used in other operations.

Sediment discharge, unused and used chemicals, and frac water are potential pollutants of concern during this phase of construction.

As equipment is demobilized at the completion of this phase, the well pad and surrounding areas will be carefully inspected to identify any spills or leaks that may have occurred so that those areas can be remediated prior to initiation of the production phase.

Production

The Production phase includes the installation of long-term facilities such as permanent well heads, storage tanks, gas processing equipment, flow measurement equipment, and any associated flow lines needed to produce natural gas from the formation. An active gas well produces fluid phase products along with gas phase products. Storage tanks may be placed on site during this phase to hold any produced water and/or fluid phase hydrocarbons (condensate). The presence of tanks for storage may require implementation of a Spill Prevention Control and Countermeasure (SPCC) plan to prevent and control possible leaks from those tanks. In addition, secondary containment will be provided for any tanks storing chemicals that are utilized during the life of the wells.

Sediment discharge, produced fluids, and small amounts of equipment operational lubricant, fuel, corrosion inhibitors or other chemicals are potential pollutants of concern during this phase.

Interim Reclamation

The Interim Reclamation phase includes the contouring of the majority of the pad to a smaller area. The reduced area will be utilized for long-term production and ongoing routine maintenance of the well(s). In general, this phase includes contouring of the site, spreading of topsoil on contoured areas and seeding those areas.

Sediment discharge, produced fluids and small amounts of equipment operational lubricant, fuel, corrosion inhibitors or other chemicals are potential pollutants of concern during this phase of construction.

Permit coverage may be inactivated for oil and gas construction sites even if stabilized unpaved surfaces exist and/or disturbed land that has been restored to cropland remains non-vegetated, as long as construction activities have been completed and all other disturbed areas re-vegetated.

Final Reclamation

When the natural gas production of a well is exhausted it will be abandoned. Upon well abandonment each borehole will be plugged, capped, and all surface equipment will be removed. Subsurface pipelines will be removed to specified locations or abandoned in place as per COGCC Rule 1103.

The pad area will be reclaimed by contouring disturbed soils to conform to the surrounding terrain, by redistributing the stockpiled topsoil, seeding of disturbed soil areas in order to reestablish cover vegetation, and by construction of erosion and sediment control structures as needed.

1.C Estimate of Total Area of Site and Area to be Disturbed

The total permitted area is 21,000 gross acres. Individual pad sites in the permitted area range from ¾ acre to five acres in size. This area includes all site-specific access roads and pipelines. As new sites are added to the permitted area, the SWMP and PDC's database will be updated to reflect the new disturbances.

1.D Soil Data and Erosion Potential

Runoff characteristics are based primarily on site topography, soil type, and vegetative cover. All soil types in the permitted area are well drained soils with very low (1.6 inches) to high (11.4 inches) water holding capacity.

The K-factor approximates soil detachment due to runoff and raindrop impact. Lower k-Factor values (0.1 – 0.17) indicate less susceptibility to sheet and rill erosion, while higher k-Factor values (>0.30) indicate greater susceptibility to erosion.

The Hydrologic Group describes soil and soil units with the potential for runoff under similar storm and cover conditions. Group A has a high infiltration rate and a corresponding lower potential for runoff, while Groups C and D have low infiltration rates due to finer soil texture or a high water table, giving them a high potential for runoff.

NRCS Soils Report for each soil type is provided in **Appendix B**.

The average annual precipitation for the SECO field is approximately 15.2 inches (Western Regional Climate Center, Lamar, Colorado [Station 054770]).

Table 1 shows the soils data and erosion potential for each soil in the area.

Table 1: Soils Data and Erosion Potential

			Representative value		
Soil name	**Hydrologic Group**	**K-factor**	**% Sand**	**% Silt**	**% Clay**
Arvada and Deertrail soils, eroded					
Arvada, eroded	D	0.24	35.4	33.6	31
Deertrail, eroded	-	-	-	-	-
Colby silt loam, 1 to 3 percent slopes					
Colby	B	0.37	11.3	67.7	21
Baca	-	-	-	-	-
Wiley	-	-	-	-	-

Deertrail clay loam, 0 to 5 percent slopes					
Deertrail	C	0.2	35.4	33.6	31
Wiley	-	-	-	-	-
Minnequa	-	-	-	-	-
Arrada	-	-	-	-	-
Manvel loam, 1 to 9 percent slopes					
Manvel	B	0.37	36.9	42.1	21
Litle	-	-	-	-	-
Minnequa	-	-	-	-	-
Penrose	-	-	-	-	-
Manvel loam, 1 to 9 percent slopes, erode					
Manvel	B	0.37	36.9	42.1	21
Eroded soils	-	-	-	-	-
Minnequa loam, 1 to 9 percent slopes					
Minnequa	C	0.37	36.9	42.1	21
Manvel	-	-	-	-	-
Penrose	-	-	-	-	-
Minnequa-Penrose loams, 1 to 9 percent slopes					
Minnequa	C	0.37	36.9	42.1	21
Penrose	D	0.37	41.6	37.4	21
Litle	-	-	-	-	-
Manvel	-	-	-	-	-
Penrose Channery loam, 1 to 25 percent slopes					
Penrose	D	0.37	41.6	37.4	21
Minequa	-	-	-	-	-
Samsil	-	-	-	-	-
Samsil soils					
Samsil	D	0.28	7.6	54.9	37.5
Litle	-	-	-	-	-
Minnequa	-	-	-	-	-
Satanta loam, 0 to 3 percent slopes					
Satanta	B	0.28	43	39.5	17.5
Baca	-	-	-	-	-
Kim	-	-	-	-	-
Manzanola	-	-	-	-	-
Stoneham loam, 0 to 3 percent slopes					
Stoneham	B	0.37	41.6	37.4	21
Deertrail	-	-	-	-	-
Vona	-	-	-	-	-
Wiley	-	-	-	-	-
Stoneham loam 3 to 9 percent slopes					
Stoneham	B	0.37	41.6	37.4	21
Vona	-	-	-	-	-

Weld silt loam, 0 to 1 percent slopes					
Weld	C	0.32	26.3	52.7	21
Baca	-	-	-	-	-
Stoneham	-	-	-	-	-
Wiley silt loam, 0 to 3 percent slopes					
Wiley	B	0.43	11.3	67.7	21
Colby	-	-	-	-	-
Wiley	-	-	-	-	-

1.E Vegetation Description and Estimate

Native vegetation includes Bluegrass, Bottlebrush squirreltail, Fourwing saltbush, Fringed sagewort, Balleta, Greasewood, Green needlegrass, Juniper, Little bluestem, Needleandthread, Needlegrass, Prairie junegrass, Sand dropseed, Sideoats grama, True mountain mahogany, Twoneedle pinyon, Western wheatgrass and Winterfat. Pre-disturbance ground cover varies from approximately 30 to 75 percent.

1.F Potential Pollution Sources and Locations

Potential pollution sources associated with construction sites and natural gas development include:

- Sediment resulting from erosion of soil stockpiles, well pads, access roads, pipelines, and other areas cleared of vegetation
- Sediment discharges from vehicle tracking
- Leakage of fuels and lubricants from equipment
- Trash and debris from clearing activities, construction materials, and workers
- Leaks or spills from storage tanks and process equipment associated with the natural gas development activities

The most common source of pollution from pad and access road construction is sediment, which can be carried away from the work site with stormwater runoff and impact the water quality of a receiving stream. Clearing, grading, and otherwise altering previously undisturbed land can increase the rate of soil erosion over pre-disturbance rates.

Petroleum products can also be potential stormwater pollutants. These products are used in construction activities to power or lubricate equipment and include: fuel, gear oil, hydraulic oil, brake fluid, and grease.

Debris from laydown areas, residue from equipment cleaning and maintenance, and solid waste generated from land clearing operations and human activity (trees, brush, paper, trash, etc.) present other potential pollution sources within the construction site. Additionally, one or more facilities may contain construction supplies such as various sized pipe, culverts, metal sheds, empty tanks, drums and vessels, fencing and stairs.

Loading and unloading of condensate and produced water from above ground storage tanks may be common and regular activities within the SECO area. Spills and or tank overflows can contaminate stormwater runoff.

Water, magnesium chloride solution, or other chemical dust suppressants may be applied to the surface in order to reduce fugitive dust generation. If dust from vehicle traffic becomes significant, procedures will be implemented for dust suppression.

Spills or leaks from potential sources are described in the SPCC plan. Response to certain events may require specialized training due to health and safety concerns.

1.G Non-Stormwater Discharges

Non-stormwater discharges are not expected from the construction projects. Possible exceptions include fire prevention/suppression or dust control activities.

1.H Receiving Waters

Stormwater runoff receiving waters include un-named tributaries and seasonal washes, Wiley Drainage Ditch, Fort Lyon Canal, Kickingbird Canal, Limestone Creek, West Limestone Creek, Lubers Drainage Ditch. The final receiving water is the Arkansas River. **Figure 1** shows all receiving waters for the permitted area**.**

2. SITE MAPS

PDC will maintain an electronic database to record and update all information as required by the General permit (Part I.C.2). This database is updated at every inspection and dated to show the changes from one inspection to the next. All stormwater records are tracked and managed through the database. Hard copies of the site maps will be added to **Appendix C** of the SWMP as each site is developed.

Construction site boundaries, areas of ground surface disturbance, areas of cut and fill, areas used for storage, locations of all structural BMPs, locations of non-structural BMPs, and locations of springs, streams, wetlands and other surface waters will be included on the maps in the database.

3. STORMWATER MANAGEMENT CONTROLS

3.A Stormwater Administrator

The SWMP Administrator for PDC's SECO field is:

Mr. Chad Sailors
Field Projects Supervisor
36621 Highway 385
Wray, CO 80758
Office: 970.332.3520 ext. 3999
Mobile: 970.630.2815

The SWMP Administrator is responsible for developing, implementing, maintaining and revising the SWMP as necessary. The administrator may delegate the SWMP inspections and maintenance of records to qualified personnel.

3.B Potential Pollution Sources

Potential pollution sources associated with construction sites and natural gas development include:

- Sediment resulting from erosion of soil stockpiles, well pads, access roads, pipelines, and other areas cleared of vegetation
- Sediment discharges from vehicle tracking
- Leakage of fuels and lubricants from equipment and spills from fueling
- Trash and debris from clearing activities, construction materials, and workers and
- Leakage or spills from storage tanks and process equipment associated with the natural gas development activities

A common source of pollution from pad and access road construction is sediment, which can be carried away from the work site with stormwater runoff and impact the water quality of a receiving stream. Clearing, grading, and otherwise altering previously undisturbed land can increase the rate of soil erosion over pre-disturbance rates.

Petroleum products can also be potential stormwater pollutants. These products are used in construction activities to power or lubricate equipment and include: fuel, gear oil, hydraulic oil, brake fluid, and grease.

Debris from laydown areas, residue from equipment cleaning and maintenance, and solid waste generated from land clearing operations and human activity (trees, brush, paper, trash, etc.) present other potential pollution sources within the construction site. Additionally, one or more facilities may contain construction supplies such as various sized pipe, culverts, metal sheds, empty tanks, drums and vessels, fencing and stairs.

Loading and unloading of condensate and produced water from above ground storage tanks may be common and regular activities within the SECO area. Spills and or tank over flows can contaminate stormwater runoff.

Water, magnesium chloride solution, or other chemical dust suppressants may be applied in order to reduce fugitive dust generation. If dust from vehicle traffic becomes significant, procedures will be implemented for dust suppression.

Spills or leaks from potential sources will be handled as described in PDC's Spill Prevention SPCC plan. Response to certain events may require specialized training due to health and safety concerns.

3.C BMPs for Stormwater Pollution Prevention

3.C.1 Structural Practices

The description, implementation, and application practices of structural BMPs available can be found in the BMP Selection Guide & BMP Manual in **Appendix D**. The location of structural BMPs will be found in the site specific maps.

3.C.2 Non-Structural Practices

The description and application practices of non-structural BMPs available and/or implemented will be found in the BMP manual. The location of non-structural practices will be found in the site specific maps**.**

3.C.3 Phased BMP Installation

The project will be phased to the extent practical to limit the amount of disturbed area that is exposed at any given time. BMP implementation will be coordinated with the various stages of construction. BMPS that control erosion and sediment transport from initial site activities will be installed prior to earth disturbing activities. As work progresses and additional areas are disturbed, BMPs that control erosion and sediment transport will be implemented prior to start of earth disturbing activities in those areas. As portions of the site are completed and previously disturbed areas are stabilized or the BMP is no longer needed, BMPs will be removed.

Permanent or temporary soil erosion control measures for all slopes, channels, ditches, or any disturbed land area and soil stockpiles, will be implemented as soon as practicable after final grading or the final earth disturbance has been completed. When it is not possible to permanently stabilize a disturbed area after an earth disturbance has been completed or where significant earth disturbance activity ceases, temporary erosion control measures will be implemented as soon as practicable.

Project Phase	BMPs to be implemented during each phase
Pre-Disturbance/Site Preparation	• Prepare stabilized staging area. • Install vehicle tracking pad, geotextile, or mud mats where needed to provide designated access into the ROW. • Install BMPs around areas that are anticipated to be disturbed. • Limit access to areas that are not to be disturbed protecting existing vegetation.
Construction	• Locate stockpiles in work areas with perimeter BMPs. • Install BMPs per details in the Site Maps. • Leave disturbed area of site in a surface roughened condition when feasible. • Protect, inspect and repair BMPs as necessary.
Post-construction	• Maintenance and repair of BMPs installed during previous phases. • Stabilize surface with gravel when feasible • Inspection of BMPs
Final Stabilization	• Perform seeding and mulching or the installation of erosion control blankets where applicable. • Remove all non-biodegradable temporary BMPs when applicable.

3.C.4 Materials Handling and Spill Prevention

Spills, prevention, or leaks from potential sources will be handled as described in PDC's SPCC plan.

Fuels and Materials Management

Pollutants from petroleum products used during construction activities adhere easily to soil particles and other surfaces. In case of a spill or leak, soils contaminated with petroleum products will be contained and remediated onsite or removed to a proper disposal site. Proposed soil erosion and sediment control practices will aid in retention of spills or leaks. Use of secondary containment and drip pans will reduce the likelihood of spills or leaks contacting the ground. Proposed maintenance and safe storage practices will reduce the chance of petroleum products contaminating the road site. Oily wastes such as crankcase oil, cans, rags, and paper containing oils will be placed in proper receptacles and disposed of or recycled. An additional source of petroleum contamination is leaks from equipment and vehicles. Routine daily inspections will be conducted to identify leaks and initiate corrective actions, if needed.

The following guidelines for storing and managing petroleum products will be used:

- All product containers will be clearly labeled
- Drums will be kept off the ground within secondary containment and stored under cover if needed
- Fuel tanks will be stored within secondary containment
- Lids of drummed materials will be securely fastened
- Emergency spill response procedures will be available on-site. Persons trained in handling spills will be on call at all times
- Spill cleanup and containment materials (absorbent, shovels, etc.) will be easily accessible. Spills will be immediately cleaned up and contaminated materials will be properly stored on site until they can be disposed of in accordance with applicable regulations
- Storage areas and containers will be regularly monitored for leaks and repaired or replaced as necessary. Contractors and subcontractors should be reminded about proper storage, handling and transferring of petroleum products or other hazardous materials during safety meetings

All spills and releases of exploration and production waste or produced fluid exceeding 5 barrels (210 gallons) including those contained within unlined berms, shall be reported in writing on the COGCC Spill/Release Report Form 19 within 10 days of discovery of the spill.

All spills/releases that exceed 20 barrels (840 gallons) of exploration and production liquids/waste shall be verbally reported to the COGCC at (303) 894-2100 within 24 hours of discovery.

Spills or releases of any size that impact or threaten to impact any waters of the state, residence or occupied structure, livestock or public byway, shall be verbally reported to the COGCC as soon as practical after discovery (COGCC Rule 906). If the spill may potentially reach waters of the state (which includes surface water, ground water and dry gullies or storm sewers leading to surface water), it must also be reported immediately to the CDPHE at 1-877-518-5608.

Spills or releases of more than 25 gallons of refined petroleum crude oil products such as gasoline, diesel fuel, oil, or derivatives of mineral, animal or vegetable oil shall be reported to the CDPHE at 1-877-518-5608, within 24 hours.

A hazardous substance release in any amount which enters or threatens to enter waters of the state shall be reported to the CDPHE.

Other Material/Chemical Product Management

Additional materials may be used and stored on site for use in construction. These materials will be stored appropriately and managed to minimize spills and leaks. Storage areas will be regularly inspected and any minor spills or leaks will be cleaned up immediately.

The construction contractor will maintain a laydown or staging area for equipment and materials storage on site. These areas will be maintained with good housekeeping and will be inspected on a regular basis for spills, leaks, and potential of materials commingling with stormwater runoff.

3.C.5 Dedicated Asphalt or Concrete Batch Plants

There will be no dedicated asphalt or concrete batch plants within the permitted area.

3.C.6 Vehicle Tracking

Access roads used within the permitted area will be properly constructed and graveled to provide the best off-site tracking. In most cases cattle guards are utilized where access roads are adjacent to paved roads. Vehicle tracking controls will be shown on the site specific maps.

3.C.7 Waste Management and Disposal, Concrete Washout

Waste Management and Disposal

Well pad construction and drilling will generate various wastes during the course of construction. Wastes may include, but are not limited to the following:

- Sagebrush, shrubs and trees from clearing operations
- Trash and debris from construction materials and workers
- Drill cuttings, drilling fluids
- Sanitary sewage

Each of these wastes will be managed so as to not contribute to stormwater pollution. Construction trash and debris will be collected in containers and hauled off-site for disposal in suitable landfills. Sanitary waste will be containerized in portable toilets or other storage tanks with waste materials regularly pumped and transported off-site for disposal at approved facilities.

There will be no concrete washout within the permitted area.

3.C.8 Ground Water and Stormwater Dewatering

No groundwater dewatering is anticipated at this time. If groundwater is encountered, the dewatering of the site will be regulated by a dewatering permit issued through CDPHE. All stormwater will be diverted by diversion berms to avoid contact with the groundwater.

4. FINAL STABILIZATION AND LONG TERM STORMWATER MANAGEMENT

A site is considered finally stabilized when all ground surface disturbing activities at the site have been completed, and all disturbed areas have been either built on, compacted, covered, paved, or otherwise stabilized in such a way as to minimize erosion to the extent practicable, or a uniform vegetative cover has been established that reflects pre-disturbance or reference area forbs, shrubs, and grasses with total percent plant cover of at least seventy percent (70%) of pre-disturbance levels or reference areas. The approved seed mixes and application rates for the SECO field are presented below in **Table 2.**

Table 2
Approved Seed Mixes and Application Rates
Southeastern Colorado (SECO)

Seed Mix				
Species	Variety	% Species in Mixture	Required PLS Rate	Per Species
Dryland Sandy Plains Mix				
Sand bluestem	Elida, Woodward, Garden	15	16	2.40
Prairie sandreed	Goshen	15	6.5	0.98
Swithgrass	Grenville, Nebraska 28, Blackwell, Pathfinder	10	4	0.40
Sideoats grama	Vaughn, Butte, Niner, El Reno, Haskell, Trailway	10	9	0.90
Yellow indiangrass	Llano, Holt, Cheyeene, Oto	10	10	1.00
Western wheatgrass	Arriba, Barton, Rosana	10	16	1.60
Blue gramma	Lovington, Hachita	10	3	0.30
Little bluestem	Pastura	20	7	1.40
Dryland Loamy Plains Mix				
Western wheatgrass	Arriba, Barton, Rosana	15	16	2.40
Sideoats grama	Vaughn, Butte, Niner, El Reno, Haskell, Trailway	15	9	1.35
Blue gramma	Lovington, Hachita	10	3	0.30
Green Needlegrass	Lordorm, Green stipagrass	10	10	1.00
Yellow indiangrass	Llano, Holt, Cheyeene, Oto	10	10	1.00
Swithgrass	Grenville, Nebraska 28, Blackwell, Pathfinder	10	4	0.40
Big bluestem	Kaw, Pawnee	10	11	1.10
Little bluestem	Pastura	20	7	1.40

Notes:
% = percent
PLS = pure live seed
PLS Rate is for 100% seeding per acre
PLS Rate per species is also per acre

Sites are considered finally stabilized once site preparation and interim reclamation (COGCC Rule 1003) are complete and the above stabilization criteria have been met, even though the site will be disturbed again in the future for final reclamation.

Once final stabilization is achieved, the well pad and/or access road will be removed from this SWMP for sediment controls. If petroleum hydrocarbons or other chemicals impact stormwater as a result of activities onsite, the affected site will maintain permit coverage and SPCC plan BMPs will be maintained. Permanent BMPs may be left in place if it is deemed necessary to maintain site stability.

5. INSPECTIONS AND MAINTENANCE PROCEDURES

Site inspections will be conducted with the requirements and minimum schedule as outlined in Part I.D.6 of the General Permit (COR-030000). The requirements are as follows:

- All active construction sites will be inspected at a minimum of at least once every 14 calendar days, and within 24 hours after the end of any precipitation or snowmelt event that causes surface erosion.
- If a site is considered temporarily idle, that is, no construction activities will occur following a storm event, then a post-storm inspection will be conducted prior to re-commencing constructing activities, but no later than 72 hours following the storm event. Routine inspections must still be conducted at least every 14 calendar days.
- For sites or portions of sites in which all construction activities that will result in ground disturbance are completed, and all activities for final stabilization, as outlined above in section 4, with the exception of vegetative coverage are completed, inspections will be conducted at least once every month, and post-storm inspections are not required.
- Inspections are not required at sites where snow cover exists over the entire site for an extended period of time as long as melting conditions do not exist. The following information must be documented in the inspection record for the use of this exclusion: dates when snow cover occurred, date when construction activities ceased, and date melting conditions began.

A trained and qualified person familiar with the SWMP and stormwater controls will conduct all inspections. The scope of the inspection will cover the construction site perimeter, all disturbed areas, material and/or waste storage areas that are exposed to precipitation, discharge locations, and locations where vehicles access the site. These areas will be inspected for evidence of, or the potential for, pollutants leaving the construction site boundaries, entering the stormwater drainage system, or discharging to waters of the state. Also, all erosion and sediment control practices identified in this SWMP will be evaluated to ensure that they are maintained and operating correctly.

Personnel performing site inspections will record the information as outlined below on the in PDC's database. Inspection reports will identify any incidents of non-compliance with the terms and conditions of the General Permit. The inspection report will include:

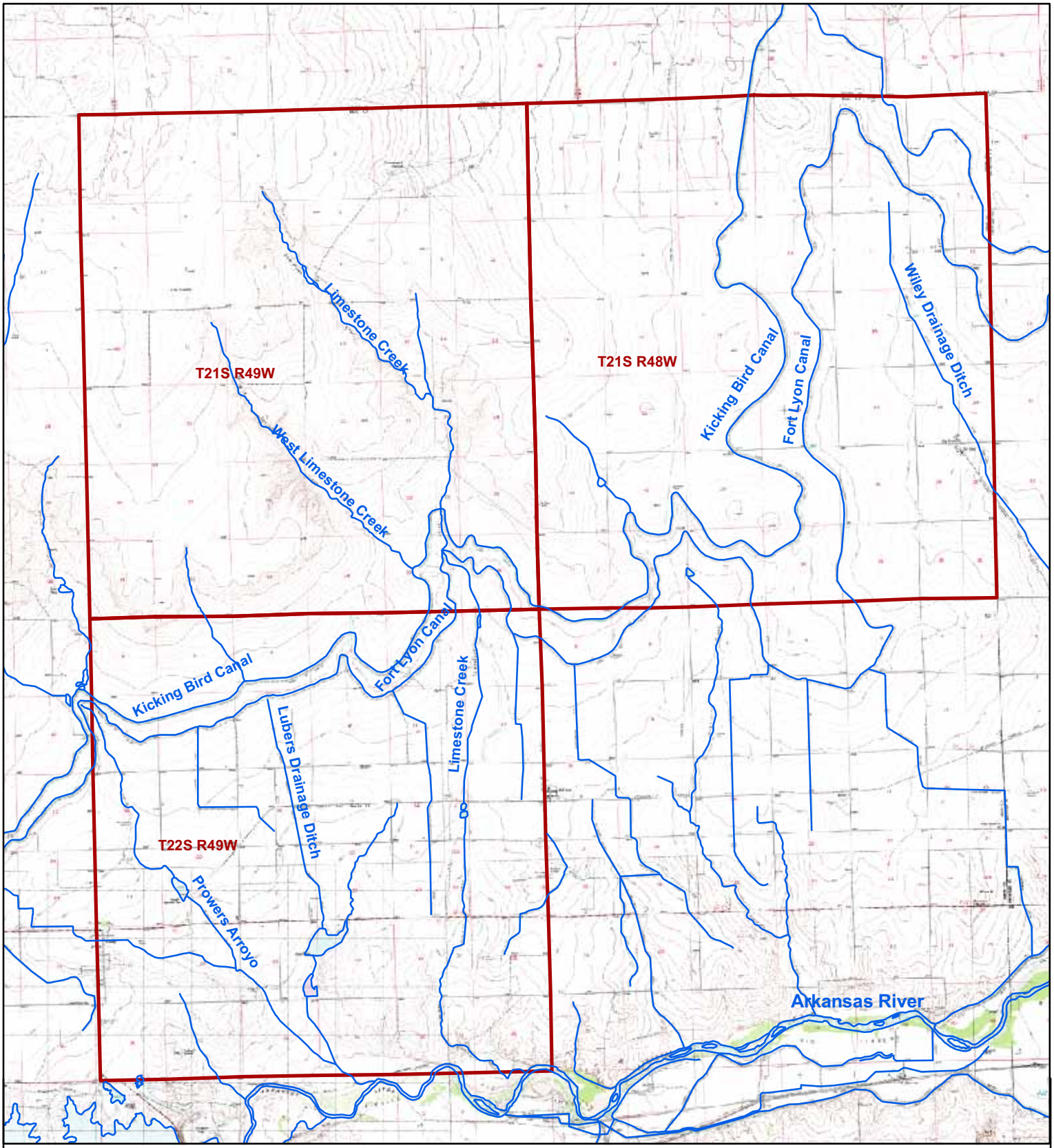
i. The inspection date
ii. Name(s) and title(s) of personnel making the inspection
iii. Location(s) of discharges of sediment or other pollutants from the site
iv. Location(s) of BMPs that need to be maintained
v. Location(s) of BMPs that failed to operate as designed or proved inadequate for a particular location
vi. Location(s) where additional BMPs are needed that were not in place at the time of inspection
vii. Deviations from the minimum inspection schedule as outlined above
viii. Description of corrective action for items iii, iv, v, and vi, above, dates corrective action(s) taken, and measures taken to prevent future violations, including requisite changes to the SWMP, as necessary

ix. After adequate corrective action(s) have been taken, or where a report does not identify any incidents requiring corrective action(s), the report shall contain a signed statement indicating the site is in compliance with the permit to the best of the signer's knowledge and belief.

If deficiencies or maintenance issues are noted on the inspection form, or additional BMPs need installed, then the Stormwater Administrator for PDC will be contacted and they will direct a subcontractor to perform the proper actions. BMPs that have failed, or have the potential to fail without maintenance or modification, will be addressed as soon as possible, immediately in many cases, to prevent the discharge of pollutants. All BMPs will be adequately maintained in accordance with good engineering, hydrologic and pollution control practices, including removal of collected sediment outside the acceptable tolerances of the BMPs.

All inspection records will be kept for a minimum of three years from expiration or inactivation of permit coverage at PDC's Wray Office.

Figures



PROJECT NO:	010-2050
DRAWN BY:	Leslie Booth GIS Analyst
DATE:	09/15/2010

PERMITTED AREA MAP
SOUTHEASTERN COLORADO FIELD
PDC ENERGY
TOWNSHIPS 21 & 22, RANGE 49W
TOWNSHIP 21, RANGE 48W
BENT COUNTY, COLORADO

OLSSON ASSOCIATES
826 21-1/2 ROAD
GRAND JUNCTION,
CO 81505
TEL 970.263.7800
FAX 970.263.7456

FIGURE

1

Appendix A

General Permit COR-030000

CDPS GENERAL PERMIT

STORMWATER DISCHARGES ASSOCIATED WITH
CONSTRUCTION ACTIVITY

AUTHORIZATION TO DISCHARGE UNDER THE

COLORADO DISCHARGE PERMIT SYSTEM

In compliance with the provisions of the Colorado Water Quality Control Act, (25-8-101 et seq., CRS, 1973 as amended) and the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.; the "Act"), this permit authorizes the discharge of stormwater associated with construction activities (and specific allowable non-stormwater discharges in accordance with Part I.D.3 of the permit) certified under this permit, from those locations specified throughout the State of Colorado to specified waters of the State. Such discharges shall be in accordance with the conditions of this permit.

This permit specifically authorizes the facility listed on the certification page (page 1) of this permit to discharge, as of this date, in accordance with permit requirements and conditions set forth in Parts I and II hereof. All discharges authorized herein shall be consistent with the terms and conditions of this permit.

This permit and the authorization to discharge shall expire at midnight, **June 30, 2012.**

Issued and Signed this 31st day of May, 2007

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Janet S. Kieler
Permits Section Manager
Water Quality Control Division

SIGNED AND ISSUED MAY 31, 2007

EFFECTIVE JULY 1, 2007

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PART I

TABLE OF CONTENTS (cont.)

PART II

PART I

A. COVERAGE UNDER THIS PERMIT

1. **Authority to Discharge**

Under this permit, facilities are granted authorization to discharge stormwater associated with construction activities into waters of the state of Colorado. This permit also authorizes the discharge of specific allowable non-stormwater discharges, in accordance with Part I.D.3 of the permit, which includes discharges to the ground. This includes stormwater discharges from areas that are dedicated to producing earthen materials, such as soils, sand and gravel, for use at a single construction site (i.e., borrow or fill areas). This permit also authorizes stormwater discharges from dedicated asphalt batch plants and dedicated concrete batch plants. (Coverage under the construction site permit is not required for batch plants if they have alternate CDPS permit coverage.) This permit does not authorize the discharge of mine water or process water from such areas.

a) **Applicable Sections:** In accordance with Part I.A.3 of this permit, some parts of this permit do not apply to sites covered under a Qualifying Local Program, as defined in I.A.2.d. For sites not covered by a Qualifying Local Program, all parts of the permit apply except Part I.A.3. The permittee will be responsible for determining and then complying with the applicable sections.

b) **Oil and Gas Construction:** Stormwater discharges associated with construction activities directly related to oil and gas exploration, production, processing, and treatment operations or transmission facilities are regulated under the Colorado Discharge Permit System Regulations (5CCR 1002-61), and require coverage under this permit in accordance with that regulation. However, references in this permit to specific authority under the Federal Clean Water Act (CWA) do not apply to stormwater discharges associated with these oil and gas related construction activities, to the extent that the references are limited by the federal Energy Policy Act of 2005.

2. **Definitions**

a) **Stormwater:** Stormwater is precipitation-induced surface runoff.

b) **Construction activity:** Construction activity refers to ground surface disturbing activities, which include, but are not limited to, clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging areas, stockpiling of fill materials, and borrow areas. Construction does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility.

c) **Small construction activity:** Stormwater discharge associated with small construction activity means the discharge of stormwater from construction activities that result in land disturbance of equal to or greater than one acre and less than five acres. Small construction activity also includes the disturbance of less than one acre of total land area that is part of a larger common plan of development or sale, if the larger common plan will ultimately disturb equal to or greater than one and less than five acres.

d) **Qualifying Local Program:** This permit includes conditions that incorporate qualifying local erosion and sediment control program (Qualifying Local Program) requirements by reference. A Qualifying Local Program is a municipal stormwater program for stormwater discharges associated with small construction activity that has been formally approved by the Division.

Other Definitions: Definitions of additional terms can be found in Part I.E. of this permit.

3. **Permit Coverage Without Application – for small construction activities under a Qualifying Local Program only**

If a small construction site is within the jurisdiction of a Qualifying Local Program, the operator of the construction activity is authorized to discharge stormwater associated with small construction activity under this general permit without the submittal of an application to the Division.

a) **Applicable Sections**: For sites covered by a Qualifying Local Program, only Parts 1.A.1, 1.A.2, 1.A.3, I.D.1, I.D.2, I.D.3, I.D.4, I.D.7, I.D.8, I.D.11, I.E and Part II of this permit, with the exception of Parts II.A.1, II.B.3, II.B.8, and II.B10, apply.

A. COVERAGE UNDER THIS PERMIT (cont.)

b) **Local Agency Authority:** This permit does not pre-empt or supersede the authority of local agencies to prohibit, restrict, or control discharges of stormwater to storm drain systems or other water courses within their jurisdiction.

c) **Permit Coverage Termination:** When a site under a Qualifying Local Program has been finally stabilized, coverage under this permit is automatically terminated.

d) **Compliance with Qualifying Local Program:** A construction site operator that has authorization to discharge under this permit under Part I.A.3 shall comply with the requirements of the Qualifying Local Program with jurisdiction over the site.

e) **Full Permit Applicability:** The Division may require any operator within the jurisdiction of a Qualifying Local Program covered under this permit to apply for and obtain coverage under the full requirements of this permit. The operator must be notified in writing that an application for full coverage is required. When a permit certification under this permit is issued to an operator that would otherwise be covered under Part I.A.3 of this permit, the full requirements of this permit replace the requirements as per Part I.A.3 of this permit, upon the effective date of the permit certification. A site brought under the full requirements of this permit must still comply with local stormwater management requirements, policies or guidelines as required by Part I.D.1.g of this permit.

4. **Application, Due Dates**

a) **Application Due Dates:** At least **ten calendar days** prior to the commencement of construction activities, the applicant shall submit an application form as provided by the Division, with a certification that the Stormwater Management Plan (SWMP) is complete.

One original completed discharge permit application shall be submitted, by mail or hand delivery, to:

Colorado Department of Public Health and Environment
Water Quality Control Division
WQCD-Permits-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

b) **Summary of Application:** The application requires, at a minimum, the following:

1) The applicant's company name; address; telephone number; and email address (if available); whether the applicant is the owner, developer, or contractor; and local contact information;
2) Project name, address, county and location of the construction site, including the latitude and longitude to the nearest 15 seconds of the approximate center of the construction activity;
3) Legal description or map of the construction site;
4) Estimates of: the total area of the site, the area of the site that is expected to be disturbed, and the total area of the larger common plan of development or sale to undergo disturbance;
5) The nature of the construction activity;
6) The anticipated start date and final stabilization date for the project;
7) The name of the receiving water(s), or the municipal separate storm sewer system and the ultimate (i.e., named) receiving water(s);
8) Certification that the SWMP for the construction site is complete (see Part I.C. below); and
9) The signature of the applicant, signed in accordance with Part I.F.1 of this permit.

5. **Permit Certification Procedures**

If this general permit is appropriate for the applicant's operation, then a certification will be developed and the applicant will be authorized to discharge stormwater under this general permit.

a) **Request for Additional Information**: The Division shall have up to **ten calendar days** after receipt of the above information to request additional data and/or deny the authorization for any particular discharge. Upon receipt of additional information, the Division shall have an additional **ten calendar days** to issue or deny authorization for the particular discharge. (Notification of denial shall be by letter, in cases where coverage under an alternate general permit or an individual permit is required, instead of coverage under this permit.)

A. COVERAGE UNDER THIS PERMIT (cont.)

b) **Automatic Coverage**: If the applicant does not receive a request for additional information or a notification of denial from the Division dated within ten calendar days of receipt of the application by the Division, authorization to discharge in accordance with the conditions of this permit shall be deemed granted.

c) **Individual Permit Required**: If, after evaluation of the application (or additional information, such as the SWMP), it is found that this general permit is not appropriate for the operation, then the application will be processed as one for an individual permit. The applicant will be notified of the Division's decision to deny certification under this general permit. For an individual permit, additional information may be requested, and 180 days may be required to process the application and issue the permit. At the Division's discretion, temporary coverage under this general permit may be allowed until the individual permit goes into effect.

d) **General vs. Individual Permit Coverage**: Any permittee authorized by this permit may request to be excluded from the coverage of this permit by applying for an individual CDPS permit. The permittee shall submit an individual application, with reasons supporting the request, to the Division at least 180 days prior to any discharge.

e) **Local Agency Authority:** This permit does not pre-empt or supersede the authority of local agencies to prohibit, restrict, or control discharges of stormwater to storm drain systems or other water courses within their jurisdiction.

6. **Inactivation Notice**

When a site has been finally stabilized in accordance with the SWMP, the permittee must submit an **Inactivation Notice** form that is signed in accordance with Part I.F.1. of this permit. The Inactivation Notice form is available from the Division and includes:

a) Permit certification number;
b) The permittee's name, address, telephone number;
c) Name, location, and county for the construction site for which the inactivation notice is being submitted; and
d) Certification that the site has been finally stabilized, and a description of the final stabilization method(s).

7. **Transfer of Permit**

When responsibility for stormwater discharges at a construction site changes from one entity to another, the permittee shall submit a completed **Notice of Transfer and Acceptance of Terms** form that is signed in accordance with Part I.F.1. of this permit. The Notice of Transfer form is available from the Division and includes:

a) Permit certification number;
b) Name, location, and county for the construction site for which the Notice of Transfer is being submitted;
c) Identifying information for the new permittee;
d) Identifying information for the current permittee; and
e) Effective date of transfer.

If the new responsible party will not complete the transfer form, the permit may be inactivated upon written request to the Division and completion of the Inactivation Notice if the permittee has no legal responsibility, through ownership or contract, for the construction activities at the site. In this case, the new owner or operator would be required to obtain permit coverage separately.

8. **Reassignment of Permit**

When a permittee no longer has control of a specific portion of a permitted site, and wishes to transfer coverage of that portion of the site to a second party, the permittee shall submit a completed **Notice of Reassignment of Permit Coverage** form that is signed in accordance with Part I.F.1. of this permit. The Notice of Reassignment of Permit Coverage form is available from the Division and includes:

a) Current permit certification number;
b) Identifying information and certification as required by Part I.A.4.b for the new permittee;
c) Identifying information for the current permittee, revised site information and certification for reassignment; and
d) Effective date of reassignment.

A. COVERAGE UNDER THIS PERMIT (cont.)

If the new responsible party will not complete the reassignment form, the applicable portion of the permitted site may be removed from permit coverage upon written request to the Division if the permittee has no legal responsibility, through ownership or contract, for the construction activities at the portion of the site. In this case, the new owner or operator would be required to obtain permit coverage separately.

9. **Sale of Residence to Homeowners**

For residential construction only, when a residential lot **has been conveyed to a homeowne**r and all criteria in paragraphs a through e, below, are met, coverage under this permit is no longer required and the conveyed lot may be removed from coverage under the permittee's certification. At such time, the permittee is no longer responsible for meeting the terms and conditions of this permit for the conveyed lot, including the requirement to transfer or reassign permit coverage. The permittee remains responsible for inactivation of the original certification.

a) The lot has been sold to the homeowner(s) for private residential use;
b) the lot is less than one acre of disturbed area;
c) all construction activity conducted by the permittee on the lot is completed;
d) a certificate of occupancy (or equivalent) has been awarded to the home owner; and
e) the SWMP has been amended to indicate the lot is no longer covered by permit.

Lots not meeting all of the above criteria require continued permit coverage. However, this permit coverage may be transferred (Part I.A.7, above) or reassigned (Part I.A.8, above) to a new owner or operator.

10. **Permit Expiration Date**

Authorization to discharge under this general permit shall expire on June 30, 2012. The Division must evaluate and reissue this general permit at least once every five years and must recertify the permittee's authority to discharge under the general permit at such time. Therefore, a permittee desiring continued coverage under the general permit must reapply by March 31, 2012. The Division will initiate the renewal process; however, it is ultimately the permittee's responsibility to ensure that the renewal is submitted. The Division will determine if the permittee may continue to operate under the terms of the general permit. An individual permit may be required for any facility not reauthorized to discharge under the reissued general permit.

11. **Individual Permit Criteria**

Various criteria can be used in evaluating whether or not an individual (or alternate general) permit is required instead of this general permit. This information may come from the application, SWMP, or additional information as requested by the Division, and includes, but is not limited to, the following:

a) the quality of the receiving waters (i.e., the presence of downstream drinking water intakes or a high quality fishery, or for preservation of high quality water);
b) the size of the construction site;
c) evidence of noncompliance under a previous permit for the operation;
d) the use of chemicals within the stormwater system; or
e) discharges of pollutants of concern to waters for which there is an established Total Maximum Daily Load (TMDL).

In addition, an individual permit may be required when the Division has shown or has reason to suspect that the stormwater discharge may contribute to a violation of a water quality standard.

B. STORMWATER MANAGEMENT PLAN (SWMP) – **GENERAL REQUIREMENTS**

1. A SWMP shall be developed for each facility covered by this permit. The SWMP shall be prepared in accordance with good engineering, hydrologic and pollution control practices. (The SWMP need not be prepared by a registered engineer.)

B. STORMWATER MANAGEMENT PLAN (SWMP) – **GENERAL REQUIREMENTS** (cont.)

2. The SWMP shall:

   a) Identify all potential sources of pollution which may reasonably be expected to affect the quality of stormwater discharges associated with construction activity from the facility;

   b) Describe the practices to be used to reduce the pollutants in stormwater discharges associated with construction activity at the facility; and ensure the practices are selected and described in accordance with good engineering practices, including the installation, implementation and maintenance requirements; and

   c) Be properly prepared, and updated in accordance with Part I.D.5.c, to ensure compliance with the terms and conditions of this permit.

3. Facilities must implement the provisions of the SWMP as written and updated, from commencement of construction activity until final stabilization is complete, as a condition of this permit. The Division reserves the right to review the SWMP, and to require the permittee to develop and implement additional measures to prevent and control pollution as needed.

4. The SWMP may reflect requirements for Spill Prevention Control and Countermeasure (SPCC) plans under section 311 of the CWA, or Best Management Practices (BMPs) Programs otherwise required by a separate CDPS permit, and may incorporate any part of such plans into the SWMP by reference, provided that the relevant sections of such plans are available as part of the SWMP consistent with Part I.D.5.b.

5. For any sites with permit coverage before June 30, 2007, the permittee's SMWP must meet the new SWMP requirements as summarized in Section II.I of the rationale. Any needed changes must be made by **October 1, 2007**.

C. STORMWATER MANAGEMENT PLAN (SWMP) – **CONTENTS**

The SWMP shall include the following items, at a minimum.

1. **Site Description.** The SWMP shall clearly describe the construction activity, to include:

   a) The nature of the construction activity at the site.
   b) The proposed sequence for major activities.
   c) Estimates of the total area of the site, and the area and location expected to be disturbed by clearing, excavation, grading, or other construction activities.
   d) A summary of any existing data used in the development of the site construction plans or SWMP that describe the soil or existing potential for soil erosion.
   e) A description of the existing vegetation at the site and an estimate of the percent vegetative ground cover.
   f) The location and description of all potential pollution sources, including ground surface disturbing activities (see Part I.A.2.b), vehicle fueling, storage of fertilizers or chemicals, etc.
   g) The location and description of any anticipated allowable sources of non-stormwater discharge at the site, e.g., uncontaminated springs, landscape irrigation return flow, construction dewatering, and concrete washout.
   h) The name of the receiving water(s) and the size, type and location of any outfall(s). If the stormwater discharge is to a municipal separate storm sewer system, the name of that system, the location of the storm sewer discharge, and the ultimate receiving water(s).

2. **Site Map.** The SWMP shall include a legible site map(s), showing the entire site, identifying:

   a) construction site boundaries;
   b) all areas of ground surface disturbance;
   c) areas of cut and fill;
   d) areas used for storage of building materials, equipment, soil, or waste;
   e) locations of dedicated asphalt or concrete batch plants;
   f) locations of all structural BMPs;
   g) locations of non-structural BMPs as applicable; and
   h) locations of springs, streams, wetlands and other surface waters.

C. STORMWATER MANAGEMENT PLAN (SWMP) – **CONTENTS** (cont.)

3. **Stormwater Management Controls.**

The SWMP must include a description of all stormwater management controls that will be implemented as part of the construction activity to control pollutants in stormwater discharges. The appropriateness and priorities of stormwater management controls in the SWMP shall reflect the potential pollutant sources identified at the facility.

The description of stormwater management controls shall address the following components, at a minimum:

a) **SWMP Administrator** - The SWMP shall identify a specific individual(s), position or title who is responsible for developing, implementing, maintaining, and revising the SWMP. The activities and responsibilities of the administrator shall address all aspects of the facility's SWMP.

b) **Identification of Potential Pollutant Sources** - All potential pollutant sources, including materials and activities, at a site must be evaluated for the potential to contribute pollutants to stormwater discharges. The SWMP shall identify and describe those sources determined to have the potential to contribute pollutants to stormwater discharges, and the sources must be controlled through BMP selection and implementation, as required in paragraph (c), below.

At a minimum, each of the following sources and activities shall be evaluated for the potential to contribute pollutants to stormwater discharges, and identified in the SWMP if found to have such potential:

1) all disturbed and stored soils;
2) vehicle tracking of sediments;
3) management of contaminated soils;
4) loading and unloading operations;
5) outdoor storage activities (building materials, fertilizers, chemicals, etc.);
6) vehicle and equipment maintenance and fueling;
7) significant dust or particulate generating processes;
8) routine maintenance activities involving fertilizers, pesticides, detergents, fuels, solvents, oils, etc.;
9) on-site waste management practices (waste piles, liquid wastes, dumpsters, etc.);
10) concrete truck/equipment washing, including the concrete truck chute and associated fixtures and equipment;
11) dedicated asphalt and concrete batch plants;
12) non-industrial waste sources such as worker trash and portable toilets; and
13) other areas or procedures where potential spills can occur.

c) **Best Management Practices (BMPs) for Stormwater Pollution Prevention -** The SWMP shall identify and describe appropriate BMPs, including, but not limited to, those required by paragraphs 1 through 8 below, that will be implemented at the facility to reduce the potential of the sources identified in Part I.C.3.b to contribute pollutants to stormwater discharges. The SWMP shall clearly describe the installation and implementation specifications for each BMP identified in the SWMP to ensure proper implementation, operation and maintenance of the BMP.

1) Structural Practices for Erosion and Sediment Control. The SWMP shall clearly describe and locate all structural practices implemented at the site to minimize erosion and sediment transport. Practices may include, but are not limited to: straw bales, wattles/sediment control logs, silt fences, earth dikes, drainage swales, sediment traps, subsurface drains, pipe slope drains, inlet protection, outlet protection, gabions, and temporary or permanent sediment basins.

2) Non-Structural Practices for Erosion and Sediment Control. The SWMP shall clearly describe and locate, as applicable, all non-structural practices implemented at the site to minimize erosion and sediment transport. Description must include interim and permanent stabilization practices, and site-specific scheduling for implementation of the practices. The SWMP should include practices to ensure that existing vegetation is preserved where possible. Non-structural practices may include, but are not limited to: temporary vegetation, permanent vegetation, mulching, geotextiles, sod stabilization, slope roughening, vegetative buffer strips, protection of trees, and preservation of mature vegetation.

C. STORMWATER MANAGEMENT PLAN (SWMP) – **CONTENTS** (cont.)

3) Phased BMP Implementation. The SWMP shall clearly describe the relationship between the phases of construction, and the implementation and maintenance of both structural and non-structural stormwater management controls. The SWMP must identify the stormwater management controls to be implemented during the project phases, which can include, but are not limited to, clearing and grubbing; road construction; utility and infrastructure installation; vertical construction; final grading; and final stabilization.

4) Materials Handling and Spill Prevention. The SWMP shall clearly describe and locate all practices implemented at the site to minimize impacts from procedures or significant materials (see definitions at Part I.E.) that could contribute pollutants to runoff. Such procedures or significant materials could include: exposed storage of building materials; paints and solvents; fertilizers or chemicals; waste material; and equipment maintenance or fueling procedures.

   Areas or procedures where potential spills can occur must have spill prevention and response procedures identified in the SWMP.

5) Dedicated Concrete or Asphalt Batch Plants. The SWMP shall clearly describe and locate all practices implemented at the site to control stormwater pollution from dedicated concrete batch plants or dedicated asphalt batch plants covered by this certification.

6) Vehicle Tracking Control. The SWMP shall clearly describe and locate all practices implemented at the site to control potential sediment discharges from vehicle tracking. Practices must be implemented for all areas of potential vehicle tracking, and can include: minimizing site access; street sweeping or scraping; tracking pads; graveled parking areas; requiring that vehicles stay on paved areas on-site; wash racks; contractor education; and/or sediment control BMPs, etc.

7) Waste Management and Disposal, Including Concrete Washout.

   i) The SWMP shall clearly describe and locate the practices implemented at the site to control stormwater pollution from all construction site wastes (liquid and solid), including concrete washout activities.
   ii) The practices used for concrete washout must ensure that these activities do not result in the contribution of pollutants associated with the washing activity to stormwater runoff.
   iii) Part I.D.3.c of the permit authorizes the conditional discharge of concrete washout water to the ground. The SWMP shall clearly describe and locate the practices to be used that will ensure that no washout water from concrete washout activities is discharged from the site as surface runoff or to surface waters.

8) Groundwater and Stormwater Dewatering.

   i) The SWMP shall clearly describe and locate the practices implemented at the site to control stormwater pollution from the dewatering of groundwater or stormwater from excavations, wells, etc.
   ii) Part I.D.3.d of the permit authorizes the conditional discharge of construction dewatering to the ground. For any construction dewatering of groundwater not authorized under a separate CDPS discharge permit, the SWMP shall clearly describe and locate the practices to be used that will ensure that no groundwater from construction dewatering is discharged from the site as surface runoff or to surface waters.

4. **Final Stabilization and Long-term Stormwater Management**

a) The SWMP shall clearly describe the practices used to achieve final stabilization of all disturbed areas at the site, and any planned practices to control pollutants in stormwater discharges that will occur after construction operations have been completed at the site.

b) Final stabilization practices for obtaining a vegetative cover should include, as appropriate: seed mix selection and application methods; soil preparation and amendments; soil stabilization practices (e.g., crimped straw, hydro mulch or rolled erosion control products); and appropriate sediment control BMPs as needed until final stabilization is achieved; etc.

C. STORMWATER MANAGEMENT PLAN (SWMP) – **CONTENTS** (cont.)

c) Final stabilization is reached when all ground surface disturbing activities at the site have been completed, and uniform vegetative cover has been established with an individual plant density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed.

The Division may, after consultation with the permittee and upon good cause, amend the final stabilization criteria in this section for specific operations.

5. **Inspection and Maintenance**

Part I.D.6 of the permit includes requirements for site inspections. Part I.D.7 of the permit includes requirements for BMP maintenance. The SWMP shall clearly describe the inspection and maintenance procedures implemented at the site to maintain all erosion and sediment control practices and other protective practices identified in the SWMP, in good and effective operating condition.

D. TERMS AND CONDITIONS

1. **General Limitations**

The following limitations shall apply to all discharges covered by this permit:

a) Stormwater discharges from construction activities shall not cause, have the reasonable potential to cause, or measurably contribute to an exceedance of any water quality standard, including narrative standards for water quality.

b) Concrete washout water shall not be discharged to state surface waters or to storm sewer systems. On-site permanent disposal of concrete washout waste is not authorized by this permit. Discharge to the ground of concrete washout waste that will subsequently be disposed of off-site is authorized by this permit. See Part I.D.3.c of the permit.

c) Bulk storage structures for petroleum products and any other chemicals shall have secondary containment or equivalent adequate protection so as to contain all spills and prevent any spilled material from entering State waters.

d) No chemicals are to be added to the discharge unless permission for the use of a specific chemical is granted by the Division. In granting the use of such chemicals, special conditions and monitoring may be addressed by separate correspondence.

e) The Division reserves the right to require sampling and testing, on a case-by-case basis, in the event that there is reason to suspect that compliance with the SWMP is a problem, or to measure the effectiveness of the BMPs in removing pollutants in the effluent. Such monitoring may include Whole Effluent Toxicity testing.

f) All site wastes must be properly managed to prevent potential pollution of State waters. This permit does not authorize on-site waste disposal.

g) All dischargers must comply with the lawful requirements of federal agencies, municipalities, counties, drainage districts and other local agencies regarding any discharges of stormwater to storm drain systems or other water courses under their jurisdiction, including applicable requirements in municipal stormwater management programs developed to comply with CDPS permits. Dischargers must comply with local stormwater management requirements, policies or guidelines including erosion and sediment control.

2. **BMP Implementation and Design Standards**

Facilities must select, install, implement, and maintain appropriate BMPs, following good engineering, hydrologic and pollution control practices. BMPs implemented at the site must be adequately designed to provide control for all potential pollutant sources associated with construction activity to prevent pollution or degradation of State waters.

D. TERMS AND CONDITIONS (cont.)

3. **Prohibition of Non-Stormwater Discharges**

a) Except as provided in paragraphs b, c, and d below, **all discharges covered by this permit shall be composed entirely of stormwater associated with construction activity**. Discharges of material other than stormwater must be addressed in a separate CDPS permit issued for that discharge.

b) Discharges from the following sources that are combined with stormwater discharges associated with construction activity may be authorized by this permit, provided that the non-stormwater component of the discharge is identified in the SWMP (see Part I.C.1.g of this permit):

- emergency fire fighting activities
- landscape irrigation return flow
- uncontaminated springs

c) Discharges to the ground of concrete washout water from washing of tools and concrete mixer chutes may be authorized by this permit, provided that:

1) the source is identified in the SWMP;
2) BMPs are included in the SWMP in accordance with Part I.C.3(c)(7) and to prevent pollution of groundwater in violation of Part I.D.1.a; and
3) these discharges do not leave the site as surface runoff or to surface waters

d) Discharges to the ground of water from construction dewatering activities may be authorized by this permit, provided that:

1) the source is groundwater and/or groundwater combined with stormwater that does not contain pollutants in concentrations exceeding the State groundwater standards in Regulations 5 CCR 1002-41 and 42;
2) the source is identified in the SWMP;
3) BMPs are included in the SWMP, as required by Part I.C.3(c)(8); and
4) these discharges do not leave the site as surface runoff or to surface waters.

Discharges to the ground from construction dewatering activities that do not meet the above criteria must be covered under a separate CDPS discharge permit. Contaminated groundwater requiring coverage under a separate CDPS discharge permit may include groundwater contaminated with pollutants from a landfill, mining activity, industrial pollutant plume, underground storage tank, or other source.

4. **Releases in Excess of Reportable Quantities**

This permit does not relieve the permittee of the reporting requirements of 40 CFR 110, 40 CFR 117 or 40 CFR 302. Any discharge of hazardous material must be handled in accordance with the Division's Noncompliance Notification Requirements (see Part II.A.3 of the permit).

5. **SWMP Requirements**

a) **SWMP Preparation and Implementation**: The SWMP shall be prepared prior to applying for coverage under the general permit, and certification of its completion submitted with the application. The SWMP shall be implemented prior to commencement of construction activities. The plan shall be updated as appropriate (see paragraph c, below), below). SWMP provisions shall be implemented until expiration or inactivation of permit coverage.

b) **SWMP Retention Requirements**: A copy of the SWMP must be retained on site unless another location, specified by the permittee, is approved by the Division.

c) **SWMP Review/Changes**: The permittee shall amend the SWMP:

1) when there is a change in design, construction, operation, or maintenance of the site, which would require the implementation of new or revised BMPs; or

2) if the SWMP proves to be ineffective in achieving the general objectives of controlling pollutants in stormwater discharges associated with construction activity; or

D. TERMS AND CONDITIONS (cont.)

3) when BMPs are no longer necessary and are removed.

SWMP changes shall be made prior to changes in the site conditions, except as allowed for in paragraph d, below. SWMP revisions may include, but are not limited to: potential pollutant source identification; selection of appropriate BMPs for site conditions; BMP maintenance procedures; and interim and final stabilization practices. The SWMP changes may include a schedule for further BMP design and implementation, provided that, if any interim BMPs are needed to comply with the permit, they are also included in the SWMP and implemented during the interim period.

d) **Responsive SWMP Changes**: SWMP changes addressing BMP installation and/or implementation are often required to be made in response to changing conditions, or when current BMPs are determined ineffective. The majority of SWMP revisions to address these changes can be made immediately with quick in-the-field revisions to the SWMP. In the less common scenario where more complex development of materials to modify the SWMP is necessary, SWMP revisions shall be made in accordance with the following requirements:

1) the SWMP shall be revised as soon as practicable, but in no case more than 72 hours after the change(s) in BMP installation and/or implementation occur at the site, and

2) a notation must be included in the SWMP prior to the site change(s) that includes the time and date of the change(s) in the field, an identification of the BMP(s) removed or added, and the location(s) of those BMP(s).

6. **Inspections**

Site inspections must be conducted in accordance with the following requirements and minimum schedules. The required minimum inspection schedules do not reduce or eliminate the permittee's responsibility to implement and maintain BMPs in good and effective operational condition, and in accordance with the SWMP, which could require more frequent inspections.

a) **Minimum Inspection Schedule:** The permittee shall, at a minimum, make a thorough inspection, in accordance with the requirements in I.D.6.b below, at least once every 14 calendar days. Also, post-storm event inspections must be conducted within 24 hours after the end of any precipitation or snowmelt event that causes surface erosion. Provided the timing is appropriate, the post-storm inspections may be used to fulfill the 14-day routine inspection requirement. A more frequent inspection schedule than the minimum inspections described may be necessary, to ensure that BMPs continue to operate as needed to comply with the permit. The following conditional modifications to this Minimum Inspection Schedule are allowed:

1) **Post-Storm Event Inspections at Temporarily Idle Sites** – If no construction activities will occur following a storm event, post-storm event inspections shall be conducted prior to re-commencing construction activities, but no later than 72 hours following the storm event. The occurrence of any such delayed inspection must be documented in the inspection record. Routine inspections still must be conducted at least every 14 calendar days.

2) **Inspections at Completed Sites/Areas** – For sites or portions of sites that meet the following criteria, but final stabilization has not been achieved due to a vegetative cover that has not become established, the permittee shall make a thorough inspection of their stormwater management system at least once every month, and post-storm event inspections are not required. This reduced inspection schedule is *only* allowed if:

i) all construction activities that will result in surface ground disturbance are completed;
ii) all activities required for final stabilization, in accordance with the SWMP, have been completed, with the exception of the application of seed that has not occurred due to seasonal conditions or the necessity for additional seed application to augment previous efforts; and
iii) the SWMP has been amended to indicate those areas that will be inspected in accordance with the reduced schedule allowed for in this paragraph.

D. TERMS AND CONDITIONS (cont.)

3) **Winter Conditions Inspections Exclusion** – Inspections are not required at sites where construction activities are temporarily halted, snow cover exists over the entire site for an extended period, and melting conditions posing a risk of surface erosion do not exist. This exception is applicable only during the period where melting conditions do not exist, and applies to the routine 14-day and monthly inspections, as well as the post-storm-event inspections. The following information must be documented in the inspection record for use of this exclusion: dates when snow cover occurred, date when construction activities ceased, and date melting conditions began. Inspections, as described above, are required at all other times.

When site conditions make the schedule required in this section impractical, the permittee may petition the Division to grant an alternate inspection schedule.

b) **Inspection Requirements**

1) **Inspection Scope** - The construction site perimeter, all disturbed areas, material and/or waste storage areas that are exposed to precipitation, discharge locations, and locations where vehicles access the site shall be inspected for evidence of, or the potential for, pollutants leaving the construction site boundaries, entering the stormwater drainage system, or discharging to state waters. All erosion and sediment control practices identified in the SWMP shall be evaluated to ensure that they are maintained and operating correctly.

2) **Inspection Report/Records** - The permittee shall keep a record of inspections. Inspection reports must identify any incidents of non-compliance with the terms and conditions of this permit. Inspection records must be retained for three years from expiration or inactivation of permit coverage. At a minimum, the inspection report must include:

i) The inspection date;
ii) Name(s) and title(s) of personnel making the inspection;
iii) Location(s) of discharges of sediment or other pollutants from the site;
iv) Location(s) of BMPs that need to be maintained;
v) Location(s) of BMPs that failed to operate as designed or proved inadequate for a particular location;
vi) Location(s) where additional BMPs are needed that were not in place at the time of inspection;
vii) Deviations from the minimum inspection schedule as provided in Part I.D.6.a above;
vii) Description of corrective action for items iii, iv, v, and vi, above, dates corrective action(s) taken, and measures taken to prevent future violations, including requisite changes to the SWMP, as necessary; and
viii) After adequate corrective action(s) has been taken, or where a report does not identify any incidents requiring corrective action, the report shall contain a signed statement indicating the site is in compliance with the permit to the best of the signer's knowledge and belief.

c) **Required Actions Following Site Inspections** – Where site inspections note the need for BMP maintenance activities, BMPs must be maintained in accordance with the SWMP and Part I.D.7 of the permit. Repair, replacement, or installation of new BMPs determined necessary during site inspections to address ineffective or inadequate BMPs must be conducted in accordance with Part I.D.8 of the permit. SWMP updates required as a result of deficiencies in the SWMP noted during site inspections shall be made in accordance with Part I.D.5.c of the permit.

7. **BMP Maintenance**

All erosion and sediment control practices and other protective measures identified in the SWMP must be maintained in effective operating condition. Proper selection and installation of BMPs and implementation of comprehensive Inspection and Maintenance procedures, in accordance with the SWMP, should be adequate to meet this condition. BMPs that are not adequately maintained in accordance with good engineering, hydrologic and pollution control practices, including removal of collected sediment outside the acceptable tolerances of the BMPs, are considered to be no longer operating effectively and must be addressed in accordance with Part I.D.8, below. A specific timeline for implementing maintenance procedures is not included in this permit because BMP maintenance is expected to be proactive, not responsive. Observations resulting in BMP maintenance activities can be made during a site inspection, or during general observations of site conditions.

D. TERMS AND CONDITIONS (cont.)

8. **Replacement and Failed BMPs**

Adequate site assessment must be performed as part of comprehensive Inspection and Maintenance procedures, to assess the adequacy of BMPs at the site, and the necessity of changes to those BMPs to ensure continued effective performance. Where site assessment results in the determination that new or replacement BMPs are necessary, the BMPs must be installed to ensure on-going implementation of BMPs as per Part I.D.2.

Where BMPs have failed, resulting in noncompliance with Part I.D.2, they must be addressed as soon as possible, immediately in most cases, to minimize the discharge of pollutants.

When new BMPs are installed or BMPs are replaced, the SWMP must be updated in accordance with Part I.D.5(c).

9. **Reporting**

No scheduled reporting requirements are included in this permit; however, the Division reserves the right to request that a copy of the inspection reports be submitted.

10. **SWMP Availability**

A copy of the SWMP shall be provided upon request to the Division, EPA, or any local agency in charge of approving sediment and erosion plans, grading plans or stormwater management plans, and within the time frame specified in the request. If the SWMP is required to be submitted to any of these entities, it must include a signed certification in accordance with Part I.F.1 of the permit, certifying that the SWMP is complete and meets all permit requirements.

All SWMPs required under this permit are considered reports that shall be available to the public under Section 308(b) of the CWA and Section 61.5(4) of the Colorado Discharge Permit System Regulations. The permittee shall make plans available to members of the public upon request. However, the permittee may claim any portion of a SWMP as confidential in accordance with 40 CFR Part 2.

11. **Total Maximum Daily Load (TMDL)**

If a TMDL has been approved for any waterbody into which the permittee discharges, and stormwater discharges associated with construction activity have been assigned a pollutant-specific Wasteload Allocation (WLA) under the TMDL, the Division will either:

a) Ensure that the WLA is being implemented properly through alternative local requirements, such as by a municipal stormwater permit; or

b) Notify the permittee of the WLA, and amend the permittee's certification to add specific BMPs and/or other requirements, as appropriate. The permittee may be required to do the following:

   1) Under the permittee's SWMP, implement specific management practices based on requirements of the WLA, and evaluate whether the requirements are being met through implementation of existing stormwater BMPs or if additional BMPs are necessary. Document the calculations or other evidence that show that the requirements are expected to be met; and

   2) If the evaluation shows that additional or modified BMPs are necessary, describe the type and schedule for the BMP additions/revisions.

Discharge monitoring may also be required. The permittee may maintain coverage under the general permit provided they comply with the applicable requirements outlined above. The Division reserves the right to require individual or alternate general permit coverage.

E. ADDITIONAL DEFINITIONS

For the purposes of this permit:

1. **Best Management Practices (BMPs)**: schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, pollution prevention, and practices to control site runoff, spillage or leaks, waste disposal, or drainage from material storage.

2. **Dedicated asphalt plants and concrete plants**: portable asphalt plants and concrete plants that are located on or adjacent to a construction site and that provide materials only to that specific construction site.

3. **Final stabilization**: when all ground surface disturbing activities at the site have been completed, and uniform vegetative cover has been established with an individual plant density of at least 70 percent of pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed. For purposes of this permit, establishment of a vegetative cover capable of providing erosion control equivalent to pre-existing conditions at the site will be considered final stabilization.

4. **Municipal separate storm sewer system**: a conveyance or system of conveyances (including: roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains), owned or operated by a State, city, town, county, district, or other public body (created by state law), having jurisdiction over disposal of sewage, industrial waste, stormwater, or other wastes; designed or used for collecting or conveying stormwater.

5. **Operator**: the entity that has day-to-day supervision and control of activities occurring at the construction site. This can be the owner, the developer, the general contractor or the agent of one of these parties, in some circumstances. It is anticipated that at different phases of a construction project, different types of parties may satisfy the definition of 'operator' and that the permit may be transferred as the roles change.

6. **Outfall**: a point source at the point where stormwater leaves the construction site and discharges to a receiving water or a stormwater collection system.

7. **Part of a larger common plan of development or sale**: a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules.

8. **Point source**: any discernible, confined and discrete conveyance from which pollutants are or may be discharged. Point source discharges of stormwater result from structures which increase the imperviousness of the ground which acts to collect runoff, with runoff being conveyed along the resulting drainage or grading pattern.

9. **Pollutant**: dredged spoil, dirt, slurry, solid waste, incinerator residue, sewage, sewage sludge, garbage, trash, chemical waste, biological nutrient, biological material, radioactive material, heat, wrecked or discarded equipment, rock, sand, or any industrial, municipal or agricultural waste.

10. **Process water**: any water which, during manufacturing or processing, comes into contact with or results from the production of any raw material, intermediate product, finished product, by product or waste product. This definition includes mine drainage.

11. **Receiving Water**: any classified stream segment (including tributaries) in the State of Colorado into which stormwater related to construction activities discharges. This definition includes all water courses, even if they are usually dry, such as borrow ditches, arroyos, and other unnamed waterways.

12. **Significant Materials** include, but are not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to section 313 of title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with stormwater discharge.

13. **Stormwater**: precipitation-induced surface runoff.

F. GENERAL REQUIREMENTS

1. **Signatory Requirements**

a) All reports required for submittal shall be signed and certified for accuracy by the permittee in accordance with the following criteria:

1) In the case of corporations, by a principal executive officer of at least the level of vice-president or his or her duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge described in the form originates;
2) In the case of a partnership, by a general partner;
3) In the case of a sole proprietorship, by the proprietor;
4) In the case of a municipal, state, or other public facility, by either a principal executive officer, ranking elected official, or other duly authorized employee, if such representative is responsible for the overall operation of the facility from which the discharge described in the form originates.

b) **Changes to authorization**. If an authorization under paragraph a) of this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph a) of this section must be submitted to the Division, prior to or together with any reports, information, or applications to be signed by an authorized representative.

c) **Certification**. Any person signing a document under paragraph a) of this section shall make the following certification:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

2. **Retention of Records**

a) The permittee shall retain copies of the SWMP and all reports required by this permit and records of all data used to complete the application to be covered by this permit, for three years after expiration or inactivation of permit coverage.

b) The permittee shall retain a copy of the SWMP required by this permit at the construction site from the date of project initiation to the date of expiration or inactivation of permit coverage, unless another location, specified by the permittee, is approved by the Division.

3. **Monitoring**

The Division reserves the right to require sampling and testing, on a case-by-case basis (see Part I.D.1.e), for example to implement the provisions of a TMDL (see Part I.D.11 of the permit). Reporting procedures for any monitoring data collected will be included in the notification by the Division of monitoring requirements.

If monitoring is required, the following definitions apply:

a) The **thirty (30) day average** shall be determined by the arithmetic mean of all samples collected during a thirty (30) consecutive-day period.

b) A **grab** sample, for monitoring requirements, is a single "dip and take" sample.

PART II

A. MANAGEMENT REQUIREMENTS

1. **Amending a Permit Certification**

The permittee shall inform the Division (Permits Section) in writing of changes to the information provided in the permit application, including the legal contact, the project legal description or map originally submitted with the application, or the planned total disturbed acreage. The permittee shall furnish the Division with any plans and specifications which the Division deems reasonably necessary to evaluate the effect on the discharge and receiving stream. If applicable, this notification may be accomplished through submittal of an application for a CDPS process water permit authorizing the discharge. The SWMP shall be updated and implemented prior to the changes (see Part I.D.5.c).

Any discharge to the waters of the State from a point source other than specifically authorized by this permit or a different CDPS permit is prohibited.

2. **Special Notifications - Definitions**

a) **Spill:** An unintentional release of solid or liquid material which may cause pollution of state waters.

b) **Upset:** An exceptional incident in which there is unintentional and temporary noncompliance with permit discharge limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

3. **Noncompliance Notification**

a) The permittee shall report the following instances of noncompliance:

1) Any noncompliance which may endanger health or the environment;

2) Any spill or discharge of hazardous substances or oil which may cause pollution of the waters of the state.

3) Any discharge of stormwater which may cause an exceedance of a water quality standard.

b) For all instances of noncompliance based on environmental hazards and chemical spills and releases, all needed information must be provided orally to the Colorado Department of Public Health and Environment spill reporting line (24-hour number for environmental hazards and chemical spills and releases: 1-877-518-5608) within 24 hours from the time the permittee becomes aware of the circumstances.

For all other instances of noncompliance as defined in this section, all needed information must be provided orally to the Water Quality Control Division within 24 hours from the time the permittee becomes aware of the circumstances.

For all instances of noncompliance identified here, a written submission shall also be provided within 5 calendar days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of:

1) The noncompliance and its cause;

2) The period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue;

3) Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

A. MANAGEMENT REQUIREMENTS (cont.)

4. **Submission of Incorrect or Incomplete Information**

Where the permittee failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or report to the Division, or relevant new information becomes available, the permittee shall promptly submit the relevant application information which was not submitted or any additional information needed to correct any erroneous information previously submitted.

5. **Bypass**

a) A bypass, which causes effluent limitations (i.e., requirements to implement BMPs in accordance with Parts I.B.3 and I.D.2 of the permit) to be exceeded is prohibited, and the Division may take enforcement action against a permittee for such a bypass, unless:

1) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities (e.g., alternative BMPs), retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if the permittee could have installed adequate backup equipment (e.g., implemented additional BMPs) to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance; and

3) The permittee submitted notices as required in "Non-Compliance Notification," Part II.A.3.

6. **Upsets**

a) **Effect of an Upset:** An upset constitutes an affirmative defense to an action brought for noncompliance with permit limitations and requirements if the requirements of paragraph b of this section are met. (No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.)

b) **Conditions Necessary for a Demonstration of Upset:** A permittee who wishes to establish the affirmative defense of upset shall demonstrate through properly signed contemporaneous operating logs, or other relevant evidence that:

1) An upset occurred and that the permittee can identify the specific cause(s) of the upset;

2) The permitted facility was at the time being properly operated;

3) The permittee submitted notice of the upset as required in Part II.A.3. of this permit (24-hour notice); and

4) The permittee complied with any remedial measures required under 40 CFR Section 122.41(d) of the federal regulations or Section 61.8(3)(h) of the Colorado Discharge Permit System Regulations.

c) **Burden of Proof:** In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

7. **Removed Substances**

Solids, sludges, or other pollutants removed in the course of treatment or control of discharges shall be properly disposed of in a manner such as to prevent any pollutant from such materials from entering waters of the State.

8. **Minimization of Adverse Impact**

The permittee shall take all reasonable steps to minimize any adverse impact to waters of the State resulting from noncompliance with any terms and conditions specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

A. MANAGEMENT REQUIREMENTS (cont.)

9. **Reduction, Loss, or Failure of Stormwater Controls**

The permittee has the duty to halt or reduce any activity if necessary to maintain compliance with the permit requirements. Upon reduction, loss, or failure of any stormwater controls, the permittee shall, to the extent necessary to maintain compliance with its permit, control production, or remove all pollutant sources from exposure to stormwater, or both, until the stormwater controls are restored or an alternative method of treatment/control is provided.
It shall not be a defense for a permittee in an enforcement action that it would be necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

10. **Proper Operation and Maintenance**

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

B. RESPONSIBILITIES

1. **Inspections and Right to Entry**

The permittee shall allow the Director of the State Water Quality Control Division, the EPA Regional Administrator, and/or their authorized representative(s), upon the presentation of credentials:

a) To enter upon the permittee's premises where a regulated facility or activity is located or in which any records are required to be kept under the terms and conditions of this permit;

b) At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit and to inspect any monitoring equipment or monitoring method required in the permit; and

c) To enter upon the permittee's premises to investigate, within reason, any actual, suspected, or potential source of water pollution, or any violation of the Colorado Water Quality Control Act. The investigation may include, but is not limited to, the following: sampling of any discharge and/or process waters, the taking of photographs, interviewing permittee staff on alleged violations and other matters related to the permit, and access to any and all facilities or areas within the permittee's premises that may have any effect on the discharge, permit, or any alleged violation.

2. **Duty to Provide Information**

The permittee shall furnish to the Division, within the time frame specified by the Division, any information which the Division may request to determine whether cause exists for modifying, revoking and reissuing, or inactivating coverage under this permit, or to determine compliance with this permit. The permittee shall also furnish to the Division, upon request, copies of records required to be kept by this permit.

3. **Transfer of Ownership or Control**

Certification under this permit may be transferred to a new permittee if:

a) The current permittee notifies the Division in writing when the transfer is desired as outlined in Part I.A.7; and

b) The notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit responsibility, coverage and liability between them; and

c) The current permittee has met all fee requirements of the Colorado Discharge Permit System Regulations, Section 61.15.

B. RESPONSIBILITIES (cont.)

4. **Modification, Suspension, or Revocation of Permit By Division**

All permit modification, inactivation or revocation and reissuance actions shall be subject to the requirements of the Colorado Discharge Permit System Regulations, Sections 61.5(2), 61.5(3), 61.7 and 61.15, 5 C.C.R. 1002-61, except for minor modifications.

a) This permit, and/or certification under this permit, may be modified, suspended, or revoked in whole or in part during its term for reasons determined by the Division including, but not limited to, the following:

1) Violation of any terms or conditions of the permit;

2) Obtaining a permit by misrepresentation or failing to disclose any fact which is material to the granting or denial of a permit or to the establishment of terms or conditions of the permit;

3) Materially false or inaccurate statements or information in the application for the permit;

4) Promulgation of toxic effluent standards or prohibitions (including any schedule of compliance specified in such effluent standard or prohibition) which are established under Section 307 of the Clean Water Act, where such a toxic pollutant is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit.

b) This permit, and/or certification under this permit, may be modified in whole or in part due to a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted discharge, such as:

1) Promulgation of Water Quality Standards applicable to waters affected by the permitted discharge; or

2) Effluent limitations or other requirements applicable pursuant to the State Act or federal requirements; or

3) Control regulations promulgated; or

4) Other available information indicates a potential for violation of adopted Water Quality Standards or stream classifications.

c) This permit, or certification under this permit, may be modified in whole or in part to include new effluent limitations and other appropriate permit conditions where data submitted pursuant to Part I indicate that such effluent limitations and permit conditions are necessary to ensure compliance with applicable water quality standards and protection of classified uses.

d) At the request of the permittee, the Division may modify or inactivate certification under this permit if the following conditions are met:

1) In the case of inactivation, the permittee notifies the Division of its intent to inactivate the certification, and certifies that the site has been finally stabilized;

2) In the case of inactivation, the permittee has ceased any and all discharges to state waters and demonstrates to the Division there is no probability of further uncontrolled discharge(s) which may affect waters of the State.

3) The Division finds that the permittee has shown reasonable grounds consistent with the Federal and State statutes and regulations for such modification, amendment or inactivation;

4) Fee requirements of Section 61.15 of the Colorado Discharge Permit System Regulations have been met; and

5) Applicable requirements of public notice have been met.

For small construction sites covered by a Qualifying Local Program, coverage under this permit is automatically terminated when a site has been finally stabilized.

B. RESPONSIBILITIES (cont.)

5. **Permit Violations**

Failure to comply with any terms and/or conditions of this permit shall be a violation of this permit.

Dischargers of stormwater associated with industrial activity, as defined in the EPA Stormwater Regulation (40 CFR 122.26(b)(14) and Section 61.3(2) of the Colorado Discharge Permit System Regulations, which do not obtain coverage under this or other Colorado general permits, or under an individual CDPS permit regulating industrial stormwater, will be in violation of the federal Clean Water Act and the Colorado Water Quality Control Act, 25-8-101, as amended. Failure to comply with CDPS permit requirements will also constitute a violation.

6. **Legal Responsibilities**

The issuance of this permit does not convey any property or water rights in either real or personal property, or stream flows, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority granted by Section 510 of the Clean Water Act.

7. **Severability**

The provisions of this permit are severable. If any provisions of this permit, or the application of any provision of this permit to any circumstance, are held invalid, the application of such provision to other circumstances and the application of the remainder of this permit shall not be affected.

8. **Renewal Application**

If the permittee desires to continue to discharge, a permit renewal application shall be submitted at least ninety (90) days before this permit expires. If the permittee anticipates that there will be no discharge after the expiration date of this permit, the Division should be promptly notified so that it can inactivate the certification in accordance with Part II.B.4.d.

9. **Confidentiality**

Except for data determined to be confidential under Section 308 of the Federal Clean Water Act and Colorado Discharge Permit System Regulations, Section 61.5(4), all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Division. The permittee must state what is confidential at the time of submittal.

Any information relating to any secret process, method of manufacture or production, or sales or marketing data which has been declared confidential by the permittee, and which may be acquired, ascertained, or discovered, whether in any sampling investigation, emergency investigation, or otherwise, shall not be publicly disclosed by any member, officer, or employee of the Commission or the Division, but shall be kept confidential. Any person seeking to invoke the protection of this section shall bear the burden of proving its applicability. This section shall never be interpreted as preventing full disclosure of effluent data.

10. **Fees**

The permittee is required to submit payment of an annual fee as set forth in the Water Quality Control Act. Failure to submit the required fee when due and payable is a violation of the permit and will result in enforcement action pursuant to Section 25-8-60l et. seq., C.R.S. l973 as amended.

B. RESPONSIBILITIES (cont.)

11. **Requiring an Individual CDPS Permit**

The Director may require the permittee to apply for and obtain an individual or alternate general CDPS permit if:

a) The discharger is not in compliance with the conditions of this general permit;

b) Conditions or standards have changed so that the discharge no longer qualifies for a general permit; or

c) Data/information become available which indicate water quality standards may be violated.

The permittee must be notified in writing that an application for an individual or alternate general CDPS permit is required. When an individual or alternate general CDPS permit is issued to an operator otherwise covered under this general permit, the applicability of this general permit to that operator is automatically inactivated upon the effective date of the individual or alternate general CDPS permit.

Appendix B

NRCS Soils Report

Bent County, Colorado

Av2—Arvada and deertrail soils, eroded

Map Unit Setting

Elevation: 3,900 to 5,600 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Deertrail, eroded and similar soils: 45 percent
Arvada, eroded and similar soils: 45 percent

Description of Arvada, Eroded

Setting

Landform: Depressions, swales
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from limestone and shale

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 5 percent
Maximum salinity: Slightly saline to moderately saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 25.0
Available water capacity: Low (about 3.2 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: Salt Flat (R069XY033CO)
Other vegetative classification: Salt Flat (069AY033CO_1)

Typical profile

0 to 2 inches: Clay loam
2 to 18 inches: Silty clay
18 to 32 inches: Silty clay
32 to 36 inches: Weathered bedrock

Description of Deertrail, Eroded

Setting

Landform: Hummocks

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from shale

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Very slightly saline to slightly saline (4.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 18.0
Available water capacity: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability (nonirrigated): 6s
Ecological site: Salt Flat (R069XY033CO)
Other vegetative classification: Salt Flat (069AY033CO_1)

Typical profile

0 to 6 inches: Clay loam
6 to 13 inches: Clay loam
13 to 20 inches: Silty clay loam
20 to 60 inches: Silty clay loam

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

CoB—Colby silt loam, 1 to 3 percent slopes

Map Unit Setting

Elevation: 4,400 to 6,000 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Colby and similar soils: 90 percent
Minor components: 10 percent

Description of Colby

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous loess

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Available water capacity: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 6c
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 6 inches: Silt loam
6 to 60 inches: Silt loam

Minor Components

Wiley

Percent of map unit: 5 percent

Baca

Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

DeB—Deertrail clay loam, 0 to 5 percent slopes

Map Unit Setting

Elevation: 3,900 to 5,600 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 50 to 52 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Deertrail and similar soils: 90 percent
Minor components: 10 percent

Description of Deertrail

Setting

Landform: Plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey alluvium derived from shale

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Very slightly saline to slightly saline (4.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum: 18.0
Available water capacity: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): 4s
Land capability (nonirrigated): 6s
Ecological site: Alkaline Plains (R069XY047CO)

Typical profile

0 to 6 inches: Clay loam
6 to 13 inches: Silty clay loam
13 to 20 inches: Silty clay loam
20 to 60 inches: Silty clay loam

Minor Components

Wiley

Percent of map unit: 5 percent

Minnequa
Percent of map unit: 4 percent

Arrada
Percent of map unit: 1 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

MaC2—Manvel loam, 1 to 9 percent slopes, erode

Map Unit Setting

Elevation: 3,500 to 5,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Manvel and similar soils: 95 percent
Minor components: 5 percent

Description of Manvel

Setting

Landform: Plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium derived from limestone and shale

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Gypsum, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: High (about 9.9 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 6 inches: Loam
6 to 34 inches: Silt loam
34 to 60 inches: Loam

Minor Components

Eroded soils
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

MaC—Manvel loam, 1 to 9 percent slopes

Map Unit Setting

Elevation: 3,500 to 5,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Manvel and similar soils: 85 percent
Minor components: 15 percent

Description of Manvel

Setting

Landform: Plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium derived from limestone and shale

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Gypsum, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: High (about 9.9 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 6 inches: Loam
6 to 34 inches: Silt loam
34 to 60 inches: Loam

Minor Components

Minnequa

Percent of map unit: 5 percent

Penrose
Percent of map unit: 5 percent

Litle
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

MeC—Minnequa loam, 1 to 9 percent slopes

Map Unit Setting

Elevation: 3,000 to 6,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 125 to 170 days

Map Unit Composition

Minnequa and similar soils: 90 percent
Minor components: 10 percent

Description of Minnequa

Setting

Landform: Pediments
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 35 percent
Gypsum, maximum content: 4 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water capacity: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): 3s
Land capability (nonirrigated): 6c
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 8 inches: Loam
8 to 34 inches: Silt loam
34 to 38 inches: Weathered bedrock

Minor Components

Manvel

Percent of map unit: 5 percent

Penrose

Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

MpC—Minnequa-Penrose loams, 1 to 9 percent slopes

Map Unit Setting

Elevation: 3,000 to 6,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 125 to 170 days

Map Unit Composition

Minnequa and similar soils: 60 percent
Penrose and similar soils: 30 percent
Minor components: 10 percent

Description of Minnequa

Setting

Landform: Pediments
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 35 percent
Gypsum, maximum content: 4 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 10.0
Available water capacity: Low (about 5.1 inches)

Interpretive groups

Land capability (nonirrigated): 6c
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 6 inches: Loam
6 to 34 inches: Silt loam
34 to 38 inches: Weathered bedrock

Description of Penrose

Setting

Landform: Escarpments
Landform position (three-dimensional): Crest

Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 75 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Very low (about 2.2 inches)

Interpretive groups

Land capability (nonirrigated): 6s
Ecological site: Limestone Breaks (R069XY058CO)
Other vegetative classification: LIMESTONE BREAKS (069XY058CO_1)

Typical profile

0 to 3 inches: Loam
3 to 14 inches: Loam
14 to 18 inches: Unweathered bedrock

Minor Components

Manvel

Percent of map unit: 5 percent

Litle

Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

PcD—Penrose channery loam, 1 to 25 percent slopes

Map Unit Setting

Elevation: 3,500 to 6,000 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Penrose and similar soils: 90 percent
Minor components: 10 percent

Description of Penrose

Setting

Landform: Escarpments
Landform position (three-dimensional): Crest
Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 1 to 25 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 75 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Very low (about 2.1 inches)

Interpretive groups

Land capability (nonirrigated): 6s
Ecological site: Limestone Breaks (R069XY058CO)
Other vegetative classification: LIMESTONE BREAKS (069XY058CO_1)

Typical profile

0 to 3 inches: Channery loam
3 to 14 inches: Loam
14 to 18 inches: Unweathered bedrock

Minor Components

Minnequa

Percent of map unit: 5 percent

Samsil
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

Sa—Samsil soils

Map Unit Setting

Elevation: 3,500 to 5,500 feet
Mean annual precipitation: 11 to 14 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 130 to 160 days

Map Unit Composition

Samsil and similar soils: 90 percent
Minor components: 10 percent

Description of Samsil

Setting

Landform: Hills
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 3 to 20 percent
Depth to restrictive feature: 4 to 20 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Gypsum, maximum content: 5 percent
Maximum salinity: Nonsaline to very slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water capacity: Very low (about 1.6 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Ecological site: Shaly Plains (R069XY046CO)
Other vegetative classification: SHALY PLAINS (069XY046CO_1)

Typical profile

0 to 4 inches: Silty clay loam
4 to 10 inches: Silty clay
10 to 14 inches: Weathered bedrock

Minor Components

Litle

Percent of map unit: 5 percent

Minnequa
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

SnB—Satanta loam, 0 to 3 percent slopes

Map Unit Setting

Elevation: 3,500 to 5,600 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Satanta and similar soils: 85 percent
Minor components: 15 percent

Description of Satanta

Setting

Landform: Swales, drainageways, flood plains
Landform position (three-dimensional): Tread, dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits and/or loamy alluvium derived from sandstone

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Gypsum, maximum content: 2 percent
Available water capacity: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 4c
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 9 inches: Loam
9 to 26 inches: Clay loam
26 to 60 inches: Silt loam

Minor Components

Kim

Percent of map unit: 5 percent

Baca
Percent of map unit: 5 percent

Manzanola
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

StB—Stoneham loam, 0 to 3 percent slopes

Map Unit Setting

Elevation: 3,600 to 5,600 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Stoneham and similar soils: 85 percent
Minor components: 15 percent

Description of Stoneham

Setting

Landform: Plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Moderate (about 7.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 4c
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 3 inches: Loam
3 to 8 inches: Clay loam
8 to 13 inches: Loam
13 to 32 inches: Sandy loam
32 to 60 inches: Loamy coarse sand, loamy sand

Minor Components

Wiley

Percent of map unit: 5 percent

Vona
Percent of map unit: 5 percent

Deertrail
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

StC—Stoneham loam, 3 to 9 percent slopes

Map Unit Setting

Elevation: 3,600 to 5,600 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Stoneham and similar soils: 95 percent
Minor components: 5 percent

Description of Stoneham

Setting

Landform: Plains
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: Moderate (about 7.6 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 3 inches: Loam
3 to 8 inches: Clay loam
8 to 13 inches: Loam
13 to 32 inches: Sandy loam
32 to 60 inches: Loamy coarse sand, loamy sand

Minor Components

Vona

Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

WeA—Weld silt loam, 0 to 1 percent slopes

Map Unit Setting

Elevation: 3,600 to 5,700 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 46 to 55 degrees F
Frost-free period: 100 to 155 days

Map Unit Composition

Weld and similar soils: 90 percent
Minor components: 10 percent

Description of Weld

Setting

Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 6 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.7 inches)

Interpretive groups

Land capability (nonirrigated): 4e
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 7 inches: Silt loam
7 to 17 inches: Silty clay
17 to 26 inches: Silt loam
26 to 60 inches: Silt loam

Minor Components

Baca

Percent of map unit: 5 percent

Stoneham
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Bent County, Colorado

WlB—Wiley silt loam, 0 to 3 percent slopes

Map Unit Setting

Elevation: 4,500 to 6,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 140 to 170 days

Map Unit Composition

Wiley and similar soils: 90 percent
Minor components: 10 percent

Description of Wiley

Setting

Landform: Plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 4e
Ecological site: Loamy Plains (R069XY006CO)
Other vegetative classification: LOAMY PLAINS (069XY006CO_1)

Typical profile

0 to 5 inches: Silt loam
5 to 13 inches: Silt loam
13 to 60 inches: Silt loam

Minor Components

Wiley

Percent of map unit: 5 percent

Colby
Percent of map unit: 5 percent

Data Source Information

Soil Survey Area: Bent County, Colorado
Survey Area Data: Version 7, Apr 28, 2009

Appendix C

Site Maps

Stormwater Inspection Forms

Maps outlining the site details will be maintained in PDC’s database.

Appendix D

BMP Selection Guide

BMP Manual

BMP SELECTION CRITERIA
SOUTHEASTERN COLORADO
PDC ENERGY

ACTIVE	COMPLETED	FINAL STABILIZATION
Pads		
Gravel Surfacing	Gravel Surfacing	Gravel Surfacing
Land Grading	Silt Fence	Revegetation
Revegetation	Vegetated Buffer	
Berms	Wattles	
Stabilized Construction Entrance		
Surface Roughening		
Vegetated Buffer		
Wattles		
Pipelines		
Land Grading	Silt Fence	Revegetation
Revegetation	Vegetated Buffer	
Silt Fence	Wattles	
Surface Roughening		
Vegetated Buffer		
Wattles		
Berms		
Access Roads		
Gravel Surfacing	Gravel Surfacing	Gravel Surfacing
Land Grading	Silt Fence	Revegetation
Revegetation	Vegetated Buffer	
Silt Fence	Wattles	
Stabilized Construction Enterance		
Vegetated Buffer		
Wattles		
Berms		

Notes:
BMP = Best Management Practice

Best Management Practices (BMPs) Manual

Berm (B)

Description

A berm is a ridge of compacted soil located at the top or base of a sloping disturbed area to contain or divert surface runoff. Berms may be constructed from either excavated topsoil or subsoil.

The purpose of a berm is to control runoff velocity, divert onsite surface runoff to a sediment trapping device,divert clean water away from disturbed areas, and to provide a safe slope barrier for vehicle traffic.

Applicability

Berms are usually appropriate for drainage basins smaller than five acres, but with modifications they can be capable of servicing areas as large as ten acres. With regular maintenance, earthen berms have a useful life span of approximately 18 months. Berms are applicable for the following applications:

- Along the outside shoulder of an insloped road to ensure that runoff from the roadway drains inward and to protect the fill slope from continual disturbance during road blading and maintaining.

- Upslope of cut or fill slopes to divert flows away from disturbed areas.

- Downslope of cut or fill slopes to divert onsite runoff to a stabilized outlet or sediment trapping device, although diversions are more commonly used for this application.

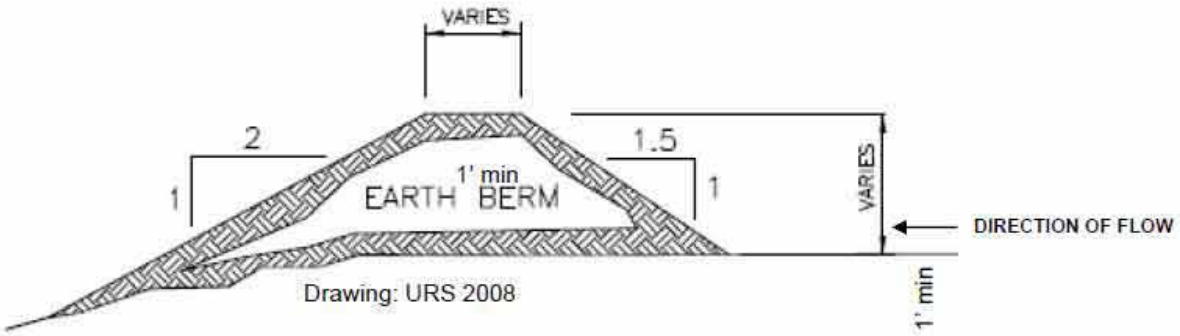
- Along the outside shoulder of a road to provide vehicle safety.

Limitations

- Berms may erode if not properly compacted and stabilized with vegetation. Berms which are adjacent to concentrated flows will require erosion blanketing.

- If a berm crosses a vehicle roadway or entrance, its effectiveness can be reduced. Wherever possible, berms should be designed to avoid crossing vehicle pathways.

Design Criteria



Construction Specifications

1. Prior to berm construction, remove all trees, brush, stumps and other objects in the path of the berm and till the base of the berm before laying the fill. Fill may consist of topsoil or subsoil excavated during the construction of nearby roads or well pads.

2. For roadside berms, construct according to Figure B-1.

3. To remain effective, berms should be compacted with tracked equipment, if possible.

4. All berms shall have positive drainage to a stabilized outlet so that runoff does not collect in ponds on the upslope side of the berm, but instead flows along the berm until ti reaches a stabilized outlet. Field location should be adjusted as needed. Stabilized outlet may be a well-vegetated area, a well pad detention pond, or a sediment control such as a silt fence or sediment trap where sedment can settle out of the runoff before being discharged to surface water.

5. If the expected life span of the berm is greater than 15 days, it is strongly recommended that the berm be stabilized with vegetation or an erosion control blanket immediately after construction. Stabilization is required where concentrated flows are expected.

6. Berms should be constructed and fully stabilized prior to commencement of major upslope land disturbance. This will maximize the effectiveness of the structure as a storm water control device.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Berms should be inspected for evidence of erosion or deterioration to ensure continued effectiveness. Berms should also be maintained at the original height. Any decrease in height due to settling or erosion, which impacts the effectiveness of the BMP, should be repaired.

Removal

Berms should remain in place and in good condition until all upslope disturbed areas are permanently stabilized. There is no need to formally remove the berm on completion of stabilization until interim or final reclamation.

References

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control*.
Washington, D.C., February, 2003.
http://www.dec.state.ny.us/website/dow/toolbox/escstandards

New York State Department of Environmental Conservation, *New York Guidelines for Urban Erosion and Sediment Control*. New York. Fourth Edition, 1997.
http://www.dec.state.ny.us/website/dow/toolbox/escstandards

Table B-1
Berm Stabilization

Treatment Type	Channel Grade (1)	A (<5 Ac.)	B (5-10 Ac.)
1	0.5-3.0%	Hydro-seed and use tacifier	Hydro-seed and use tacifier
2	3.0-5.0%	Hydro-seed and use tacifier	Seed and cover with erosion control blanket, or lined with 2-inch stone
3	5.0-8.0%	Seed and cover with erosion control blanket, or lined with 2-inch stone	Line with 4 to 8-inch stone or rock (2)
4	8.0-20.0%	Line with 4 to 8-inch stone or rock (2)	Engineering Design

(1) In highly erodible soils, as defined by the local approving agency, refer to the next higher slope grade for type of stabilization.

(2) Site rock, if available, shall be broken into the required size.

Check Dam (CD

Description

Check dams are small, temporary dams constructed across a diversion or road side ditch. Check dams can be constructed using gravel, rock, sandbags, gravel bags, earth with erosion control blanketing, straw bales, or synthetic materials to slow the velocity of concentrated flow in a channel and thus reduce erosion. As a secondary function, check dams can also be used to catch sediment from the channel itself or from the contributing drainage area as storm water runoff flows through or over the structure.

Applicability

Check dams are most often used in small, open channels with contributing drainage area of less than 10 acres, and side slopes of 2:1 or less. Check dams may be used in the following applications:

- In diversion or roadside ditches where it is not practical to line the channel or implement other flow control and sediment control practices.

- In diversions or roadside ditches where temporary seeding has been recently implemented but has not had time to take root and fully develop.

- As a series of check dams, spaced at appropriate intervals, used in one of the above two applications.

- Rock ditch checks should be **perpendicular** to the flowline of the ditch.

- Rock ditches must be designed so that water can flow over them, not around them. The ditch check should extend far enough so that the ground level at the ends of the check is higher than the low point on the crest of the check.

The following table provides check spacing for a given ditch grade:

Ditch Grade (Percent)	Check Spacing (feet)	Check Spacing (meters)
5	59	18
6	49	15
7	43	13
8	36	11
9	33	10
10	30	9

Limitations

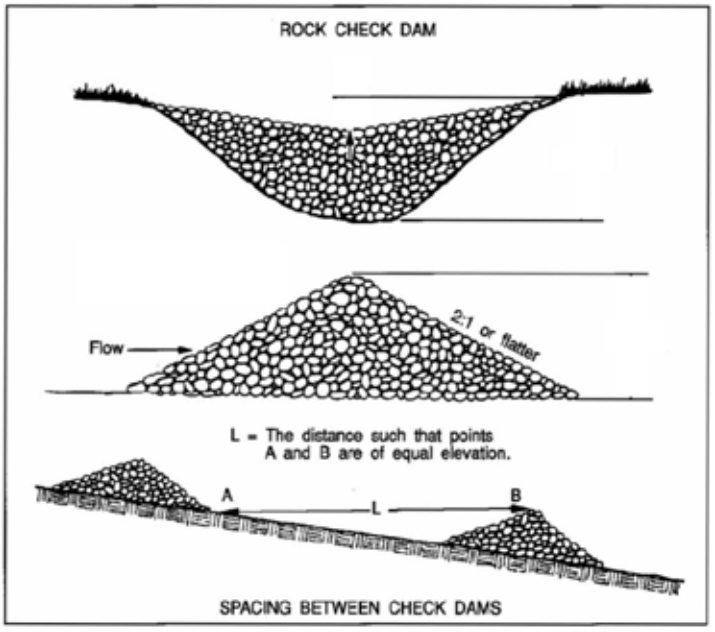
- Check dams should not be used in live, continuously flowing streams unless approved by an appropriate regulatory agency.

- Check dams may require frequent removal of accumulated sediments. Dams should therefore be located in areas accessible to maintenance vehicles.

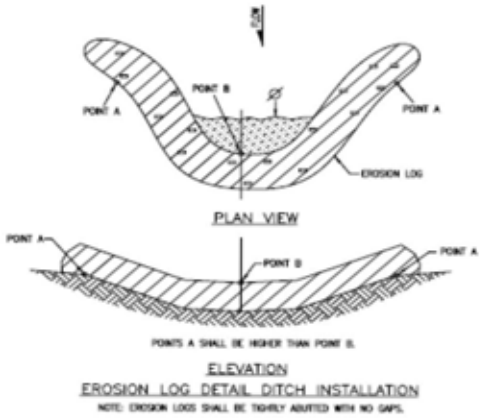
- Leaves have been shown to be a significant problem by clogging check dams in the fall. Therefore, they might necessitate increased inspection and maintenance.

- Straw bale check dams decompose over time, and may be consumed by livestock.

Design Criteria



From: Virginia Soil and Water Conservation Commission, 1985



Construction Specifications

- Install straw bale check dams, rock check dams and other check dams according to Figures and respectively. Other types of check dams shall have similar designs.

- Check dams should be located in areas accessible to maintenance vehicles for the periodic removal of accumulated sediments.

- Dams should be installed with careful placement of the construction material. Mere dumping of the dam material into a channel is not appropriate and will reduce overall effectiveness.

- Check dams can be constructed from a number of different materials. Most commonly, they are made of straw bales or rock. When using rock, the material diameter should be 4 to 8 inches depending on the expected velocity and quantity of runoff within the channel. Wattles or sand/gravel bags may also be used, but only if straw bales or rock is unavailable or not feasible for the location. Earth collected during excavation of diversions or roadside ditches may also be placed as check dams if covered with erosion control blanketing.

- All check dams should have a maximum height of three feet with sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage. The center of the dam should be at least six inches lower than the edges. This design creates a weir effect that helps to channel flows away from the banks and prevent further erosion.

- Additional stability can be achieved by implanting the dam material approximately six inches into the sides and bottom of the channel.

- In order to be most effective, dams used in a series should be spaced such that the base of the upstream dam is at the same elevation as the top of the next downstream dam.

- When installing more than one check dam in a channel, outlet erosion stabilization measures should be installed below the final dam in the series. Because this area is likely to be vulnerable to further erosion, riprap, erosion control blanket lining, or some other stabilization measure is highly recommended.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). During inspection, large debris, trash, and leaves should be removed. The center of a check dam should always be lower than its edges. If erosion or heavy flows cause the edges of a dam to fall to a height equal to or below the height of the center, and the effectiveness of the check dam is compromised, repairs should be made immediately. Accumulated sediment should be removed from the upstream side of a check dam when the sediment has reached a height of the dam (measured at the center). Close attention should be paid to the repair of damaged or

rotting straw bales, end runs and undercutting beneath bales. Replacement of bales should be accomplished promptly.

Removal

Removal of check dams is optional. Check dams within roadside ditches are usually used as temporary controls, where other check dams may be left in place to silt out. If removing a check dam, all accumulated sediment should be removed. Removal of a check dam should be completed only after the contributing drainage area has been completely stabilized. Permanent vegetation should replace areas from which rock or other material has been removed.

References

Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide*. 2002. http://ww.dot.state.co.us/enviromental.envWaterQual/wqms4.asp

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

http://cfpud.epa.gov/npdes/stormwater/menufbmps/con_site.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

North Dakota Department of Health Division of Water Quality, *A Guide to Temporary Erosion-Control Measures for Contractors, Designers and Inspectors, June 2001*

*Other materials may be used instead of straw.

Culvert (C)

Description

Culverts are typically concrete, steel, aluminum, or plastic pipe used to move ditch water under the road or to direct stream flow under the road or construction area.

Applicability

Culverts are ideal on road grates less than 15%. For grades over 15%, it is difficult to slow down the water or remove it from road surface rapidly. On such steep grades, it is best to use frequently spaced relief culverts and drainage crossings culverts, with armored ditches (see RIPRAP [R]). Culverts may be used in the following applications.

- As drainage crossing culverts in streams and gullies to allow normal drainage to flow under the traveled way.

- As ditch relief culverts to periodically relieve the inside ditch line flow by piping water to the opposite side of the road where the flow can be dispersed away from the roadway. Culverts placed in natural drainages may be utilized for ditch relief.

Limitations

- If undersized, culverts are susceptible to plugging and require cleaning.

- Culverts will not filter sediment.

- Culverts are easily crushed if not properly designed.

Design Criteria

Pipe size can be determined using general design criteria, such as in table C-1, but is ideally based upon site specific hydrologic analysis.

Depth

The depth of culvert burial must be sufficient to ensure protection of the culvert barrel for the design life of the culvert. This requires anticipating the amount of material that may be lost to road use and erosion.

Headwalls

Use headwalls on culvert pipes as often as possible (see RETAINING WALL [RW]). The advantages of headwalls include: preventing large pipes from floating out of the ground when they plug; reducing the length of the pipe capacity; helping to funnel debris through the pipe; retaining the backfill material; and reducing the chances of culvert failure if it is overtopped.

Construction Specifications

Drainage crossing culverts

- Make road crossings of natural drainages perpendicular to the drainage to minimize pipe length and area of disturbance (Figure C-1).

- Use single large pipes versus multiple smaller diameter pipes to minimize plugging potential in most channels (unless roadway elevation is critical). In very broad channels, multiple pipes are desirable to maintain the natural flow spread across the channel. All culverts should be concrete corrugated metal pipe made of steel or aluminum, or properly bedded and backfilled corrugated plastic pipe.

- Align culverts in the bottom and middle of the natural channel flowline so that installation causes no change in the stream alignment or stream bottom elevation. Culverts should not cause damming or pooling or increase stream velocities significantly.

- Extend the outlet of the culvert at least one foot beyond the toe of the slope to prevent erosion of the fill material. Alternatively, use retaining walls (headwalls) to hold back the fill slope.

- It may be necessary to install rip-rap, erosion control blanketing, a combination of both, or other energy dissipater device at the outlet end of the culvert to reduce soil erosion or to trap sediment (see CULVERT PROTECTION [CP]).

- It may be desirable to construct pulloffs/turnouts for vehicle on one or both sides of narrow culvert crossings. This will help avoid culvert crushing as well as disturbance to roadside ditches and berms.

Ditch relief culverts

- See figure C-2 for installation details.

- Ditch relief culverts can provide better flow when skewed 0 to 30 degrees perpendicular to the road.

- The culvert gradient should be at least 2% greater than the approach ditch gradient. This improves the flow hydraulics and reduces siltation and debris from plugging the culvert inlet.

- Discharge culvert at natural ground level where possible (see figure C-3,type A), on firm, non-erosive soil or in rocky or bushy areas. If discharge on the fill slopes, armor outlets with riprap or logging slash (see figure C-3, type B), or use down-drain structures (see figure C-3, type C and SLOPE DRAIN [SD]).

- Extend the inlet of the culvert at least one foot beyond the flowline of the roadside ditch. Extend the outlet of the culvert at least one foot beyond the toe slopes to prevent erosion of the fill material.

- It may be necessary to install riprap or other energy dissipater devices at the outlet end of the culvert to prevent soil erosion or to trap sediment (see CULVERT PROTECTION [CP]).

- Spacing of culverts is dependent on the road gradient, soil types, and runoff characteristics according to the following table:

Soil Type	Road Grade		
	2-4%	**2-4%**	**2-4%**
Highly corrosive granitic or sandy	240'	180'	140'
Intermediate erosive clay or load	310'	260'	200'
Low erosive shale or gravel	400'	325'	250'

- It may be desirable to construct pulloffs/turnouts for vehicle on one or both sides of narrow culvert crossings. This will help avoid culvert crushing as well as disturbance to roadside ditches and berms.

Backfill and Compaction

See figure C-4.

- Firmly compact well-graded fill material (soil or road base) around culverts, particularly around the bottom half, using placement in layers to achieve a uniform density. Use slightly plastic sandy gravel with fines. Avoid the use of fine sand and silt rich soils for bedding material because of their susceptibility to piping. Pay particular attention to culvert bedding and compaction around the haunches of the pipe. Do not allow the compaction to move or raise the pipe. In large fills, allow for settlement.

- Cover the top of the metal and plastic culvert pipes with fill to a depth of at least 1 foot to prevent crushing by heavy trucks. Use a minimum cover of 2 feet of fill over concrete pipe. For maximum allowable fill height, follow manufacturer's recommendations.

- Mound fill over the top of culvert pipes so that the road is slightly raised at culvert locations to help prevent erosion and water from ponding over culvert crossings. This practice, as well as placing large boulders around the culvert outlets, will also help to prevent culverts from crushing.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). If any damage to culvert or inlet/outlet protection is noted or if there is any evidence of scour, repairs should be made immediately. Any debris that may be blocking the culvert inlet or outlet should be removed.

References

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

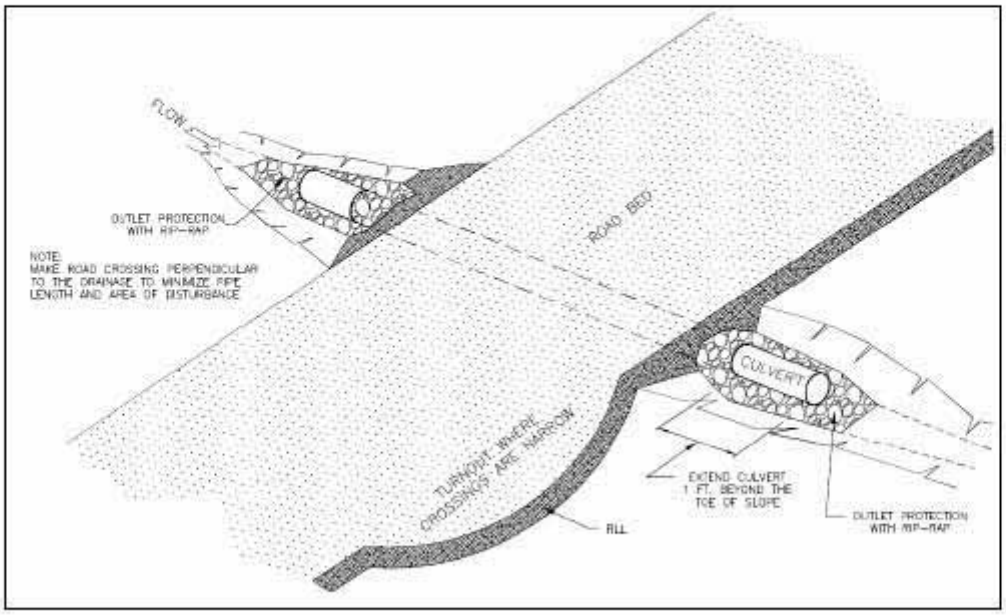
Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency od International Development (USAID), 2005. http://www.blm.gov/bmp/field%20guide.htm

United States Department of the Interior and United States Department of Agriculture. *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book".* BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

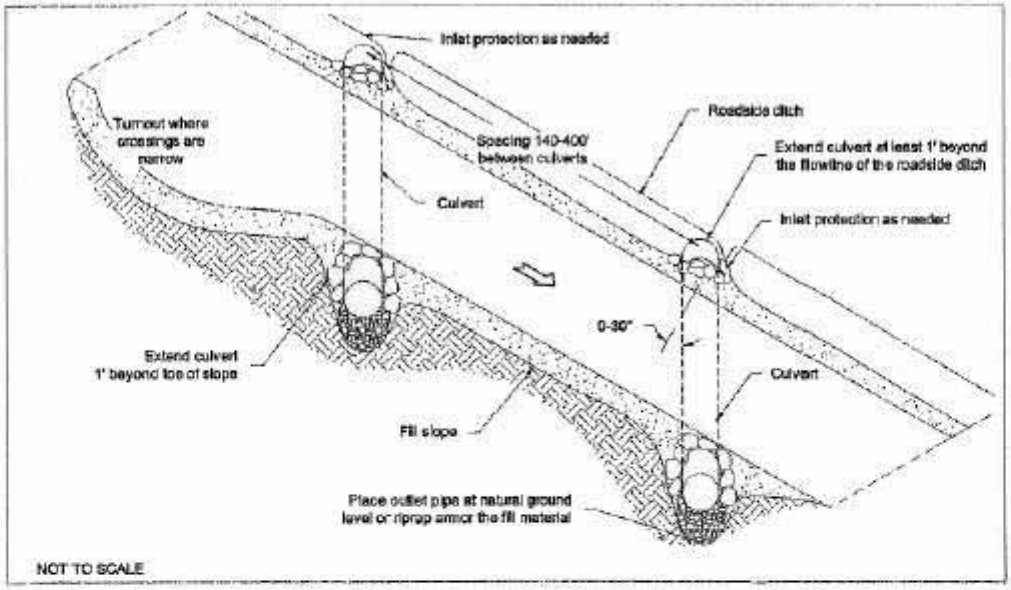
Drainage Area (acres)	Size of Drainage Structure (diameter and area)			
	Steep Slopes (Light Vegetation) C=0.7		Gentle Slopes (Heavy Vegetation) C=0.2	
	Round Pipe (In)	Area (sq.ft)	Round Pipe (In)	Area (sq.ft)
0-10	30"	4.9	18"	1.8
10-20	42"	9.6	24"	3.1
20-35	48"	12.6	30"	4.9
35-75	72"	28.3	42"	9.6
75-125	84"	38.5	48"	12.6
125-200	96"	50.3	60"	19.6

* This Table serves as a guidance tool.

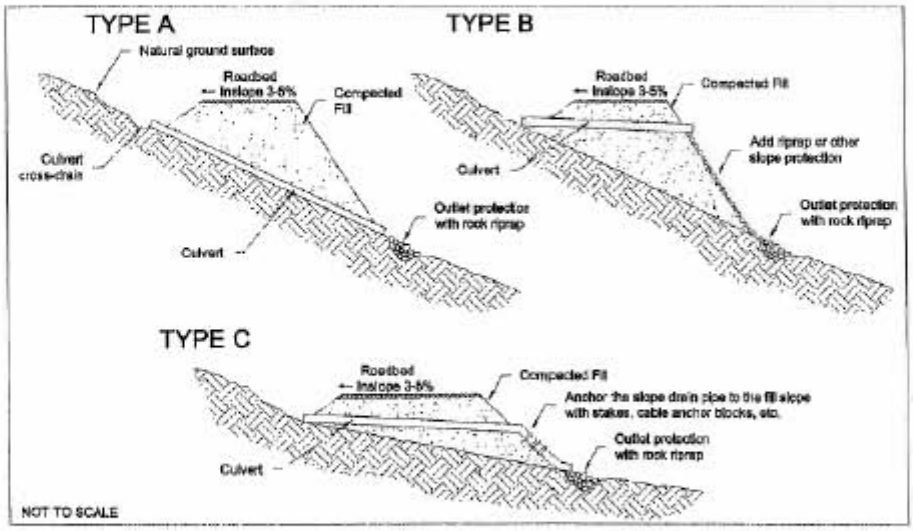
Drainage Crossing Culvert Alignment & Overflow Dip



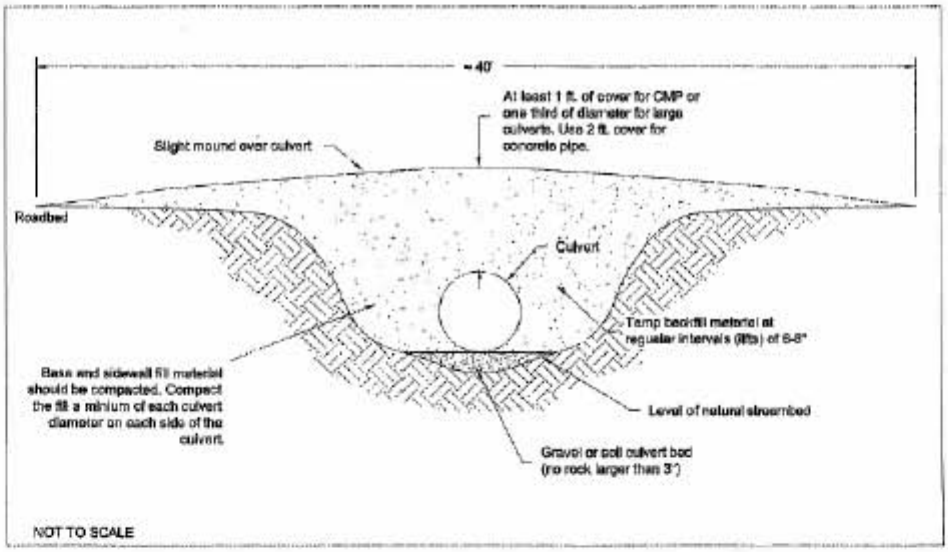
Ditch Relief Culvert Installation



Culvert Installation Options



Culvert Backfill and Compaction



Culvert Protection

Description

Culvert protection may be required at the inlet of the culvert (upstream side) and/or the outlet side of the culvert (downstream side).

Culvert inlet protection could involve placing boulders, riprap, gabions, rock retaining walls, slash, and/or any other protection at the inlet pipes. Riprap, or other energy-dissipating devices, will reduce the velocity of storm water flows and thereby prevent erosion and help protect the inlet structure.

Culvert outlet protection involves placing structurally lined aprons or other appropriate energy-dissipating devices, such as large boulders or plunge pools, at the outlets of the pipes to reduce the velocity of storm water flows and thereby prevent scouring at storm water outlets, protect the outlet structure, and minimize potential for erosion downstream.

Applicability

Riprap inlet protection should be used where velocities and energies at the inlets of culvert are sufficient to erode around the inlet structure. Riprap may also be used to help channel the storm water to the inlet of the culvert.

Culvert outlet protection should be used where discharge velocities and energies at the outlets of the culverts or channels are sufficient to erode the next downstream reach.

Limitations

Rock aprons at the culvert outlets should not be placed on slopes steeper than 10 percent. Runoff from pipe outlets at the top of cut/fills or on slopes steeper than 10 percent should be routed via slope drains or riprap chutes to a rock apron at the toe of the slope. Otherwise will re-concentrate and gain velocity as the flow leaves the apron.

Design Criteria

Culvert inlet protection: Riprap, gabions, or rock retaining walls at culvert inlets shall be designed according to RIPRAP (R) or RETAINING WALL (RW).

Culvert Outlet Protection: Gabions or rock retaining walls at culvert outlets shall be designed according to RETAINING WALL (RW). No formal design is required for plunge pools at outlets. Riprap aprons at culvert outlets shall be designed as follows.

Tail-water depth: The depth of tail-water immediately below the pipe outlet must be determined for design capacity of the pipe. If the tail-water depth is less than half the diameter of the outlet pipe, and the receiving stream is wide enough to accept divergence of the flow, it shall be classified as a minimum tail-water condition. If the tail-water depth is greater than half the

pipe diameter and the receiving stream will continue to confine the flow, it shall be classified as a maximum tail-water condition. Pipes that outlet onto flat areas with no defined channel may be assumed to have a minimum tail-water condition.

Riprap Apron Size & D_{50}: The apron length (L_A) and the D_{50} of the riprap shall be determined from table CP-1 according to the design flow and weather there is a minimum or maximum tail-water condition. The apron width (W) shall then be determined as ($W=d+0.4L_A$) where d is the diameter of the culvert. If the pipe discharges directly into a well defines channel, the apron shall extend across the channel bottom and up the channel banks to an elevation one foot above the maximum tail-water depth or to the top of the bank, whichever is less. The upstream end of the apron, adjacent to the pipe, shall have a width of two (2) times the diameter of the outlet pipe, or confirmed to pipe and section if used.

Riprap Materials: The outlet protection may be done using rock riprap or grouted riprap. Riprap shall be composed of a well-graded mixture of stone size so that 50 percent of the pieces, by weight, shall be larger than the D_{50} size determined from table CP-1. A well-graded mixture, as used herein, is defined as a mixture composed primarily of larger stone sizes, but with a sufficient mixture of other sizes to fill the smaller voids between the stones. The diameter of the largest stone size in such a mixture shall be 1.5 times the D_{50} size. All grout for grouted riprap must be one part Portland cement for every three parts sand, mixed thoroughly with water.

Filter: If a filter cloth or gravel is used, it should be designed according to RIPRAP (R).

Apron Thickness: The minimum thickness of the riprap layer shall be 1.5 times the maximum stone diameter for D_{50} of 15 inches or less; and 1.2 times the maximum stone size for D_{50} greater than 15 inches.

Riprap Stone Quality: Stone for riprap shall consist of field stone or rough un-hewn quarry stone. The stone shall be hard and angular and of quality that will not disintegrate in exposure to water or weathering. The specific gravity of the individual stone shall be at least 2.5. Site rock or site boulders may be used provided it has a density of at least 150 pounds per cubic foot, and does not have any exposed steel or reinforcing bars.

Construction Specifications

Culvert Inlet Protection:

1. Riprap, gabions, or rock retaining walls at culvert inlets shall be constructed in accordance to RIPRAP (R) or RETAINING WALL (RW).

2. After installation of a culvert, examine the stream channel for the amount of debris, logs, and brushy vegetation present. In channels with large amounts of debris, consider using oversized pipes.

3. Boulder should be dry-stacked around the culvert inlet and up the slope to the edge of the road.

Culvert outlet protection: Gabions or rock retaining walls at culvert outlets shall be designed according to RETAINING WALL (RW). Riprap aprons at culvert outlets shall be constructed according to CP-2 and as follows.

1. Prepare the sub-grade for the riprap to the required lines and grades. Any fill required in the sub-grade shall be compacted to a density of approximately that of the surrounding undisturbed material.

2. If a pipe discharges into a well-defined channel, the channel's side slopes may not be steeper than 2:1.

3. Construct apron to the design length and width with no slope (figure CP-2). The invert elevations must be equal at the receiving channel and the apron's downstream end. No over-fall at the end of the apron of the apron is allowed. The elevation of the downstream and of the apron shall be equal to the elevation of the receiving channel or adjacent ground. The outlet protection apron shall be located so that there are no bends in the horizontal alignment.

4. Line the apron with riprap, grouted riprap, or concrete. Riprap should be the appropriate size thickness and design. See RIPRAP (R) for the placement of riprap.

5. If a culvert outlets at the top of cut/fills or on slopes steeper than 10 percent one of the following option is suggested:

6. Transition culvert to a slope drain according to SLOPE DRAIN (SD). The slope drain shall convey storm water to the bottom of the slope where riprap apron, as designed above, shall prevent erosion at the slope drain outlet.

7. Line slope below culvert outlet with a riprap channel to convey storm water to the bottom of the slope where a riprap apron, as designed above, shall prevent erosion at the bottom of the slope. The riprap channel shall be designed according to the table in the RIPRAP (R) construction specification that is based on depth of flow and slope. The riprap channel shall dip into the slope so that all water is contained within the channel, flows to the riprap outlet apron at the base of the slope, and does not spill over the sides onto unprotected soil.

Maintenance Considerations

The frequency of inspection should be in accordance with the Storm Water Management Plan (SWMP). Inspect for debris at the entrance to culverts and within culverts. Inspect riprap at culvert inlets for damage and dislodged stones. The maintenance needs are usually very low for properly installed riprap aprons at culvert outlets. However, inspect for evidence of scour beneath riprap at outlets aprons or for dislodged stones. Anything that is found to reduce the effectiveness of the culvert or culvert outlet protection should be repaired immediately.

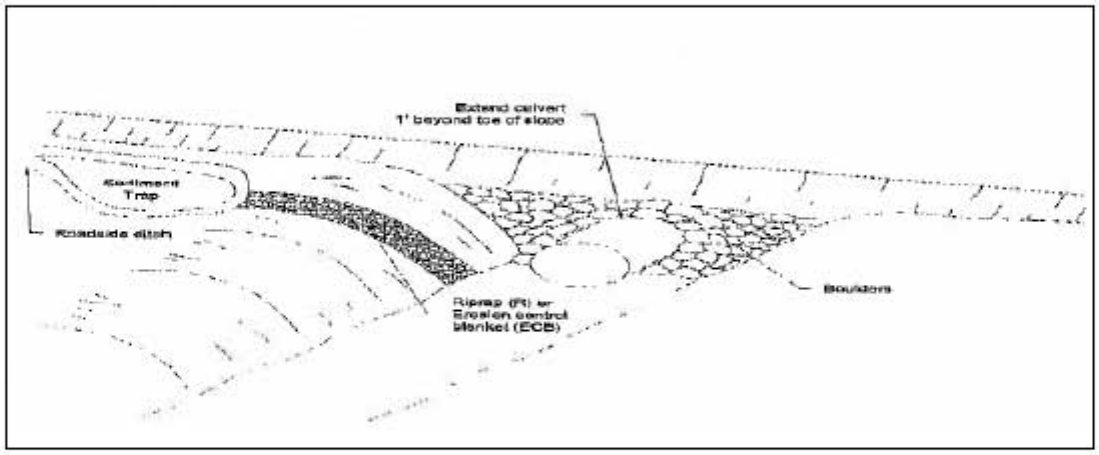
References

Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency od International Development (USAID), 2005. http://www.blm.gov/bmp/field%20guide.htm

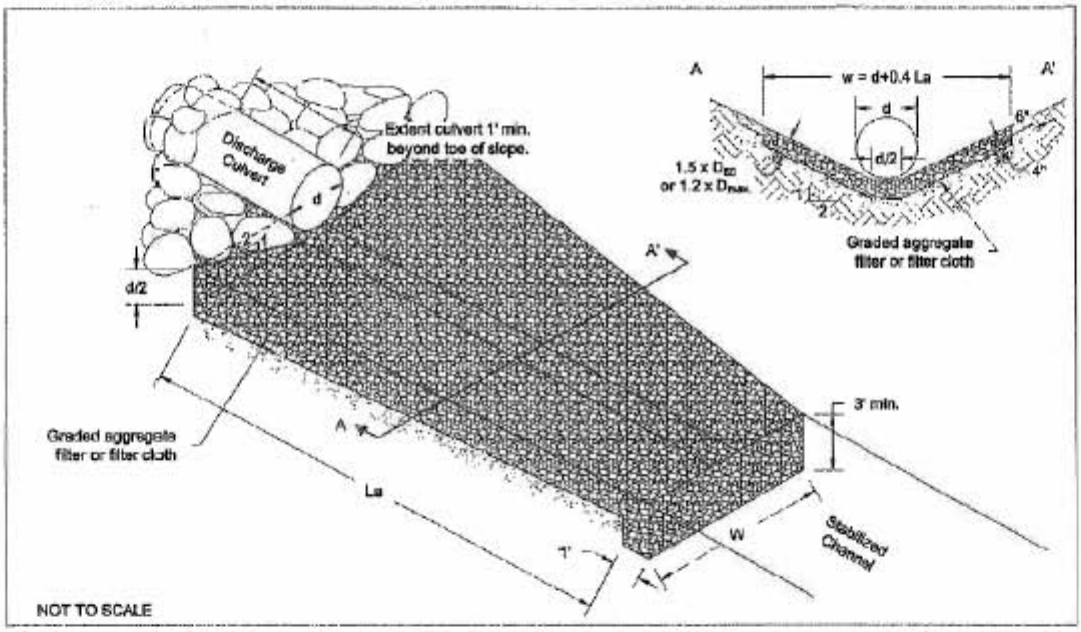
New York State Department of Environmental Conservation, *New York Guidelinesfor Urban Erosion and Sediment Control.* New York. Forth Edition, 1997.http://www.dec.state.ny.us/website/dow/toolbox/escstandards

Riprap Aprons for Low Tailwater (downstream flow depth < 0.5 x pipe diameter)															
Culvert Diameter	**Lowest Value**			**Intermediate values to interpolate from**									**Highest Value**		
	Q	**L_A**	**D_{50}**	Q	**L_A**	**D_{50}**	**Q**	**L_A**	**D_{50}**	**Q**	**L_A**	**D_{50}**	**Q**	**L_A**	**D_{50}**
	Cfs	**Ft**	**In**	**Cfs**	**Ft**	**In**	**Cfs**	**Ft**	**In**	**Cfs**	**Ft**	**In**	**Cfs**	**Ft**	**In**
12"	4	7	2.5	6	10	3.5	9	131	6	12	16	7	14	17	8.5
15"	6.5	8	3	10	12	5	15	16	7	20	18	10	25	20	12
18"	10	9	3.5	15	14	5.5	20	17	7	30	22	11	40	25	14
21"	15	11	4	25	18	7	35	22	10	45	26	13	60	29	18
24"	21	13	5	35	20	8.5	50	26	12	65	30	16	80	33	19
27"	27	14	5.5	50	24	9.5	70	29	14	90	34	18	110	37	22
30"	36	16	6	60	25	9.5	90	33	15.5	120	38	20	140	41	24
36"	56	20	7	100	32	13	140	40	18	180	45	23	220	50	28
42"	82	22	8.5	120	32	12	160	39	17	200	45	20	260	52	26
48"	120	26	10	170	37	14	220	46	19	270	54	23	320	64	37
Riprap Aprons for High Tailwater (downstream flow depth > 0.5 x pipe diameter)															
Culvert Diameter	**Lowest Value**			**Intermediate values to interpolate from**									**Highest Value**		
	Q	**L_A**	**D_{50}**	Q	**L_A**	**D_{50}**	**Q**	**L_A**	**D_{50}**	**Q**	**L_A**	**D_{50}**	**Q**	**L_A**	**D_{50}**
	Cfs	**Ft**	**In**	**Cfs**	**Ft**	**In**	**Cfs**	**Ft**	**In**	**Cfs**	**Ft**	**In**	**Cfs**	**Ft**	**In**
12"	4	8	2	6	18	2.5	9	28	4.5	12	36	7	14	40	8
15"	7	8	2	10	20	2.5	15	34	5	20	42	7.5	25	50	10
18"	10	8	2	15	22	3	20	34	5	30	50	9	40	60	11
21"	15	8	2	25	32	4.5	35	48	7	45	58	11	60	72	14
24"	20	8	2	35	36	5	50	55	8.5	65	68	12	80	80	15
27"	27	10	2	50	41	6	70	58	10	90	70	14	110	82	17
30"	36	11	2	60	42	6	90	64	11	120	80	15	140	90	18
36"	56	13	2.5	100	60	7	140	85	13	180	104	18	220	120	23
42"	82	15	2.5	120	50	6	160	75	10	200	96	14	260	120	19
48"	120	20	2.5	170	58	7	220	85	12	270	105	16	320	120	20

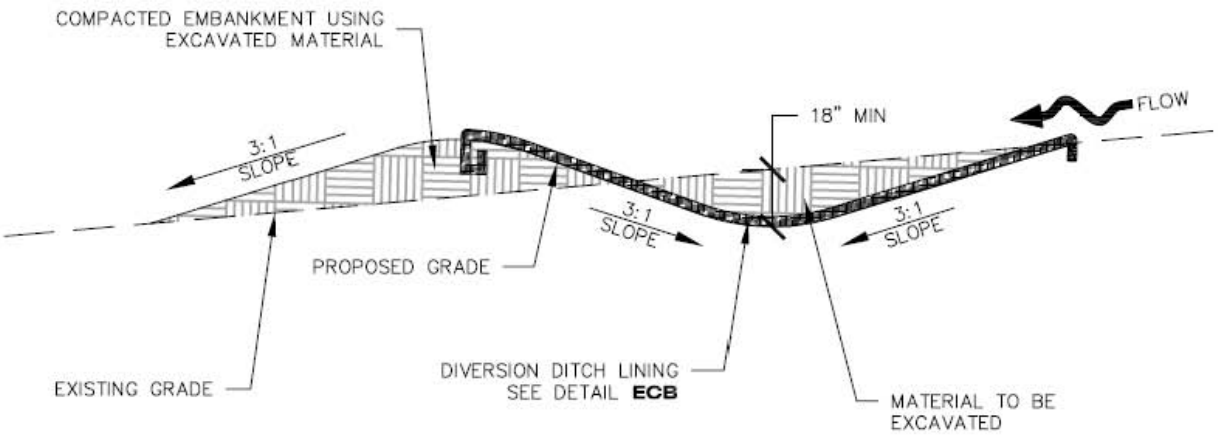
Typical Inlet Protection



Typical Outlet Protection

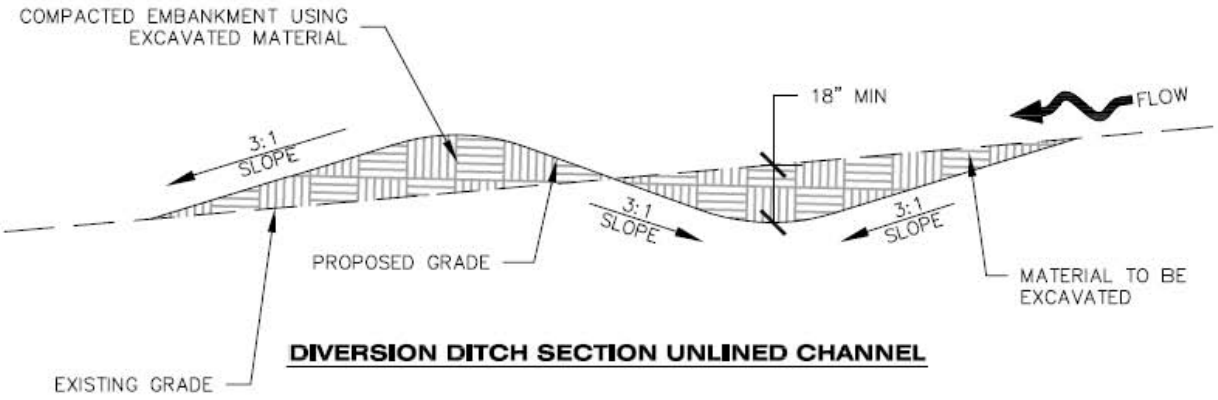


Diversion Dike (DD)



DIVISION DITCH GEOMETRY AND REQUIRED LINING MATERIAL SHALL BE OBTAINED FROM ASSOCIATED CBMP PLANS. IF THIS INFORMATION IS NOT PROVIDED ON THE CBMP PLANS, THE CONTRACTOR SHALL NOTIFY THE TOWN PRIOR TO CONSTRUCTION

DIVERSION DITCH SECTION LINED CHANNEL



DIVERSION DITCH SECTION UNLINED CHANNEL

DD DD

DIVERSION DITCH FOR EMBANKMENT BASES OR MIDSLOPES

A PLASTIC LINER, RIPRAP, OR EROSION CONTROL BLANKET MAY BE NECESSARY TO PROTECT THE DIVERSION DITCH. THE REQUIRED LINING MATERIAL SHALL BE OBTAINED FROM THE CBMP PLANS. IN THE EVENT A LINER, RIPRAP, OR EROSION CONTROL BLANKET IS REQUIRED FOLLOW THE APPROPRIATE INSTALLATION DETAIL.

ALL MATERIAL EXCAVATED FROM THE DITCH SHALL BE USED TO CONSTRUCT THE BERM ON THE DOWNHILL SIDE OF THE DITCH.

THE DIVERSION DITCH SHALL BE A MINIMUM OF 18" DEEP WITH 3:1 SIDE SLOPES. THE ADJACENT BERM SHALL BE A MINIMUM OF 18" IN HEIGHT WITH 3:1 SIDE SLOPES. ALL EMBANKMENTS SHALL BE FIRMLY COMPACTED.

THE DISCHARGE FROM THE DIVERSION DITCH SHALL BE DIRECTED TOWARDS AN APPROPRIATELY SIZED AND CONSTRUCTED SLOPE DRAIN, OR SEDIMENT POND.

IN LOCATIONS WHERE CONSTRUCTION TRAFFIC MUST CROSS A DIVERSION DITCH, THE EROSION CONTROL SUPERVISOR SHALL INSTALL A TEMPORARY CULVERT WITH A MINIMUM DIAMETER OF 12".

Installation and Maintenance

THE EROSION CONTROL SUPERVISOR SHALL INSPECT THE DIVERSION DITCH AT THE FOLLOWING INTERVALS:

- IMMEDIATELY FOLLOWING INITIAL INSTALLATION.
- EVERY 7 DAYS WHILE THE SITE IS UNDER ACTIVE CONSTRUCTION.
- IMMEDIATELY FOLLOWING ANY STORM EVENT THAT CAUSES SOIL EROSION.
- ONCE A MONTH FOLLOWING THE END OF CONSTRUCTION, UNTIL VEGETATIVE COVER HAS REACHED A CONSISTENT DENSITY OF AT LEAST 70% OF FULL VEGETATIVE COVER.

ACCUMULATED SEDIMENT SHALL BE REMOVED ONCE THE SEDIMENT HAS REACHED A DEPTH EQUAL TO 1/4 THE CREST HEIGHT.

DIVERSION DITCHES SHALL BE RE-GRADED IMMEDIATELY FOLLOWING ANY SIGNS OF SOIL EROSION.

DIVERSION DITCHES ARE TO REMAIN IN PLACE AND PROPERLY MAINTAINED UNTIL VEGETATIVE COVER HAS REACHED A CONSISTENT DENSITY OF AT LEAST 70% OF FULL VEGETATIVE COVER AND EROSION AND SEDIMENTATION IS NO LONGER A POSSIBILITY AS DETERMINED BY THE TOWN'S INSPECTOR. IN SOME INSTANCES, THE DIVERSION DITCHES MAY REMAIN IN PLACE PERMANENTLY.

WHEN DIVERSION DITCHES ARE REMOVED, EXCAVATIONS SHALL BE FILLED WITH SUITABLE COMPACTED TOPSOIL, THE BERM PORTION OF THE DIVERSION DITCH SHALL BE GRADED OUT AND ANY DISTURBED AREAS ASSOCIATED WITH THE INSTALLATION, MAINTENANCE, AND/OR REMOVAL OF THE DIVERSION DITCHES SHALL BE ROUGHENED, SEEDED, MULCHED, AND CRIMPED

Erosion Control Blanket (ECB)

Description

Erosion control blankets, also called turf reinforcement mats (TRM), are porous fabrics and are manufactured by weaving or bonding fibers made from organic or synthetic materials. Erosion control blankets are installed on steep slopes, over berms, or in channels to prevent erosion until final vegetation is established. However, blankets can also be used as separators or to aid in plant growth by holding seeds, fertilizers and topsoil in place.

Applicability

Erosion control blankets may be used in the following applications:

- To control erosion on steep slopes and to promote the establishment of vegetation.
- To stabilize channels against erosion from concentrated flows.
- To protect berms and diversions prior to the establishment of vegetation.
- To protect exposed soils immediately and temporary, such as when active piles of soil are left overnight.
- As a separator between riprap and soil to prevent soil from being eroded from beneath the riprap and to maintain the riprap's base.
- May be used on slopes as steep as 1:1.

Limitations

- Blankets used on slopes should be biodegradable, or photodegradable, non-toxic to vegetation or germination of seed, and non-toxic or injurious to humans.
- Should not be used on slopes where vegetation is already established.
- Some blankets might promote increased runoff and might blow away if not firmly anchored.
- If the fabric is not properly selected, designed, or installed, the effectiveness may be reduced drastically. Manufacturer's specification should be followed.

Design Criteria

There are many types of erosion control blankets available. Therefore, the selected fabric should match its purpose. Effective netting and matting require firm, continuous contact between the material and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material. Table ECB-1 indicates some recommended criteria for the selection of erosion control blankets.

Construction Specifications

- Smooth soil prior to installation and apply seed prior to fabric installation for stabilization of construction sites.

- Select the appropriate fabric type using the guidelines from table ECB-1.

- Installation of the blankets shall be in accordance with the manufacturer's recommendations and according to figure ECB-1. For blankets being placed in channels, the fabric should be rolled out parallel to the channel if the width is sufficient to cover the entire width of the channel. The fabric needs to be in continuous contact with the exposed soil.

- Pins or staples shall be made of wire 0.1621" or larger in diameter. "U" shaped staples shall have legs 8" long, and a 1" crown. The bar of the "T" shall be at least 4" long. Triangular survey stakes can also be used.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Inspections should determine if cracks, tears, or breaches have formed in the fabric. If the effectiveness of the erosion control blanket has been reduced, the fabric should be repaired or replaced immediately. Re-anchor loosened matting and replace missing matting and staple as required. It is necessary to maintain contact between the ground and the blanket at all times. Trapped sediment should be removed after each storm event.

References

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

http://cfpud.epa.gov/npdes/stormwater/menufbmps/con_site.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

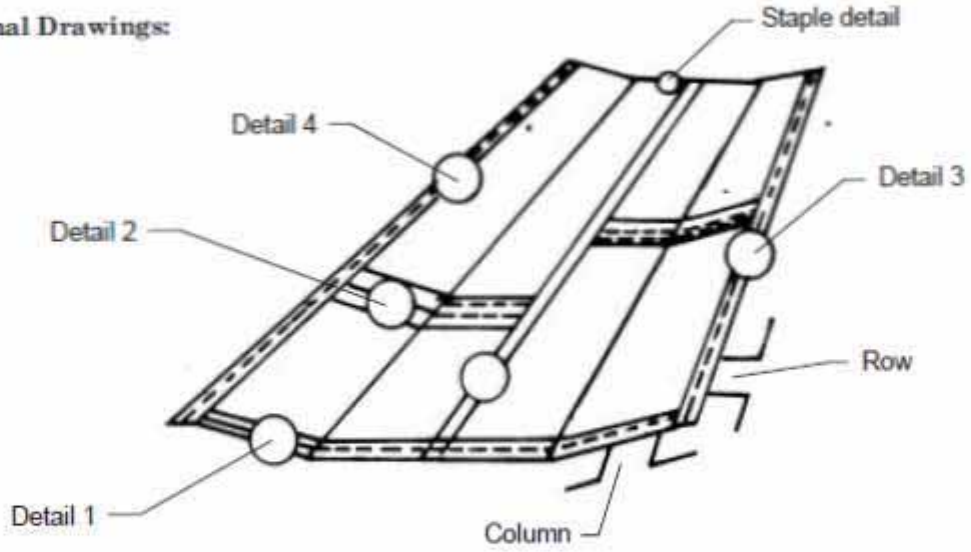
Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency od International Development (USAID), 2005. http://www.blm.gov/bmp/field%20guide.htm

North American Green, 2004.<http://www.nagreen.com

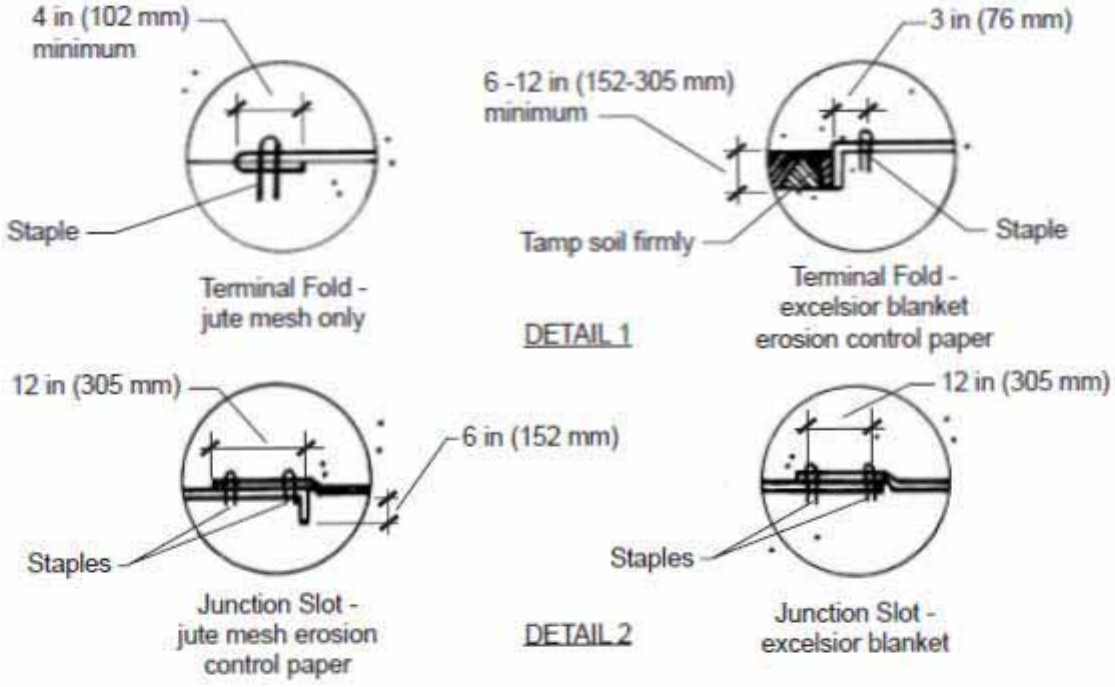
Table ECB-1
Suggested Blanket Types

Description	Longevity	Applications	Max. Flow Velocity (feet/sec.)
Single Net Straw Blanket	12 months	4:1 - 3:1 Slopes Low Flow Channels	5
Rapid Degrading Net	45 - 60 Days	4:1 - 3:1 Slopes Low Flow Channels	5
Double Net Straw Blanket	12 months	3:1 - 2:1 Slopes Moderate Flow Channels	6
Rapid Degrading Nets	45 - 60 Days	3:1 - 2:1 Slopes Moderate Flow Channels	6
Double Net Blanket 70% Straw/30% Coconut	24 months	2:1 - 1:1 Slopes Medium Flow Channels	8
Double Net Blanket 100% Coconut	36 months	1:1 & Greater Slopes High Flow Channels	10
Double Net Blanket Polypropylene Fiber		1:1 Slopes Extended Flow Areas High Flow Channels	9 (unveg.) 16 (veg.)
Organic Net	12 months	4:1 - 3:1 Slopes Low Flow Channels	5
Organic Nets	12 months	3:1 - 2:1 Slopes Moderate Flow Channels	6
	18 months	2:1 - 1:1 Slopes Medium Flow Channels	8
	24 months	1:1 & Greater Slopes High Flow Channels	10

Additional Drawings:

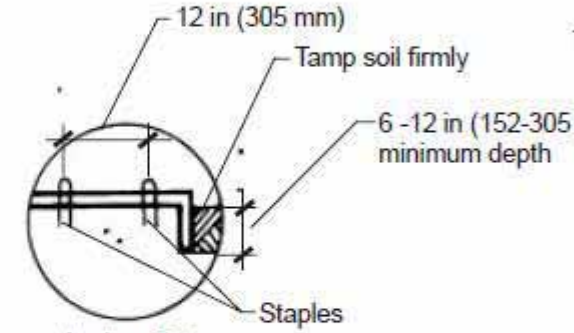


Erosion Control Blanket
Persective View



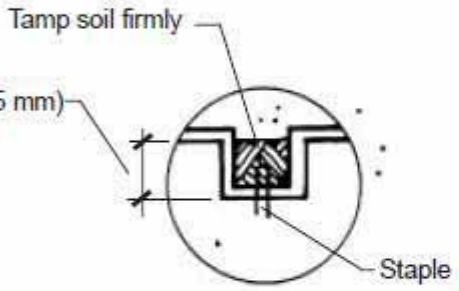
Erosion Control Blanket;
Detail 1 and Detail 2
Section View

Additional Drawings:



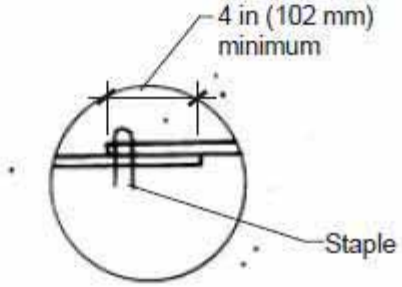
Anchor Slot -
jute mesh
excelsior blanket
erosion control paper

DETAIL 3



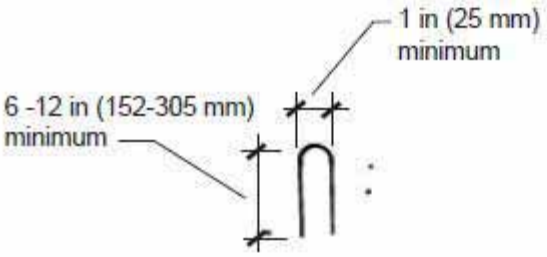
Check Slot -
erosion control paper

DETAIL 4



Lap Joint -
jute mesh
excelsior blanket
erosion control paper shall
be butted togther

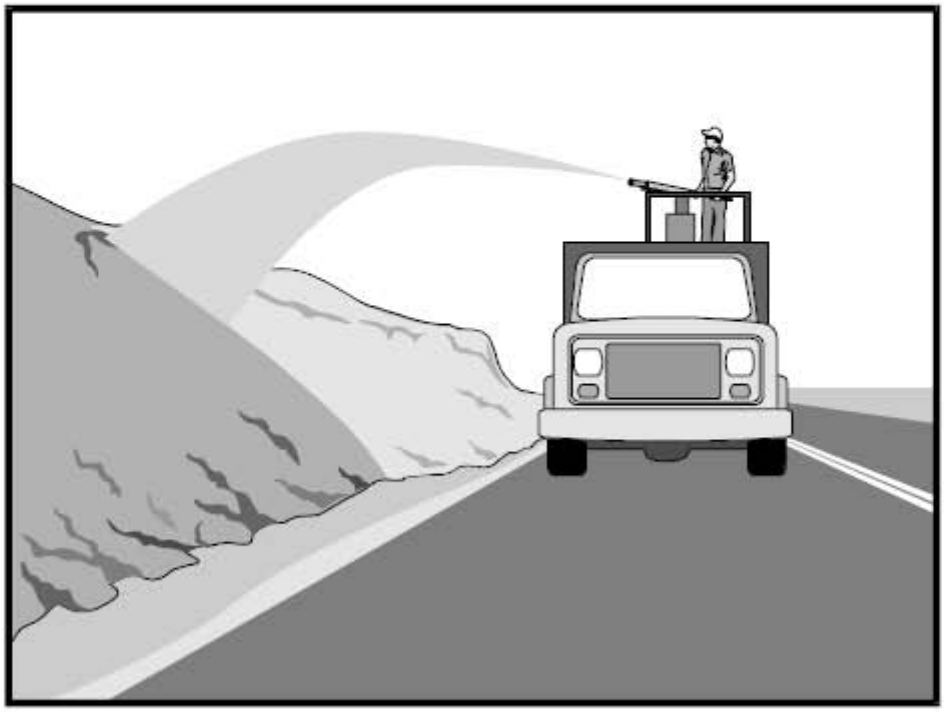
DETAIL 5



STAPLE DETAIL

Erosion Control Blanket;
Detail 3, Detail 4, Detail 5, and Staple Detail
Section View

Hydraulic Mulch



Description and Purpose

Hydraulic mulch consists of applying mixture of shredded wood fiber or a hydraulic matrix, and a stabilizing emulsion or tackifier with hydro-mulching equipment, which temporarily protects exposed soil from erosion by raindrop impact or wind.

Applicability

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

Limitations

Wood fiber hydraulic mulches are generally short lived and need 24 hours to dry before rainfall occurs to be effective. May require a second application in order to remain effective for an entire rainy season.

Construction Specifications

- Prior to application, roughen embankment and fill areas by rolling with a crimping or punching type roller or by track walking. Track walking shall only be used where other methods are impractical.

- To be effective, hydraulic matrices require 24 hours to dry before rainfall occurs.

- Avoid mulch over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

- Paper based hydraulic mulches alone shall not be used for erosion control.

Hydraulic Mulches

Wood fiber mulch can be applied alone or as a component of hydraulic matrices. Wood fiber applied alone is typically applied at the rate of 2,000 to 4,000 lb/acre. Wood fiber mulch is manufactured from wood or wood waste from lumber mills or from urban sources.

Hydraulic Matrices

Hydraulic matrices include a mixture of wood fiber and acrylic polymer or other tackifier as binder. Apply as a liquid slurry using a hydraulic application machine (i.e., hydro seeder) at the following minimum rates, or as specified by the manufacturer to achieve complete coverage of the target area: 2,000 to 4,000 lb/acre wood fiber mulch, and 5 to 10% (by weight) of tackifier (acrylic copolymer, guar, psyllium, etc.)

Bonded Fiber Matrix

Bonded fiber matrix (BFM) is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion resistant blanket that promotes vegetation, and prevents soil erosion. BFMs are typically applied at rates from 3,000 lb/acre to 4,000 lb/acre based on the manufacturer's recommendation. A biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should not dissolve or disperse upon re-wetting. Typically, biodegradable BFMs should not be applied immediately before, during or immediately after rainfall if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Land Grading (LG)

Description

Grading involves reshaping the ground surface to planned grades. Grading provides more suitable topography for well pads and pipelines and helps to control runoff, soil erosion, and sediment during and after construction in these areas. This BMP shall include the following:

- Proper cut and fill techniques to ensure roads and well pads remain stable over time.
- Road crowning or sloping to properly route runoff off the roadway.
- Surfacing of roads or well pads with gravel to avoid mud, rutting, and large quantities of sediment that will wash away during storms.

Applicability

- This BMP is applicable to the construction and maintenance of any road or well pad, but particularly those located on steep topography or easily erodible soils.
- Surface gravel is applicable to all areas with "soft" soils sections, steep grades, highly erosive soils, or where all weather access is needed. Gravel may be used as "fill" material in ruts or as a full structural section over the entire road or well pad.

Limitations

- Improper cut and fill slopes that disrupt natural storm water patterns might lead to poor drainage, high runoff velocities, and increased peak flows during storm events.
- Rutting and wash boarding may develop if surface gravel is not designed properly or if road or well pad is not sloped.
- Flat-blading to maintain the roadway must be done properly to avoid changes in gravel thickness, road slope, and road grade.

Design Criteria

Practices must be developed for erosion control, slope stabilization, and safe disposal of runoff water and drainage, such as ditches and culverts, grade stabilization structures, retaining walls, and surface drains. Land grading should be based upon well pad and pipeline layouts that fit and utilize existing topography and desirable natural surroundings to avoid extreme grade modifications. Clearing and grading should only occur at those areas necessary for well pad activity and equipment traffic. Maintaining undisturbed temporary or permanent buffer zones in

the grading operation provides a low cost sediment control measure that will help reduce runoff and offsite sedimentation.

Slope Failures

Landslides and failed cuts and fills can be a major source of sediment. They can close the roads or require major repairs, and they can greatly increase maintenance costs. Slope failures, or landslides typically occur where a slope is over-steep, where fill material is not compacted, or where cuts in natural soils encounter groundwater or zones of weak material. Good road location can often avoid landslide areas and reduce slope failures. When failure does occur, the slide area should be stabilized by removing the slide material, flattening the slope, adding drainage, or using structures as discussed below. Designs are typically site specific and may require input from geotechnical engineers and engineering geologist. Failures that occur typically impact operations and can be costly to repair. Failures near streams and channel crossings have an added risk of impact to water quality.

Road Slope

See figure LG-1. All roads should be designed with one of the following three slope types:

- Out-sloped roads minimize the concentration of water and minimize road width by avoiding the need for an inside ditch, but nay require roadway surface and fill slope stabilization. Out-sloped roads with clay rich, slippery road surface materials often require surface stabilization with gravel or limited use during rainy periods to assure traffic safety. On road grades over 10 to 12 percent and on steep hill slope areas, out-sloped roads are difficult to drain and can feel unsafe.

- In-sloped roads are the best method to control surface water. However, in-sloped roads also concentrate water and require a system of ditches and turnouts or cross draining culverts.

- Crowned roads are appropriate for higher standard, two lane roads on gentle grades. They may or may not require roadside ditches, turnouts, and/or cross drains. It is difficult to create and maintain a crown on a narrow road, so generally in-sloped or out-sloped road drainage is more effective.

Construction Specifications

Cut and fill Slopes

- All areas to be disturbed (both cut and fill) shall be cleared, grubbed, and stripped of topsoil to remove trees, vegetation, roots, or other objectionable material.

- Fill material shall be free of brush, logs, stumps, roots, or other objectionable material that would interfere with, or prevent construction or satisfactory fills. This material can be set aside and later used at the toe of fill slopes as filter berms.

- Table LG-1 presents a range of commonly used cut and fill slope ratios appropriate for the soil and rock types described. Figures LG-2 and LG-3 present typical cut and fill slope design options for varying slope and site conditions. Vertical cut slopes should not be used unless the cut is in rock or very well cemented soil. Ideally, both cut and fill slopes should be constructed with a 2:1 or flatter slope to promote growth of vegetation, but cut slopes in dense, sterile soils or rocky material are often difficult to vegetate.

- All fills shall be compacted as requires to reduce erosion, slippage, settlement, subsidence, or other related problems.

- Topsoil required for the establishment of vegetation shall be stockpiled in the amount necessary to complete finished grading of all exposed areas. Areas that are to be top-soiled shall be scarified to a minimum depth of four inches prior to placement of topsoil.

Road Slope

- See figure LG-1. Compact soil or road base material to direct runoff.

- If crowning a road, runoff is directed to both sides of the road requiring two roadside ditches, unless runoff will drain directly to well stabilized areas.

- If using an in-slope design, runoff will be directed toward the hillside and requires a roadside ditch with periodic turnouts or cross drain culvert installation.

- If using an outslope design, ensure a moderate road slope with dense vegetative cover

Surface Gravel

- Ideally, aggregate surfacing material is (1) hard, durable, and crushed or screened to a minus 2 inch size; (2) well graded to achieve maximum density; (3) contains 5-15% clayey binder to prevent raveling; and (4) had a plasticity index of 2 to 10.

- Gravel should be placed to a thickness of at least twice the diameter of the largest stone with a minimum thickness of four inches. Over very weak soils gravel thickness can be reduced with the use of geotextile or geogrid subgrade reinforcement. Also, geotextile layers are useful over soft soils to separate the gravel from the soil, keep it uncontaminated, and extend the useful life of the gravel.

- Compact the aggregate during construction and maintenance to achieve a dense, smooth surface and thus reduce the amount of water that can soak into the road or well pad.

- "Spot" stabilize local wet areas and soft areas with four to six inches of coarse rocky material, add more as needed.

- Blend coarse aggregate and fine clay-rich soil (when available) to produce a desirable composite roadway material that is coarse yet well graded with 5-15% fines for binder.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Inspect cut and fill slopes for rills or other indications of erosion. Maintain all crowns, out-slopes, in-slopes, and surface gravel.

References

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

http://cfpud.epa.gov/npdes/stormwater/menufbmps/con_site.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

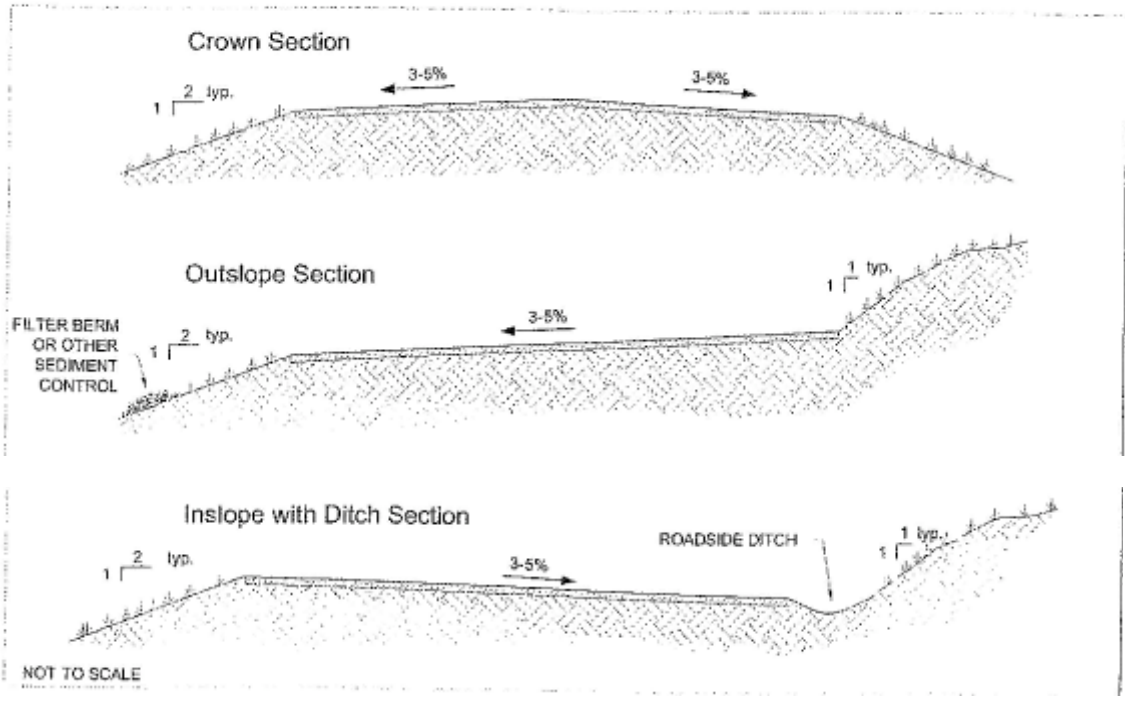
Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency od International Development (USAID), 2005. http://www.blm.gov/bmp/field%20guide.htm

New York State Department of Environmental Conservation, *New York Guidelinesfor Urban Erosion and Sediment Control.* New York. Forth Edition, 1997.

http://www.dec.state.ny.us/website/dow/toolbox/escstandards

LG-1		
Stable Slope Ratios for Various Conditions		
Soil/Rock Condition		**Slope Ratio (Hor:Vert)**
Most rock		1/4:1 to 1/2:1
Very well cemented soils		1/4:1 to 1/2:1
Most n-place soils		3/4:1 to1:1
Very fractured rock		1:1 to 1 1/2:1
Loose coarse granular soils		1 1/2:1
Heavy clay soils		2:1 to 3:1
Soft clay rich zones or wet seepage areas		2:1 to 3:1
Fills of most soils		1 1/2:1 to 2:1
Fills of hard, angular rock		1 1/3:1
Low cuts and fills (<10 ft high)		2:1 or flatter (for revegetaton)

Figure LG-1
Typical Road Surface Drainage Options



Revegetation (RV)

Description

Revegetation involves planting seed to establish a vegetative cover in disturbed areas. Revegetation reduces erosion and sediment by stabilizing disturbed areas in a manner that is economical, adaptable to site conditions, and allows selection of the most appropriate plant material. Revegatation also:

- Absorbs the impact of raindrops.
- Reduces the velocity of runoff

.

- Reduces runoff volumes by increasing water percolation into the soil.
- Binds soil with roots.
- Protects soil form wind.
- Improves wildlife habitat.
- Enhances natural beauty.

Applicability

Revegetation is most effective on slopes no steeper than 2:1. Revegetation may be used as a permanent control or a temporary control in areas where exposed soil surfaces are not to be regarded for periods longer than 30 days. Such areas include denuded areas, soil stockpiles, berms, temporary road banks, etc.

Limitations

The effectiveness of revegetation can be due to the following:

- High erosion potential during establishment.
- The need for stable soil temperature and soil moisture content during germination and early growth.

- The need to reseed areas that fail to establish.

- Limited seeding times depending on the season.

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

- Seeding does not immediately stabilize soils. Prior to seeding, install necessary erosion and sediment control practices such as diversions, straw bales, and basins until vegetation is established.

Design Criteria

Successful plant establishment can be maximized with proper planning; consideration of soil characteristics; selection of plant materials that are suitable for the site; adequate seedbed preparation, liming, and fertilization; timely planting; and regular maintenance.

When to seed

Areas to be stabilized with vegetation must be seeded or planted one to four months after grading is completed unless temporary stabilization measures are in place. Possible dates for seeding are as follows:

Seed Mix

Climate, soils, and topography are major factors that dictate the suitability of plants for a particular site. Vegetation that is adapted to the site, has strong roots, and provides good ground cover should be used. Although a native need mix is best some grasses, such as Vetiver, have been used extensively worldwide because of their strong, deep roots, adaptability, and non-invasive properties.

Construction Specifications

1. Seeding does not immediately stabilize soils. Temporary erosion and sediment control measures should be in place o prevent off-site transport of sediments from disturbed areas until vegetation is established.

2. Vegetation should not be established on slopes that are unsuitable due to inappropriate soil texture, poor internal structure or internal drainage, volume of overland flow, or excessive steepness, until measures haven taken to correct these problems.

3. If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted, or hardened, the soil surface shall be loosened by disking, raking, harrowing,

or other acceptable means to ensure good water infiltration and root penetration (see SURFACE ROUGHENING [SR]).

4. The soil on a disturbed site may need to be modified to provide an optimum environment for seed germination and seedling growth. To maintain a good stand of vegetation, the soil must meet certain minimum requirements as a growth medium. If any of the below criteria cannot be met then topsoil shall be applied. The existing soil must have these characteristics:

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

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

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

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

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

5. Add fertilizer and/or lime, if necessary. Lime and fertilizer may be incorporated into the top two to four inches of the soil if possible. The addition of lime is equally as important as applying fertilizer. Lime will modify the pH and supply calcium and magnesium. Its effect on pH makes other nutrients more available to the plant.

6. The appropriate seed shall be evenly applied with a broadcast seeder, drill, cultipacker seeder or hydroseeder. Seeding depth should be ¼ to ½ inch.

7. If necessary, apply mulch according to MULCHING (M). the mulch will hold moisture and modify temperature extremes, and prevent erosion while seedlings are growing.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Vegetation is considered established when a density of at least 70 percent of pre-disturbance levels has been reached. Seeded areas should be inspected for failure and any necessary repairs and re-seedings should be made within the same season if possible.

References

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

http://cfpud.epa.gov/npdes/stormwater/menufbmps/con_site.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency od International Development (USAID), 2005. http://www.blm.gov/bmp/field%20guide.htm

Riprap (R)

Description

Riprap is a permanent, erosion resistant layer made of stones or boulders. It is intended to stabilize areas subject to erosion and protect against scour of the soil caused by concentrated, high velocity flows.

Applicability

Riprap can be used for areas subject to erosion or weathering, particularly where conditions prohibit the establishment of revegetation or where flow velocities exceed 5ft/sec. Riprap can be used in the following applications.

- Cut and fill slopes
- Chanel side slopes and/or bottoms
- Inlets and outlets to culverts, slope drains, and sediment traps
- Roadside ditches

Limitations

Riprap is limited by steepness of slope, because slopes are greater than 1.5:1 have potential riprap loss die to erosion and sliding. When working within flowing streams, measure should be taken to prevent excessive turbidity and erosion during construction. Bypassing base flows or temporary blocking base flows are two possible methods.

Design Criteria

Gradation

W well-graded mixture of rock sizes should be used instead of one uniform size (with the exception of dry stacking boulders). 50 percent by weight should be larger than the specified design size. The diameter of the largest stone size in such a mixture should be 1.5 times the d50 size with smaller sizes graded down to one inch. When dry stacking up a slope, boulders may be uniform in size or may get gradually smaller as he boulders are placed up the slope.

Quality

Riprap must be durable so that freeze/thaw cycles do not decompose it in a short time. They should be angular and not subject to breaking down when exposed to water or weathering.

Size

The sizes of stones used for riprap protection are determined by purpose and specific site conditions:

1. Slope Stabilization. Riprap stone for slope stabilization not subject to flowing water should be sized for the proposed grade. The gradient of the slope to be stabilized should be less than the natural angle of the repose of the stone selected. Angles of the repose of riprap stones may be estimated from figure R-1. Riprap used for surface stabilization of slopes does not add significant resistance to sliding or slope failure and should not be considered a retaining wall. Slopes approaching 1.5:1 may require special stability analysis. The inherent stability of the soil must be satisfactory before riprap is used for surface stabilization.

2. Outlet Protection. Design criteria for sizing stone and determining dimensions of riprap aprons are presented in CULVERT PROTECTION (CP).

3. Stream bank Protection. If the shear stress is estimated, riprap stone for stream bank protection can be selected from the gradations in Table R-1, below. The shear stress can be estimated from the depth of flow and the channel slope (see not for Table R-1). The riprap should extend two feet below the channel bottom and be keyed into the bank both at the upstream end and downstream end of the proposed work or reach.

Filter Material

Filter material is sometimes used between riprap and the underlying soil surface to prevent soil from moving through the riprap. Filter cloth material or a layer of sand and/or gravel is usually used for the filter.

The design of a sand/gravel filter blanket is based on the ratio of particle size in the overlying filter material to that of the base material in accordance with the criteria below. Multiple layers (each a minimum of 6 inches thick) may be designed to affect a proper filter if necessary. A sand/gravel filter blanket should have the following relationship for a stable design:

$$\frac{d15\ \text{filter}}{d85\ \text{base}} \leq 5$$

$$5 < \frac{d15\ \text{filter}}{d50\ \text{base}} \leq 40$$

$$\frac{d50\ \text{filter}}{d50\ \text{base}} \leq 40$$

The design of a synthetic filter fabric, which may be used with or in pace of gravel filters, is

Filter fabric covering a base containing 50% or less by weight of fine particles (#200 sieve size):

$$\frac{\text{d85 base (mm)}}{\text{EOS* filter fabric (mm)}} > 1$$

total open area of filter fabric should not exceed 36%

1. Filter fabric covering other soils:
a. EOS is no larger than 0.21 mm (#70 sieve size)
b. Total open area of filter fabric shold not exceed 10%

*EOS- Equivalent opening size compared to a U.S. standard sieve size.

No filter fabric should have less than 4% open area or an EOS less than U.S. Standard Sieve #100 (0.15 mm). The permeability of the fabric must be greater than that of the soil. The fabric may be made of woven or non-woven monofilament yarns and should meet the following minimum requirements:

Thickness 20-60 mils

Grab strength 90-120 lbs

Conform to ASTM D-1682 or ASTM D=177

Construction Specifications

See Figure R-2 for riprap slope stabilization and stream bank protection. See Figure R-3 for dry stacking boulders. See SEDIMENT TRAP (ST) for a detail of a riprap lined channel leading into a sediment trap. For culvert outlet protection, construct according to Culvert Protection (CP).

2. **Subgrade Preparation**. Prepare the subgrade for riprap to the required lines and grades. Compact any fill required in the subgrade to a density approximating that of the undisturbed material or overfill depressions with riprap. Remove brush, trees, stumps, and other objectionable material. Cut the subgrade sufficiently deep so that the finished grade of the riprap will be at the elvation of the surrounding area. Channels should be excavated sufficiently to allow placement of the riprap in a manner such that the finished inside dimensions and grade the riprap meet design specification.

3. **Sand/Gravel filter basket**. If using a granular filter, spread filter stone in a uniform layer to the specified depth. Where more than one later of filter material is used, spread the layers with minimal missing.

4. **Synthetic filter fabric.** If using a filter fabric, place the cloth directly on the prepared foundation. Where large stones are to be placed, a 4-inch layer of fine sand or gravel is recommended to protect the filter cloth. Filter fabric is not recommended as a filter on slopes steeper than 2 horizontal to 1 vertical.

5. **Stone placement.** Place riprap so that it forms dense, well-graded mass of stone with a minimum of voids. The desired distribution of stones throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement. Place riprap though chutes or other methods that cause segregation of stone sizes. If a filter is used, be careful not to lodge the underlying base filter or damage the filter cloth when placing the stones. If damage occurs, remove the riprap and repair filter.

The toe of the riprap should be keyed into a stable foundation at its base as shown in Figure R-2 if required for slope stabilization and stream bank protection. The finished slope should be free of pockets of small or clusters of large stones. Hand placing may be necessary to achieve proper distribution of stone sizes to produce a relatively smooth, uniform surface. The finished grade of the riprap should blend with the surrounding area.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). If riprap has been damaged or dislodged, repairs should be made to prevent a progressive failure. If repairs are needed repeatedly a one location, the site should be evaluated to determine if the original design conditions have changed. Channel obstructions such as trees and sediment bars can change flow patterns and cause erosive forces that may damage riprap. Control of weed and brush growth may be needed in some locations.

Removal

Riprap is generally not removed.

References

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

http://cfpud.epa.gov/npdes/stormwater/menufbmps/con_site.cfmNew York State Department of Environmental Conservation, *New York Guidelinesfor Urban Erosion and Sediment Control.* New York. Forth Edition, 1997.

http://www.dec.state.ny.us/website/dow/toolbox/escstandards

Table R-1
Riprap Gradations

Unit shear stress (lb/ft^2)	D_{50}	d_{max}	Minimum blanket thickness (inches)
0.67	2	4	6
2	6	9	14
3	9	14	20
4	12	18	27
5	15	22	32
6	18	27	32
7.8	21	32	38
8	24	36	43

Unit shear stress calculated as T=y*d*s where:

T = shear stress in lb/ft^2

y = unit weight of water, 62.4 lb/ft^2

d = flow depth in ft

s = channel gradient in ft/ft

Figure R-1
Angles of Repose of Riprap Stones

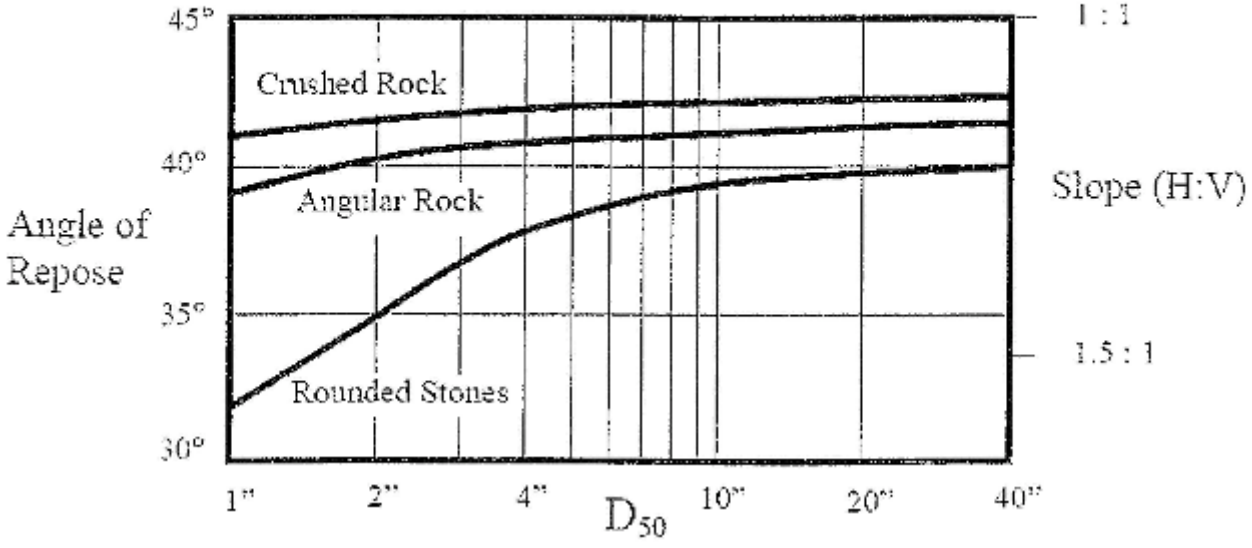
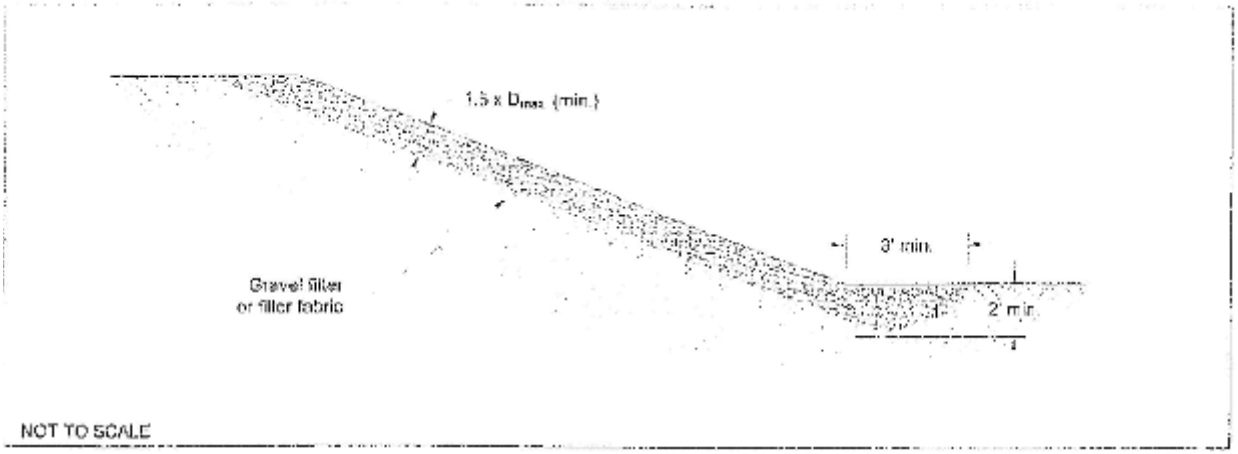


Figure R-2
Typical Riprap Slope Protection Detail



NOT TO SCALE

Figure R-3
Typical Boulder Drystack Detail

NOT TO SCALE

Roadside Ditches (RSD) and Turnouts (TO)

Description

Roadside ditches are channels constructed parallel to roads. The ditches convey concentrated runoff of surface water from roads and surrounding areas to a stabilized outlet. Turnouts (also called wing ditches) are extensions of road side ditches. Turnouts effectively remove run- off water from the roadside ditch into well-stabilized areas before it reaches a waterway.

Applicability

- Roadside ditches should be used for all roads built on sloping topography and with either an inslope or a crowned design.

- Ditch turnouts should be used as much as possible but their best use may be on slopes longer than 150ft or greater than 5%, as conditions allow.

- Turnouts are applicable where fairly flat naturally vegetative areas exist at intervals by the roadside.

Limitations

- If these structures are not installed correctly they may become a source of erosion.

- Road-side ditches do not necessarily filter sediment from runoff.

- Turnouts should be on gradual slopes only.

- Turnouts require vegetative cover or other filter at the discharge point.

- Turnouts only work well if small volumes of runoff drain into the turnout. Turnouts should only receive runoff from the road and ditch surface, not from large, uphill watersheds.

Design Criteria

No formal design required.

Construction Specifications

Roadside ditches

1. Roadside ditches should be constructed with no projections of roots, stumps, rocks, or similar debris.

2. Excavate ditches along roadside to a width and depth that can handle expected flow according to figure RAD-1.

3. All ditches shall have uninterrupted positive grade to an outlet. Slope ditch so that water velocities do not cause excessive erosion, but no less than 0.5%. If steep slopes and high velocities exist, use check dams to slow runoff and catch sediment.

4. To control erosion and collect sediment, construct aggregate check dams according to figure CD-1 of CHECK DAM (CD).

5. All ditches shall convey runoff to a sediment trapping device such as a SEDIMENT TRAP (ST) or an undisturbed, well vegetated and stabilized area at non-erosive velocity.

6. If necessary, stabilize ditches with RIPRAP (R) or EROSION CONTROL BLANKET (ECB).

Turnouts

1. Use turnouts wherever possible and on undisturbed soil.

2. Turnouts should be on gradual slopes only and should slope gradually down from the bottom of the road-side ditch.

3. Angle turnout at approximately 30 degrees to the road-side ditch

4. Discharge turnout into well-vegetated area or install a secondary control such as a wattle, sediment trap, or silt fence. As a good rule of thumb, the vegetated outlet area should be a minimum of one half the size of the total drainage area draining into it. If well-vegetated outlets areas are not available, use culverts or other controls to direct runoff to a stabilized area.

5. Space turnouts according to slope as indicated on figure TO-1.

6. Turnouts only work well if small volumes of runoff drain into the turnout. Turnouts should only receive runoff from the road and ditch surface, not from large, uphill watersheds.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Road ditches and turnouts should be inspected for any signs of channelization, and repaired as necessary. Structures will fail if water exists in channelized flow. Also inspect for sediment buildup at the outlet and at aggregate check dams and remove if necessary.

References

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency od International Development (USAID), 2005. http://www.blm.gov/bmp/field%20guide.htm

United States Department of the Interior and United States Department of Agriculture. *Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development "Gold Book".* BLM/WO/ST-06/021+3071. Bureau of Land Management (BLM). Denver, Colorado. Fourth Edition, 2006.

Figure RSD-1
Roadside Ditch Installation

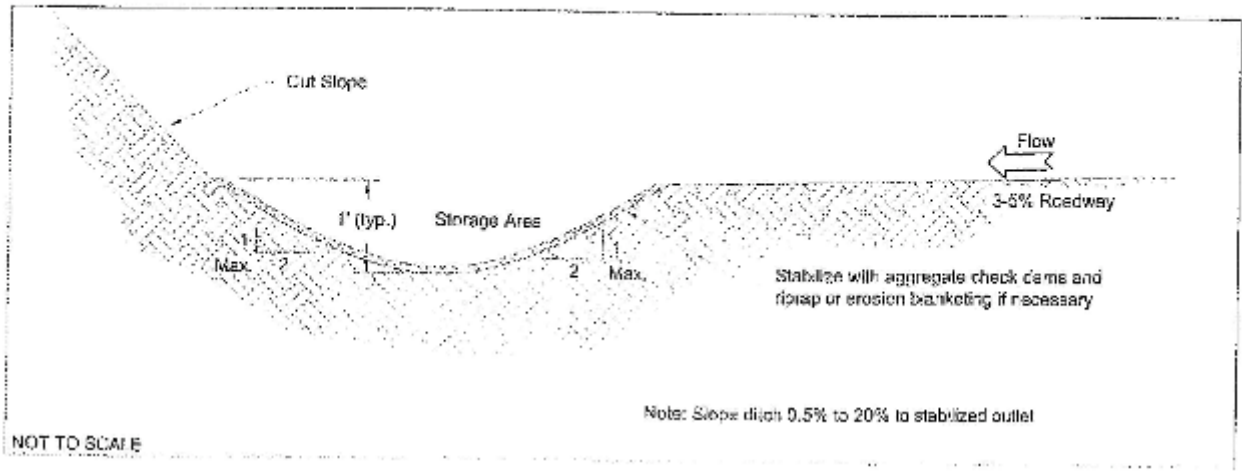
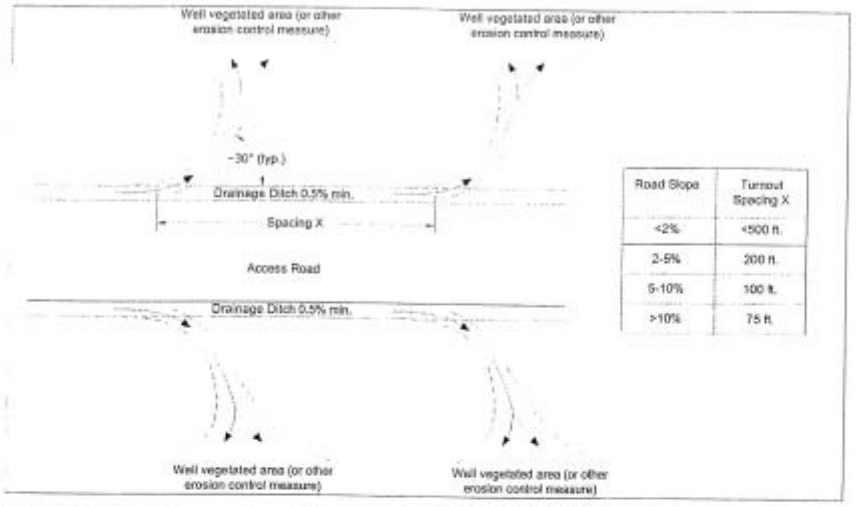
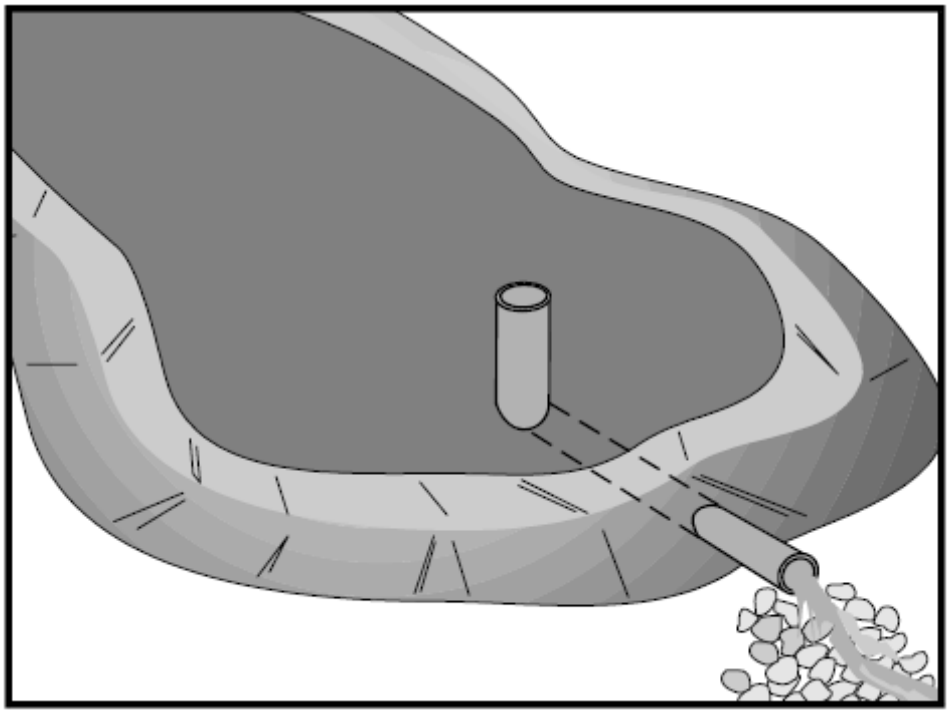


Figure TO-1
Turnout Layout

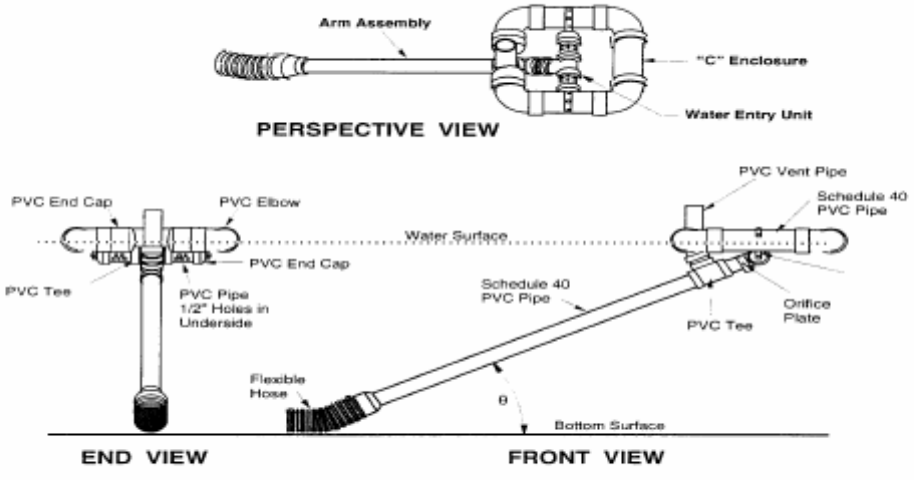


Road Slope	Turnout Spacing X
<2%	<500 ft.
2-5%	200 ft.
5-10%	100 ft.
>10%	75 ft.

Sediment Basin (SB)



Skimmer



θ should be 45° or less when the water surface is at the maximum pool elevation - the elevation of the 2 cfs/acre discharge.

Description and Purpose

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

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres
- At the outlet of large disturbed watersheds, as necessary
- Where post construction detention basins are required
- In associated with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Sediment Trap (ST)

Description

Sediment traps are small ponding areas that allow sediment to settle out of runoff water. They are usually installed in a drainage way or other point of discharge from a disturbed area. Sediment traps are formed by excavating below grade and/or by constructing an earthen embankment with a lined spillway to slow the release of runoff.

Applicability

Sediment traps are generally temporary control measures used at the outlets of storm water diversion structures, channels, slope drains, construction site entrance wash racks, or any other runoff conveyance that discharges waters containing erosion sediment and debris. Sediment raps should be used for drainage areas less than five acres. The effective life span of these temporary structures is usually limited to 24 months. Traps may be located in series to allow for backup control in case one trap fails.

Limitations

- Regular maintenance is needed to remove sediment. Traps should be located near roads or where accessible to remove sediment.

- Although sediment traps allow for settling of eroded soils, because of their short detention periods for storm water they typically do not remove fine particles such as silts and clays.

- Water may remain in trap for extended periods causing an ideal spot for mosquitoes and other insects to gather. Locate the trap in a sunny spot if possible.

- Never construct a sediment trap on a live flow stream or in wetlands.

Design Criteria

No formal design required

Location

Traps should be located at points of discharge from disturbed areas. The location will be determined by the natural terrain, drainage pattern of the runoff, and the accessibility for maintenance. Sediment traps should not be located in areas where their failure due to storm water runoff excess can lead to further erosive damage of the landscape. Alternative diversion pathways should be designed to accommodate these potential overflows. Sediment trap locations should also allow for easy maintenance access for the periodic removal of accumulated sediment.

Storage Capacity

A sediment trap should be designed to maximize surface area for infiltration and sediment settling. This will increase the effectiveness of the trap and decrease the likelihood of backup during and after periods of high runoff intensity. The approximate storage capacity of each trap should be 3,600 ft3 per acre of contributing drainage area. Half of this volume may be in the form of wet storage (a permanent pool) and the other half may be in the form of dry storage. When possible, the wet storage volume should be contained within the excavated portion of the trap. The volume of a natural sedimentation trap can be approximated by the following equation:

Volume (ft3) = 0.4 x surface area (ft2) x maximum pool depth (ft)

Construction Specifications

See Figure ST-1 for installation details.

1. If possible, sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.

2. Traps should be located above the floodplain, where possible, if there are space constraints, several small sediment traps may be constructed in series.

3. Area under embankment shall be cleared, grubbed and stripped of any vegetation and root mat. The pool area shall be cleared.

4. The fill material for the embankment shall be free of roots and other woody vegetation as well as over-sized stones, rocks, organic material or other objectionable material. The embankment shall be compacted by traversing with equipment while it is being constructed. Seeding of the embankment should be performed as soon as possible after construction of the sediment trap. Erosion control blanketing may also be used to cover the embankment in combination with seeding or during time periods when seeding is ineffective.

5. The spillway may consist of a stone section in the embankment formed by a combination coarse aggregate/riprap to provide for filtering/detention capability. Riprap shall be 4- to 8-inch rock, while the coarse aggregate shall be ½ to ¾ inches. A geo-textile may be placed at the stone-soil interface to act as a separator.

6. Another option for the spillway is to use straw bales or wattles at the overflow point in the trap and line the rest of the spillway with an erosion control blanket (see applicable specification).

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). The primary maintenance consideration for temporary sediment traps is the removal of accumulated sediment from the basin to ensure the continued effectiveness of the sediment trap. Sediments should be removed when the basin reaches approximately 50 percent sediment capacity. Inspectors should also ensure that the trap is draining properly and check the structure for damage from erosion. The depth of the spillway should be checked and maintained at a minimum of 1.5 feet below the low point of the trap embankment.

Removal

The structure shall be removed and the area stabilized when the drainage area has been properly stabilized.

References

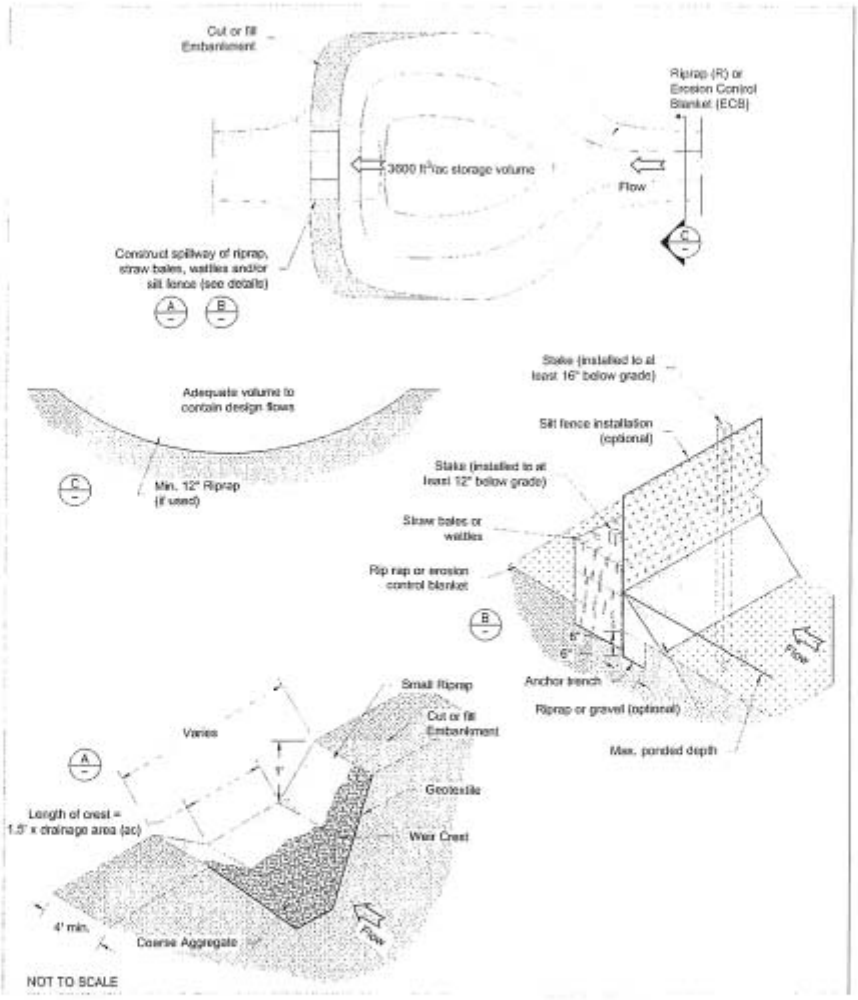
Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide.* 2002. http://www.dot.state.co.us/environtmental/envWaterQual/wqms4.asp

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003

http://cfpub.epa.gov/ndpes/stormwater/menufbmps/con_site.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004

Figure ST-1
Sediment Trap Installation



Silt Fence (SF)

Description

Silt fences are used as temporary perimeter control around sites where there will be soil disturbance due to construction activities. They consist of a length of filter fabric stretched between anchoring post at regular intervals along the site perimeter.

Applicability

Silt fences are generally applicable to construction sites with relatively small drainage areas. They are appropriate in areas where runoff will be occurring as low-level shallow flow, not exceeding 0.5cfs. The drainage area for silt fences generally should not exceed 0.25 acre per 100-foot fence length. Slope length above the fence should not exceed 100 feet.

Limitations

- Silt fence should not be installed along areas where rocks or other hard surfaces will prevent uniform anchoring of fence posts and entrenching of the filter fabric. This will greatly reduce the effectiveness of silt fencing and can create runoff channels leading offsite.

- Silt fences are not suitable for areas where large amounts of concentrated runoff are likely.

- Open areas where wind velocity is high may present a maintenance challenge, as high winds may accelerate deterioration of the filter fabric.

- Silt fences should not be installed across streams, ditches, or waterways.

- When the pores of the fence fabric become clogged with sediment, pools of water are likely to form on the uphill side of the fence. Location and design of the silt fence should account for this and care should be taken to avoid un-necessary diversion of storm water from these pools that might cause further erosion damage.

Design Criteria

The fence should be designed to withstand the runoff from a 10-year storm event.

Construction Specifications

1. Erect silt fence according to figure SF-1.

2. If standard strength fabric is used in combination with wire mesh, the support posts should be spaced no more than 10 feet apart. If extra-strength fabric is used without wire mesh reinforcement, the support posts should be spaced no more than 6 feet apart.

3. Stakes used to anchor the filter fabric should either be wooden or metal. Wooden stakes should be at least three feet tall and have a minimum diameter of two inches if a hardwood such as oak is used. Softer woods such as pine should be at least four inches in diameter. When using metal post in place of wooden stakes, they should have a minimum weight of 1 to 1.33lb/linear foot. If metals post are used, attachment points are needed for fastening the filter fabric using wire ties. The height of the fence post should be between 16 and 34 inches above the original ground surface.

4. Material for silt fences should be a pervious sheet of synthetic fiber such as polypropylene, nylon, polyester, or polyethylene yarn, chosen based on minimum synthetic fabric requirements, as shown in the following table:

Physical Property	Requirements
Filtering Efficiency	75 – 85% (minimum): highly dependent on local conditions
Tensile Strength at 20% (maximum) Elongation	Standard Strength: 30 lbs/linear inch (minimum) Extra Strength: 50 lbs/linear inch (minimum)
Ultraviolet Radiation	90% (minimum)
Slurry Flow Rate	0.3 gal/ft^2/min (minimum)

5. Use a continuous roll of fabric to eliminate unwanted gaps in the fence. If a continuous roll of fabric is not available, the fabric should overlap from both directions only at the stakes or posts with a minimum overlap of six inches.

6. Extend silt fence across grade and upslope for a short distance.

7. Compact backfill at base of fabric.

8. Plow in or entrench the bottom of the fabric fence at least 6 inches below the ground surface. This will help prevent gaps from forming near the ground surface that would render the fencing useless as a sediment barrier.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Inspect silt fences to ensure that they are intact and that there are no gaps at the fence-ground interface or tears along the length of the fence. If gaps or tears which impact the

effectiveness of the silt fence are discovered, they should be repaired or the fabric should be replaced immediately. Accumulated sediments should be removed from the fence base when the sediment reaches 1/3 to 1/2 the height of the fence. Sediment removal should occur more frequently if accumulated sediment is creating noticeable strain on the fabric and there is the possibility of the fence failing from a sudden storm event.

Removal

Remove silt fences and all accumulated sediment after uphill drainage areas are stabilized by vegetation or other means.

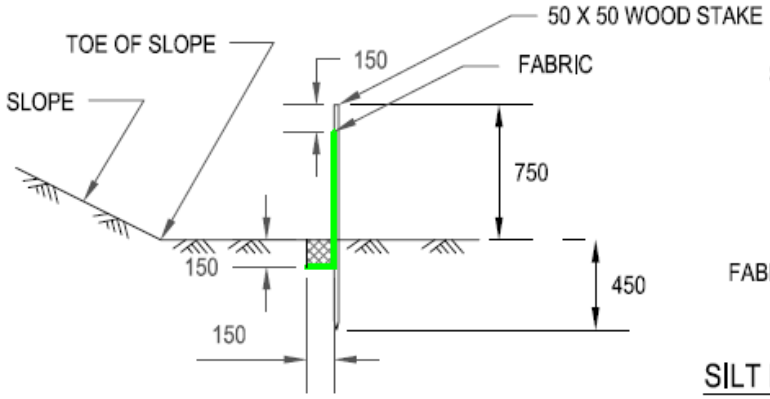
References

Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide*. 2002. http://ww.dot.state.co.us/enviromental.envWaterQual/wqms4.asp

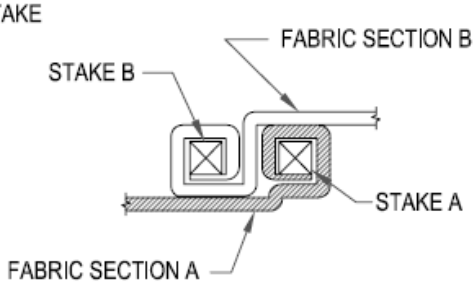
Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

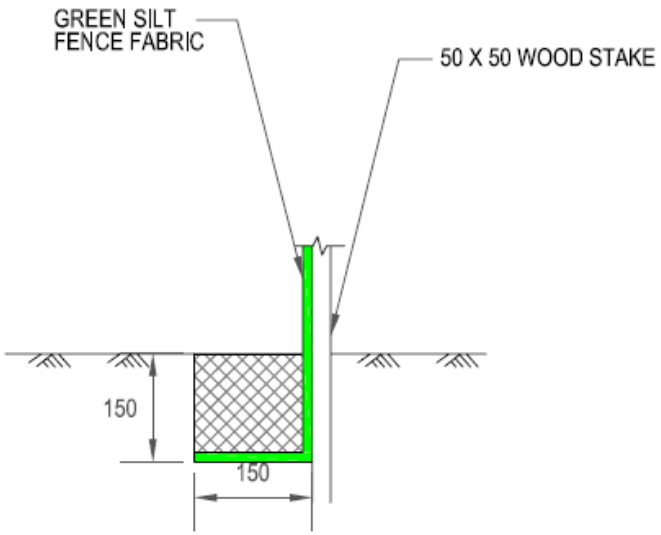
Keller, Gordon and James Sherar, *Low-Volume Roads Engineering, Best Management Practices Field Guide.* United States Department of Agriculture (USDA), Forest Service, US Agency od International Development (USAID), 2005. http://www.blm.gov/bmp/field%20guide.htm



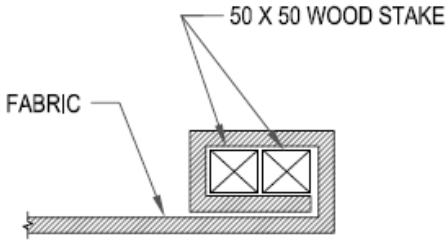
SILT FENCE INSTALLATION AT SLOPE BASE



SILT FENCE JOINING ROLL TO ROLL DETAIL (PLAN VIEW)



INSTALLATION TRENCH DETAIL (PLAN VIEW)



END STAKE DETAIL (PLAN VIEW)

Stabilized Construction Entrance (SCE)

Description CATTLE GUARD

A stabilized construction entrance (tracking pad) is a pad of gravel or cattle guard where construction traffic leave a site. The purpose of a stabilized entrance to a site is to minimize the amount of tracked mud and dust that leaves a site. As a vehicle drives over the gravel pad, mud and sediment are removed from the vehicle's wheels and offsite transport of soil is reduced. The gravel pad also reduces erosion and rutting in the soil beneath the stabilized structure. The filter fabric separates the gravel from the soil below, preventing the gravel from being ground into the soil. The fabric also reduces the amount of rutting caused by vehicle tires by spreading the vehicle's weight over a larger soil area than just the width of the tire.

Applicability

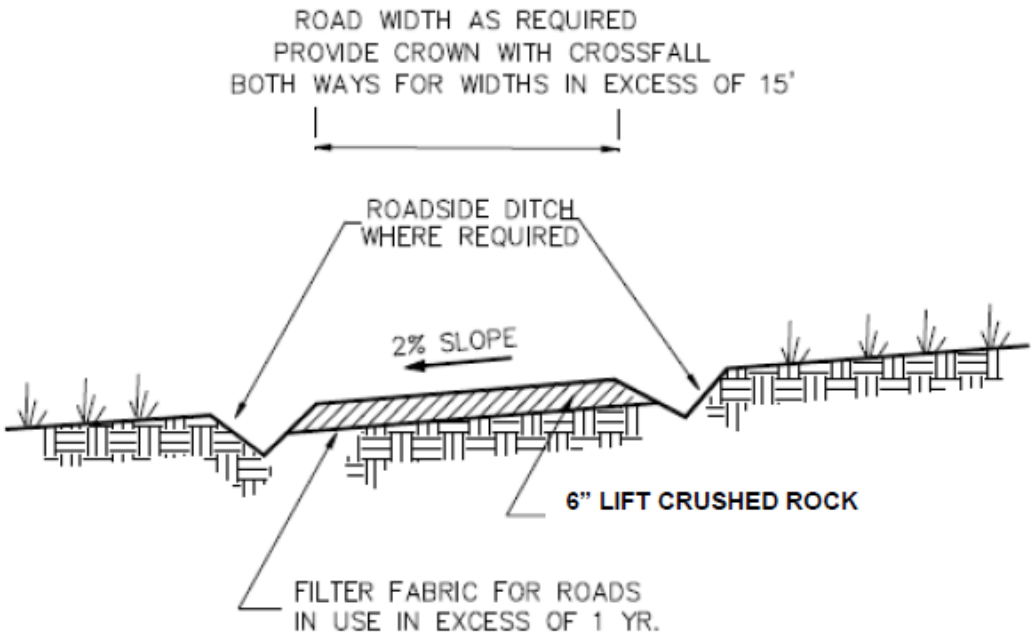
Typically, stabilizing a construction entrances are installed at locations where construction traffic leaves or enters an existing paved road. However, the applicability of site entrance stabilization should be extended to any roadway or entrance where vehicles will access or leave the site.

Limitations

- Although stabilizing a construction entrance is a good way to help reduce the amount of sediment leaving a site, some soil may still be deposited from vehicle tires onto paved surfaces. To further reduce the chance of these sediments polluting storm water runoff, sweeping of the paved area adjacent to the stabilized site entrance is recommended.

- Site traps or other secondary sediment controls are needed to capture that sediment that accumulates at the pad and may run off during storm events.

Design Criteria



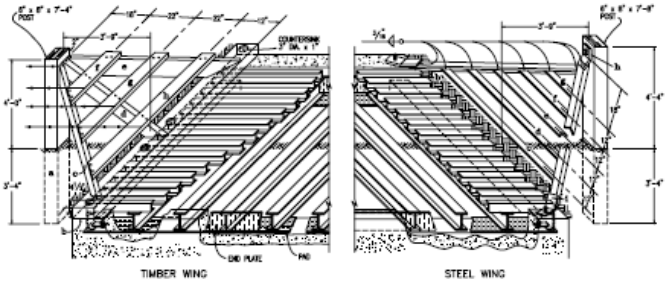
Construction Specifications

See figure SCE-1 for installation details.

- If the pad in constructed on a crowned road, a road side ditch with check dams or sediment traps be located on both sides of the road to collect runoff from the pad. If the road slopes to only one side of the road then only one roadside ditch with sediment controls will be needed.

- Place a matrix of 2 to 4 inch washed stone, reclaimed or recycled concrete equivalent to a minimum of 12 feet wide and 20 feet in length.

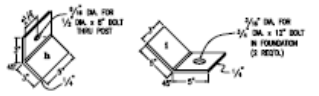
- All surface water flowing or diverted toward construction entrance shall be piped across the entrance. If piping is impractical, a mountable berm with 5:1 slopes will be permitted.

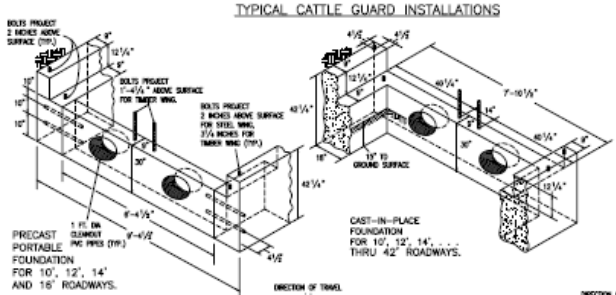


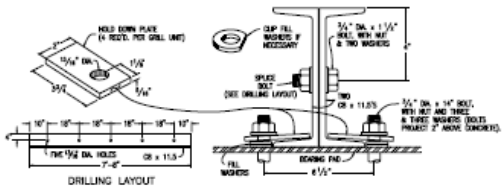
TYPICAL CATTLE GUARD INSTALLATIONS

GENERAL NOTES

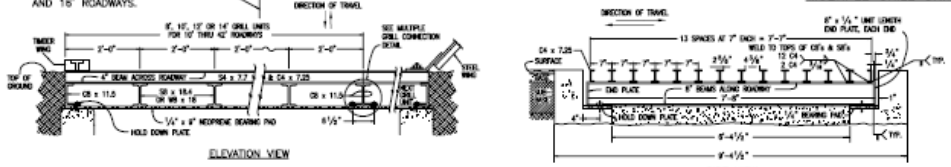
1. CONCRETE SHALL BE CLASS S. FOUNDATION MAY BE CAST-IN-PLACE OR PRECAST.
2. REINFORCING BARS SHALL BE DEFORMED TYPE NO. 4.
3. ALL TIMBER SHALL BE TREATED IN ACCORDANCE WITH AASHTO M 133 AND AWPA C14.
4. WING POSTS MAY BE MADE FROM 8 IN. ROUND NATIVE TIMBER.
5. ALL STRUCTURAL STEEL SHALL BE FABRICATED AND PAINTED WITH ALUMINUM PAINT IN ACCORDANCE WITH SECTION 506. ALL HARDWARE SHALL BE GALVANIZED IN ACCORDANCE WITH AASHTO M 111 OR PAINTED WITH ZINC-RICH PAINT MEETING MILITARY SPECIFICATION DOD-P-21035
6. ALL STRUCTURAL STEEL SHALL CONFORM TO ASTM A 709 (AASHTO M 270) GRADE 36.
7. WELDING SHALL CONFORM TO THE LATEST EDITION OF THE AWS STRUCTURAL WELDING CODE AND AASHTO STANDARD SPECIFICATIONS FOR WELDING OF STRUCTURAL STEEL HIGHWAY BRIDGES.
8. WHEN CATTLE GUARD IS TO BE INSTALLED IN IMPERVIOUS MATERIAL, ADEQUATE DRAINAGE SHALL BE PROVIDED TO INSURE AGAINST POSSIBLE SUBGRADE DAMAGE. DRAINAGE DETAILS SHALL BE AS SHOWN ON THE PLANS. OUTLET CULVERT MAY BE CONSIDERED.
9. TYPE OF WING (TIMBER OR STEEL) SHALL BE STEEL UNLESS OTHERWISE SHOWN ON THE PLANS.
10. STRUCTURE EXCAVATION AND STRUCTURE BACKFILL WILL NOT BE MEASURED AND PAID FOR SEPARATELY, BUT SHALL BE INCLUDED IN THE COST OF THE CATTLE GUARD.



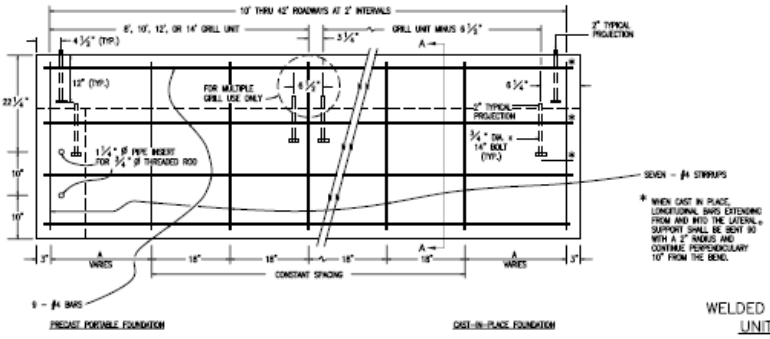




MULTIPLE GRILL UNIT CONNECTION



WELDED GRILL CROSS SECTIONS



ELEVATION OF FOUNDATION

FOUNDATION QUANTITIES

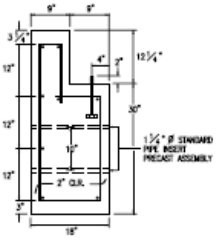
ROADWAY WIDTH (FT.)	USE GRILL UNITS (FT.)	PRECAST CONCRETE (CU. YD.)	PRECAST REINF. STEEL (LBS.)	CAST-IN-PLACE CONCRETE (CU. YD.)	CAST-IN-PLACE REINF. STEEL (LBS.)	A (IN.)	TOTAL GRILL WEIGHT (LBS.)
10 12	10 12	5.0 6.5	295 340	5.6 6.5	318 364	24 18	1946 2328
14 16	14 8 8	7.4 8.1	378 414	7.4 8.1	399 435	21 24	2170 3128
18 20	8 10 10 10			9.0 9.8	482 518	18 21	3434 3806
22 24	10 12 12 12			10.8 11.5	553 601	24 18	4274 4656
26 28	12 14 14 14			12.3 13.1	638 672	21 24	5038 5420
30 32	10 10 10 10 12 10			13.9 14.8	719 755	18 21	5838 6220
34 36	12 10 12 12 12 12			15.5 16.4	790 838	24 18	6602 6984
38 40 42	12 14 12 14 12 14 14 14 14			17.3 18.0 18.8	873 909 956	21 24 18	7366 7748 8130

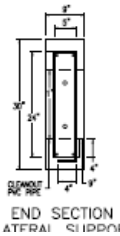
WELDED GRILL UNITS

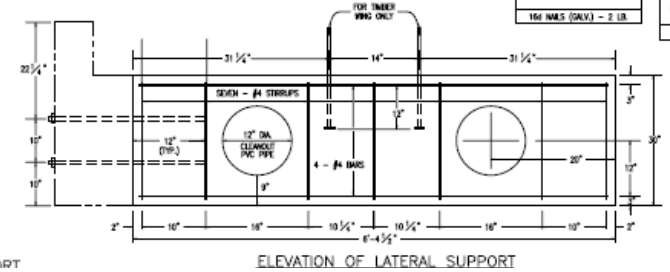
SIZE	WEIGHT (LBS.)
8'	1594
10'	1946
12'	2328
14'	2710

WING QUANTITIES

ONE TIMBER WING		ONE STEEL WING		
a	8" x 8" x 7'-4"	a	2" x 2" x ¼" x 70"	LBS. STEEL WING
b	4" x 8" x 9'-4½"	b	2" x 2" x ¼" x 70"	63.26
c	2" x 8" x 6'-7"	c	2" x 2" x ¼" x 84"	
d	2" x 8" x 5'-8"	d	1½" x 1½" x ¼" x 68"	
e	2" x 8" x 6'-7"	e	1½" x 1½" x ¼" x 55"	36.06
f	2" x 8" x 2'-5"	f	1½" x 1½" x ¼" x 40"	
g	2" x 8" x 4'-4"	g	1½" x 1½" x ¼" x 25"	
h	2" x 8" x 6'-2"	h	5" x 8" x ¾" x BAR	2.13
		i	TWO 3" x 10" x ½" x BARS	4.35
16d NAILS (GALV.) – 2 LB.		5" x 8" x 7'-8" TIMBER POST		
		LBS. STEEL = ~ 106.5		







Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Stabilization of site entrances should be maintained until the remainder of the construction site has been fully stabilized. Stone and grave; might need to be periodically added to each stabilized construction site entrance to keep the entrance effective. Soil that is tracked offsite should be swept op immediately for proper disposal.

References

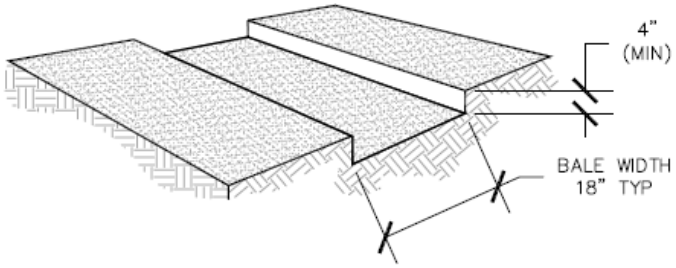
Colorado Department of Transportation (CDOT), *Erosion Control and Stormwater Quality Guide*. 2002. http://ww.dot.state.co.us/enviromental.envWaterQual/wqms4.asp

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

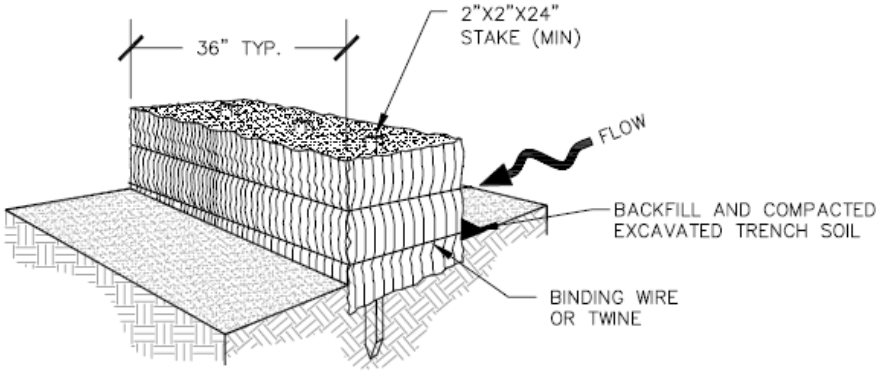
http://cfpud.epa.gov/npdes/stormwater/menufbmps/con_site.cfm

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

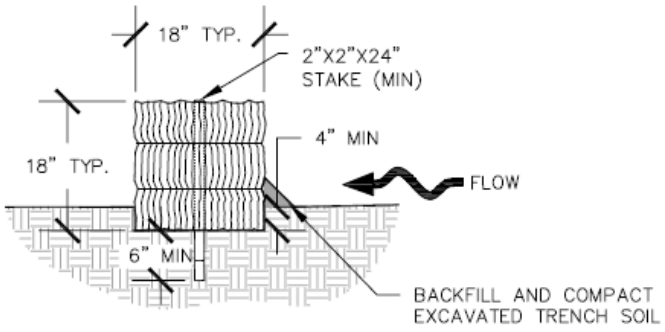
Straw Bale (SB) – Straw Bale Placement in Swale (SBS)



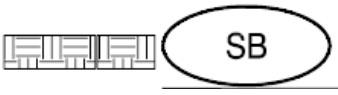
TRENCH EXCAVATION



STRAW BALE INSTALLATION

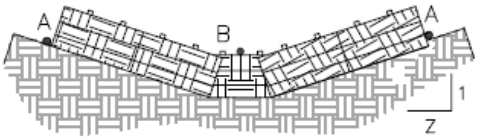


SECTION



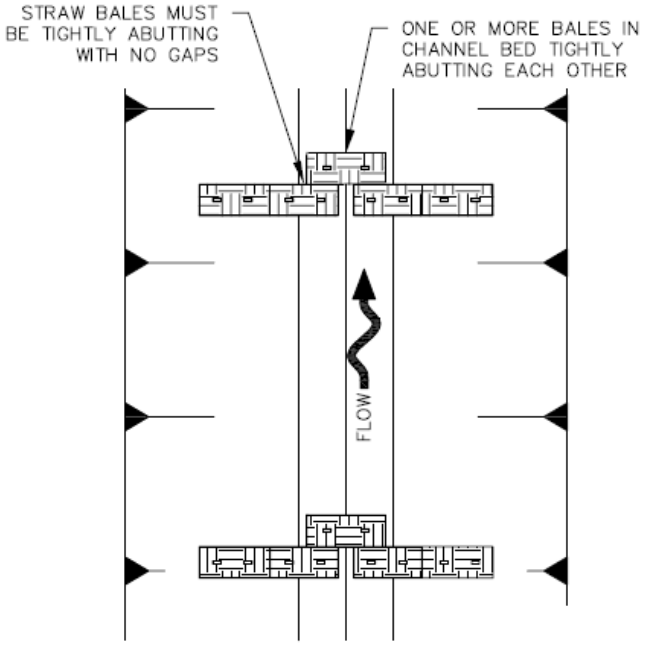
STRAW BALE

END POINTS "A" MUST BE HIGHER THAN POINT "B"



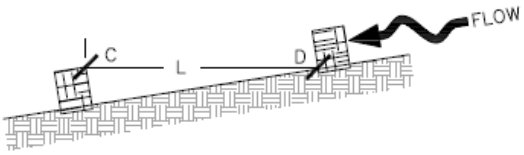
STRAW BALE IN SWALES SECTION

STRAW BALES SHALL NOT BE USED IN CHANNELS/SWALES LESS THAN 3.0' IN DEPTH. CONTRACTOR SHALL INSTALL ROCK SOCK **RSS** IN ALL CHANNELS/SWALES LESS THAN 3.0' IN DEPTH.



STRAW BALE IN SWALES SECTION

L = THE DISTANCE SUCH THAT POINT D AND C ARE OF EQUAL ELEVATION.



STRAW BALE DOWNSTREAM SPACING

SBS

STRAW BALE PLACEMENT IN SWALE

Straw Bale Installation Notes

STRAW BALES SHALL CONSIST OF CERTIFIED WEED FREE STRAW OR HAY CERTIFIED UNDER THE COLORADO DEPARTMENT OF AGRICULTURE WEED FREE FORAGE CERTIFICATION PROGRAM AND INSPECTED AS REGULATED BY THE WEED FREE FORAGE ACT, TITLE 35, ARTICLE 27.5, CRS. EACH CERTIFIED WEED FREE MULCH BALE SHALL BE IDENTIFIED BY ONE OF THE FOLLOWING:

- ONE OF THE TIES BINDING THE BALE SHALL CONSIST OF BLUE AND ORANGE TWINE, OR
- ONE OF THE TIES BINDING THE BALE SHALL CONSIST OF SPECIALLY PRODUCED GALVANIZED SHINY WIRE, OR
- THE BALE SHALL HAVE A REGIONAL FORAGE CERTIFICATION PROGRAM TAG INDICATING THE REGIONAL FORAGE CERTIFICATION PROGRAM NUMBER.

STRAW BALES SHALL BE INSPECTED FOR AND REGIONALLY CERTIFIED AS WEED FREE BASED ON THE REGIONALLY DESIGNATED NOXIOUS WEED AND UNDESIRABLE PLANT LIST FROM COLORADO, WYOMING, MONTANA, NEBRASKA, UTAH, IDAHO, KANSAS, SOUTH DAKOTA OR ANY OTHER STATE NOT LISTED THAT SERVED AS THE PLACE OF ORIGIN FOR THE STRAW MULCH.

NO ONE SHALL UNLOAD CERTIFIED WEED FREE MULCH BALES OR REMOVE THE IDENTIFYING TWINE, WIRE OR TAGS UNTIL THE TOWN'S INSPECTOR HAS INSPECTED AND ACCEPTED THEM.

THE CONTRACTOR SHALL PROVIDE A TRANSIT CERTIFICATE THAT HAS BEEN FILLED OUT AND SIGNED BY THE GROWER AND BY THE DEPARTMENT OF AGRICULTURE INSPECTOR.

THE CONTRACTOR MAY OBTAIN A CURRENT LIST OF COLORADO WEED FREE FORAGE CROP PRODUCERS WHO HAVE COMPLETED CERTIFICATION BY CONTACTING THE COLORADO DEPARTMENT OF AGRICULTURE, DIVISION OF PLANT INDUSTRY.

STRAW BALES SHALL BE APPROXIMATELY 5 CUBIC FEET OF MATERIAL AND WEIGH NOT LESS THAN 35 POUNDS.

TYPICAL STRAW BALES SHALL BE APPROXIMATELY 36"X18"X18".

A UNIFORM ANCHOR TRENCH SHALL BE EXCAVATED TO A DEPTH OF 6". STRAW BALES SHALL BE PLACED SO THAT BINDING TWINE IS ENCOMPASSING THE VERTICAL SIDES OF THE BALE(S). ALL EXCAVATED SOIL SHALL BE PLACED ON THE UPHILL SIDE OF THE STRAW BALE(S) AND COMPACTED.

TWO (2) WOODEN STAKES SHALL BE USED TO HOLD EACH BALE IN PLACE. WOODEN STAKES SHALL BE 2"X2"X24".

WOODEN STAKES SHALL BE PLACED 6" INTO THE GROUND.

STRAW BALES SHALL BE SPACED AND POSITIONED ACCORDING TO DETAILS.

Straw Bale Installation & Maintenance Notes

THE EROSION CONTROL SUPERVISOR SHALL INSPECT THE STRAW BALES AT THE FOLLOWING INTERVALS:

- IMMEDIATELY FOLLOWING INITIAL INSTALLATION.
- EVERY 14 DAYS WHILE THE SITE IS UNDER ACTIVE CONSTRUCTION.
- AFTER ANY STORM EVENT THAT CAUSES SOIL EROSION.
- ONCE A MONTH FOLLOWING THE END OF CONSTRUCTION, UNTIL VEGETATIVE COVER HAS REACHED A CONSISTENT DENSITY OF AT LEAST 70% OF FULL VEGETATIVE COVER.

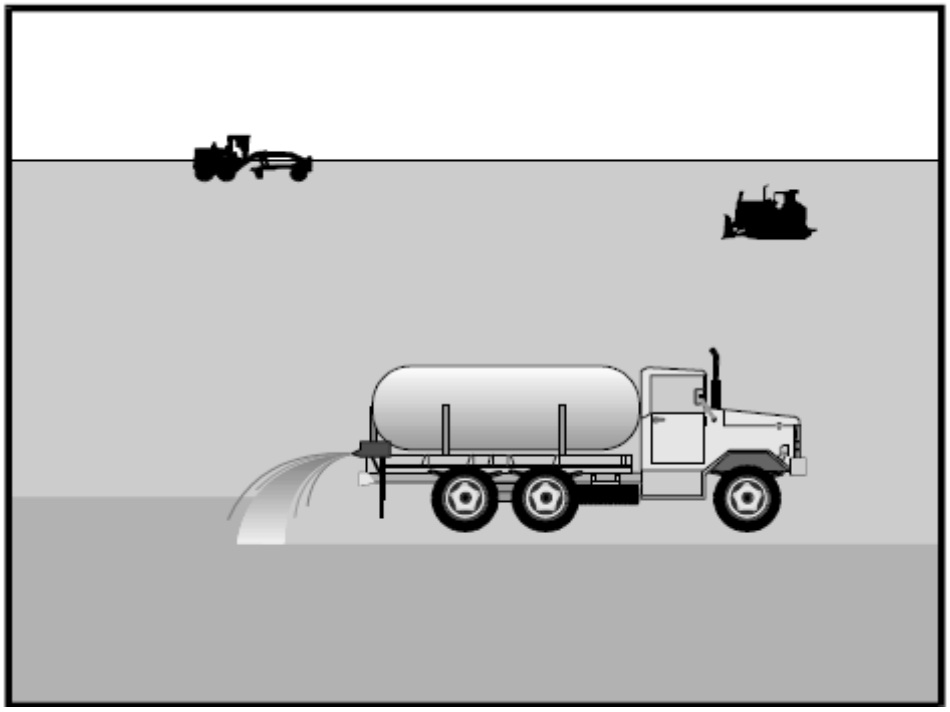
ACCUMULATED SEDIMENT SHALL BE REMOVED ONCE THE SEDIMENT HAS REACHED A DEPTH EQUAL TO 1/4 THE HEIGHT OF THE STRAW BALE.

STRAW BALES SHALL BE REPLACED IF THEY BECOME HEAVILY SOILED, ROTTEN, OR OTHER DAMAGES.

STRAW BALES SHALL REMAIN IN PLACE AND PROPERLY MAINTAINED UNTIL VEGETATIVE COVER HAS REACHED A CONSISTENT DENSITY OF AT LEAST 70% OF FULL VEGETATIVE COVER AND EROSION AND SEDIMENTATION IS NO LONGER A POSSIBILITY AS DETERMINED BY THE TOWN'S INSPECTOR.

WHEN THE STRAW BALES ARE REMOVED, ANY DISTURBED AREAS ASSOCIATED WITH THE INSTALLATION, MAINTENANCE, AND/OR REMOVAL OF THE STRAW BALES SHALL BE ROUGHENED, SEEDED, MULCHED, AND CRIMPED PER THE TOWN'S SPECIFICATIONS (SEE DETAIL SMC).

Wind Erosion Control (WEC)



Description and Purpose

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.

Suitable Applications

Wind erosion controls BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Sediment tracking onto paved roads
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil

- Final grading/site stabilization

Limitations

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

- Over watering may cause erosion.

- Oil or oil-treated sub grade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.

- Effectiveness depends on soil, temperature, humidity, and wind velocity.

- Chemically treated sub grades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation on the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.

- Asphalt, as a mulch tack or chemical mulch, requires a 24-hour curing time to avoid adherence to equipment, worker shoes, etc. Application should be limited because asphalt surfacing may eventually migrate into the drainage system.

- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.

Implementation

General

Dust control, as a BMP, is a practice that is already in place for many construction activities. Colorado, among others, have enacted dust control ordinances for construction activities that cause dust to be transported beyond the construction project property line.

Recently, the State Air Resources Control Board has, under the authority of the Clean Air Act, started to address air quality in relation to inhalable particulate matter less than 10 microns (PM-10). Approximately 90 percent of these small particles are considered to be dust. Existing dust control regulations by local agencies, municipal departments, public works department, and public health departments are in place in some regions within Colorado.

Dust Control Practices

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 asphalt surfacing, temporary gravel construction entrances, equipment wash-out 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. Preventive measures would include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph, and controlling the number and activity of vehicles on a site at any given time.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.

- Check areas protected to ensure coverage.

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

Wattles (W)

Description

A wattle, (consist of straw, rock, flax, or other similar materials bound into a tight tubular roll. When wattles are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.

Applicability

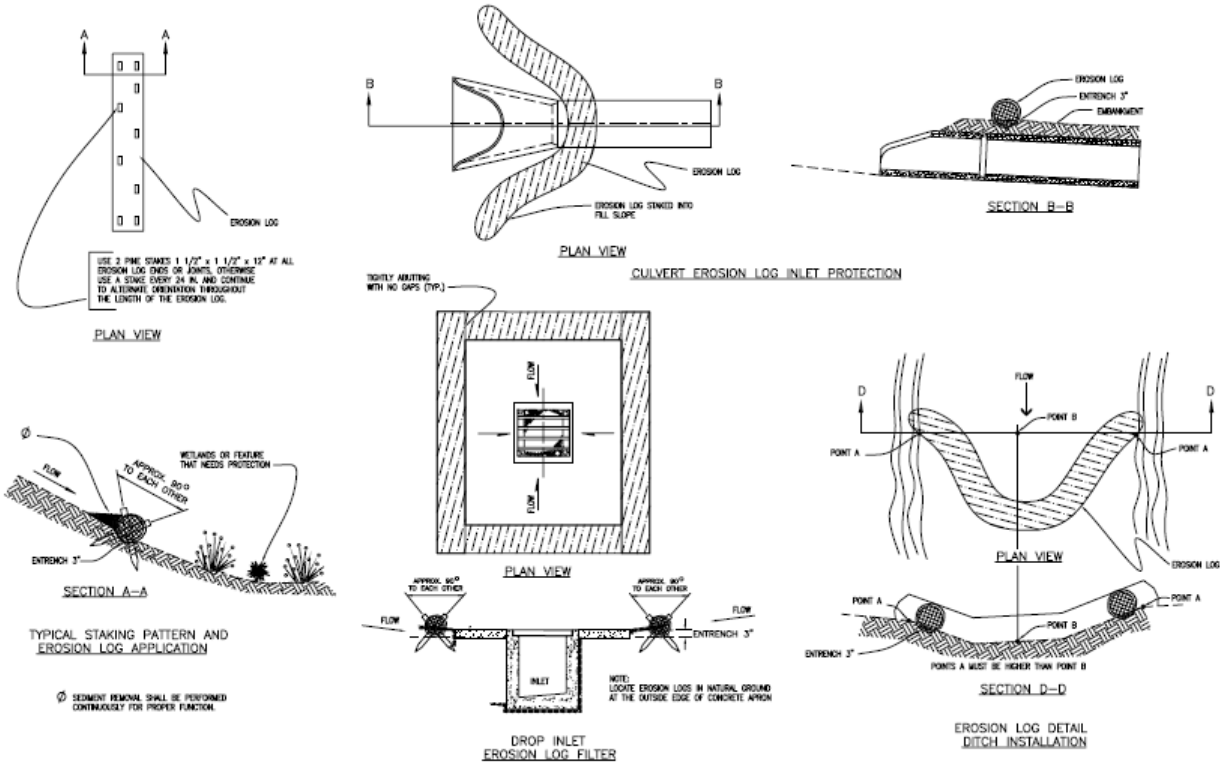
Wattles may be suitable:

- At the end of a downward slope where it transitions to a steeper slope.
- Along the perimeter of a project.
- At the overflow locations of s sediment traps.
- As check dams in unlined ditches.
- Around temporary stockpiles.

Limitations

- Wattles are not effective unless trenched.
- Wattles at the toe of the slope greater than 5:1 (H:V) should be a minimum of 20 inch diameter or installations achieving the same protection (i.e., stacked smaller diameter wattles, etc.).
- Difficult to move once saturated.
- If not properly staked and trenched in, wattles could be transported in high flows.
- Wattles have a very limited sediment capture zone.
- Wattles should not be used on sloped subject to creep, slumping, or landslide.
- Wattles should not be used where periodic road or surface maintenance activities are expected.

Design Criteria



Construction Specifications

Wattles should be either prefabricated rolls or rolled tubes of erosion control blankets. If using erosion control blankets, roll the length of erosion control blanket, roll the length of the blanket into a tube of minimum 8” diameter and bind roll at each end and every 4 feet along length of roll with jute type twine.

See figure W-1 for wattles used to control erosion along slopes.

1. Locate wattles on level contours spaced as follows:

a. Slope inclination of 4:1 or flatter: Fiber rolls should be placed at a maximum interval of 20 feet.

b. Slope inclination between 4:1 and 2:1: Fiber rolls should be placed at a maximum of 15 feet.

c. Slope inclination 2:1 or greater: Fiber rolls should be placed at a maximum interval of 10 feet.

2. Turn the ends of the wattles up slope to prevent runoff from going around the roll.

Mulching (M)

Grass mulching is applied to stabilize exposed soils and to reduce stormwater runoff velocity

Description

Mulching is a temporary erosion control practice in which materials such as grass, hay, wood chips, wood fibers, straw, or gravel are placed on exposed or recently planted soil surfaces. Mulching stabilizes soils by minimizing rainfall impact and reducing storm water runoff velocity. When used in combination with seeding or planting, mulching can aid plant growth by holding seeds, fertilizers, and topsoil in place, preventing birds from eating seeds, retaining moisture, and insulating plant roots against extreme temperatures.

Mulch matting are materials such as jute or other wood fibers that are formed into sheets and are more stable than loose mulch. Jute and other wood fibers, plastic, paper, or cotton can be used individually or combined into mats to hold mulch to the ground. Netting can be used to stabilize soils while plants are growing, although netting does not retain moisture or insulate against extreme temperatures. Mulch binders consist of asphalt or synthetic materials that are sometimes used instead of netting to bind loose mulch.

Applicability

Mulching is often used after (or in combination with) seeding to help aid in the establishment of vegetation. Hydraulic application of mulch is often used in steep areas (up to 1:1) where regular mulching is difficult because of environmental constraints. Mulch matting, with net or anchoring to hold it in place, can also be used on steep slopes or in critical areas such as waterways. Mulch can last for one to two years and is most effective when used on an area less than two acres in size.

Limitations

1. Mulching, matting and netting might delay seed germination because the cover changes soil surface temperatures.

2. The mulches themselves are subject to erosion and may be washed away in a large storm.

3. Maintenance is necessary to ensure that mulches provide effective erosion control.

Design Criteria

No formal design is required.

Construction Specifications

Site preparation:

- Prior to mulching, install the necessary temporary or permanent erosion control practices and drainage system within or adjacent to the area to be mulched.
- Slope, grade and smooth the side to fit needs of selected mulch products.
- Remove all undesirable stones and other debris to meet the needs of the anticipated land use and maintenance required.

Mulching and Anchoring.

- Select the appropriate mulch and application rate that will best meet the need and availability if material. When possible, organic mulches should be used for erosion control and plant material establishment. See Table M-1 for suggested materials and application rates. Other materials include hydraulic mulch products with 100-percent post-consumer paper content and yard trimming composts. All materials should be free of seed.
- Apply mulch after soil amendments and planting is accomplished or simultaneously if hydro-seeding is used. See Table M-1 for installation guidelines.
- Use a mulch crimper to apply and anchor mulch. Crimper should have approximately 6 inch cleats with perpendicular, dull, disc blades. If a crimper is unavailable the Contractor shall apply mulch and anchor it to the soil using one of the methods described in Table M-2. The mulch should be anchored the same day as mulch application. Materials that are heavy enough to stay in place (for example, bark or wood chips on flat slopes) do not need anchoring. Mulches may or may not require a binder, netting, or tacking. Mulch binders should be applied at rates recommended by the manufacturer. Effective use of netting and matting material requires firm, continuous contact between the materials and the soil.

Hydraulic Mulching:

- For steep slopes or other areas where hydraulic application of mulch is desired, a high-quality type of hydraulic matrix known as a Bonded Fiber Matrix (BFM) may be used. A BFM refers to a continuous later of elongated wood fiber strands that are held together by a water-resistant bonding agent to form a water-absorbing crust.

- A typical construction specification for wood fiber mulch (hydro-mulch) is as follows: Biodegradable green dyed-wood cellulose-fiber mulch, non toxic, free of plant growth- or germination-inhibitors, with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- A typical construction specification for weed free straw non-asphaltic tackifier: Organic derivative vegetative gum tackifier recommended by fiber-mulch manufacturer for slurry application, nontoxic and free of plant growth-or germination-inhibitor.
- Hydraulic application of BFM must be done when no rainfall in expected, preferably within a 24-hour time period. Mix BFM in a hydraulic application machine (such as a hydro-seeder or a mulch blower) and then apply to slope as a liquid slurry. The slurry must be constantly agitated to keep the proper application rated and achieve uniform effective coverage. The minimum application rate shall be 2000 pounds per acre with a typical application rate between 3000 and 4000 pounds per acre.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Areas should be identified where mulch has loosened or been removed. Such areas should be reseeded (if necessary) and the mulch cover replaced. If washout, breakage, or erosion occurs, surfaces should be repaired, reseeded, and re-mulched, and new netting should be installed. Inspections should be continued until vegetation is firmly established.

Removal

Anchor netting and any other artificial mulch material should be removed when protection in no longer needed and disposed of in a landfill.

References

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.http://cfpub.epa.gov/npdes/stormwater/menufmps/con_site.cfm

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New York State Department of Environmental Conservation, *New York Guidelines for Urban Erosion and Sediment Control.* New York. Fourth Edition, 1997.http://www.dec.state.ny.us/website/dow/toolbox/escstandards

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), *Field Office Technical Guide.* 2002www.nrcs.usda.gov/technical/efotg

Table M-1
Typical Mulching Materials and Application Rates

Material	Rate per Acre	Requirements	Notes
Organic Mulches			
Straw	1 - 2 tons	Dry, unchopped, unweathered; certified weed free.	Spread by hand or machine; must be tacked or tied down.
Wood fiber or wood cellulose	½ - 1 ton		Use with hydroseeder, may be used to tack straw. Do not use in hot, dry weather.
Wood chips	5 - 6 tons	Air dry. Add fertilizer N, 12 lb/ton.	Apply with blower, chip handler, or by hand. Not for fine turf areas.
Bark	35 yd^3	Air dry, shredded, or hammermilled, or chips	Apply with mulch blower, chip handler, or by hand. Do not use asphalt tack.
Nets and Mats			
Jute net	Cover area	Heavy, uniform; woven of single jute yarn. Used with organic mulch.	Withstands water flow.
Excelsior (wood fiber) mat	Cover area		

Table M-2
Mulch Anchoring Guide

Anchoring Method or Material	Kind of Mulch to be Anchored	How to Apply
1. Mulch netting	Hay or straw	Staple the light-weight paper, jute, wood fiber, or plastic nettings to soil surface according to manufacturer's recommendations. Should be biodegradable. Most products are not suitable for foot traffic.
2. Wood cellulose fiber	Hay or straw	Apply hydroseeder immediately after mulching Use 500 lbs. Wood fiber per acre. Some products contain an adhesive material, possibly advantageous.
3. Mulch anchoring tool/Crimper	Hay or straw	Apply mulch and pull a mulch anchoring tool (blunt, straight discs) over mulch as near to the contour as possible. Mulch material should be "tucked" into soil surface about 3".
4. Chemical	Hay or straw	Apply Terra Tack AR 120 lbs./ac. In 460 gal. of water (#156/ac.) or Aerospray 70 (60 gal/ac.) according to manufacturer's instructions. Avoid application during rain. A 24-hour curing period and a soil temperature higher than 45 deg. Fahrenheit are required.

Surface Roughening (SR)

Exposed soils can be temporarily stabilized by driving a tractor over the surface

Description

Surface (soil) roughening is a temporary erosion control practice often used in conjunction with grading. Soil roughening involves increasing the relief of a bare soil surface with horizontal grooves (corrugating) or tracks using construction equipment. Slopes that are not fine graded and that are left in a roughened condition can reduce erosion. Soil roughening reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares soil for seeding and planting by giving seed an opportunity to take hold and grow.

Applicability

Soil roughening is most effective for areas of one acre or less, and works well for the following applications:

- Any slope, but particularly fill slopes greater than 3:1
- Areas with highly erodible soils
- Soils that are frequently disturbed

Limitations

- Soil roughening is not appropriate for rocky slopes.

- Soil compaction might occur when roughening with tracked machinery.
- Soil roughening is of limited effectiveness in anything more than a gentle or shallow depth rain.
- If roughening is washed away in a heavy storm, the surface will have to be re-roughened and new seed laid.

Design Criteria

No formal design required. However, the selection of the appropriate method (corrugated/grooving or tracking) depends on the type of slope. Steepness, mowing requirements, and/or a cut or fill slope operation are all factors considered in choosing a roughening method.

Construction Specifications

To slow erosion, roughening should be done as soon as possible after grading activities have ceased (temporary or permanently) in an area. All cut and fill slopes should be roughened whenever possible. Do not blade or scrap the final fill slope face. Excessive compacting of the soil surface should be avoided during roughening, and areas should be seeded as soon as possible after roughening is completed.

Corrugated/grooving

Corrugated or grooving (figure SR-1) uses machinery to create a series of ridges and depressions that run across the slope on the contour. Groove using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth of a front-end loader bucket.

Tracking

Tracking (figure SR-2) is the most common method of soil roughening and is sometimes used as a method to hold down mulch. However, tracking is generally not as effective as corrugating. Tracking should be used primarily in sandy soils to avoid undue compacting of the soil surface. Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Roughening might need to be repeated after storm events.

References

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

http://cfpud.epa.gov/npdes/stormwater/menufbmps/con_site.cfm

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New York State Department of Environmental Conservation, *New York Guidelinesfor Urban Erosion and Sediment Control.* New York. Forth Edition, 1997.

http://www.dec.state.ny.us/website/dow/toolbox/escstandards

Figure SR-1
Corrugating/Grooving

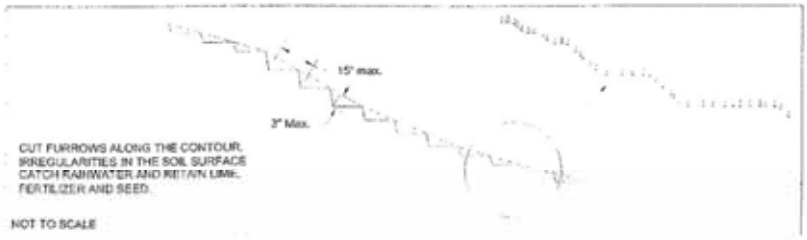
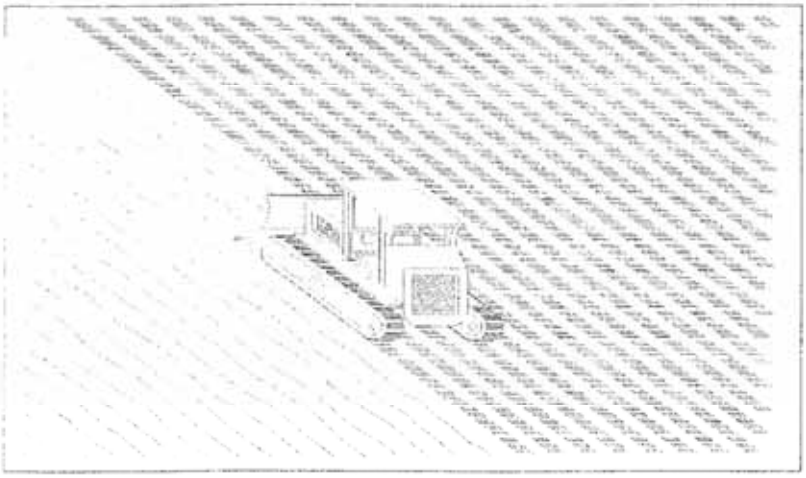


Figure SR-2
Tracking



Vegetative buffer (VB)

Description

Vegetative buffers (also known as vegetative filter strips) are areas either natural or established vegetation that are maintained to protect the water quality of neighboring areas. Buffers reduce the velocity of storm water runoff, provide an area for the runoff to permeate the soil, contribute to ground water recharge, and act as filters to catch sediment. The reduction in velocity also helps to prevent soil erosion.

The use of existing natural vegetation is preferred over newly established vegetation for the following reasons:

- Can process higher quantities of storm water runoff than newly seeded areas.
- Does not require time to establish.
- Has a higher filtering capacity than newly planted vegetation because aboveground and root structures are typically denser.
- Reduces storm water runoff by intercepting rainfall, promoting infiltration, and lowering the water table through transpiration.
- Provides a fully developed habitat for wildlife.

Applicability

Vegetative buffers can be used in any area that is able to support vegetation but they are most effective and beneficial on floodplains, near wetlands, along stream banks, and as stabilized outlets to runoff controls such as diversions, water bars, or culverts. Buffers are also effective in separating land use areas that are not compatible and in protecting wetlands or water bodies by displacing activities that might be potential sources of non-point pollution.

Limitations

- Vegetated buffers require plant growth before they can be effective, and land on which to plant the vegetation must be available.

- Although vegetative buffers help to protect water quality, they usually do not effectively counteract concentrated storm water flows to neighboring or downstream wetlands.

Design Criteria

No formal design required.

Construction Specifications

- Buffer widths should be determine after careful consideration of slope, vegetation, soils, depth to impermeable layers, runoff sediment characteristics, type and quantity of storm water pollutants, and annual rainfall. Buffer widths should increase as the slope increases.

- Fertilizing seeded or planted ground may enhance growth and improve its effectiveness as a buffer.

- Direct sediment laden water onto the naturally vegetated or stabilized planted ground.

- Do not place any equipment, construction debris, or extra soil in the buffer area.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Keeping vegetation healty in a recent established buffer requires routine maintenance, which (depending on species, soil types, and climatic conditions) may include weed control, fertilizing, liming, and irrigating. Once established or if using a naturally vegetated area, buffers do not require much maintenance beyond repairing or replacing damaged vegetation. Inspections focus on encroachment, gully erosions, density of vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. If there is more than six inches of sediment in one place, it should be removed.

Removal

Removal is not necessary.

References

Environmental Protection Agency (EPA), *National Pollutant Discharge Elimination System (NPDES). Construction Site Storm Water Runoff Control.* Washington, D.C., February 2003.

http://cfpud.epa.gov/npdes/stormwater/menufbmps/con_site.cfm

Water Bar (B)

Description

A water bar is an earthen ridge and channel, constructed diagonally across a sloping road, trail, or disturbed area that is subject to erosion. Water bars are normally used for drainage and erosion protection of closed, blocked or infrequently used roads to limit the accumulation of erosive volumes of water by diverting surface runoff at pre-designed intervals.

Applicability

Water bars are applicable where runoff protection is needed to prevent erosion on sloping access right-of-ways or long, narrow sloping areas generally less than 100 feet in width. This is a practice that is often used on limited-use roads, trails and firebreaks. It is an excellent method of retiring roads and trails as well as abandoned roads where surface waters may cause erosion of exposed mineral soil.

Limitations

- Not for use on concentrated flows.
- May cause concentrated flows from sheet flow.
- Requires vegetative cover or other filter at discharge point.

Design Criteria

No formal design is required.

Construction Specifications

See figure WB-1

- Clear the base for the ridge before placing fill.

- Track the ridge to compact it to the design cross section.

- Install the water bar according to figure WB-1 as soon as the base is cleared and graded. The positive grade shall not exceed 2 percent,
- Vehicle crossings shall be stabilized with gravel. Exposed areas shall be immediately seeded and mulched.

- Extend the water bar inlet and outlet 1 foot or more beyond the side of the road, trail or disturbed area to keep the diverted water from re-entering the area.

- Space the water bars according to table WB-1.

- Locate the outlet on an undisturbed area. Field spacing shall be adjusted to use the most stable outlets areas. Outlet protection will be provided when natural areas are not adequate

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Inspect water bars for erosion damage and sediment. Check outlet areas and make repairs as needed to restore operation.

Removal

If water bars are used on a closed or blocked road, they should be removed prior to re-opening of the road. Water bars on infrequently used roads or other disturbed areas nay remain in place as long as necessary.

References

Horizon Environmental Services, Inc, *Guidance Document Reasonable and Prudent Practices for Stabilization (RAPPS) of Oil and Gas Construction Sites.* April 2004.

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Maine Department of Conservation, *Best Management Practices for Forestry: Protecting Maine's Water Quality.* Maine Forest Service, Forest Policy and Management Division. Augusta, Maine. 2004. <http://www.dec.state.me.us/doc/mfs/pubs/pdf/bmp_manual/bmp_manual.pdf>

New York State Department of Environmental Conservation, *New York Guidelinesfor Urban Erosion and Sediment Control.* New York. Forth Edition, 1997.

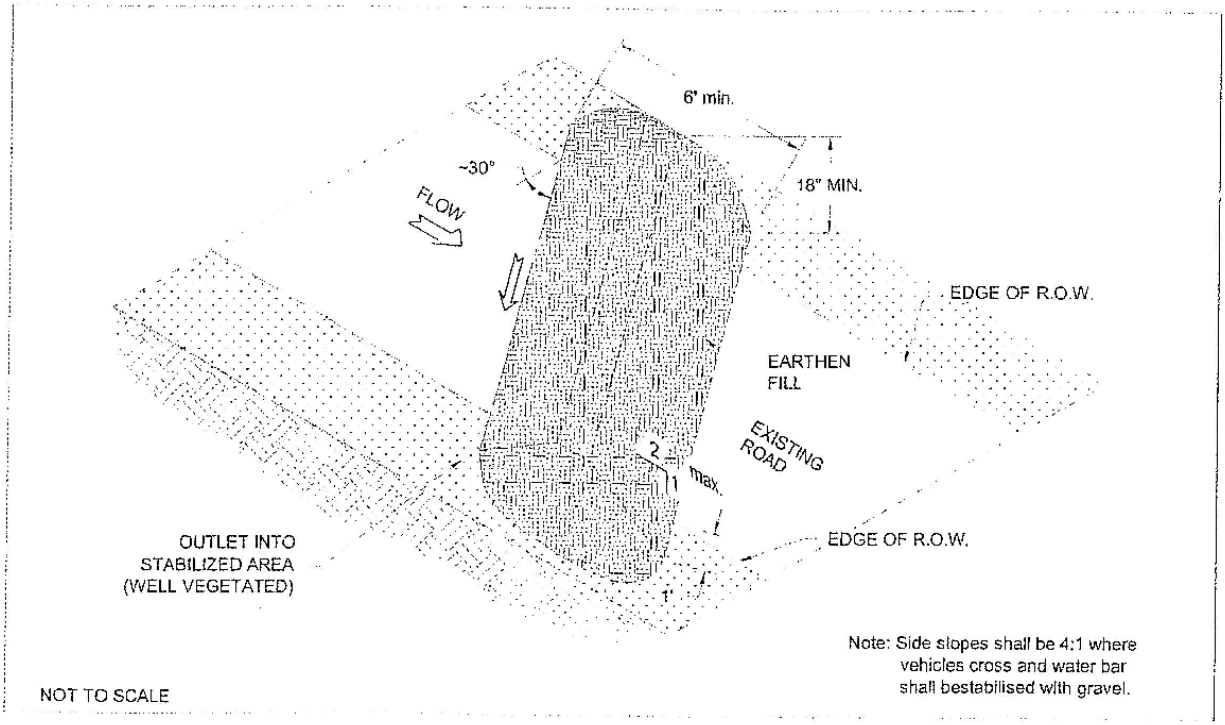
http://www.dec.state.ny.us/website/dow/toolbox/escstandards

Table WB-1
Water Bar Spacing

Road/Trail Grade (%)	Low to Non-Erosive Soils[1]	Erosive Soils[2]
0 - 5	245'	130'
6 – 10	200'	100'
11 - 15	150'	65'
16 - 20	115'	50'
21 - 30	100'	40'
31+	50'	30'

[1]Low Erosion Soils = Coarse Rocky Soils, Gravel, and Some Clay
[2]High Erosion Soils = Fine, Friable Soils, Silt, Fine Sands

Figure WB-1
Water Bar Installation



3. Stake wattles into a 2 to 4 inch deep trench with a width equal to the diameter of the wattle. Drive stakes at the end of each wattle and spaced 4 feet maximum on center.

4. If more than one wattle is placed in a row, the rolls should be overlapped, not abutted.

Maintenance Considerations

The frequency of inspections should be in accordance with the Storm Water Management Plan (SWMP). Repair or replace split, torn, unraveling, or slumping rolls. If the wattle is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates must be periodically removed in order to maintain wattle effectiveness. Sediment should be removed when sediment accumulation reaches half the distance between the top of the wattle and the adjacent ground surface.

Removal

Wattles are typically left in place. If wattles are removed, collect and disposed of sediment accumulation, and fill and compact holes, trenches, depressions, or any other gorund disturbance to blend with adjacent ground.

References

California Stormwater Quality Association, *Stormwater Best Managemant Practices(BMP) handbook-Construction.* January, 2003. <http://www.cabmphandbooks.com/Construction.asp>