EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES: FIELD MANUAL

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Final Report

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DEPARTMENT OF TRANSPORTATION

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FEDERAL HIGHWAY ADMINISTRATION

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RESEARCH PROGRAMS

Erosion and Sediment Control Best Management Practices: Field Manual

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The processes of soil erosion and deposition are natural, ongoing geological mechanisms caused by the transportation and settlement of soil particles through mechanisms like water or wind. While these mechanisms are natural processes that provide stream and floodplain formation and shaping, construction activities can accelerate these natural processes and produce more sediment than are beneficial to waterways. Highway construction activities occur in both rural and urbanized areas. In both circumstances, two mechanisms can occur that increase erosion and thereby increase sediment in waterways. First, construction activities and urbanization can significantly increase the impervious area, preventing precipitation from infiltrating into the soil. The resulting increase in the volume of runoff from a given area often results in higher water velocities in streams and drainage channels, thus increasing the potential for soils to be eroded. Secondly, construction activities generally necessitate the removal of natural ground cover that acts to hold topsoil in place during precipitation events. Removal of this vegetation leaves soil unprotected against storm runoff. Consequently, erosion and sedimentation are increased drastically, which results in reduced water drainage and storage capacities. This increase in erosion and sediment can cause flooding and significant degradation of the water quality in the receiving water bodies. Contaminants that are bound to sediment particles can also be transported into the waterways through storm water runoff. These contaminants, in combination with the sediment, can decrease water quality, harming both wildlife and vegetation. The purpose of this Erosion and Sediment Control Field Manual is to describe the procedures and methods to reduce erosion and sedimentation associated with highway-related pre-construction, construction and post construction activities.

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16. Abstract **The Erosion and Sediment Control Best Management Practices Construction Field Manual was developed to assist in design, construction, and post-construction phases of MDT projects. This manual provides background to concepts of Erosion and Sediment Control. Most of MDTs Best Management Practices are listed within the manual based on application categories. Each BMP is described; its applications and limitations are listed, as well as its design criteria. Construction phase and post-construction phase BMPs are described. This manual is a field guide and condensed version of the Erosion and Sediment Control Design Construction Best Management Practices Manual. For more detailed discussion on topic found within, refer to the Erosion and Sediment Control Construction Best Management Practices Manual.**		
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Contents

Section 1
Concepts of Erosion and Sedimentation

Highway Construction activities have the potential to cause excessive erosion and sedimentation.

Each year the Montana Department of Transportation (MDT) completes numerous construction projects where soils are disturbed. This disturbance can increase the potential for excess erosion if not properly addressed. Excess soil erosion from construction projects removes the soil surface layer, rich in nutrients, and transports the sediments into surface waters contributing to sediment loading and pollution transported with the sediments. The excess sediment collects in reservoirs, lakes, rivers, and streams reducing their water holding capacity and quality; and is detrimental to aquatic life. While erosion and sedimentation are natural processes that help shape Montana's rivers and valleys, activities such as highway construction can greatly accelerate these natural processes causing serious and costly problems. The implementation of Best Management Practices (BMPs) to prevent soil erosion and the resulting sedimentation from entering the waterways during the early stages of planning can significantly reduce serious and costly problems in the future.

Types of Erosion

Erosion is often described as the detachment of soil particles from the ground surface by running water, wind, ice, or other geological agents. Once detachment occurs, the particles are transported by water or wind.

Water Erosion

The types of erosion associated with the flow or movement of water can be categorized as follows:

Splash Erosion: This type of erosion is caused by the impact of raindrops on bare or sparsely vegetated soil. The soil particles are detached and transported by runoff creating a water/soil solution. Splash erosion destroys the soil structure forming a hard crust once the soil dries. The crust prevents future water from infiltrating, hindering plant establishment, which can cause further erosion.

Water erosion from bare slopes is a major source or erosion.

Sheet Erosion: As the name implies, this type of erosion is caused by sheet type water flows over soil surfaces. True sheet flow is uncommon because water most often concentrates in surface depressions. Soil particles dislodged or loosened by splash erosion are entrained in the runoff water and transported down gradient. This type of erosion is characterized by the uniform removal of material from the ground surface.

Rill/Gully Erosion: This type of erosion occurs when water flows over the surface of the soil and accumulates in depressions. Once the water reaches sufficient velocity to cut into the depression, it creates channels (rills), which transport sediment. As the scouring action of the water intensifies, larger channels (gullies) are created. This action releases large amounts of sediments.

Rill/Gully Erosion releases large amounts of sediments.

Stream Bank Erosion: This type of erosion occurs in natural drainage channels and occurs naturally in all streams. Stream bank erosion can be accelerated by upstream development or disturbances to the stream banks. This type of erosion can begin with erosion of the toe of the stream bank that may lead to bank sloughing into the creek.

Shoreline Erosion: This type of erosion occurs at lakeshores and ocean coastlines. It is characterized by sloughing of banks and mass wasting of material in to the water body. It is caused by high-energy wave action.

Stream Bank erosion can be caused by upstream construction activities.

Snow Melt Erosion: This type of erosion occurs when large volumes of snow are allowed to accumulate in disturbed areas and subsequently cause significant erosion. As moisture accumulates in the soils, the soil expands during freezing causing the soil particles to detach. The snow melts and becomes runoff transporting detached sediment downstream. Also, water stored in structures like sediment ponds tend to freeze, reducing their holding capacity and subsequently leading to flooding and concentrated flow.

Wind Erosion

The second main type of erosion is wind erosion. This type of erosion usually occurs in flat poorly vegetated areas. As the soil particles dry and loosen, the wind lifts the particles and transports them to other locations. Although this is a natural process, construction activities create temporary bare areas that are receptive to erosion.

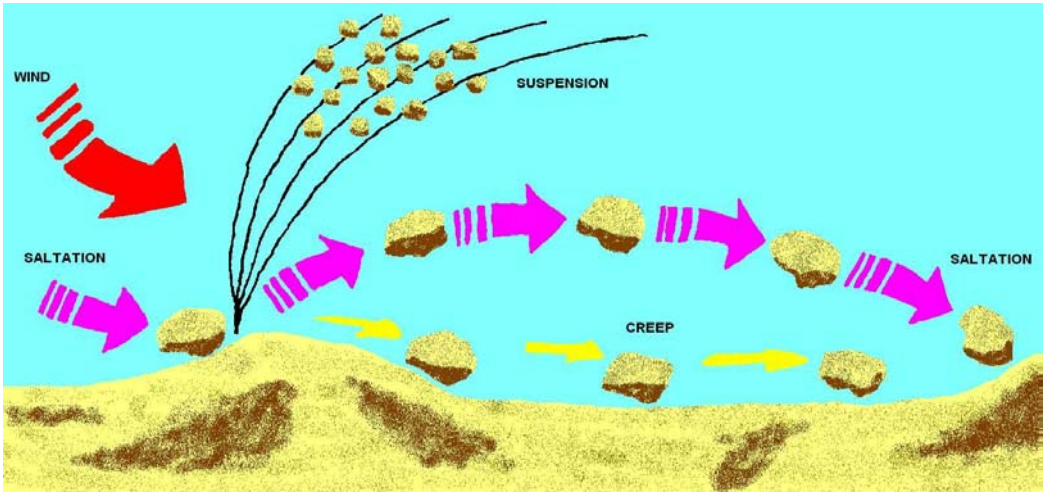
Bare construction areas are very receptive to wind erosion.

There are three main types of wind erosion which are described below:

Suspension Erosion: This type of erosion is attributed to the movement of very fine particles due to impact with other particles or due to the wind itself. The particles are suspended in the air and transported long distances at high altitudes.

Saltation Erosion: This type of erosion is when large quantities of soil particles are lifted into the air by the wind forces and moved mainly horizontally across the surface. The particles bounce onto the surface lifting other particles and causing damage to the surface and to the vegetation.

Surface Creep Erosion: This type of erosion is caused when heavy particles roll across the soil surface after they come in contact with smaller particles that moved by saltation or by suspension.



Wind Erosion can transport sediment by suspension, saltation or creep.

Sediments and Pollutants

High turbidity in waterways has environmental and economic implications

Erosion is the predominant source of suspended material in surface water. Erosion is a naturally occurring process, and as such, attention should focus on erosion rates above those occurring naturally or prior to development. Although erosion rates are difficult to determine, every effort should be made to reduce erosion caused by construction projects and existing facilities. This can be accomplished by implementing BMPs.

Suspended Sediment Material

(i.e., soil, gravel, etc.) in storm water runoff is considered a pollutant of primary importance. Excess suspended particles or high turbidity in waterways and water bodies have environmental and economic implications. The quality of aquatic life habitats degrades as the quantity of sediments increase. The high turbidity prevents the sunlight from reaching the lower sections of the water bodies; therefore, reducing photosynthesis and consequently reducing food production. The sunlight is absorbed in the water, increasing the temperature, which changes the natural aquatic habitats. The sediment settles on the bottom of the water bodies, creating a smooth crust that harms fish spawning habitats. Excess sediments can also be costly because they can affect adjacent properties and clog catch basins and storm

drains, causing flooding and resulting in higher maintenance costs. When sediments enter streams and lakes, they create cloudy or turbid water conditions as well as reducing the flow capacity of the water bodies. These conditions can interfere with industrial and recreational activities. In addition, sediments can transport many other pollutants, including metals, and other organic pollutants.

Contaminated sediments affect small creatures such as worms, crustaceans, and insect larvae that inhabit the bottom of a water body, known as the benthic environment. Some kinds of toxic sediments kill benthic organisms, reducing the food available to larger animals such as fish. EPA lists five major types of pollutants found in sediments: nutrients, bulk organics, halogenated hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and metals. EPA's description of these major pollutants is provided below:

Nutrients

Including phosphorous and nitrogen compounds such as ammonia, can be toxic to benthic organisms. Elevated levels of phosphorous can promote the unwanted growth of algae. This can lead to depletion of oxygen in the water causing the algae to die and to decay. Decomposition of vegetation can generate unpleasant odors and tastes, as well as unsightly conditions. Sources of elevated nutrient levels can be encountered when channels and storm drains are disturbed and where sewer lines and fertilized vegetated areas used are excavated.

Excessive nutrients in water can promote unwanted growth of algae, which can lead to depletion of oxygen in water bodies.

Bulk Organics

A class of hydrocarbons that includes oil and grease. Construction activities require the presence of hydrocarbons as fuels, solvent, lubricants and many other applications. If fuels, solvents, or lubricants, are released into the environment they might work they way into the water bodies via erosion. Hydrocarbons can be toxic to fish and plant habitats, as well as consume oxygen during their decay process resulting in fish kill and unsightly conditions. On construction sites, the storage, transfer, and usage of these compounds should be performed following all federal, state, and local regulations.

Oil and grease discovered or generated at construction sites must be kept out of waterways.

Halogenated Hydrocarbons or Persistent Organics

A group of chemicals that are very resistant to decay. Compounds such as DDT and PCBs are in this category. These compounds accumulate in the food chain becoming toxic to aquatic life, wildlife, and humans. The main sources of these compounds are atmospheric deposition, urban, industrial, and

municipal discharges from past and ongoing activities. When encountered, these compounds should be treated as hazardous waste and the appropriate governmental agencies should be contacted as well as all the federal, state, and local regulations shall be followed.

PAHs

Are a group of organic chemicals that includes several petroleum products and byproducts. These compounds are very toxic and most of them are carcinogens. They tend to be persistent in the environment, absorbent in soil particles, bioaccumulative in living tissue, and lethal to several organisms. Urban runoff from industrial, urban, and municipal sources is suspected to be a major contributor of PAH in water bodies, as well as atmospheric deposition.

Metals

Include iron, manganese, lead, cadmium, zinc, and mercury; metalloids include arsenic and selenium. The major sources of metals are inactive and active mines; atmospheric deposition from urban, industrial, and municipal discharges.

Abandoned tailings piles can be a source of metal contamination to waterways.

In Montana, many areas have been mined for precious metals. The mining areas typically exhibit high metal concentrations in the ore, waste rock, and tailings presenting a threat to human health and the environment. Erosion and sedimentation of these materials can be dangerous to the environment and should be avoided. Mine waste is often characterized by oxidation zones, which results in soils or wastes having a very uniform texture and colors such as all gray, red, or yellow. Special care should be taken when construction activities disturb areas affected by mine wastes. The appropriate MDT and DEQ environmental departments should be contacted and the federal, state, and local regulations should be followed.

Contaminated sediments do not always remain at the bottom of a water body. Any activity that stirs up the water, such as a storm or a boat's propeller, can resuspend sediments. Resuspension may mean that all of the animals in the water, and not just the bottom-dwelling organisms, can be directly exposed to toxic contaminants.

Principles of Erosion and Sediment Control

Erosion control practices during construction activities protect the soil surface by using soil stabilization BMPs. **Erosion control** treats soil as a valuable resource that needs to be protected from erosion mechanisms. **Sediment control** practices trap soil particles after they have been dislodged and prevent or minimize their movement off site. Sediment controls are generally passive systems that rely on filtering and/or settling soil particles before they leave the site.

Vegetation

Vegetation is the key to long-term soil stability. Therefore, sediment control is dependent on the reestablishment of vegetation on disturbed areas. Vegetation serves to physically impede runoff by the presence of stems and leaves which retard runoff shear stress and protects the soil surface. Vegetation also greatly increases water infiltration into the soil. A vegetated soil surface might exhibit 80-99% less runoff compared to a barren soil surface depending on the soil texture and vegetation cover. Rapid establishment of vegetation is a critically important component of long-term stability. A number of construction practices are available which promote successful vegetation development.

Vegetation is a key component of erosion and sediment control (BMPs SS-2, SS-4, SS-15).

Preserving existing vegetation within and adjacent to construction sites has a positive impact on erosion and sediment control (BMP SS-2).

Erosion control mats are often used to prevent erosion and aid in the reestablishment of vegetation (BMP SS-7).

Section 2
BMPs for the Construction Site

In order to address the requirements of pollution prevention at construction sites, a variety of techniques should be employed to reduce soil erosion, reduce site sediment loss, and manage some of the more common construction-generated wastes and construction related toxic materials. The BMPs identified in the field manual consist of temporary methods to reduce pollution from a construction site. Hazardous and toxic wastes and construction-generated wastes will require coordination with multiple state and/or federal agencies and the procedures and requirements for management of these wastes are not described in this document. Hazardous and toxic waste issues should be coordinated with EPA, MDT Environmental Services, and DEQ.

The BMP fact sheets contained in this manual were developed by the State of California Department of Transportation (Caltrans) and have been modified for Montana (CDM, 1997. Caltrans Storm Water Quality Handbooks). The majority of BMPs address soil loss from the site. Soil loss in the form of erosion and sedimentation due to storm events, snowmelt, and wind constitute the majority of pollution at construction sites. BMPs that address erosion and sediment control are typically more site specific than waste and toxics management. Erosion and sediment control BMPs are dependent on site slopes, drainage patterns, and drainage quantities along with other site-specific conditions. Waste management consists primarily of "good housekeeping" practices that are dependent on the type of construction, and the quantity and type of building materials.

The fact sheets in this manual provide details for the design maintenance limitations and purpose of each of the BMPs. In order to address the requirements of pollution reduction at MDT construction sites, a variety of techniques should be employed to reduce soil erosion and sedimentation.

Temporary Soil Stabilization BMPs

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 (BMP SS-12).

Temporary soil stabilization on disturbed soils of construction projects consists of preparing the soil surface and applying one of the BMPs shown in Table 2-1, or combination thereof, to disturbed soil surfaces. These soil stabilization BMPs are primarily used in perimeter areas around construction sites to either limit water flows across the site or limit the erosion in disturbed areas within the construction site that are not being actively worked.

Temporary concentrated flow conveyance controls, SS-9 through SS-11, are grouped with temporary soil stabilization BMPs and consist of a system of BMPs that are used alone or in combination to intercept, divert, convey, and discharge concentrated flows with a minimum of soil erosion, both on site and downstream (off-site). Temporary concentrated flow conveyance controls may be required to direct water running onto the construction site or through the project in a non-erodible fashion.

Rock Lined channels are a method of conveying discharges with a minimum of soil erosion (BMP SS-9).

BMPs should be implemented when construction activities disturb native soils and vegetation exposing bare surfaces to water and wind erosion. The BMPs should be installed as close as possible to the original disturbed site of sediments. The EPA stresses the use of a management system approach (tool box approach), which utilizes a combination of BMPs at each construction site to maximize the overall effectiveness of the BMPs.

Soil binders and hydraulic mulch are used to stabilize soils (BMP SS-3).

The presence of vegetation prevents soils from being eroded by creating a natural cover and holding soils together. If possible, vegetation should not be disturbed during construction activities or only removed when construction activities begin at a particular area of the site. Designers should consider phasing the activities and only removing vegetation when necessary to avoid creating bare soils for long periods of time. The use of designated haul routes, temporary fencing, and other measures that minimize the disturbance of natural vegetation should also be considered when planning construction activities.

Temporary seeding is used to stabilize soils through new plant growth (BMP SS-4).

Synthetic liners can be used to minimize soil erosion during construction (BMP SS-7).

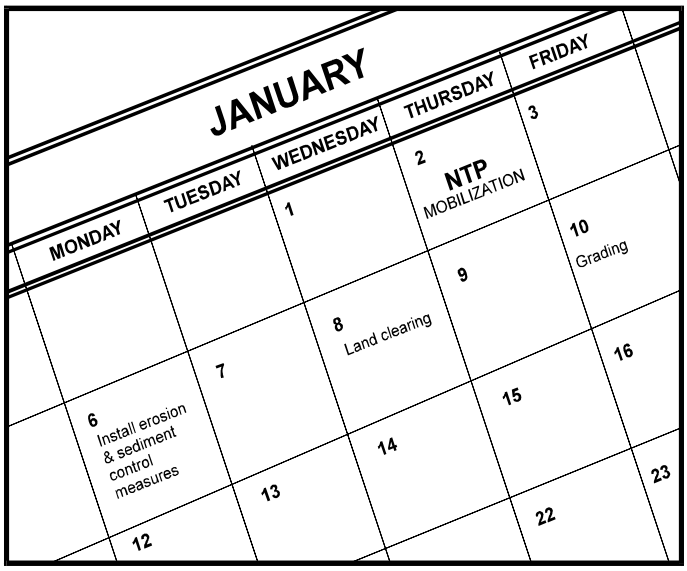
Table 2-1 BMP Selection Guidelines

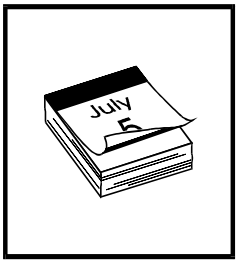
ID	BMP Name	Primary Purpose	Erosion Processes
SS-1	Scheduling	Sequencing of BMPs	All
SS-2	Preservation of Existing Vegetation	Protection of desirable vegetation by limiting soil detachment	All
SS-3	Hydraulic Mulch	Protection of disturbed soil with mulch by limiting soil detachment	Splash, Sheet, Rill/Gully, Wind, and Snow Melt.
SS-4	Temporary Seeding	Provide soil protection through new plant growth	All
SS-5	Soil Binders	Soil stabilization to prevent wind and water induced erosion	Splash, Sheet, Wind, and Snow Melt.
SS-6	Straw Mulch	Protect disturbed soil with straw mulch by limiting soil detachment	Splash, sheet, Rill/Gully, Wind, and Snow Melt.
SS-7	Geotextiles, Plastic Covers, & Erosion Control Blankets/Mats	Protect disturbed soil or slopes	All
SS-8	Wood Mulching	Protect disturbed soil with wood mulch	Splash, Sheet, Rill/Gully, Wind, and Snow Melt.
SS-9	Earth Dikes/Drainage Swales & Lined Ditches	Intercept, divert, and convey surface run-on	Stream Bank, Sheet, Rill/Gully, and Snow Melt.
SS-10	Outlet Protection/Velocity Dissipation Devices	Prevent scour of exiting storm water flows	Stream Bank, Snow Melt, and Shoreline.
SS-11	Slope Drains	Route overland flow into a pipe to protect slope	Rill/Gully, Sheet, and Snow Melt.
SS-12	Slope Roughening	Reduce runoff velocity, increase infiltration, trap sediments, and create microenvironment for seeding	Rill/Gully, Sheet, Splash, Wind, and Snow Melt.
SS-13	Terraced Slope	Reduce velocity and allow upland deposition	Rill/Gully, Sheet, Wind, and Snow Melt.
SS-14	Vegetated Buffer	Prevent soil erosion and catch sediment	Stream Bank, Sheet, Wind, Snow, and Shoreline.
SS-15	Erosion Seeding	Erosion control on steep slopes	All

Crimped straw can be used alone or in conjunction with temporary seeding to help stabilize soils (BMP SS-6).

Terraced slopes help reduce velocities and allow deposition of sediment on the terraces. Steep slope revegetation can be a difficult task (BMP SS-13).

Scheduling SS-1





BMP Objectives

- Soil Stabilization
- Sediment Control
- Tracking Control
- Wind Erosion Control
- Non-Storm Water Management
- Materials and Waste Management

Definition and Purpose

This BMP involves developing a schedule for every project that includes sequencing of construction activities with the implementation of construction site BMPs such as temporary soil stabilization (erosion control) and temporary sediment controls measures. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

Appropriate Applications

Any construction project where soils will be disturbed will benefit from a BMP sequencing schedule that is generated in conjunction with the construction-sequencing schedule. BMP sequencing can help minimize land disturbance during construction.

Limitations

The BMP sequencing schedule must be agreed upon between MDT and the construction contractor. BMP scheduling is only effective if the scheduled is followed closely and modified as required throughout the construction project.

Design Guidelines and Considerations

- Plan the project and develop an implementation schedule of construction site BMPs. The schedule is designed to clearly show how the BMPs relate to soil-disturbing and re-stabilization activities. The construction schedule is typically incorporated into the SWPPP.
- A BMP schedule includes details on the implementation and deployment of:
  - temporary soil stabilization BMPs,
  - temporary sediment control BMPs,

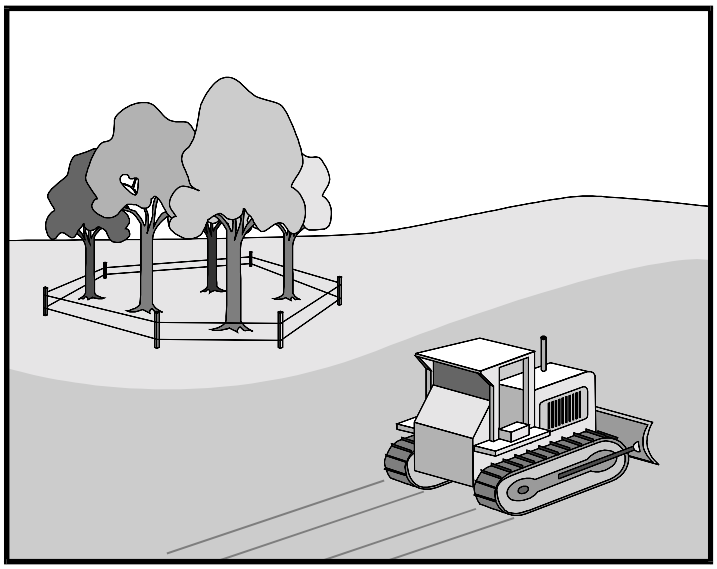
- tracking control BMPs,
- wind erosion control BMPs,
- non-storm water BMPs, and
- waste management and materials pollution control BMPs.

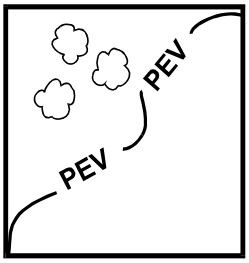
- Also included in the BMP schedule are dates for significant long-term operations or activities that may have planned non-storm water discharges such as dewatering, saw cutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, bridge cleaning, etc.
- Coordinate sequencing and create a timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, pouring foundations, installing utilities, etc., to minimize the active construction area during the peak storm seasons.
- Stabilize non-active areas as soon as practical.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment controls on all disturbed areas prior to the onset of rain.
- Be prepared year-round to deploy soil stabilization and sediment control practices. Erosion may be caused during dry seasons by unseasonable rainfall, wind, and vehicle tracking. Keep the site stabilized year-round, and retain and maintain sediment trapping devices in operational condition.
- Trenching of utility lines is often required on construction projects. Sequence trenching and excavation activities so that most open portions are closed before new trenching or excavations begin.
- Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
- Consider scheduling when establishing permanent vegetation (appropriate planting time for specified vegetation).
- Schedule BMP Maintenance, Inspection, and Removals.

Maintenance, Inspection, and Removal

- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted or when directed by the Engineer.
- Include anticipated BMP removal information on the schedule.

Preservation of Existing Vegetation SS-2





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Preservation of existing vegetation relates to the identification and protection of desirable vegetation. Benefits of preservation of existing vegetation include minimizing disturbance on construction sites, erosion control, detention, and infiltration of storm water, biofiltration, velocity dissipation and aesthetic value.

Appropriate Applications

- Preserve existing vegetation at areas on a site where no construction activity is planned or where activities may occur at a later date.
- Beneficial for use in wetlands, floodplains, stream banks, steep slopes and other areas where erosion controls would be difficult to establish, install, or maintain.
- Preservation of existing vegetation is also used to maintain pre-construction drainage patterns to avoid vegetation die off as a result of water flows being intercepted and diverted away from the existing vegetation.
- On a year-round basis, temporary fencing can be installed prior to clearing and grubbing operations or other soil-disturbing activities in areas where no construction activity is planned or will occur later. Upon Engineer's approval, flagging or verbal designation of vegetation preservation areas may be substituted for temporary fencing.
- No grading or disturbances occurs in areas identified on the plans to be preserved.
- Protection of existing vegetation requires planning, and may limit the area available for construction activities.

Design Guidelines and Considerations

- Preservation of existing vegetation is best provided prior to the commencement of clearing and grubbing operations or other soil-disturbing activities in areas where no construction activity is planned or will occur later.

- Preservation of existing vegetation needs to conform to scheduling requirements set forth in the special provisions.

- Mark areas to be preserved with temporary fencing made of orange polypropylene that is stabilized against ultraviolet light. MDT Standard Specifications and Detail Drawings outline the installation of temporary fencing.

- Minimize the disturbed areas by locating temporary roadways to avoid stands of trees and shrubs and to follow existing contours to reduce cutting and filling.

- Consider the impact of grade changes to existing vegetation and the root zone.

- Locate construction materials, equipment storage, and parking areas to minimize root compaction. Staging areas should be selected to avoid negatively impacting large areas of existing vegetation.

- Keep equipment away from trees to prevent trunk and root damage.

- Maintain existing irrigation systems.

- Protective devices are only effective if all personnel understand and honor them. No heavy equipment, vehicular traffic, or stock piles of construction materials shall be permitted within the drip line of trees. Removed trees shall not be felled, pushed, or pulled into any retained trees. Fires shall not be permitted within 30 m (100 ft) of the drip line of any retained trees. No toxic or construction materials - including paint, acid, nails, gypsum board, chemicals, fuels, and lubricants - shall be stored within 15 m (50 ft) of the drip line of any retained trees, nor shall they be disposed of in any way which would injure vegetation.

Maintenance, Inspection, and Removal

- During construction, clearly marked limits of disturbance should be observable at all times. Irrigate or maintain the existing vegetation in conformance to the requirements in the landscaping plan. If damage to protected trees still occurs, notify the MDT Agronomist and arrange for any repairs. Remove fencing and flagging according to the BMP removal schedule.

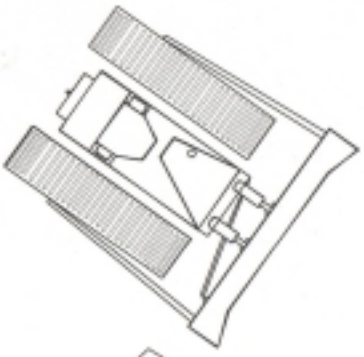
SYMBOL: ———————— ———PEV———

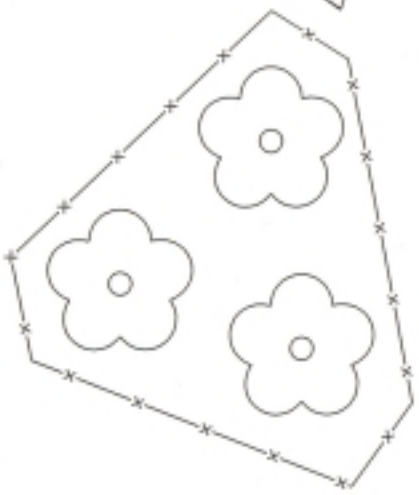
PRESERVATION OF EXISTING VEGETATION SS-21

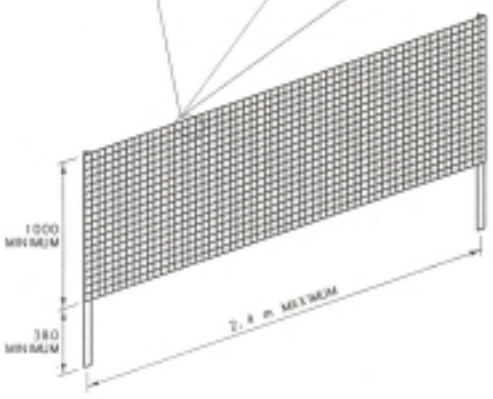
PRESERVATION OF EXISTING VEGETATION IS THE IDENTIFICATION AND PROTECTION OF DESIRABLE VEGETATION THAT PROVIDES EROSION AND SEDIMENT CONTROL BENEFITS. PROVIDE PRESERVATION OF EXISTING VEGETATION PRIOR TO COMMENCEMENT OF CLEARING AND GRUBBING OPERATIONS OR OTHER SOIL DISTURBING ACTIVITIES. MARK THE AREA AS DESIGNATED ON THE CONSTRUCTION PLANS USING TEMPORARY FENCING MADE OF ORANGE POLYPROPYLENE THAT IS STABILIZED AGAINST ULTRAVIOLET LIGHT. AFFIX FENCING TO METAL "T" POST USING 3.05 mm WIRE. PLACE FENCING AN ADEQUATE DISTANCE FROM TREES AND BUSHES TO PREVENT ROOT AND IRRIGATION SYSTEM DAMAGE.

UPON WRITTEN APPROVAL BY THE ENGINEER, THE CONTRACTOR MAY BE ALLOWED TO FLAG OR VERBALLY DESIGNATE AREAS OF EXISTING VEGETATIVE PRESERVATION.

PRESERVATION OF EXISTING VEGETATION MAY BE USED IN CONJUNCTION WITH VEGETATIVE BUFFER (SS-14), WIND EROSION CONTROL (WE-1) AND SNOW ACCUMULATION (SN-1).







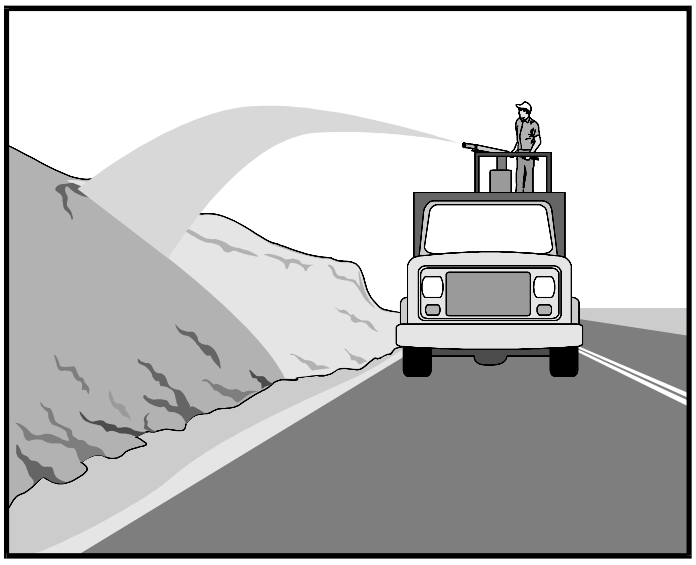
PRELIMINARY

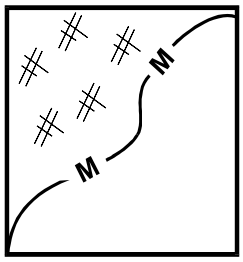
REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-22
PRESERVATION OF EXISTING VEGETATION ISS-21	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

Hydraulic Mulch SS-3





BMP Objectives
- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Hydraulic mulch consists of applying a mixture of small pieces of cellulose fibers that can be made from shredded wood fiber or recycled paper and a stabilizing emulsion and tackifier (if desired) with hydro-mulching equipment. This will protect exposed soil from erosion by raindrop impact or wind. Mulching can also provide protection and warmth for seed growth.

Appropriate Applications

- Hydraulic mulch is applied to disturbed areas requiring temporary protection until permanent vegetation is established or to disturbed areas that must be re-disturbed.
- Avoid use in areas where the mulch would be incompatible with immediate earthwork activities and would have to be removed.
- Hydraulic mulch is most effective when used in conjunction with erosion or temporary seeding applications.

Limitations

- Wood fiber hydraulic mulches are generally short-lived (only last a part of a growing season).
- Hydraulic matrices need 24 hours to dry before rainfall occurs to be effective.

Design Guidelines and Considerations

- Prior to application, roughen embankment and fill areas by rolling with a crimping, punching type roller, or by track walking. Track walking shall only be used where other methods are impractical.
- Avoid mulch over-spray onto the traveled way, sidewalks, lined drainage channels, and existing vegetation.

- Selection of hydraulic mulches by the Contractor must be approved by the Engineer.

- Materials for wood fiber based hydraulic mulches and hydraulic matrices shall conform to MDT Standard Specifications.

- Refer to BMP SS-5 (Soil Binder) for tackifier requirements.

- Recycled paper mulch must contain 100% post-consumer paper.

Hydraulic Mulches

- Wood cellulose fiber mulch and recycled paper fiber mulch shall conform to MDT Standard Specifications.

- Apply as a liquid slurry using a hydraulic application machine (i.e., hydroseeder). Follow manufacture's recommendations for application rates, for mulch and stabilizing emulsion, to achieve complete coverage of target area.

Hydraulic Matrices

- Apply a wood fiber base layer and a paper fiber top layer, both mixed with acrylic polymers as binders. Apply as a liquid slurry using a hydraulic application machine (i.e., hydroseeder) at minimum rate of 841 kg/ha (750 lb/acre) wood fiber mulch, 1,140 kg/ha (1020 lb/acre) recycled paper mulch and 520 liters/ha (55 gal/acre) of acrylic copolymer or as specified by the special provisions, to achieve complete coverage of the target area.

- Alternatively, a bonded fiber matrix shall be applied at the rate specified in the special provisions. The bonded fiber matrix shall be applied at a rate of 3,400 to 4,500 kg/ha (3025 to 4000 lbs/acre) based on manufacturers recommendation, to achieve complete coverage of the target area unless specified in the special provision. Do not apply immediately before, during, or after a rainfall.

Maintenance, Inspection, and Removals

- Maintain an unbroken, temporary mulched ground cover throughout the period of construction when soils are not being reworked. Inspect mulch before expected rain storms and repair any damaged ground cover and re-mulch exposed areas.

- After any rainfall event, the Contractor is responsible for maintaining all slopes to prevent erosion.

SYMBOL:

HYDRAULIC MULCH SS-3

HYDRAULIC MULCH CONSISTS OF APPLYING A MIXTURE OF SMALL PIECES OF CELLULOSE FIBERS WHICH CAN BE MADE FROM SHREDDED WOOD FIBERS OR RECYCLED PAPER AND A STABILIZING EMULSION AND TACKIFIER (SUBJECT TO ENGINEERS DISCRETION) USING HYDRO-MULCHING EQUIPMENT. HYDRAULIC MULCH IS APPLIED TO DISTURBED AREAS REQUIRING TEMPORARY PROTECTION UNTIL PERMANENT VEGETATION IS ESTABLISHED OR DISTURBED AREAS THAT MUST BE RE-DISTURBED FOLLOWING AN EXTENDED PERIOD OF INACTIVITY.

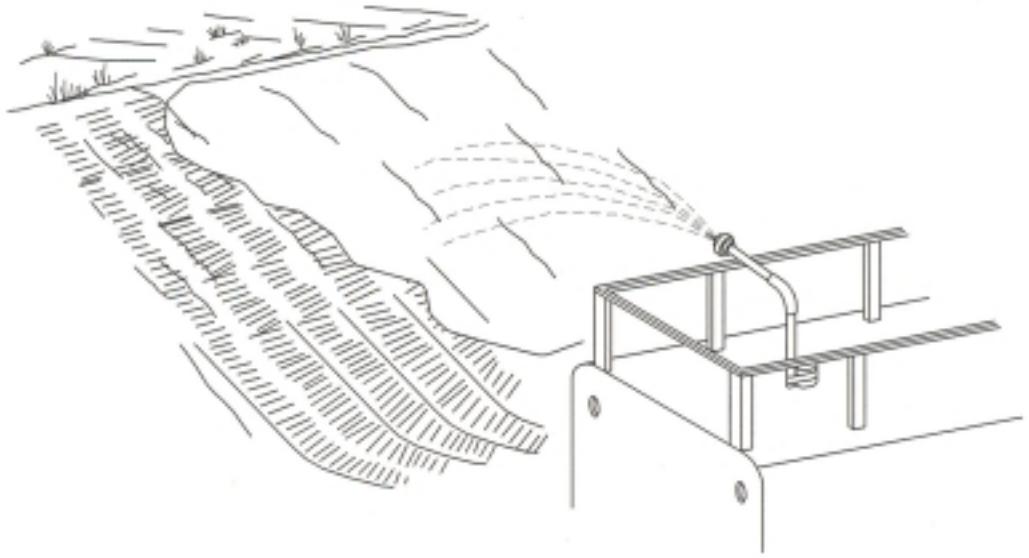
APPLY HYDRAULIC MULCH A MINIMUM OF 24 HOURS PRIOR TO A STORM EVENT TO ALLOW FOR ADEQUATE DRYING.

HYDRAULIC MULCH SELECTION MUST MEET MDT SPECIFICATIONS AND BE APPROVED BY THE ENGINEER PRIOR TO PLACEMENT. ROUGHEN EXISTING EMBANKMENT FOLLOWING GUIDELINES SPECIFIED IN BMP SS-12. WHEN EITHER TEMPORARY SEEDING OR PERMANENT SEEDING IS COMBINED WITH THE HYDRAULIC MULCH BMP, COMPLETE SEEDING OPERATIONS PRIOR TO HYDRAULIC MULCHING OPERATIONS. REFER TO BMPs SS-4 AND SS-5 FOR SEEDING REQUIREMENTS. REMOVE ANY OVER SPRAY FROM ROADWAYS OR SIDEWALKS IMMEDIATELY FOLLOWING APPLICATION.

REAPPLY HYDRAULIC MULCH TO ANY DISTURBED AREAS FOLLOWING A RAIN EVENT OR RESULTING FROM CONSTRUCTION ACTIVITIES.

RECYCLED PAPER MULCH SHOULD CONTAIN 100% POST CONSUMED PAPER.

REFER TO BMP SS-5 (SOIL BINDER) FOR TACKIFIER REQUIREMENTS. ADD ENVIRONMENTALLY SAFE GREEN DYE AS A VISUAL AID DURING APPLICATION.



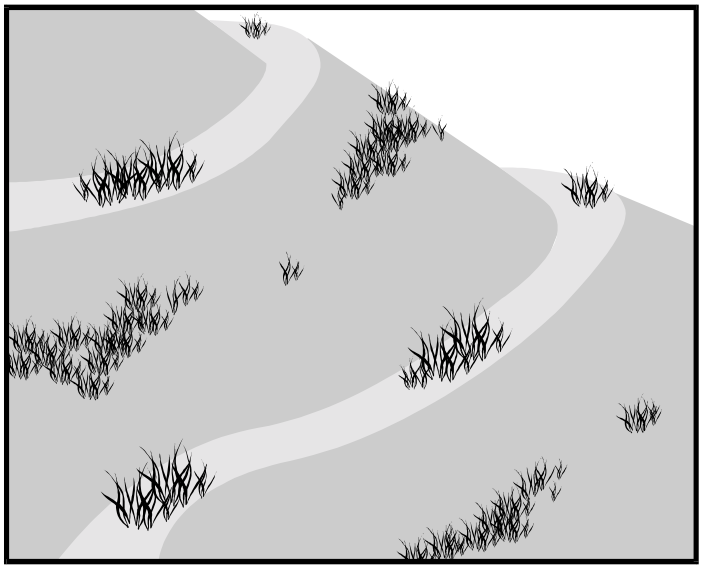
HYDRAULIC MULCH		
PRODUCT	MATERIAL	APPLICATION RATE *
PAPER-BASED HYDRAULIC MULCH	PAPER	1 120 kg/ha (MIN)
WOOD-BASED HYDRAULIC MULCH	WOOD OR WOOD & PAPER	1 120 kg/ha (MIN)

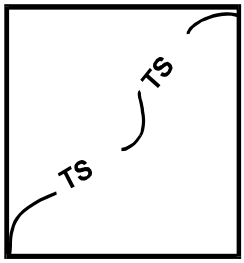
* APPLICATION RATES VARY WITH SLOPE & MUST BE APPROVED BY THE ENGINEER

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-??
HYDRAULIC MULCH (SS-3)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Temporary Seeding SS-4





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Well-established vegetative cover is one of the best erosion control measures available. **Temporary seeding** is the establishment of a temporary vegetative cover on areas with a **slope of 3:1** or flatter that will be exposed for longer than 14 days and that will undergo further disturbance. Temporary seeding is not the same as erosion seeding. **Erosion seeding** (as shown in SS-15) is the immediate seeding of freshly exposed cut and fill **slopes steeper than 3:1** that will not undergo further disturbance. Cereal barley is used as the vegetative cover for temporary seeding. Erosion seeding uses a mixture of seed.

Appropriate Applications

- Temporary seeding is used on disturbed areas requiring temporary protection until permanent vegetation is established, or areas that must be re-disturbed following an extended period of inactivity. Temporary seeding can provide rapid erosion protection on disturbed areas. Once established temporary seeding also traps sediments, promotes infiltration, and improves the appearance of the site. Temporary seeding is a relatively inexpensive erosion control measure.

Limitations

- Rock slopes that cannot be excavated by ripping are not temporarily seeded.
- Temporary seeding may not be appropriate in dry areas or periods without supplemental irrigation.
- Areas impacted by construction traffic will not have successful vegetative growth.
- Temporary seeding should only be utilized when there is sufficient time and conditions are favorable for the vegetation to become established.

- Mulching may be necessary in addition to temporary seeding during the establishment of vegetation because temporary vegetation takes several weeks to establish.

- Steep slopes are not to be seeded with the temporary seeding mix. Erosion seeding shall be substituted for temporary seeding when slopes steeper than 3:1.

- Temporary vegetation is not appropriate for short-term inactivity (less than 14 days).

- Seeding applications may require fertilizer to establish on poor quality soils.

Design Guidelines and Considerations

- Seeding dates and application rates are as follows:

April 1 – June 30	Cereal Barley – 13.5 kg/ha (12.0 lbs/ac)
July 1 – August 31	Temporary Seeding Not Recommended
Sept. 1 – Nov. 15	Cereal Barley – 13.5 kg/ha* (12.0 lbs/ac)

* Do not temporary seed in this timeframe if the area is to be permanently seeded that fall.

- Contact the MDT agronomist, through the Engineer, prior to using substitutions or placing temporary seeding outside these dates. Substitutions shall be approved in writing by the Engineer during the construction phase.

- Drill seed slopes of 3:1 or flatter.

- Following to application, roughen the slopes, or areas to be seeded with the furrows trending along the contours.

- Mulch should be considered in combination with temporary seeding to enhance plant establishment. Mulch will help keep seeds in place and will moderate soil moisture and temperature until the seeds germinate.

- All seeds shall be in conformance with MDT Standard Specifications. Each seed bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, manufacture's guarantee, and dates of test.

- Follow-up applications shall be made as needed to cover spots of poor germination, and to maintain adequate soil protection.

Maintenance, Inspection, and Removal

- All seeded areas shall be inspected for failures, re-seeded, and mulched within the planting season, using no less than half the original application rates. Any temporary seeding efforts that do not provide adequate cover must be revegetated as required by the Engineer.

- After any rainfall event, the Contractor is responsible for maintaining all slopes to prevent erosion.

SYMBOL: ———————— ———TS———

TEMPORARY SEEDING SS-4:

TEMPORARY SEEDING IS THE ESTABLISHMENT OF A TEMPORARY VEGETATIVE COVER BY SEEDING WITH CEREAL BARLEY. USE TEMPORARY SEEDING ON AREAS 3:1 OR FLATTER THAT WILL BE EXPOSED FOR LONGER THAN 14 DAYS AND THAT WILL UNDERGO FURTHER DISTURBANCE. EXCLUDE ROCK SLOPES THAT CANNOT BE EXCAVATED BY RIPPING.

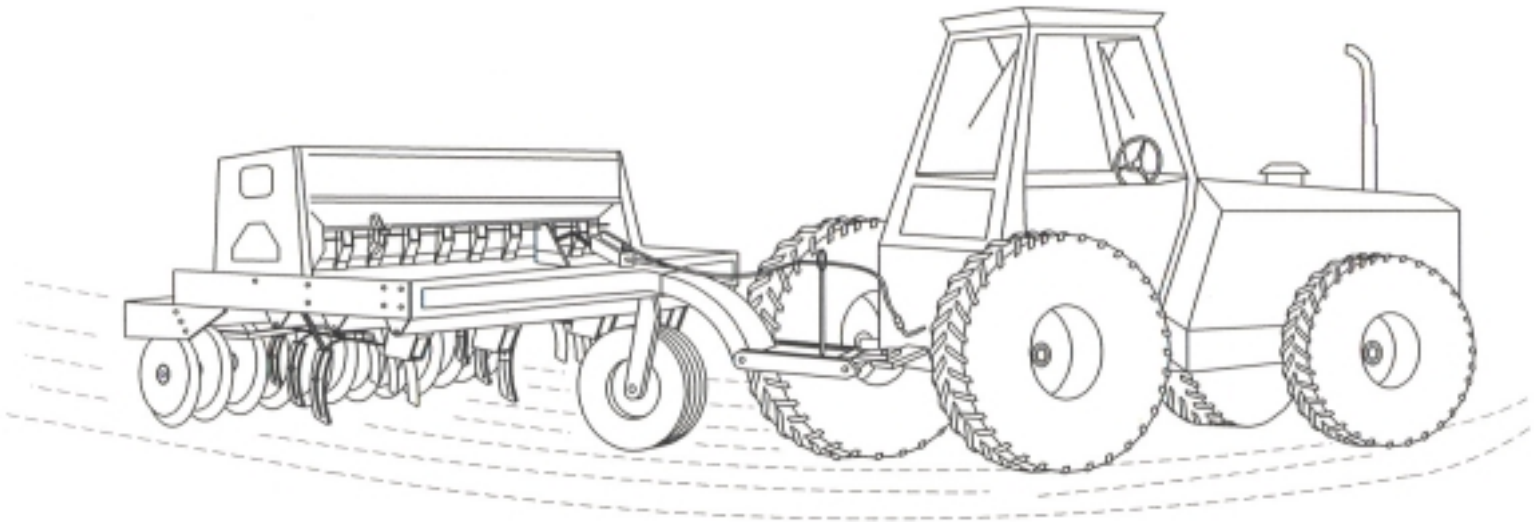
SEEDING DATES AND APPLICATION RATES ARE AS FOLLOWS:

APR. 1 TO JUN. 30: CEREAL BARLEY AT 13.5 kg/ha
JUL. 1 TO AUG. 31: TEMPORARY SEEDING NOT RECOMMENDED
SEP. 1 TO NOV. 15: CEREAL BARLEY AT 13.5 kg/ha

DO NOT TEMPORARY SEED FROM SEP. 1 TO NOV. 15 IF THE AREA IS TO BE PERMANENTLY SEEDED THAT FALL.

CONTACT THE MDT AGRONOMIST, THROUGH THE ENGINEER, PRIOR TO USING SUBSTITUTIONS OR PLACING TEMPORARY SEEDING OUTSIDE THESE DATES. DRILL SEED SLOPES OF 3:1 OR FLATTER. FOR SLOPES STEEPER THAN 3:1, REFER TO EROSION SEEDING.

ANY TEMPORARY SEEDING EFFORTS THAT DO NOT PROVIDE ADEQUATE COVER MUST BE RE SEEDED AS REQUIRED BY THE ENGINEER.



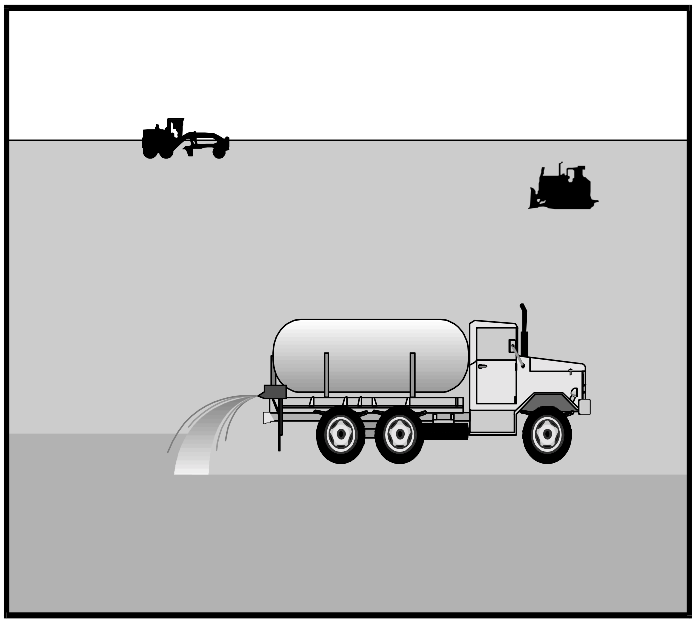
SLOPES 3:1 OR FLATTER

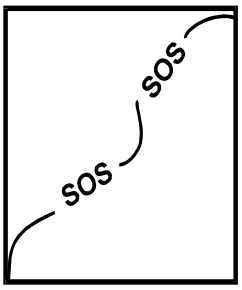
PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
TEMPORARY SEEDING (SS-4)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Soil Binder SS-5





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Soil binders consist of applying and maintaining polymeric or lignin sulfonate soil stabilizers or emulsions. Soil binders are materials applied to the soil surface to temporarily prevent water-induced erosion of exposed soils on construction sites. Soil binders typically also provide dust, wind, and soil stabilization (erosion control) benefits.

Appropriate Applications

Soil binders are applied to disturbed areas requiring short-term protection. Because soil binders can often be incorporated into the earth work, they may be a good choice for areas where grading activities will soon resume.

Limitations

- Soil binders are temporary in nature and may need reapplication.
- Soil binders require a minimum curing time as prescribed by the manufacturer, which may be 24 hours or longer until fully effective.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.
- Soil binders do not hold up to pedestrian or vehicular traffic across treated areas.
- Soil binders may not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.

- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.

- Soil binders may not cure if low temperatures occur within 24 hours of application.

Design Guidelines and Considerations

General Considerations

- Regional soil types will dictate which soil binders are appropriate for use.

- A soil binder must be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and shall not stain paved or painted surfaces.

- Some soil binders are compatible with existing vegetation.

- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.

- Avoid over-spray onto the traveled way, sidewalks, lined drainage channels, and existing vegetation.

Selecting a Soil Binder

Properties of common soil binders used for erosion control are provided on the Detail Drawings.

Factors to consider when selecting a soil binder include the following:

- Suitability to situation - Consider where the soil binder will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the soil binder will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed soil binders. Soil binders may also be used for dust control using the provided dust control application rates. The dust control application rates will not be adequate to provide protection from water-induced erosion.

- Soil types and surface materials - Fines and moisture content are key properties of surface materials. Consider a soil binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials.

- Frequency of application - The frequency of application can be affected by subgrade conditions, surface type, traffic volumes, climate, and maintenance schedule. Frequent applications could lead to high costs. Application frequency may be minimized if the soil binder has good penetration, low evaporation, and good longevity. Consider also that frequent application will require frequent equipment clean-up.

- After considering the above factors, the soil binders are generally appropriate as follows:

  - *Copolymer:* Appropriate for long term soil stabilization in areas where cross-traffic might occur, or where stabilization needs to be achieved in conjunction with preserving existing vegetation. Longevity can be up to 2 years, it has a high resistance to abrasion,

and is compatible with existing vegetation. However, it is also relatively costly which makes it less desirable for short-term or frequent applications.

- *Lignin sulfonate:* Appropriate for short- or medium-term soil stabilization applications in low traffic areas. The moderate relative cost makes it less desirable to reapply frequently, though it typically lasts longer than psyllium or guar. With only moderate penetration and a low resistance to abrasion, it would be more suited to areas which will not be disturbed frequently by construction activities. Lignin sulfonate can have an unpleasant odor when applied.
- *Psyllium/Guar:* Appropriate for typical soil stabilizing situations or short-term applications. Because of the relatively low cost, they can be applied more frequently. Their high penetration provides good stabilization, but their moderate resistance to abrasion limits their longevity. They are not very compatible with vegetation.

Applying Soil Binders

After selecting an appropriate soil binder, the untreated soil surface must be prepared before application. The untreated soil surface must contain sufficient moisture to assist the agent in achieving uniform distribution. Refer to manufacture's specifications, but in general, the following steps shall be followed:

- Follow manufacturer's recommendations for application rates, pre-wetting of application area, and cleaning of equipment after use.

- Prior to application, roughen embankment and fill areas. Track walking shall only be used where rolling is impractical.

- Soil binders shall not be applied during or immediately before rainfall.

- Avoid over-spray onto the traveled way, sidewalks, lined drainage channels, sound walls, and existing vegetation.

- Do not apply soil binders to frozen soil, areas with standing water, under freezing or rainy conditions, or when the temperature is below 4^0C (40^0F).

- More than one treatment is often necessary, although the second treatment may be diluted or have a lower application rate.

- Generally, soil binders require a minimum curing time of 24 hours before they are fully effective. Refer to manufacturer's specifications for specific cure times.

- For liquid agents:

  - Crown or slope ground to avoid large depressions.

  - Uniformly pre-wet ground at 0.14 to 1.4 l/m^2 (0.003 to 0.03 gal/ft^2) or according to manufacturer's recommendations.

  - Apply solution under pressure. Overlap solution 150 to 300 mm (6 to 12 in).

  - Allow treated area to cure for the time recommended by the manufacturer, typically, at least 24 hours.

- Apply second treatment before first treatment becomes ineffective, using 50% application rate.

- In low humidities, reactivate chemicals by re-wetting with water at 0.5 to 0.9 l/m^2 (0.01 to 0.02 gal/ft^2).

Maintenance, Inspection, and Removal

- Reapplying the selected soil binder may be needed for proper maintenance. High traffic areas shall be inspected on a daily basis, and lower traffic areas should be inspected on a weekly basis.

- After any rainfall event, the Contractor is responsible for maintaining all slopes to prevent erosion.

SYMBOL:

SOIL BINDERS SS-5:

SOIL BINDERS CONSIST OF APPLYING AND MAINTAINING POLYMERIC OR LIGNIN SULFONATE SOIL STABILIZERS OR EMULSIONS. SOIL BINDERS ARE MATERIALS APPLIED TO THE SOIL SURFACE TO TEMPORARILY PREVENT WATER-INDUCED EROSION OF EXPOSED SOILS ON CONSTRUCTION SITES. SOIL BINDERS TYPICALLY ALSO PROVIDE DUST, WIND AND SOIL STABILIZATION BENEFITS. BECAUSE SOIL BINDERS CAN OFTEN BE INCORPORATED INTO THE WORK, THEY MAY BE A GOOD CHOICE FOR AREAS WHERE GRADING ACTIVITIES MAY SOON RESUME.

DUE TO THE TEMPORARY NATURE OF SOIL BINDERS, REAPPLICATION MAY BE REQUIRED OVER AREAS WITH PEDESTRIAN AND VEHICLE TRAFFIC.

SOIL BINDER TYPE AND APPLICATION PROCEDURES REQUIRE THE ENGINEER'S APPROVAL PRIOR TO PLACEMENT. APPLY PER MANUFACTURES SPECIFICATIONS.

REAPPLY SOIL BINDERS, AS SPECIFIED BY THE ENGINEER, IN HIGH TRAFFIC AREAS AND FOLLOWING RAIN EVENTS TO ENSURE AN ADEQUATELY MAINTAINED SURFACE.

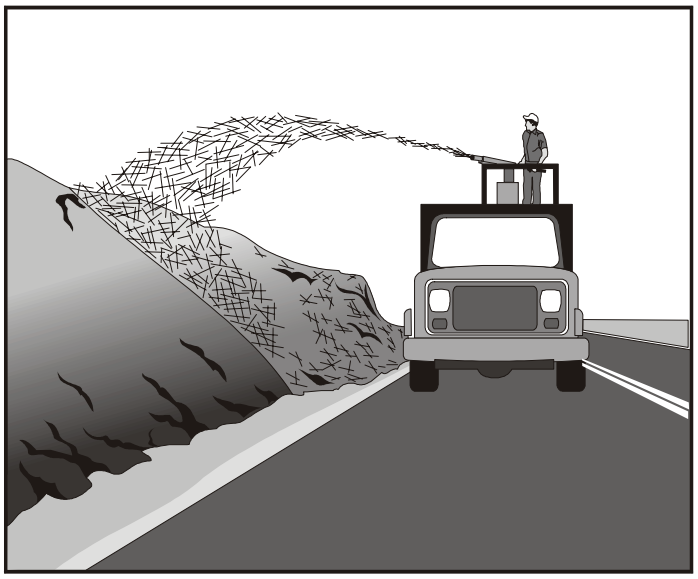
PROPERTIES OF SOIL BINDERS FOR EROSION CONTROL

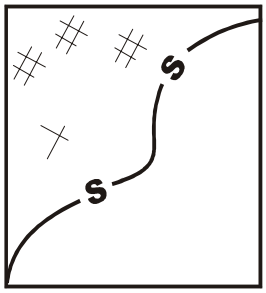
CHEMICALS	COPOLYMER	LIGNIN SULFONATE	PSYLLIUM	GUAR
COMMENTS	FORMS SEMIPERMEABLE TRANSPARENT CRUST, RESISTS ULTRAVIOLET RADIATION & MOISTURE INDUCED BREAKDOWN.	PAPER INDUSTRY WASTE PRODUCT. ACTS AS DISPERSING AGENT. BEST IN DRY CLIMATES. CAN BE SLIPPERY.	EFFECTIVE ON DRY, HARD SOILS. FORMS A CRUST.	EFFECTIVE ON DRY, HARD SOILS. FORMS A CRUST.
RELATIVE COST	HIGH	MODERATE	LOW	LOW
ENVIRONMENTAL HAZARD	LOW	LOW	LOW	LOW
PENETRATION	MODERATE	MODERATE	HIGH	HIGH
EVAPORATION	MODERATE	MODERATE	MODERATE	MODERATE
LEACHING RESISTANCE	LOW	HIGH	HIGH	HIGH
ABRASION RESISTANCE	HIGH	LOW	MODERATE	MODERATE
LONGEVITY	1 TO 2 YEARS	6 MONTHS TO 1 YEAR	3 TO 6 MONTHS	3 TO 6 MONTHS
MINIMUM CURING TIME BEFORE RAIN	24 HOURS	24 HOURS	24 HOURS	24 HOURS
COMPATIBILITY WITH EXISTING VEGETATION	GOOD	POOR	POOR	POOR
MODE OF DEGRADATION	CHEMICALLY DEGRADABLE	BIOLOGICALLY/PHYSICALLY/CHEMICALLY	BIOLOGICALLY DEGRADABLE	BIOLOGICALLY DEGRADABLE
LABOR INTENSIVE	NO	NO	NO	NO
SPECIALIZED APPL. EQUIPMENT	YES	YES	YES	YES
LIQUID/POWDER	LIQUID	POWDER	POWDER	POWDER
SURFACE CRUSTING	YES	YES, BUT DISSOLVED ON REWETTING	YES, BUT DISSOLVED ON REWETTING	YES, BUT DISSOLVED ON REWETTING
CLEAN-UP	SOLVENTS	SOLVENTS	WATER	WATER
EROSION CONTROL APPLICATION RATE	APPLY 800-1000 l/ha	APPLY 5600-6500 l/ha)	APPLY 170 kg/ha WITH 560-2200 kg/ha FIBER MULCH	APPLY 110-220 kg/ha WITH 560-2200 kg/ha FIBER MULCH
DUST CONTROL APPLICATION RATE	APPLY 280-520 l/ha	LOOSEN SURFACE 25-50 mm. NEED 4-8% FINES. APPLY 470-1900 l/ha.	APPLY 170 kg/ha.	APPLY 45-70 kg/ha.

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
SOIL BINDERS (SS-5)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Straw Mulch SS-6





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller or anchoring it with a tackifier.

Appropriate Applications

- Straw mulch is used for soil stabilization as a temporary surface cover on disturbed areas until soils can be prepared for re-vegetation and permanent vegetation is established.
- Also typically used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

Limitations

- Availability of erosion control contractors and straw may be limited due to high demand.
- When straw blowers are used to apply straw mulch, the treatment areas must be within 45 m (150 ft) of a road or surface capable of supporting trucks.
- Straw mulch applied by hand is more time intensive and potentially costly.
- May have to be removed prior to permanent seeding or soil stabilization.
- "Punching" of straw does not work in sandy soils.

Design Guidelines and Considerations

- Straw shall be certified weed free and shall follow MDT Standard Specifications.
- A tackifier is the preferred method for anchoring straw mulch to the soil on slopes.

- Crimping, punch type rollers, or track-walking may also be used to incorporate straw mulch into the soil on slopes. Track walking shall only be used where other methods are impractical.

- Avoid placing straw onto the traveled way, sidewalks, lined drainage channels, sound walls, and existing vegetation.

- Straw mulch with tackifier shall not be applied during or immediately before rainfall.

Application Procedures

- Apply loose straw at a minimum rate of 4,490 kg/ha (4000 lbs/acre), or as indicated in the Special Provisions, either by machine or by hand distribution.

- The straw mulch must be evenly distributed on the soil surface.

- Anchor the mulch in place by using a tackifier or by "punching" it into the soil mechanically.

- A tackifier acts to glue the straw fibers together and to the soil surface. The tackifier shall be selected based on longevity and ability to hold the fibers in place.

- A tackifier is typically applied at a rate of 140 kg/ha (125 lbs/ac). In windy conditions, the rates are typically 200 kg/ha (175 lbs/ac).

- Methods for holding the straw mulch in place depend upon the slope steepness, accessibility, soil conditions, and longevity. If the selected method is incorporation of straw mulch into the soil, then do as follows:

    - Applying and incorporating straw shall follow the requirements in MDT Standard Specifications.

    - On small areas, a spade or shovel can be used.

    - On slopes with soils, which are stable enough, and of sufficient gradient to safely support construction equipment without contributing to compaction and instability problems, straw can be "punched" into the ground using a knife-blade roller or a straight bladed coulter, known commercially as a "crimper."

    - On small areas and/or steep slopes, straw can also be held in place using plastic netting or jute. The netting shall be held in place using wire staples, geotextile pins or wooden stakes (as described in BMP SS-7, "Geotextiles, Plastic Covers and Erosion Control Blankets/Mats").

Maintenance, Inspection, and Removals

- The key consideration in maintenance, inspection, and removal is that the straw needs to last long enough to achieve erosion control objectives.

- Reapplication of straw mulch and tackifier may be required by the Engineer to maintain effective soil stabilization over disturbed areas and slopes.

SYMBOL: ———————— ————SM————

STRAW MULCH SS-6:

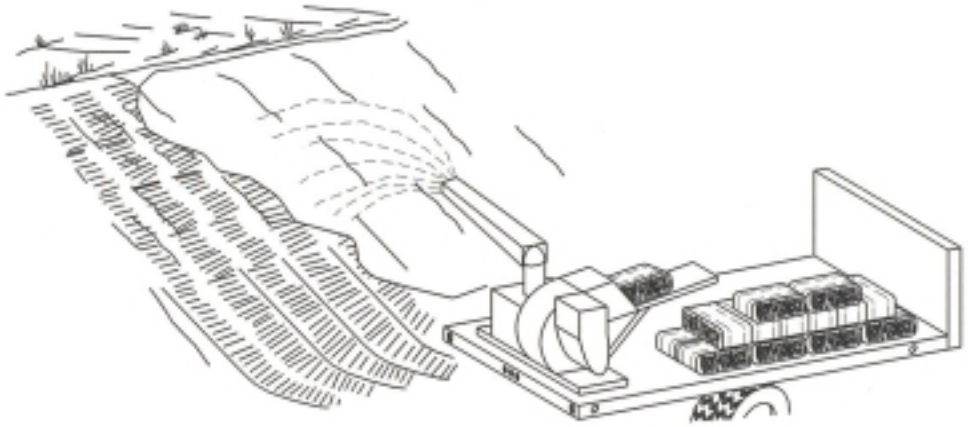
STRAW MULCH CONSISTS OF PLACING A UNIFORM LAYER OF STRAW AND ANCHORING IT INTO THE SOIL WITH A STUDDED ROLLER OR DISK OR BINDING THE STRAW TOGETHER WITH AN ENGINEER APPROVED TACKIFIER.

USE STRAW MULCH FOR SOIL STABILIZATION AS A TEMPORARY SURFACE COVER ON DISTURBED AREAS UNTIL SOILS CAN BE PREPARED OR RE-VEGETATION/PERMANENT VEGETATION IS ESTABLISHED. STRAW MULCH IS COMMONLY USED IN COMBINATION WITH TEMPORARY SEEDING, BMPs SS-4 & SS-15, AND/OR PERMANENT SEEDING TO ENHANCE PLANT ESTABLISHMENT.

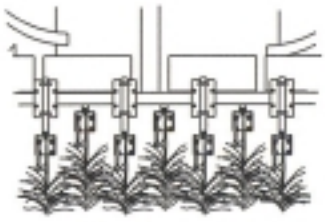
ALL STRAW MULCH IS REQUIRED TO BE CERTIFIED WEED FREE AND DERIVED FROM WHEAT, BARLEY OR RICE. ENGINEERS APPROVAL IS REQUIRED PRIOR TO ANY PLACEMENT OF STRAW MULCH.

STRAW MULCH CAN BE APPLIED BY HAND OR BLOWN UNDER LOW WIND CONDITIONS. OBTAIN ENGINEERS APPROVAL FOR PLACEMENT METHODS PRIOR TO PLACEMENT. EVENLY DISTRIBUTE STRAW MULCH AT A MINIMUM LOOSE RATE OF 4 490 kg/ha. IMMEDIATELY FOLLOWING PLACEMENT, CRIMP OR APPLY TACKIFIERS TO RETAIN MULCH. CRIMP USING DISKS OR A PUNCH-TYPE ROLLER. IF TACKIFIERS ARE USED, FOLLOW GUIDELINES PROVIDED IN BMP SS-5. WHEN EITHER TEMPORARY OR PERMANENT SEEDING IS COMBINED WITH THE STRAW MULCH BMP, COMPLETE SEEDING OPERATIONS PRIOR TO STRAW MULCH PLACEMENT. REFER TO BMPs SS-4 AND SS-15 FOR SEEDING GUIDELINES.

REAPPLICATION OF STRAW MULCH AND TACKIFIER MAY BE REQUIRED BY THE ENGINEER TO MAINTAIN EFFECTIVE SOIL STABILIZATION OVER DISTURBED AREAS AND SLOPES.



STRAW BLOWER

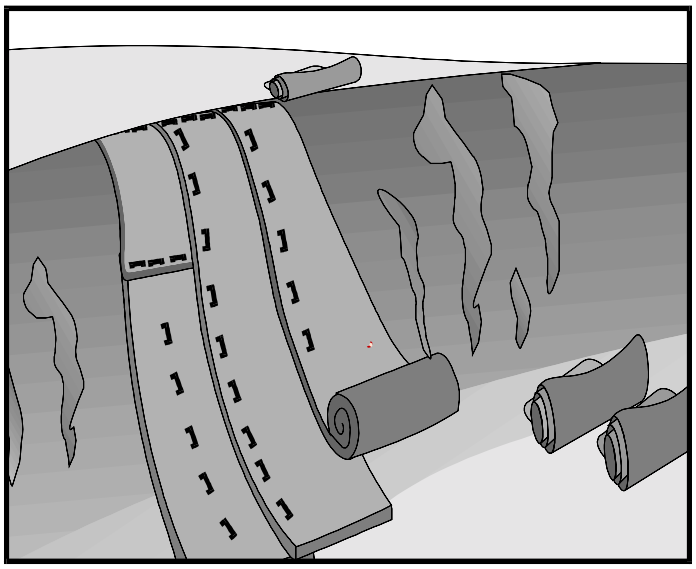


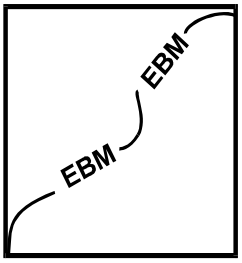
STRAW CRIMPING

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
STRAW MULCH (SS-6)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Geotextiles, Plastic Covers, and Erosion Control Blankets/Mats SS-7





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

This BMP involves the placement of geotextiles, plastic covers, or erosion control blankets/mats to stabilize disturbed soil areas and protect soils from erosion by wind or water.

Appropriate Applications

These measures are used when disturbed soils may be particularly difficult to stabilize, including the following situations:

- Steep slopes, generally steeper than 3:1.
- Slopes where the erosion hazard is high.
- Slopes and disturbed soils where mulch must be anchored.
- Disturbed areas where plants are slow to develop adequate protective cover.
- Channels with flows velocities exceeding 1.0 m/s (3 ft/s).
- Channels intended to be vegetated.
- Stockpiles.
- Slopes adjacent to water bodies.

Limitations

- Blankets and mats are more expensive than other erosion control measures, due to labor and material costs. This usually limits their application to areas inaccessible to hydraulic equipment, or where other measures are not applicable, such as channels.

- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).

- Blankets and mats must be removed and disposed of prior to application of permanent soil stabilization measures.

- Plastic sheeting is easily vandalized or torn. In addition plastic sheeting is susceptible to photodegradation and must be disposed of at a landfill.

- The use of plastic sheeting results in 100 percent runoff, which may cause serious erosion problems in the areas receiving the increased flow.

- The use of plastic shall be limited to covering stockpiles, or very small graded areas for short periods of time (such as through one damaging storm event), until alternative measures, such as seeding and mulching, may be installed.

Design Guidelines and Considerations

Material Selection

There are many types of erosion control blankets and mats, and selection of the appropriate type should be based on the specific type of application and site conditions. Selection(s) made by the Contractor must be approved by the Engineer prior to placement. The following criteria are helpful in the selection of the appropriate material:

- Cost
  - Material cost
  - Preparation cost
  - Installation cost
  - Add-ons
- Effectiveness
  - Reduction of erosion
  - Reduction of flow velocity
  - Reduction of runoff
- Acceptability
  - Environmental compatibility

- Institutional/regulatory acceptability
- Visual impact

- Vegetation Enhancement
  - Native plant compatibility
  - Moisture retention
  - Temperature modification
  - Open space/coverage

- Installation
  - Durability
  - Longevity
  - Ease of installation
  - Safety

- Operation and Maintenance
  - Maintenance frequency

Geotextiles

- Geotextile materials shall meet MDT Geosynthetics specifications.

- Geotextiles may be reused if, in the opinion of the Engineer, they are suitable for the use intended.

Plastic Covers

- Plastic cover material used for temporary soil stabilization shall be polyethylene sheeting and shall have a minimum thickness of 6 mils. Plastic covers shall be anchored by sandbags placed no more than 3 m (10 ft) apart and by keying into the tops of slopes to prevent infiltration of surface waters under the plastic. All seams shall be taped or weighted down their entire length, and there shall be at least a 300 mm to 600 mm (12 to 24 in) overlap of all seams.

- Plastic covers may be reused if, in the opinion of the Engineer, they are suitable for the use intended.

Erosion Control Blankets/Mats

- Erosion control blankets/mats shall meet MDT soil retention/erosion control blankets and mats specifications.

Geosynthetics Construction

- Follow MDT geosynthetics construction specifications, detail drawings, and the project special provisions.

Maintenance, Inspection, and Removal

- Areas treated with temporary soil stabilization shall be inspected and maintained to provide adequate erosion control. Temporary soil stabilization shall be reapplied or replaced on exposed soils when greater than 10 percent of the previously treated area becomes exposed or exhibits visible erosion.

- All blankets and mats shall be inspected periodically after installation.

- Installation shall be inspected after significant rainstorms to check for erosion and undermining. Any failures shall be repaired immediately.

- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.

- When no longer required for the work, temporary soil stabilization shall be properly disposed.

SYMBOL:

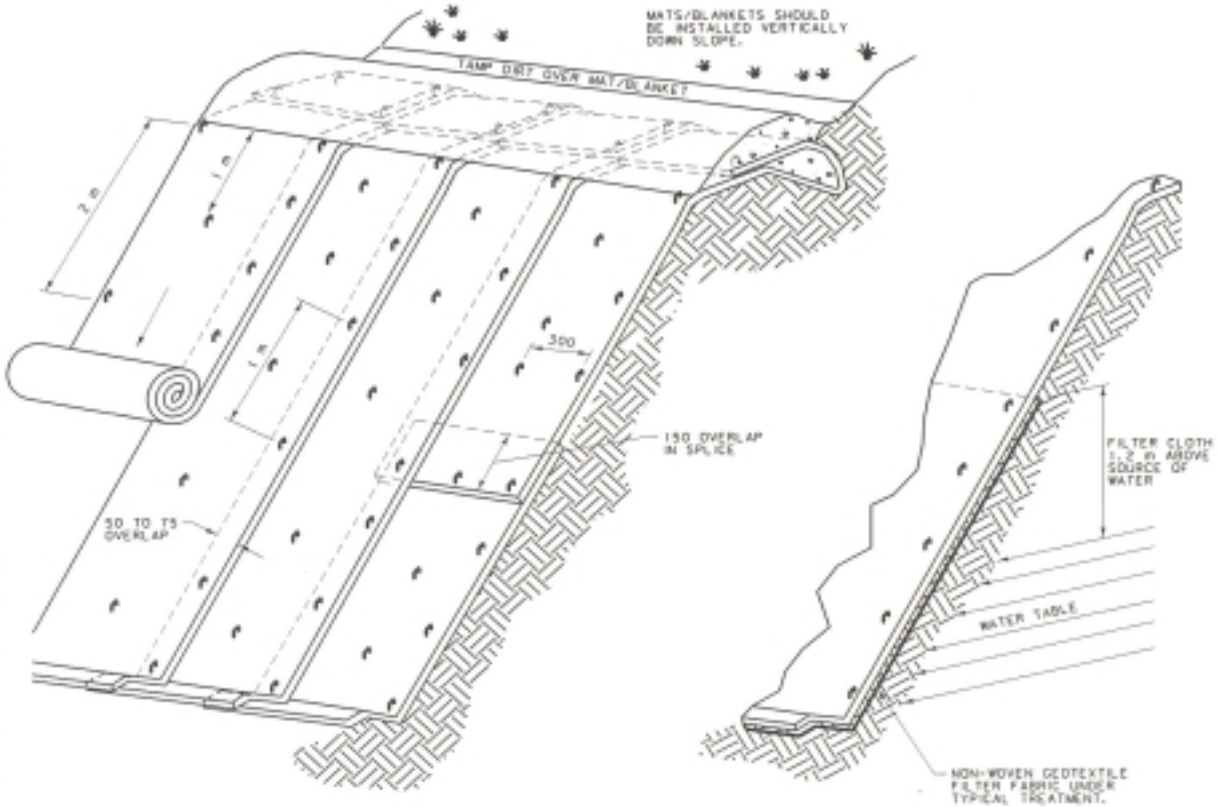
GEOTEXTILES, PLASTIC COVERS & EROSION CONTROL BLANKETS/MATS SS-7:

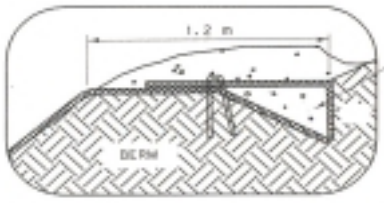
GEOTEXTILES, PLASTIC COVERS, AND EROSION CONTROL BLANKETS/MATS ARE USED TO STABILIZE DISTURBED SOIL AREAS AND PROTECT SOILS FROM EROSION BY WIND AND WATER. THESE PRODUCTS CAN BE USED ON STEEP SLOPES, SLOPES WITH HIGH EROSION HAZARDS, SLOPE WHERE MULCHES CAN NOT BE ANCHORED, UNPROTECTED CHANNELS AND HIGH FLOW CHANNELS.

INSTALL GEOTEXTILES AND EROSION CONTROL BLANKETS/MATS IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS AND MDT SECTION 622.

PROVIDE GEOTEXTILE MATERIALS MEETING MDT STANDARD SPECIFICATION T13.

LIMIT USE OF PLASTIC COVERS TO COVERING STOCKPILES, OR VERY SMALL GRADED AREAS FOR SHORT PERIODS OF TIME (SUCH AS THROUGH ONE IMMINENT STORM EVENT) UNTIL ALTERNATIVE MEASURES MAY BE INSTALLED. PLASTIC COVERS ARE REQUIRED TO BE POLYETHYLENE SHEETING HAVING A MINIMUM THICKNESS OF 6 mil. ANCHOR PLASTIC COVERS WITH SANDBAGS PLACED NO MORE THAN 3 m APART AND BY KEYING INTO THE TOP OF SLOPE TO PREVENT INFILTRATION OF SURFACE WATERS UNDER THE PLASTIC. TAPE OR WEIGHT DOWN THE ENTIRE LENGTH OF ALL SEAMS WITH AT LEAST 300 mm TO 600 mm OVERLAP.

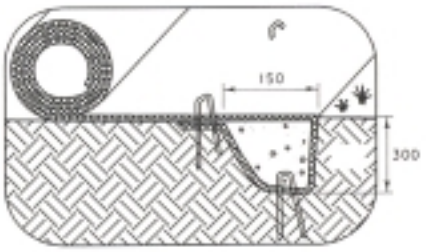




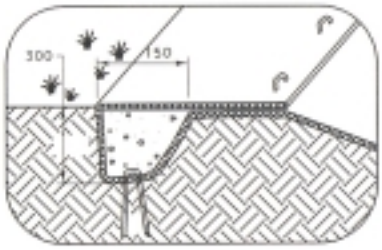
ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

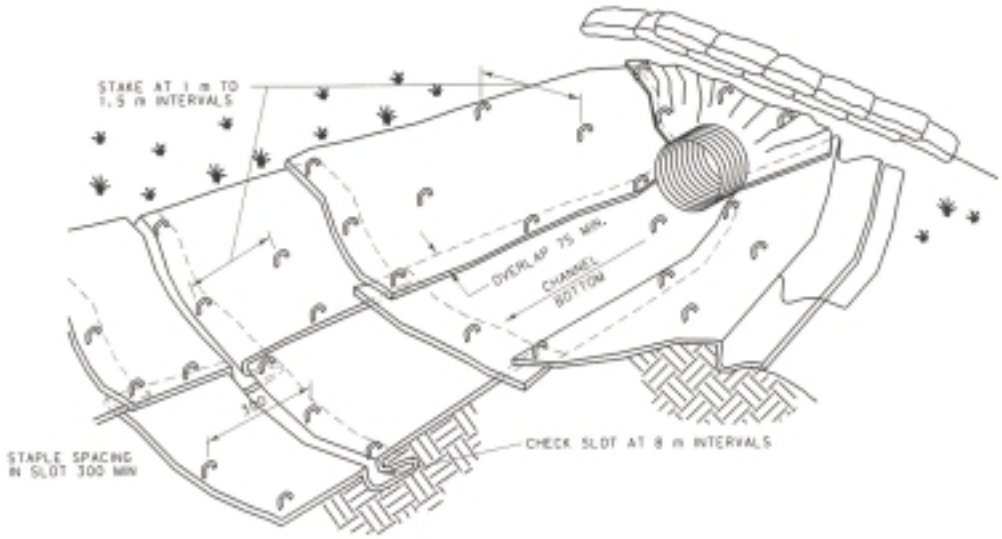
REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-30
GEOTEXTILES, PLASTIC COVERS & EROSION CONT. BLANKETS/ MATS (SS-7) (SHEET 1)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	



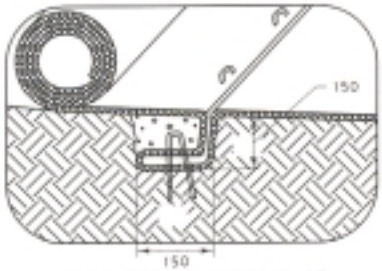
INITIAL CHANNEL ANCHOR TRENCH



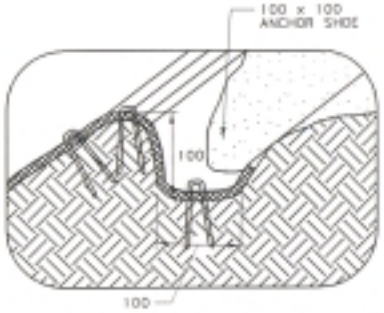
TERMINAL SLOPE & CHANNEL ANCHOR TRENCH



TYPICAL CHANNEL DETAIL - ISOMETRIC VIEW



INTERMITTENT CHECK SLOT



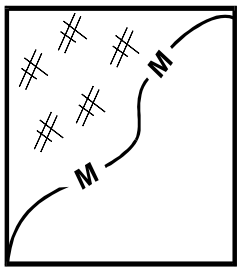
LONGITUDINAL ANCHOR TRENCH

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
GEOTEXTILES, PLASTIC COVERS & EROSION CONT. BLANKETS/ MATS (SS-T) (SHEET 2)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

Wood Mulching SS-8



BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Wood mulching consists of applying a mixture of shredded wood mulch, bark, or compost. Wood mulch is mostly applicable to landscape projects.

The primary function of wood mulching is to reduce erosion by protecting bare soil from rainfall impact, increasing infiltration, and reducing runoff.

Appropriate Applications

Wood mulching is considered a temporary soil stabilization alternative in the following situations:

- As a stand-alone temporary surface cover on disturbed areas until soils can be prepared for revegetation and permanent vegetative cover can be established.
- As short term, non-vegetative ground cover on slopes to reduce rainfall impact, decrease the velocity of sheet flow, settle out sediment, and reduce wind erosion.

Limitations

- Wood mulch may introduce unwanted plant species.
- Shredded wood does not withstand concentrated flows and is prone to sheet erosion.
- Green material has the potential for the presence of unwanted weeds and other plant materials.
- Delivery system is primarily by manual labor, although pneumatic application equipment is available.

Design Guidelines and Considerations

Mulch Selection

There are many types of mulches, and selection of the appropriate type shall be based on the type of application and site conditions. Engineers approval is required prior to use of wood mulches since some mulch use on construction projects may not be compatible with planned or future projects. Selection of wood mulches by the Contractor shall comply with MDT Standard Specifications and must be approved by the Engineer.

Application Procedures

After existing vegetation has been removed, roughen embankment and fill areas by rolling with a punching type roller or by track walking. Wood mulch can be applied once the surface has been prepared. The application procedures for wood mulches vary significantly depending upon the type of mulching method specified. Two (2) methods are highlighted here:

- Green Material: This type of mulch is produced by recycling of vegetation trimmings such as grass, shredded shrubs, and trees. Methods of application are generally by hand, although pneumatic methods are available. Mulch shall be composted to kill weed seeds.
  - It can be used as a temporary ground cover with or without seeding.
  - The green material shall be evenly distributed on site to a depth of 75 mm (3 in).
- Shredded Wood: Suitable for ground cover in ornamental or revegetated plantings.
  - Refer to limitations for conditions where shredded wood/bark is suitable.
  - Distribute wood/bark by hand, or approved pneumatic methods.
  - The mulch shall be evenly distributed across the soil surface to a depth of 75 mm (3 in).
- Avoid mulch placement onto the traveled way, sidewalks, lined drainage channels, sound walls, and existing vegetation.
- All material must be removed before resuming earthwork activities.

Maintenance, Inspection, and Removal

- Regardless of the mulching technique selected, the key consideration in maintenance and inspection is that the mulch needs to last long enough to achieve erosion-control objectives. If the mulch is applied as a stand-alone erosion control method over disturbed areas, it shall last the length of time the site will remain barren or until final re-grading and revegetation.
- When wood mulch is used as ornamental or landscaping application inspection and maintenance shall focus on longevity and integrity of the mulch.

SYMBOL: ——————— ———M———

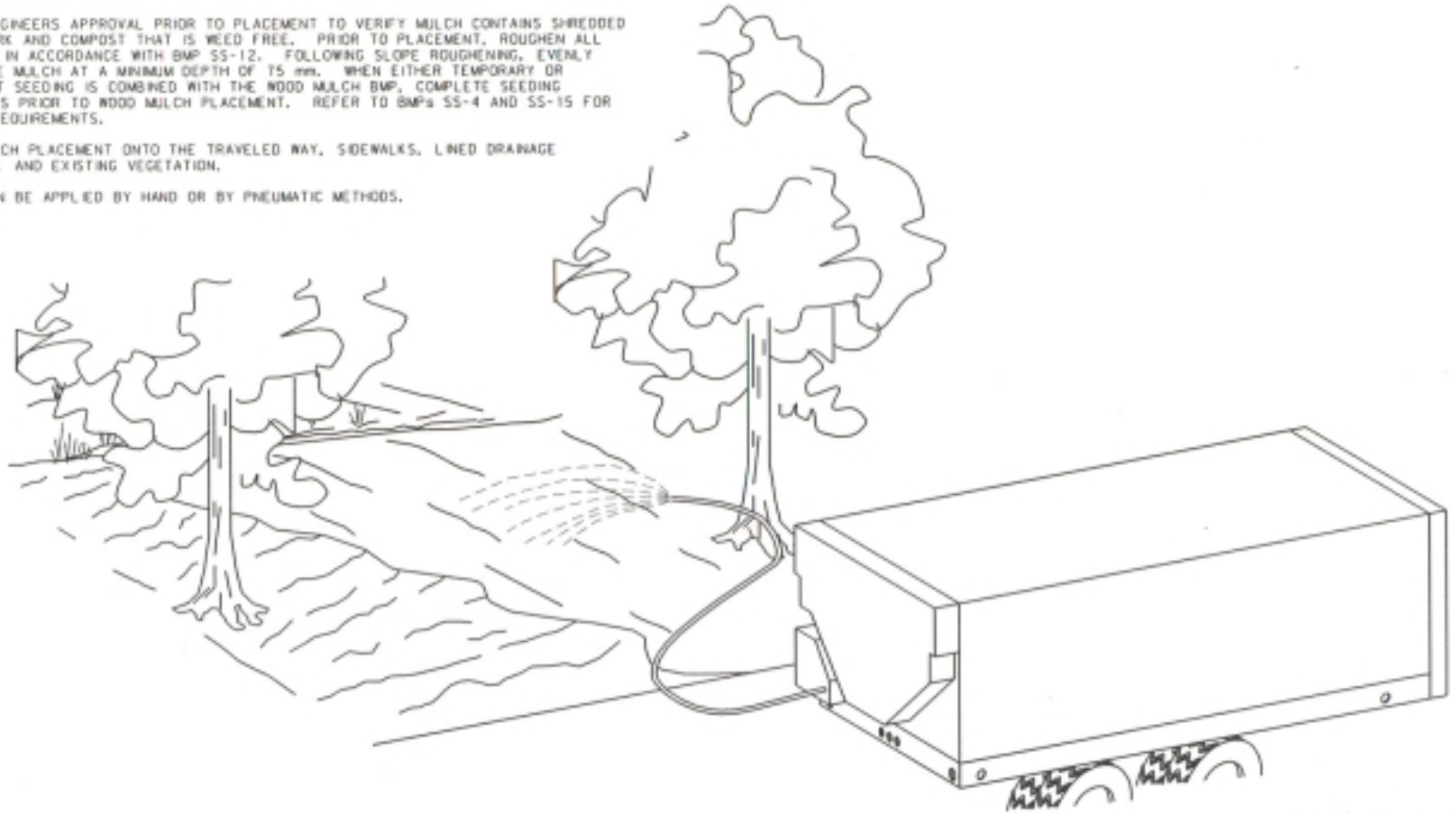
WOOD MULCH SS-8:

WOOD MULCHING CONSISTS OF APPLYING A MIXTURE OF SHREDDED WOOD MULCH, BARK, OR COMPOST. WOOD MULCH IS MOSTLY APPLICABLE TO LANDSCAPE PROJECTS. WOOD MULCHING REDUCES EROSION BY PROTECTING BARE SOIL RAINFALL IMPACT, INCREASING INFILTRATION, AND REDUCING RUNOFF. DO NOT USE WOOD MULCH WHERE CONCENTRATED RUNOFF FLOWS MAY EXIST.

OBTAIN ENGINEERS APPROVAL PRIOR TO PLACEMENT TO VERIFY MULCH CONTAINS SHREDDED WOOD, BARK AND COMPOST THAT IS WEED FREE. PRIOR TO PLACEMENT, ROUGHEN ALL SURFACES IN ACCORDANCE WITH BMP SS-12. FOLLOWING SLOPE ROUGHENING, EVENLY DISTRIBUTE MULCH AT A MINIMUM DEPTH OF 75 mm. WHEN EITHER TEMPORARY OR PERMANENT SEEDING IS COMBINED WITH THE WOOD MULCH BMP, COMPLETE SEEDING OPERATIONS PRIOR TO WOOD MULCH PLACEMENT. REFER TO BMPs SS-4 AND SS-15 FOR SEEDING REQUIREMENTS.

AVOID MULCH PLACEMENT ONTO THE TRAVELED WAY, SIDEWALKS, LINED DRAINAGE CHANNELS, AND EXISTING VEGETATION.

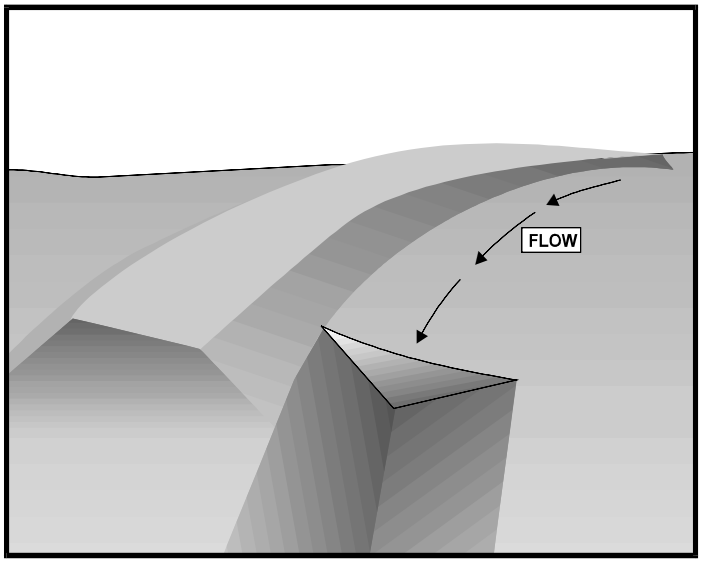
MULCH CAN BE APPLIED BY HAND OR BY PNEUMATIC METHODS.

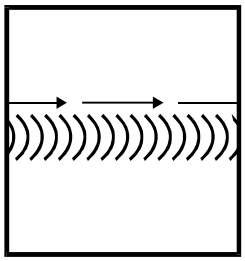


PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-22
WOOD MULCH (SS-8)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Earth Dikes/Drainage Swales and Lined Ditches SS-9





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Earth dikes/drainage swales and lined ditches are structures that intercept, divert and convey surface run-on, generally sheet flow, to prevent erosion.

Appropriate Applications

- Earth dikes/drainage swales and lined ditches may be used to:
  - Convey surface runoff down sloping land.
  - Intercept and divert runoff to avoid sheet flow over sloped surfaces.
  - Divert and direct runoff towards a stabilized watercourse, drainage pipe, or channel.
  - Intercept runoff from paved surfaces.
- Earth dikes/drainage swales and lined ditches also may be used:
  - Below steep grades where runoff begins to concentrate.
  - Along roadways and facility improvements subject to flood drainage.
  - At the top of slopes to divert run-on from adjacent or undisturbed slopes.
  - At bottom and mid-slope locations to intercept sheet flow and convey concentrated flows.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Earth dikes/drainage swales and lined ditches are not suitable as sediment trapping devices.
- May be necessary to use other soil stabilization and sediment controls, such as check dams, plastics, and blankets to prevent scour and erosion in newly graded dikes, swales, and ditches.

Design Guidelines and Considerations

- Care must be applied to correctly size and locate earth dikes, drainage swales, and lined ditches. Excessively steep, unlined dikes and swales are subject to erosion and gully formation.
- Use a lined ditch for high flow velocities.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff from the right-of-way onto other property.
- When possible, install and utilize dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Maintenance, Inspection, and Removals

- Inspect temporary measures prior to predicted storm events and as soon as possible after storm events, and regularly (approximately once per week) during the construction season.
- Inspect ditches and berms for washouts. Replace lost or damaged linings, or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment, and repair linings and embankments as needed or as directed by the Engineer.
- Temporary conveyances shall be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

SYMBOL: ——— CELL

EARTH DIKES/DRAINAGE SWALES & LINED DITCHES SS-9:

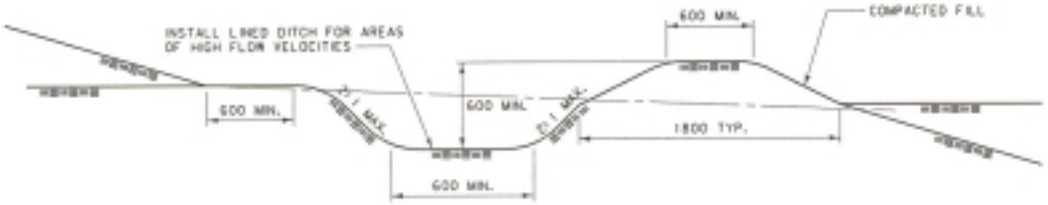
EARTH DIKES, DRAINAGE SWALES AND LINED DITCHES ARE STRUCTURES THAT INTERCEPT, DIVERT, AND CONVEY SURFACE RUN-ON, GENERALLY SHEET FLOW, TO PREVENT EROSION. THESE DEVICES MAY BE IMPLEMENTED ON A PROJECT-BY-PROJECT BASIS WITH OTHER BMPs WHEN DETERMINED NECESSARY AND FEASIBLE BY THE ENGINEER. DIKES, SWALES AND DITCHES ARE CONVEYANCE MEASURES AND ARE NOT INTENDED TO TRAP SEDIMENT. SEDIMENT CONTROL BMPs CAN BE USED IN CONJUNCTION WITH THESE CONVEYANCE DEVICES.

WHEN POSSIBLE, INSTALL AND UTILIZE DIKES, SWALES AND DITCHES EARLY IN THE CONSTRUCTION PHASE. CONSTRUCT SWALES ALONG THE TOP AND BOTTOM OF CUT AND FILL SLOPES, AS SPECIFIED IN THE PLANS OR AS DESIGNATED BY THE ENGINEER. "V" BOTTOM DITCHES CAN BE USED FOR SWALE CONSTRUCTION FOLLOWING ENGINEERS APPROVAL. USE SEDIMENT CONTROL DEVICES FOR RUNOFF THAT IS DIVERTED FROM DISTURBED AREAS. CONVEY FLOWS FROM UNDISTURBED AREAS INTO A STABILIZED AREA AT NON-EROSIVE VELOCITIES. DO NOT PLACE DIKES, SWALES, AND DITCHES IN A MANNER THAT ALLOWS HIGHWAY RUNOFF TO ENTER ONTO OTHER PROPERTY'S RIGHT-OF-WAY.

USE LINED DITCHES FOR AREAS OF HIGH FLOW VELOCITIES FOLLOWING THE GUIDELINES SPECIFIED IN SS-7 (GEOTEXTILES, PLASTIC COVERS & EROSION CONTROL BLANKETS/MATS) AND/OR SS-11 (SLOPE DRAINS). SEED ALL UNLINED PORTIONS OF DITCHES, DIKES AND SWALES THAT WILL BE IN USE FOR MORE THEN 14 DAYS IN ACCORDANCE WITH SS-15 (EROSION SEEDING).

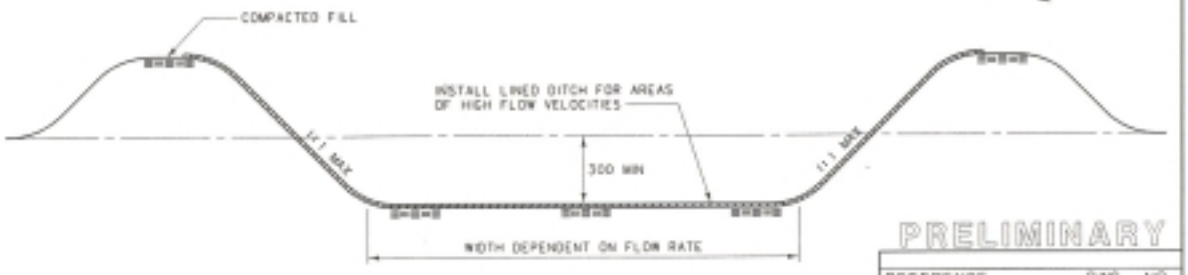
INSPECT DIKES, SWALES, AND DITCHES AFTER RAINFALL EVENTS. REMOVE DEBRIS AND SEDIMENT, AND REPAIR LININGS AND EMBANKMENTS AS NEEDED OR AS SPECIFIED BY THE ENGINEER.

REMOVAL ALL DIKES, SWALES AND LINED DITCHES FROM THE CLEAR ZONES EXPEDIENTLY UPON COMPLETION OF CONSTRUCTION ACTIVITIES.



TYPICAL DRAINAGE SWALE

TYPICAL EARTH DIKE



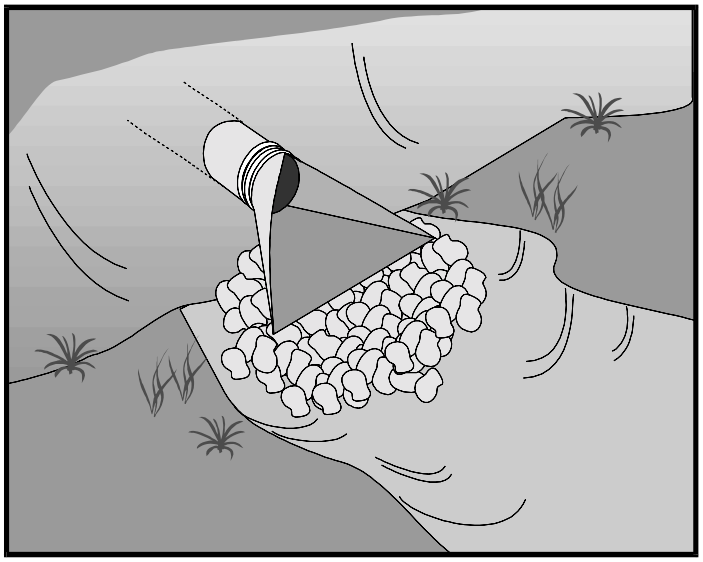
TYPICAL TRAPEZOIDAL DITCH

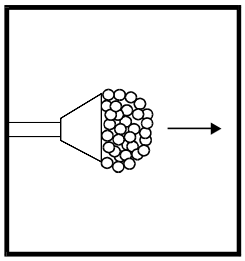
ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-??
EARTH DIKES/DRAINAGE SWALES & LINED DITCHES (SS-9)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Outlet Protection/Velocity Dissipation Devices SS-10





BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

These devices are temporarily placed at pipe outlets to prevent scour and reduce the velocity and/or energy of exiting storm water flows. The devices shall be used for temporary pipe placement and temporary stabilization until the final work is completed. MDT Hydraulics Section designs permanent outlet protection and velocity dissipation devices.

Appropriate Applications

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, or channels.
  - Outlets located at the bottom of mild to steep slopes.
  - Discharge outlets that carry continuous flows of water.
  - Outlets subject to short, intense flows of water, such as flash floods.
  - Points where lined conveyances discharge to unlined conveyances.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Loose rock may be washed away during high flows.
- Grouted riprap may break up in areas of freeze and thaw.

- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.

Design Guidelines and Considerations

- There are many types of energy dissipater's, with rock being the one that is represented in the attached Detail Drawings. This is only one example and the Engineer may approve any other type of device proposed by the Contractor.

- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction.

- Carefully place riprap to avoid damaging the filter fabric.

- For proper operation of apron:

    - Align apron with receiving stream such that a straight line is created. If a curve is needed to fit site conditions, place it in upper section of apron.

    - If size of apron riprap is large, protect underlying filter fabric with a gravel blanket.

- Outlets on slopes steeper than 10 percent shall have additional protection.

Maintenance, Inspection, and Removal

- Inspect temporary measures prior to predicted storm events, and as soon as possible after storm events, and regularly (approximately once per week) during the construction season.

- Inspect apron for displacement of dissipation devices and/or damage to the underlying fabric and repair as needed.

- Inspect for scour beneath the dissipation devices and around the outlet. Repair damage to slopes or underlying filter fabric immediately.

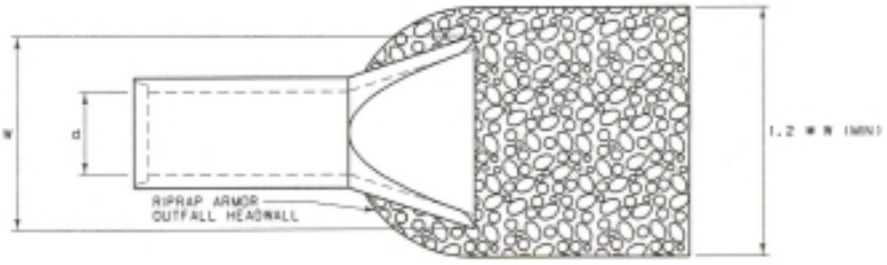
- Temporary devices shall be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

SYMBOL: CELL

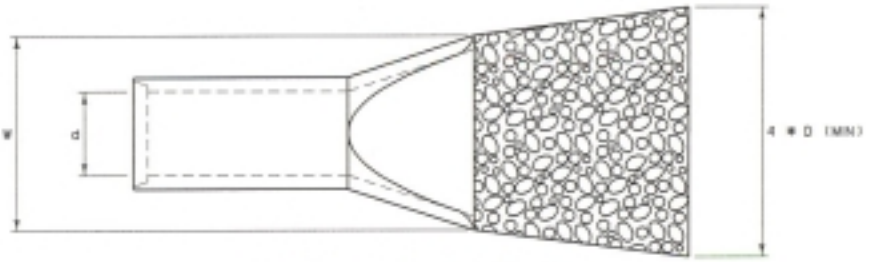
OUTLET PROTECTION/VELOCITY DISSIPATION DEVICES SS-10

OUTLET PROTECTION AND VELOCITY DISSIPATION DEVICES ARE PLACED AT PIPE OUTLETS TO PREVENT SCOUR AND REDUCE THE VELOCITY AND/OR ENERGY OF EXITING STORM WATER FLOWS. THESE DEVICES CAN BE USED AT THE OUTLETS OF PIPES, DRAINS, CULVERTS, SLOPE DRAINS, DIVERSION DITCHES, SWALES, CONDUITS OR CHANNELS AND SHOULD BE IMPLEMENTED ON A PROJECT-BY-PROJECT BASIS WITH OTHER BMPs WHEN DETERMINED NECESSARY BY THE ENGINEER.

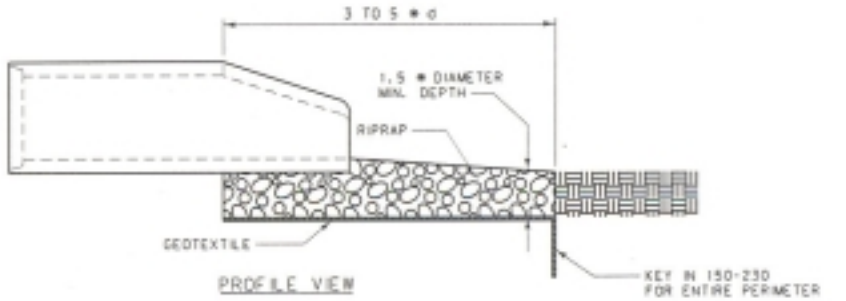
FOLLOW GUIDELINES BELOW FOR SIZING OUTLET PROTECTION AND VELOCITY DISSIPATION DEVICES. FOLLOWING ENGINEER'S APPROVAL, OTHER MATERIALS MAY BE SUBSTITUTED FOR RIPRAP. GEOTEXTILE PLACEMENT MAY BE ELIMINATED FOLLOWING ENGINEERS APPROVAL. PLACE TYPE I OR TYPE 2 BANK PROTECTION AT PIPE OUTLET. FOR PIPE DIAMETERS LARGER THAN 600 mm AND/OR HIGH FLOWS, THE APPLICATION IS NOT CONSIDERED TEMPORARY AND A MONTANA REGISTERED ENGINEER'S DESIGN IS REQUIRED.



PLAN VIEW - CHANNELIZED FLOW
(OUTFALL TO CHANNEL OR DITCH)



PLAN VIEW - UNCHANNELIZED FLOW
(OUTFALL TO UNCONFINED SURFACE-OVERLAND FLOW)



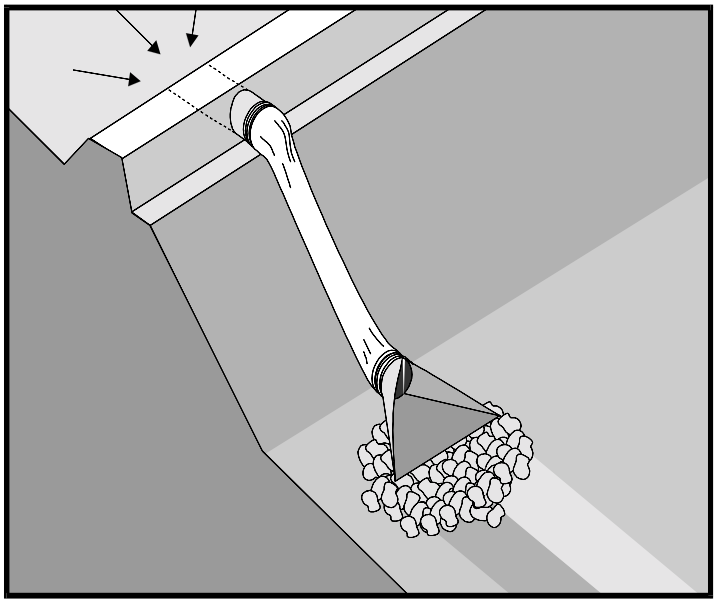
PROFILE VIEW

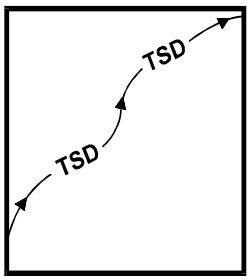
PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
OUTLET PROTECTION/VELOCITY DISSIPATION DEVICES (SS-10)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

Slope Drains SS-11





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A slope drain is a temporary pipe used to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device or stabilized area. Slope drains are often used with lined ditches to intercept and direct surface flow away from slope areas to protect cut or fill slopes.

Appropriate Applications

- Slope drains may be used at construction sites where slopes may be eroded by surface runoff.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Severe erosion may result when slope drains fail by over topping, piping, or pipe separation.

Design Guidelines and Considerations

- When using slope drains, limit drainage area to 4 ha (10 acre) per pipe. For larger areas, use a rock-lined channel or a series of pipes.
- Maximum slopes are generally limited to 2:1 as energy dissipation below steeper slopes is difficult.
- Direct surface runoff to and from slope drains with interceptor dikes. See BMP SS-8, "Earth Dikes/Drainage Swales, and Lined Ditches."
- Slope drains can be placed above or buried underneath the slope surface.

- Slope drain materials, including pipes, riprap, synthetic liners, and concrete, need to comply with MDT Standard Specifications or project special conditions.

- When installing slope drains:

  - Install slope drains perpendicular to slope contours.

  - Compact soil around and under entrance, outlet, and along length of pipe.

  - Securely anchor and stabilize pipe and appurtenances into soil.

  - Check to ensure that pipe connections are watertight.

  - Protect area around inlet with geosynthetic liner meeting MDT Standard Specifications. Protect outlet with riprap or other energy dissipation device. For high-energy discharges, reinforce riprap with concrete or use reinforced concrete device.

  - Protect inlet and outlet of slope drains: use standard flared end sections at entrances and exists for pipes 300 mm (12 in) and larger in diameter.

Maintenance, Inspection, and Removal

- Inspect before and after each rainstorm, and weekly until the tributary drainage area has been stabilized. Follow routine inspection procedures for inlets thereafter.

- Inspect outlet for erosion and downstream scour. If eroded, repair damage and install additional energy dissipation measures. If downstream scour is occurring, it may be necessary to reduce flows being discharged into the channel unless other preventative measures are implemented.

- Inspect slope drainage for accumulations of debris and sediment.

- Remove built-up sediment from entrances and outlets as required. Flush drains if necessary; capture and settle out sediment from discharge.

- Make sure water is not ponding onto inappropriate areas (e.g., active traffic lanes, material storage areas, etc.).

- Remove temporary slope drains when permament drains are completed.

SYMBOL: ——————— ———TSD———

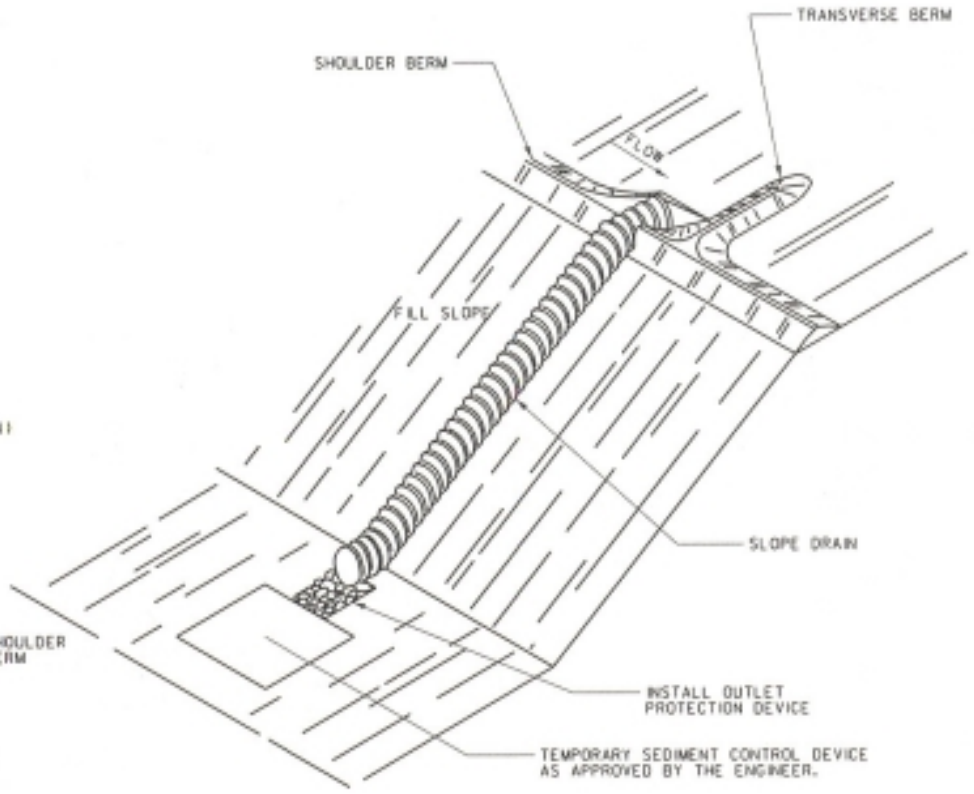
SLOPE DRAINS SS-11

A SLOPE DRAIN IS A PIPE OR LINED CHANNEL USED TO INTERCEPT AND CONVEY SURFACE RUNOFF OR GROUNDWATER INTO A STABILIZED WATERCOURSE, TRAPPING DEVICE, OR STABILIZED AREA. THIS DEVICE MAY BE USED AT CONSTRUCTION SITES WHERE SLOPES MAY BE ERODED BY SURFACE RUNOFF.

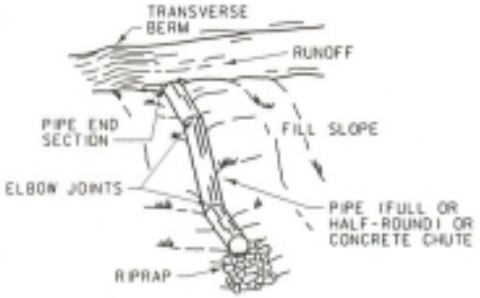
DO NOT EXCEED A DRAINAGE AREA OF 4 ha PER SLOPE DRAIN PIPE. FOR AREAS LARGER THAN 4 ha USE ROCK LINED CHANNELS. DO NOT PLACE SLOPE DRAINS ON SLOPES THAT EXCEED 2:1 SLOPES. INCORPORATE BMP SS-9 (EARTH DIKES/DRAINAGE SWALES & LINED DITCHES) TO AID IN FLOW DIVERSION.

INSTALL SLOPE DRAINS AS FOLLOWS:
- INSTALL DRAINS PERPENDICULAR TO SLOPE
- COMPACT SOIL AROUND INLET, OUTLET AND LENGTH OF STRUCTURE
- SECURELY ANCHOR SLOPE DRAINS INTO SOIL
- ENSURE CONNECTIONS ARE WATER TIGHT
- PROTECT INLET AND OUTLET WITH BMP SS-10 (OUTLET PROTECTION & VELOCITY DISSIPATION)

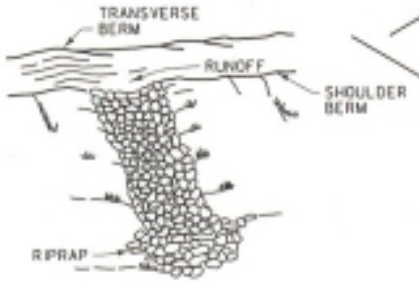
ALL MATERIALS REQUIRE ENGINEER'S APPROVAL PRIOR TO PLACEMENT.



PIPE SLOPE DRAIN

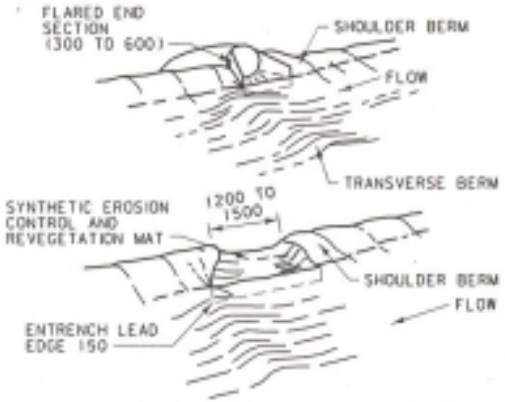


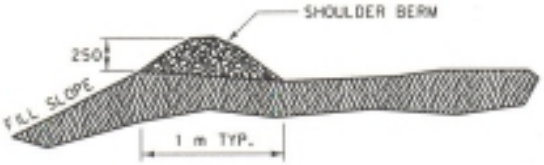
RIPRAP SLOPE DRAIN



DITCH LINER: SYNTHETIC EROSION CONTROL AND REVEGETATION MAT

SLOPE DRAIN INLETS





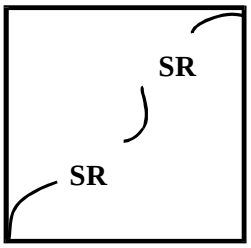
ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-72
SLOPE DRAINS (SS-11)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Slope Roughening SS-12



BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Soil roughening is a temporary erosion control practice often used in conjunction with grading. Soil roughening involves increasing the relief of a bare soil surface with horizontal grooves or tracking using construction equipment. Slopes that are not fine graded and that are left in a roughened condition can also reduce erosion. Soil roughening reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares the soil for seeding and planting.

Appropriate Applications

Soil roughening works well on slopes steeper than 3:1, on piles of excavated soil, and in areas with highly erodible soils. This technique is especially appropriate for soils that are frequently moved or disturbed because roughening is relatively easy to accomplish. To slow erosion, roughening should be done as soon as possible after the vegetation has been removed. Roughening can be used with both seeding and temporary mulching to stabilize an area. For steeper slopes and slopes that will be left roughened for longer periods of time, a combination of surface roughening and vegetation is appropriate. Roughening should be performed immediately after grading activities have ceased (temporarily or permanently) in an area.

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 shall be re-roughened.

Design Guidelines and Considerations

Graded areas with smooth, hard surfaces increase erosion potential by decreasing the amount of storm water infiltration. A rough soil surface allows surface ponding and slows storm water velocities. Grooves in the soil are cooler and provide more favorable moisture conditions than hard, smooth surfaces. These conditions promote seed germination and vegetative growth. It is important to avoid excessive compacting of the soil surface, especially when tracking,

because soil compaction inhibits vegetation growth and causes higher runoff velocity. Therefore, it is best to limit roughening with tracked machinery to sandy soils that do not compact easily and to avoid tracking on heavy clay soils, particularly when wet. Bare soil areas should be seeded immediately following slope roughening. Proper dust control procedures also should be followed when soil roughening.

There are different methods for achieving a roughened soil surface on a slope. The selection of an appropriate method depends on the type of slope and the available equipment. Roughening methods include grooving and tracking. Factors to consider when choosing a method are slope steepness, mowing requirements, whether the slope is formed by cutting or filling, and available equipment. The following methods can be used for surface roughening.

Grooving. This technique uses machinery to create a series of ridges and depressions that run across the slope along the contour. Grooves should be made using an appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth on a front-end loader bucket. The grooves should be made more than 75 mm (3 in) deep and less than 380 mm (15 in) apart.

Tracked. Roughening with tracked machinery should be limited to sandy soils to avoid undue compaction of the soil surface. Tracked machinery should be operated perpendicular to the slope to leave horizontal depressions in the soil. Tracking is generally not as effective as other roughening methods.

Fill slope roughening for areas that will not be mowed. Fill slopes with a gradient steeper than 3:1 should be placed in lifts and compacted per MDT Standard Specifications. To obtain a roughened slope, the face of the slope should consist of loose, non-compacted, 100-150 mm lifts (4 in- 6 in). Grooving or tracking should be used to roughen the face of the slopes. The final slope face should not be bladed or scraped.

Cuts, fills, and graded areas that will be mowed. Mowed slopes should be made no steeper than 3:1. These areas should be roughened with shallow grooves less than 25 mm (1 in) deep and more than 250 mm (10 in) apart using normal tilling, disking, or harrowing equipment (a cultipacker-seeder can also be used). Excessive roughness is undesirable where mowing is planned.

Maintenance, Inspection, and Removal

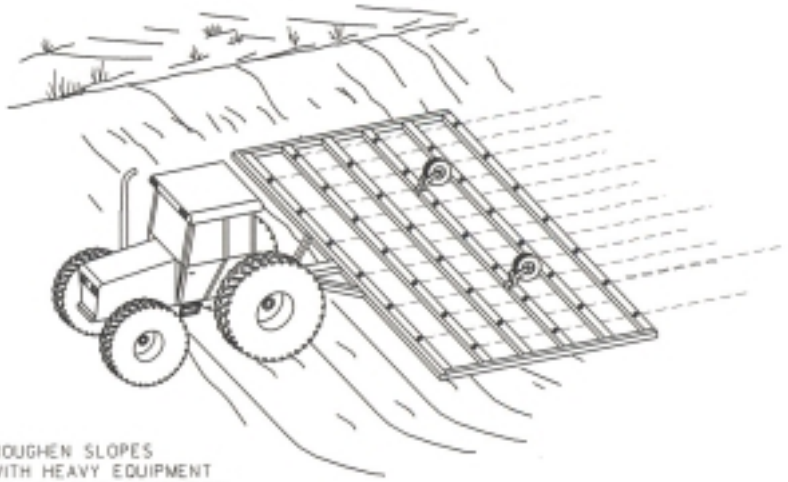
Areas need to be inspected after storms, since roughening might need to be repeated. Weekly inspection of roughened slopes will indicate where additional erosion and sediment control measures are needed. If rills appear, they should be filled, graded again, and reseeded immediately. Proper dust control methods should be used.

SYMBOL:

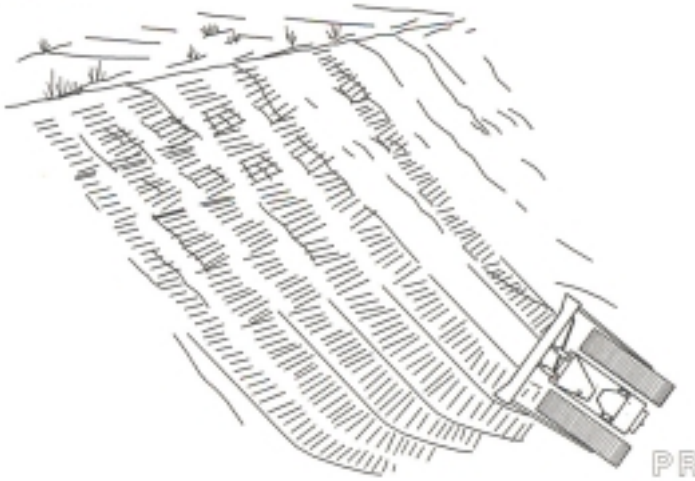
SLOPE ROUGHENING SS-12:

SLOPE ROUGHENING IS A VERY ROUGH SOIL SURFACE ON SLOPES RESULTING FROM CONSTRUCTION ACTIVITIES OR THE SYSTEMATIC ROUGHENING USING HEAVY EQUIPMENT TO CREATE RIDGES OR FURROWS PERPENDICULAR TO THE SLOPE. THE RIDGES OR FURROWS ARE TO BE EQUAL TO OR GREATER THAN 50 mm IN HEIGHT AND NO FURTHER THAN TWICE THE HEIGHT OF THE RIDGE OR FURROW APART. SLOPE ROUGHENING IS A GOOD FIRST LINE OF DEFENSE TO CONTROL EROSION AND SEDIMENT RUNOFF. DEGREE OF SLOPE ROUGHENING IS DEPENDENT ON THE GRADES AND PROXIMITY TO WATER RESOURCES.

ALL SLOPES STEEPER THAN 3:1 AND GREATER THAN 1500 VERTICAL MILLIMETERS REQUIRE SLOPE ROUGHENING. EXCLUDING ROCK SLOPES THAT CANNOT BE EXCAVATED BY RIPPING. ROUGHEN DISTURBED SLOPES OR LEAVE IN A ROUGHENED CONDITION. APPROPRIATE SUPPLEMENTS INCLUDE SOIL STABILIZATION BMPs SUCH AS TEMPORARY SEEDING OR EROSION SEEDING. WHEN FILL SLOPES ARE WITHIN 15 m OF SURFACE WATER, EARTH DIKES/DRAINAGE SWALES & LINED DITCHES (SS-9) AND/OR A SEDIMENT CONTROL BMP ARE REQUIRED.



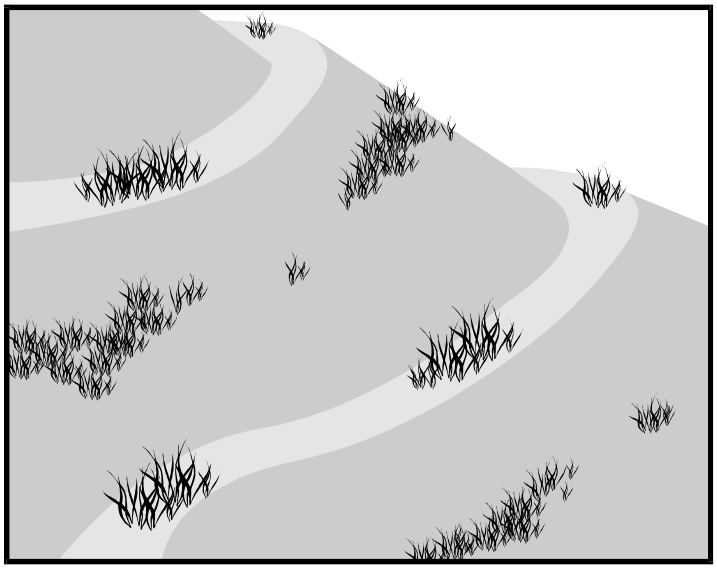
ROUGHEN SLOPES
WITH HEAVY EQUIPMENT
OR LEAVE IN ROUGHENED
CONDITION

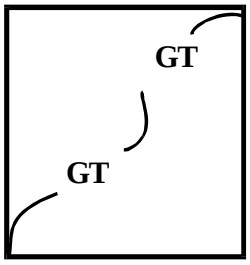


PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-27
SLOPE ROUGHENING (SS-12)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Gradient Terraces SS-13





BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Gradient terraces are made of either earthen embankments or ridge and channel systems. They reduce damage from erosion by collecting and redistributing surface runoff to stable outlets at slower speeds and by increasing the distance of overland runoff flow. They also surpass smooth slopes in holding moisture and help to minimize sediment loading of surface runoff.

Appropriate Applications

Gradient terraces are most suitable for un-vegetative slopes that have existing or expected water erosion problem and they are only effective when there are suitable runoff outlets provided. They are usually limited to use on long, steep slopes.

Limitations

Gradient terraces are not appropriate for use on sandy, or shallow soils. Sloughing could occur if too much water permeates the soil in a terrace system and cut and fill costs could increase substantially. Terraces should not be constructed on slopes containing rocky or sandy soil.

Design Guidelines and Considerations

Gradient terraces should be designed with adequate and appropriate outlets and should be installed according to a well-developed plan. Acceptable outlets include grassed waterways, vegetated areas, or tile outlets. Any outlet that is used should be able to redirect surface runoff away from the terraces and toward an area that is not susceptible to erosion or other damage.

Design considerations include:

- Whenever possible, vegetative cover should be used in the outlet.
- The terrace's water surface design elevation should be no lower than the outlet's water surface design elevation when both are performing at design flow.

- During construction of the terrace system, dust control procedures should be followed.
- Proper vegetation/stabilization practices should be followed while constructing these graded terraces.

Maintenance, Inspection, and Removal

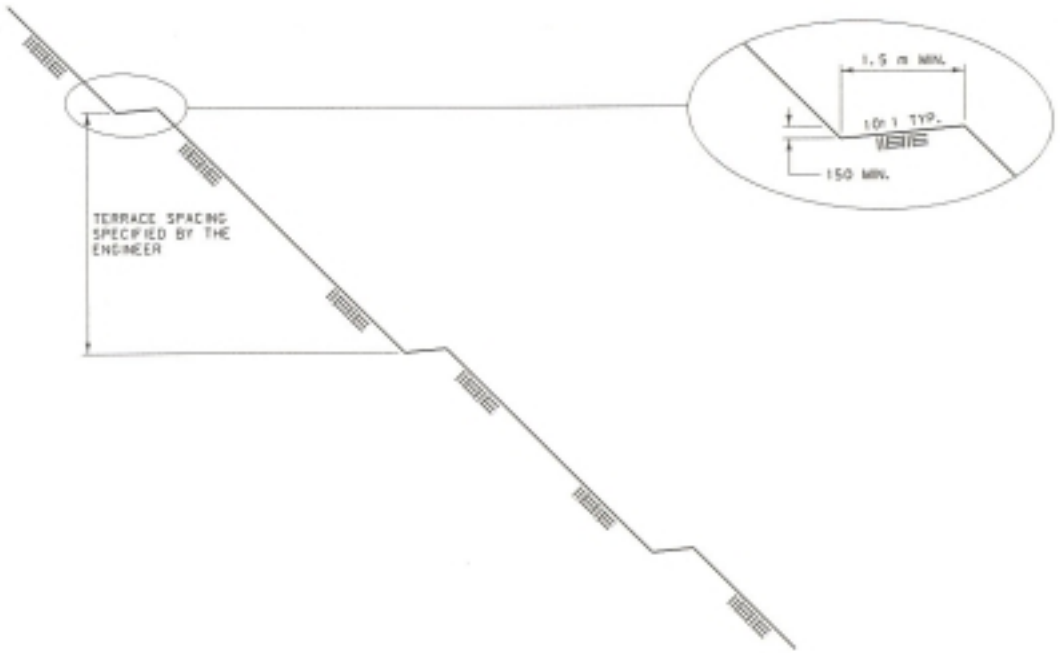
- Regular inspections of the terraces should occur after any major storms and during the weekly BMP inspections to ensure that the terraces are structurally sound and have not been subject to erosion.

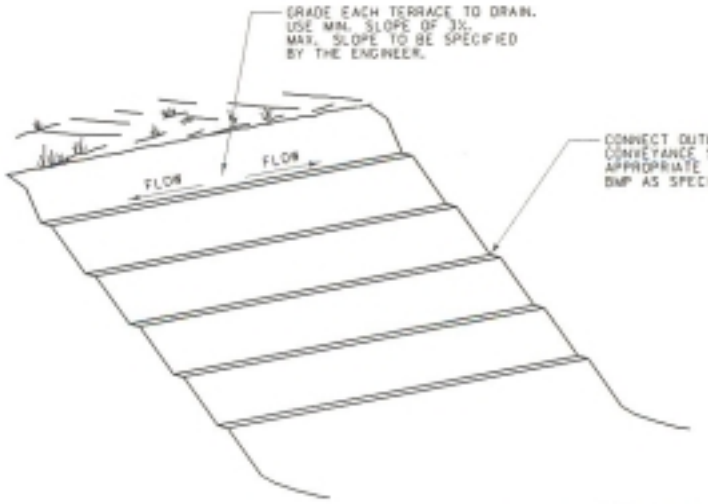
SYMBOL: ———————— ———TS———

TERRACED SLOPES SS-13:

TERRACED SLOPES ARE MADE OF EITHER EARTHEN EMBANKMENTS OR RIDGE AND CHANNEL SYSTEMS THAT ARE PROPORTIONALLY SPACED AND ARE CONSTRUCTED WITH AN ADEQUATE GRADE. TERRACES REDUCE DAMAGE FROM EROSION BY COLLECTING AND REDISTRIBUTING SURFACE RUNOFF TO STABLE OUTLETS AT SLOWER VELOCITIES AND BY INCREASING THE DISTANCE OF OVERLAND RUNOFF FLOW. THIS BMP IS USUALLY LIMITED TO USE ON LONG STEEP SLOPES WITH A WATER EROSION PROBLEM, OR WHERE IT IS ANTICIPATED THAT WATER EROSION WILL BE A PROBLEM. TERRACED SLOPES ARE NOT APPROPRIATE FOR USE ON SANDY, STONY, OR SHALLOW SOILS.

DESIGN TERRACED SLOPES WITH ADEQUATE AND APPROPRIATE OUTLETS. ENGINEER'S APPROVAL IS REQUIRED PRIOR TO MODIFICATIONS OF SPECIFIED TERRACED SLOPES.



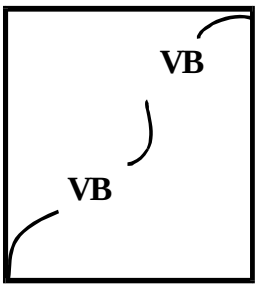


ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
TERRACED SLOPES (SS-13)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Vegetated Buffer SS-14



BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Vegetated buffers are areas of either natural or established vegetation that are maintained to protect the water quality of neighboring areas. Buffer zones 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.

Appropriate Applications

Vegetated buffers can be used in most areas that are able to support vegetation, but they are most effective and beneficial on floodplains, near wetlands, along stream banks, and on steep, unstable slopes. They are also effective in separating land use areas that are not compatible and protecting wetlands or water bodies from construction activities that might be potential sources of non-point source pollution.

Limitations

Vegetated buffers require plant growth before they can be effective, and land on which to plant the vegetation must be available. If the cost of the land is very high, buffer zones might not be cost-effective. Although vegetated buffers help to protect water quality, they usually do not effectively counteract concentrated storm water flows to neighboring or downstream wetlands. Vegetative buffer zones require additional sediment control BMPs when slopes have significant lengths or steepness.

Design Guidelines and Considerations

To establish an effective vegetative buffer, the following guidelines should be followed:

- ■ Soils should not be compacted.

- Slopes should be less than 20:1.
- Buffer widths should be determined 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 slope increases.
- Zones of vegetation including grasses, deciduous and evergreen shrubs, and understory and overstory trees, should be intermixed.
- In areas where flows are concentrated and velocities are high, buffer zones should be combined with other structural or nonstructural BMPs as a pretreatment.

Maintenance, Inspection, and Removal

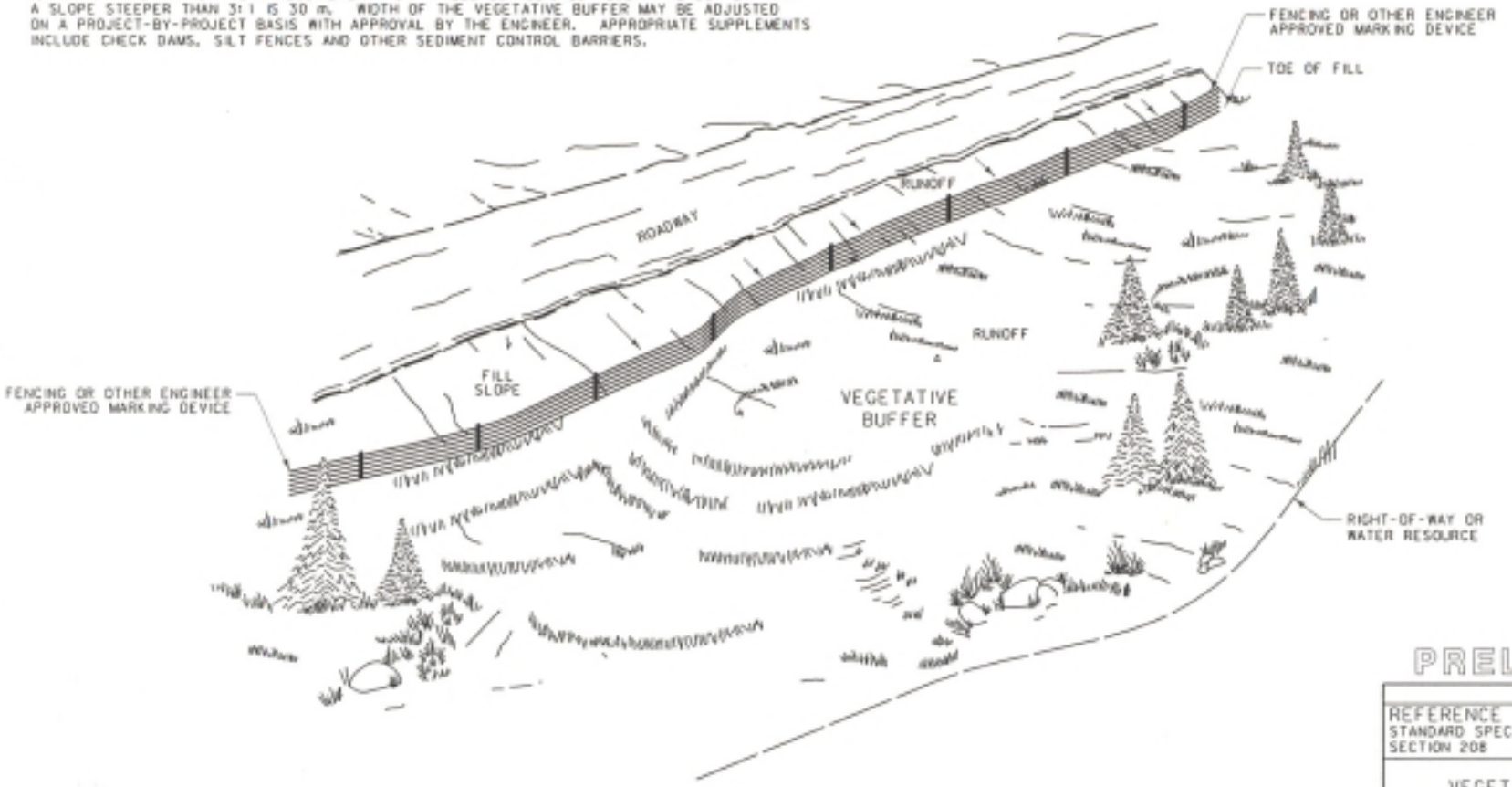
- Keeping vegetation healthy in vegetated buffers requires routine maintenance, which can include weed and pest control, mowing, fertilizing, liming, irrigating, and pruning. Inspection and maintenance are most important when buffer areas are first installed. Once established, vegetated buffers do not require much maintenance beyond the routine procedures listed earlier and periodic inspections of the areas, especially after any heavy rainfall and at least once a year. Inspections should focus on encroachment, gully erosion, density of vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. Remove any sediment that has encroached onto the vegetative buffer and has a depth greater than 150 mm (6 in).

SYMBOL: ———————— ————VB————

VEGETATIVE BUFFER SS-14:

VEGETATIVE BUFFER IS AN UNDISTURBED AREA OR STRIP OF ESTABLISHED VEGETATION. A VEGETATIVE BUFFER PROVIDES A LIVING SEDIMENT FILTER TO REDUCE RUNOFF VELOCITIES AND ALLOW CAPTURE AND SETTLING OF COARSE-GRAINED SEDIMENT. VEGETATIVE BUFFERS REDUCE OR PREVENT SEDIMENTATION FROM LEAVING THE RIGHT-OF-WAY.

IDENTIFY EXISTING VEGETATIVE BUFFERS BEFORE CONSTRUCTION OCCURS AND MARK AREA PER SS-2 (PRESERVATION OF EXISTING VEGETATION) OR WITH SC-1 (SILT FENCE). ESTABLISHED VEGETATIVE BUFFERS SHOULD INCLUDE GRASSES AND SHRUBS. IRRIGATION, FERTILIZATION AND WEED AND PEST CONTROL MAY BE REQUIRED IN ORDER TO ESTABLISH AND MAINTAIN AN EFFECTIVE VEGETATIVE BUFFER. KEEP EQUIPMENT AND FILL MATERIAL OFF OF VEGETATIVE BUFFERS. ALWAYS CONSIDER VEGETATIVE BUFFER BUFFERS WHEN WATER RESOURCES ARE ADJACENT TO OR NEAR DISTURBANCES AND REQUIRE PROTECTION. THE MINIMUM WIDTH REQUIREMENT FOR A WELL-ESTABLISHED VEGETATIVE BUFFER WITH A SLOPE OF 3:1 OR FLATTER IS 15 m. THE MINIMUM WIDTH REQUIREMENT FOR A WELL-ESTABLISHED VEGETATIVE BUFFER WITH A SLOPE STEEPER THAN 3:1 IS 30 m. WIDTH OF THE VEGETATIVE BUFFER MAY BE ADJUSTED ON A PROJECT-BY-PROJECT BASIS WITH APPROVAL BY THE ENGINEER. APPROPRIATE SUPPLEMENTS INCLUDE CHECK DAMS, SILT FENCES AND OTHER SEDIMENT CONTROL BARRIERS.

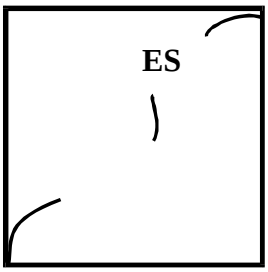


PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
VEGETATED BUFFER (SS-14)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Erosion Seeding SS-15



BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Well-established vegetative cover is one of the best erosion control measures available. Erosion seeding is the immediate seeding of freshly exposed slopes. Use erosion seeding on cut and fill slopes steeper than 3:1 that will not undergo further disturbance. Erosion seeding is not the same as temporary seeding. Temporary seeding (as shown in SS-4) is the establishment of a temporary vegetative cover on areas with a slope of 3:1 or flatter that will be exposed for longer than 14 days and that will undergo further disturbance. Erosion seeding uses a mixture of seed.

Appropriate Applications

Erosion seeding is used on freshly exposed slopes requiring temporary protection until permanent vegetation is established. Erosion seeding provides erosion protection on disturbed areas and traps sediments, promotes infiltration, and improves the appearance of the site. Erosion seeding is a relatively inexpensive erosion control measure.

Limitations

- Rock slopes that cannot be excavated by ripping are not seeded.
- Erosion seeding may not be appropriate in dry areas or periods without supplemental irrigation.
- Erosion seeding vegetation may have to be removed before permanent vegetation is applied.

Design Guidelines and Considerations

- The erosion seed mix and rate of application are found in the MDT Erosion Seeding (SS-15) Detail Drawing.

- Freshly exposed slopes are to be seeded daily, regardless of the time of year.
- Accomplish seeding by manual broadcasting with a shoulder-harnessed spreader seeder or its equivalent.
- Store the recommended mix on-site prior to initiation of slope excavation.
- If one or more species is unavailable, contact the MDT Agronomist, through the Engineer, for the substitute. Substitutions shall be approved in writing by the Engineer during the construction phase.
- The following considerations should be addressed if a hydroseeder is approved by the MDT Agronomist, through the Engineer, instead of manual broadcasting with a shoulder-harnessed spreader:
  - Hydroseeding typically consists of applying a mixture of fiber, seed, fertilizer, and stabilizing emulsion with hydro-mulch equipment, which temporarily protects exposed soils from erosion by water and wind. In order to select appropriate hydroseeding mixtures, an evaluation of site conditions shall be performed with respect to soil conditions, maintenance requirements, site topography, sensitive adjacent areas, season and climate, water availability, vegetation types, and plans for permanent vegetation.
  - Selection of hydroseeding mixtures shall be approved through the Engineer by the MDT Agronomist.
  - The following steps shall be followed for implementation:
  - Seed mix shall comply with MDT Erosion Seeding (SS-15) Detail Drawing and the project's special provisions.
  - Hydroseeding can be accomplished using a multiple-step or one-step process. The multiple-step process ensures maximum direct contact of the seeds to soil. When the one-step process is used to apply the mixture of fiber, seed, etc., the seed rate shall be increased to compensate for all seeds not having direct contact with the soil.
  - Each seed bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. The container shall be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. All legume seed shall be pellet-inoculated. Inoculant sources shall be species specific and shall be applied at a rate of 2 kg (4.5 lbs) of inoculant per 100 kg (220 lbs) of seed.
  - Follow-up applications shall be made as needed to cover weak spots and to maintain adequate soil protection.
  - Avoid over-spray onto the travel way, sidewalks, lined drainage channels, and existing vegetation.

Maintenance, Inspection, and Removal

- All seeded areas shall be inspected for failures and re-seeded within the planting season following guidance from the MDT Agronomist. Any temporary revegetation efforts that do not provide adequate cover must be revegetated as required by the Engineer.

- After any rainfall event, the Contractor is responsible for maintaining all slopes to prevent erosion.

SYMBOL: ———————— ——ES——

EROSION SEEDING BMP SS-15:

EROSION SEEDING IS THE IMMEDIATE SEEDING OF FRESHLY EXPOSED SLOPES. USE EROSION SEEDING ON CUT AND FILL SLOPES STEEPER THAN 3:1 THAT ARE NOT SUBJECT TO FURTHER DISTURBANCE. EVALUATE ROCK AREAS THAT CANNOT BE RIPPED ON A PROJECT-BY-PROJECT BASIS FOR THE NEED OF EROSION SEEDING. THESE AREAS WILL RECEIVE EROSION SEEDING FOLLOWING THE ENGINEER'S APPROVAL. SEEDING DOES NOT REPLACE OR SUBSTITUTE FOR FINAL SEEDING ACTIVITIES SPECIFIED IN THE SEEDING SPECIAL PROVISION.

SEED COMPLETED SECTIONS DAILY, REGARDLESS OF THE TIME OF YEAR. ACCOMPLISH SEEDING BY MANUAL BROADCASTING WITH A SHOULDER-HARNESSED SPREADER SEEDER WITH NO MULCH OR FERTILIZER APPLIED. TRACK AREAS FOLLOWING SEEDING IN ACCORDANCE TO BMP SS-12, SLOPE ROUGHENING. HYDROSEEDING MAY ONLY BE USED AS APPROVED BY THE MDT AGRONOMIST, THROUGH THE ENGINEER. STORE THE RECOMMENDED SEED MIX ON-SITE PRIOR TO INITIATION OF SLOPE EXCAVATION. IF ONE OR MORE SPECIES IS UNAVAILABLE, CONTACT THE MDT AGRONOMIST, THROUGH THE ENGINEER, FOR THE SUBSTITUTE. THE SEED MIX AND RATE OF APPLICATION ARE AS FOLLOWS:

DISTRICT	SPECIES	kg/ha PLS
1 (MISSOULA)	CANADA WILDRYE	3.5
	SECAR BLUEBUNCH WHEATGRASS	5.5
	CRITANA THICKSPIKE WHEATGRASS	5.5
	COVAR SHEEP FESCUE	2.0
	CEREAL BARLEY	5.5
2, 3, 5 (BUTTE, GREAT FALLS, BILLINGS)	CANADA WILDRYE	3.5
	SECAR BLUEBUNCH WHEATGRASS	5.5
	SODAR STREAMBANK WHEATGRASS	5.5
	COVAR SHEEP FESCUE	2.0
	CEREAL BARLEY	5.5
4 (GLENDIVE)	CANADA WILDRYE	3.5
	SECAR BLUEBUNCH WHEATGRASS	5.5
	ROSANA WESTERN WHEATGRASS	5.5
	LODORM GREEN NEEDLEGRASS	3.5
	CEREAL BARLEY	5.5

SLOPES STEEPER THAN 3:1

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208

DWG. NO. 208-??

EROSION SEEDING (SS-15)

EFFECTIVE:

CDM Camp Dresser & McKee Inc.

Temporary Sediment Control BMPs

Fiber rolls intercept runoff and remove sediment (BMP SC-5).

Construction activities normally result in soil disturbances on construction sites due to grading operations, clearing, and other activities. BMPs shall be installed to contain the detached sediments from being transported off site by using techniques like soil sedimentation and sediment trapping.

Temporary sediment control practices include the BMPs listed in Table 2-2. Note that some measures are designed to prevent erosion while other are designed to repair damage occurred due to erosion. For example, silt fences are installed to reduce velocities and protect the soils against channel erosion, as well as to collect sediment before they discharge into surface waters. Silt fences are not designed to reduce erosion occurring upgradient the silt fence but to prevent sediments from migrating offsite.

Silt fencing is a commonly used sediment control BMP (BMP SC-1).

Check dams provide minor water ponding and removal of sediment (BMP SC-4).

Sediment traps are used to collect sediment laden runoff from disturbed areas on construction sites (BMP SC-3).

Sandbag barriers are used for slowing the flow of sediment laden water or to divert water flows (BMP SC-8).

Table 2-2 Temporary Sediment Control BMPs

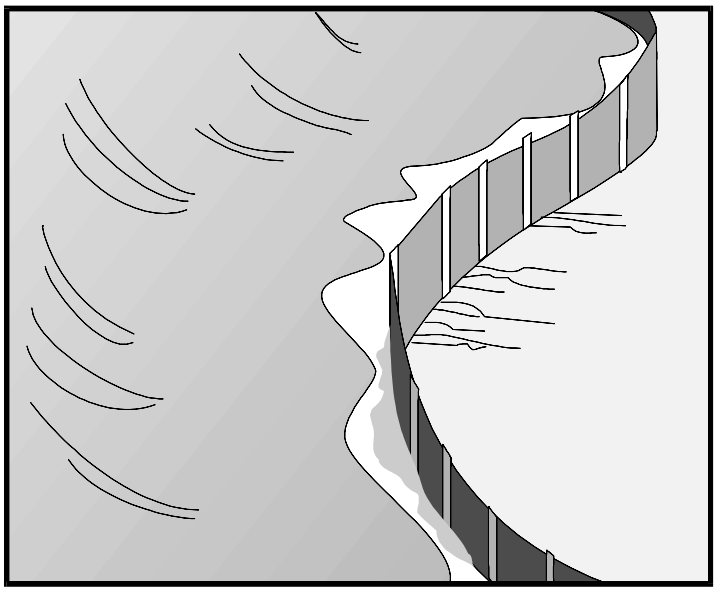
ID	BMP Name	Primary Purpose	Erosion Processes
SC-1	Silt Fence	Slow and filter runoff to retain sediment	Stream Bank, Wind, Snow, and Shoreline.
SC-2	Desilting Basin	Large pond with controlled outflow which allows sediment to settle out of runoff	Stream Bank and Snow Melt.
SC-3	Sediment Trap	Reducing sediment before it enters live water bodies	Stream Bank and Snow Melt.
SC-4	Check Dam	Provides minor detention and retention of sediment for small swales and concentrated flows	Stream Bank and Snow Melt.
SC-5	Fiber Rolls	Intercept runoff and remove sediment	Rill/Gully, Sheet, Stream Bank, and Snow Melt.
SC-6	Gravel Bag Berm	Intercept runoff and remove sediment	Rill/Gully, Sheet, Stream Bank, Shoreline and Snow Melt.
SC-7	Street Sweeping and Vacuuming	Prevent sediment from entering waterway	Stream Bank and Wind.
SC-8	Sandbag Barrier	Intercept runoff and remove sediment	Rill/Gully, Sheet, Stream Bank, Shoreline and Snow Melt.
SC-9	Straw Bale Barrier	Intercept runoff and remove sediment	Rill/Gully, Sheet, Stream Bank, Shoreline and Snow Melt.
SC-10	Storm Drain Inlet Protection	Intercept sediment at curb and field inlets. Should be used in conjunction with other on-site techniques.	Stream Bank and Snow Melt.
SC-11	Dugout Ditch Basin	Provides minor detention and retention of sediment for small swales and concentrated flows	Stream Bank and Snow Melt.

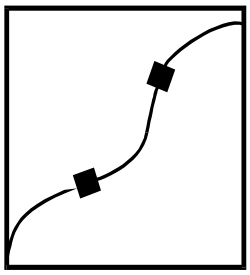
Straw bale barriers used to intercept runoff and remove sediment (BMP SC-9).

Silt fencing is one method of providing storm drain protection during construction (BMP SC-10).

Silt fencing is also used to protect culvert inlets and outlets from sediment (BMP SC-1).

Silt Fence SC-1





BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A silt fence is a temporary linear sediment barrier of permeable fabric designed to intercept and slow the flow of sediment-laden sheet flow runoff. Silt fences allow sediment to settle from runoff before water leaves the construction site.

Appropriate Applications

Silt fences are placed:

- Below the toe of exposed and erodible slopes.
- Down-slope of exposed soil areas.
- Around temporary stockpiles.
- Along streams and channels.

Limitations

- Not effective unless trenched and keyed in.
- Not intended for use as mid-slope protection on slopes greater than 4:1.
- Must be maintained to remain effective.
- Not intended for use in streams, channels, or anywhere flow is concentrated.
- Difficult to install and maintain in windy areas.
- Must be removed and disposed of.

Design Guidelines and Considerations

- Do not use below slopes subject to creep, slumping, or landslides.
- Do not use in streams, channels, or anywhere flow is concentrated.
- Do not use silt fences to divert flow.
- The maximum length of slope upgradient of the silt fence should be 60 m (200 ft) or less to minimize flow volumes and velocities and increase the effectiveness of the silt fence.
- Slope of areas draining to fence should be less than 1:1 but can be used below steeper slopes at the Engineers discretion.
- Limit to locations suitable for temporary ponding or deposition of sediment.
- Fabric life span generally limited to between five and eight months. Longer periods may require fabric replacement.
- Lay out in accordance with MDT Standard Specifications for Geosynthetics Construction and the Silt Fence (SC-1) Detail Drawing.
- For slopes steeper than 2:1 and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence or use stabilized silt fencing installation method as shown in the Silt Fence (SC-1) Detail Drawing.
- For slopes adjacent to water bodies, additional soil stabilization BMPs shall be used.
- Materials shall conform to MDT Standard Specification - Geosynthetic Construction and Miscellaneous Materials.
- Generally, silt fences should be used in conjunction with soil stabilization source controls up slope to provide effective control.
- Trenches should not be excavated wider and deeper than necessary for proper installation of the temporary linear sediment barriers.
- Excavation of the trenches should be performed immediately before installation of the temporary linear sediment barriers.
- Silt fences should be set back at least 1 m (3 ft) from the toe of a slope. Where a silt fence is determined to be not practicable due to specific site conditions, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable.
- Construct the length of each silt fence section so that the change in base elevation along the section does not exceed 1/3 the height of the barrier. This will minimize the chance of storm water from the higher elevation areas traveling along the silt fence from overtopping the silt fence in the lower elevation areas. Each silt fence reach should be limited to 150 m

(500 ft) in order to minimize the amount of water that may accumulate in lower elevation areas.

- When stabilized silt fences are required, they should be installed with steel posts and wire backing following MDT Standard Specifications and the Silt Fence (SC-1) Detail Drawing.

- Cross barriers (barriers that limit water movement along the silt fence) should be a minimum of 1/3 and a maximum of 1/2 the height of the silt fence. Cross barrier placement along silt fencing is shown in the Silt Fence (SC-1) Detail Drawing.

Maintenance, Inspection, and Removal

- Repair undercut silt fences as soon as possible.

- Repair or replace split, torn, slumping, or weathered fabric as soon as possible.

- Inspect silt fence when rain is forecast. Perform necessary maintenance, or maintenance required by the Engineer.

- Inspect silt fence following rainfall events. Perform maintenance as necessary, or as required by the Engineer.

- Maintain silt fences to provide adequate sediment holding capacity. Sediment should be removed when the sediment accumulation reaches 1/3 of the barrier height. Removed sediment should be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.

- Silt fences that are damaged and become unsuitable for the intended purpose, as determined by the Engineer, should be removed from the site and disposed of outside the right-of-way in conformance with the Standard Specifications. Replace damaged silt fence with new silt fence in accordance to MDT Special Provisions and Detail Drawings.

- Holes, depressions or other ground disturbance caused by the removal of the temporary silt fences should be backfilled and repaired.

- Remove silt fence when no longer needed or as required by the Engineer. Fill and compact postholes and anchorage trench, remove sediment accumulation, and grade fence alignment to blend with adjacent ground.

SYMBOL: ——————— ———SF———

SILT FENCE SC-1:

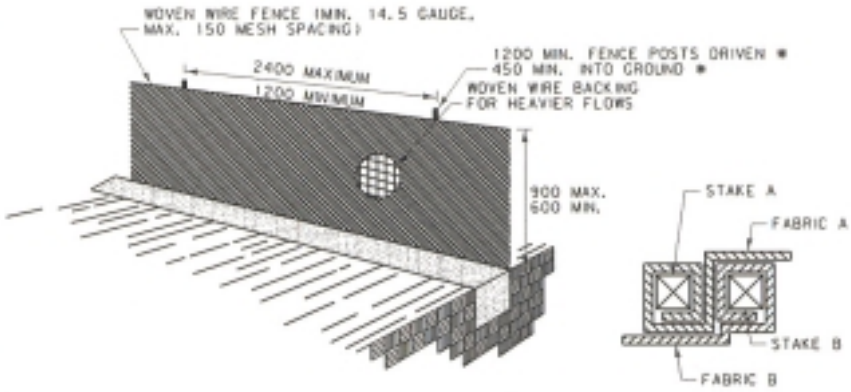
SILT FENCE IS A SINGLE OR SERIES OF FILTER FABRIC SEDIMENT BARRIER STRETCHED AND ATTACHED TO SUPPORTING POSTS. THE FENCE BOTTOM IS ENTRENCHED.

SILT FENCES ARE USED FOR SHEET FLOWS TO ASSIST IN SEDIMENT CONTROL BY RETAINING SOME OF THE ERODED SOIL PARTICLES AND SLOWING THE RUNOFF VELOCITY TO ALLOW PARTICLE SETTLING. APPLICATIONS INCLUDE WATER RESOURCE PROTECTION, INLET PROTECTION, BANK PROTECTION, AND TOE OF SLOPE PROTECTION. INSTALL SILT FENCES PRIOR TO DISTURBING AREAS REQUIRING THIS BMP OR AS SLOPE GRADES ARE ACHIEVED. MAXIMUM CUT OR FILL SLOPE FOR A SILT FENCE IS 2:1. FOLLOW MDT STANDARD SPECIFICATION 622 FOR SILT FENCE MATERIALS AND INSTALLATION.

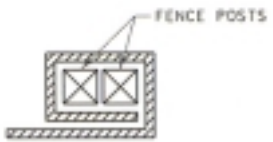
THERE ARE TWO TYPE OF SILT FENCE INSTALLATIONS:
- UNSTABILIZED - SILT FENCE SUPPORTED WITH EITHER WOOD OR METAL FENCE POSTS.
- STABILIZED - SILT FENCE SUPPORTED WITH METAL POSTS AND WITH WOVEN WIRE BACKING.

ENTRENCHMENT - THE INITIAL SILT FENCE INSTALLATION REQUIRES ONLY THE VERTICAL ENTRENCHMENT COMPONENT UNLESS THE ENGINEER DETERMINES BOTH VERTICAL AND HORIZONTAL ENTRENCHMENT COMPONENTS ARE NECESSARY. IF THE FENCE REQUIRES REPLACEMENT DUE TO FAILURE FROM PULLOUT OR UNDERCUTTING, THE SUBSEQUENT INSTALLATION WILL INCLUDE BOTH VERTICAL AND HORIZONTAL ENTRENCHMENT COMPONENTS.

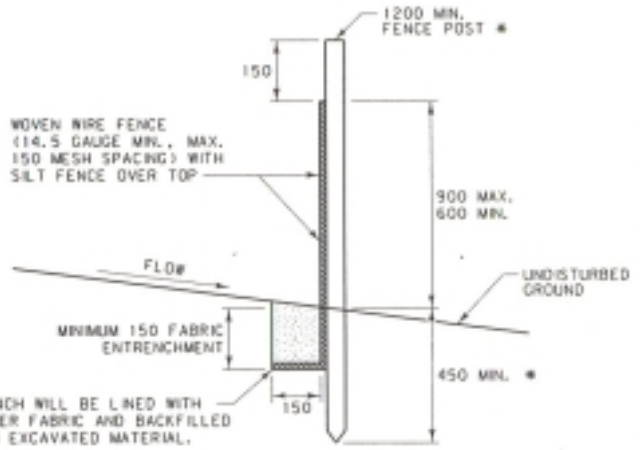
SILT FENCES ARE USED BETWEEN THE EDGE OF CONSTRUCTION DISTURBANCE AND A WATER RESOURCE, AND AT A CRITICAL RESOURCE OR RIGHT-OF-WAY LINE THAT IS ADJACENT TO CONSTRUCTION ACTIVITY. POSITION THE BARRIER TO PREVENT SEDIMENT FROM ENTERING DRAINAGES. DO NOT PLACE THE BARRIER ACROSS LIVE STREAMS. WOVEN WIRE BACKING IS NECESSARY WHEN DEALING WITH HEAVIER FLOW VELOCITIES AND SEDIMENT OR AS A ROCK BARRIER. REMOVE SEDIMENT FROM BEHIND THE FENCE WHEN IT ACCUMULATES TO ONE-THIRD THE ORIGINAL HEIGHT. EITHER GRADE AND SEED OR REMOVE THE SEDIMENT DEPOSITS PRIOR TO REMOVAL OF THE FENCE. DISTANCES BETWEEN SILT FENCE WHEN USED FOR SEDIMENT RETENTION ARE AS FOLLOWS:
- FROM 2% TO 3% PLACE SILT FENCE AT 150 METER SPACING
- FROM 3% TO 4% PLACE SILT FENCE AT 90 METER SPACING
- FROM 4% + PLACE SILT FENCE AT 45 METER SPACING



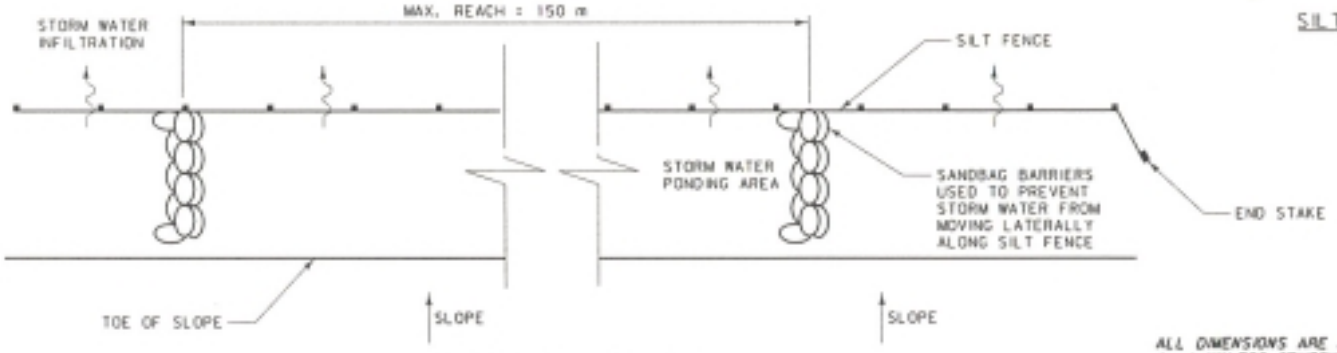
JOINING SECTION DETAIL



END STAKE DETAIL



SILT FENCE - CROSS SECTION



SILT FENCE - PLAN VIEW

* FOR CLEAR ZONE APPLICATIONS USE MAX. POST LENGTH OF 1500 mm WITH A MIN. BURIAL DEPTH OF 450 mm.

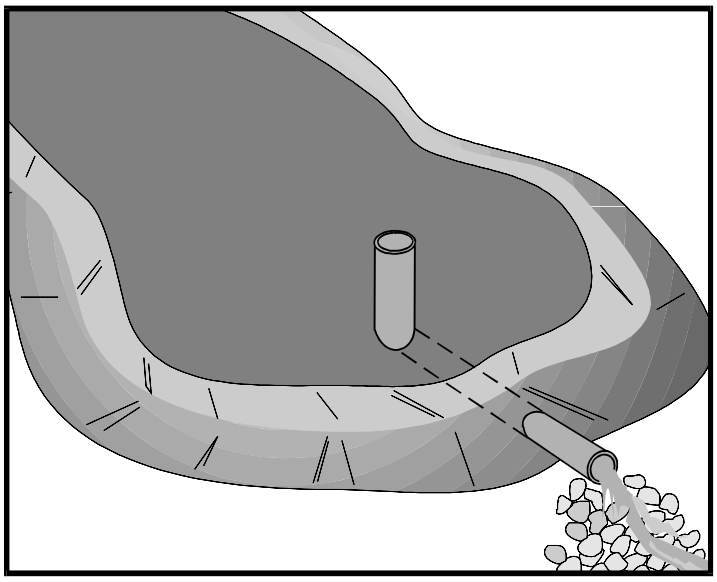
ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

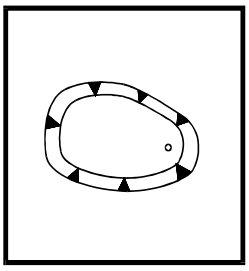
PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-22
SILT FENCE (SC-1)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Desilting Basin SC-2





BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A desilting basin is a temporary basin formed by excavation and/or constructing an embankment so that sediment-laden runoff is temporarily detained under slow flowing conditions, allowing sediment to settle out before the runoff is discharged. MDT's Hydraulics Section is responsible for the design of desilting basins that will be left as permanent structures.

Appropriate Applications

Desilting basins shall be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses; and
- At outlets of disturbed soil areas with areas between 2 ha (5 acres) and 4 ha (10 acres).

Limitations

- Alternative BMPs must be thoroughly investigated for erosion control before selecting temporary desilting basins.
- Requires large surface areas to allow sediment to settle.
- Not appropriate for drainage areas greater than 30 ha (75 acres).
- Not to be located in live streams.
- If safety is a concern, basins may require protective fencing.
- Size may be limited by availability of right-of-way.

Design Guidelines and Considerations

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

- Desilting basins shall be designed to have a capacity equivalent to 100 m^3 (1500 ft^3) of storage (as measured from the top of the basin to the principal outlet,) per hectare (acre) of contributory area. This design is less than that required to capture 0.01 mm (0.0004 in) particle size, but larger than that required to capture particles 0.02 mm (0.0008 in) or larger.

- The length of the basin shall be more than twice the width of the basin; the length shall be determined by measuring the distance between the inlet and the outlet.

- The depth must be no less than 1 m (3 ft) nor greater than 1.5 m (5 ft).

- Any basin meeting the definition of a "High Hazard Dam" must be designed by a professional civil engineer registered in the state of Montana. Basins capable of impounding more than 1000 m^3 (35,000 ft^3), must also be designed by a professional Civil Engineer registered with the state of Montana. Temporary desilting basin design must be approved by the Engineer prior to the basin construction. The design shall include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.

- Design and locate desilting basins so that they can be maintained. Construct desilting basins prior to construction activities.

- Desilting basins, regardless of size and storage volume, shall include features to accommodate overflow or bypass flows that exceed the design storm event. The calculated basin volume and proposed location shall be submitted to the Engineer for approval prior to the basin construction.

- Basins shall be designed to drain within 72 hours following storm events.

- The outflow from the desilting basin shall be provided with outlet protection to prevent erosion and scouring of the embankment and channel.

- Basin shall be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, (3) where failure would not cause loss of life or property damage, and (4) where the basins can be maintained on a year-round basins to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

- Areas under embankments, structural works, and desilting basin must be cleared, stripped of vegetation.

- Basin inlets shall be located to maximize travel distance to the basin outlet.

- Rock or vegetation shall be used to protect the basin inlet and slopes against erosion.

- A forebay (a reservoir or channel constructed upstream of the basin) may be provided to remove debris and larger particles.

- Principal outlet shall consist of a corrugated metal, HDPE, or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure shall be designed to accommodate the inflow design storm.

- Structure shall be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.

- Attach riser pipe (watertight connection) to a horizontal pipe (barrel) which extends through the embankment to toe of fill. Provide anti-seep collars on the barrel.

- Cleanout level shall be clearly marked on the riser pipe.

- Avoid dewatering of groundwater to the desilting basin during the rainy season. Insignificant quantities of accumulated precipitation may be dewatered to the desilting basin unless precipitation is forecasted within 24 hours.

- Chain link fencing around each desilting basin may be specified by the Engineer to prevent unauthorized entry to the basin or if safety is a concern. Fencing shall be in accordance with MDT Standard Specifications Section 607 - Fences.

- One of the dewatering configurations shown below for the principal outlet may be used. The Contractor shall verify that the outlet is properly designed to handle the design and peak flows.

Outlet #1, See Detailed Drawings

- Perforate the top 1/3 of the riser with 13 mm (1/2 in) diameter holes spaced 200 mm (8 in) vertically and 250 mm (10 in) - 300 mm (12 in) horizontally.

- Place 19 mm (3/4 in) gravel over perforated holes to approximately 50 mm (2 in) minimum thickness to assist in prevention of clogging of dewatering holes. Gravel will naturally settle into a cone surrounding the riser pipe.

Outlet #2, See Detailed Drawings

- Perforate the lower 1/2 of the riser pipe with 13 mm (1/2 in) diameter holes spaced approximately 75 mm (3 in) apart, in each outside valley (corrugated metal pipe).

- Place 19 mm (3/4 in) gravel over perforated holes to approximately 50 mm (2 in) minimum thickness to assist in prevention of clogging of dewatering holes. Gravel will naturally settle into a cone surrounding the riser pipe.

Outlet #3, See Detailed Drawings

- Provide two 25 mm (1 in) diameter holes above the sediment storage volume on opposite sides of the non-perforated riser pipe. This will typically provide sufficient detention time for basins to drain approximately 4 ha (10 acre).

- Construct an emergency spillway to accommodate flows not carried by the principal spillway. Spillway shall consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap.

- Spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, shall be a minimum of 6 m (20 ft) in length.

- Use outlet protection at the pipe outlet. See BMP SS-10, "Outlet Protection/Velocity Dissipation Devices."

Maintenance, Inspection, and Removal

- Inspect temporary desilting basins before and after rainfall events and weekly during the rest of the rainy season. During extended rainfall events, inspect at least every 24 hours.

- Examine basin banks for seepage and structural soundness.

- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed, or as directed by the Engineer.

- Check inlet and outlet area for erosion and stabilize if required, or if directed by the Engineer.

- Remove sediments when storage zone is 1/3 full.

- Check fencing for damage and repair as needed or as directed by the Engineer.

SYMBOL: ———————

DESILTING BASIN SC-2:

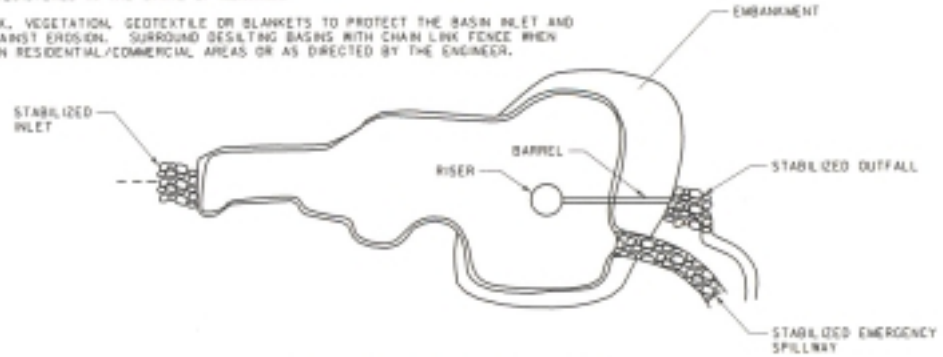
A DESILTING BASIN IS A TEMPORARY BASIN FORMED BY EXCAVATION AND/OR CONSTRUCTING AN EMBANKMENT SO THAT SEDIMENT-LADEN RUNOFF IS TEMPORARILY DETAINED UNDER SLOW FLOWING CONDITIONS, ALLOWING SEDIMENT TO SETTLE OUT BEFORE THE RUNOFF IS DISCHARGED.

USE DESILTING BASINS FOR DISTURBED AREAS BETWEEN 2 ha AND 4 ha WHERE SEDIMENT-LADEN WATER MAY ENTER THE DRAINAGE SYSTEM OR WATERCOURSE.

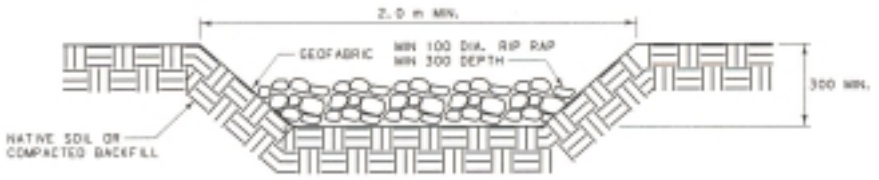
DO NOT USE DESILTING BASINS FOR DRAINAGE AREAS GREATER THEN 30 ha AND DO NOT LOCATE BASINS WITHIN LIVE STREAMS.

SIZE DESILTING BASINS SUCH THAT THERE IS 100 m³ PER 1 ha OF CONTRIBUTING AREA, LENGTH MUST BE EQUAL OR LARGER THAN TWICE THE WIDTH, DEPTH MUST BE BETWEEN 1 m AND 1.5 m. ANY BASIN MEETING THE DEFINITION OF A "HIGH HAZARD DAM" MUST BE DESIGNED BY A PROFESSIONAL CIVIL ENGINEER REGISTERED IN THE STATE OF MONTANA. BASINS LARGER THAN 1000 m³ MUST ALSO BE DESIGNED BY A PROFESSIONAL CIVIL ENGINEER REGISTERED IN THE STATE OF MONTANA.

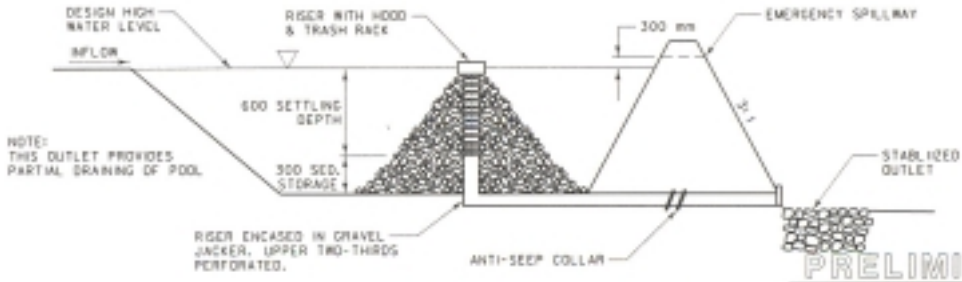
PLACE ROCK, VEGETATION, GEOTEXTILE OR BLANKETS TO PROTECT THE BASIN INLET AND SLOPES AGAINST EROSION. SURROUND DESILTING BASINS WITH CHAIN LINK FENCE WHEN DESIGNED IN RESIDENTIAL/COMMERCIAL AREAS OR AS DIRECTED BY THE ENGINEER.



TYPICAL DESILTING BASIN - TOP VIEW



TYPICAL DESILTING BASIN - EMERGENCY SPILLWAY CROSS SECTION

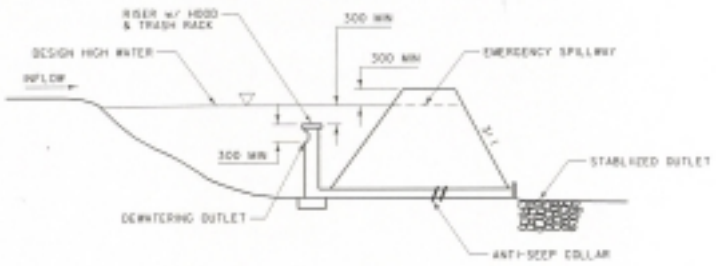


TYPICAL DESILTING BASIN - OUTLET #1

PRELIMINARY

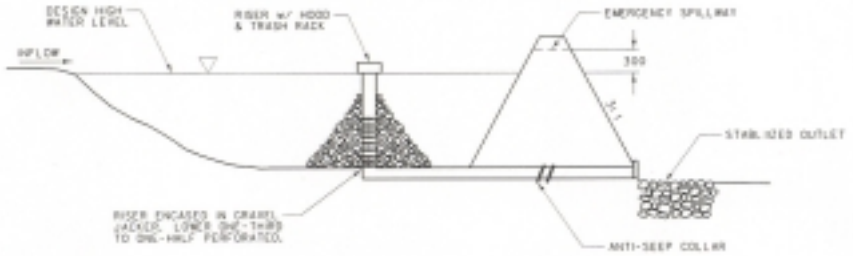
REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
DESILTING BASIN (SC-2) (SHEET 1)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.



NOTE:
THIS OUTLET PROVIDES NO
DRAINING OF PERMANENT POOL

TYPICAL DESILTING BASIN - OUTLET #2



NOTE:
THIS OUTLET PROVIDES
COMPLETE DRAINING OF POOL

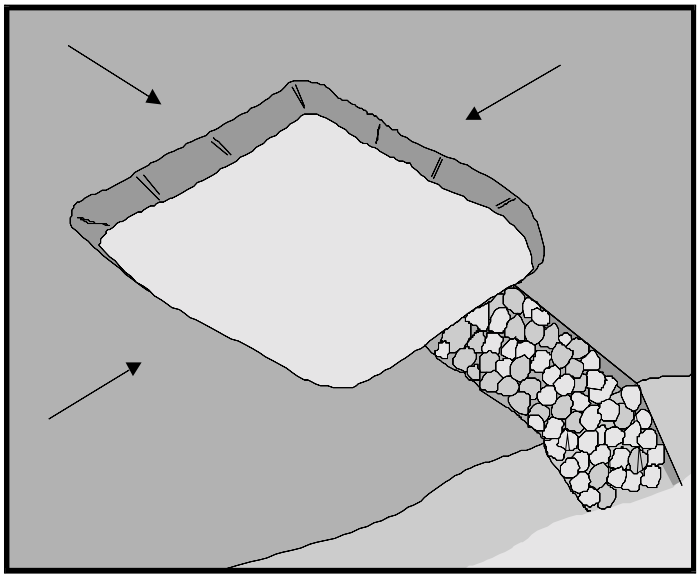
TYPICAL DESILTING BASIN - OUTLET #3

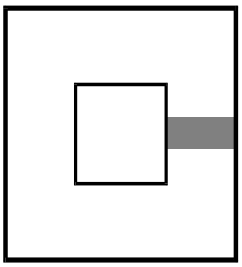
PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
DESILTING BASIN (SC-2) (SHEET 2)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

Sediment Trap SC-3





BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A sediment trap is a temporary basin with a controlled release structure, formed by excavating or constructing an earthen embankment across a waterway or low drainage area.

Appropriate Applications

- Sediment traps may be used on construction projects where the contributing drainage area is less than 2 ha (5 acres). Traps would be placed where sediment laden storm water may enter a storm drain or watercourse, and around and/or up-slope from storm drain inlet protection measures.
- This BMP may be implemented on a project-by-project basis in addition to other BMPs when determined necessary and feasible by the Engineer.
- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Limitations

- Requires large surface areas to allow sediment to settle.
- Not appropriate for drainage areas greater than 2 ha (5 acres).
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Not to be located in live streams.
- Size may be limited by availability of right-of-way.

Design Guidelines and Considerations

- Construct sediment traps prior to rainy season and construction activities.

- Trap shall be located: (1) where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance.

- Trap shall be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 130 m^3/ha (1850 ft^3/acre) and 65 m^3/ha (925 ft^3/acre) of contributing drainage area, respectively, based on 12.7 mm (1/2 in) of runoff volume over a 24-hr period. Multiple traps and/or additional volume may be required to accommodate site-specific rainfall and soil conditions.

- Any sediment trap meeting the definition of a "High Hazard Dam" must be designed by a professional Civil Engineer registered in the state of Montana. Sediment traps capable of impounding more than 1000 m^3 (35000 ft^3), must also be designed by a professional Civil Engineer registered with the state of Montana. Sediment trap designs must be reviewed by the MDT Hydraulics Section and approved by the Engineer prior to the sediment trap construction. The design shall include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the trap outlet.

- Areas under embankments, structural works, and sediment traps shall be cleared and stripped of vegetation.

- Trap shall have a length to width ratio greater than 3:1 or baffles are required to prevent short circuiting of the inlet flow.

- Trap inlets shall be located to maximize the travel distance to the trap outlet. Use rock or vegetation to protect the trap outlets against erosion.

- Chain link fencing around large sediment traps may be specified by the Engineer to prevent unauthorized entry to the trap or if safety is a concern. Fencing shall be in accordance with MDT Standard Specifications.

- To dewater the trap, the outlet shall be constructed in one of the following two ways:

    - Use corrugated metal, HDPE, or reinforced concrete riser pipe with dewatering holes encased in gravel to prevent floating debris from flowing out of the trap or obstructing the system.

    - Construct a crushed stone outlet section of the embankment at the low point of the trap. The stone section serves as a non-erosive spillway outlet for flood flows and the bottom section provides a means of dewatering the trap between rainfall events.

Maintenance, Inspection, and Removal

- Inspect sediment traps before and after rainfall events and weekly during the rest of the rainy season. During extended rainfall events, inspect sediment traps at least every 24 hours.

- Check trap banks for seepage and structural soundness.
- Check outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed or as directed by the Engineer.
- Check outlet area for erosion and stabilize if required, or as directed by the Engineer.
- Remove accumulated sediment when the volume has reached 1/3 the original trap volume.
- Properly disposed of sediment and debris removed from the trap.
- Check fencing for damage and repair as needed or as directed by the Engineer.

SYMBOL:

SEDIMENT TRAP SC-31

A SEDIMENT TRAP IS A TEMPORARY BASIN THAT WITH A CONTROLLED RELEASE STRUCTURE, FORMED BY EXCAVATING OR CONSTRUCTION OF AN EARTHEN EMBANKMENT ACROSS A WATERWAY OR LOW DRAINAGE AREA.

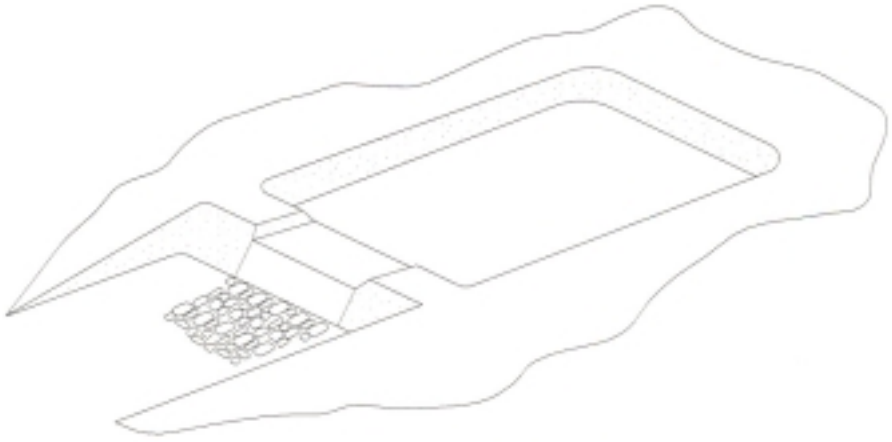
USE SEDIMENT TRAPS WHEN DISTURBED AREAS ARE LESS THAN 2 ha. THIS BMP CAN BE USED TO PROVIDE ADDITIONAL PROTECTION FOR A WATER BODY OR FOR REDUCING SEDIMENT BEFORE IT ENTERS A DRAINAGE SYSTEM.

SEDIMENT BASINS ARE NOT APPROPRIATE FOR DRAINAGE AREAS LARGER THAN 2 ha AND ONLY REMOVE LARGE TO MEDIUM SIZED PARTICLES. DO NOT USE SEDIMENT TRAPS IN LIVE STREAMS.

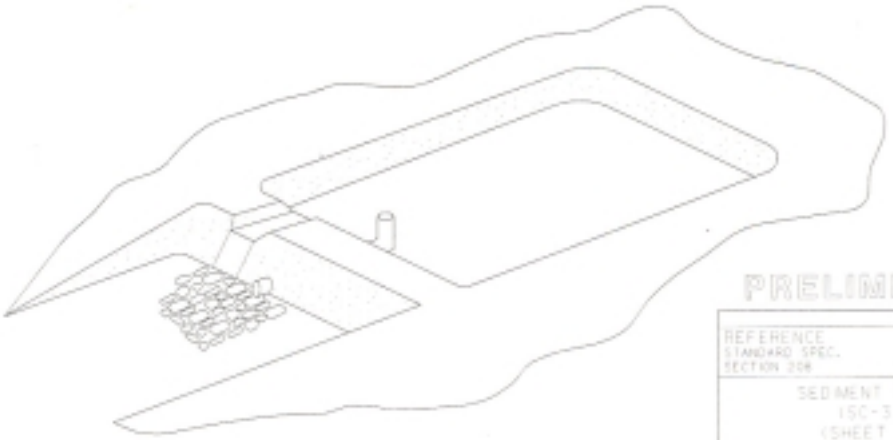
A MINIMUM SETTLING ZONE OF 130 m³ PER ha AND A MINIMUM SEDIMENT ZONE OF 65 m³ PER ha IS REQUIRED FOR EACH SEDIMENT TRAP. ANY TRAP MEETING THE DEFINITION OF A "HIGH HAZARD DAM" MUST BE DESIGNED BY A PROFESSIONAL CIVIL ENGINEER LICENSED IN THE STATE OF MONTANA. ALL TRAPS LARGER THAN 1000 m³ REQUIRE A DESIGN BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF MONTANA.

PLACE ROCK, VEGETATION, GEOTEXTILE OR BLANKETS TO PROTECT THE TRAP'S INLET, OUTLET AND SLOPES AGAINST EROSION. ENCLOSE THE SEDIMENT TRAP WITH CHAIN LINK FENCE WHEN PLACED IN RESIDENTIAL/COMMERCIAL AREAS OR AS DIRECTED BY THE ENGINEER.

REFER TO BMP SC-2 FOR RISER PIPE CONFIGURATIONS AND OVERFLOW SPILLWAY DESIGNS.



TYPICAL SEDIMENT TRAP WITH SPILLWAY TYPE OUTFALL

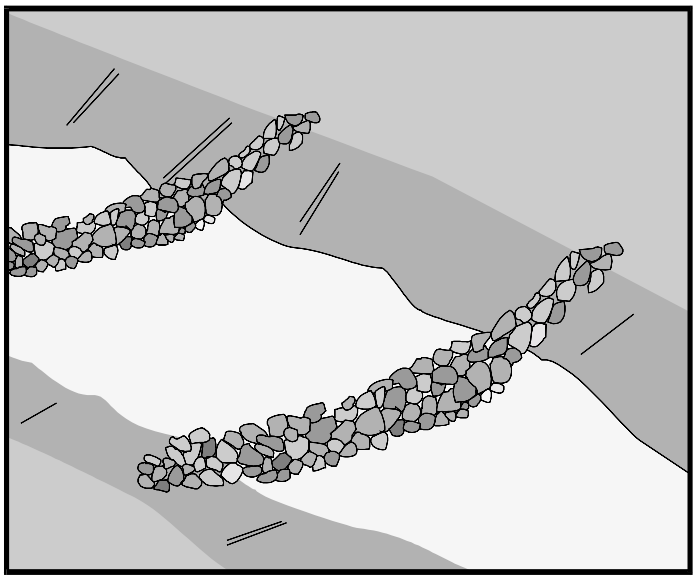


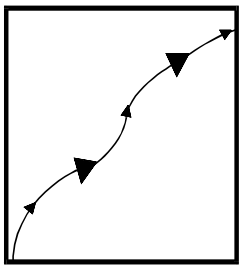
TYPICAL SEDIMENT TRAP WITH RISER PIPE TYPE OUTFALL

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
SEDIMENT TRAP (SC-31) (SHEET 1)	
(EFFECTIVE)	
CDM Camp Dresser & McKee Inc.	

Check Dams SC-4





BMP Objectives

- Soil Stabilization
- Sediment Control
- Tracking Control
- Wind Erosion Control
- Non-Storm Water Management
- Materials and Waste Management

Definition and Purpose

A check dam is a small device constructed of rock, sandbags, or fiber rolls, placed across a natural or man-made channel or drainage ditch. Check dams reduce scour and channel erosion by reducing flow velocity and encouraging sediment dropout.

Appropriate Applications

- Check dams may be installed in the following:
  - In small open channels which drain 4 ha (10 acres) or less.
  - In steep channels where storm water runoff velocities exceed 1.5 m/s (5 ft/s).
  - During the establishment of grass linings in drainage ditches or channels.
  - In temporary ditches where a short length of service does not warrant establishment of erosion-resistant linings.
- Check dams can be left in place following construction activities and allowed to accumulate sediment and vegetation as approved by the Engineer.

Limitations

- Not to be used in live streams.
- Not appropriate in channels which drain areas greater than 4 ha (10 acres).
- Not to be placed in channels, which are already grass-lined unless erosion is expected, as installation may damage vegetation.

- Require extensive maintenance following high velocity flows and may have to be replaced.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam. Check dams may be left in place and allowed to accumulate sediment and vegetation.
- Not to be constructed from straw bales or a silt fence.
- Can be difficult to seed around.

Design Guidelines and Considerations

- Check dams shall be placed at a distance and height to allow small pools to form behind them.
- Install the first check dam approximately 5 m (15 ft) from the outfall device and at regular intervals based on slope gradient and soil type.
- High flows (typically a 2-year storm or larger) shall safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams may be removed when grass has matured sufficiently to protect the ditch or swale if the removal does not jeopardize the established vegetation.

Maintenance, Inspection, and Removal

- Inspect check dams after each storm event. Repair damage as needed or as required by the Engineer.
- Remove sediments when depth reaches 1/3 of the check dam height.
- Remove accumulated sediment prior to permanent seeding or soil stabilization or seed accumulated sediment to stabilize.
- Remove check dams and accumulated sediment when check dams are no longer needed or when required by the Engineer. Check dams can be left in place following construction activities and allowed to accumulate sediment and vegetation as approved by the Engineer.
- Removed sediment shall be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.

SYMBOL:

CHECK DAMS SC-4:

A CHECK DAM IS A SMALL DEVICE CONSTRUCTED OF GRAVEL, SANDBAGS, OR FIBER ROLLS, PLACED ACROSS A NATURAL OR MAN-MADE CHANNEL OR DRAINAGE DITCH. CHECK DAMS REDUCE SCOUR AND CHANNEL EROSION BY REDUCING FLOW VELOCITIES AND ENCOURAGING SEDIMENT DROPOUT.

CHECK DAMS MAY BE INSTALLED IN SMALL CHANNELS WITH DRAINAGE AREAS OF 4 ha OR LESS AND/OR STEEP CHANNELS WHERE STORM WATER RUNOFF VELOCITIES EXCEED 1.5 m/s. THE MAXIMUM HEIGHT FOR CHECK DAMS WITHIN THE CLEAR ZONE IS 150 mm.

CHECK DAMS CANNOT BE USED IN LIVE STREAMS OR FOR DRAINAGE AREAS LARGER THAN 4 ha. IN ADDITION, CHECK DAMS CANNOT BE CONSTRUCTED FROM SILT FENCE.

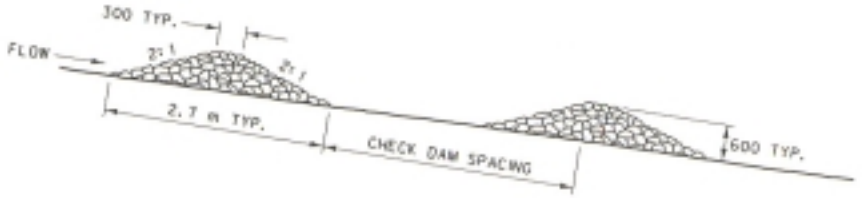
PLACE CHECK DAMS AT A DISTANCE THAT WILL ALLOW SMALL POOLS TO BE FORMED BEHIND EACH DAM. INSTALL THE FIST CHECK DAM APPROXIMATELY 5 METERS FROM THE OUTFALL DEVICE. PLACE MULTIPLE CHECK DAMS SUCH THAT BACKWATER FROM THE DOWNSTREAM DAM WILL REACH THE TOE OF THE UPSTREAM DAM. ROCK MAY BE PLACED BY HAND OR BY MECHANICAL METHOD TO ACHIEVE COMPLETE DITCH OR SWALE COVERAGE.

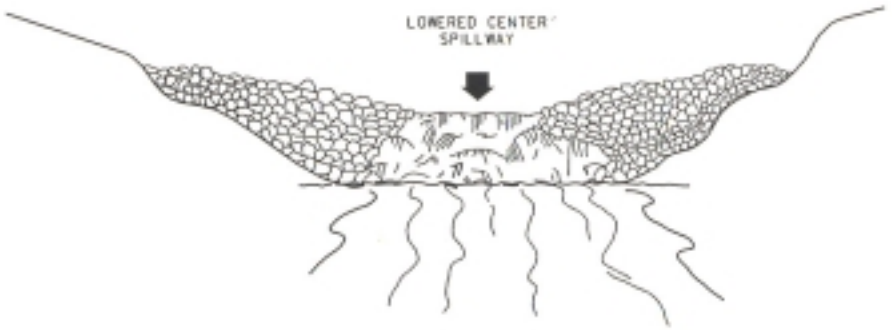
CHECK DAMS CONSTRUCTED FROM GRAVEL MUST BE 100% PASSING THE 50 mm SCREEN AND 10% MAXIMUM PASSING THE 4.75 mm SIEVE. DAM MATERIAL MAY BE PITRUN OR CRUSHED AGGREGATE. REFER TO BMPs SC-5 AND SC-6 FOR USE OF FIBER ROLLS AND SAND BAGS AS CHECK DAMS.

REMOVE SEDIMENT FROM BEHIND THE DAM WHEN IT ACCUMULATES TO ONE-HALF THE ORIGINAL HEIGHT UNLESS ITS DRAINAGE AREA HAS BEEN STABILIZED.

DISTANCES BETWEEN CHECK DAMS ARE AS FOLLOWS:
- FROM 1% TO 3% PLACE CHECK DAMS AT 90 METER SPACING
- FROM 3% TO 4% PLACE CHECK DAMS AT 60 METER SPACING
- FROM 4% + PLACE CHECK DAMS AT 30 METER SPACING

CHECK DAM SPACING MAY BE ADJUSTED ON A PROJECT-BY-PROJECT BASIS BY THE ENGINEER. DO NOT USE CHECK DAMS ON 1-2% GRADES UNLESS DETERMINED NECESSARY BY THE ENGINEER.





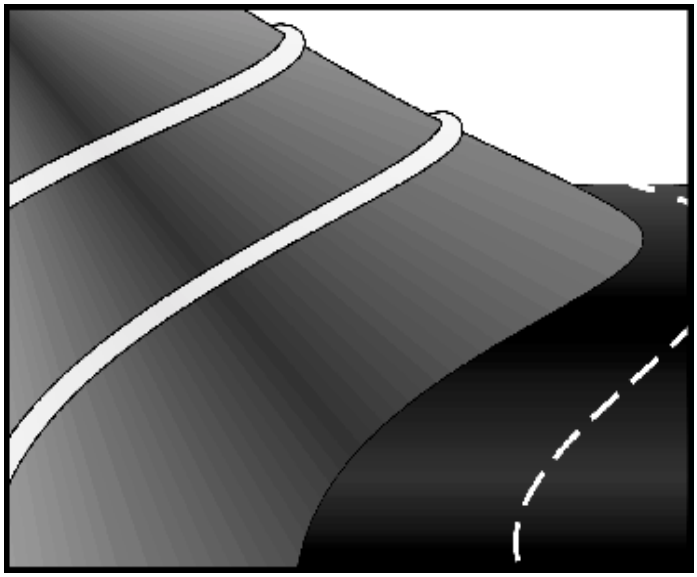
ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

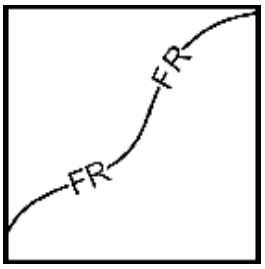
PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
CHECK DAMS (SC-4)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Fiber Rolls SC-5





BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A fiber roll consists of straw, flax, or other similar materials that are rolled and bound into a tight tubular roll and placed on the face of slopes at regular intervals to intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide some removal of sediment from the runoff.

Appropriate Applications

- May be used along the top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- Fiber rolls may be used as check dams if approved by the Engineer.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Although fiber rolls provide some sediment removal, this BMP is not to be used in place of a linear sediment barrier (i.e., a silt fence, sandbag barrier, or straw bale barrier).

Design Guidelines and Considerations

Fiber Roll Materials

- Fiber rolls shall be either:
  - prefabricated rolls; or,
  - rolled tubes of erosion control blanket.

Assembly of Field Rolled Fiber Roll

- Roll length of erosion control blanket into a tube of minimum 200 mm (8 in) diameter.

- Bind roll at each end and every 1.2 m (4 ft) along length of roll with jute-type twine.

Installation

- Entrench and install fiber rolls as shown in the Fiber Rolls (SC-5) Detail Drawing.
- If more than one fiber roll is placed in a row, the rolls shall be butted; not overlapped. Stake butted fiber rolls ends to maintain a tight joint.

Removal

- Fiber rolls are typically left in place as removals may cause damage to the stabilized slope.
- If fiber rolls are removed, collect and dispose of sediment accumulation, and fill, compact and seed holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

Maintenance, Inspection, and Removal

- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- Inspect fiber rolls when rain is forecast. Perform maintenance as needed or as required by the Engineer.
- Inspect fiber rolls as soon as possible following storm events and a least daily during prolonged rainfall. Perform maintenance as needed or as required by the Engineer.

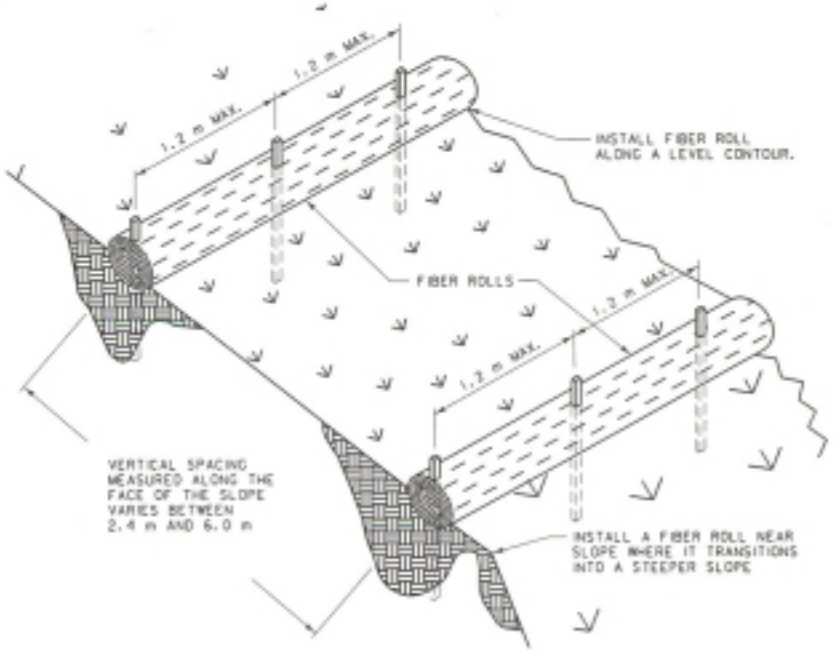
SYMBOL: ———— —— FR ——

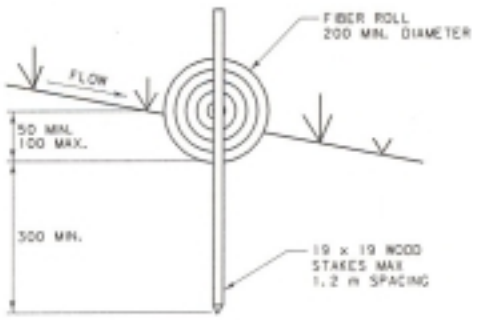
FIBER ROLLS SC-5:

A FIBER ROLL CONSISTS OF EROSION CONTROL BLANKET MATERIAL THAT IS PREFABRICATED, OR ROLLED AND BOUND IN THE FIELD INTO A TIGHT TUBULAR ROLL AND PLACED ON THE FACE OF SLOPES AT REGULAR INTERVALS TO INTERCEPT RUNOFF, REDUCE ITS FLOW VELOCITY, RELEASE THE RUNOFF AS SHEET FLOW, AND PROVIDE SOME REMOVAL OF SEDIMENT FROM THE RUNOFF.

FIBER ROLLS MAY BE USED ALONG THE TOP, FACE, AND AT GRADE BREAKS OF EXPOSED AND ERODIBLE SLOPES TO SHORTEN SLOPE LENGTH AND SPREAD RUNOFF AS SHEET FLOW. ROLLS MAY BE USED AS CHECK DAMS IF APPROVED BY THE ENGINEER. FOR USE AS CHECK DAMS, PLACE FIBER ROLLS AT 15 m MAXIMUM SPACING OR AS APPROVED BY THE ENGINEER.

ALTHOUGH FIBER ROLLS PROVIDE SOME SEDIMENT REMOVAL, FIBER ROLLS ARE NOT TO BE USED IN PLACE OF A LINEAR SEDIMENT BARRIER (I.E., SILT FENCE, SANDBAG BARRIER, OR STRAW BALE BARRIER).



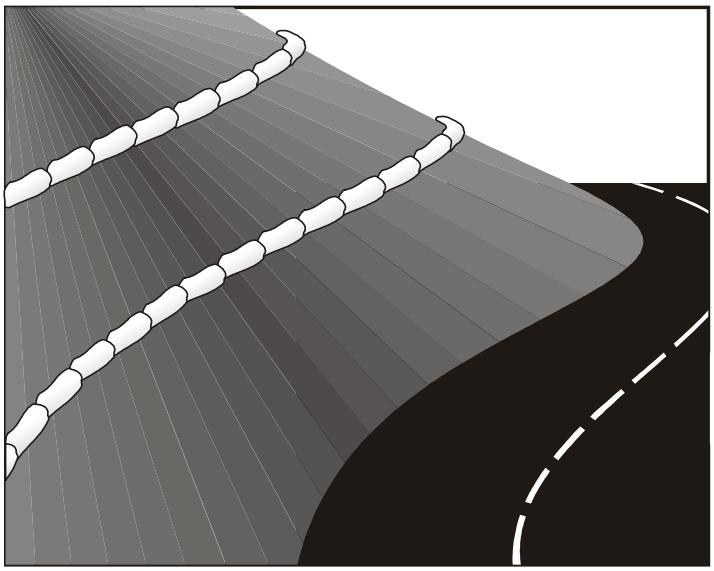


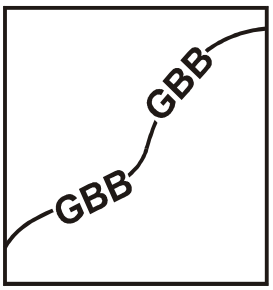
ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
FIBER ROLLS (SC-5)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Gravel Bag Berm SC-6





BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A gravel bag berm consists of a single row of gravel bags that are installed end-to-end to form a barrier across a slope to intercept runoff, reduce runoff velocity, release runoff as sheet flow, and provide some sediment removal.

Appropriate Applications

- Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Although this BMP will remove some sediment, it is not to be used in place of a linear sediment barrier (i.e., a silt fence, sandbag barrier, or straw bale barrier).
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Limited durability for long-term projects.

Design Guidelines and Considerations

- Bag material and size are shown in the Gravel Bag Berm (SC-6) Detail Drawing.
- Gravel Bag Berm installation is described in the Gravel Bag Berm (SC-6) Detail Drawing.
- Tightly abut bags.

Maintenance, Inspection, and Removal

- Inspect gravel bag berms before predicted storm events, as soon as possible after storm events, and weekly during construction activities.

- Reshape or replace gravel bags as needed, or as directed by the Engineer.

- Inspect gravel bag berms for sediment accumulation and remove sediments when accumulation reaches 1/3 the berm height. Removed sediment shall be incorporated within the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.

- Remove gravel bag berms when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilize the area. Sediment accumulation may remain if seeded and stabilized. Gravel from bags can be left in place; however, the bags should be removed.

SYMBOL: ———————— ———GBB———

GRAVEL BAG BERM SC-61

A GRAVEL BAG BERM CONSISTS OF A SINGLE ROW OF GRAVEL BAGS THAT ARE INSTALLED END-TO-END TO FORM A BARRIER ACROSS A SLOPE TO INTERCEPT RUNOFF, REDUCE RUNOFF VELOCITY, RELEASE RUNOFF AS SHEET FLOW, AND PROVIDE SOME SEDIMENT REMOVAL. GRAVEL BAG BERMS CAN BE USED ALONG THE FACE AND AT GRADE BREAKS OF EXPOSED AND ERODIBLE SLOPES TO SHORTEN SLOPE LENGTHS AND SPREAD RUNOFF AS SHEET FLOW.

THESE DEVICES ARE NOT TO BE USED IN PLACE OF A LINEAR SEDIMENT BARRIER (I.E., SILT FENCE, SANDBAG BARRIERS, OR STRAW BALE BARRIERS).

USE WOVEN POLYPROPYLENE, POLYETHYLENE, OR POLYAMIDE FABRIC OR BURLAP MATERIAL FOR BAGS. BAG MATERIAL IS REQUIRED TO HAVE A MINIMUM UNIT WEIGHT OF 135 g/m², MULLEN BURST STRENGTH EXCEEDING 2 070 kPa AND AN ULTRAVIOLET STABILIZATION EXCEEDING 70%.

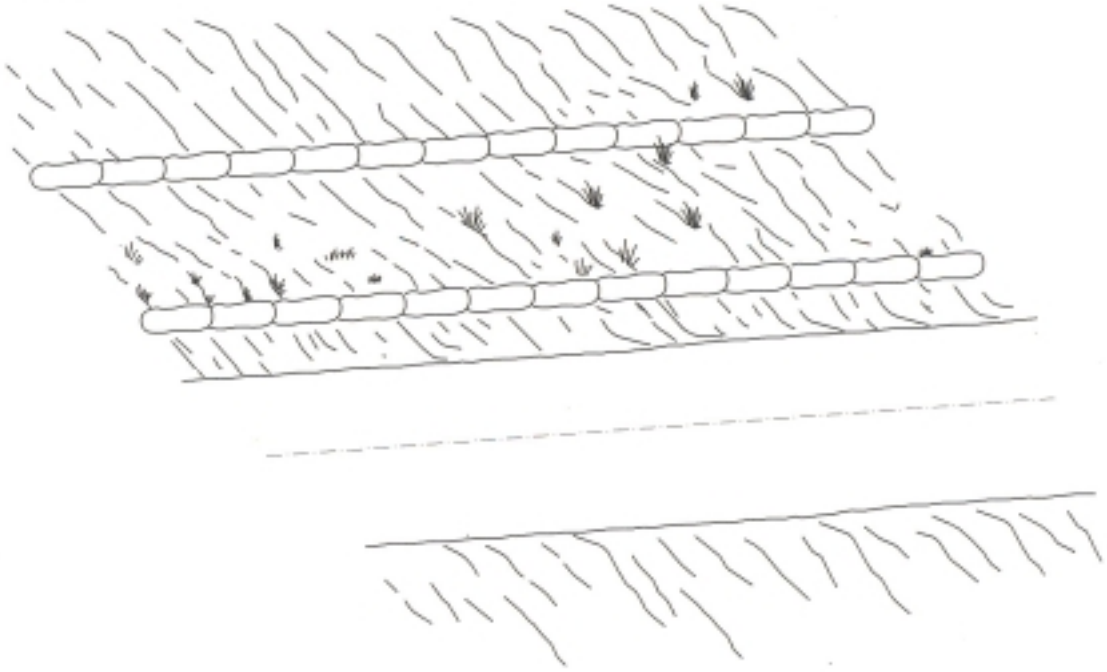
USE GRAVEL BAGS HAVING A LENGTH OF 450 mm, WIDTH OF 300 mm, THICKNESS OF 75 mm, AND A MASS OF APPROXIMATELY 15 kg. ALTERNATIVE BAG SIZES REQUIRE ENGINEERS APPROVAL PRIOR TO USE.

FILL GRAVEL BAGS APPROXIMATELY 75% FULL WITH GRAVEL CONSISTING OF 100% PASSING THE 19 mm SCREEN AND 10% MAXIMUM PASSING THE 4.75 mm SIEVE. FILL MATERIAL MAY BE PITRUN OR CRUSHED AGGREGATE. FILL MATERIAL IS SUBJECT TO APPROVAL BY THE ENGINEER.

TIGHTLY PLACE GRAVEL BAGS TO MINIMIZE GAPS BETWEEN BAGS. BAGS MAY BE STAGGERED ON A PROJECT-BY PROJECT BASIS AS APPROVED BY THE ENGINEER.

PLACE GRAVEL BAG BERMS AT 2.4 TO 6 m SPACING ALONG THE SLOPE. FOR ABNORMALLY STEEP OR SHALLOW SLOPES FOLLOW ENGINEERS GUIDELINES.

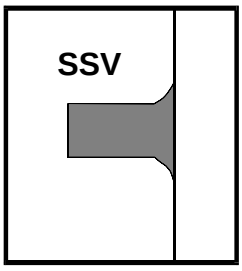
ALL BAGS PLACED WITHIN THE CLEAR ZONE REQUIRE MEASURES TO PROTECT GRAVEL FROM FREEZING. ALL FREEZE REDUCTION METHODS REQUIRE ENGINEERS APPROVAL PRIOR TO IMPLEMENTATION.



PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
GRAVEL BAG BERM (SC-61	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Street Sweeping and Vacuuming SC-7



BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ● Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Practices to remove tracked sediment to prevent the sediment from entering a storm drain or watercourse.

Appropriate Applications

These practices are implemented anywhere sediment is tracked from the project site onto public or private paved roads, typically at points of egress.

Limitations

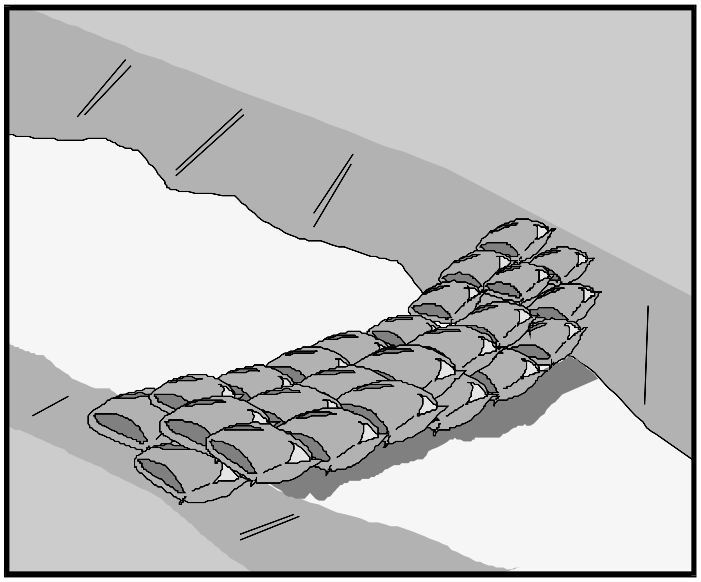
- Sweeping and vacuuming may not be effective when soil is wet or muddy.
- Do not use kick brooms or sweeper attachments.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking shall be swept and vacuumed on a daily basis.
- If not mixed with debris or trash, consider incorporating the removed sediment back into the project.

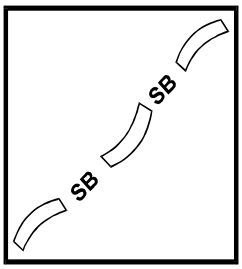
Maintenance, Inspection, and Removal

- Inspect ingress/egress access points daily and sweep tracked sediment as needed, or as required by the Engineer.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.

- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite in conformance with the provisions in MDT Standard Specifications.

Sandbag Barrier SC-8





BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A sandbag barrier is a temporary linear sediment barrier consisting of stacked sandbags, designed to intercept and slow the flow of sediment-laden sheet flow runoff. Sandbag barriers allow sediment to settle from runoff before water leaves the construction site. Sandbags can also be used where flows are moderately concentrated, such as ditches, swales, and storm drain inlets (see BMP SC-10, "Storm Drain Inlet Protection") to divert and/or detain flows.

Appropriate Applications

- Along the perimeter of a site.
- Along streams and channels.
- Below the toe of exposed and erodible slopes.
- Down slope of exposed soil areas.
- Around stockpiles.
- Across channels to serve as a barrier for utility trenches or provide a temporary channel crossing for construction equipment, to reduce stream impacts.
- Parallel to a roadway to keep sediment off paved areas.
- At the top of slopes to divert roadway runoff away from disturbed slopes.
- To divert or direct flow or create a temporary sediment basin.
- During construction activities in stream beds when the contributing drainage area is less than 2 ha (5 acres).

- When extended construction period limits the use of either silt fences or straw bale barriers.
- Along the perimeter of vehicle and equipment fueling and maintenance areas or chemical storage areas.
- To capture and detain non-storm water flows until proper cleaning operations occur.
- When site conditions or construction sequencing require adjustments or relocation of the barrier to meet changing field conditions and needs during construction.
- To temporarily close or continue broken, damaged or incomplete curbs.
- This BMP may be implemented on a project-by-project basis in addition to other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Limit the drainage area upstream of the barrier to 2 ha (5 acres).
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor intensive.
- Limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.

Design Guidelines and Considerations

- Bag material and size are shown in the Sand Bag Barrier (SC-8) Detail Drawing.
- Gravel Bag Berm installation is described in the Sand Bag Barrier (SC-8) Detail Drawing.
- When used as a linear control for sediment removal:
    - Install along a level contour.
    - Turn ends of sandbag row up slope to prevent flow around the ends.
    - Generally, sandbag barriers shall be used in conjunction with temporary soil stabilization controls up slope to provide effective control.
- When used for concentrated flows:
    - Stack sandbags to required height using a pyramid approach as shown in the Detailed Drawings.
    - Upper rows of sandbags shall overlap joints in lower rows.
- Construct sandbag barriers with a set-back of at least 1m (3 ft) from the toe of a slope. Where it is determined to be not practicable due to specific site conditions, the sandbag

barrier may be constructed at the toe of the slope, but shall be constructed as far from the toe of the slope as practicable.

Maintenance, Inspection, and Removal

- Inspect sandbag barriers before predicted and as soon as possible after each storm event, and weekly throughout the construction season.
- Reshape or replace sandbags as needed, or as directed by the Engineer.
- Repair washouts or other damages as needed, or as directed by the Engineer.
- Inspect sandbag barriers for sediment accumulations and remove sediments when accumulation reaches 1/3 the barrier height. Removed sediment shall be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way in conformance with the Standard Specifications.
- Remove sandbags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilized the area.

SYMBOL: ———— ——SB——

SAND BAG BARRIERS SC-8

A SANDBAG BARRIER IS A TEMPORARY LINEAR SEDIMENTATION BARRIER CONSISTING OF STACKED SANDBAGS, DESIGNED TO INTERCEPT AND SLOW THE FLOW OF SEDIMENT-LADEN SHEET FLOW RUNOFF. SANDBAGS CAN ALSO BE USED WHERE FLOWS ARE MODERATELY CONCENTRATED, SUCH AS DITCHES, SWALES, AND STORM DRAIN INLETS TO DIVERT AND/OR DETAIN FLOWS.

LIMIT THE USE OF SANDBAG BARRIERS TO DRAINAGE AREAS OF 2 ha OR SMALLER. DUE TO THE BAG MATERIAL, SANDBAG BARRIERS HAVE A TENDENCY TO FAIL OVER LONG-TERM PROJECTS.

USE WOVEN POLYPROPYLENE, POLYETHYLENE, OR POLYAMIDE FABRIC OR BURLAP MATERIAL FOR BAGS. BAG MATERIAL IS REQUIRED TO HAVE A MINIMUM UNIT WEIGHT OF 135 g/m², A MULLEN BURST STRENGTH EXCEEDING 2 070 kPa AND AN ULTRAVIOLET STABILIZATION EXCEEDING 70%.

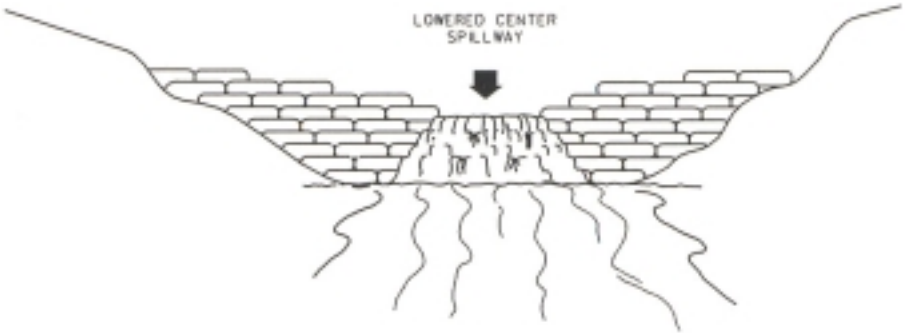
USE SANDBAGS HAVING A LENGTH OF 450 mm, WIDTH OF 300 mm, THICKNESS OF 75 mm, AND A MASS OF APPROXIMATELY 15 kg. ALTERNATIVE BAG SIZES MAY REQUIRE ENGINEER'S APPROVAL PRIOR TO USE.

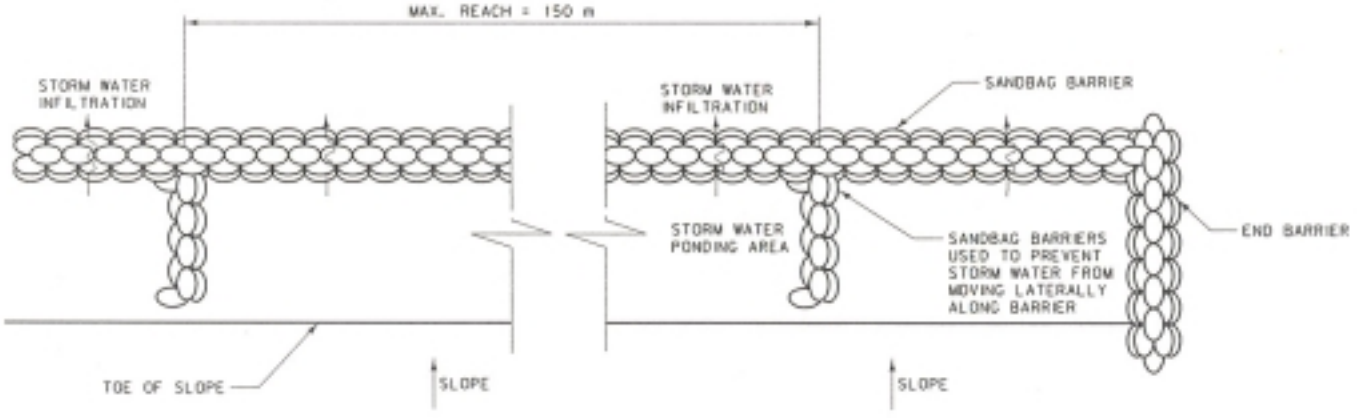
FILL SANDBAGS WITH SAND CONSISTING OF 100% PASSING THE 4.75 mm SCREEN, 50% PASSING THE 2.00 mm SIEVE, AND 20% MAXIMUM PASSING THE 0.075 mm SIEVE. FILL MATERIAL IS SUBJECT TO APPROVAL BY THE ENGINEER.

WHEN INSTALLING SANDBAG BARRIERS AS LINEAR CONTROL, PLACE BAGS ALONG A LEVEL CONTOUR. UPON ENDING THE SANDBAG RUN, PLACE THE LAST BAGS TO ANGLE UP THE SLOPE SO THAT FLOWS DO NOT ESCAPE AROUND THE END.

WHEN SANDBAG BARRIERS ARE PLACED IN CONCENTRATED FLOWS, STACK SANDBAGS TO HEIGHT USING A PYRAMID APPROACH WITH THE UPPER SANDBAGS OVERLAPPING THE LOWER ROW. THIS APPLICATION MAY NOT BE USED WITHIN THE CLEAR ZONE UNLESS OVERALL HEIGHT IS 150 mm OR LESS.

ALL BAGS PLACED WITHIN THE CLEAR ZONE REQUIRE MEASURES TO PROTECT SAND FROM FREEZING. ALL FREEZE REDUCTION METHODS REQUIRE ENGINEERS APPROVAL PRIOR TO IMPLEMENTATION.





PRELIMINARY

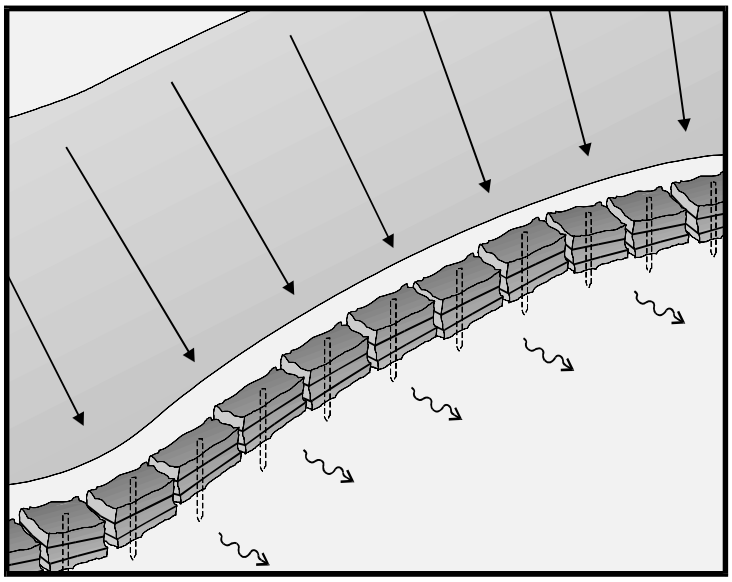
REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77

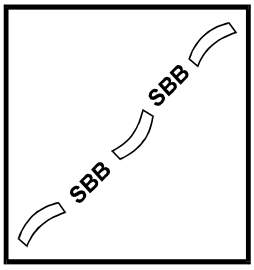
SAND BAG BARRIERS (SC-8)

EFFECTIVE:

CDM Camp Dresser & McKee Inc.

Straw Bale Barriers SC-9





BMP Objectives
- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A straw bale barrier is a temporary linear sediment barrier consisting of straw bales, designed to intercept and slow sediment-laden sheet flow runoff. Straw bale barriers allow sediment to settle from runoff before water leaves the construction site.

Appropriate Applications

- Along the perimeter of a site.
- Along streams and channels.
- Below the toe of exposed and erodible slopes.
- Down slope of exposed soil areas.
- Around stockpiles.
- Across minor swales or ditches with small catchments.
- Around above grade type temporary concrete washouts (See BMP WM-8, “Concrete Waste Management”).
- This BMP may be implemented on a project-by-project basis in addition to other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Don’t use in areas subjected to highly concentrated flows, such as channels or live streams.
- Installation can be labor intensive.

- Straw bale barriers are maintenance intensive.
- Degraded straw bales may fall apart when removed or left in place for extended periods.
- Can not be used on paved surfaces.
- Shall not be used on lined ditches.
- Shall not be used with clear zone limits unless approved by the Engineer.

Design Guidelines and Considerations

- Straw bale materials and size are shown in the Straw Bale Barriers (SC-9) Detail Drawing.
- Straw Bale Barrier installation is described in the Straw Bale Barriers (SC-9) Detail Drawing.
- Limit the drainage area upstream of the barrier to 0.3 ha/100 m (0.75 ac/325 ft) of barrier.
- Limit the slope length draining to the straw bale barrier to 30 m (100 ft).
- Slopes of 50:1 or flatter are preferred. If the slope exceeds 10:1 the length of slope upstream of the barrier must be less than 15 m (50 ft).
- Straw bales shall be installed with two offset lines of bales and embedded to prevent holes between bales and bridging due to undercutting.
- Construct straw bale barriers with a set-back of at least 1 m (3 ft) from the toe of a slope. Where it is determined to be not practicable due to specific site conditions, the straw bale barrier may be constructed at the toe of the slope, but shall be constructed as far from the toe of the slope as practicable.

Maintenance, Inspection, and Removal

- Inspect straw bale barriers prior to forecasted storm events, as soon as possible after each storm event, and weekly throughout the rainy season.
- Inspect straw bale barriers for sediment accumulations and remove sediments when depth reaches 1/3 the barrier height. Removed sediment shall be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.
- Replace or repair damage bales as needed or as directed by the Engineer.
- Repair washouts or other damages as needed or as directed by the Engineer.
- Bales can be scattered when their function as a storm water barrier is completed. Accumulated sediment can be removed or seeded and stabilized.

SYMBOL: ——————— ———SBB———

STRAW BALE BARRIERS SC-9:

STRAW BALE BARRIERS ARE A SEDIMENT BARRIER CONSISTING OF ENTRENCHED, OVERLAPPING AND ANCHORED STRAW BALES THAT REDUCE RUNOFF VELOCITIES AND RETAIN SEDIMENT. DO NOT USE STRAW BALE BARRIERS INSIDE THE CLEAR ZONE. STRAW BALES MUST BE CERTIFIED WEED-FREE.

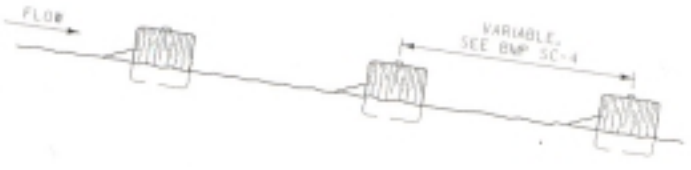
STRAW BALE BARRIERS ARE USED FOR SHEET OR CONCENTRATED FLOWS TO REDUCE RUNOFF VELOCITY, PROMOTE SEDIMENT RETENTION AND ALLOW SETTLING. DO NOT USE STRAW BALES IN HIGH FLOWS SUCH AS CHANNELS OR LIVE STREAMS. IN ADDITION, STRAW BALES CAN NOT BE USED ON SURFACE WHICH DO NOT ALLOW FOR ENTRENCHMENT.

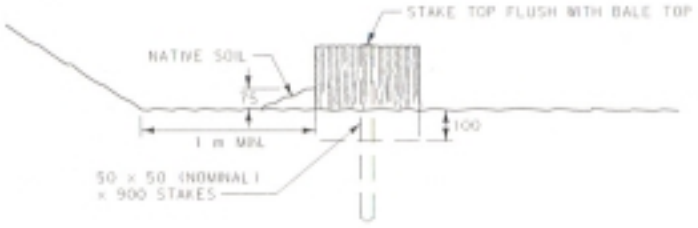
MINIMUM STRAW BALES SIZE REQUIREMENTS ARE A WIDTH OF 360 mm, HEIGHT OF 450 mm, LENGTH OF 900 mm AND A MASS OF 23 kg. USE STEEL WIRE (1.57 mm MIN. DIAMETER), NYLON OR POLYPROPYLENE STRING (2 mm MIN. DIAMETER) TO BIND BALES. MINIMUM BREAKING STRENGTH OF BINDING MATERIAL IS 360 N. USE 50 mm BY 50 mm (NOMINAL) BY 900 mm LONG WOODEN STAKES. DO NOT USE METAL STAKES.

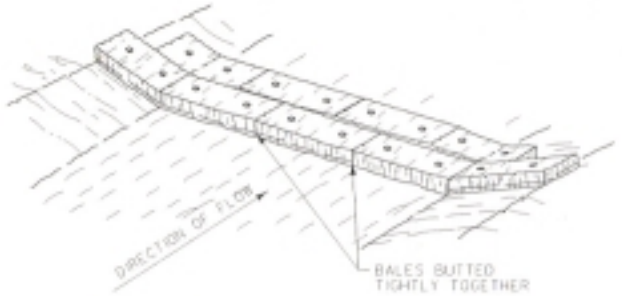
INSTALL STRAW BALES ALONG A LEVEL CONTOUR, WITH THE LAST BALE TURNED UP SLOPE. PLACE BALES IN A 100 mm DEEP TRENCH, TIGHTLY ABUT ADJACENT BALES, AND STAKE USING A MINIMUM OF TWO STAKES PER BALE. IF SLOPES EXCEED 10:1 THE LENGTH OF SLOPE UP STREAM OF THE BARRIER MUST BE LESS THAN 15 m. OFFSET BALES AT LEAST 1 m FROM THE TOE OF SLOPES. IF SITE CONDITIONS DO NOT ALLOW FOR OFFSET, BALES MAY BE PLACED AT TOE.

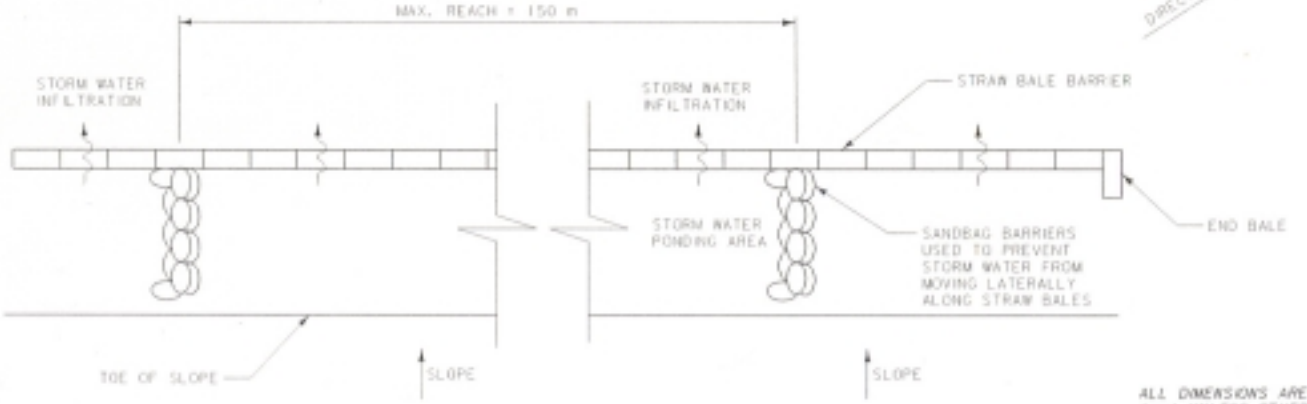
FOLLOW GUIDELINES IN BMP SC-4 IF BALES ARE USED AS CHECK DAMS.

REPAIR OR REPLACE DAMAGED, UNDER-CUT OR END RUN BALES. REMOVE SEDIMENT BUILDUP FROM BALES ONCE IT REACHES A HEIGHT OF 1/3 THE BALE HEIGHT.









ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

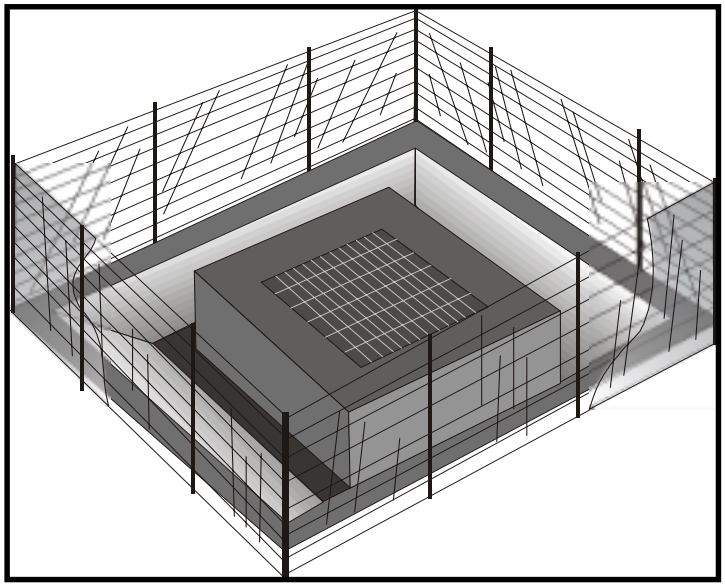
REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-22

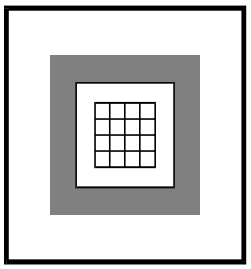
STRAW BALE BARRIERS (SC-9)

EFFECTIVE:

CDM Camp Dresser & McKee Inc.

Storm Drain Inlet Protection SC-10





BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Storm Drain Inlet Protection is used at storm drain inlets that are subject to runoff from construction activities to detain and/or to filter sediment-laden runoff to allow sediment to settle and/or to filter sediment prior to discharge of storm water into storm water drainage systems or watercourses.

Appropriate Applications

- Where ponding will not encroach into highway traffic.
- Where sediment laden surface runoff may enter an inlet.
- Where disturbed drainage areas have not yet been permanently stabilized.
- Where the drainage area is 0.4 ha (1 acre) or less.
- Appropriate during wet and snow-melt seasons.

Limitations

- Use only when ponding will not encroach into highway traffic or onto erodible surfaces and slopes. If safety is a concern, use other methods of temporary protection to prevent sediment-laden storm water and non-storm water discharges to enter the storm drain system.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use other on-site sediment trapping techniques in conjunction with inlet protection.
- Frequent maintenance is required.

- For drainage areas larger than 0.4 ha (1 acre), runoff shall be routed to a sediment trapping device designed for larger flows. See BMPs SC-2, "Desilting Basin," and SC-3 "Sediment Traps."

- Filter fabric fence inlet protection appropriate in open areas is subject to sheet flow and for flows not exceeding 0.014 m^3/s (0.5 ft^3/s).

- Sandbag barriers for inlet protection are applicable when sheet flows or concentrated flows exceed 0.014 m^3/s (0.5 ft^3/s), and it is necessary to allow for overtopping to prevent flooding.

- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected and overflow capability is needed.

Design Guidelines and Considerations

- Identify existing and/or planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed, and which method to use.

- The Straw Bale Barrier method materials and installation are described in the Storm Drain Inlet Protection (SC-10) Detail Drawing.

- The Filter Fabric Fence method materials and installation are described in the Storm Drain Inlet Protection (SC-10) Detail Drawing.

- Do not place filter fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced.

- Use Sandbag Barriers and Gravel Check Dams for high flows as described in the Storm Drain Inlet Protection (SC-10) Detail Drawing.

- The Sandbag Barrier materials and installation are described in the Storm Drain Inlet Protection (SC-10) Detail Drawing.

- Flow from a severe storm should not overtop the sandbags. In areas of high clay and silts, use filter fabric and gravel as additional filter media.

- The Gravel Check Dam method materials and installation are described in the Storm Drain Inlet Protection (SC-10) Detail Drawing.

Maintenance, Inspection, and Removal

General

- Inspect all inlet protection devices before predicted storm events, as soon as possible after storm events, and weekly during the construction season. During extended rainfall events, inspect inlet protection devices at least once every 24 hours.

- Inspect the storm drain inlet after severe storms to check for bypassed material.

- Remove all inlet protection devices within thirty days after the site is stabilized, or when the inlet protection is no longer needed.

- Bring the disturbed area to final grade and smooth and compact it. Appropriately stabilize all bare areas around the inlet.

- Clean and re-grade area around the inlet and clean the inside of the storm drain inlet as it must be free of sediment and debris at the time of final inspection.

Requirements by Method

Straw Bale Barriers

- Inspect straw bale barriers prior to forecasted storm events, as soon as possible after each storm event, and weekly throughout the rainy season.

- Inspect straw bale barriers for sediment accumulations and remove sediments when depth reaches 1/3 the barrier height. Removed sediment shall be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.

- Replace or repair damage bales as needed or as directed by the Engineer.

- Repair washouts or other damages as needed or as directed by the Engineer.

- Bales can be scattered when their function as a storm water barrier is completed. Accumulated sediment can be removed or seeded and stabilized.

Filter Fabric Fence

- Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes.

- Replace or clean the fabric when the fabric becomes clogged with sediment. Make sure the fabric does not have any holes or tears. Repair or replace fabric as needed or as directed by the Engineer.

- At a minimum, remove the sediment behind the fabric fence when accumulation reaches 1/3 the height of the fence or barrier height. Removed sediment shall be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.

Sandbag Barrier

- Inspect bags for holes, gashes, and snags.

- Check sandbags for proper arrangement and displacement. Remove the sediment behind the barrier when it reaches 1/3 the height of the barrier. Removed sediment shall be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.

Gravel Check Dam

- Inspect check dams after each storm event. Repair damage as needed or as required by the Engineer.

- Remove sediments when depth reaches 1/3 of the check dam height.

- Remove accumulated sediment prior to permanent seeding or soil stabilization or seed accumulated sediment to stabilize.

- Remove check dam and accumulated sediment when check dams are no longer needed or when required by the Engineer. Check dams can be left in place following construction activities and allowed to accumulate sediment and vegetation as approved by the Engineer.

- Removed sediment shall be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.

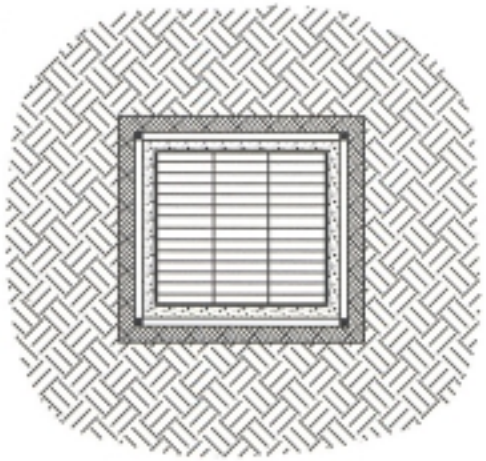
SYMBOL:

STORM DRAIN INLET PROTECTION SC-10:

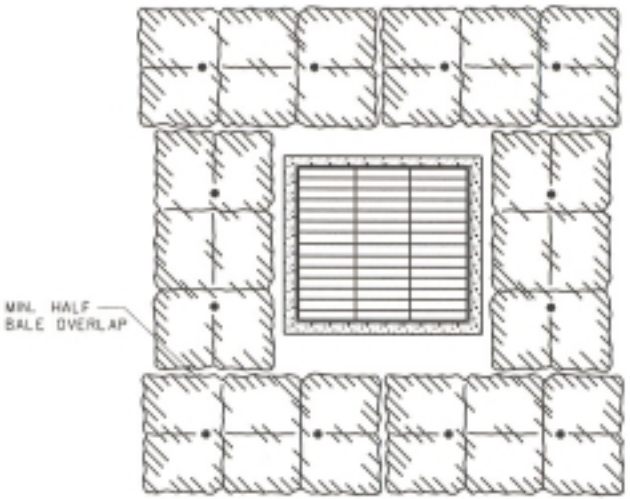
STORM DRAIN INLET PROTECTION IS USED AT STORM DRAIN INLETS THAT ARE SUBJECT TO RUNOFF FROM CONSTRUCTION ACTIVITIES. THESE DEVICES DRAIN AND/OR FILTER SEDIMENT-LADEN RUNOFF AND ALLOW SEDIMENT TO SETTLE PRIOR TO DISCHARGE OF STORM WATER INTO STORM WATER DRAINAGE SYSTEMS OR WATERCOURSES.

USE STORM DRAIN INLET PROTECTION WHEN PONDING WILL NOT ENCROACH INTO HIGHWAY AND FOR DRAINAGE AREAS OF 0.4 ha OR LESS. FOR FLOWS LESS THEN 0.014 m^3/s SILT FENCE OR STRAW BALES MAY BE USED. WHEN FLOWS EXCEED 0.014 m^3/s USE SANDBAG BARRIERS OR GRAVEL CHECK DAMS. FOLLOW SILT FENCE (SC-1), STRAW BALE BARRIERS (SC-9), SANDBAG BARRIERS (SC-8) AND CHECK DAMS (SC-4) FOR INSTALLATION REQUIREMENTS FOR EACH TYPE OF MATERIAL.

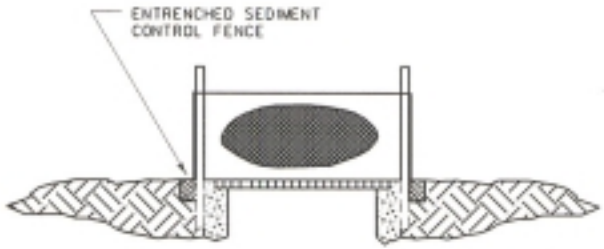
STRAW BALES, SAND BAGS, AND GRAVEL BERMS MAY BE USED WITHIN THE CLEAR ZONE UPON ENGINEERS APPROVAL. EXPEDIENTLY REMOVE ALL STRAW BALES, SAND BAGS, AND GRAVEL BERMS FROM THE CLEAR ZONE UPON COMPLETION OF CONSTRUCTION ACTIVITIES.



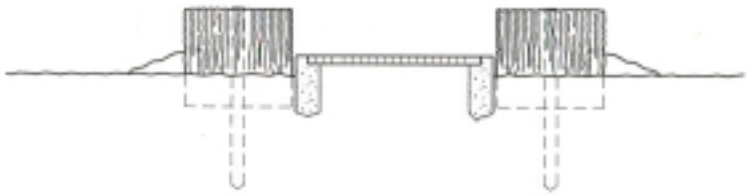
SILT FENCE - PLAN VIEW



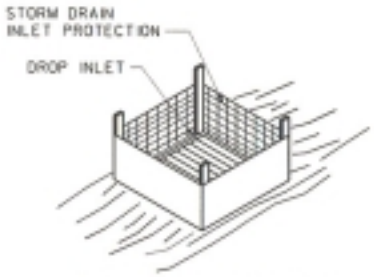
STRAW BALE BARRIER - PLAN VIEW



SILT FENCE - PROFILE VIEW



STRAW BALE BARRIER - PROFILE VIEW



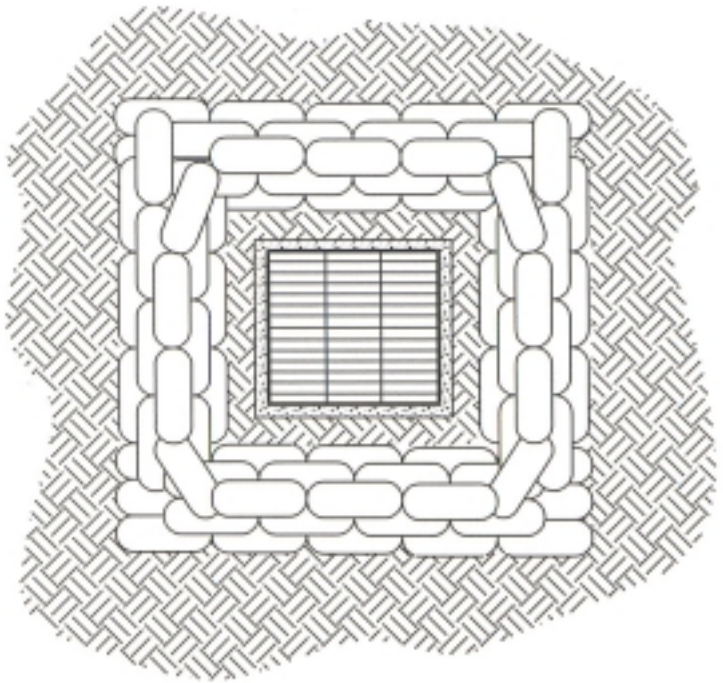
EXAMPLE ISOMETRIC VIEW

ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

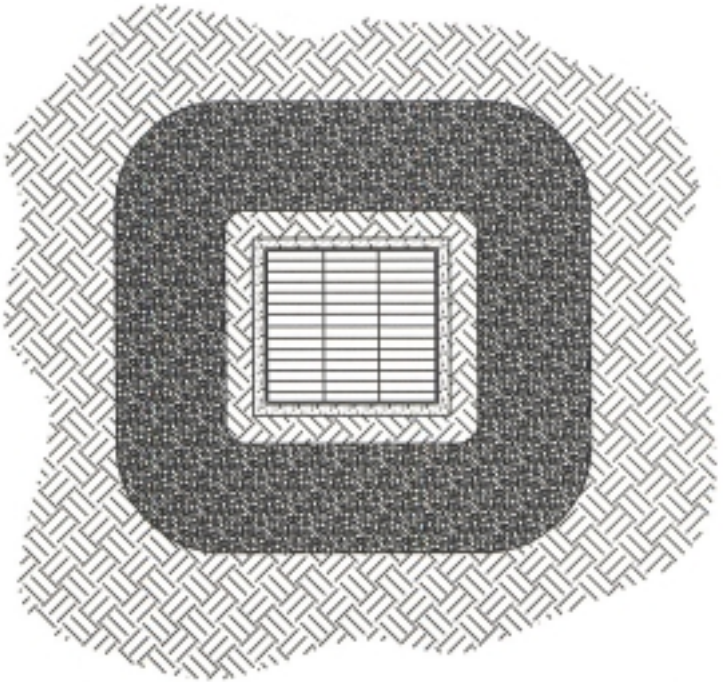
PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-22
STORM DRAIN INLET PROTECTION (SC-10) (SHEET 1)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.



SANDBAG BARRIER - PLAN VIEW



GRAVEL CHECK DAM - PLAN VIEW

SANDBAG BARRIER - PROFILE VIEW

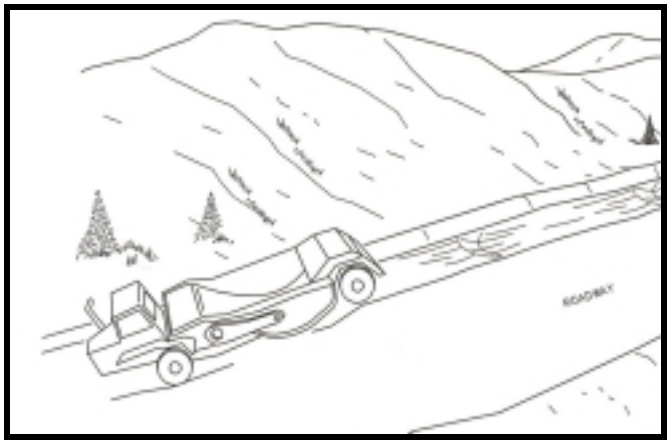
GRAVEL CHECK DAM - PROFILE VIEW

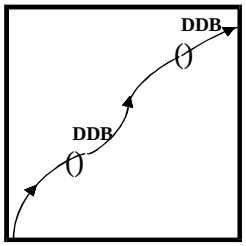
PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-??
STORM DRAIN INLET PROTECTION (SC-10) (SHEET 2)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Dugout Ditch Basin SC-11





BMP Objectives

- ● Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Dugout ditch basins consist of one or a series of small dugout basins located within a flow channel. Dugout ditch basins are used to reduce runoff velocity, promote sediment retention and allow settling within longitudinal roadside ditches in a cut section or as longitudinal sediment retention basins at the toe of fills.

Appropriate Applications

- Dugout ditch basins are used for longitudinal slope steepness (grade) sediment retention. Applications include ditch sediment traps, interceptor ditches, and toe of slope protection.
- The Designer determines the locations requiring ditch sediment traps and the proper placement intervals of the basins.

Limitations

- Not to be used in live streams.
- Not to be placed in channels which are already grass lined unless erosion is expected, as installation may damage vegetation.
- Require maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms.

Design Guidelines and Considerations

- Dugout ditch basins shall be placed at a depth that allows small pools to form in them.
- The maximum height for dugout ditch basins used inside the errant vehicle recovery area is 150 mm (6 in).
- The distance between dugout ditch basins is dependent on the length of ditch section relating to the grade that needs sediment retention. The interval is as follows:

Ditch Slope	Dugout Ditch Basin Spacing
2% to 3%	91 meters
3% to 4%	46 meters
4% +	15 meters

- The dugout ditch basin spacing values are empirical and are the maximal interval distances for a 2 year, 24-hour rain event. Intervals may be shortened at the discretion of the Engineer if soil conditions and/or precipitation indicate a need to do so.

- Dugout ditch basins can remain in place and be seeded during permanent seeding of the ditch.

Maintenance, Inspection, and Removal

- Inspect basins prior to predicted storm events and as soon as possible after each storm event. Repair damage as needed or as required by the Engineer.

- Remove sediments when required by the Engineer.

- Removed sediment shall be incorporated in the project at locations designated by the Engineer or disposed of outside the right-of-way as approved by the Engineer.

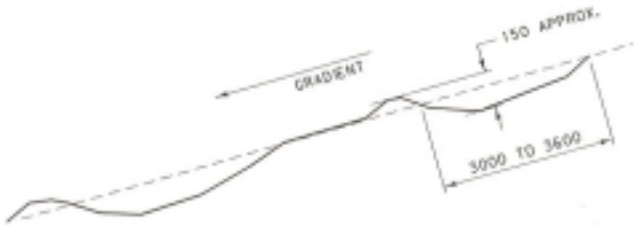
SYMBOL: ——————— ———DDB———

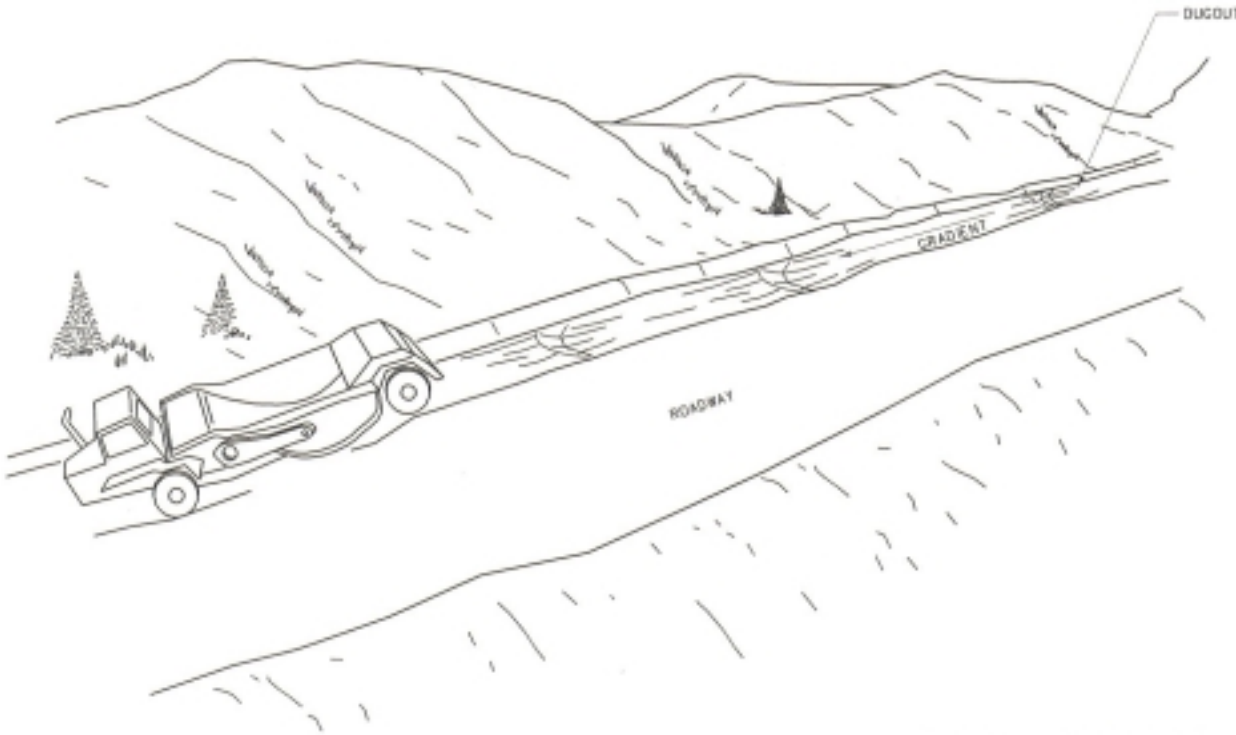
DUGOUT DITCH BASIN SC-111

DUGOUT DITCH BASINS CONSIST OF ONE OR A SERIES OF SMALL DUGOUT BASINS USED FOR CONCENTRATED FLOWS TO REDUCE RUNOFF VELOCITY, PROMOTE SEDIMENT RETENTION AND ALLOW SETTLING. THE MAXIMUM HEIGHT FOR DUGOUT DITCH BASINS USED INSIDE THE CLEAR ZONE IS 150 mm.

DUGOUT DITCH BASINS ARE USED FOR LONGITUDINAL SLOPE STEEPNESS (GRADE) SEDIMENT RETENTION. APPLICATIONS INCLUDE DITCH SEDIMENT TRAPS, INTERCEPTOR DITCHES AND TOE OF SLOPE PROTECTION. USE IS DEPENDENT ON SOIL TYPE. DISTANCES BETWEEN DUGOUT DITCH BASINS ARE AS FOLLOWS:
- FROM 2% TO 3% PLACE DUGOUT DITCH BASINS AT 90 METER SPACING
- FROM 3% TO 4% PLACE DUGOUT DITCH BASINS AT 45 METER SPACING
- FROM 4% + PLACE DUGOUT DITCH BASINS AT 15 METER SPACING

DUGOUT DITCH BASIN SPACING CAN BE ADJUSTED ON A PROJECT-BY-PROJECT BASIS FOLLOWING ENGINEERS APPROVAL.





ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

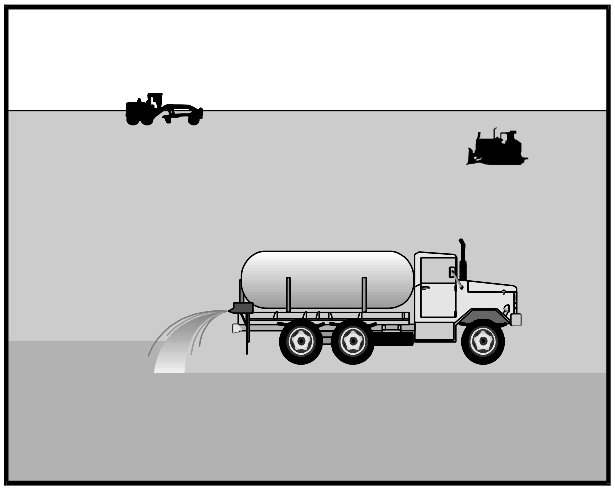
REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-22
DUGOUT DITCH BASIN (SC-111)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Wind Erosion Control BMPs

Wind erosion control consists of installing wind fencing or applying water or other dust palliatives as necessary to prevent or control dust nuisance. Additionally, other BMPs sometimes used to reduce wind erosion are BMPs SS-3 through SS-7.

Wind Erosion Control WE-1



BMP Objectives

- ○ Soil Stabilization
- ○ Sediment Control
- ○ Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Wind erosion control consists of applying water or other dust suppressants as necessary to prevent soil erosion. Most BMPs described in Section 3.1 can also be applied to wind erosion. Several BMPs protect the soil surface like vegetative covers (SS-2, SS-4, and SS-15), buffer or mulch covers (SS-3, SS-6, and SS-8), as well as other control techniques that require periodic applications. These techniques include wet suppressions (i.e. watering, application of surfactants or other additives) and chemical stabilizers that change the physical and chemical characteristics of the surface. Other techniques are: surface roughening (SS-12) and wind barriers like board fences, wind fences, hay bales, crate walls, and similar materials. Stockpiles and other temporary soil structures shall also be protected from wind erosion. Stockpiles can be covered with plastic or fabric and materials can be stored in open ended buildings or storage silos. Work practices can be conducted to prevent soil erosion, like load-in and load-out operations, restricted pile activity, loading and unloading downwind, and minimizing spillage of material, and subsequent spreading of material. All dust controls shall be applied in accordance with MDT Standard Specification.

Appropriate Applications

Wind erosion should be considered for be all exposed soils subject to wind erosion.

Limitations

Effectiveness depends on soil, temperature, humidity, wind velocity, and wind direction.

Design Guidelines and Considerations

- Water shall be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution. In the winter months, the amount of water used for dust suppression shall be monitored not to saturated the soil and create other problems, like icing, excess runoff, and mud/dirt carry out.

- All distribution equipment shall be equipped with a positive means of shutoff.

- Unless water is applied by means of pipelines, at least one mobile unit shall be available at all times to apply water or dust suppressants.

- If reclaimed wastewater is used, the sources and discharge must meet Montana DEQ water reclamation criteria. Non-potable water shall not be conveyed in tanks or drain pipes that will be used to convey potable water and there shall be no connection between potable and non-potable supplies. Non-potable tanks, pipes and other conveyances shall be marked "NON-POTABLE WATER - DO NOT DRINK."

- Materials applied as temporary soil stabilizers and soil binders will also provide wind erosion control benefits. These materials shall be applied at manufacturer's specifications in accordance with all federal, state, local regulations.

Maintenance, Inspection, and Removal

- Check areas protected to ensure coverage.

- Implement requirements of MDT Standard Specifications as appropriate.

- Dust control measures require constant attention. Water may be dispersed on a regular basis depending on weather conditions.

- Special care shall be taken with the storage, handling, and disposal of chemical soil stabilizers, and soil binders. Section 3.7 describes BMPs related to Waste Management and Material Pollution Controls.

- Remove wind fencing and other non-degradable devices when soils are stabilized.

SYMBOL:

WIND EROSION CONTROL WE-1:

WIND EROSION CONTROL CONSISTS OF APPLYING WATER OR OTHER DUST SUPPRESSANTS, ROUGHENING SURFACES OR INSTALLING WIND BARRIERS TO PREVENT WIND EROSION BY PROTECTING SOIL SURFACES OR BY REDUCING WIND VELOCITIES.

WATER SPRAYING:

APPLY BY MEANS OF PRESSURE-TYPE DISTRIBUTORS OR PIPELINES EQUIPPED WITH A SPRAY SYSTEM OR HOSES AND NOZZLES THAT MAY ENSURE EVEN DISTRIBUTION. DO NOT USE EXCESSIVE AMOUNTS OF WATER FOR DUST SUPPRESSION THAT MAY CAUSE SOILS TO BECOME SATURATED AND CREATE OTHER PROBLEMS SUCH AS EXCESS RUNOFF, MUD/DIRT TRACKING OR ICING IN THE WINTER MONTHS. EQUIP ALL DISTRIBUTION SYSTEM WITH A POSITIVE MEANS OF SHUTOFF. UNLESS WATER IS APPLIED BY MEANS OF PIPELINES, AT LEAST ONE MOBILE IS REQUIRED TO BE AVAILABLE AT ALL TIMES ON THE CONSTRUCTION SITE TO APPLY WATER OR DUST SUPPRESSANTS. IF RECLAIMED WASTEWATER IS USED, THE SOURCES AND DISCHARGE MUST MEET MONTANA DEQ WATER RECLAMATION CRITERIA. DO NOT USE NON-POTABLE WATER IN TANKS OR DRAIN PIPES THAT MAY BE USED TO CONVEY POTABLE WATER. DO NOT CONNECT BETWEEN POTABLE AND NON-POTABLE SUPPLIES. MARK ALL NON-POTABLE TANKS, PIPES AND OTHER CONVEYANCES AS "NON-POTABLE WATER - DO NOT DRINK".

DUST SUPPRESSANTS:

MATERIALS APPLIED AS TEMPORARY SOIL STABILIZERS AND SOIL BINDERS MAY ALSO PROVIDE WIND EROSION CONTROL BENEFITS. APPLY THESE MATERIALS PER MANUFACTURE'S SPECIFICATIONS IN ACCORDANCE WITH ALL FEDERAL, STATE, LOCAL REGULATIONS. SEE SS-5 SOIL BINDERS.

CALCIUM CHLORIDE OR OTHER DUST SUPPRESSANTS USED ON ROADWAYS THAT ARE NOT LISTED IN SS-5 MUST MEET MDT SPECIFICATIONS AND/OR BE APPROVED BY THE ENGINEER PRIOR TO USE.

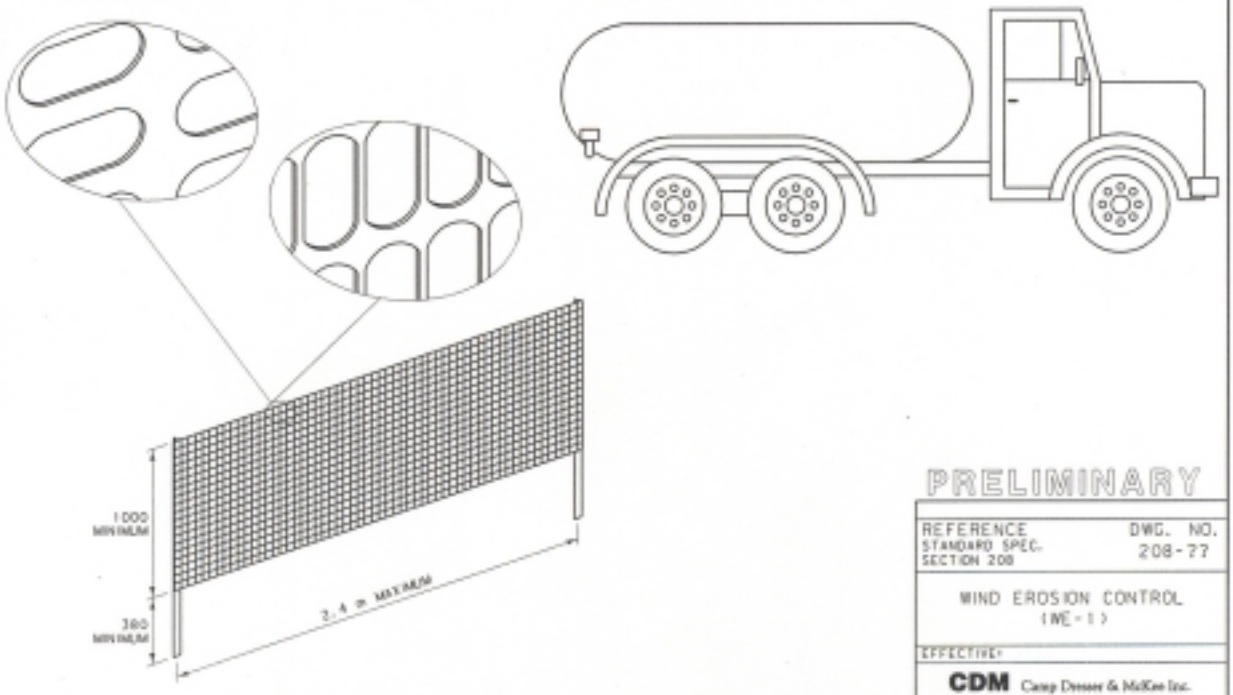
SLOPE ROUGHENING:

REFER TO SLOPE ROUGHENING TECHNIQUES DISCUSSED IN SS-12 SLOPE ROUGHENING.

WIND BARRIERS:

WIND BARRIERS PROVIDE AN AREA OF REDUCED WIND VELOCITY WHICH ALLOWS SETTLING OF LARGE SEDIMENT PARTICLES. MAXIMUM REDUCTION OF WIND VELOCITIES OCCUR IMMEDIATELY DOWNWIND OF THE WIND BARRIER, GRADUALLY DECREASING FURTHER DOWNWIND.

USE TEMPORARY WIND FENCING AS WIND BARRIERS ON CONSTRUCTION SITES. BOARD FENCING, EARTHEN BANKS, STRAW BOWS, ROCK WALLS, OR OTHER TEMPORARY WIND BARRIERS MAY BE UTILIZED AS APPROVED BY THE ENGINEER. WIND FENCING CAUSE WIND VELOCITY TO SLOW DOWN FOR APPROXIMATELY 40-50 TIMES THE FENCE HEIGHT, HOWEVER THE WIND FENCING IS ONLY EFFECTIVE FOR WIND BREAKING FOR APPROXIMATELY 10-25 TIMES THE HEIGHT OF THE FENCE. WIND FENCE IS REQUIRED TO BE A PREFABRICATED COMMERCIAL PRODUCT MADE OF WOVEN, POLYETHYLENE, AND ULTRAVIOLET RESISTANT MATERIAL WITH A POROSITY OF 50% MINIMUM. WIND FENCING IS MOST PROTECTIVE IN A DIRECTION THAT IS PERPENDICULAR TO THE WIND DIRECTION. FOR WIND PROTECTION OF STOCKPILES, PLACE WIND FENCING APPROXIMATELY 3 PILE HEIGHTS UPWIND OF THE STOCKPILE BASE.



PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
WIND EROSION CONTROL (WE-1)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Snow Accumulation and Snow Melt BMPs

Winter conditions such as heavy snow and ice can cause BMP failure.

Snow accumulation, icing, and snowmelt cause significant problems in Montana, particularly in Montana's upper mountain valleys. Heavy accumulation of snow in disturbed areas or poor snow removal practices can lead to severe erosion and sediment transport. In addition, freezing can cause BMPs to fail resulting in sediment discharge. Other soil stabilization and sediment control BMPs may also be effective. Snow accumulation and snow melt BMPs are shown in Table 2-3.

Table 2-3 Snow Accumulation and Snow Melt BMPs

ID	BMP Name	Primary Purpose	Erosion Processes
SN-1	Snow Management	Reduce the volume of runoff in disturbed areas	Rill/Gully, Sheet, Stream Bank, and Snow Melt.
SN-2	Snow Barriers	Reduce the volume of runoff in disturbed areas	Rill/Gully, Sheet, Stream Bank, and Snow Melt.
SN-3	Freeze Reduction	Increase effectiveness of structures and BMPs	Rill/Gully, Sheet, Stream Bank, and Snow Melt.

Removal of snow in sensitive areas prior to Spring melting can reduce erosion (BMP SN-1).

Fence can be used to limit snow accumulation in selected areas (BMP SN-2).

Snow Management SN-1

BMP Objectives
- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Snow management involves the relocation of snow by transporting, plowing, dozing, and/or blowing snow to locations where erosion impacts are less likely to occur during melting. This BMP can be used in conjunction with snow fences.

Appropriate Applications

This BMP is appropriate when construction projects extend through winter months and at locations (such as high mountain areas) where snow accumulation can be significant.

Limitation

This BMP may not be appropriate in areas with little snow accumulations and where access is limited.

Design Guidelines and Considerations

- Utilize snow blowers, snowplows, or other equipment to remove snow or move snow to less erosionally sensitive areas with proper drainage.
- Modify existing snowplow operations so snow is not piled in erosionally sensitive areas.
- Remove heavy snow accumulations from around temporary structures such as culverts to minimize ice jamming and structure failure during freeze-thaw cycles.
- Place snow in areas where soil/cover is stable and snowmelt will have a less significant impact.

Maintenance, Inspection, and Removal

- Remove or move snow as needed to reduce melt impacts.
- Inspect snow placement areas during the thaw cycle.

Snow Accumulation Management SN-2

BMP Objectives

- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

At construction sites, snow can accumulate on disturbed areas and in drainages prior to cover being established. The Snow Barrier BMP involves the installation of snow barriers to reduce the amount of erosion on disturbed areas. Temporary Snow Barriers are most commonly constructed from synthetic materials; however, boards, hay bales, rocks, and other similar materials can be used as well.

Appropriate Applications

In areas where snow drifts of 1.5 to 3 meters (5 to 10 feet) in depth can occur, snow fences can be installed to prevent snow from accumulating on sensitive areas. This practice will minimize erosive snowmelt runoff and ice blockages. Snow fencing can be used in conjunction with Preservation of Existing Vegetation (SS-2) and Wind Erosion Control (WE-1).

Limitation

Snow fences are difficult to install on steep slopes and rocky surfaces. Snow fences may not be cost effective when large areas need to be protected from snow accumulation. Removal at the end of the project is manpower intensive.

Design Guidelines and Considerations

- Install snow barriers adjacent to disturbed areas, perpendicular to the prevailing wind direction, and “upwind” of disturbance area.
- Fences in moderate snow areas should be 1.2 to 1.8 meters (4 to 6 ft) in height. Two or more parallel rows of snow fence may be used in areas of heavy snow accumulations.
- Synthetic fence density (the ratio of the solid area to the area of the fence) should be between 40% and 60%.
- Fences should be placed, if practical, at a distance of 15 to 20 times the fence height from the area to be protected.

Maintenance, Inspection, and Removal

- Inspect snow barrier materials and installation throughout the winter to make sure they are functioning properly.
- Remove snow barriers when the areas to be protected have been stabilized.

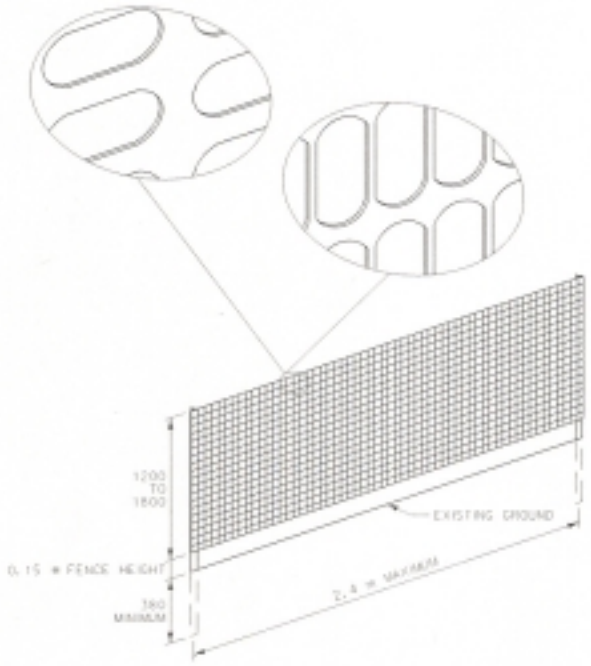
SYMBOLS

SNOW ACCUMULATION MANAGEMENT (SN-21)

SNOW ACCUMULATION BARRIERS PROVIDE AN AREA OF REDUCED WIND VELOCITY WHICH ALLOWS SETTLING OF SNOW. MAXIMUM REDUCTION OF WIND VELOCITIES OCCUR IMMEDIATELY DOWNWIND OF THE SNOW BARRIER, GRADUALLY DECREASING FURTHER DOWNWIND.

SNOW FENCING IS ONLY EFFECTIVE FOR DRIFT CONTROL FOR APPROXIMATELY 15-20 TIMES THE HEIGHT OF THE FENCE. SNOW FENCE IS REQUIRED TO BE A PREFABRICATED COMMERCIAL PRODUCT MADE OF WOVEN, POLYETHYLENE, AND ULTRAVIOLET RESISTANT MATERIAL WITH A POROSITY OF 40-60%. SNOW FENCING IS MOST PROTECTIVE IN A DIRECTION THAT IS PERPENDICULAR TO THE WIND DIRECTION. SEVERAL PARALLEL FENCES CAN BE USED IN AREAS OF HIGH SNOW ACCUMULATION OR HIGH WIND CONDITIONS. SECURE FENCING TO APPROVED POSTS WITH FOLLOWING MANUFACTURE RECOMMENDATIONS.

MAINTAIN SNOW FENCING AS NEED OR AS SPECIFIED BY THE ENGINEER. REMOVE SNOW ACCUMULATIONS FROM FENCING ONCE LEVELS HAVE REACHED THE BOTTOM OF THE FENCE.

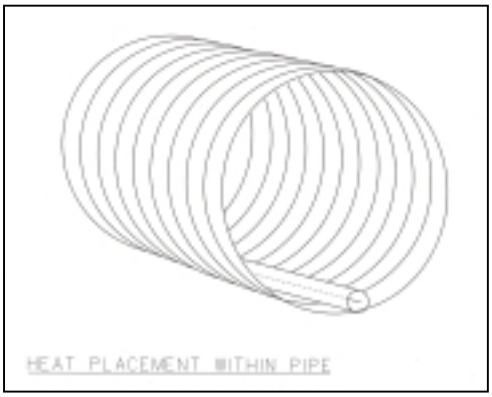


ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-22
SNOW ACCUMULATION MANAGEMENT (SN-21)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Freeze Reduction SN-3



BMP Objectives
- ○ Soil Stabilization
- ● Sediment Control
- ○ Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

Snow and ice accumulations in structures such as ditches and culverts can lead to plugging and subsequently to significant water flows across disturbed areas causing erosion. Frozen culverts can cause water to flow over roadways destabilizing them. Ice blockage in channels can increase water levels in the channels causing flooding and potentially resulting in significant damage. The freeze reduction BMP involves the use of oversized culverts, dual culverts, elevated culvert outlets, and heat trace to reduce the impacts of freezing weather on culvert effectiveness.

Appropriate Applications

Generally, ice blockage occurs during the winter months in Montana and proper slopes and proper installation of standard hydraulic structures reduce freezing. However, in areas where failure could cause significant damage, conservation methods such as the ones described in this BMP may be necessary.

Freeze reduction BMPs are appropriate in areas where heavy frost and snow may cause unacceptable failure, such as at or near environmentally hazardous sites, or in locations where failures could be a health hazard or cause unacceptable problems.

Limitation

Areas with limited access and space to install oversized and/or dual hydraulic structures. Elevated culvert outlets in streams should be avoided if fish migration is a concern. Heat trace may not be appropriate for remote areas with limited access to electricity.

Design Guidelines and Considerations

- Install oversized culverts to allow for some freezing.
- Install dual culverts with one culvert raised higher in elevation than the other culvert. This will allow water passage through the upper culvert if the lower culvert freezes.
- A vertical drop of approximately 0.6 meters (2 feet) at a culvert outlet may reduce water freezing within the culvert.

- Install channel freeze protective measures as shown in the Freeze Reduction (SN-3) Detail Drawing.

Maintenance, Inspection, and Removal

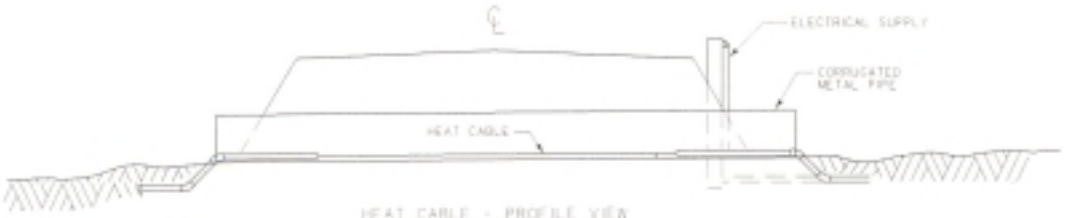
- Inspect temporary structures during freezing conditions and prior to spring thaw to assure that they are properly functioning.
- Disconnect and remove any electrical components when no longer required for freeze reduction.

SYMBOL: _____

FREEZE REDUCTION SN-51

FREEZE REDUCTION BMPS ARE USED TO ENSURE THAT CRITICAL CULVERTS DO NOT FREEZE DURING THE WINTER MONTHS. USE HEAT TRACE IN CULVERTS TO PREVENT FREEZING. IN ENGINEER APPROVED CONDITIONS A DOUBLE CULVERT SYSTEM MAY BE USED. WITH THIS SYSTEM IF ONE CULVERT FREEZES A SECOND HIGHER OR LOWER, CULVERT WILL CONTAIN RUNOFF.

ALL ELECTRICAL WORK TO BE COMPLETED BY A LICENSED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODES AND MDT STANDARD SPECIFICATIONS. HEAT CABLE IS INTENDED FOR CONTINUOUS OPERATION IN THE WINTER AND CAN NOT BE USED TO THAW FROZEN CULVERTS.



HEAT CABLE - PROFILE VIEW

HEAT CABLE - PLAN VIEW

HEAT PLACEMENT WITHIN PIPE

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-22
FREEZE REDUCTION (SN-51)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Tracking Control BMPs

Tracking control consists of preventing or reducing vehicle from tracking soil on the tires off site and consequently entering a storm drain or watercourse. Tracking control BMPs are shown in Table 2-4.

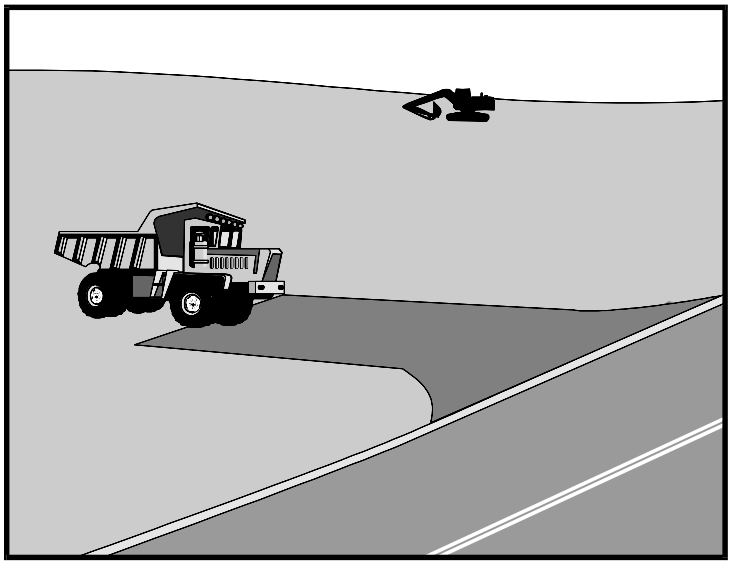
Table 2-4 Tracking Control BMPs.

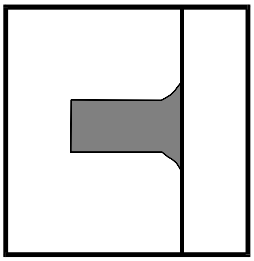
ID	BMP Name	Primary Purpose	Erosion Processes
TC-1	Stabilized Construction Entrance/Exit	Reduces offsite sediment tracking from trucks and construction equipment	Special
TC-2	Stabilized Construction Roadway	Control of dust and erosion created by vehicular traffic	Special
TC-3	Entrance/Outlet Tire Wash	Reduces offsite sediment tracking from trucks and construction equipment	Special

Washing tires at construction site outlets reduces off-site tracking of soils that they may end up in waterways (BMP TC-3).

Stabilized construction roads limit dust generation and off-site tracking of soil (BMP TC-2).

Stabilized Construction Entrance/Exit TC-1





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ● Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A stabilized construction access is a defined point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Appropriate Applications

- Use at construction sites:
  - where dirt or mud is tracked onto public roads.
  - adjacent to water bodies.
  - where poor soils are encountered.
  - where dust is a problem during dry weather conditions.
- This BMP may be implemented on a project-by-project basis in addition to other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Site conditions will dictate design and need.

Design Guidelines and Considerations

- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.

- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment-trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. The use of asphalt concrete (AC) grindings for stabilized construction access/roadway should be approved by the MDT Environmental Services Bureau.
- Use of constructed or constructed/manufactured steel plates with ribs for entrance/exit access is allowed with written approval of the Engineer.
- Designate combination or single purpose entrances and exits to the construction site. Require all employees, subcontractors and others to use them.

Maintenance, Inspection, and Removal

- Inspect routinely for damage and assess effectiveness of the BMP. Repair if access is clogged with sediment or as directed by the Engineer.
- Keep all temporary roadway ditches clear.

SYMBOL: ——————— CELL SCEE

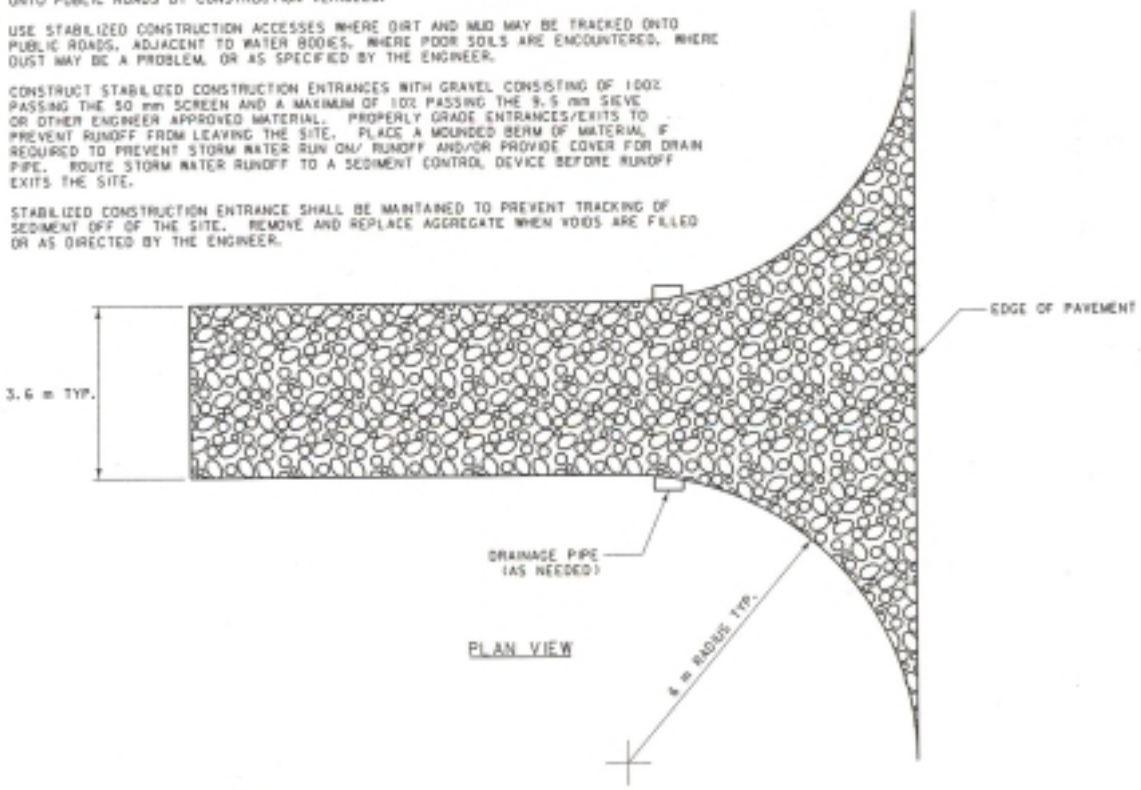
STABILIZED CONSTRUCTION ENTRANCE/EXIT TC-1:

A STABILIZED CONSTRUCTION ACCESS IS A DEFINED POINT OF ENTRANCE/EXIT TO A CONSTRUCTION SITE THAT IS STABILIZED TO REDUCE THE TRACKING OF MUD AND DIRT ONTO PUBLIC ROADS BY CONSTRUCTION VEHICLES.

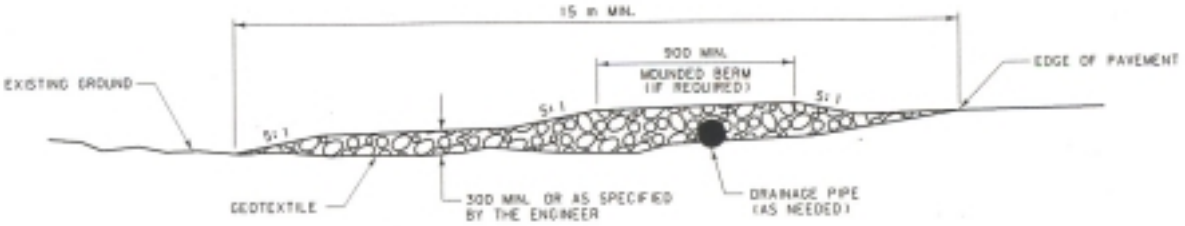
USE STABILIZED CONSTRUCTION ACCESSES WHERE DIRT AND MUD MAY BE TRACKED ONTO PUBLIC ROADS, ADJACENT TO WATER BODIES, WHERE POOR SOILS ARE ENCOUNTERED, WHERE DUST MAY BE A PROBLEM, OR AS SPECIFIED BY THE ENGINEER.

CONSTRUCT STABILIZED CONSTRUCTION ENTRANCES WITH GRAVEL CONSISTING OF 100% PASSING THE 50 mm SCREEN AND A MAXIMUM OF 10% PASSING THE 9.5 mm SIEVE OR OTHER ENGINEER APPROVED MATERIAL. PROPERLY GRADE ENTRANCES/EXITS TO PREVENT RUNOFF FROM LEAVING THE SITE. PLACE A MOUNDED BERM OF MATERIAL IF REQUIRED TO PREVENT STORM WATER RUN ON/ RUNOFF AND/OR PROVIDE COVER FOR DRAIN PIPE. ROUTE STORM WATER RUNOFF TO A SEDIMENT CONTROL DEVICE BEFORE RUNOFF EXITS THE SITE.

STABILIZED CONSTRUCTION ENTRANCE SHALL BE MAINTAINED TO PREVENT TRACKING OF SEDIMENT OFF OF THE SITE. REMOVE AND REPLACE AGGREGATE WHEN VOIDS ARE FILLED OR AS DIRECTED BY THE ENGINEER.



PLAN VIEW



PROFILE VIEW

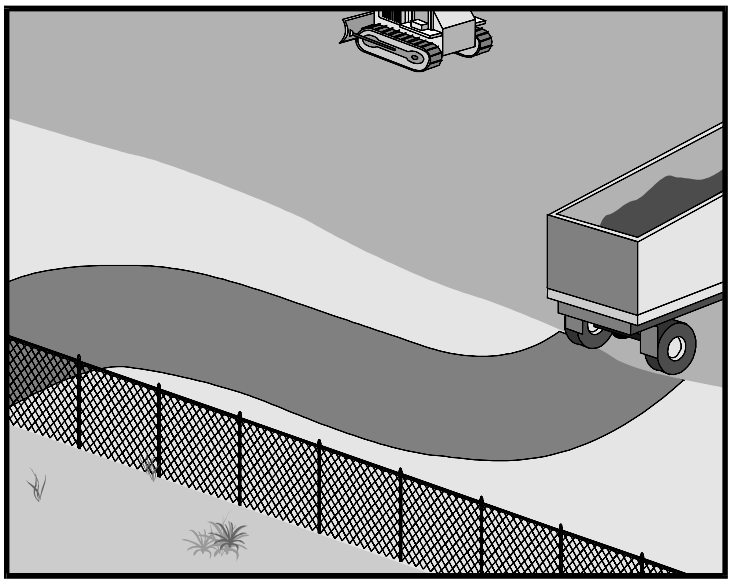
END VIEW

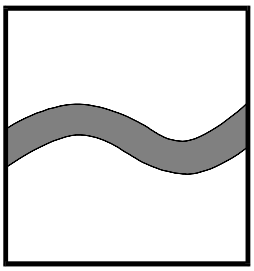
ALL DIMENSIONS ARE MILLIMETERS (mm) UNLESS OTHERWISE NOTED.

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-??
STABILIZED CONSTRUCTION ENTRANCE/EXIT (TC-1)	
EFFECTIVE:	
CDM Camp Dresser & McKee Inc.	

Stabilized Construction Roadway TC-2





BMP Objectives

- ● Soil Stabilization
- ○ Sediment Control
- ● Tracking Control
- ● Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A stabilized construction roadway is a temporary access road connecting existing public roads to a remote construction area. It is designed for the control of dust and erosion created by vehicular tracking.

Appropriate Applications

- Construction roadways and short-term detour roads:
  - Where mud tracking is a problem during wet weather.
  - Where dust is a problem during dry weather.
  - Adjacent to water bodies.
  - Where poor soils are encountered.
- This BMP may be implemented on a project-by-project basis with other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Materials will likely need to be removed prior to final project grading and stabilization.
- Site conditions will dictate design and need.
- May not be applicable to very short duration projects.
- Limit speed of vehicles to control dust.

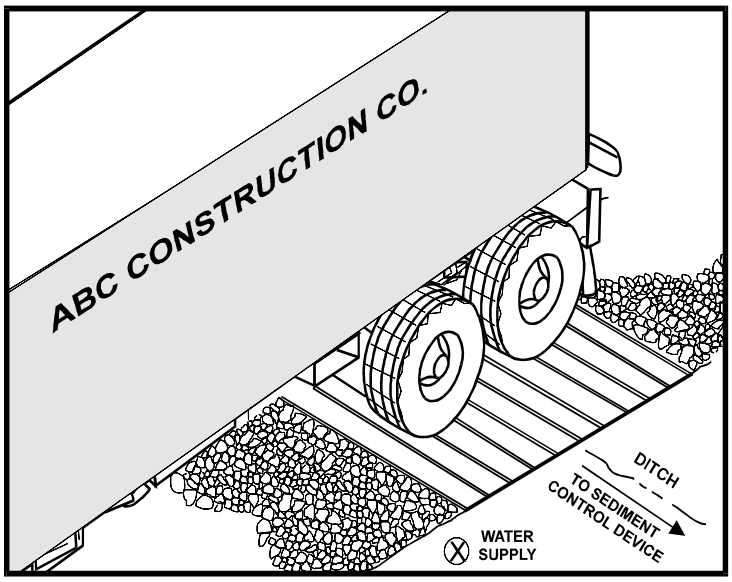
Design Guidelines and Considerations

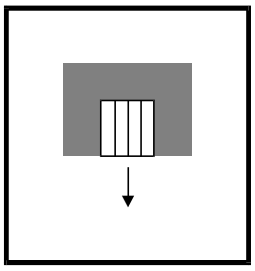
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.
- Stabilize roadway, using aggregate, AC, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or AC grindings for stabilized construction roadway should be approved by the MDT Environmental Services Bureau.
- Coordinate materials with those used for stabilized construction entrance/exit points.

Maintenance, Inspection, and Removal

- Inspect routinely for damage and repair as needed, or as directed by the Engineer.
- Keep all temporary roadway ditches clear.
- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.

Entrance/Outlet Tire Wash TC-3





BMP Objectives
- ● Soil Stabilization
- ● Sediment Control
- ● Tracking Control
- ○ Wind Erosion Control
- ○ Non-Storm Water Management
- ○ Materials and Waste Management

Definition and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and under carriage, and to prevent sediment from being transported onto public roadways.

Appropriate Applications

- Tire washes may be used on construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.
- This BMP may be implemented on a project-by-project basis in addition to other BMPs when determined necessary and feasible by the Engineer.

Limitations

- Requires a supply of wash water.
- Requires a turnout or doublewide exit in order to keep entering vehicles from having to drive through the wash area.

Design Guidelines and Considerations

- Incorporate with a stabilized construction entrance/exit. See BMP TC-1, "Stabilized Construction Entrance/Exit."
- Construct on level ground when possible, on a pad of coarse aggregate, greater than 75 mm (3 in) but smaller than 150 mm (6 in).
- Wash rack shall be designed and constructed/manufactured for anticipated traffic loads.

- Provide a drainage ditch that will convey the runoff from the wash area to a sediment sump device. The drainage ditch shall be of sufficient grade, width, and depth to carry the wash runoff.

- Require that all employees, subcontractors, and others that leave the site with mud-caked tires and/or undercarriages use the wash facility.

- Constructed/Manufactured steel-ribbed plates may be used in lieu of rock.

Maintenance, Inspection, and Removal

- Remove accumulated sediment in wash rack and/or sediment sump to maintain system performance.

- Inspect routinely for damage and repair as needed.

SYMBOL: ———————— CELL EOTW

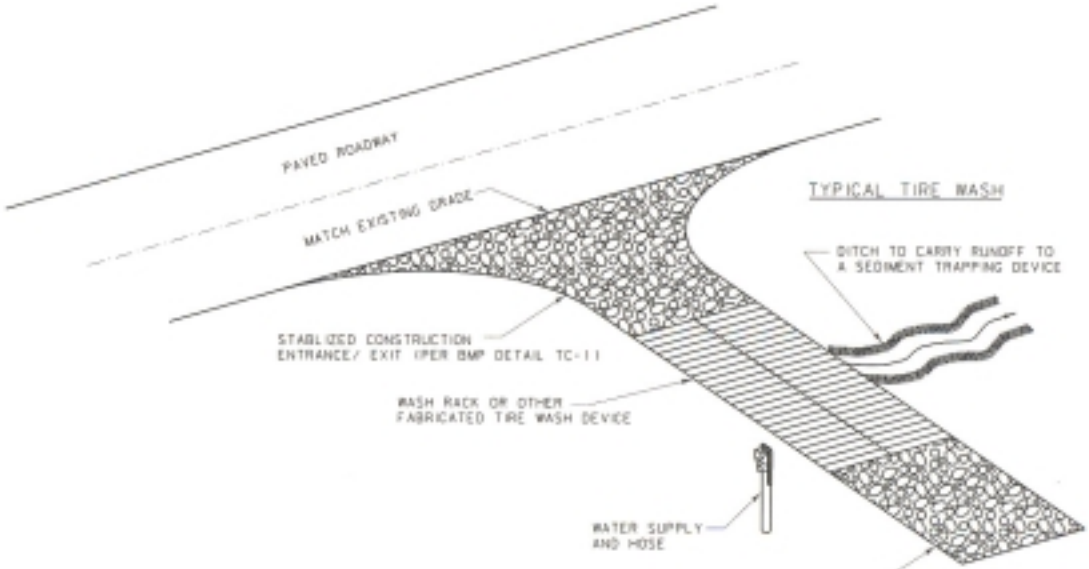
ENTRANCE/OUTLET TIRE WASH TC-3I

A TIRE WASH IS AN AREA LOCATED AT A STABILIZED CONSTRUCTION ACCESS POINT WHERE PRESSURIZED WATER IS USED TO REMOVE SEDIMENT FROM TIRES AND UNDERCARRIAGE, AND TO PREVENT SEDIMENT FROM BEING TRANSPORTED ONTO PUBLIC ROADWAYS.

TIRE WASHES ARE MEANT TO BE USED ON A PROJECT-BY-PROJECT BASIS AND REQUIRES APPROVAL BY THE ENGINEER. THESE DEVICES REQUIRE A SUPPLY OF WASH WATER AND MAY REQUIRE A TURNOUT OR DOUBLE WIDE ACCESS.

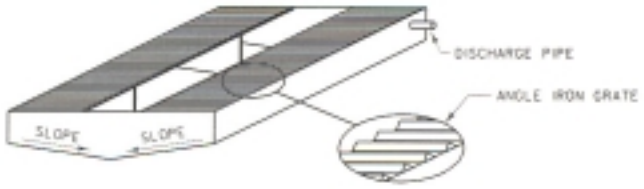
FOLLOW BMP TC-1 FOR STABILIZED CONSTRUCTION ENTRANCES/EXITS. PROVIDE WASH RACK SUITABLE FOR SUPPORTING TRAFFIC LOADS. DIRECT WASH WATER FROM THE RACK, THROUGH A DRAINAGE DITCH, TO A SEDIMENT TRAP DEVICE. ENGINEERS APPROVAL IS REQUIRED PRIOR TO CONSTRUCTION.

TIRE WASH DEVICES OTHER THEN THOSE SHOWN MAY BE USED AS APPROVED BY THE ENGINEER.



TYPICAL TIRE WASH

STEEL GRATE WASH RACK



SELF-CONTAINED STEEL TIRE WASH

PRELIMINARY

REFERENCE STANDARD SPEC. SECTION 208	DWG. NO. 208-77
ENTRANCE/OUTLET TIRE WASH (TC-3)	
EFFECTIVE:	

CDM Camp Dresser & McKee Inc.

Non-Storm Water Management BMPs

Non-storm water management BMPs are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with storm water. These practices involve day-to-day operations of the construction site and are usually under the control of the Contractor. These BMPs are also referred to as "good housekeeping practices", which involve keeping a clean, orderly construction site. Table 2-5 lists the non-storm water management BMPs. Fact sheets for these BMPs can be found in the MDT Erosion and Sediment Control Best Management Practices Manual (CDM, 2003).

Table 2-5 Non-Storm Water Management BMPs

ID	BMP Name	Primary Purpose	Erosion Processes
NS-1	Water Conservation Practices	Conserving water on construction sites	Special
NS-2	Dewatering Operations	Manage pollutants from dewatering operations	Special
NS-3	Paving and Grinding Operations	Minimize pollution of storm water during paving operations	Other Pollutants
NS-4	Temporary Stream Crossing	Minimize pollution at waterway crossings	Stream Bank
NS-5	Clear Water Diversion	Intercepts clear surface water runoff upstream of a project site	Rill/Gully, Stream Bank, and Snow Melt.
NS-6	Illicit Connection/Illegal Discharge Detection and Reporting	Recognize illicit connections or illegally dumped or discharged materials	Other Pollutants
NS-7	Potable Water/Irrigation	Reduce potential pollutants during discharge of water lines.	Other Pollutants
NS-8	Vehicle and Equipment Cleaning	Procedures to minimize or eliminate discharge of pollutants from cleaning operations	Other Pollutants
NS-9	Vehicle and Equipment Fueling	Procedures to eliminate the discharge of fuel spills into waterways	Other Pollutants
NS-10	Vehicle and Equipment Maintenance	Procedures to eliminate the discharge of pollutants into waterways from maintenance activities	Other Pollutants

Waste Management and Materials Pollution Control BMPs

Waste management and materials pollution control BMPs, like non-storm water management BMPs, are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with storm water. These BMPs also involve day-to-day operations of the construction site and are under the control of the Contractor. They are additional "good housekeeping practices", which involve keeping a clean, orderly construction site.

Materials pollution control (also called materials handling) consists of implementing procedural and structural BMPs for handling, storing, and using construction materials to prevent the release of those materials into storm water discharges. The objective is to reduce the opportunity for rainfall to come in contact with these materials. These controls shall be implemented for all applicable activities, material usage and, site conditions. Table 2-6 lists the waste management and materials pollution control BMPs. Fact sheets for these BMPs can be found in the MDT Erosion and Sediment Control Best Management Practices Manual (CDM, 2003).

Table 2-6 Waste Management and Material Pollution Control BMPs

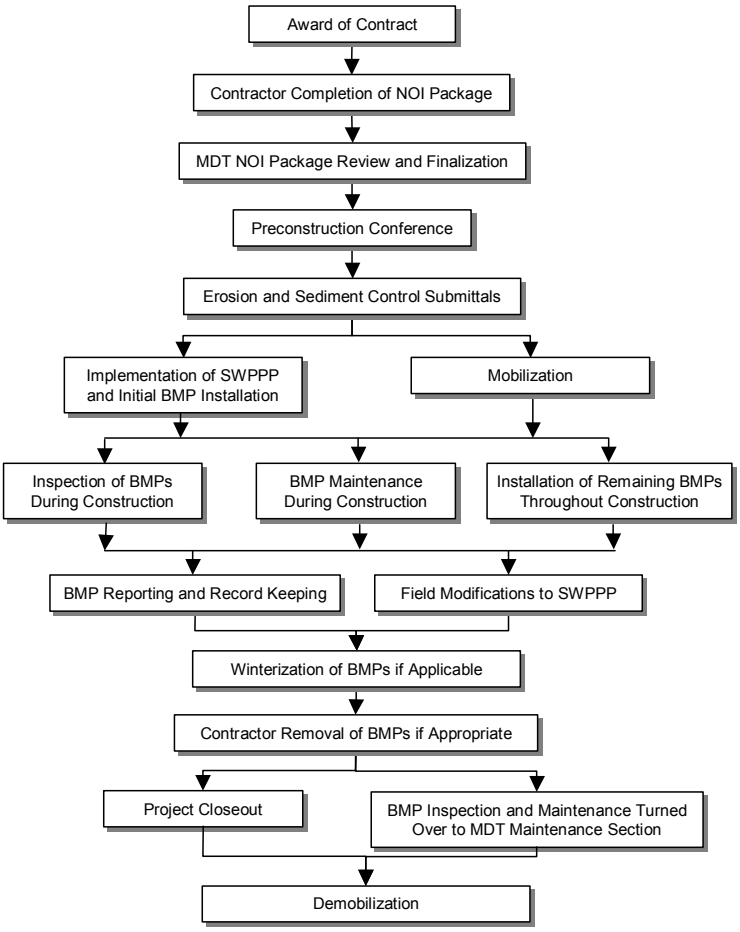
ID	BMP Name	Primary Purpose	Erosion Processes
WM-1	Material Delivery and Storage	Proper handling and storage of materials	Other Pollutants
WM-2	Material Use	Procedures for eliminating or reducing the discharge of materials to waterways	Other Pollutants
WM-3	Stockpile Management	Procedures for eliminating or reducing pollution of storm water from stockpiles	Splash, Sheet, Rill/Gully, Stream Bank, Wind, and Snow Melt.
WM-4	Spill Prevention and Control	Prevent and control spills	Other Pollutants
WM-5	Solid Waste Management	Management of packaging, building materials, etc.	Other Pollutants
WM-6	Hazardous Waste Management	Management of paints, chemicals, fertilizer, pesticides, oil and grease, etc.	Other Pollutants
WM-7	Contaminated Soil Management	Procedures for eliminating or reducing pollution of storm water from contaminated soils	Other Pollutants
WM-8	Concrete Waste Management	Procedures for eliminating or reducing pollution of storm water from concrete wastes	Other Pollutants
WM-9	Sanitary/Septic Waste Management	Procedures for eliminating or reducing pollution of storm water from concrete wastes	Other Pollutants
WM-10	Liquid Waste Management	Reduce liquid waste pollution	Other Pollutants

* BMP functions best primarily in western region.

Section 3
Erosion and Sediment Control Construction Phase Process

Overview of Erosion and Sediment Control Construction

The goal of the erosion and sediment control plan sheets and the SWPPP is to protect Montana surfaces by incorporating erosion and sediment control devices into the construction stage of transportation projects in order to prevent excessive erosion and sedimentation. This section identifies the required activities and individual's responsibilities to ensure that the project has the necessary erosion and control measures in place during construction activities. Key MDT personnel, Contractors, and Regulatory Agencies are required in the construction stage of the project to properly integrate erosion and sediment control devices into the project. The three major areas of responsibility for construction of erosion and sediment control BMPs are the Engineer/Inspector, Contractor, and the Regulatory Agencies. The flow chart below summarizes the construction phase process.



Erosion and Sediment Control Post-Construction Process

MDT Responsibilities

MDT employees who oversee the construction phase of MDT projects hold the title of Engineer and/or Inspector. This manual will use "Engineer" for the project overseer. Under some circumstances the Engineer may be a contracted third party brought in to aid MDT in construction oversight. The third party is not allowed to have an affiliation with the Contractor in order to avoid conflicts of interest.

As a part of the general requirements listed above, the Engineer is responsible for ensuring that the Contractor constructs all erosion and sediment control BMPs as specified on the construction plans and in accordance with the SWPPP. In addition, the Engineer is responsible for monitoring the timeliness of the installation of each BMP following the construction timeline. BMPs shall be inspected at minimum once every fourteen calendar days (unless otherwise specified) and within 24 hours after any storm event of 0.5 inches or greater. The Engineer will notify the Contractor of any repairs, additions, or maintenance that are deemed necessary.

Contractor Responsibilities

The Contractor is the individual or legal entity contracted to perform the prescribed work. For purposes of consistency, the Contractor will encompass the prime contractor and any and/or all subcontractors used to complete the project.

As a part of the above tasks, the Contractor is responsible for installation and maintenance (and possibly the removal of) temporary BMPs on the construction site during the contract period. The Contactor shall work with the Engineer to ensure that all erosion and sediment control devices are working correctly. The Contractor shall inspect all BMPs at a minimum once every fourteen calendar days (unless other wise specified) and within 24 hours after any storm event of 0.5 inches or greater. Upon routine maintenance, the Contractor shall adjust any BMPs that are not functioning correctly or install additional temporary BMPs as required to prevent erosion and contain sediment. Devices that are beyond adjustment shall be removed and replaced.

Regulatory Agencies Responsibilities

The primary regulatory agency that will be involved during the construction phase process is DEQ for non-Tribal lands and EPA for Tribal lands. DEQ/EPA is responsible for ensuring that all construction activities are in compliance with the General Permit. The following activities will be performed by DEQ/EPA:

- Check records that must be kept under the condition of the General Permit.
- Inspect any facilities, equipment, measures, or operations regulated or required under the General Permit.
- Sample or monitor any substances or parameters at any location within the construction activity area to assure permit compliance.

The operator shall allow DEQ/EPA to enter upon the construction site at reasonable times to perform the activities described above. Questions regarding DEQ's role during the construction phase process may be directed to:

Montana Department of Environmental Quality
Water Protection Bureau
Storm Water Program
1520 East Sixth Avenue
PO Box 200901
Helena, MT 59620-0901
(406) 444-3080

Questions regarding EPA's role and permitting obligations should be directed to:

EPA – Notice of Intent Processing Center
Storm Water Notice of Intent (4203M)
USEPA
1200 Pennsylvania Avenue, NW
Washington, DC 20460
(866) 352-7755

BMP Monitoring/Maintenance Checklist

On-site monitoring is necessary to assure the proper functioning of soil erosion, sedimentation, and storm water control measures. To meet the General Permit requirements, all erosion and sediment control measures must be monitored at least once every fourteen calendar days and within 24 hours after any storm event of 13 mm (0.5 inches) or greater. MDT requires monitoring of BMPs once a week, prior to forecasted storm events, and after storm events. The Contractor and Engineer may want to use the following example inspection form to inspect the site.

BMP Monitoring / Maintenance Checklist

Yes	No	
		Are BMPs accessible for monitoring and maintenance activities?
		Is there evidence of excessive sediment loss or pollution from site?
		Are slope stabilization BMPs effective in preventing excess erosion?
		Are rills/gullies present on reclaimed slopes?
		Do slope stabilization BMPs require maintenance to remove sediment?
		Are additional or different BMPs required for slope stabilization?
		Are sediment control BMPs effective in preventing excessive soil loss from site?
		Is sediment laden water undercutting or bypassing BMPs?
		Do sediment control BMPs require maintenance to remove sediment?
		Are any off-site conditions or activities negatively affecting on-site BMPs?
		Is winterization of BMPs required?
		Are wind control BMPs effective in reducing off-site dust?
		Are there BMPs that can be removed?
		Do sediment traps and desilting basins require sediment removal?
		Have BMP monitoring report and maintenance forms been completed for each BMP?
		Have maintenance follow-up action items been recorded?

Winterization Checklist

BMP Winterization Checklist

Limit fall–time disturbance of surface area to only that which can be properly protected for snowmelt runoff?

Schedule temporary or erosion seeding prior to ground freezing?

Determine applicability of snow management BMPs and apply as appropriate?

Evaluate wintertime access to maintain BMPs?

Make sure all BMPs are in place and able to with stand spring thawing and snow melt conditions?

Project Close-out Checklist

Project close-out is the culmination of the construction activities. As construction ends, the Contractor and MDT work together to ensure that the project is constructed as designed. The activities listed below will assist the Contractor and the Engineer in assessing the completion of the project.

Are all temporary BMPs in place that are scheduled to remain after construction completion?

Are BMPs in proper working order and constructed in accordance to the plans, specifications, details?

Are BMPs free of sediment accumulation?

Have BMPs that are no longer necessary been removed?

Is proper access provided to all BMPs requiring post-construction maintenance?

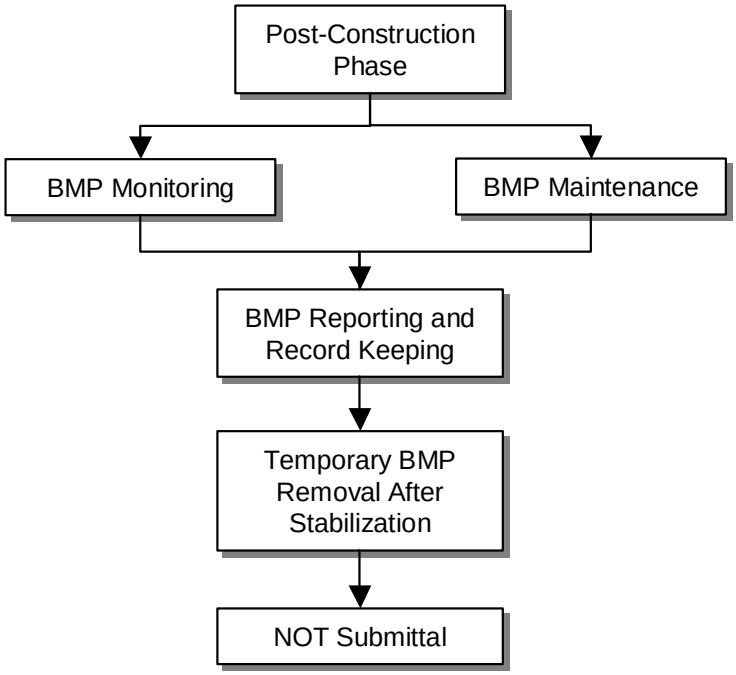
Have all outstanding items from the last BMP monitoring been corrected?

Is a representative of the MDT Maintenance Division present for close-out inspection?

Section 4
Erosion and Sediment Control Post-Construction Phase Process

Overview of Erosion and Sediment Control Post-Construction

The post-construction phase of a project addresses monitoring, maintenance, and removal of temporary erosion and sediment control BMPs after construction activities are completed. During the post-construction phase of a project, the long-term maintenance of BMPs is performed and corrective measures are taken to ensure that the BMPs perform their intended objective of preventing erosion and sedimentation in areas disturbed during construction activities. Post-construction activities include, but are not limited to, monitoring BMP effectiveness; removal of excess sediment trapped by BMPs; monitoring and maintenance of revegetation areas; repair and replacement of damaged BMPs; and removal of BMPs that are no longer required. Failure to properly address the long-term reclamation and erosion and sediment controls of a disturbed site can result in years of environmental damage both on the site and downgradient of the site. A brief overview of the post-construction phase processes as it relates to erosion and sediment control is shown below.



MDT Responsibilities

Following construction close-out, MDT becomes solely responsible for the project, unless maintenance agreements were made with Contractors or other outside organizations. At the project close-out, the project responsibilities are transferred from the Construction Bureau to the Maintenance Division. The Maintenance Division is now responsible for ensuring that all post-construction BMPs are functioning properly, and that permanent and temporary BMPs are monitored and maintained to control erosion and sedimentation. The Maintenance Division is also required to submit a Notice of Termination (NOT) to the regulatory agency.

Contractor Responsibilities

Once MDT has approved the project close-out, the Contractor has minimal if any responsibility for post-construction. The Contractor may be required by MDT to complete some tasks that were not completed during the project close-out. Additionally, the Contractor, or another agency may be brought in to perform routine maintenance on post-construction BMPs. It is important that the Maintenance Division be involved with the final Contractor close-out inspections to ensure that all the repairs were completed prior to responsibility transfer to the Maintenance Division.

Regulatory Agencies Responsibilities

DEQ is the primary regulatory agency involved with the post-construction phase monitoring of BMPs and the protection of surface waters from sedimentation and other pollution related to construction activities for sites not located on Tribal land. DEQ issues a NOT when a site is stabilized. Final stabilization of the site will be achieved when all soil disturbing activities at the site have been completed, and a vegetative cover has been established with a density of at least 70 percent of the pre-disturbance levels, or equivalent permanent, physical erosion reduction methods have been employed. DEQ is responsible to provide site inspections during and after construction activities.

BMP Monitoring/Maintenance Checklist

Yes	No	
		Are BMPs accessible for monitoring and maintenance activities?
		Is there evidence of excessive sediment loss or pollution from site?
		Are slope stabilization BMPs effective in preventing excess erosion?
		Are rills/gullies present on reclaimed slopes?
		Do slope stabilization BMPs require maintenance to remove sediment?
		Are additional or different BMPs required for slope stabilization?
		Are sediment control BMPs effective in preventing excessive soil loss from site?
		Is sediment laden water undercutting or bypassing BMPs?
		Do sediment control BMPs require maintenance to remove sediment?
		Are BMP materials in sufficient condition to work as designed?
		Are any off-site conditions or activities negatively affecting on-site BMPs?
		Is winterization of BMPs required?
		Are wind control BMPs effective in reducing off-site dust?
		Are there BMPs that can be removed?
		Do sediment traps and desilting basins require sediment removal?
		Have BMP monitoring report and maintenance forms been completed for each BMP?
		Have maintenance follow-up action items been recorded?

BMP Removal Checklist

Yes	No	
		Is site vegetation of adequate species and density (as specified by MDT Agronomist) to maintain soil stabilization?
		Have any rills or gullies formed on reclaimed slopes since last monitoring event?
		Is sediment still accumulating behind BMPs?
		Are permanent BMPs (if any) functioning properly?
		Can BMPs that are designed to collect small volumes of sediment be used in replacement of larger, more intrusive BMPs (e.g. replace silt fence with check dam)?

Section 5
Rules of Thumb

Rules of thumb consist of a variety of different tools to aid in the design and construction process. Within the rules of thumb are erosion and sediment control planning and design checklists, slope measurement tables, slope inclination conversion tables, and seeding application rate tables.

Slope Measurement Tables

Slope measurement tables, like the one listed below, are a useful tool during the design and construction of a variety of earthwork projects. Typically, plan sheets show the run to rise ratio. The table below shows the commonly used slopes with the correspondingly multiplication factor. The Pythagorean Theorem ($A^2 + B^2 = C^2$) describes the relationship between the run, rise, and slope length.

- **Run** is the horizontal change of the slope (A).
- **Rise** is the vertical change of the slope (B).
- **Slope length** at run length is the length of the slope using the run and rise factors (C).
- **Multiplication factor** is multiplied by the run to calculate the slope length.

Slope Measurement

Run	Rise	Slope Length	Multiplication Factor
20	1	20.025	1.00125
10	1	10.050	1.005
9	1	9.055	1.006
8	1	8.062	1.0078
7	1	7.071	1.0102
6	1	6.083	1.0138
5	1	5.099	1.0198
4	1	4.123	1.0308
3	1	3.162	1.0541
2	1	2.236	1.118
1.5	1	1.803	1.2018
1.25	1	1.601	1.2806
1	1	1.414	1.414
0.75	1	1.250	1.667
0.50	1	1.118	2.2361
0.25	1	1.031	4.1231

Slope Inclination Conversion Tables

Slope inclination conversion tables like the one listed below are another useful tool for design and construction of earthwork projects. They allow for the designer to gain another perspective of the slope and its correlation to erosion and sediment control. Three of these perspectives are the rise/run ratio, percent slope, and degree slope.

- **Rise** is the vertical distance used to measure slopes. This distance is usually set at a unit of one and the run is adjusted accordingly.
- **Run** is the horizontal distance used to measure slopes.

- **Run to rise ratio** is simply the run to rise correlation, i.e. 20:1 is 20 units of run for every unit of rise.
- **Percent slope** is the percentage difference between the run and the rise, i.e. a 20:1 slope would be 1 divided by 20, then multiplied by 100, to equal 5.0.
- **Degree slope** is the angle at the toe of the slope formed by the rise and the run. Since Tan θ equals rise over run, the slope in degrees can be calculated by taking the Tan^{-1} of the rise over the run.

Slope Inclination Conversion Worksheet

Run	Rise	Ratio	Percent	Degree
20	1	20:1	5.0	2.86
10	1	10:1	10.0	5.71
9	1	9:1	11.1	6.34
8	1	8:1	12.5	7.12
7	1	7:1	14.3	8.13
6	1	6:1	16.7	9.46
5	1	5:1	20.0	11.31
4	1	4:1	25.0	14.04
3	1	3:1	33.3	18.43
2	1	2:1	50.0	26.57
1.5	1	1.5:1	66.7	33.69
1.25	1	1.25:1	80.0	38.66
1	1	1:1	100.0	45.00
0.75	1	0.75:1	133.3	53.13
0.50	1	0.50:1	200.0	63.43
0.25	1	0.25:1	400.0	75.96

Seed Application Rate Tables

Seeding application rate tables can be found in the Detail Drawings (SS-4, and SS-15) shown in Section 3, Best Management Practices.

Conversion Tables (Metric ◄► English)

Area, Length, and Volume Conversion Factors

Quantity	From English Units	To Metric Units	Multiply By
Length	Mile	Km	1.609 344
	Yard	M	0.914 4
	Foot	M	0.304 8
	Foot	Mm	304.8
	Inch	Mm	25.4
Area	square mile	km^2	2.590
	Acre	m^2	4 046.856
	Acre	ha (10 000 m^2)	0.404 685 6
	square yard	m^2	0.836 127 36
	square foot	m^2	0.092 903 04
	square foot	ha (10 000 m^2)	0.000 009 29
	square inch	mm^2	645.16
Volume	acre foot	m^3	1 233.49
	cubic yard	m^3	0.764 555
	cubic foot	m^3	0.028 316 8
	cubic foot	cm^3	28 316.85
	cubic foot	L (1000 cm^3)	28.316 85
	100 board feet	m^3	0.235 974
	Gallon	L (1000 cm^3)	3.785 41
	1000 gallons	kL (1000 L)	3.785 41
	cubic inch	cm^3	16.387 064
	cubic inch	mm^3	16 387.064

NOTE: Underline denotes exact number

Civil and Structural Engineering Conversion Factors

Quantity	From English Units	To Metric Units	Multiply By
Mass	Lb kip (1000 lb)	kg metric ton (1000 kg)	0.453 592 0.453 592
Mass/unit length	Plf	kg/m	1.488 16
Mass/unit area	Psf	kg/m^2	4.882 43
Mass density	Pcf	kg/m^3	16.018 5
Force	Lb Kip	N kN	4.448 22 4.448 22
Force/unit length	Plf Klf	N/m kN/m	14.593 9 14.593 9
Pressure, stress, modulus of elasticity	Psf ksf psi ksi	Pa kPa kPa MPa	47.880 3 47.880 3 6.894 76 6.894 76
Bending moment, torque, moment of force	ft-lb ft-kip	N·m kN·m	1.355 82 1.355 82
Moment of mass	lb-ft	kg·m	0.138 255
Moment of inertia	$lb\text{-}ft^2$	$kg{\cdot}m^2$	0.042 140 1
Second moment of area	in^4 ft^4	mm^4 m^4	416 231 0.008 63
Section modulus	in^3	mm^3	<u>16 387.064</u>

NOTE: Underline denotes exact number.