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SECTION 1

The Contractor Certification Training Program

CONTRACTOR CERTIFICATION PROGRAM

Course Description

Inspector and Contractor Certification Program, Controlling Construction Site Erosion and Sedimentation.

This one-day program has been developed for the installers and inspectors of Best Management Practices (BMPs) for the control of erosion and sedimentation at construction sites. The program covers:

- The Colorado Stormwater Program requirements and permitting.
- Erosion and Sedimentation at construction sites.
- Types of BMPs for specific situations to control erosion and sedimentation.
- Installing construction site BMPs.
- Inspecting and maintaining construction site BMPs.

Course Completion Requirement

Attendance at a recognized training program in erosion and sediment control during construction is required. You cannot miss more than 10% of the total class time. There is no grandfathering.

What if I miss more than the allowable class time?
Makeup is required. You may attend the section(s) you missed at a later date.

Passing of a certification test
You must pass a certification test with a score of at least 72%.

What if I don't pass the certification test?
Retesting is permitted, but you must retest within six months of your original test date. You can take the test as many times as you wish. Retesting will be made available.

Certification Expiration
Contractor certifications are good for three years from the date you passed your examination. You will receive a card with the expiration date printed directly on the front.

Refresher Training
You must attend/complete a recognized refresher training program ***before*** your certification expires. A 4-hour refresher and recertification course is available from the Keep it Clean Partnership.

TOPICAL OUTLINE FOR CONTRACTOR CERTIFICATION TRAINING PROGRAM

Section	***Time***	***Topics***
Section 1 *Introduction*	8:00-8:20 a.m.	❖ Participant & Course Objective ❖ Learning Objectives ❖ Contractor Certification Program
Section 2 *Construction Site Erosion & Water Quality*	8:20-8:45 a.m.	❖ The Erosion Process ❖ Types & Impacts of Erosion
Section 3 *Regulatory Requirements*	8:45-9:30 a.m.	❖ Colorado Stormwater Program Permit Requirements
BREAK	9:30-9:40 a.m.	
Sections 4 & 5 *Administrative* *BMPs for Erosion Control* *Covering the Soil* *Vehicle Tracking Controls*	9:40-12:00 a.m.	❖ Administrative Controls for Erosion Control ❖ Methods to Cover Exposed Areas, Reduce Erosion, and Keep Soils On-Site
LUNCH	12:00 p.m. – 1:00 p.m.	
Section 6 *BMPs for Erosion Control (continued)*	1:00-1:30 p.m.	❖ Check Dams
Section 7 *Sediment Control Measures* *BMP's for Sediment Removal*	1:30-2:00 p.m.	❖ Silt Fencing – Straw Bales ❖ Keeping Sediment Out of Stormwater Inlets
BREAK	2:00 – 2:10 p.m.	
Section 7 (con) *BMPs for Sediment Removal Ponds*	2:10-2:40 p.m.	❖ Sediment Traps & Sediment Basins
Section 8 *Materials Handling*	3:10-3:30 p.m.	❖ Description of BMP Inspection & Recordkeeping Procedures ❖ Chemical Handling, Storage, & Spill Cleanup ❖ Concrete Washout & Concrete Saw Cutting ❖ Vehicle & Equipment Maintenance, Sanitary Services
BREAK	3:30 – 3:40 p.m.	
Section 9 *Inspections & Maintenance*	3:40 – 4:00 p.m.	❖ Conducting BMP inspections and follow-up maintenance
Section 13 *Contractor Certification Examination*	4:00-4:30 p.m.	❖ Certification Examination & Wrap-up

COURSE OBJECTIVES FOR CONTRACTOR CERTIFICATION TRAINING PROGRAM

1. Describe the State of Colorado's regulatory requirements under the Water Quality Control Act for stormwater management and erosion control during construction activities.
    a. Name the state agency in Colorado with authority to implement the stormwater management and erosion control provisions of the Water Quality Control Act.
    b. Describe the permitting requirements for the stormwater management and erosion control program.
    c. Locate specific legal requirements for the stormwater management and erosion control program.
    d. List the components of a stormwater management plan (SWMP).
    e. Define the following terms:
        Stormwater
        Waters of the State
        Stormwater Management Plan (SWMP)
        General Permit
        Inactivation Notice
        Transfer Notice
        Best Management Practices
        Illegal Discharge
    f. Describe the stormwater permit conditions.
    g. Identify local requirements for controlling erosion on construction sites.

2. Describe the effects of soil erosion on receiving waters (lakes, rivers, streams, ponds, wetlands, and other waters of the state) from construction sites.
    a. Identify the types and causes of soil and wind erosion.
    b. Define the following terms:
        Rill Erosion
        Gully Erosion
        Raindrop Impact
        Surface or Sheet Flow
        Channeling
        Flow Velocity
        Pollutant
        Concentrated Flow
        Tributary Acreage

3. Identify areas on a construction site that could be affected by erosion, including roadways, culverts, walls, and steep slopes.

4. Evaluate site conditions for erosion potential and identify site conditions to avoid.
    a. Identify steep slope areas that have greater erosion potential.
    b. Identify soil types that present greater erosion potential.

   c. Identify areas of a construction site that present long slope lengths.
   d. Evaluate the run-on potential for a construction site.
   e. Evaluate the total tributary acreage for a construction site.
   f. Identify times of the year that present the greatest potential for erosion.

5. Describe typical storm events and runoff potential for Colorado.

6. Select administrative and structural BMPs for construction site erosion control.
   a. Evaluate the benefits of short-term vs. long-term BMPs.
   b. Determine which BMPs will be (or could be) permanent erosion control or flood control structures.
   c. Evaluate specific constraints and limitations for implementing construction site BMPs.
   d. Match construction site conditions with the best BMP.
   e. Justify the use of BMPs for specific areas of a construction site.

7. Install BMPs for construction site erosion control.
   a. Locate and read specifications for the installation of construction site BMPs.
   b. Identify the tools and resources required to install construction site BMPs.
   c. Apply design criteria for BMPs to actual site conditions.
   d. Describe installation requirements based on applicable specifications.

8. Evaluate construction site BMPs for effectiveness and maintenance requirements and oversee maintenance activities for BMPs.

9. Inspect construction site BMPs.
   a. Develop a site inspection schedule based on permit requirements.
   b. Identify areas of a construction site requiring inspection.
   c. Document and communicate inspection findings to others.

SECTION 2

Construction Site Erosion and Water Quality

THE EROSION PROCESS

When the land's surface is worn away by the forces of wind, water, ice, and gravity, it is called erosion. The process of erosion is clearly a natural one; however, activities during construction remove the natural cover protecting the soil, greatly increasing erosion. Bare, loose soil is more easily moved by wind and water. This training program and manual are designed to address wind and water erosion. Water erosion has five primary mechanisms:

- Raindrop impact erosion
- Rill erosion
- Sheet erosion
- Gully erosion
- Channel erosion

Loose silt and sand-sized particles are more susceptible to erosion than sticky clay soils. Most of the soils in the Denver Metropolitan area are susceptible to wind and water erosion. Wind erosion occurs when wind blows at a sufficient velocity (which can be as low as 10 mph) to cause soil particles to move. Factors influencing wind erosion include:

- Soil cover
- Soil particle size
- Wind velocity
- Wind duration
- Unsheltered distance

Examples of Erosion

Grading work at a construction site can facilitate erosion by creating grooves in the direction of water flow. This usually happens accidentally as the equipment operator is working the slopes. The picture to the right shows the increased size of the grooves caused by water flow. *Be sure to grade on the contour*. In the bottom picture, sediment has started to fill in the drainage swale and culvert pipe (not in picture). Both conditions can result in severe erosion and lots of maintenance work to clean out sediment and redefine the drainage swale. If enough sediment collects in the culverts, water may overtop onto the roadway.

Grooving up and down the slope facilitating erosion

SEDIMENTATION

When sediment-laden runoff slows, the sediment is deposited. When later runoff comes in contact with the deposited sediment, it is re-suspended and carried downstream. In this way, sediment is progressively moved downstream in the waterway. The amount of sediment a watercourse can carry is dependent on the velocity and volume of the runoff. Windblown soil particles can also be deposited in waterways as well as behind obstructions like fences and buildings. ***Prevention is the key.***

Sediment-laden water entering a storm sewer

Effects on Water Quality

Polluted stormwater runoff from construction sites may discharge directly into a waterway, such as a stream, lake, or even a drinking water supply reservoir – or the runoff flows to the storm sewer system and is then discharged into local rivers and streams. Sediment is usually the main pollutant of concern from construction sites, and significant amounts of soil in short periods of time can be transported off the site. The resultant sedimentation causes physical, chemical, and biological harm to the receiving waters. For example, excess sediment can fill rivers, lakes, and water storage reservoirs requiring dredging. Removal of sediment from waterways is difficult, expensive, and destroys aquatic habitats. In addition, sediment covers stream bottoms and fills in the deep pools impacting fish spawning areas and aquatic insect breeding areas. Additional pollutants are also often present in stormwater runoff from construction sites and may result in degradation of receiving waters.

Nutrients and dissolved chemicals of specific concern include:

Nitrogen	Phosphorous	Manganese
Calcium	Magnesium	Sulfur
Sodium	Potassium	

Nitrogen, for example, can stimulate the growth of algae and affect fish life. In addition, solid and sanitary wastes, pesticides, oil and grease, concrete truck washout water,

construction chemicals, construction debris, and metals may be discharged, altering characteristics of the water impacting the aquatic ecosystem.

Other Impacts of Erosion and Sedimentation

Erosion of supporting soils from around structures can create a serious structural problem and possibly a public safety concern. In addition, all of the soil being eroded from slopes may collect on roadways, in culverts, and in other drainage features. The maintenance for these conditions can be expensive and time-consuming. The best approach is to keep the soil on the slopes and prevent erosion.

Practice Erosion Control vs. Sediment Removal

The best approach is to keep the soil in place

Sediment discharged into storm sewers is deposited directly into waterways without treatment

SECTION 3

Stormwater Regulations and Program Requirements

THE COLORADO STORMWATER REGULATIONS

Noncompliance penalties can be $10,000 per day per violation and up to $25,000 per day.

REGULATORY REQUIREMENTS

Stormwater Runoff and the Construction Industry

Stormwater is made up of rain, snow, and hail, as well as snowmelt runoff, surface runoff, and drainage associated with the storm events. Stormdrain systems consist of gutters, stormdrains, underground pipes, open channels, culverts, and creeks. In Boulder County, as in many Colorado counties, stormdrain systems drain **directly** to streams with **no** treatment. In route to streams, stormwater picks up pollutants, such as sediment, oil and grease, and nutrients as it travels over hard surfaces, such as pavement, asphalt, and roofs. These pollutants are delivered directly to our streams and are a major source of water pollution. This training will focus on pollutants generated by construction sites and the practices that control stormwater pollution from construction sites.

Soil exposed during construction activities contributes sediments to stormwater runoff. Animal and plant life in streams suffer negative effects from increased sediments delivered from construction sites to streams. These effects from increased sediment include:

- clogging of fish spawning areas and areas for raising young fish
- clogging and abrading fish gills, causing suffocation and injury
- reducing water clarity making it difficult to find food
- displacing aquatic organisms which are food for fish
- transporting additional contaminants, such as nutrients and metals

Construction materials, such as fuel, concrete wash water, and hydraulic fluids, are also pollutants which can be carried to streams by stormwater.

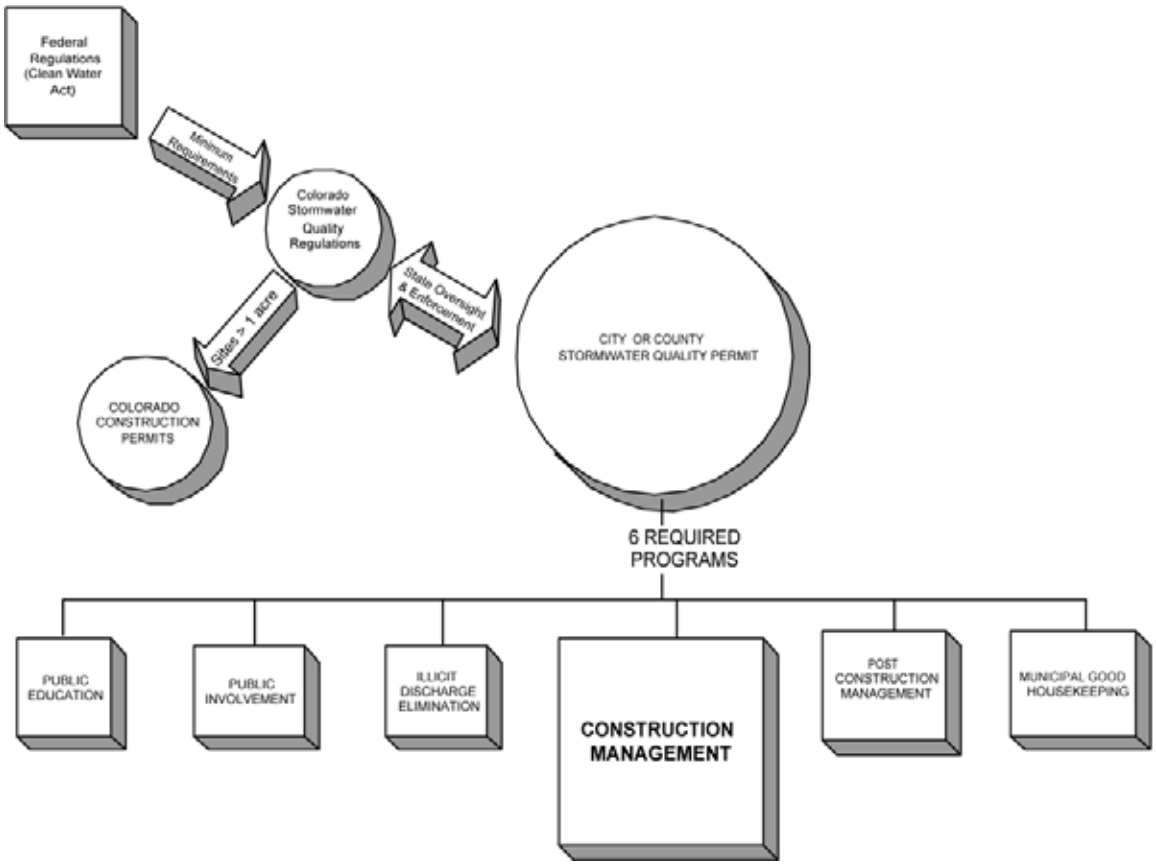
Practices designed to prevent increased stormwater sediment loads and construction materials pollutants are available. When these practices, known as **Best Management Practices (BMPs),** are properly implemented, sediment and pollutants generated by construction sites are greatly reduced.

To address sediment and pollutants in stormwater runoff, a system of federal, state, and local regulations exists, which requires programs to manage sources of stormwater pollution that discharge to municipal storm drain systems and streams. Specific requirements for construction site management are currently in effect through state and local regulations.

REGULATORY REQUIREMENTS

Federal Requirements

The federal Clean Water Act (CWA) requires that cities and counties and other public facilities that meet specific population standards apply for a stormwater permit for their storm sewer systems (See Figure). The goal of the stormwater permit program is to reduce the amount of pollutants entering streams, lakes, and rivers as a result of runoff from residential, commercial, municipal, and industrial areas, including construction sites. The federal regulations which govern these permit standards require cities and counties to implement six programs designed to reduce pollutant loading from urban areas via storm sewer systems.



These six programs include:

1. **Public Education:** Provide information and training for the general public to understand their role in stormwater pollution impacts to streams in their community.
2. **Public Involvement:** Provide opportunities for the public to be involved in decisions which address stormwater pollution management

3. **Illicit Discharge Elimination:** Develop and implement programs to track and stop illegal discharges to storm sewer systems.
4. **Construction Management:** Develop and implement ordinances and inspection and enforcement procedures to manage sediment and pollutant discharges from construction sites that disturb greater than one acre.
5. **Post-Construction Management:** Develop and implement ordinances and inspection and enforcement procedures to manage pollutant discharges after construction is complete.
6. **Municipal Good Housekeeping:** Implement procedures and practices to prevent pollution from operations of city, county, and other public entities.

In Colorado, the Environmental Protection Agency (EPA) has given responsibility for implementing these regulations and permits to the Colorado Department of Public Health and Environment (CDPHE). This training will focus on putting the requirements of the construction management programs into action in the state of Colorado.

Colorado Requirements

CDPHE has implemented state regulations which require identified cities and counties and other public entities to permit their storm sewer systems and implement six programs to manage stormwater pollution, as required by the federal regulations (See Figure). The permit will allow five years to fully implement all six programs. Cities and counties are required to develop and put a construction management program into action; however, the state will also require a CDPHE General Construction permit for any soil disturbing activities at construction sites. This permit is required for private and public projects, which disturb greater than one acre as part of development or redevelopment construction activities. The General Construction permit requires implementation of BMPs to manage generation of sediment and pollutants.

CDPHE General Construction Permit

Currently, both private and public construction sites are required to apply for a general construction permit from the Colorado Department of Public Health and Environment (CDPHE) if they:

- disturb over at least one acre, or
- are part of a larger common plan of development or sale that will disturb at least one acre.

The general construction permit requires the permit holder to (refer to the permit itself for the complete requirements):

- ✓ Develop a Stormwater Management Plan (SWMP).
- ✓ File a permit application at least 10 days prior to the start of construction activities.
- ✓ Maintain the SWMP and keep it on-site.
- ✓ Install best management practices (BMPs) according to specifications outlined in the SWMP.

- ✓ Perform inspections of stormwater and erosion controls following each significant storm event and every 14 days.
- ✓ Maintain inspection records.
- ✓ Provide SWMP and records to inspector upon request.
- ✓ Maintain and modify BMPs to reflect current conditions of job site.
- ✓ Achieve stabilization.
- ✓ Remove all temporary BMPs.
- ✓ Inactivate permit.
- ✓ Prevent contamination, pollution, or degradation of state waters.

The SWMP must identify appropriate stormwater pollution prevention measures or best management practices (BMPs). A best management practice, or BMP, is defined as any program, technology, process, practice, operating method, measure, or device that controls, prevents, removes, or reduces pollution. This training will provide information about available stormwater BMPs, appropriate installation and maintenance, and final site stabilization.

For more specific information about SWMP requirements and general construction permit application forms, contact the Water Quality Control Division, Stormwater Program by calling (303) 692-3517 or visit the website at:
http://www.cdphe.state.co.us/wq/PermitsUnit/wqcdpmt.html.

In a few limited situations, some or all of the general construction permit requirements may be waived for construction sites disturbing less than five acres. One condition is met if a local government or entity has a state-designated qualifying local program. A construction activity disturbing less than five acres in a municipality with a qualifying local program may not be required to submit an application, inactivation, or fees to the state, although state permit coverage is still obtained through the local municipality. The local municipality will be responsible for letting you know you do not need to apply for state coverage, if this is an option. You can review a list of municipalities with qualifying local programs at *http://www.cdphe.state.co.us/wq/PermitsUnit/wqcdpmt.html*.

Sites under five acres of disturbance may also apply for coverage under the R-Factor Waiver. In general, the waiver is for sites that will be completed and stabilized in a few months and during dry times of the year. Sites that will be seeded for final stabilization will generally not qualify.

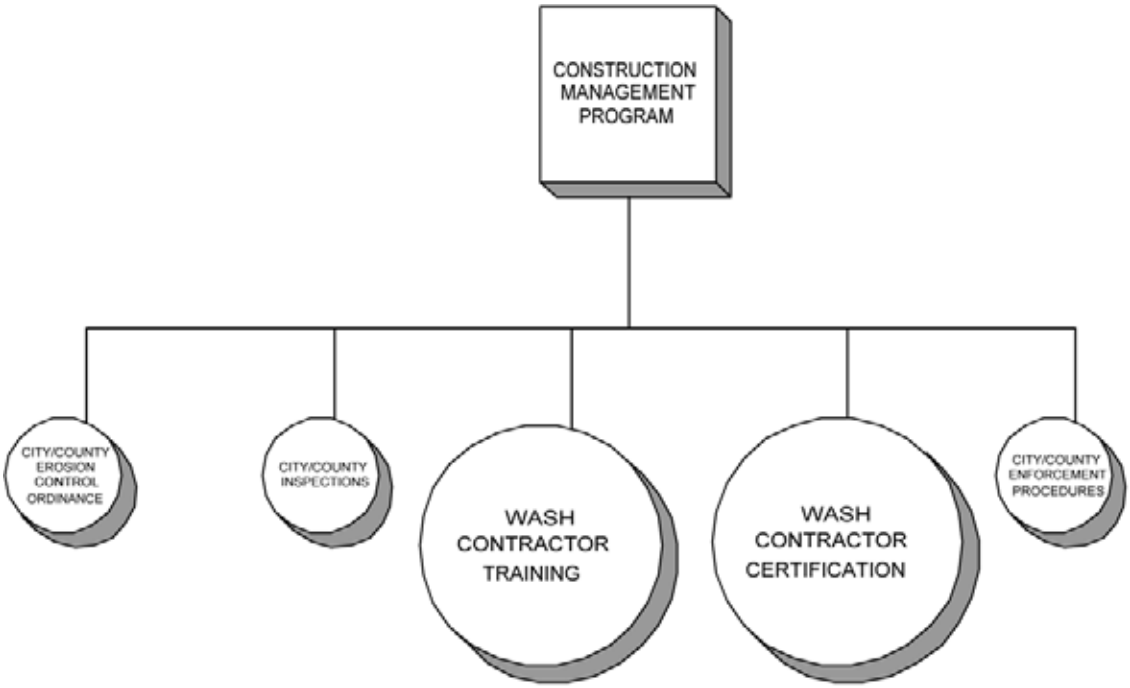
The application with instructions is located at:
http://www.cdphe.state.co.us/wq/PermitsUnit/wqcdpmt.html.

Local Government Requirements

Boulder County, the cities of Boulder, Longmont, and Louisville; and the towns of Erie and Superior are required by federal and state regulations to develop local programs to which meet the requirements for a state storm sewer permit. These Boulder County entities will develop common standards for construction sites, which will be incorporated into individual community ordinances.

As a result, in the future your development and construction projects will be subject to requirements designed to improve stormwater quality such as:

- ✓ Training and certification requirements for employees.
- ✓ Expanded plan check and review.
- ✓ Increased site inspection.



As of March 2003, Keep it Clean Partnership, formerly known as the Watershed Approach to Stream Health (WASH) Project, municipalities began development of the six programs required by the state permit for their storm sewer system. The local construction program required by this permit will be developed over the five years of the permit cycle. All six programs will be developed and implemented by 2008.

This training is designed to meet the Keep it Clean Partnership contractor training requirements when training is required for compliance with the state storm sewer permit. The information provided in this manual supports the Keep it Clean Partnership training, which will be provided to meet Keep it Clean Partnership entity permit requirements. This training is being developed in advance of permit requirements due to early funding received from the EPA to develop a training program. Contractor certification of attendance at this training is required by most Keep it Clean Partners. Contact the Keep it Clean coordinator for information on specific local construction site requirements, as the construction program is implemented by Keep it Clean Partnership entities.

Other Construction Related Permits and Reporting

There are other permits that may be required of construction operations. They may include, but are not limited to:

- WQCD Process Water General Permits:
  - ✓ Construction Dewatering: 303-692-3553
  - ✓ Minimal Industrial Discharge (e.g. hydrostatic testing): 303-692-3553
  - ✓ Sand and Gravel w/Process Water: 303-692-3539
- Permits NOT from WQCD:
  - ✓ Corps of Engineers 404 Wetlands Permit: 303-979-4120
  - ✓ General Air Pollution Emission Notice - Construction Permit: 303-692-3100

These permits and reporting requirements are beyond the scope of this training but are listed for the student's benefit.

DEVELOPING AND IMPLEMENTING A STORMWATER MANAGEMENT PLAN (SWMP)

The key document providing the description of the best management practices (BMPs) for a construction project is the *Stormwater Management Plan (SWMP).* The SWMP must include a site description, map, and the BMPs to be used on the project. The SWMP is a requirement of a construction permit for stormwater and must be completed and implemented at the time the project breaks ground. Be sure to have the plan at the job site. Also, the plan must be revised to reflect the current site conditions. The State of Colorado does not require that the SWMP be submitted to the Water Quality Control Division as part of the permit filing process; however, they may ask for a copy, and those sites filing for a permit must sign they indeed have a SWMP they will implement. Further, if a state inspector visits a construction site, they will ask to review the plan. As far as the State of Colorado is concerned, no formal revision procedure for a SWMP is required, but the plan must reflect the current site conditions. Development and revisions to a SWMP may require specific procedures be followed depending on the project and location.

Some local jurisdictions require that the SWMP be submitted for review and approved prior to the issuance of a grading permit. Be sure to check with the local authorities for any specific SWMP requirements. These plans are also known as stormwater pollution prevention plans, but may go by another name in a particular jurisdiction.

Key Points for the SWMP

- Required as a permit condition
- Must reflect current site conditions
- Local jurisdictions may require submittal for approval
- Must be available for review by state inspectors
- Is available as a public document

The Colorado Water Quality Control Division has developed a guidance document for developing a SWMP. It is available online at:
http://www.cdphe.state.co.us/wq/PermitsUnit/wqcdpmt.html

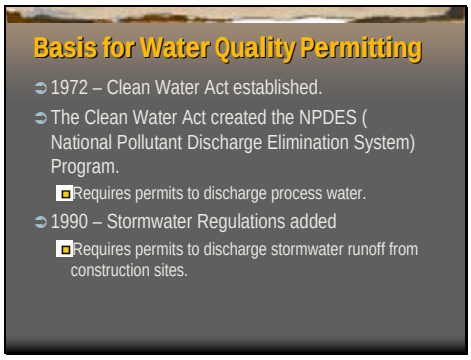
Regulatory Program Goal

Improve water quality by reducing the amount of pollutants entering waterways

Inspections under the permit are required every 14 days and after every significant storm event

Slide 1

Slide 2



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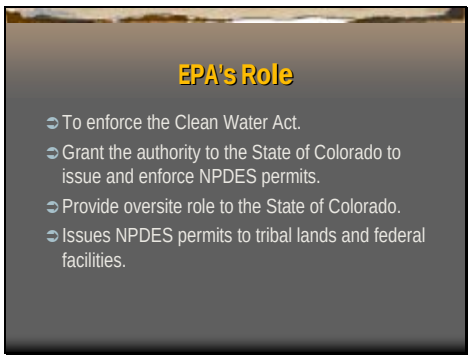

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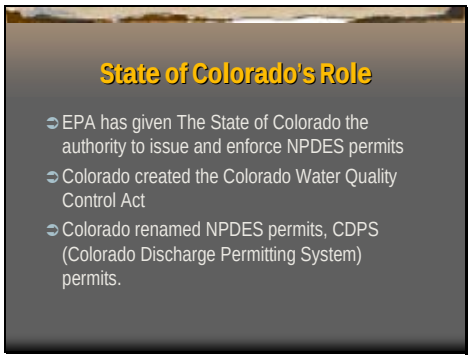

Slide 5

Q: WHAT DISCHARGES FROM A CONSRUCTION SITE NEED A STATE CDPS PERMIT?

A: ANY WATER DISCHARGED FROM THE CONSTRUCTION SITE NEEDS A PERMIT. (except water associated with: fire fighting activities, springs, or landscape irrigation return flow.)

Slide 6

Permits

- Stormwater General Permits
  - Construction sites disturbing 1 acre or more of ground
  - Sand & Gravel Operations
  - Asphalt and Concrete Batch Plants
  - Industrial Facilities

Contact: Matt Czahor at (303)-692-3575

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Permits

Local Municipality permitting

Construction Dewatering (Water Quality Control Division)
Andrew Neuhart – 303-692-3655

Minimal Industrial Discharge (Water Quality Control Division)
Andrew Neuhart – 303-692-3655

404 Permitting (Army Corps of Engineers)
303-979-4120

Fugitive Dust (Air Pollution Control Division)
303-692-3100

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Permits

- Construction activities requiring a stormwater discharge permit?
  - As of July 1, 2002 All construction activities disturbing 1 or more acres of land, or are part of a larger common plan of development which disturbs one acre or more over a period of time.

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Permits Cont…

- Who issues these permits?
  - The "State" - Colorado Department of Public Health and Environment, Water Quality Control Division.

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Permits Cont…

- How do I get a state stormwater discharge permit for construction activity?
  - 1st Step – Develop a Stormwater Management Plan (SWMP) for the site that meets permit requirements and is ready to be implemented (see guidance document).
  - 2nd Step – Complete the 2 page application and send in with original signatures (no faxed copies).

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Permits Cont…

- How long will it take to get my permit?
  - About two weeks, if application is complete.
- Do I need to submit a copy of my SWMP with my application?
  - No, an updated copy of the SWMP must be retained on site.

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Permits Cont…

- Notes on the application process.
  - Applications must have original signatures (no faxed copies).
  - If anything on the application is not completed the application will be sent back. Delays permitting.
  - If site does not have a street address, use the closest cross streets.
  - Latitude and Longitude for a point on the site must be included in degrees, minutes, and seconds.
  - The anticipated end date for the project is when Final Stabilization will be reached on the site.

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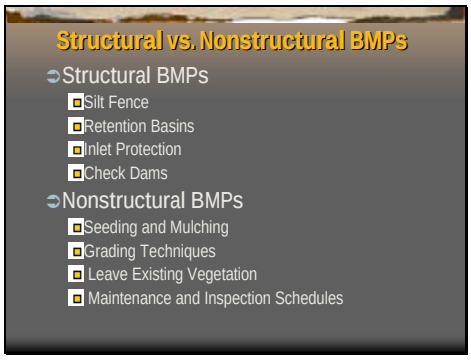

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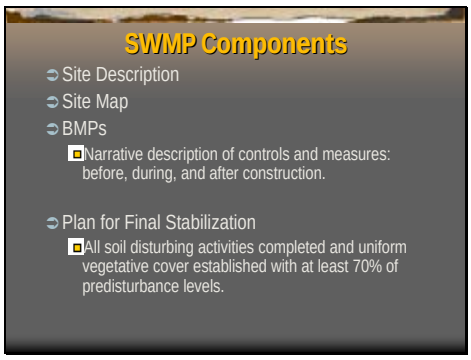

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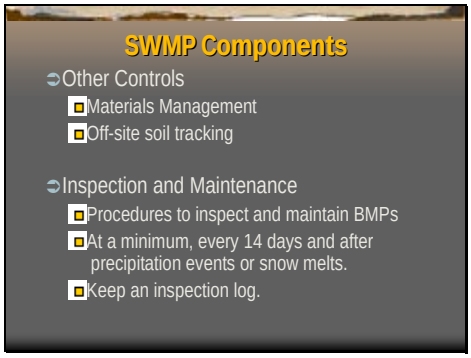

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SWMP Notes

- Do Not include maps that are too busy
- A Site Map is not a SWMP
- Narrative descriptions and design details must be included.
- Inspection and Maintenance Schedules
- SWMP must be on site
- SWMP must be adjusted to conform to field conditions
- Guidance:
  - www.cdphe.state.co.us/wq/PermitsUnit

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Terms and Conditions

- Specific Limitations
  - Keep the water clean!
- General Limitations
  - Don't discharge wash water
  - Bulk Storage shall have adequate protection (2ndary or equivalent)
  - Permittee must comply with local requirements

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Why?

Keep Pollutants out of State Waters!!!

- Sediment is a Pollutant, it can:
  - Change the physical nature of a stream bed
  - Eliminate habitat
  - Contribute nutrients and metals
- Other pollutants
  - Oil & Grease
  - Concrete Truck Washout

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Administration

- Transfers
  - Permits may be transferred
  - Portions of permit coverage may not
- Inactivation
  - Permits may be inactivated upon final stabilization
  - You must inactivate or you will continue to be billed

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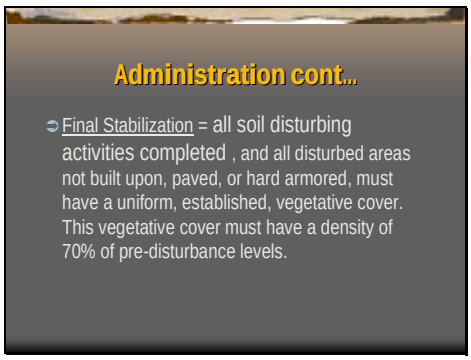

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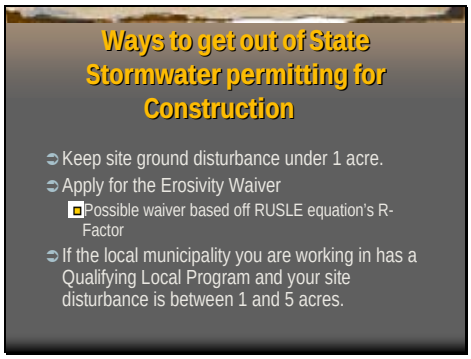

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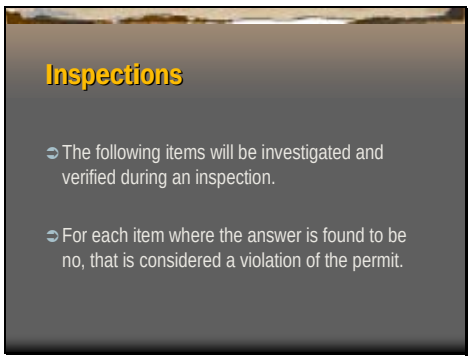

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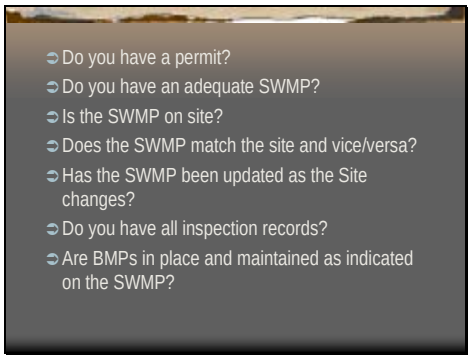

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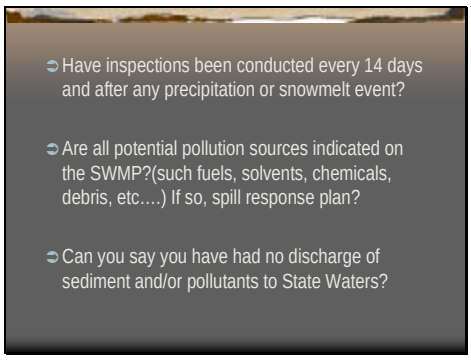

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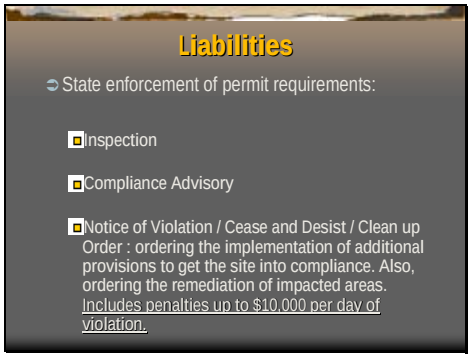

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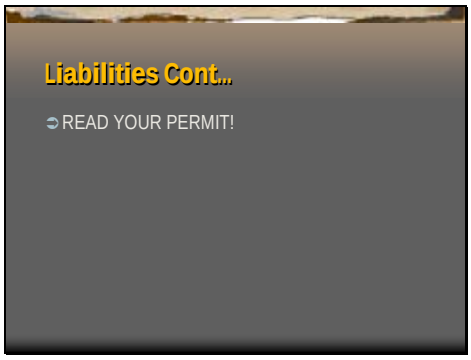


SECTION 4

Administrative Controls for Erosion Control

Planning, Scheduling, Project, and BMP Phasing

ADMINISTRATIVE CONTROLS FOR EROSION CONTROL

Any activity to minimize the amount of erosion or sedimentation is a BMP. ***Administrative controls*** are those involving the way works gets done and don't involve the actual construction of any device. The best example of an administrative control is ***training***. The more workers understand about controlling erosion, the better site work will be conducted according to plan. Further, those workers installing BMPs need to know exactly how they are to be installed and how they are designed to function. In fact, it can be even more important for installers to understand how a BMP is supposed to work.

Planning and Scheduling (adopted from Urban Drainage and Flood Control District, Volume 3, Drainage Criteria Manual, 1999, pages C14 – C-17)

Proper planning is one of the most important BMPs and can be the most cost-effective as well. The planning process can be divided into five steps:

1. Assess the Site – collect information about the site:
   - Topography
   - Soils
   - Drainage characteristics
   - Predominant site features like proximity to waterways
   - Existing vegetation including types and coverage
   - Limits of clearing and grading
   - Boundaries of watershed

2. Evaluate the information collected to determine:
   - Areas expected to present erosion problems
   - Special site features or sensitive areas requiring protection
   - Aspects of the job controlled with administrative BMPs
   - The layout for roads, buildings, etc.
   - Permanent drainage features
   - Location of stockpiles, waste storage areas, fuel tanks, and concrete wash-out areas.
   - Training requirements for personnel

3. Develop a plan to:
   - Take advantage of permanent drainage features
   - Incorporate project phasing
   - Provide for minimization of erosion
   - Schedule construction activities
   - Phase BMPs with the project plan
   - Effectively schedule work for installation and maintenance of BMPs
   - Meet regulatory requirements

4. Develop a Stormwater Management Plan (SWMP) providing:
   - Consistency with other permit conditions and other plans
   - A site description
   - The BMPs to be used on the project for erosion and sediment control
   - A map of the site
   - For inspections and maintenance of BMPs

5. Implement the Plan
   - Evaluate effectiveness of selected BMPs and SWMP
   - Revise as necessary – phase the SWMP with the project
   - Alter or replace BMPs as necessary
   - Establish at least 70% of pre-existing vegetative cover.

Planning, scheduling, and phasing of BMPs include:

- Keeping as much of the existing vegetation as possible for as long as possible.
- Adjusting the BMPs as the project progresses.
- Scheduling work in such a way to avoid large open or disturbed areas during the time of the year of the heaviest precipitation.
- Complete or stabilize areas of the job as soon as possible or at least during the same season.
- Be sure drainage features for the job are fully functional as part of the construction process.
- Keep slope stabilization, erosion, and sediment control as current as possible with site construction.
- Locate and develop borrow pits to minimize sediment.
- Place debris, overburden, soil stockpiles, and waste materials away from waterways and areas of runoff.
- Stabilize the site prior to winter shutdown to avoid serious erosion during spring meltdown. Remember, it may not be possible to install any erosion or sediment control BMPs because of snowpack.
- Installation of BMPs on areas that are planned to be left for 30 days or more.
- Locate stockpiles and other pollutant sources at least 50’ from waterways.

Work areas to completion

Minimize the time soil is disturbed

Minimize the amount of disturbed soil

Minimize disturbance during heaviest precipitation

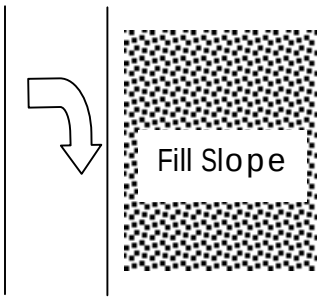
Divert water away from exposed areas

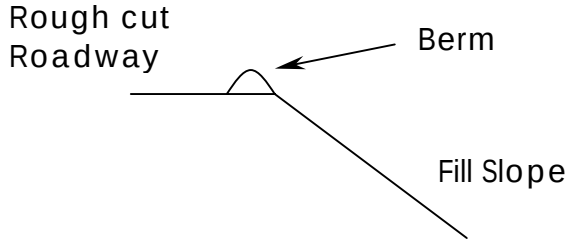
GRADING TECHNIQUES FOR EROSION CONTROL

Grading techniques for temporary erosion control can be used to minimize erosion and facilitate infiltration and plant growth. These techniques include:

- Surface roughening (or leaving the surface rough)
- Terracing slopes
- Rounding the slope at the tops of cuts, transitions, and roadway ditches
- Avoiding angles in cut-and-fill transition areas by rounding transition line
- Rounded channel bottoms
- Construct cut and fill slopes at stable angles to avoid slumping
- Use in conjunction with seeding
- Diversions

Avoid excessive compacting of the soil surface, as it inhibits the growth of vegetation. Roughened areas should be seeded and mulched as soon as possible. Fill slopes should be left with loose, uncompacted fill (4"-6" deep) that can be grooved using a disk. Grooves along the contour should be 2"-4" deep and spaced 6" apart. Steeper slopes can be stair-stepped (terraced). During the process of cut-and-fill, avoid letting side cast or waste material enter waterways and avoid placing it on unstable areas. Efficiently move excavated material to areas needing fill or to a stockpile. Remove stumps cleanly and relatively free of soil. Use slow, controlled grading for rough-cut road maintenance to avoid damage from graders to stabilized slopes. Berms or a windrow of topsoil can divert water down the road, causing erosion. At the same time, berms can be used to keep runoff from eroding fill slopes. Rundowns can be placed at intervals in the berm to convey water from the top of the slope to the bottom. See Section 9 of the manual for more information. Berms are easily constructed and may serve as an alterative to sediment barriers like silt fence.





Diverting water from
erodible fill slopes

DIVERSIONS AND SLOPE DRAINS

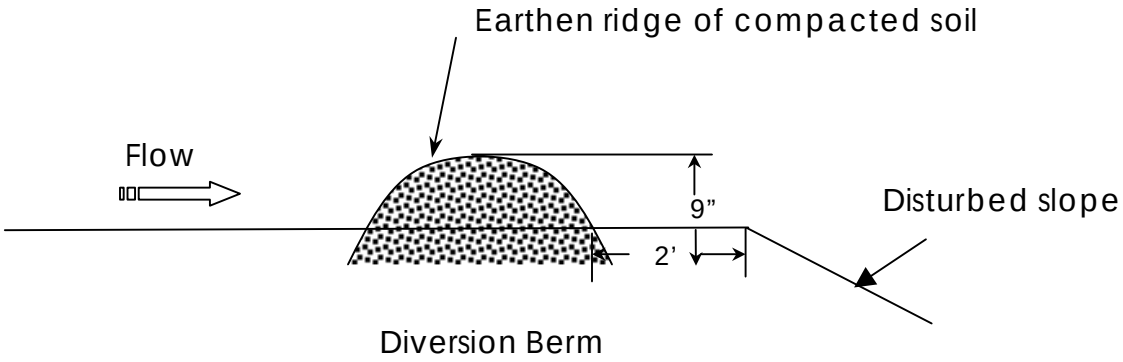
Temporary Diversions

Temporary diversions can be berms or dikes. ***Diversion berms*** are ridges made of soil, course aggregate, or other material placed on the surface of the ground. ***Diversion dikes*** (slope diversion dikes) are an earthen ridge constructed behind an excavated diversion. Both berms and diversion dikes are designed to divert water away from disturbed areas and carry flow elsewhere. Some diversions are designed to divert sediment-laden water to a slope drain or sediment entrapment facility like a sediment basin or a sediment trap. In any case, water is not allowed to impact exposed areas. Diversions are an excellent BMP because:

- They are easy to construct.
- They are relatively inexpensive.
- They can be used in a variety of situations.
- They are easy to maintain.
- They are easy to remove or change.

Diversions may be placed at the top or bottom of a slope or even mid-slope to divert flow.

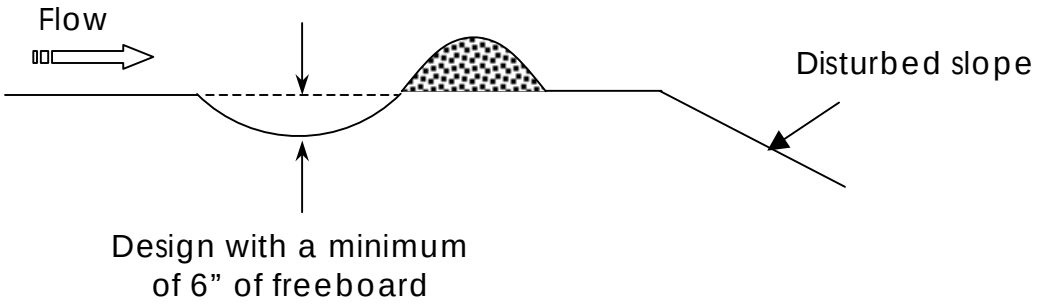
Construction of Diversions
Diversions can be constructed with earth-moving equipment already on the job site. Construct diversions along the contour (perpendicular to the slope) and angled slightly to provide drainage; however, keep the slope angled at 1% or less to prevent erosion of the bottom of the diversion. If the diversion is to drain to another structure like a slope drain, be sure the water will flow directly and not by-pass the structure.



Diversion Berm

If necessary, provide protection of the diversion berm channel with rip rap or turf reinforcement material of some kind. Remove all trees, roots and other debris that may interrupt proper flow in the channel. Plan for some settlement of the

compacted material. Products currently on the market can also be used in place of a constructed berm. For example, a product called a silt dike (triangular piece of foam wrapped in geotextile) can be used. Silt dikes may be useful in areas of public traffic that preclude the use of a construction berm. Also, sediment barrier materials like straw bales and silt fence can act as diversions. Remember, if these materials are placed with too much of a slope, the water will erode along its path resulting in deposited sediment somewhere downstream and lots of maintenance.



Slope Diversion Dike

Side slopes of the berm should be 2:1 or flatter. Diversion dikes may be of a variety of shapes including parabolic or rounded bottom (as shown above), trapezoidal, and V-shaped.

Inspection of Diversions

During inspections, check to be sure water is not bypassing the diversion(s) and no erosion is occurring in the channel. Also look for any weakness or breaches along its length. Keep diversions free of trash and debris. If the channel is protected with hard or soft armor, inspect the material to make sure it is secure and water is not flowing under or around the protection. As necessary, have the channel re-defined back to its original shape and depth. Some sediment will be deposited in the channel. Remove as necessary.

Slope Drains

Slope drains are for those situations requiring runoff to be conveyed from the top of a slope to the bottom to avoid damage to disturbed areas, especially on step slopes. Slope drains can be of flexible or rigid pipe and are typically designed to be temporary features. However, they can also be used as a permanent control with proper design. Rundowns of all types can also be used to convey runoff to the bottom of slopes. The inlet in this picture is for a slope drain at a bridge deck during highway construction. Note the outlet protection (rip rap) for the pipe at the bottom of the slope.

Construction of Slope Drains

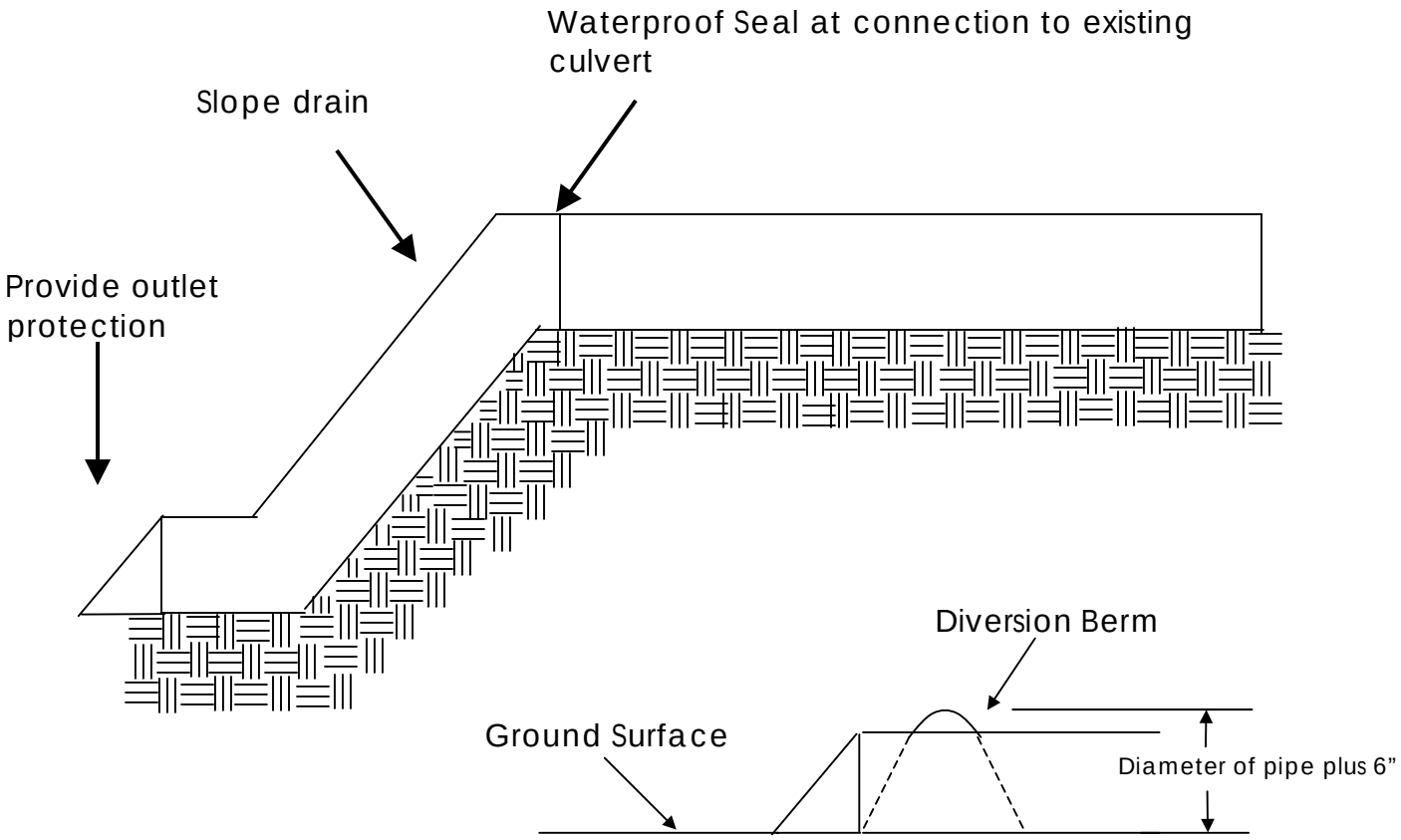
If the slope is to collect runoff from diversions, make sure it is placed in the right location. Pipe sizing (from Virginia Soil and Water conservation Commission, 1985) should be:

- 12” for drainage areas less than 1.5 acres
- 18” for drainage areas less than 5.0 acres
- 24” for drainage areas less than 10.0 acres

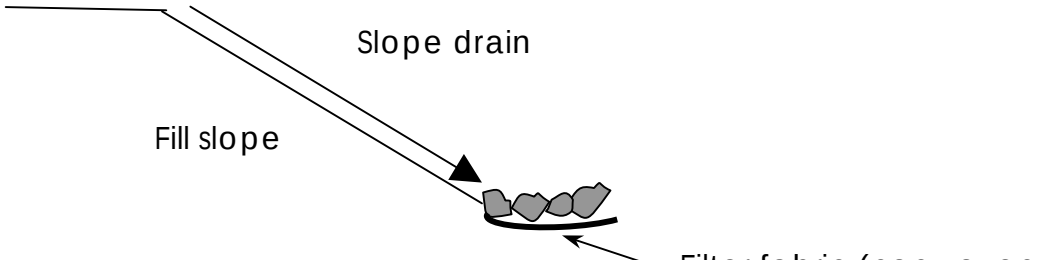
Fasten all pipe sections securely. Use watertight fittings. Anchor the pipe to the slope. The inlet of the pipe should be tapered. Compact the soil and place rip rap (or other armor) around the inlet for protection. Proper backfilling around and under the pipe will ensure firm contact with the soil to prevent seepage along the pipe. Be sure to extend the drain beyond the toe of the slope. Extension collars can be used for this purpose. *Outlet protection must be placed at the discharge end of the pipe.* If using a diversion in conjunction with a slope drain, make the diversion at least 6” above the height of the pipe.

Inspections of Slope Drains

Check all diversions to ensure they are transferring runoff to the slope drain(s). Check each section of pipe to be sure it is secure and not migrating down the slope. Inlet and outlet protection should be protecting each end of the pipe and not scouring underneath or at the edges. All debris or sediment collected should be removed. Look for signs that the pipe has been sized correctly. Check the areas around the pipe for proper compaction to see if runoff is seeping into the soil. Water saturating the soil around the pipe can lead to slope failure.



Inlet Side of Slope Drain



Outlet protection

SECTION 5

Methods to Cover Exposed Areas, Reduce Erosion, and Keep Soil On-Site

COVERING THE SOIL

There are many ways to cover exposed or disturbed areas. Regardless of the method, cover protects the soil from raindrop impact, wind erosion, facilitates the infiltration of stormwater, slows the flow velocity, and protects planted areas. Covering areas previously seeded is absolutely necessary. Cover should be applied within 14 days to all disturbed areas that are not at final grade but will remain open for longer than 30 more calendar days (from Urban Drainage and Flood Control District, Volume 1 & 3 Drainage Criteria Manual)

Vegetative Cover – the first line of defense against erosion

Grasses and other types of vegetative cover are some of the most important BMPs. Vegetative cover:

- Protects the soil from raindrop impact
- Facilitates infiltration of runoff, thus reducing erosion
- Helps remove pollutants from runoff
- Requires minimal maintenance
- May be integral to a drainage structure (e.g. grass-lined swale)
- Helps reduce noxious weeds
- Provides habitat for wildlife
- Returns disturbed areas to a natural look
- Provides good public relations

In addition, officials may mandate re-establishing vegetative cover. Vegetative cover could include grasses, shrubs, bushes, trees, ground cover, and other plants. When planning for re-vegetation, be sure to check on all requirements that may apply. For example, the city, county, or other applicable government agency may require specific types of seed mixes at specific application rates. Other considerations include:

- Type of soil and soil preparation
- Will the area be irrigated
- What watering restrictions may apply
- Type of seed mix (see the *Drainage Criteria Manual Vol. 1*)
- Application rate for seed mix
- Method of planting (e.g. drill seeding, hydroseeding)
- Type of cover (e.g. mulching)
- Time of year (fall and spring)
- Elevation
- Project phasing
- Long-term maintenance plan
- Topography
- Weed management and control

Establishing Vegetative Cover

The first step to establishing vegetative cover is to evaluate the site for existing cover to properly plan re-vegetation activities. Also, save as much of the existing vegetation as possible. For example, leaving vegetative buffer strips, especially along water bodies, slows the runoff and allows infiltration of the stormwater providing filtering. This filtering effect reduces the amount of pollutants. If necessary, set up barriers so equipment and vehicles do not damage the existing cover. As construction proceeds, establish cover as soon as slopes are worked to completion. In fact, by design, diligently work slopes and once completed, re-vegetate. Do everything you can to make the re-vegetation efforts succeed. Temporary cover like rye grass can provide both the benefits of erosion control and shade for the protection of permanent grasses.

The process basically can be outlined as follows:

Site evaluation (prior to construction)
Sample soil for analysis as necessary
Review of existing plans (e.g. drainage plan, landscaping)
Development of seeding plan or planting plan
Site preparation
Seeding and planting
Maintenance

Things you can do to ensure successful planting:

- **Drill seed** when possible. The drill seeder "opens" the soil with a shank or disc, drops the seed at the desired depth and compacts the soil with a pack wheel, providing an effective seeding method. Further, the grooves left behind will catch water, helping to keep valuable moisture for plant growth. Be sure to drill seed on the contour.

- Use **proper seed mix** and application rate. For example, adapted species may be more readily available, less expensive, and establish themselves faster than native species. When broadcast seeding, the application rate should be doubled.

- **Remove plant competition**. Infestation of weeds makes it harder to establish the desired cover. In addition, most communities have code requirements for the control of noxious weeds. Establishing a good stand of cover can reduce the cost of weed control programs as well as protect the slopes from erosion.

- **Prepare a good seed bed**. A seedbed that is too "fluffy" does not provide good seed-to-soil contact. A seedbed that is too compact interferes with seed germination and growth. Work slopes on the contour.

- **Don't prepare slopes for seeding and leave them for extended periods of time.** A crust forms on the surface of the soil that requires reworking.

- **Cover seed to the proper depth** (e.g. ⅓" to ½" for most seed mixes). Ensure good seed-to-soil contact. If broadcast seeding, hand rake lightly into the soil. For larger areas, drag an object over the surface to help seed-to-soil contact.

- **Plant at the proper time of the year**. Spring and fall are the best times to plant.

- **Ensure even seed distribution**.

- **Provide sufficient plant nutrients** like nitrogen, phosphorus, and potassium. Soil conditioners and slow-release fertilizers may include humate conditioner and biosol (fertilizer). Any mixture must be thoroughly mixed into the soil.

Blowing landscape materials

Blower trucks can shoot landscape materials, including mulch, compost, topsoil, and other landscape materials quickly and easily. The operator can walk the site (300' - 500' of hose) blowing the material on exposed slopes and under and around plants. The machines can move up to fifteen yards per hour. Getting topsoil and amendments onto exposed slopes can speed up the planting schedule, thus establishing cover sooner.

Contacts

- Boulder County: 303-678-6110
- Colorado State University Cooperative Service: 303-776-4865
- Colorado Weed Management Association: www.cwma.org
- Native Plant Revegetation Guide for Colorado
  http://parks.state.co.us/cnap/Revegetation_Guide/Reveg_index.html

Rolled Erosion Control Products (RECP)

A ***rolled erosion control product*** is a product made up of either natural or synthetic material that's designed to be rolled onto an exposed area and stapled in place to protect it from erosion and facilitate seed growth. These products provide a good method to protect steeper slopes, drainage ways (like roadside ditches and stream banks).

***Erosion Control Blankets*:** These are made from natural organic materials like mulch or excelsior (shredded aspen) and manufactured into a blanket. The blanket is formed into a roll for ease of handling and shipping and later placement. These blankets have netting stitched into the material for additional support. The netting may be a natural product or a geosynthetic mesh.

***Turf Reinforcement Mats (TRM)*:** These are a permanent, nondegradable, rolled erosion control product made from stabilized (UV) synthetic materials formed into a reinforcement matrix. These products are three-dimensional, meaning they have thickness. TRMs offer an alternative to hard armor materials like rip rap. Composite Turf Reinforcement Mats (C-TRM) are made of the same basic synthetic materials as TRMs but incorporate a natural product like coconut fiber. Between the net structure and the natural fiber matrix, a product that can be rolled into place is produced. Successful installations of C-TRM provides extensive interaction between the vegetative root structure of planted grasses and the three-dimensional netting structure.

Installation Guidelines for Rolled Erosion Control Products

These products are only as good as their installation. All are designed to be rolled onto the area and stapled in place. Additional supporting construction practices may be required (e.g. check slots for blankets). Proper installation of all rolled erosion control products (RECP) includes:

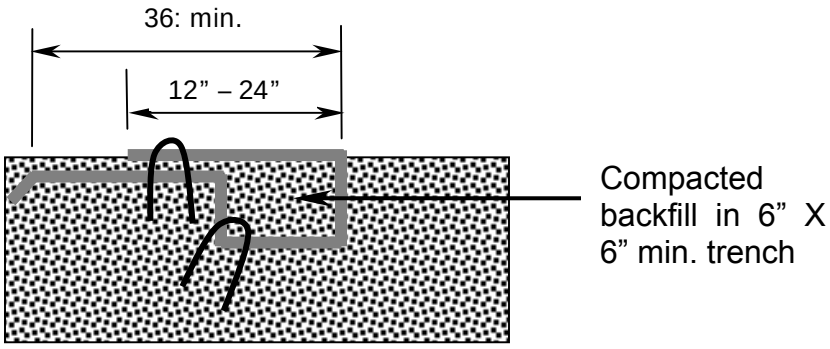
- Soil prepared and planted
- Proper placement (orientation)
- Trenching and anchoring of product
- Contact with the ground (avoid "tenting")
- Stapling pattern and number of staples
- Proper overlapping of rolls

1. Start at the top of the slope by excavating a 6" X 6" trench called an *anchor slot*. Allow enough of the roll for placement in the anchor slot with 12" to 24" on top.

2. Place the blanket into the trench and anchor with a row of staples or stakes in the bottom.

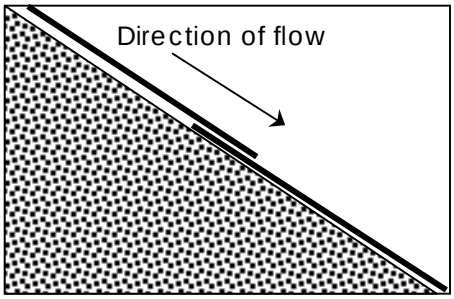
3. Backfill and compact the trench. Seed disturbed area as necessary.

4. Fold the remaining portion of the blanket or mat back over the compacted trench and staple or stake (12" intervals or as necessary).



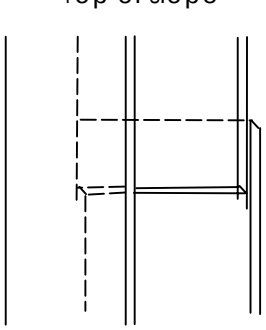
5. Roll the blanket or mat over the surface of the ground. Blankets will unroll with the proper side down.

6. Overlap: when connecting two consecutive rolls, overlap shingle style – end over end.



Overlap consecutive blankets 3" – 6"

Overlap edges of parallel blankets 2" – 4"



Mulching

Mulching with certified weed-free straw or hay is a temporary BMP; however, seeding before applying mulch to establish permanent vegetative cover is, of course, a permanent BMP. The maximum time limit for exposure after the application of mulch (mulch only) is 12 months. Therefore, if an area to be mulched is planned to be left for more than a year, it should also be seeded.

Installation Requirements for Mulching

Considerations:

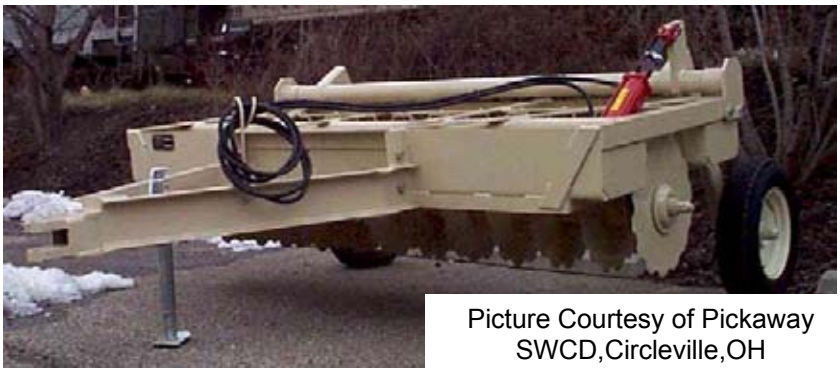
Availability of straw or hay (certified weed and seed free)
Types of slopes to be mulched
Time schedule
Equipment availability
Amount of time the area is planned to be idle
Apply if area is to be left exposed for 30 days or more

The long-stemmed straw or hay mulch (hay preferred) should be applied evenly at a rate of ***two tons per acre***. At least 50% by weight of the mulch should be ten inches in length or longer to provide good cover and facilitate securing. The method of application depends on the slopes to be mulched. For example, using a mechanical crimper is limited to slopes flatter than 3:1. ***Hydraulic mulching*** may be necessary for steeper slopes, difficult installations, and areas with limited access. Hydraulic mulching is applied by mixing wood cellulose fibers mixed with water and a tackifying agent (2,000 pounds per acre) and sprayed onto the slopes.

The best way to secure mulch is anchoring by crimping. Crimping is a mechanical method of anchoring mulch using a weighted roller. The crimping device is drawn behind a tractor over the surface immediately after applying the mulch. The crimper wheels, or mulch disc, resemble a sheep's foot and "punches" the mulch into the ground.

A portion of the crimped straw stands upright among the horizontal fibers, creating windrows and preventing migration in high winds.

Finn Crimper



Picture Courtesy of Pickaway SWCD,Circleville,OH

Mulch blowing (power mulching) equipment is usually towed behind large flatbed trucks that carry the mulch bales. Crews remove the baling wires and feed them into the machine, which cuts them into smaller pieces. If planning to use crimping as the anchoring method, mulch blowing may not be the most effective means to apply the mulch, as it tends to chop up the fibers into shorter lengths.

Bonded Fiber Matrix

Like other forms of cover, ***bonded fiber matrix*** (also called hydro-matting) is designed to:

- Reduce the amount of runoff by facilitating infiltration.
- Protect the slopes from erosion by providing a protective layer over the soil.
- Promote seed germination and growth by providing a protective layer.

Bonded fiber matrix (BFM) is a product that is applied hydraulically (liquid slurry) using standard hydraulic seeding equipment. Once dry, the material forms a porous protective cover that adheres to the surface. The matrix of biodegradable fibers is held together by organic tackifiers and other bonding agents that are insoluble in water. BFM can also be mixed with the other ingredients (seed, fertilizer) for hydroseeding, providing the convenience of a one-step application; however, it is important to remember mixing seed with anything that would result in the seed being "bound up" in a topical layer can hurt germination rates.

Possible applications for BFM:

- Steeper slopes with uneven surfaces
- Slopes with obstacles like rock formations
- Slopes with stands of existing vegetation
- Slopes exposed to harsh conditions

Installation Requirements

- Mix according to manufacturer's recommendations.
- Apply at a rate of 3,000 to 4,000 pounds per acre or as directed by the manufacturer.
- Spray apply the BFM in layers until soil is evenly covered.
- Don't apply if precipitation is anticipated. Plan so the BFM has an opportunity to dry.
- Apply so there are no gaps between the product and the soil to prevent tenting and possible erosion *under* the material.

Applied Bonded Fiber Matrix (still wet)

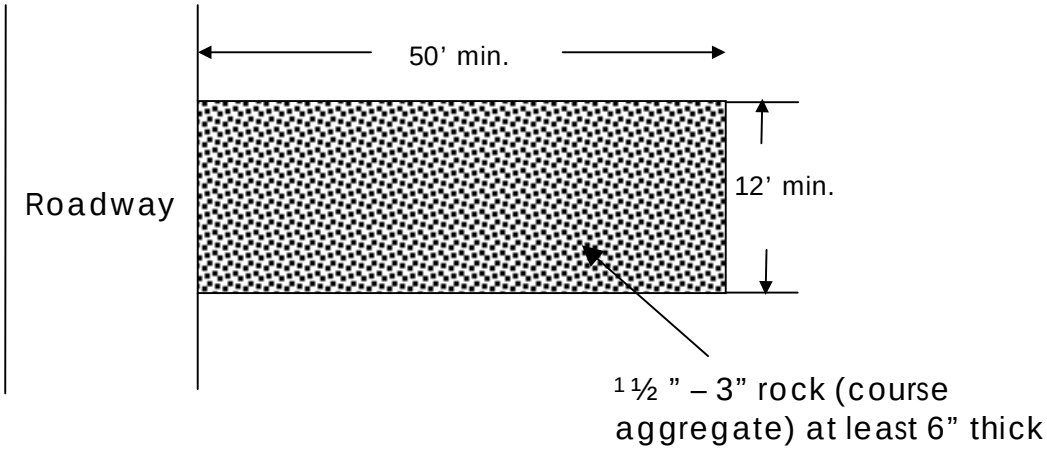
VEHICLE TRACKING CONTROL

Mud tracked from a construction site onto roadways will simply be washed into the storm sewer system if not controlled. A stabilized entrance to a construction site can keep vehicle traffic out of the mud.

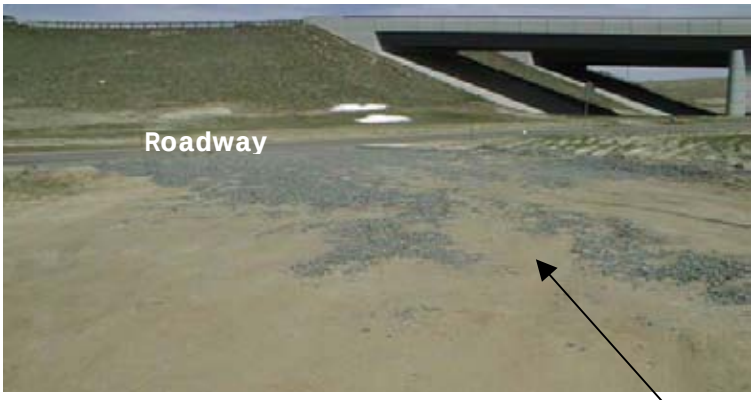
A "track pad" constructed of course aggregate can be used at the entrance, parking, and loading/ unloading areas for stabilization. In the event sediment is tracked onto roadways, it must be cleaned by shoveling or using equipment to get the bulk of the dirt from the road and then sweeping the remainder. Clearly, it is best to keep the dirt where it belongs – on the site. Remember, simply washing the street will put the sediment in the exact place it should not go – the storm sewer system. On occasion, dirt is placed in the curb flow line to allow access to the site more easily. This will only allow sediment to be deposited into the storm sewer system during times of runoff. Use some other ramp material, like a steel plate, to allow vehicles to pass over the curb. In some situations, a ***wash rack*** may be necessary. A wash rack is a stabilized pad at the entrance of a site designed to provide a location to clean vehicles before they travel onto a roadway. This BMP is not very practical because a water source is required and the resultant sediment-laden cleaning water must be prevented from leaving the site or being discharged. However, for locations with base facilities, like well fields and ski resorts, a wash pad with a sump system that can be pumped may be an easier way to clean vehicles.

Construction of Vehicle Tracking Control Pads

Lay a non-woven geotextile (filter fabric) over the area to be the pad right up to the roadway curb. Place 1 ½ " – 3" rock (course aggregate) at least 6" thick for a distance of 50' minimum over the fabric being careful not to damage it. Unroll smaller sections of fabric at a time and place the rock section by section. The width of the pad will depend on the site but should be at least 12'. If the pad is to be constructed on a grade, build a ridge parallel to the curb to slow runoff and channel water to the side.



Vehicle Track Pad Detail
(Urban Drainage and Flood Control District, Volume 3 Drainage Criteria Manual)



Vehicle Track Pad

Note sediment washing onto the pad

Inspection of Vehicle Track Pads

Check to be sure a sufficient amount of rock remains in place and add more rock as it is pushed down or displaced. Check to see if rock is being carried into the roadway. Be sure sediment is not collecting on the track pad from runoff (see picture on previous page). Divert water away from the pad if necessary. Clean any sediment that has collected on the roadway daily. Maintain original dimensions.

SECTION 6

Check Dams

Check Dams

Check dams are temporary dams constructed across a swale, channel or ditch line. ***Check dams work by slowing the velocity of concentrated flow preventing erosion.*** Check dams will also act as a sediment barrier and will catch sediment from the runoff. However, when too much sediment collects behind check dams, the runoff flows around or passes too quickly over the top of the dam. Design and build check dams with the intent of slowing the flow velocity to prevent erosion of the swale, yet still allowing water to pass. Check dams can be constructed of a variety of materials including:

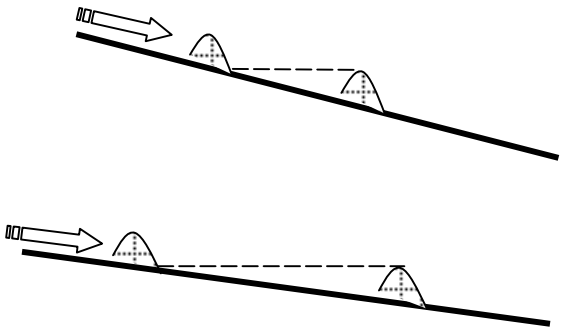
- Rock (preferred)
- Erosion bales or logs
- Sandbags
- Logs
- Silt dikes

Check dams are usually used in small open channels with a contributing drainage area of 2 to 10 acres.

The material of choice will depend on its availability, schedule, and timing, gradient, soil type, cost, maintenance considerations, local requirements, and public safety concerns. **Silt fence is not recommended as a check dam material because it typically cannot withstand the pressure.** Although rock may be the more expensive material, overall cost may be lower because of the lower maintenance requirements. The best method to control erosion in drainage swales is to permanently protect it. Lining the channel with blankets, turf reinforcing mats (TRM), sod, or hard armor like rip rap virtually eliminates erosion, and check dams would be unnecessary.

Location and Spacing of Check Dams

Check dams must be used in series spaced at appropriate intervals. They should be spaced such that the base of the upstream dam is at the same elevation as the top of the next downstream dam.



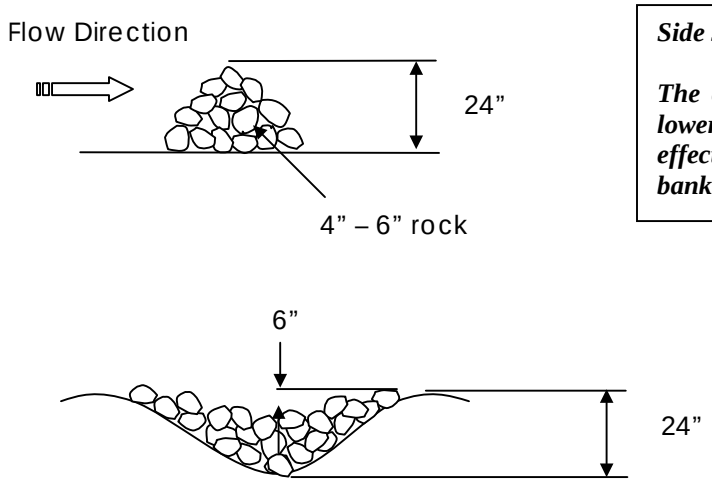
Spacing of check dams

A common installation problem is when spacing is too far apart. This allows runoff to erode the channel between dams as well as fill in each dam with sediment, thus creating lots of maintenance work.

Installation and Construction of Check Dams

In addition to the proper spacing, construction of check dams includes:

- Distance across the swale
- Height
- Configuration



Side slopes should be 2:1 or flatter.

The center of the dam should be at least 6 inches lower than the edges. This design creates a weir effect that helps to channel flows away from the banks.

(Urban Drainage and Flood Control District, Volume 3 Drainage Criteria Manual)

After placement, hand interlock the rock. All check dams should have a maximum height of 3 feet. If necessary, additional stability can be achieved by placing the rock approximately 6 inches into the sides and bottom of the channel. Do not place check dams in live, flowing streams.

Inspection and Maintenance

Check dams should be inspected as part of the routine 14-day inspections as well as after each storm event. If possible, inspect the check dams while water is flowing in the swale to see what alterations may be necessary. In particular, check to see if water is by-passing the check dam by flowing around the structure or backing water onto a roadway or diverting water elsewhere. Water pushed onto a roadway, especially in cold weather, creates a public safety concern. Check to see how much sediment has been trapped behind the structure. **If 50% of the total height, as measured at the center, has filled with sediment, it is time to remove the sediment**. In addition, all accumulated sediment should be removed prior to removing a check dam. If trash and debris has collected, it must be removed as well. Be sure the center of each check dam is lower than its edges. Erosion or heavy flows cause the edges of a dam to fall. Removal of a check dam should be completed only after the contributing drainage area has been completely stabilized.

SECTION 7

Removing Sediment from Construction Site Runoff

Sediment Barriers
Sediment Ponds

SEDIMENT BARRIERS

Silt Fence
A silt fence is a BMP called a sediment barrier. A silt fence is designed to stop the flow of water and create a pond. While the water is backed up behind the fence, sediment is allowed to settle. The weave of the fabric is designed to allow water to pass through, providing filtering. Because the intent of a silt fence is to "pond" water, its location is critical. There needs to be enough room to provide sufficient ponding volume and, at the same time, limit the size of the drainage area per section of fence. When installed properly and maintained, a silt fence is a very effective BMP. There are basically two types of silt fence and two methods to install them:

Types of Silt Fence

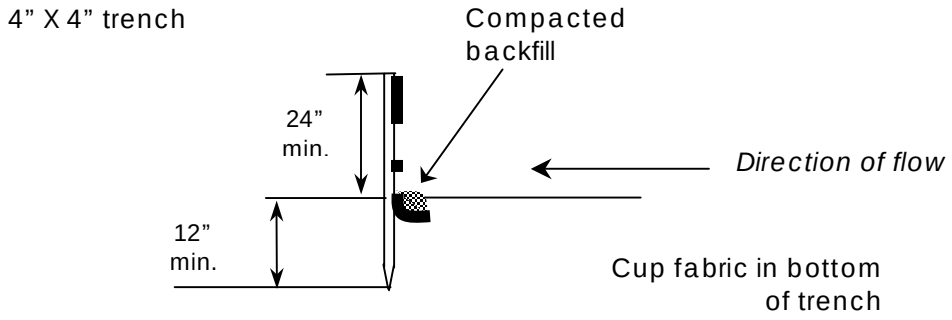
1. Posts come attached to the fabric - the fabric roll is run through a machine at the factory (or distributor), which attaches the posts with staples at a consistent interval (e.g. 8').
2. Posts are separate – the fabric has a pocket sewn into it spaced at 8' intervals. The posts are placed into these pockets, eliminating the need to staple the fabric to the posts.

Types of Installations

1. Fabric is placed into a trench cut with a trenching machine. Cutting the trench and placing the fabric are separate steps. The required depth and width of the trench are cut with the trencher.
2. Soil Slicing Construction: fabric is "sewn" into the ground with a specialized machine or attachment. The required depth and width are settings on the machine. The "trench" is cut and the fabric placed at the same time ("sewn"). Like a sewing machine punching the hole and placing the thread, this machine cuts a line and places the fabric in the ground behind it and does so as fast as the machine can travel. Next, the posts are set and secured to the fabric.

Total drainage area for a silt fence should not exceed five acres.

Installation specifications (UDFCD Vol. 3 Drainage Criteria Manual)



Parameter	***Specification***
Trench	4" X 4"
Height of fabric *above* the ground	24" min. 36" max.
Depth or length of fabric *in* the ground	8"
Post depth	12" min
Post spacing	15' max.
Posts	Metal or hard wood (2" X 4")

Other considerations for a silt fence installation:

- Location
- Material selection (fabric, posts, reinforcing mesh)
- Arrangement (limited drainage area, curving the ends up hill)
- Method of installation (trenched or "sewn")
- Type of fabric
- Method to secure fabric to posts
- Overlap to the next post at joints
- Removal after final stabilization has been achieved.

If the type of silt fence being used has the posts pre-stabled to the fabric, place the fence in the back of the trench (downslope), stretch the fabric tight, and hammer the stakes to the minimum depth. Backfill sections of fence as you go. If using a pocketed silt fence, unroll the fabric for a length and slide the posts into the pockets. If the posts are getting hung up on the fabric, use a piece of PVC pipe first. Slide the post inside the pipe and simply pull the pipe out, leaving the post behind. Be sure the backfill is compacted.

Limit to 1/4 acre of tributary acreage per 100 ft. of fence

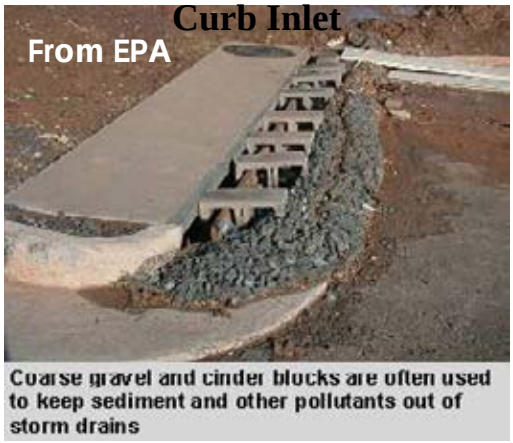
Straw Bale Barriers
Like a silt fence, straw bales can be used at the base of a slope to pond water and allow the majority of sediment to settle out. Straw bales should only be used for a limited time (weeks or months).

Excavate an area the width of a bale and 4" deep. Place the bales upright in the trench and stake with 2 stakes per bale, being sure each stake is at least 12" in the ground. Bales can be staked with metal fence posts or wood stakes, but rebar is not allowed. When placing the bales, be sure they are tight against each other. If necessary, wedge loose straw between bales. Wood stakes should be 2" X 2" nominal. Backfill tight against each bale and especially the upslope side as this is the flow direction. Compacted soil will prevent piping underneath the bales.

Inspection of Sediment Barriers

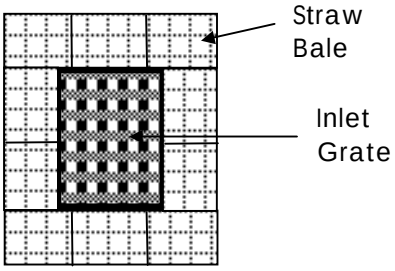
Remove the sediment from behind the barrier when half of the original height has been covered. Check to make sure the stakes are secure. Replace broken stakes and reattach fabric on the silt fence as necessary. If water is piping around or under the barrier, place additional backfill material and compact. If water is piping around the outside edge, be sure the end has been curved back uphill to form a pond. Estimate the total amount of drainage area and confirm only ¼ acre per 100' of barrier.

KEEPING SEDIMENT OUT OF STORMWATER INLETS



Coarse gravel and cinder blocks are often used to keep sediment and other pollutants out of storm drains

When storm sewer inlets are completed, sediment-laden water must be prevented from entering the system. The objective of inlet protection is to filter the water and/or allow the cleaner water to overtop into the inlet. Water flow for ***curb inlets*** is usually such that little actually filters through the material. Most of the water entering the inlet overtops the protection. For this reason, a gap must be built into the protection so the water simply doesn't by-pass the inlet. If water is not allowed to enter the inlet, it may back up onto a roadway, creating a hazard or overtopping the curb flowing behind the inlet. In the picture above, the gap is provided by using cinder blocks to keep the area around the throat of the curb inlet open. The rock is placed in front so the dirtiest water will not be allowed to pass into the inlet. For ***drop inlets***, the opening needs to be protected by some kind of barrier, like straw bales placed around the outside of the inlet. Water should still be allowed to pass through the material.



Drop Inlet Top View


Drop Inlet protection made from silt fence

These two approaches to curb inlet protection have kept sediment-laden water from entering the inlet and sediment has settled out. The throat opening of this curb inlet is essentially blocked. This could result in water overtopping the curb, causing damage behind the inlet structure. Water must still be allowed to enter the inlet.

There are a host of products available designed for inlet protection. For example, ***curb socks*** are

made from ¾" gravel placed inside ¼" mesh or burlap and placed in front of the curb inlet, leaving an overflow gap, or placed in the gutter flow line in sequence upgradient of the inlet. Socks should be perpendicular to and flush with the curb. Inlet protection for drop inlets made from silt fence tend to fail because the weight of the water cannot be supported. Reinforced silt fence material should be used and wood cross members added as necessary.

Installation Requirements for Drop Inlet Protection Using Bales

Excavate an area the width of a bale and 4" deep. Place the bales upright in the trench and stake with two stakes per bale, making sure each stake is at least 12" in the ground. When placing the bales, be sure they are tight against each other. Stakes should be 2" X 2" nominal. Backfill tight against each bale and especially along the sides in the flow path. Compacted soil will prevent piping.

Inspecting Inlet Protection

Check for damage of the construction materials and replace or repair as necessary. Determine if water has been allowed to enter the inlet or if it has by-passed the inlet, overtopped, or simply backed up behind the protection. If water has not been allowed to enter the inlet, evaluate a different design. Remove accumulated sediment, trash, and other debris from behind the inlet protection. Rock or other material that has entered the inlet must be removed.

SEDIMENT PONDS

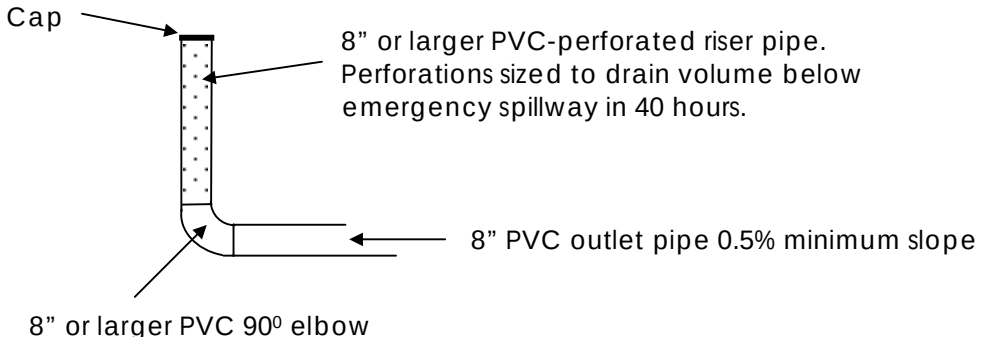
Sediment Traps & Sediment Basins

Sediment ponds serve as an excellent BMP to capture sediment prior to leaving a site, especially when erosion control BMPs cannot be implemented; however, any body of water creates a public safety concern. A safety fence and other security measures should be implemented. Also, ponded water provides a nice breeding ground for mosquitoes. Be sure ponds can dewater effectively. Many projects call for permanent ponds that can be modified to be used temporarily during construction by altering the outlet structure to only allow the cleanest water to be released.

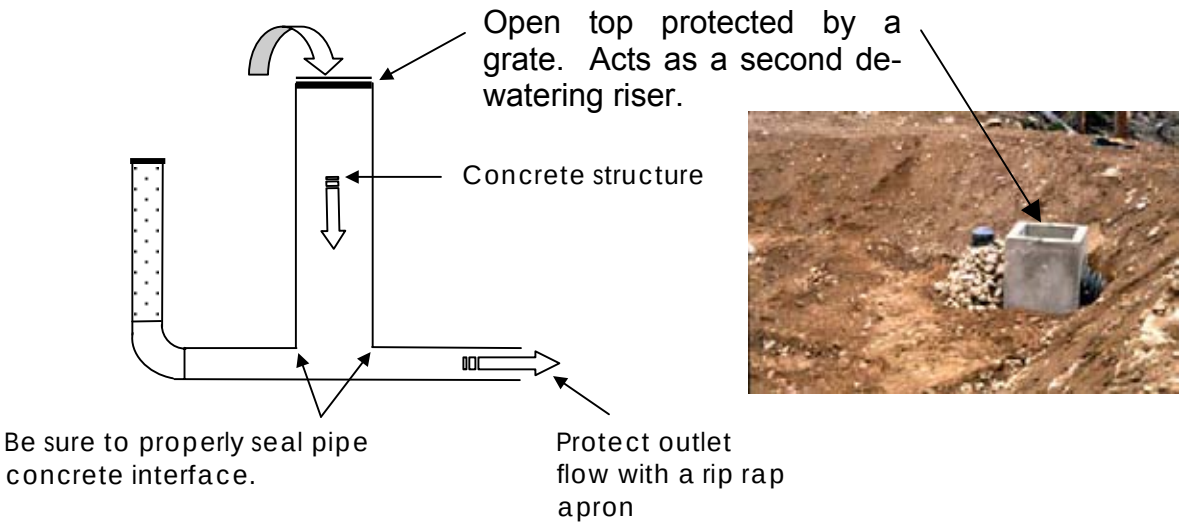
Sediment traps are small ponds that allow sediment to settle out of runoff water to prevent the discharge of sediment downstream. Sediment traps are formed by excavating an area or by placing an earthen embankment across a low area or drainage swale. A spillway is constructed using rip rap to allow water to flow out of the trap when it fills to capacity. Sediment traps are generally temporary control measures; however, they can be part of a permanent water quality pond adapted for use during construction. Temporary diversions can be used to direct runoff to the sediment trap. **Sediment traps are best when used for areas less than five acres.**

Sediment basins are temporary basins similar to sediment traps except they are constructed with a stable outlet structure. The outlet structure called a de-watering riser is typically made of a PVC-perforated riser pipe. The riser pipe is designed to release the stored water over a period of time that allows the majority of sediment to settle out. Sediment basins are also constructed with an emergency spillway set slightly above the water surface elevation (of the design storage volume) and protected by rip rap. A common design of a sediment basin includes an open top concrete structure connected to the de-watering riser that acts as a second de-watering riser. **Sediment basins are used when a stable outlet is required and for areas greater than five acres.**

De-Watering Riser for a Sediment Basin



Sediment Basin Design Model



Location of Sediment Traps & Sediment Basins
The location chosen to construct a sediment trap will depend on:

- Site terrain
- Proximity of waterways and sensitive habitat
- Drainage pattern
- Maintenance considerations
- Structures or other site features
- If it can function throughout construction

Other Considerations
A *sediment trap* should be designed to maximize surface area for infiltration and sediment settling. The storage capacity of each trap should be at least ***1,800 ft^3 per acre of total drainage area*** (CDOT recommends 3,600 ft^3). Half of the storage volume should be wet storage, preferably in the excavated portion of the trap. Sediment traps should not be used for drainage areas greater than five acres. The effective life span of these temporary structures is usually limited to 24 months. The USEPA (1993) estimates an average total suspended solids removal rate of 60 percent.

Sediment basins are sized the same as sediment traps. The 100-year emergency spillway must be protected with rip rap. Do not construct the spillway over fill material. The slopes of a sediment basin should be 3:1 or flatter, preferably 4:1 or flatter. The outlet should be designed to empty its volume in 40 hours. The basin's

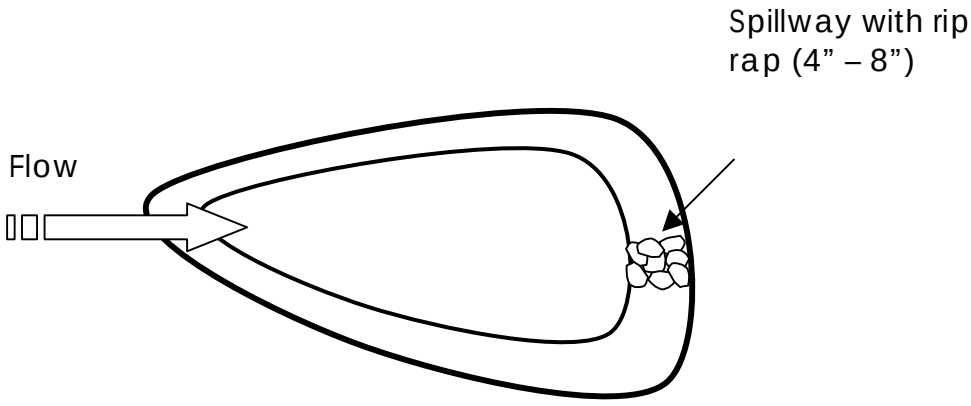
length shall be no less than twice its width (L/W greater than 2.0). Rock must be placed around the riser pipe to prevent it from floating.

Construction of Sediment Traps & Basins

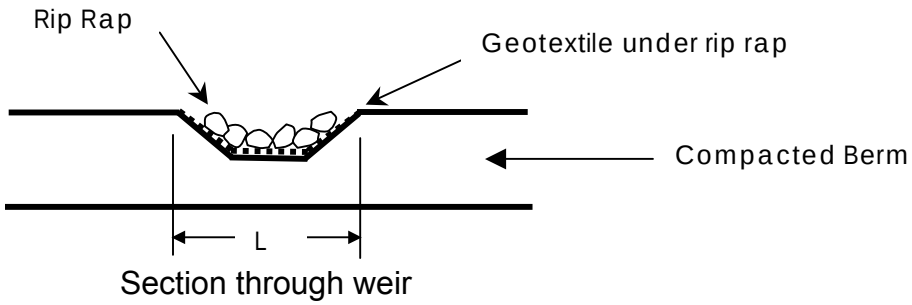
The construction of any sediment pond should be done early in the construction (before site grading) process so it can function throughout construction. Further, at the beginning of a project, it may not be possible to install other BMPs because of the heavy vehicle traffic and required access. The best shape for a pond is oblong or rectangular and shallow with a length-to-width ration of 2:1 or greater. Fill material for the embankment should be free of roots and other vegetation and debris. The spillway should consist of a stone section in the embankment formed by a combination of course aggregate and rip rap.

When excavating an area for a sediment trap:

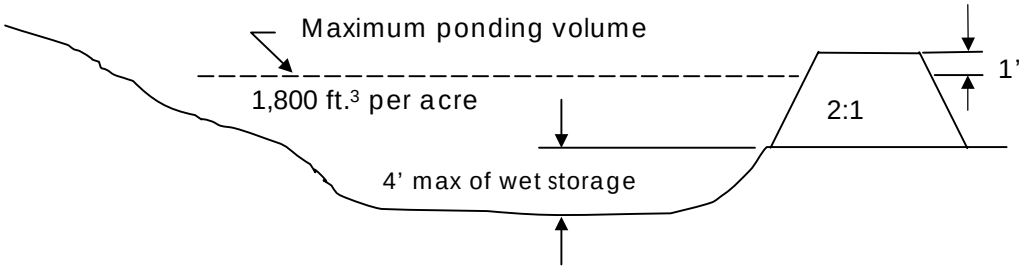
- Side slopes should not be steeper than 2:1.
- All embankments should be machine compacted to ensure stability.
- The outlet should be lined with a geotextile with rip rap on top.
- The spillway weir length (L)(feet) should be 1.5 times (EPA recommends 2X) the drainage area (acres).
- The depth of the spillway should be 1' (EPA recommends 1.5') below the low point of the embankment.



Sediment Trap



Section through weir



Cross Section of Outlet for a Sediment Trap

A sediment trap presents a potential public safety consideration. If necessary, place a safety fence around the perimeter of the trap allowing for access to conduct inspections. A post can be placed in the trap to mark sediment level.

Maintenance Considerations

The primary maintenance consideration for temporary sediment ponds is the removal of accumulated sediment. Sediment should be removed when the basin reaches 50 percent sediment capacity. Sediment can also collect on the outlet structure rock for a trap requiring cleaning. For basins, water can bypass the de-watering riser if leaks develop at the pipe/concrete connection, allowing the dirtiest water to flow out. Check all areas of pipe, especially areas where a water sediment trap should be inspected during all required inspections for:

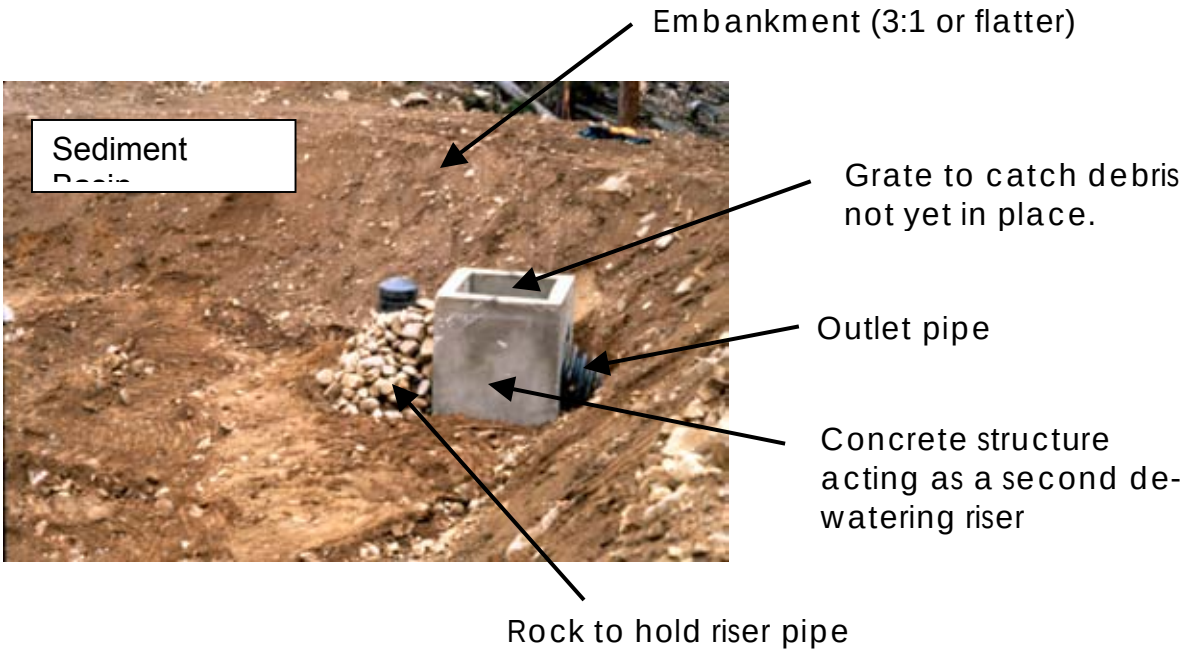
- Amount of accumulated sediment
- Outlet structure for stability and accumulated sediment
- Depth of spillway
- Areas of possible bypassing
- Public safety concerns
- Stability of embankments
- De-watering riser for clogging and damage
- De-watering riser and pipe seal points (basin)
- Rip rap apron for outlet (basin)

1. Sediment _____?

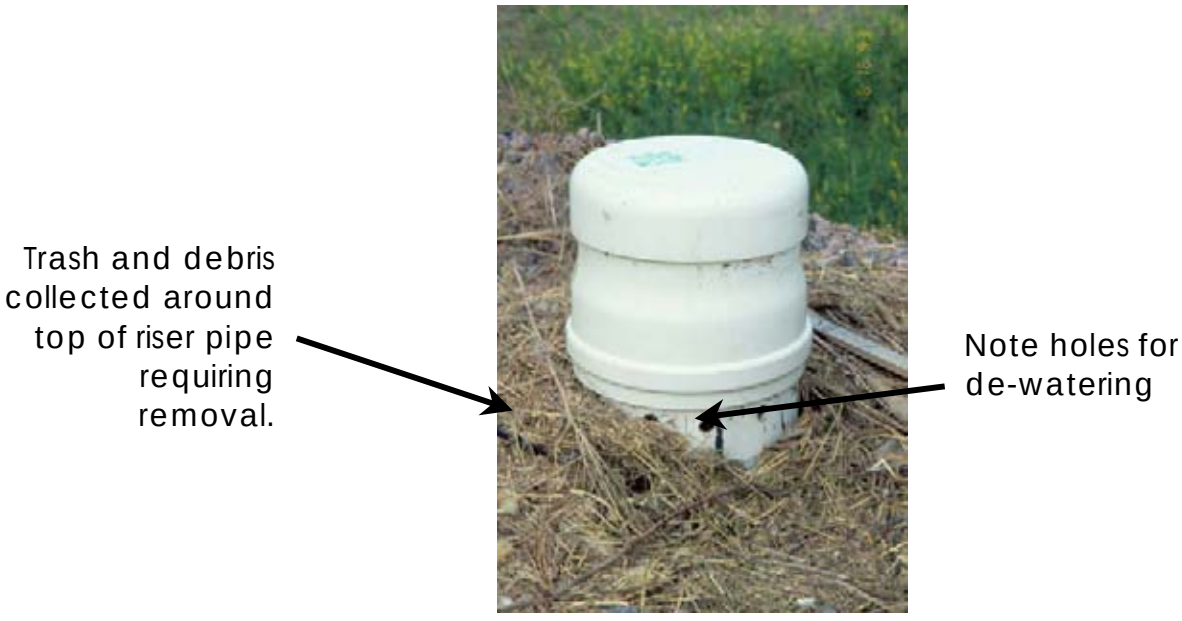
For number 1, name the type of temporary pond. For 2 – 5, name each feature. Answers at bottom of page.

1. _____
2. _____
3. _____
4. _____
5. _____

1. Sediment basin
2. Inlet pipe from storm sewer system
3. De-watering riser secured with rock
4. Access road on top of embankment
5. Receiving water



Components of a Sediment Basin



Top section of a de-watering riser on a sediment basin

SECTION 8

Materials Handling and Disposal

MATERIALS HANDLING

Many products used during construction, such as fuels, lubricants, oils, paints, and coatings, and herbicides and pesticides, are classified as hazardous materials. In addition, once these materials are no longer useable, they become a regulated waste. These materials present a potential serious threat to waterways because even very small quantities can have dramatic impacts on aquatic ecosystems. Practices must be implemented on the project to ensure these materials are properly handled and stored to prevent contamination of stormwater runoff. Many of the practices required are mandated by other regulations developed by EPA, OSHA, DOT, CDPHE, and the local fire department. Check with your safety officer and environmental manager to determine what specific practices are required.

Chemical Handling, Storage, and Spill Clean p

Safe Work Practices for Chemical Handling – Personal Safety and Spill Prevention

- Consult MSDS or other information about the materials to determine proper handling and safety procedures. All personnel handling hazardous chemicals must be adequately trained.
- Follow all safety procedures and wear proper personal protective equipment. Ensure emergency phone numbers are readily available.
- Secondary containment is required for bulk storage containers, like fuel tanks.
- Conduct regular inspections. Chemical storage areas should be part of all stormwater inspections *and* safety inspections.
- There should be no eating, drinking, smoking, or chewing tobacco when handling chemicals.
- Wash hands thoroughly after handling.
- Complete adequate decontamination procedures for equipment and personnel.
- Do not spread materials in any fashion.
- Do not handle containers of unknown contents, containers that are bulging, bubbling, hissing, or have crystallized residue.
- Do not touch your face, eyes, or other sensitive areas.
- Report all spills, releases, injuries or dangerous situations immediately.
- Ensure proper spill cleanup equipment is easily accessible.
- Do not allow vehicle traffic to travel through spill areas.

- *ATTEND ALL TRANSFERS OF CHEMICALS TO ENSURE PROPER PROCEDURES ARE FOLLOWED BY THE DRIVER, THAT NO SPILLS OR LEAKS HAPPEN, AND CONTAINERS ARE NOT DAMAGED. MANY CHEMICAL SPILLS HAPPENED DURING TRANSFER.*

Container Handling

- Store containers in a secure, protected location away from busy areas and ensure adequate ventilation if stored in a building. Store all containers upright and do not stack. Do not store chemical materials near waterways. Provide some kind of containment in case of a spill. For example, containers can be stored on spill pallets; inside approved lockers equipped with a containment basin; or placed in a lined, bermed area.
- Ensure packages and containers are in tact. Check for leaks, cracks, tears, splits, loose caps, and integrity of container.
- Repackage into recovery drum or bucket, if necessary.
- Record all label and container information.
- Do not handle containers of unknown contents or origin.
- Do not tip, drop, or spill contents.
- Segregate products, as required.
- Document all containers and debris packed in recovery drums. Disposable personal protective equipment should be placed with packaged waste for proper disposal.
- For waste material, make arrangements for proper disposal. Store materials for the least amount of time possible.

Spill Clean up

Chemical spills present safety hazards to site personnel and may contaminate waterways. If you have not been trained on chemical spill cleanup and discover a leaking drum or other spill:

- Contact the responsible person immediately, regardless of size or severity. Some spills may require response from emergency responders for hazardous materials.
- Stay a safe distance from the spill, upwind.
- Keep people out of the area, and if necessary, place cones or barricade tape.
- Place diking material downstream of the spill to prevent spreading. Act in a defensive fashion only. ONLY DO THIS IF IT IS SAFE TO DO SO.
- Wait for responsible party to arrive, maintaining a safe distance.
- Seek prompt medical attention for any injuries no matter how minor they may seem.

After initial discovery, the proper personnel need to complete the spill cleanup as soon as possible.

- Contain the release with diking materials and absorb free liquids.
- Place all contaminated debris into an over-pack or recovery drum. This will include the absorbent material from the spill area, other contaminated soil and debris, and personal protective equipment used during cleanup. Label the containers as to the contents and other required hazard warnings.
- Seek prompt medical attention for any injuries, no matter how minor they may seem.
- All hazardous wastes must be packaged, stored, and removed according to federal and state law.

Concrete Waste

BMPs are required to prevent the release of concrete waste into stormwater. Concrete waste may be generated from:

- Demolition activities involving concrete materials
- Concrete truck washout
- Concrete saw cutting
- Concrete batching or mixing

Store any concrete waste a sufficient distance from drainage ways, storm sewer inlets, highway right-of-way, or receiving waters. Concrete waste must be placed in a *concrete wash facility*.

Requirements for concrete wash facilities

- Constructed of sufficient size to contain all of the concrete waste generated, including liquids.
- Located away from receiving waters but easily accessible.
- Comprised of an excavation with a protected perimeter.
- Excavated such that groundwater is not impacted.
- Provided with signage informing site personnel of its location.
- Maintained in good condition. Remove hardened concrete, as necessary.
- Clean-out should be conducted when it's approximately three quarters full or sooner.
- Inspections must be conducted regularly.

For concrete saw cutting, utilize equipment that does not allow the discharge of the water or direct the water to a wash facility. For dry cutting, scoop up the debris and dispose of it in the concrete waste facility for the site. A sweeper will remove any remaining dust and debris. Adding any flocculants or other additive to the wash water is prohibited. Hardened concrete must be disposed of properly.

Vehicle and Equipment Maintenance
Designate locations for conducting equipment maintenance activities. Provide protection from leaking vehicle fluids such as drip pads and pans. Maintain containers for the storage of vehicle fluids as described above. Have fluids for recycling removed as soon as possible. Maintain spill cleanup materials and clean up leaks and spills immediately. Do not allow leaking fluids to soak into soils or to migrate.

Sanitary Services
Practices to prevent the spill or leakage of sanitary and septic waste from contacting stormwater are required. In addition to the water quality concerns, sanitary and septic waste presents a potential public health risk. Establish sanitary facilities away from drainage ways, inlets, receiving waters, high traffic areas, and areas susceptible to flooding or high winds. Construction activities may encroach on the facilities, so be sure they are protected from damage. Sanitary sewer system connections must comply with local health agency requirements, including the removal of temporary facilities. In areas of high wind, be sure the facilities are properly secured. Clean up spills or leaks immediately. Be sure to wear the proper personal protective equipment during spill cleanup. When in doubt, contact a proper spill cleanup company. Use licensed haulers for the waste and ensure its proper disposal. Have transfers of the waste attended to ensure proper procedures are followed by the driver and no spills or leaks occur. Be sure to conduct regular inspections of sanitary facilities as part of the stormwater management plan and during heavy winds.

SECTION 9

List of Acronyms

LIST OF ACRONYMS

BMPs	Best management practices – physical, structural, and/or managerial practices that, when used singly or in combination, prevent or reduce pollution of stormwater
CCR	Colorado Code of Regulations
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System – Colorado's version of the NPDES program
CDPS MS4 permit	Discharge permit issued by the Division that authorizes the discharge of stormwater from the MS4 to state waters
CFR	Code of Federal Regulations
CRS	Colorado Revised Statutes
Division	Water Quality Control Division, which is under the CDPHE
EPA	U.S. Environmental Protection Agency
Minimum measures	Stormwater management programs that are required under the CDPS MS4 permit. They include public education and outreach, public participation/involvement, illicit discharge detection and elimination, construction site stormwater runoff control, post-construction stormwater management, and pollution prevention/good housekeeping for municipal operations
MS4	Municipal Separate Storm Sewer System – see more complete definition in Chapter 1, Section B
Municipality	A city, town, county, district, association, or other public body created by or under state law and having jurisdiction over disposal of sewage, industrial wastes, or other wastes
NPDES	National Pollutant Discharge Elimination System – Section 402 of the federal Clean Water Act
NURP	National Urban Runoff Program
Permittee	The owner/operator to whom the CDPS stormwater discharge permit is issued
Phase II	Second stage of the state and federal stormwater permit regulations (see Chapter I, Introduction)
Regulation 61	Colorado Discharge Permit System Regulations – includes stormwater regulations
SWMP	Stormwater Management Plan – required under Colorado's industrial stormwater permits
TMDL	Total Maximum Daily Load – the amount of a specific pollutant that a listed waterbody can assimilate without violating applicable water quality standards
TRM	Turf Reinforcement Mat
UDFCD	Urban Drainage & Flood Control District

SECTION 10

List of Contacts

LIST OF CONTACTS

Janice Buswell Lopitz, Keep it Clean Partnership Coordinator
Boulder County Health Department
3450 Broadway
Boulder, CO 80301
jlopitz@co.boulder.co.us
www.KeepitCleanPartnership.org
Boulder County Public Health……..……(303) 441-1439

Scott Olson
Altitude Training Associates
875 N. Table Mountain Loop
Cheyenne, WY……..(307) 637-4828
scott@gotoecs.com

Tom Gore
Altitude Training Associates
Golden, CO ……(303) 886-1133
Tgore.ATA@comcast.net

Keep it Clean Partner Contact Information

City of Boulder
Jeff Arthur, Civil Engineer II
City of Boulder Public Works
1739 Broadway, Suite 300
Boulder, CO 80306-0791
(303) 441-4418
arthurj@ci.boulder.co.us

Donna Scott
Stormwater Quality Specialist
City of Boulder Water Quality
4049 75th Street
Boulder, CO 80301
(303) 413-7364
scottd@ci.boulder.co.us

Betty Solek
City of Boulder Water Quality
4049 75th Street
Boulder, CO 80301
(303) 413-7366
soleke@ci.boulder.co.us

County of Boulder
Dale Case, Planner
Boulder County Land Use Planning
PO Box 471
Boulder, CO 80306
(303) 441-3930
dcase@co.boulder.co.us

Denise Grimm, Planner
Boulder County Land Use Planning
PO Box 471
Boulder, CO 80306
(303) 441-3930
dgrimm@co.boulder.co.us

Janice Buswell Lopitz, Keep it Clean Partnership Coordinator
Boulder County Public Health
3450 Broadway
Boulder, CO 80301
(303) 441-1439
jlopitz@co.boulder.co.us

Dave Webster
Boulder County Transportation/Engineering
PO Box 471
Boulder, CO 80306
(303) 441-3900 x5185
dwebster@co.boulder.co.us

Mark Williams, Water Quality
Boulder County Health Department
3450 Broadway
Boulder, CO 80301
(303) 441-1143
mwilliams@co.boulder.co.us

City of Longmont
David Hollingsworth, Civil Engineer
City of Longmont
350 Kimbark St.
Longmont, CO 80501
(303) 651-8328
david.hollingsworth@ci.longmont.co.us

Ela Nelson, Civil Engineer
City of Longmont
350 Kimbark St.
Longmont, CO 80501
(303) 774-4390
ela.nelson@ci.longmont.co.us

Town of Erie

Wendi Palmer
Town of Erie
Erie, CO 80516
(303) 926-2875
wpalmer@ci.erie.co.us

City of Louisville

Ken Mason
City of Louisville Public Works
749 Main Street
Louisville, CO 80027
(303) 665-7452
MasonK@ci.louisville.co.us

Town of Superior

Rick Beck, Engineer
RG Consulting
1331 17th Street, Suite 710
Denver, CO 80211
303-293-8107
rbeck@rgengineers.com

Other Participants

Kathy Dolan
CDPHE
WQCD-P-B2
4300 Cherry Creek Drive South
Denver, CO 80246-1530
kathy.dolan@state.co.us

Nathan Moore
CDPHE
WQCD-P-B2
4300 Cherry Creek Drive South
Denver, CO 80246-1530
nathan.moore@state.co.us

John Doerfer, Project Hydrologist
Urban Drainage and Flood Control District
2480 West 26th Avenue, Suite 156B
Denver, CO 80211-5580
303 455 6277
jdoerfer@udfcd.org

Additional Contacts

Boulder County - Tim D'Amato, (303) 678-6110

Colorado State University Cooperative Service - (303) 776-4865

Native Plant Revegetation Guide for Colorado
-http://parks.state.co.us/cnap/Revegetation_Guide/Reveg_index.html

Water Quality Permitting for the Construction Industry
Colorado Department of Public Health and Environment (CDPHE)
Water Quality Control Division

Discharge permits related to the construction industry

Colorado Water Quality Control Division……..(303) 692-3500
Stormwater Program……....(303) 692-3517
Stormwater General Permits
Matt Czahor……...(303) 692-3575
Nathan Moore……..….(303) 692-3555
Kathy Dolan……...(303) 692-3596
http://www.cdphe.state.co.us/wq/PermitsUnit/wqcdpmt.html

Construction Dewatering General Permits
John Nieland……..……..(303) 692-3553

Minimal Industrial Discharge (MINDI) General Permit
Chris Gates……..(303) 692-3539

Sand and Gravel General Permit……..(303) 692-3500

Other Colorado State Agencies

Department of Natural Resources
Soil Conservation Board……(303) 866-3311
Colorado State Forest Service……..(970) 491-6303
Department of Agriculture……(303) 239-4100

Federal Agency Contacts

Region VIII Environmental Protection Agency (EPA), Stormwater Program

Gregory Davis……..(303) 312-6082
Lee Hanley……(303) 312-6555
www.epa.gov

Army Corps of Engineers 404 Permitting……..(303) 979-4120

Natural Resources Conservation Service
Colorado State Office…….(720) 544-2810
FAX (720) 544-2962

Associations

Colorado Weed Management Association - www.cwma.org

International Erosion Control Association (IECA)……..(970) 879-3010
FAX (970) 879-8563

IECA Mountain States Chapter, Chance Foreman……(303) 341-2604

Colorado Chapter, Soil and Water Conservation Society
President, Wendell Hassell……..(303) 422-2440

SECTION 11

Sample Examination Test

CONTRACTOR CERTIFICATION PROGRAM
Sample Certification Examination

1. Best management practices (BMPs) used to control erosion and sedimentation include which of the following:

   a) Scheduling of activities
   b) Preserving natural vegetation
   c) Installation of clean water diversions
   d) All of the above

2. Stormwater runoff is water generated by which of the following:

   a) Washing out a concrete truck
   b) Rain water & snowmelt
   c) Dewatering an excavation
   d) Washing mud from vehicles prior to leaving the site

3. Collecting sediment from runoff is the best way to prevent water pollution caused by sediment.

   True False

4. The goal of the stormwater regulations is to improve water quality by reducing the amount of pollutants that wash into waterways.

   True False

5. Which of the following are keys to establishing vegetative cover on disturbed areas:

   a) Proper seedbed preparation
   b) Seed selection and method of application
   c) Time of year planting is done
   d) All of the above

6. The Stormwater Management Plan (SWMP) contains the best management practices to:

   a) Control erosion and sedimentation
   b) Control suspended solids in construction dewatering
   c) Protect species habitat
   d) None of the above

7. Proper installation of blankets includes:

   a) Digging anchor and check slots
   b) Overlapping the edges
   c) Stapling or pinning
   d) All of the above

8. A _____may be used to prevent water from impacting a slope by conveying runoff from the top to the bottom of the slope.

   a) Dozer track
   b) Straw Wattle
   c) Geotextile
   d) Slope drain

9. For silt fence installations to be effective, they must:

   a) Be placed on the toe of the slope
   b) Block water flow completely
   c) Placed up and down the slope
   d) None of the above

10. Effective best management practices (BMPs) for erosion control include:

   a) Removing sediment from runoff in a sediment pond.
   b) Working disturbed areas to completion and final stabilization
   c) Phasing construction to minimize disturbance
   d) b & c only