MONO COUNTY
BEST MANAGEMENT PRACTICES MANUAL

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MONO COUNTY
BEST MANAGEMENT PRACTICES
FOR EROSION CONTROL AND SEDIMENTATION

I. INTRODUCTION AND PURPOSE

Purpose of the Manual

The purpose of this manual is to help implement requirements in the County's Erosion and Sediment Control Ordinance, Chapter 19.xx of the Land Development Code. The intent of the ordinance is to implement erosion and sediment control standards in order to protect and improve water and air quality and to eliminate hazards to the public health, safety, and welfare. More specifically, the intent of the ordinance is to minimize disturbance to natural drainage processes, to prevent water and wind erosion, and to provide standards and procedures to mitigate unavoidable impacts to water and air quality, both on-site and off-site, which result from development and on-going maintenance activities.

This manual establishes erosion and sediment control standards for future development in Mono County. It also presents BMP's which are designed to provide reasonable assurance that those erosion and sediment control standards will be achieved. The BMP's have been determined to be an effective means of mitigating potentially adverse effects to water and air quality.

What is a BMP?

Best Management Practices (BMP's) are resource management practices whose purpose in the context of erosion and sediment control is to maintain water and air quality and to prevent or minimize water and wind erosion. They include a variety of practices which are intended to address both short-term impacts to air and water quality, such as those resulting from construction activities, as well as long-term impacts, such as those resulting from site development and design.

Who Should Use This Manual

The installation or use of BMP's is required of all development activities with the potential to adversely affect air or water quality, whether or not they require a grading permit (see 19.xx.030). The installation or use of BMP's is also required of on-going maintenance activities such as snow removal or road maintenance.

All landowners and public agencies managing land and/or facilities must install and/or implement and maintain erosion and sediment control BMP's to protect water and air quality, in accordance with this manual and Chapter 19.xx, Erosion and Sediment Control. Projects which require a grading permit shall comply through the grading permit process. Projects which do not require a grading permit may comply through the building permit process.

How to Use This Manual

BMP's are to be implemented using the following four-step process:

Step 1--Planning
The project proponent identifies erosion/sediment control issues, concerns or opportunities arising from the proposed project and selects BMP's from the County's Grading and Erosion Control Manual to resolve those concerns.

Since no one BMP is 100 percent effective, usually more than one practice must be applied to the problem. The project proponent should select a combination of practices best suited to the project. Such a selection should address short-term (construction) BMP's as well as long-term (site development and design) BMP's.

Where an applicant demonstrates to the satisfaction of the County that an exception to the BMP's specified in the Code is necessary based upon site specific conditions, the Director may approve a different BMP. Where the County allows such an exception, project conditions shall specify verifiable, site-specific BMP's and procedures for their implementation. The use of a BMP not included in the Code must be demonstrated to be equal to or better in achieving the erosion and sediment control standards than BMP's contained in the Code.

Step 2--Project Planning
The applicant develops site specific applications of the selected BMP's. These specific measures are included as project conditions and/or mitigation measures for the applicable permit (e.g. grading permit, building permit, etc.). The conditions and/or mitigation measures include a monitoring schedule for compliance.

Step 3--Application
The applicant implements the selected BMP's during the development of his project.

Step 4--Monitoring and Evaluation
The County monitors the installation and maintenance of the BMP's. If a particular BMP is found to be ineffective, the County may require the installation of an alternate BMP.

Organization of This Manual

BMP's in this manual are organized in the following categories:

Short Term

Long Term

II. SHORT-TERM BMPS

BMP 1 DEVELOPMENT SITE PLAN

Definition

A site plan identifying the physical features of the site, the location of proposed development, and the location of temporary and permanent BMPs.

Purpose

The required site plan provides basic information about the physical characteristics of the site so that development can be situated to minimize impact on the land and to enable water quality protection measures and runoff conveyance measures to be properly located.

Applicability

Site plans are required in a variety of situations, especially when construction that results in land disturbance is involved.

Planning Criteria

The first step in site planning is to identify the physical features of the site.

1. Topography - A topographic map that shows the existing topography and site conditions is required. Mono County requires that the map show topographic contours at 2 foot intervals for slopes less than 16%. For slopes 16% and greater, 5 foot intervals are required.

2. Drainage - The topographic map will help indicate which way water will flow across the site. On the map identity points where runoff will enter and leave the site. Mark all existing streams and drainage ways on the map. Perform a drainage analysis for the site as it exists before development.

3. Vegetation - Show the existing locations of the trees and shrubs on the map.

4. Identify land capability boundaries, including streams and associated riparian zones, drainages, flood plains, and other natural hazards.

5. Identify significant features such as rock outcrops, survey monuments, existing roads or other impervious coverage.

After the physical features of the site have been identified, locate the proposed development in order to minimize land disturbance.

1. Minimize earth movement - Fit development to the terrain. Minimize cuts and fills.

2. Minimize impervious coverage - Make paved areas, such as driveways and parking pads, as small as possible, consistent with other design requirements.

3. Minimize vegetation removal - Preserve trees, grass, and other native vegetation in order to maintain site stability and reduce BMP costs. Locate structures and driveways to minimize the need for site clearing.

4. Avoid steep slopes - Confine construction activities to the least critical parts of the site. Once these areas are disturbed by construction, the resulting erosion may be very difficult to stop. In addition, any construction activities on steep slopes will require installation of costly BMPs.

5. Align roads and driveways along slope contours Locate driveways parallel to slope contours rather than up and down slope. Runoff down long or steep driveways tends to channelize flows and can cut deep gullies along the driveway.

6. Retain the natural drainage system - Avoid confining any natural drainage system by placing it in a buried culvert or forcing it to a new location on-site. Accommodate all drainages entering the site, whether natural or established by man.

After the proposed developments have been located, identify the erosion and sediment control measures (BMPs) to be installed both during and after construction.

BMP 2. WINTERIZATION

Definition

Winterization is the preparation of the construction site for the rainy season and winter.

Purpose

To reduce the water quality impacts during the winter months resulting from construction works.

Applicability

Winterization is required on all construction sites which are active or inactive between October 15 and May 1.

Planning and Installation Criteria

1. Temporary BMPs shall be in place and/or inspected. Frequently, during the course of construction, straw bales are broken or knocked out of place, filter fences are knocked over, drainage ditches are blocked or filled, and sandbags are ripped open. All temporary BMPs must be repaired and functioning properly by October 15.

2. Temporary vegetation protection fencing shall be in place and/or inspected.

3. Disturbed areas shall be stabilized.

4. On-site construction slash and debris shall be cleaned up and removed from the site.

5. Permanent BMPs shall be installed wherever feasible. If the site will be active between October 15 and May 1, all permanent BMPs must be in place, especially paving of the driveway and parking areas.

6. All fill material retained for future backfilling must be protected by sediment barriers and be covered with plastic or other impervious material.

7. Any excess spill or spoil piles shall be removed from the site.

BMP 3. STABILIZED CONSTRUCTION ENTRANCE

Definition

A stabilized entrance consists of a pad of crushed stone or gravel located at any point where construction traffic enters or leaves a construction site at a public right-of-way, street, or parking area.

Purpose

To reduce or eliminate the tracking or flowing of sediment off the construction site.

Applicability

A stabilized construction entrance is applicable to construction sites where paved driveways and/or parking areas are absent.

Advantages

1. Minimizes the amount of land disturbed by construction activities.
2. Prevents sediment from reaching the public streets and storm drains.
3. Provides good consolidation of permanent roadbeds before paving.

Disadvantages

1. Application of crushed stone or gravel may be required more than once during the construction season, especially on clay subsoils.

Planning Criteria

Temporary construction entrances and roadways should be located where the permanent driveways and parking areas are planned. Only the minimum number of temporary routes to the construction site is allowed. Grading to the finished grade can be carried out and the permanent roadbed installed. The storage of materials, parking, and other construction activities can be located where permanent parking areas are planned. When necessary, wheels may have to be washed to remove sediment before leaving the construction site. Washing shall be conducted on the pad stabilized with crushed stone which drains into an approved sediment barrier, fence, trap, or basin. All sediment shall be prevented from entering any storm drain, ditch, or waterway through use of approved temporary sediment barriers. The subgrade of permanent roadbeds will be sufficient for the use of construction traffic.

Installation

The construction entrance should be dressed with clean, crushed stone or gravel (1 to 3 inches in diameter). The pad should be at least 8 inches in thickness, and at least 50 feet in length. Approximately one ton of material is required per 12 square yards of stabilized pad.

Maintenance

The construction entrance pad must be maintained in a condition which will prevent tracking or flowing of sediment from the site. Periodic top dressings of additional stone or gravel may be

required. Periodic cleanout of the temporary sediment barriers may be necessary. All sediment tracked or washed onto public rights-of-way must be removed immediately.

Effectiveness

Stabilized construction entrances and roadways are very effective in preventing sediment transport from the site. These practices are very cost effective because the cost of the subgrade is part of the permanent roadbed.

BMP 4. DUST CONTROL

Definition

Dust control is the control of wind blown soil or other materials from construction sites and roads.

Purpose

To prevent blowing and movement of dust from bare or disturbed soil surfaces, to reduce on-site and off-site damage, and to reduce health and traffic hazards.

Applicability

Dust control practices are required for any grading activity and are applicable to most construction sites.

Advantages

1. Dust control will reduce sediment delivery by runoff waters.

2. This practice prevents water quality degradation in adjacent streams and lakes from wind blown sediments.

Disadvantages

1. This practice is temporary and does not add to the capital value of the project.

Planning Criteria

1. Plan and schedule grading to disturb the least amount of land possible at one time and stabilize open areas before disturbing additional land.

2. Install temporary BMPs at the onset of construction and inspect them periodically.

3. Install permanent BMPs as soon as possible.

4. Plan to have construction traffic use the roadbeds of future road where possible.

Installation

One or more of the following methods and materials shall be utilized for controlling dust.

1. Sprinkling - the site is sprinkled with water as needed to keep the surface moistened to a depth of 2-3 inches, but is not saturated. This is generally done as an emergency treatment and must be repeated several times daily.

2. Mulches - Stone and gravel mulches can be used for temporary dust control and for permanent stabilization as well.

3. Vegetative Cover - Establish cover on bare and disturbed soil surfaces using adapted species.

4. Oil treated subgrades of roads can be used on permanent travel ways which are to be paved by the end of the grading season.

5. Chemicals - some chemicals if approved by Mono County, can be sprayed on for temporary dust control. However, most of these chemicals make the soil water-repellent, and may interfere with revegetation efforts.

Maintenance

Sprinkling shall be repeated as often as necessary to control dust, if watering is the method used. More than one application of stone and gravel may be required during construction depending on the amount of traffic and soils. Oiled subgrades should not be allowed to break-up due to over use as repeated applications of oil to maintain the surface is undesirable and may be prohibited if the result is migration of oil into drainageways.

Effectiveness

Vegetative cover is the most effective practice on bare and disturbed areas not exposed to construction traffic. Stone or gravel mulches are very effective when used where the permanent driveway and parking areas are planned. This insures good consolidation of permanent roadbeds before paving. Sprinkling is the least effective of the various practices. Oiling of prepared subgrades has a limited ability to withstand use before break-up.

BMP 5. STRAW BALE SEDIMENT BARRIER

Definition

Straw bale sediment barriers are temporary berms, diversions, or other barriers that are constructed of baled straw.

Purpose

Straw bale sediment barriers are constructed to intercept and detain small amounts of sediment from unprotected areas of limited extent.

Applicability

Applicable to all construction sites, especially where runoff can discharge onto adjacent properties. These barriers are temporary in nature and should not be used where there is concentration of water in a channel or other drainageway.

Advantages

1. If properly installed, the barriers can remove the bulk of coarse sediment from runoff before leaving the site.

2. Prevents sediment damage to adjacent property owners.

3. When the bale deteriorates, it can be broken up and spread as mulch.

Disadvantages

1. The barriers have a short life expectancy of 3-6 months.

2. The barriers are not intended for use on cut and fill slopes.

3. The barriers are not intended for use on paved surfaces.

4. The barriers are ineffective if not properly installed because of undercutting and end flow.

5. The barriers are easily damaged and/or moved by construction equipment.

6. Source of weed or exotic seeds.

Planning Criteria

Since these barriers are designed to intercept surface runoff, they are only effective for small areas generally less than one-half - one acre and where slope lengths do not exceed 100 feet. The barriers may be used on single-family residential lots or moderate slopes of less than 20%. The length of slope above the barrier should be less than 200 feet.

Installation

A row of straw bales shall be placed along the contour of a gentle slope or at the toe of a steeper slope. They can be used in this way around the disturbance area or near the property boundary where runoff from the site passes onto an adjacent property.

Maintenance

The barriers shall be checked periodically. Sediment which has accumulated needs to be removed after each storm. Bales must be replaced when rotten, disintegrating, or broken.

Effectiveness

The straw bale sediment barriers are only effective if they are properly installed and in accordance with the design criteria. Sandbags are more effective on paved surfaces than the straw bales, and filter fences are more effective on soil surfaces. The barriers are not effective for use to prevent or check channel erosion.

Figure 1 -- BMP 5 Straw Bale Sediment Barrier

BMP 6. FILTER FENCE

Definition

Filter fences are a temporary sediment barrier consisting of filter fabric attached to supporting posts. Usually a wire mesh or similar material is used to help support the fabric.

Purpose

Filter fences are constructed to intercept and detain sediment while decreasing the velocity of runoff.

Applicability

Applicable to all construction sites, especially where runoff can discharge onto adjacent properties or directly into streams. These barriers are temporary in nature and limited to situations in which surface runoff is expected. They should not be used where there is concentrated volumes of water in channels or other drainageways.

Advantages

1. If properly installed, the filter fences can remove most of the sediment from surface runoff leaving the site.

2. Prevents sediment damage to adjacent property owners.

3. Prevents degradation of water quality, especially when used adjacent to water courses.

4. Reduces the velocity of runoff, runoff, and hence the erosive capacity.

Disadvantages

1. The filter fences have a useful life expectancy of one year.

2. The fences are not intended for use in channels, drainageways or on cut and fill slopes.

3. The fences are ineffective if not properly installed because of undercutting and end cutting.

4. The fences require some soil disturbance in order to entrench the filter fabric.

5. The fences require periodic maintenance and cleaning.

Planning Criteria

Since the fences are designed to intercept surface runoff, they are effective for areas of about 1-2 acres and where the maximum slope length behind the barriers is 100 feet. The fences may be used on slopes of less than 50 percent.

Installation

Filter fences are usually made by attaching filter fabric (Mirifi lOOX, Exxon GTF lOOS, or equivalent) to a wire mesh fence. Steel posts are spaced from 4 to 10 feet along the contour depending on the application and driven at least 1 foot into the ground. A trench (4 in. x 4 in.)

is excavated along the line of posts and uphill from the barrier. The filter cloth is not only buried vertically, but also across the bottom of the trench into the direction of the water flow. The wire mesh is fastened to the uphill side of the posts and extended into the trench. The filter cloth is then fastened to the uphill side of the posts and extended into the trench. The trench is backfilled over the toe of the filter cloth and the soil compacted against the filter cloth.

Maintenance

The filter fences should be checked immediately after each rain storm and shall be repaired as necessary to keep them functional. Sediment should be removed when deposits reach approximately one-half the height of the barrier and properly removed from the site. The material must never be placed below the filter fence. Any required repairs should be made immediately.

Effectiveness

The filter fences are only effective if they are properly installed and in accordance with the design criteria. In general, a filter fence can last about twice as long as a straw bale sediment barrier and is more effective in trapping sediments. The greater effectiveness of the filter fence is due to stronger construction, greater depth of ponding, and by allowing fewer soil particles to pass through it.

BMP 7. STRAW BALE DROP INLET SEDIMENT BARRIER

Definition

Straw bale drop inlet barriers are temporary sediment barriers consisting of straw bales placed around drop inlets.

Purpose

Drop inlet sediment barriers are constructed to prevent sediment from entering the storm drain system in unpaved areas.

Applicability

Applicable to all construction sites where the drop inlet drains a relatively flat disturbed area with slopes less than 5 percent. The straw bale barriers can only be used prior to paving when bales can be staked into the ground for stability. They should not be placed around inlets receiving concentrated flows such as along major streets.

Advantages

1. If properly installed, the drop inlet barriers can prevent sediment from entering the storm drain system.

Disadvantages

1. Straw bales can be easily damaged by construction equipment operating in the area.

Planning Criteria

The drop inlet sediment barriers are for drainage areas of less than one acre. They are designed to keep sediment out of the storm drain system, and they do not have a sediment storage area.

Installation

Straw bales are placed length wise around the inlet in a 4 in. deep trench. Orient the bales with the wires or bindings around the sides. All bales shall be abutted and staked. Backfill the excavated soil and compact it against the outside of the bales.

Maintenance

The barriers should be checked periodically and shall be repaired to keep them functional. Sediment which has accumulated may need to be removed after each storm and properly removed from the site. Bales must be replaced when rotten, disintegrating, or broken.

Effectiveness

The drop inlet protection devices are only effective if they are properly installed and in accordance with the design criteria. If the bales are not tightly abutted, sediment can freely enter the storm drain system. The straw bale devices are not effective and should not be used on paved streets at curb inlets.

BMP 8. SANDBAG CURB INLET SEDIMENT BARRIER

Definition

Sandbag curb inlet barriers are temporary sediment barriers consisting of sandbags placed on the uphill side of the inlet and overlapping onto the curb.

Purpose

Curb inlet sediment barriers are used to prevent sediment from entering the storm drain system in paved areas.

Applicability

Applicable to all construction sites where the roads are already paved with the curb inlets in place. The sandbag barriers are useful on streets which receive runoff flows of less than 0.5 cfs.

Advantages

1. If properly installed, the sandbag barriers can prevent sediment from entering the storm drain system under low runoff flows.

2. Simple and cheap to install.

Disadvantages

1. Once the area behind the sandbags fills with sediment, future runoff will enter the storm drain without the sediment settling out.

2. Sandbags and contents are treated as spoils and must be removed from the site or the contents used as backfill.

Planning Criteria

The sandbag curb inlet sediment barriers are for drainage areas of less than 1 acre. They are designed to keep sediment out of the storm drain system when the roads are already paved. There is a small area of sediment storage behind the sandbags.

Installation

The sandbag should be of plastic woven material rather than burlap. Burlap bags rot and deteriorate, and as a result, can cause more problems if broken. Only clean washed sand shall be used to fill the bags. The sandbags should be placed in a curved row from the top of the curb at least 3 feet into the street. The row should be at least 6 feet from the inlet and curved at the ends which should be pointing uphill. Several layers of bags should be overlapped and packed tightly together in order to eliminate any spaces between the bags. Leave a 6 inch gap in the middle of the top row of sandbags to serve as the spillway.

Maintenance

The curb inlet barriers must be checked after each storm and shall be repaired to keep them functional. Sediment which has accumulated needs to be removed and placed where it will not enter the storm drain. Additional sediment storage capacity can be obtained by constructing a

series of sandbag barriers along the curb and gutter so that each barrier traps a small amount of sediment.

BMP 9. FILTER BERM

Definition

A filter berm is a temporary ridge of gravel or crushed rock constructed across a graded driveway.

Purpose

To retain sediment on-site by retarding and filtering runoff while allowing water to be discharged from the site and construction traffic to proceed along the driveway.

Applicability

Filter berms are used primarily where graded driveways meet paved streets or across stabilized construction entrances. This application would only apply to parcels which are located upslope from the paved right-of-way. Filter berms may also be used as outlets for sediment barriers around construction sites and in uncompleted drainage ditches prior to roadway paving.

Advantages

1. Prevents sediment from reaching public streets and storm drains.

2. Prevents sediment damage to adjacent property owners.

3. Prevents degradation of water quality, especially when used adjacent to water, courses.

Disadvantages

1. Needs periodic repair and replacement because of vehicle damage.

2. When used around the perimeter of a construction site, the cleanup and removal of the berm is costly and can cause additional soil disturbance.

3. Practice is not suitable on steep slopes or in forested and vegetated areas.

Planning Criteria

Filter berms are used to filter runoff water for discharge from construction sites. The practice is best designed for use at construction entrances on upsloping parcels. Although continuous filter berms may be used around construction sites, filter fences are more effective where vehicle traffic is restricted.

Installation

Deposit a ridge of well graded gravel or crushed rock (.75 to 3 inches) with a shovel or backhoe. Compact the material by rolling or tamping until it has the following dimensions. The dimensions of the berm depend on the location and application where installed across the construction entrance, the height should be 1.5 to 2 feet, the top width 3 to 5 feet and the side slopes 3:1 or flatter. When used where no vehicles will cross, the height can be up to 3 feet, the top width only 1 to 1.5 feet, and the side slopes 2:1. On sites where a filter berm is installed across a graded entrance which has not been stabilized with gravel mulch, filter fabric should be incorporated in the berm approximated 6 inches below the top surface. This makes cleanout and replacement much easier as only the top layer needs to be cleaned and/or replaced.

Maintenance

Remove all trapped sediment and clean out or replace clogged filter material after each storm. Repair and add material if vehicles compact the structures below minimum dimensions. The presence of ruts across the structure will lead to erosion problems.

Effectiveness

Filter berms are very effective in preventing sediment transport from construction sites. The practice is cost-effective when the berms are located on the permanent roadbeds. The gravel or crushed stone can be used as subgrade material before paving.

Figure 2 - BMP 9 Filter Berm

BMP 10 SILTATION BERM

Definition

A siltation berm is a temporary barrier of gravel or crushed rock covered with plastic sheeting constructed around construction sites.

Purpose

To capture and retain runoff from construction sites, to allow sediments to settle out, and to direct runoff water through filter berms at outlets to stabilized drainage ways.

Applicability

The impermeable siltation berms are applicable to relatively flat construction sites and should be installed on the downslope sides of the disturbed areas.

Advantages

1. Prevents sediment from reaching public streets and storm drains.
2. Prevents sediment damage to adjacent property owners.
3. Prevents degradation of water quality, especially when used adjacent to water courses.
4. Reduces the velocity of surface runoff, and hence the erosive capacity.

Disadvantages

1. When used on the perimeter of construction sites, the cleanup and removal of the berm is costly and cause additional soil disturbance.
2. Practice is not suitable on steep slopes or in forested and vegetated areas.

Planning Criteria

Siltation berms are used to capture and retain runoff from construction sites. The berms should be sized to contain the runoff water from a design storm (20-year, l-hour event). The sediments in the runoff water are allowed to settle out and the water is directed through filter berms located at points leading to stable drainage ways.

Installation

A ridge of gravel or crushed rock (.75 to 1.5 inches) should be mounded along the contour of the slope at the downhill side of the construction site. The height of the ridge should be sufficient to contain the specified volume of runoff. The height of the ridge should be at least 1.5 feet. The side slopes of the ridge should not exceed 2:1. Plastic sheeting (6 mil thick) is placed over the berm. The sheeting width should be wide enough to cover the berm and allow at least 1 foot of additional sheeting on each side of the berm to allow anchoring. The sheeting is anchored by placing gravel or crushed rock on the edges to a depth of at least 3 inches and width of at least 8 inches.

Maintenance

Siltation berms must be inspected periodically, especially after each storm, and maintained to keep functional. The plastic sheeting must be replaced as necessary in order to retain runoff water and sediments on-site.

Effectiveness

Siltation berms can be effective if they are properly installed and maintained on relatively flat sites. Filter fences are more effective in most situations, except where runoff needs to be directed to certain discharge points.

Figure 3 - BMP 10 Siltation Berm

BMP11 STRAW MULCH

Definition

Straw mulch is used as a temporary mulch to protect bare or disturbed soil areas that have not been seeded. Straw mulch can also be considered as a temporary practice when used as a mulch for short-term vegetation, such as, grass seeding on a graded right-of-way. However, straw mulch is a permanent practice when used to help establish the long-term or permanent vegetation.

Purpose

To temporarily stabilize bare and disturbed soils, to protect the soil surface from raindrop impact, to increase infiltration, to conserve moisture, to prevent soil compaction or crusting, to decrease runoff, and to provide a mulch for short-term vegetation if seeded.

Applicability

Applicable to any site where soil has been disturbed and vegetation removed. These practices provide temporary protection until the permanent vegetation can be established. As a temporary practice, they are applicable only for relatively short periods of time or until the next seeding season has been reached.

Advantages

1. Prevents erosion from raindrop impact, runoff, and wind action.
2. Prevent the discharge of degraded runoff water from construction sites.
3. Enhance revegetation efforts, either temporary (short-term) or permanent (long-term).
4. Not toxic to vegetative growth.

Disadvantages

1. Increase construction costs.
2. Requires matting, crimping, punching, or other methods to hold it in place, especially on steep slopes.
3. Provides only short-term protection (one season or winter).
4. Weed growth is common.
5. Cleanup cost may be high if the mulch is applied during winds.
6. Cannot be blown as far as hydro mulch.

Planning Criteria

Straw is an excellent mulch material, which because of its length and bulk, is highly effective in reducing the impact of raindrops and in moderating the microclimate of the soil surface. Straw mulch can be applied by hand on small sites and blown on by machine on large sites. Straw blowers have a range of about 50 feet. Some commercial models advertise a range up to

85 feet and a capacity of 15 tons per hour. Straw mulch should cover the exposed area to a uniform depth. If the mulch is being used without seeding, then the depth can range from 2 to 4 inches. However, the mulch should not be applied more than 2 inches deep on seeded sites. If the straw is applied at rates higher than 3 tons per acre, the mulch may be too dense for seedlings to penetrate. Approximately one bale of straw covers 1000 square feet adequately. The soil surface should be barely visible through the straw mulch. Straw must be anchored to keep it from blowing away. Straw mulch is commonly anchored by: 1. Crimping, rolling, disking, or punching into the soil; 2. Covering with a netting; or 3. Spraying with a chemical or tackifer.

On small sites, where straw has been distributed by hand, it can be anchored by hand punching it into the soil every 1 to 2 feet with a dull, round-hosed shovel. A sharp shovel will merely cut the straw and not anchor it.

Installation

1. Obtain clean wheat, barley, oat, or rice straw in order to prevent the spread of noxious weeds. Avoid moldy, compacted straw because it tends to clump and is not distributed evenly.

2. The straw shall be evenly distributed by hand or machine to the desired depth.

3. Anchor the mulch using an acceptable method. On areas adjacent to lakes, streams, or drainageways, netting is highly recommended in order to prevent any mulch material from entering the water. Straw can increase the BOD levels and upon decomposition, release some nutrients.

4. Straw must be anchored on slopes steeper than 2:1.

Maintenance

If properly applied and anchored, little additional maintenance is required during the first few months. After high winds, mulched areas should be checked for adequate cover and remulched, if necessary.

Effectiveness

Straw mulch is very effective if it is kept in place. Anchoring increases the costs, but it is necessary on steep slopes. Although jute matting over straw is very costly, it is one of the most effective treatments for critical areas.

BMP 12 HYDROMULCH

Definition

Hydromulch is the combination of wood fiber and water and is applied hydraulically as a slurry.

Purpose

To temporarily stabilize bare and disturbed soils, to protect the soil surface from raindrop impact, and to provide a mulch for short-term vegetation if the areas was seeded.

Applicability

Applicable to any site where the soil has been disturbed and vegetation removed, however, the practice is only recommended for use on steep, inaccessible slopes, such as highway cut and fill slopes.

Advantages

1. Prevents erosion from raindrop impact, surface runoff, and wind action.
2. Can be applied on a windy day.
3. Can provide temporary protection on slopes greater than 50 percent.
4. Can be used as a carrier for straw mulch.

Disadvantages

1. Must be applied at a heavy rate in order to be effective as a mulch.
2. Provides only short-term protection.
3. Not cost-effective for small areas or small jobs.
4. Will not adhere well to steep slopes on decomposed granite soils.
5. Provides little protection over winter.

Planning Criteria

Hydromulch consists basically of wood fiber and water. Wood fiber is a natural, short fiber product produced from clean wood chips. A nontoxic dye is used to color the mulch green in an effort to aid visual metering during its application. When sprayed on the surface of the soil, the fibers form an absorbent cover, allowing percolation of water. Although it can provide a complete ground cover, the short fibers do not provide enough mass to dissipate all of the energy from falling raindrops and flowing water.

Installation

1. Wood fiber and water are agitated into a well mixed slurry. Wood fiber can be applied at rates of 1000-3000 pounds per acre. At rates of 2000 pounds per acre or less, the

mulch is not very effective. When used as a tackifer for straw mulch, it should be applied at a rate of 750 pounds per acre.

2. Fertilizer and/or tackifers can be introduced to the slurry before the wood fiber is added.

3. Never add seed to hydromulch.

4. The slurry is hydraulically sprayed onto the areas within 125 feet of a road. When a 100 foot hose is available, the range can be extended up to 200 feet.

5. Do not use on decomposed granite slopes over 30%.

Maintenance

Hydromulched areas shall be inspected periodically for damage and remulched if necessary. Fencing or traffic barriers may be necessary to protect treated areas.

Effectiveness

Hydromulch is not effective as a mulch. It is preferable to straw mulch only for limited applications. It can be used very effectively as a tackifer for straw mulch.

BMP 13 PLASTIC NETTING

Definition

Plastic netting is used to hold mulch in place on steep slopes.

Purpose

To hold mulch in place on steep slopes and along drainageways and to help establish revegetation in critical areas. As a temporary mulching practice over straw, it stabilizes bare and disturbed soils, protects the soil surface from raindrop impact, increases infiltration, conserves moisture, prevents soil crusting or compaction, and reduces erosion caused by overland flow.

Applicability

Applicable to any sites where soil has been disturbed and vegetation removed. Plastic netting provides little soil stabilization by itself and should never be used alone. Plastic netting is used primarily to hold mulches in place on steep slopes. Applicable to long-term or short-term revegetation practices.

Advantages

1. Netting applied over straw mulch is one of the more effective soil stabilization practice on steep slopes in the County.

2. When used in combination with seeding and mulches, it is an effective way to help establish permanent vegetation on these steep slopes.

3. The cost of plastic netting is considerably less than jute netting.

Disadvantages

1. High cost of installation.

2. Cost of material.

3. Not as aesthetically pleasing as jute netting.

Planning Criteria

Plastic netting is available in rolls which range in width from 4 to 15 feet and up to 2,500 feet in length. The material is rolled out up and down the slope, never along the contour. If placed along the contour, creeping snow loads will peel it off the slope. The netting is overlapped and stapled to the slopes to provide a uniform covering over the mulched and/or seeded area. Results in areas similar to Mono County indicate that plastic netting is most effective when applied over straw mulch and seed. Plastic netting is available in various colors which differ in their rate of deterioration due to ultra-violet radiation. The green netting which may be more aesthetically pleasing is designed to last about 2 years. However, due to the high elevations of Mono County, the green netting tends to start deteriorating after one season, and thus, is inadequate. Black plastic netting is longer lasting and recommended for use in the County.

Installation

1. Seed and mulch the disturbed area.

2. Starting above the mulched and/or seeded area, bury the top end of the netting in a trench at least 4 inches deep and 8 inches wide. The trench shall be backfilled and tamped.

3. The netting shall extend beyond the edge of the mulched and/or seeded area at least 1 foot on the sides and 3 feet on the top and bottom. Fasten with a row of staples 1 foot apart.

4. Roll out the netting up and down the slope and secure with staples. Wire staples of No. 11 gauge or heavier should be used. The "U" shaped staples shall be 6 to 10 inches long with a 1-inch crown. Use longer staples on loose or sandy soils.

5. Overlap the netting at least 4 inches on the sides and secure with staples 5 feet apart along the overlap.

6. Overlap lower end of uphill strip over downhill strip at least 1 foot and secure with staples 1 foot apart.

7. Continue adding strips of netting until entire mulched area is covered and secured with staples.

8. The netting shall be cut around big rocks or tucked in around smaller ones to prevent bridging.

Maintenance

If the netting is properly installed, little maintenance is required. The areas shall be inspected periodically, especially late fall and early spring, for any damage. Repair and restaple netting if necessary.

Effectiveness

Plastic netting is as effective as jute netting and because of its lower cost, it is more cost effective.

BMP 14 EROSION CONTROL BLANKETS OR GEOTEXTILES

Definition

Erosion control blankets or geotextiles is a generic name given to support and filter fabrics that are placed in contact with the soil.

Purpose

To provide a protective mulch on steep slopes or along drainageways and to help establish vegetation in critical areas. As a temporary mulching practice, it stabilizes bare and disturbed soils, protects the soil surface from raindrop impact, increases infiltration, conserves moisture, prevents soil crusting or compaction, and reduces erosion caused by overland flow. As a channel liner, it minimizes channel erosion by restraining the soils from movement while allowing free passage of water along the plane of the fabric.

Applicability

Applicable to any area where soil has been disturbed and vegetation removed. Major alternative to jute netting and straw mulch. Can be utilized when it is cheaper or if installation is easier.

Advantages

1. Combines two steps, mulch and netting, into one.
2. Cost competitive with jute and straw.
3. Easier installation on some sites, and thus, lower installation costs.
4. Can be used effectively as a channel liner.

Disadvantages

1. Cost of materials and installation.
2. Plastic or wire netting may not be as aesthetically pleasing as jute netting.

Planning Criteria

Blankets are available in various widths, usually 6 to 8 feet, depending on the manufacturer. The material comes in rolls, 50 to 100 feet in length. The blanket material is easily rolled out on graded surfaces and securely stapled to provide a uniform covering. The blankets can be used with permanent, long-term vegetation practices.

Installation

1. Prepare and/or seed the disturbed area.
2. Starting above the disturbed area, bury the top end of the blanket in a trench at least 4 inches deep and 8 inches wide. The trench shall be backfilled and tamped.
3. The blanket material shall extend beyond the edge of the disturbed and/or seeded area at least 1 foot on the sides and 3 feet on the top and bottom. Fasten with staples 1 foot apart. Wire staples of No. 11 gauge or heavier should be used. The "U" shaped staples

shall be 6- to 10-inches long with a l-inch crown. Use longer staples on loose or sandy soils.

4. Roll out the blanket up and down the slope and secure with staples. Staples shall be applied at 2 foot intervals along the sides of the blanket and at 4 foot intervals along the center of the blanket.

5. Butt-join the blankets on the sides and ends and secure with staples.

6. The blanket shall be cut around big rocks or tucked in around smaller ones to prevent bridging and flows underneath the blankets.

Maintenance

If the blankets are properly installed, little maintenance is required. The areas shall be inspected periodically, especially late fall and early spring, for any damage. Repair, replace, and restaple blankets if necessary.

Effectiveness

Erosion control blankets are very effective in providing soil protection and in aiding the establishment of vegetation. They can be as cost effective as jute and straw on steep slopes and more cost effective on graded construction sites because of easier installation.

BMP 15 DIVERSION SWALE

Definition

A temporary ditch cut into the soil constructed immediately above new cut or fill slopes and installed with sufficient grade to divert runoff away from the erodible slopes.

Purpose

To intercept overland flow from upslope areas and divert it away from newly constructed, unstabilized, unprotected, or recently seeded slopes to a stable outlet.

Applicability

Applicable to all construction sites where disturbed and bare slopes can receive runoff from upslope areas.

Advantages

1. Prevent slope failures.
2. Prevents damage to adjacent property owners.
3. Prevents the degradation of water quality.
4. Increase potential infiltration.
5. Increase the time of concentration, and thus reduce the peaking of runoff.

Disadvantages

1. Concentrate the volume of runoff water.
2. Convert overland flow to channel flow.
3. May accumulate sediment and require cleanout.

Planning Criteria

Slopes that are formed during cut and fill operations should be protected from storm water runoff by installing a dike, swale, or combination of both at the top of the slope to divert runoff away. A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and compacted by a second pass of the tracks or wheels over the ridge.

The drainage area above the diversion should be less than 5 acres. The diversion structures should be installed during the grading season and remain in place until permanent BMPs are installed and/or the slopes are stabilized.

Installation

1. Construct a ditch immediately above the cut and fill slope. Swales should not be established on slopes greater than 15 percent.
2. Bottom width shall be at least 2 feet.

3. Depth of the swale shall be at least 18 inches from the existing ground.

4. Side slopes shall be 2:1 or flatter.

5. Swale shall have sufficient grade (1-3 percent) in order to provide drainage to a stable outlet.

6. Diverted runoff from an undisturbed area can discharge directly to a stabilized area or into a grade stabilization structure.

7. Diverted runoff from a construction site must be conveyed to a sediment trap or sediment basin before being discharged.

8. Diverted runoff shall not overtop the swale.

Maintenance

Inspect periodically and maintain as required. Locate any areas where the runoff overtopped the swale and repair immediately. Any accumulated sediment should be cleaned out when deposits fill up approximately onehalf the depth of the swale.

Effectiveness

The diversion swales are only effective if they are properly installed and in accordance with the design criteria. If drainage areas above the diversion structures are larger than 5 acres, design must include runoff calculations and follow the specifications for permanent waterways. A larger cross section and a channel lining will be required to handle the larger flows. Swales are more effective than dikes because they tend to be more stable. The combination of swale with a dike on the downhill side is the most effective and cost effective where equipment access is not limited.

BMP 16 PERIMETER SWALE

Definition

A temporary excavated ditch constructed along the perimeter of the construction site or disturbed area.

Purpose

To prevent off-site runoff from entering the disturbed area and to convey sediment laden runoff from on-site to a sediment trap or basin.

Applicability

Applicable to all construction sites where erodible soils can be exposed to runoff from upslope areas.

Advantages

1. Prevents damage to adjacent property owners.

2. Prevents the discharge of degraded runoff water from construction sites.

Disadvantages

1. Increase construction costs.

2. Require periodic maintenance and cleanout.

3. Concentrate the volume and velocity of runoff water.

Planning Criteria

Diversion practices concentrate the volume of surface runoff, convert it to channel flow, and as a result, increase its velocity and erosive force. It is necessary to plan in advance for the release of runoff collected by perimeter dikes and swales. The diverted runoff from the undisturbed upland area can be discharged directly onto a stabilized area or into a grade stabilization structure. However, the diverted runoff from the construction site or disturbed area must be conveyed to a sediment trap or basin or to an area protected by a sediment.

Installation

1. Excavate a ditch around the disturbed area. Swales should not be constructed on slopes greater than 15 percent.

2. Bottom width shall be at least 7 feet and should be level.

3. Depth shall be at least 1 foot.

4. Side slopes shall be 2:1 or flatter. The slopes need to be flat enough to allow construction traffic to cross if desired.

5. Swales shall have sufficient grade (1- to 3 percent) in order to provide drainage to a stable outlet.

6. Diverted runoff from an undisturbed area can discharge directly to a stabilized area or into a grade stabilization structure.

7. Diverted runoff from a construction site must be conveyed to a sediment trap or sediment basin before being discharged.

8. Diverted runoff shall not overtop the swale.

Maintenance

Inspect periodically and maintain as required. Locate any areas where the runoff overtopped the swale and repair immediately. Any accumulated sediment should be cleaned out when deposits fill up approximately onehalf the depth of the swale.

Effectiveness

The diversion swales are only effective if they are properly installed and in accordance with the design criteria. If drainage areas above the diversion structures are larger than 5 acres, design must include runoff calculations and follow the specifications for permanent waterways. A larger cross section and a channel lining will be required to handle the larger flows. Swales are more effective than dikes because they tend to be-more stable. The combination of swale with a dike on the downhill side is the most effective and cost effective where equipment access is not limited.

BMP 17 INTERCEPTOR DIKE

Definition

A temporary ridge of compacted soil constructed across disturbed areas or graded rights-of-way.

Purpose

To shorten the length of exposed slopes and reduce the erosion potential by intercepting runoff and diverting it to a sediment trap or basin.

Applicability

Applicable to any construction site where it is necessary to intercept on-site runoff and divert it away from unstabilized areas.

Advantages

1. Prevents damage to adjacent property owners.

2. Prevents the discharge of degraded runoff water from construction sites.

Disadvantages

1. Increase construction costs.

2. Require periodic maintenance and cleanout.

3. Concentrate the volume and velocity of runoff water.

Planning Criteria

Diversion practices concentrate the volume of surface runoff, convert it to channel flow, and as a result, increase its velocity and erosive force. It is necessary to plan in advance for the release of runoff collected by interceptor dikes and swales. The diverted runoff from the construction site or graded right-of-way must be conveyed to a sediment trap or basin or to an area protected by a sediment barrier. The drainage area should be less than 5 acres. The diversion structures should be installed during the grading season and remain in place until permanent BMPs are installed or the disturbed areas stabilized.

Installation

1. Construct a ridge of compacted soil across the disturbed areas or graded right-of-way. On graded rights-of-way gravel or crushed aggregate.

2. Top width shall be at least 2 feet.

3. Height of the dike shall be at least 18 inches from the existing ground.

4. Side slopes shall be 2:1 or flatter.

5. Dike shall have sufficient grade (l to 3 percent) in order to provide drainage to a stable outlet.

6. Diverted runoff from a construction site must be conveyed to a sediment trap or sediment basin before being discharged.

7. All dikes shall be machine-compacted.

8. Diverted runoff shall not overtop the dike.

Maintenance

Inspect periodically and maintain as required. Locate any damaged areas after each storm and repair immediately. Any accumulated sediment should be cleaned out when deposits reach approximately one-half the height of the dike.

Effectiveness

The dikes are only effective if they are properly installed and in accordance with the design criteria. The dikes should not be used to divert channel flows.

III. LONG-TERM BMPS

BMP 18 PIPE SLOPE DRAIN (PIPE DROP)

Definition

A rigid pipe, usually corrugated metal extending from the top to the bottom of a slope.

Purpose

To temporarily convey runoff down a steep slope until permanent BMPs are installed and the slope stabilized. Pipe slope drains serve as outlets for diversion dikes and swales and interceptor dikes and swales.

Applicability

Applicable to any construction site where runoff water can accumulate above critical areas, especially, cut or fill slopes, and must be conveyed down the slope without causing erosion.

Advantages

1. To protect unstabilized areas from erosion by concentrated flows.

2. To prevent the discharge of degraded runoff water from construction sites.

Disadvantages

1. Increase construction costs.

2. Require periodic checking and maintenance, especially after each storm.

Planning Criteria

These structures are used to convey runoff down a slope and are usually used in combination with diversion structures. The pipe slope drains must have a capacity adequate to carry the design storm. It is very important that these pipes be installed properly, since failure can cause gully erosion. The pipes can be buried to prevent any movement on the slope, but this practice causes additional disturbance during installation and removal and, hence is not recommended. The inlet section must be securely entrenched. All connections must be watertight. Outlet protection is necessary. If the runoff is sediment-laden, a sediment trap must be installed below the outlet protection.

Installation

1. The diameter shall be sufficient to convey runoff from the design storm.

2. The inlet structure shall be placed on undisturbed soil or well-compacted fill with a slope of 3 percent or greater.

3. The top of the inlet pipe must be at least 1 foot lower than the diversion dikes conveying water to the inlet.

4. The inlet structure and pipe slope drain shall be corrugated metal pipe of the same diameter and secured with metal strapping or watertight collars.

5. The pipe slope drain shall be anchored to the slope.

6. Discharge shall be to a stabilized outlet, such as, riprap apron or other energy dissipater.

7. Debris racks may be necessary to prevent clogging of the entrance.

Maintenance

Inspect for damage or clogging after each storm. The inlet structure should be checked for signs of undercutting of piping.

Effectiveness

The downdrains are only effective if they are properly installed and in accordance with the design criteria. Failures can occur at the inlet structure because fill material was not compacted sufficiently.

Figure 4 - BMP18 Pipe Drop

BMP 19 SEDIMENT TRAP

Definition

A sediment trap is a small temporary or permanent basin formed by an embankment and/or excavation designed to intercept the runoff from a drainage area of less than 5 acres.

Purpose

To intercept small quantities of sediment-laden runoff generated during construction activities and to trap and retain the sediment in order to protect streams, drainageways, storm drains, properties, and right-of-way from sedimentation.

Applicability

Applicable to all construction or grading sites with a drainage area of less than 5 acres.

Advantages

1. If properly installed and maintained, sediment retention structures can prevent the discharge of degraded runoff water from construction sites.

2. Can remove the coarse sediment from runoff if the settling time is adequate.

3. Prevents sediment from reaching the public streets and storm drains.

4. Prevents sediment damage to adjacent property owners.

5. Sediment traps are smaller than basins, and thus, are much easier to install and more easily moved to keep up with grading activities.

Disadvantages

1. Requires regular maintenance, removal of sediment after each storm, if the design capacity is to be maintained.

2. Increases construction costs.

3. Removes sediment after erosion has occurred and does not treat the problem at the source. Sediment has to be disposed of.

4. Traps are often not aesthetically pleasing and provide little flood control capacity.

Planning Criteria

Sediment traps are designed in the same way as basins. The main difference is that traps are designed for drainage areas less than 5 acres whereas basins are for areas greater than 5 acres. The following planning criteria must be met.

1. The sediment trap should be located to obtain the maximum storage benefit from the terrain, for ease of cleanout of the trapped sediment, and to minimize interference with construction activities.

2. The surface area of a sediment trap is measured at the elevation of the crest of the outlet. The design capacity can be expressed in square feet of surface area per acre of drainage. A rule of thumb is that there should be 263 sq. ft. of sediment trap surface area for each acre of drainage to a trap with a minimum trap depth of 2 feet. For deeper traps accommodating more sediment storage, the surface area requirement shall not be decreased.

3. Sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to within one foot of the outlet elevation. Sediment removed from the trap shall be deposited in a suitable area and in such a manner that it will not erode.

4. All embankments for sediment traps shall not exceed 5 feet in height as measured at the low point of the original ground along the centerline of the embankment. The top width of the embankments shall be a minimum of 4 feet, and the side slopes shall be 2:1 or flatter. The embankment shall be compacted by traversing with equipment while it is being constructed. Equipment shall compact at least 90 percent of the surface area.

5. All excavation operations shall be carried out in such a manner that erosion and water pollution shall be minimal. Any excavated portion of the sediment trap shall have 2:1 or flatter slopes.

6. Outlets shall be designed, constructed and maintained in such a manner that settled sediment does not leave the trap and that erosion of the outlet does not occur. A trap may have several different outlets with each outlet conveying part of the flow.

7. If the sediment trap uses an earth outlet, the outlet width (feet) shall be equal to six times the drainage area (acres). If an embankment is used, the outlet crest shall be at least 1 foot below the top of the embankment. The outlet shall be free of any restriction to flow.

8. If the sediment trap uses a pipe outlet, the outlet pipe and riser shall be made of corrugated metal. The riser diameter shall be greater than or equal to the pipe diameter. The top of the embankment shall be at least 1-1/2 feet above the crest of the riser. At least the top two-thirds of the riser shall be perforated with 1/2-inch diameter holes spaced 8 inches vertically and 10 to 12 inches horizontally. All pipe connections shall be watertight. Pipe diameter shall be sufficient to convey flow from the design storm.

9. If the sediment trap uses a crushed stone outlet, the outlet will be over a level stone section. The stone outlet for a sediment trap differs from that for a stone outlet structure because of the intentional ponding of water in the trap. To provide for a ponding area, a relatively impervious core, such as timber, concrete block or straw bales is placed in the stone. The core shall be covered by 6 inches of stone. The minimum length (feet) of a stone outlet shall be equal to six times the drainage area (acres). The crest of the outlet, at the top of the stone, shall be at least 1 foot below the top of the embankment. The crushed stone used in the outlet shall meet AASHTO M43, Size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

10. If the sediment trap uses a storm drain inlet as its outlet, the storm drain and inlet should be placed so as not to interfere with construction activities.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a barrier or low-head dam. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainageways. The following steps must be followed during installation.

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

2. The fill material for the embankment shall be free of roots or other woody vegetation as well as oversized stones, rocks, organic material or other objectionable material. The embankment shall be compacted by traversing with equipment while it is being constructed.

3. Sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to within one foot of the outlet elevation. Removed sediment shall be deposited in a suitable area and in such a manner that it will not erode.

4. Construction operations shall be carried out in such a manner that erosion and water pollution are minimized.

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

6. All cut-and-fill slopes shall be 2:1 or flatter.

7. When a riser is used, all pipe joints shall be watertight.

8. When a riser is used, at least the top two-thirds of the riser shall be perforated with l/2-inch diameter holes spaced 8 inches vertically and lO to 12 inches horizontally.

9. When a pipe outlet is used, fill material around the pipe spillway shall be hand-compacted in 4-inch layers. A minimum of l.5 feet of hand compacted backfill shall be placed over the pipe spillway. At least 2 feet of backfill shall be placed if construction equipment will cross over the pipe spillway.

10. When an earth or stone outlet is used, outlet crest elevation shall be at least 1 foot below the top of the embankment. Pipe outlets shall be at least 1.5 feet below the top of the embankment.

11. When a crushed stone outlet is used, the crushed stone used in the outlet shall meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

Maintenance

Sediment traps must be inspected after each storm. Sediment must be removed each time the design capacity has been reduced by the trapped sediment. The ideal sediment trap should be designed to store one season's yield. However, most traps do not provide a season's storage capacity and periodic cleaning is required.

Effectiveness

When properly designed, constructed, and maintained, temporary sediment retention structures are very effective in removing a significant quantity of both fine and coarse textured sediment from storm runoff. Sediment traps are only effective in coarse sediment removal. The efficiency of sediment trapping is dependent upon the soil type. Fine textured soils, such as clays, do not settle out easily once they are suspended in water and thus, require large basins. Because of cost, space limitations on construction sites and in developed areas, it is usually not feasible to construct a structure with a 100 percent trapping efficiency. Thus, sediment retention structures are typically designed with a removal efficiency of 50 to 75 percent.

BMP 20 SEDIMENT BASIN

Definition

A sediment basin is a large engineered structure designed to treat runoff from drainage areas larger than 5 acres.

Purpose

To intercept large quantities of sediment-laden runoff generated during construction activities and to trap and retain the sediment in order to protect streams, drainageways, storm drains, properties, and right-of-way from sedimentation.

Applicability

Applicable to all construction or grading sites with a drainage area greater than 5 acres.

Advantages

1. If properly installed and maintained, sediment retention structures can prevent the discharge of degraded runoff water from construction sites.

2. Remove the bulk of coarse sediment from runoff before leaving the site.

3. Prevents sediment from reaching the public streets and storm drains.

4. Prevents sediment damage to adjacent property owners.

5. Sediment basins are larger than traps and more precisely designed, and as a result, are more effective in trapping the fine textured sediment.

6. Basins can provide flood control capacity.

Disadvantages

1. Basins are often not aesthetically pleasing, especially the muddy areas of trapped sediment exposed after storms.
2. Basins require limited access, especially when water is impounded.

3. Increases construction costs.

4. Removes sediment after erosion has occurred and does not treat the problem at the source. Sediment has to be disposed of.

Planning Criteria

If sediment basins are to be installed as part of a large project, they should be among the first structures constructed when grading begins. Basins can be very costly to construct and thus, the location should be considered during the planning phase. Basins should be placed away from construction traffic and in a place where they can remain until permanent BMPs are installed or the drainage area stabilized. Basins are generally located at or near the low point on a site so that it can intercept the sediment-laden runoff. The planning criteria should include the following:

State and local laws, ordinances, and regulations, drainage area; design capacity; cleanout frequency; embankment and/or excavation specifications; baffles to spread the flow; principal spillway; emergency spillway; outlet protection; compatibility with existing topography and scenic values; soil type, texture, and erodibility; and limited access for safety.

The precise design of a sediment basin requires a professional. The following criteria provide guidance for design purposes.

1. The sediment basin shall be located to obtain the maximum storage benefit from the terrain and for ease of cleanout of the trapped sediment. It shall be located to minimize interference with construction activities and construction of utilities.

2. The volume of the sediment basin shall consist of two portions: a sediment storage zone and a settling zone.

3. The sediment storage zone shall consist of sufficient volume to retain sediment expected to be captured by the basin between maintenance cleanouts. For a once-per-year cleaning, storage for an entire season's soil capture shall be provided. This volume is in addition to the settling zone volume of the basin.

4. The sediment settling zone shall always be kept free of sediment. Within it, particles of sediment settle to the storage zone. The sediment settling volume shall be based upon a minimum of 2-foot depth to the storage zone.

5. The surface area of the sediment basin shall be calculated at the height of the rim of the riser as follows:

   A (sq. ft.) = $\frac{\mathbf{K\,Q}\ \text{(cfs)}}{\mathbf{Vs}\ \text{(ft/sec.)}}$

   Where: **A** is the surface area of the sediment basin, in square feet;

   Q is the design overlow rate at the riser or spillway, in cubic feet per second;

   Vs is the settling velocity of the selected particle size, expressed in feet per second. (All soil particles greater than or equal to the selected particle size are to be retained in the basin.)

   K is an adjustment factor for nonideal settling basins, equal to 1.2.

6. The design overflow rate at the riser, **Q**, shall be calculated by the Rational Method, or other approved method, and shall be based upon a minimum rainfall intensity of the 20-year frequency, 1-hour duration rainfall total. Runoff computation shall be based upon the soil cover conditions expected to prevail in the contributing drainage area during the anticipated effective life of this sediment basin.

7. The settling velocity, Vs, which shall be for the 0.02-millimeter particle, is 0.00096 feet per second. (This particle size is recommended. The local jurisdiction may select another particle size based upon the efficiency desired.)

8. The basin configuration shall be such that the length is greater than or equal to the width.

Basins constructed with length-to-width ratios ranging from 1:1 to 9:1 shall have a baffle constructed anywhere from near the inlet to the basin to mid-way to the riser. This baffle can help divert the inflow evenly across the width of the basin.

9. The combined capacities of the riser or principal spillway and the emergency spillway shall be sufficient to pass the peak rate of runoff from the design storm.

10. Sediment basins shall be cleaned out when the storage volume is full. Unexpected high-intensity storms can frequently generate higher quantities of sediment than predicted. Therefore, sediment basins shall be inspected for cleanout after every major storm.

    This cleanout shall restore the sediment basin to its original design volume. The elevation corresponding to the maximum allowable sediment level shall be determined, shall be stated in the design data as a distance below the top of riser, and shall be clearly marked on the riser. In no case shall this sediment level be less than 2 feet below the top of the riser.

11. The principal spillway shall consist of a vertical pipe or box-type riser joined with a watertight connection to a pipe extending through the embankment and outlet beyond the downstream toe of the fill. The principal spillway shall meet the following specifications:

    a. The minimum capacity of the principal spillway shall be equal to the peak flow expected from the design storm. For those basins with no emergency spillway, the principal spillway shall have the capacity to handle the peakflow from a rainfall event commensurate with the degree of hazard involved. The minimum diameter of the pipe shall be 8 inches.

    b. When used in combination with an emergency spillway, the crest elevation of the riser shall be 1 foot below the elevation of the control section of the emergency spillway.

    c. The riser shall be completely watertight and shall not have any holes, leaks, rips or perforations, except for the inlet opening at the top and dewatering opening.

    d. Means for dewatering the settling zone shall be included in the sediment basin plans submitted for approval, and shall be installed during construction of the basin.

       Dewatering shall be done in such a manner as to remove the relatively clean water without removing any of the sediment that has settled out and without removing any appreciable quantities of floating debris. Usually the settling zone may be dewatered by making a hole in the riser unless otherwise required by the approving agency. This hole shall not be larger than 4 inches in diameter and the lower edge of the hole shall not be lower than the required sediment-cleanout elevation.

       The sediment itself will have a high water content, to the point of being "soupy". Dewatering the sediment is not required but does facilitate cleanout of the basin and provides a public safety factor. The only practical means of dewatering the sediment is by the use of an underdrain.

    e. A concentric anti-vortex device and trash rack shall be securely installed on top of the riser.

f. A base with sufficient weight to prevent flotation of the riser shall be attached to the rise with a watertight connection. Two approved bases for risers 10 feet or less in height are:

- concrete base 18 inches thick with the riser imbedded 6 inches in the base;

- 1/4-inch minimum thickness steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The plate shall have 2.5 feet of stone, gravel or tamped earth placed on it to prevent flotation.

In either case, each side of the square base shall be twice the riser diameter. For risers higher than 10 feet, computations shall be made to check flotation. The minimum safety factor shall be 1.25 (downward forces = 1.25 x upward forces).

g. Anti-seep collars shall be installed around the pipe conduit within the normal saturation zone to increase the seepage length at least 10 percent when any of the following conditions exist:

- the settled height of dam exceeds 10 feet;

- the embankment material has a low silt-clay content and the pipe diameter is lO inches of greater.

h. An outlet shall be provided, including a means of conveying the discharge in an erosion-free manner to an existing stable stream. Drainage easements shall be obtained is this discharge crosses the property line before reaching the stream. These easements shall be in writing, shall be referenced on the erosion and sediment control plan, and shall be submitted for review along with the erosion and sediment control plan. Protection against scour at the discharge end of the pipe spillway shall be provided. Measures may include impact basin, riprap, revetment, excavated plunge pools, or other approved methods.

12. The emergency spillway cross-section shall be trapezodial with minimum bottom width of 8 feet. Emergency spillways shall meet the following specifications:

(a) The minimum capacity of the emergency spillway shall be that required to pass the peak rate of runoff from a design storm, or one commensurate with the degree of hazard involved.

(b) Erosion protection shall be provided by vegetation or other suitable means such as riprap, asphalt or concrete.

(c) The velocity of flow in the exit channel shall not exceed 6 feet per second for vegetated channels. For channels with erosion protection other than vegetation, velocities shall be within the nonerosive range for the type of protection used.

(d) The free board shall be at least 1 foot. Freeboard is the difference between the design high-water elevation in the emergency spillway and the top of the settled embankment. If there is no emergency spillway, it is the difference between the water surface elevation required to pass the design flow through the pipe and the top of the settled embankment.

13. Embankment cross-sections shall be as follows:

    The minimum top width shall be 8 to l0 feet. The side slopes shall not be steeper than 2:1.

14. Points of entrance of surface runoff into excavated sediment basins shall be protected to prevent erosion. Dikes, swales, grade stabilization structures or other water control devices shall be installed as necessary to ensure direction of runoff and to protect points of entry into the basin. Points of entry should be located so as to ensure maximum travel distance of entering runoff to point of exit from the basin.

15. The sediment basin plans shall indicate the method(s) of disposing of the sediment removed from the basin. The sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the basin or in or adjacent to a stream or flood plain.

    The sediment basin plans shall also show the method of disposing of the sediment basin after the drainage area is stabilized, and shall include the stabilizing of the sediment basin site. Water lying over the trapped sediment shall be removed from the basin by pumping, cutting the top of the riser or other appropriate method prior to removing or breaching the embankment. Sediment shall not be allowed to flush into a stream or drainageway.

16. The appearance and design of these basins into the landscape can be greatly improved over existing practices. In time of non-storm events the basins can serve as open spaces in neighborhoods or in existing recreation areas. Terrace basin slopes whenever possible in order to minimize the safety hazard of straight, deep slopes. Terracing of side slopes also allows sediment basins to be integrated into other types of land uses such as trail systems, golf course hazards, or wetland systems. This may be an important consideration when siting a sediment basin.

    The design of basins needs to consider potential hazards to people who wander onto the site. Restricting access to sediment basins has often been accomplished by 6 foot high cyclone or chain link fence with little or no additional landscape screening. A more visually successful solution is to combine changes in grade with low (3-4 feet high) wooden fencing, and a substantial landscape screen of trees shrubs, and ground cover. Formal landscape plantings will give a more formal or urban appearance, while native or naturalized grasses and riparian species can give the appearance of a wet meadow or wetland marsh. All mechanical equipment should be screened from view of the road or the lake.

    The use of signs around sediment basins should be incorporated into the design. Signs should be of an interpretive nature as well as regulatory explaining in simple English the function and potential hazards of sediment basins. A well thought-out signage plan can stress the importance of avoiding sediment basins during and after storm events. A combination of grading, landscaping, controlling access and signage can turn a traditionally attractive nuisance and visual eyesore into a pleasing and usable community resource.

Installation

The following guidelines provide information which can be useful during installation:

1. Areas under the embankment and any structural works shall be cleared, grubbed and stripped of any vegetation and rootmat. In order to facilitate cleanout and restoration, the basin area shall be cleared also.

2. A cut-off trench shall be excavated along the centerline of earth-fill embankments. The minimum depth shall be 2 feet. The cut-off trench shall extend up both abutments to the riser crest elevation. The bottom width shall be wide enough to permit operation of excavation and compaction equipment and a minimum of 4 feet. The side slopes shall be no steeper than l:1. Compaction requirements shall be the same as those for the embankment. The trench shall be dewatered during the backfilling-compacting operations.

3. Fill material for the embankment shall be taken from approved borrow areas. It shall be clean material soil free of roots, woody vegetation, oversized stones, rocks or other objectionable material. Relatively pervious materials such as sand or gravel shall not be placed in the embankment. Areas on which fill is to be placed shall be scarified prior to placement of fill. The fill material shall contain sufficient moisture so that it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction. Fill material shall be placed in 6 to 8-inch thick continuous layers over the entire length of the fill. Compaction shall be obtained by routing the hauling equipment over the fill so that the entire surface of each layer of the fill is traversed by at least one wheel or tread track of the equipment, or by the use of a compactor. The embankment shall be constructed to an elevation 10 percent higher than the design height to allow for settlement if compaction is obtained with hauling equipment. If compactors are used for compaction, the overbuild may be reduced to not less than 5 percent.

4. The principal spillway riser shall be securely attached to the discharge pipe by welding all around and all connections shall be watertight. The pipe and riser shall be placed on a firm, smooth soil foundation. The connection between the riser and the riser base shall be watertight. Pervious materials such as sand, gravel, or crushed stone shall not be used a backfill around the pipe or anti-seep collars. The fill material around the pipe spillway shall be placed in 4-inch layers and compacted under the shoulders and around the pipe to at least the same density as the adjacent embankment. A minimum of 2 feet of hand-compacted backfill shall be placed over the pipe spillway before crossing it with construction equipment. Steel base plates shall have at least 2-1/2 feet of compacted earth, stone or gravel placed over them to prevent flotation.

5. Elevations, design width, and entrance and exit channel slopes are critical to the successful operation of the emergency spillway.

6. The exact design and placement of baffles depends on the shape of the basin and are largely at the discretion of the designer. The placement of a baffle near the inflow serves to dissipate energy at the basin inlet and to distribute water more evenly across the basin width. Baffles can reduce scour and turbulence in the basin.

7. The embankment and emergency spillway shall be stabilized with vegetation immediately following construction.

8. Construction operations shall be carried out in such a manner that erosion and water pollution will be minimized. State and local laws concerning pollution abatement shall be complied with.

9. State and local requirements shall be met concerning fencing and signs warning the public of hazards of soft sediment and floodwater.

10. Maintenance and repairs shall be carried out as follows:

    (a) All damages caused by soil erosion or construction equipment shall be repaired before the end of each working day.

    (b) Sediment shall be removed from the basin when it reaches the specified distance below the top of the riser. This sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment or in or adjacent to a stream or floodplain.

11. When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilized, the embankment and resulting sediment deposits shall be leveled or otherwise disposed of in accordance with the approved erosion and sediment control plan.

Maintenance

Sediment basins must be inspected after each storm. Sediment must be removed whenever it fills the storage zone of the basin. The ideal sediment basin should be designed to store one season's sediment yield. However when site conditions reduce the storage area and/or depth, the basin must be cleaned out periodically if it is to function as designed. Lack of maintenance is usually the reason why basins fail to trap sediment.

Effectiveness

When properly designed, constructed, and maintained, sediment retention structures are very effective in removing a significant quantity of both fine and coarse textured sediment from storm runoff. Sediment traps are only effective in coarse sediment removal. The efficiency of sediment trapping is dependent upon the soil type. Fine textured soils, such as clays, do not settle out easily once they are suspended in water and thus, require large basins. Because of cost, space limitations on construction sites and in developed areas, it is usually not feasible to construct a structure with a 100 percent trapping efficiency. Thus, sediment retention structures are typically designed with a removal efficiency of 50 to 75 percent.

BMP21 ROCK RIPRAP

Definition

Rock riprap is a layer of loose rock or aggregate placed over an erodible soil surface.

Purpose

To protect the soil surface and provide slope stabilization on oversteepened slopes.

Applicability

Applicable to cut or fill slopes which are greater than 3:1 and/or are difficult sites for revegetation practices. Rock riprap is often used on steepened slopes above low retaining walls. Although vegetation is the preferred practice above retaining walls, rock riprap can be used on difficult sites. Seed can be applied and/or shrubs and trees can be interplanted. Rock riprap's main applicability is in drainage stabilization projects, such as, channel and ditch linings and energy dissipators.

Advantages

1. If properly installed, rock riprap on slopes can prevent sediment from entering the storm drain system.

2. Effective practice on slopes with seepage and subsurface drainage problems.

3. Allows for seeding and/or interplanting.

Disadvantages

1. Some jurisdictions discourage the use of rock riprap adjacent to rights-of-way.

2. Provides a more sterile appearance than a revegetated site.

3. Riprap by itself provides no treatment of surface runoff water whereas vegetation can reduce nutrient concentrations.

4. May roll down slope if the toe is not stabilized.

5. May be sloughed over if the slope above **is not** stabilized.

6. High cost of hauling rock.

Planning Criteria

Rock riprap is the application of loose rock over a disturbed area on slopes greater than 3:1. Riprap is commonly used with grass seeding.

Installation

When rock riprap is the practice recommended for a difficult site, the following steps can be used for installation.

1. The riprap should be sound, dense, and durable rock with a specific gravity of not less than 2.5.

2. The rock shall range in size from 9 to 15 inches in size.

3. Seed can be broadcast before rock placement.

4. Rocks can be placed by hand or equipment on the slope.

5. Grading and clearing before placement of rock is not necessary. Rock should be placed by hand around any existing trees and shrubs.

6. Rocks shall be securely bedded in contact one to another. Larger rocks should be uniformly distributed and smaller rocks filling the voids.

7. A reasonable homogeneous layer of riprap shall be constructed.

Maintenance

If properly installed, rock riprap on slopes requires little maintenance. Check periodically to see if rocks have been dislodged and replace as needed.

Effectiveness

Rock riprap is effective in preventing soil erosion from oversteepened slopes. Riprap is most effective when used in combination with long-term vegetative practices. The high cost of hauling rock reduces the cost-effectiveness of this practice.

BMP 22 SLOPE SHAPING

Definition

Slope shaping consists of various modifications to cut or fill slopes to minimize the erosion potential of runoff originating on the slope. The modifications include terraces, benches, serrations, and steps.

Purpose

To reduce slope length on steep slopes, to reduce velocity of runoff, to increase the distance of overland flow, to increase infiltration, to collect sediment, and to provide the best possible environment for plant establishment.

Applicability

Applicable to large cut and fill slopes, primarily those resulting from highway construction. The practices work best on old or new cut slopes. The practices have limited applicability on decomposed granitic material because of the excessive sloughing off of material.

Advantages

1. Minimize the erosion potential of runoff originating on cut or fill slopes.
2. Provides more favorable sites for plant establishment on difficult areas.
3. Reduces runoff velocities and increase infiltration.

Disadvantages

1. Increase highway construction costs.
2. Limited success in decomposed granite material.
3. May require runoff discharge structures.

Planning Criteria

Slope shaping of cut or fill slopes should be conducted in order to reduce erosion potential and blend into the natural landscape. Maximum stability of these slopes is obtained when permanent vegetation is established. The chance for successful revegetation is greater on gentler slopes, 2:1 or flatter. If a slope is steeper than 3:1, stair-stepping it with terraces will help vegetation become established. Terraces also trap sediment eroding from the upslope areas. Terraces are applicable on steep cut slopes where the rock is soft, but not so soft that they collapse or fill up rapidly with sloughed off material.

Terraces can be large or small and are often referred to as benches, steps, or serrations.

Benches generally refer to very wide horizontal, level, or slightly reverse sloping steps. Benches are designed to be wide enough to accommodate the construction equipment in use and provide for ease of maintenance. They range from 10- to 20-feet wide.

Steps are usually horizontal and 2- to 4-feet. Steps are cut by a dozer as the excavation of the road proceeds downward.

Serrations are the smallest and are approximately 10 inches wide. A special attachment, the serrated wing blade, is used by the dozer or grader.

Maintenance

Terraces need to be inspected periodically for damage resulting from excessive surface runoff. If not repaired, rills and gullies can develop. Accumulated sediment on benches, especially slope bottom benches, must be removed when the quantity present could slough into the adjacent curb drainage and enter the storm drain system.

Effectiveness

Terraces are not effective in most soils of Mono County.

BMP 23 SUBSURFACE DRAIN

Definition

A system of drain tiles, pipes, or tubing installed beneath the ground surface to intercept and collect groundwater seepage exposed on cut slopes during construction or on other areas of groundwater seepage.

Purpose

To intercept groundwater seepage, to conduct intercepted water to a stable discharge, and to prevent sloughing or mass wasting of the slope due to seep areas.

Applicability

Applicable to all cuts or other excavations which intercept groundwater such that water seepage can cause erosion or slope failure.

Advantages

1. Prevent slope failures.

2. Collected water can be used off-site to aid plant establishment.

Disadvantages

1. Drains can become clogged and ineffective.

Planning Criteria

Seepage on cut slopes may be a major cause of slumping and gullying. Seepage also causes piping. The seepage usually results from the interception of groundwater strata. The water seepage coming out of the face of the slope may be reduced by vegetative techniques or intercepted by a properly designed drainage system. Many seepage areas can be controlled by willow wattling or planting phreatophytic vegetation (willows and alders). The resulting vegetation will partially dry the areas and promote stabilization. The presence of free-flowing water may indicate areas where vegetation alone will not stabilize the area, and other mechanical systems may be necessary.

There are two basic subsurface drain systems. Shallow seepage can be controlled using a trench system. Trench systems are designed for gentle slopes or areas which can be easily excavated to install the system. Horizontal drains are used to intercept and divert deep-seated drainage.

Horizontal drains are designed for steep slopes and areas which cannot be easily excavated. Horizontal drains also improve the mass stability of a slope by relieving pockets of hydrostatic pressure. The drains may be used in combination to intercept the groundwater from seep areas and then percolate it over a wider area rather than into a storm drain. The water percolated can be of value in aiding plant establishment or the survival of downslope vegetation which has been dependent on this water.

Installation

A. Horizontal Drains

1. Horizontal drains shall be installed in the permeable groundwater strata just above the interface with impermeable soil or rock layer.

2. Slotted or perforated pipe shall be used. The minimum is 2-inch diameter but 4-inch diameter if preferable.

3. The pipe is driven or jetted into the slope. The end of the pipe shall be pointed and closed to allow it to be driven into the slope.

4. Depth, spacing, and location of horizontal drains shall be based on local site conditions including depth of the groundwater strata.

5. Outlets of horizontal drains shall be to stable drainage conveyance systems, such as gutters, paved swales, or culverts.

B. Trench Drains

1. Design is similar to that of French drains or infiltration trenches except that they are usually located deeper in the ground. Typically these trenches can be 2-4 feet deep.

2. The simplest design is to backfill the trench with coarse aggregate.

3. Greater efficiency can be achieved by laying a 6-inch, perforated collector pipe in the trench and backfilling with a sand-gravel filter material.

4. The trench can also be lined with filter cloth if the trenches are located in fine subsoils. The filter cloth prevents fines from clogging the sand-gravel envelop around the pipe.

5. The discharge from a trench drain shall be to a stable drainage conveyance system.

Maintenance

If properly designed and installed, subsurface drains require little maintenance. If the drains become clogged, repair can be costly because they are underground.

Effectiveness

Subsurface drains can be very effective in dewatering seep areas. however, vegetative is more cost-effective if it can provide adequate control.

Figure 5 - BMP 21 Subsurface Drain-Well Point System

Figure 6 - BMP 21 Subsurface Drain - Trench System

BMP 23 DRY WELL

Definition

A dry well is a stone- or gravel-filled pit.

Purpose

To infiltrate and percolate runoff from impervious surfaces with no direct discharge to surface waters.

Applicability

Applicable to sites requiring additional storage capacity for runoff from impervious surfaces or as an alternative to infiltration trenches on steeper slopes. This practice is also applicable to buildings with roof gutters and downspouts.

Advantages

1. If properly installed and maintained, infiltration systems can prevent the discharge of runoff from impervious surfaces.

2. Reduces the peak loading of storm drain systems.

3. Increases the volume of infiltration to the groundwater.

4. Effective way to handle driveway runoff.

Disadvantages

1. Adequate infiltration capacity must be designed to determine proper size, or else excess discharge may cause erosion and flooding problems.

2. Organic sediments from leaf and needle fall may result in some loss of infiltration capacity.

3. Siltation of the structures can occur within five years and lead to failures if the structures are not replaced or rehabilitated.

4. By distributing the runoff directly into the subsoil horizon, the filtering effect of the top soil is lost.

5. Dry wells can transport groundwater to locations different than occurs naturally, thereby dewatering some areas or saturating others resulting in changes in the ecosystem.

6. Dry wells are ineffective in areas with a high groundwater table.

7. Dry wells do not provide any treatment of the runoff which the plant-soil complex can.

Planning Criteria

Dry wells are used to facilitate the percolation of runoff from impervious surfaces through the subsoil. Dry wells are used when rooftop runoff is conveyed through gutters and downspouts. A small, circular dry well is installed at each downspout. Several shallow dry wells work better than one large deep well. These dry wells can be dug using an auger with a standard size hole 18-inches in diameter and backfilled with stone or gravel.

Dry wells are also used in the design of infiltration systems on steeper slopes where infiltration trenches are ineffective and/or lack sufficient storage capacity. The runoff from the impervious surfaces is conveyed using rock-lined ditches or french drains to a dry well. These dry wells are usually larger in size and can be excavated using a backhoe.

Dry wells can also be used to infiltrate and percolate the runoff from large parking lots or other impervious surfaces where surface collection and detention systems cannot be accommodated due to space constraints. These dry wells have a larger storage capacity and must have a manhole for clean out. Generally, only paved areas should drain into these dry wells and they should either incorporate a sediment trap, grease trap, or replaceable sand filter.

The sizing of dry wells is dependent on the design storm, soil type, soil permeability, depth to groundwater and/or bedrock, and the area of impervious surface. The 20-year, one-hour event is the recommended design storm. Dry wells are not effective where there is a high water table or shallow soils. The bottom of the dry well must be at least 3.5 feet above bedrock and 1 foot above the seasonal high water table. The dry well shall penetrate at least 3 feet below the expected minimum depth of soil freezing. The ratio of bottom area to side area should not exceed 1:2. Thus, excavated pits or trenches provide more bottom surface area than deep augured holes. The final design of dry wells and other infiltration structures should be completed by a qualified professional.

Installation

1. Excavate or auger a pit of the required size. Several shallow wells will percolate a given amount of water more efficiently than a deeper well.

2. Backfill the dry well with stone or gravel (1- to 3-inch).

3. For best results and easier maintenance, backfill to within 6 inches of the top and place a layer of filter cloth over the stone or gravel. Top off with a layer of clean sand or 3/4 inch gravel.

4. Dry wells located in parking lots must be equipped with oil and grease traps and an easily accessible cleanout for removing sediment and trash.

Maintenance

Infiltration trenches require constant maintenance in order to be effective. Accumulated debris must be cleaned off periodically. The rock or gravel fill shall be removed and reworked in order to remove accumulated sediments. The removed rock fill can be washed and reused or replaced with new rock. The use of the filter cloth reduces the maintenance costs.

Effectiveness

Dry wells are only effective if they are properly installed, maintained, and in accordance with the design criteria. Dry wells are effective where surface collection and detention systems cannot be accommodated due to space constraints. Dry wells are effective only if they remain unclogged. The use of filter cloth is very cost effective to prevent clogging by soil particles because of the high cost to remove, rework, or replace the gravel.

Figure 7 - BMP 22 - Dry Wells

BMP 24 FRENCH DRAIN

Definition

A french drain is a trench containing a perforated drainage pipe surrounded by gravel and located at the dripline of roofs or adjacent to other impervious surfaces, such as, driveways and parking areas.

Purpose

To infiltrate, percolate, and collect runoff from impervious surfaces and to convey the excess to other infiltration structures.

Applicability

Applicable to steep slopes where the storage capacity of infiltration trenches is limited. The french drain allows for infiltration and some percolation from the trench; however, the perforated pipe drains the trench and conveys the excess to an infiltration trench or dry well. The french drain can also be used to percolate roof runoff collected by a gutter and downspout system.

Advantages

1. If properly installed and maintained, infiltration systems can prevent the discharge of runoff from impervious surfaces.

2. Reduces the peak loading of storm drain systems.

3. Increases the volume of infiltration to the groundwater.

4. Conveys the rooftop runoff away from the foundation and prevents water from seeping under the foundation.

Disadvantages

1. Adequate infiltration capacity must be designed to determine proper size, or else excess discharge may cause erosion and flooding problems.

2. Organic sediments from leaf and needle fall may result in some loss of infiltration capacity.
3. Siltation of the structures can occur within five years and lead to failures if the structures are not replaced or rehabilitated.

4. By distributing the runoff directly into the subsoil horizon, the filtering effect of the top soil is lost.

5. French drains can transport groundwater to locations different than occurs naturally, thereby dewatering some areas or saturating others resulting in changes in the ecosystem.

6. French drains are ineffective in areas with a high groundwater table.

7. French drains do not provide any treatment of the runoff which the plant-soil complex can.

Planning Criteria

Where a roof dripline or driveway exceeds 15 percent slope, a french drain or rocklined ditch can be used to convey the runoff to dry wells located in more level areas or lateral infiltration trenches located along the contours. French drains provide for some percolation, but their main function is to convey water to other infiltration structures. French drains are also alternative to infiltration trenches in areas with shallow soils or high water tables. When used in place of infiltration trenches, these structures must be used in combination with dry wells or other infiltration structures so that there is no direct discharge to surface waters. The final design of dry wells as part of an infiltration system should be completed by a qualified professional.

Installation

1. Excavate a trench at least 10 inches deep and 10 inches wide.
2. Add a two inch layer of small gravel (1/2- to 3/4-inch).
3. Place 4-inch perforated pipe in trench.
4. Backfill trench with gravel.
5. The trench can also be lined with filter cloth in order to reduce maintenance, especially when the trench is underground.

Maintenance

French drains require maintenance in order to be effective. Accumulated debris must be cleaned off periodically. The gravel must be removed, reworked, or replaced in order to remove accumulated sediments. The presence of the drainage pipe makes maintenance more difficult. The use of filter cloth reduces the maintenance costs.

Effectiveness

French drains are only effective if they are properly installed, maintained, and in accordance with the design criteria. These structures are effective only if they remain unclogged. The use of filter cloth is very cost effective to prevent clogging because of the high cost to rehabilitate the gravel.